The epidemiology of demand for and outcomes of contacts with telephone based healathcare with particular reference to ward deprivation scores: Analysis of calls to NHS Direct Wales 2002-2004.

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The epidemiology of demand for and outcomes of contacts with telephone based healthcare with particular reference to ward deprivation scores: Analysis of calls to NHS Direct Wales 2002-2004

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Summary

NHS Direct Wales (NHSDW) is a nurse-led 24-hour health advice and information line. This study estimated the effect of deprivation on the demand for, and outcome of, direct calls to NHSDW after controlling for potentially confounding factors.

The author analysed anonymous data from NHSDW on 410,000 calls over 2.5 years, including patient characteristics (age, gender, relationship to caller, ward of residence) and call characteristics (whether for triage or information, day of call). To each call she added ward data including: the corresponding Welsh Index of Multiple Deprivation score; population density; and distance from nearest Emergency Department (ED). She used multiple linear regression to model the relationship between deprivation and demand and binary logistic regression to model the relationship between deprivation and outcome.

Confounding variables explained 33.0% of variation in advice call rates; and 27.5% of that in information call rates (both significant at 0.1% level). Deprivation was not a statistically significant predictor of these rates (significance levels 0.158 and 0.244 respectively). Deprivation had more effect on outcomes: an increase in deprivation from one fifth to the next fifth increased by 13% the probability of receiving advice to call 999 emergency care within triage calls [Odds ratio (OR) 1.127; 95% confidence interval (CI) from 1.113 to 1.143]; and that of receiving advice to seek care face to face rather than self care by 5% (OR 1.049; CI from 1.041 to 1.058) for triage calls and by 3% (OR 1.034; CI from 1.022 to 1.047) for information calls.

In short, deprivation had no detectable effect on demand for calls, but a positive effect on the outcome of the call. While it is possible that the data underestimated the 'need' of deprived patients for healthcare, they yield no evidence that NHSDW should seek to improve access from those patients.

Declarations and Statements

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed ... .(candidate)

Date ....06.06.2014..........................

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Other sources are fully acknowledged and a reference list is appended.

Signed ....

Date ....06.06.2014..........................

STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loans and for the title and summary to be made available to outside organisations.

Signed ....

Date ....06.06.2014..........................

Preface

The National Health Service (NHS) is the organisation responsible for health and well being in the United Kingdom (UK). The service has recently undergone many changes to bring it up to date with the modern world, to tackle health inequalities and to facilitate equal use of healthcare across different members of the population. One such innovation is the introduction of telenursing, the provision of nursing services through means other than face-to-face contact. One form of this is NHS Direct (NHSD) in England and its counterparts in Wales (NHSDW) and in Scotland (NHS 24). The services are nurse-led, 24 hour confidential health advice and information telephone lines. Generally, these services aim to provide 'easier and faster advice and information to people about health, illness and the NHS, so that they are better able to care for themselves and their families'. [1]

Shortly after the introduction of NHSD in Wales (NHSDW), Swansea NHS Trust on behalf of the Welsh Assembly Government (now called the Welsh Government) commissioned a 3 year evaluation of the effectiveness of the service across clinical, professional and operational dimensions. The evaluation was led from Swansea University and I was appointed as research officer onto this project in 2003. Shortly after the project started, concerns were raised in England that NHSD was not reaching all of the population equally, in particular, those who could potentially benefit the most from a confidential service within their own homes – the very elderly, those from ethnic minorities and those from areas of high deprivation – were under represented in use of the service. In evidence arising from the NHSDW Evaluation Project, it also became apparent that these concerns were echoed in Wales, with nurses outside NHSDW in particular expressing questions over issues of access (Snooks et al. 2008) [Appendix 16].

At this time, Professor Snooks and a multidisciplinary team prepared a bid for external funding looking at access issues. Although this bid was not funded, I was able to use some of the ideas presented within it for the basis of this thesis. In particular, the concept of linking caller postcodes to deprivation scores and exploring the variation in call rates by deprivation across Wales came directly from this bid. I am very grateful to Professor Snooks and the team for letting me take this idea forward.

Further, I was interested in whether not only access to NHSDW was influenced by deprivation but whether outcomes of contacts, the advice given by the nurse, were also influenced by where a patient lived. I therefore developed this concept further as part of this thesis.

Thus, to explore issues of how deprivation is related to access and outcomes, following ethical and Caldecott approval, I collected two and a half years of call data originating across Wales to NHSDW (January 2002 – June 2004). I chose epidemiology, the study of health and illness in human populations, as a methodological basis for the study and employed multiple linear and binary logistic regression techniques to explore the relationship between patient deprivation status and the demand for, and outcomes of contacts with, NHSDW. This is reflected in the research question:

How does deprivation, affect the demand for, and the outcome of direct calls to, NHSDW after controlling for other factors?

The thesis that resulted from this contains 8 chapters.

Chapter 1 Introduction – this chapter sets the scene for the research. The NHS in Britain is introduced and NHSD services are explained in full including their background, methods of operation and key research findings arising from service evaluations. Concepts that are fundamental to this study including health inequalities, access to healthcare and deprivation are summarised. The chapter concludes with a brief discussion concerning the introduction and operation of NHSD and the resulting implications for policy, research and practice.

Chapter 2 Literature review – this chapter presents the results of the systematic review which explored the association between patient deprivation or socioeconomic status and a) demand for, and b) outcomes of contacts with telephone based unscheduled healthcare. It is structured according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al. 2009). Here, the relevant studies are summarised, critically appraised and gaps in the current literature are identified. The chapter concludes with a summary of the strengths and limitations of the review.

Chapter 3 Research aim, question and objectives – this brief chapter takes the knowledge gained from the previous two chapters summarising recent developments in the NHS and the evidence gap to set out the research question, aims and objectives for this study.

Chapter 4 Methods – this chapter is structured according to the STROBE statement (STrengthening the Reporting of OBservational studies in Epidemiology) and details the methods used in this study, including the study design, the study population, the data sources, the data themselves (including approval and ethical considerations, data collection and cleaning) and the study analysis plan.

Chapter 5 Results of Objective 1 – this chapter presents the results of Objective 1: to identify the factors associated with the demand and outcome of calls to NHSDW in order to build a model to explore the association between deprivation, demand and outcome of calls.

Chapter 6 Results of Objective 2 – this chapter presents the results of Objective 2: to model the relationship between deprivation and demand, controlling for other variables which affect demand.

Chapter 7 Results of Objective 3 – this chapter presents the results of Objective 3: to model the relationship between deprivation and call outcome, controlling for other variables which affect outcome.

Chapter 8 Discussion – this chapter summarises the key study findings and considers them in the light of the relevant literature. Strengths and limitations are highlighted and key implications of the findings are explored in terms of their impact on policy, service providers, education and research. This chapter completes the study by considering the study findings and implications and forming recommendations. It also suggests areas for future research.

The study then concludes with the references, appendices and glossary of key terms.

I submitted my thesis May 31, 2012. However, there were several delays in securing external examiners which meant that my oral exam (viva) did not occur until February 27, 2013 – nine months after my submission date. As a result, during this time period, I became aware of areas in which the thesis could be improved and undertook some additional analysis including an updated literature search and additional analysis in Chapters 5 and 6. I tabled the majority of this work in the oral examination.

After the viva, I received valuable feedback from my examiners, Professors Robin Prescott and Sarah Purdy. These two events (the further research I did between submission and viva; and the resulting feedback following the viva), have made my thesis stronger. In Table 1 below, I have provided a brief summary of these major changes and when they occurred, labelled thus:

a) Original thesis: this is work that I completed before submission
b) Preparation for viva: these are revisions that I completed to further improve the thesis while waiting for my oral examination
c) Preparation for resubmission: these revisions incorporate the examiners' suggestions and occurred following the viva.

Table 1: Summary of major changes between original thesis (a); preparation for oral (b); and resubmission (c)

Change	**Chapter(s)**	**Time**
Further 4 studies meeting inclusion criteria found	2	Preparation for oral (b)
Day of week incorporated as an additional variable in analysis	4-7	Resubmission (c)
Calculation of ward level variables to replace individual level variables	4-6	Preparation for oral (b)
Taking logarithm of call rates for analysis to improve normality	4-6	Preparation for oral (b)
Inclusion of Census 2001 demographic variables in analysis	4-6	Resubmission (c)
Enter method used for linear and logistic regression	4-7	Resubmission (c)
Creation of two dummy variable for ethnicity	7	Resubmission (c)
Deprivation fifth used in logistic regression	7	Resubmission (c)
Discussion of the impact of the above changes	8	Resubmission (c)

In order to present a coherent story of the thesis progression including my revisions I have now added to the eight chapters outlined above. In each chapter, I have labelled the narrative as one of three areas of research using (a), (b) or (c) as outlined above. Additionally, after each section heading in a chapter I have put one of these letters. So for example, in Chapter 1 there were no changes so I have labelled each heading with an (a). While in Chapter 2: the Literature Review, when I reran my literature search between submission and viva, I found four new studies which had recently been published. Therefore I have labelled the summary of these studies with a (b) as they were found between submission and viva. In many cases, revisions from (b) and (c) build on the original thesis in section (a) resulting in a natural sequence of events. However, in some cases, the revisions in (b) and (c) actually precede work done in the original thesis. For example, one piece of feedback to come from the oral was the incorporation of an additional variable (day of week) in the regression analyses. I have therefore described how I prepared this variable for data analysis with a subheading (c) in Chapter 4: Methods. Chapters 1 and 3 were the only chapters which did not change between the original submission and resubmission.

To make the sequence of events clearer, I have also written a brief summary of the 'evolution' of each chapter in the chapter overviews at the beginning of each chapter. Using these methods, I have tried to draw attention to the improvements in the thesis in such a way that the narrative is not interrupted and that the reader is presented with a cohesive story.

Between my viva and my resubmission I also drafted two papers based on my results and submitted these to the BMJ for consideration. These papers are entitled:

1. Does deprivation affect the demand for NHS Direct in Wales? Study of routine data.

2. Advice given by NHS Direct in Wales: do deprived patients get more urgent decisions? Study of routine data.

I have included these as Appendix 18 and 19. The only other changes to the Appendices are the revised analyses in Appendix 10 and the revised table in Appendix 15, showing the 30 wards with the highest and lowest residuals.

Acknowledgements

There are many people who have played a role in the development of this thesis and who have supported me both personally and professionally during the course of this work.

I owe a sincere thank you to both my supervisors, Professor Helen Snooks and Professor Ian Russell, who have been invaluable throughout the course of this study. Their guidance and support have greatly shaped and improved the development of this work and the arguments presented within. Dr Wai-Yee Cheung also provided insight and expertise early on in this study.

My thanks go as well to Dr Alan Watkins who provided me with much needed support in statistical analysis and who was always patient in his explanations. Dr Sarah Rodgers provided all the geographical expertise and Dr Steven Macey provided mapping advice, proofreading and the essential technical help of merging so many data items. All three provided support and encouragement and were always optimistic.

Several members of the Health Services Research Team in the College of Medicine have not only offered administrative and research support over the years but encouragement as well. I feel very lucky to have been a part of such a good group of people! In particular, I'd like to say a special thank you to Bridie Angela Evans for all her support, for independently screening citations for the literature review and for our Tuesday night sessions. And thank you to Claire Evans for her final push at the end!

I'd like to thank NHS Direct Wales for providing me with the data to enable this study to happen and to Huw Brunt from Public Health Wales for his advice and guidance on air quality.

Above all, I am grateful to all my family and friends who have supported me over the long haul, My Mom and Dad, Margaret and Steve, and sister, Lindsey, and my Parents-in-law, Alan and Diana. And to Tom, Timmy and Solomon, thank you for your understanding and your patience especially during the final stages of write up. I really do feel like this study has been a joint effort and I am so grateful to you all.

Please note, the author has used the coding system of a,b,c to represent when the section was completed: a) original thesis: work which was done before submission; b) preparation for viva: revisions which were completed to further improve the thesis while waiting for the oral examination and c) preparation for resubmission: these revisions incorporate the examiners' suggestions and occurred following the viva.

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Please note that all appendices are unchanged from the original submission (a) except: Appendices 10 (Additional analysis from Chapter 5) and 15 (Summary of residuals by ward), which were revised between original submission and viva (b); and the two new papers in Appendices 18 and 19 (c). The author has ordered Appendices in this way to make the papers easily locatable.

List of Abbreviations

ANOVA	One-way analysis of variances statistical test
CAS	Clinical advice system
CCDS	Computerised clinical decision support
CI	Confidence interval
CSDH	Global Commission on Social Determinants of Health
DH	Department of Health
DECS	Delivering emergency care services
ED	Emergency Department
Ediv	Electoral division
GIS	Geographical information systems
GP	General Practitioner
HIRU	Health Information Research Unit
HRP	Household reference person
ICD-10	International Classification of Diseases, 10th revision,
ICPC-2	International Classification of Primary Care-2
IMD	Index of Multiple Deprivation
IRR	Incidence rate ratio
KM	Kilometres
LREC	Local Ethics Committee
MIU	Minor injury unit
MREC	Multi-centre research ethics committee
NHS	National Health Service
NHSD	National Health Service Direct
NHSDW	National Health Service Direct Wales
NHS 24	National Health Service 24
NRES	National Research Ethics Service
ONS	Office for National Statistics
OOH	Out-of-hours
OR	Odds ratio
PCC	Primary care centre
PhD	Degree of Doctor of Philosophy
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
RCT	Randomised controlled trial
SAIL	Secure anonymised information linkage
SD	Standard deviation
SIGN	Scottish Intercollegiate Guidelines Network
SNOMED	Systematised Nomenclature of Medicine Clinical Terms
STROBE	Strengthening the reporting of observational studies in epidemiology
SOAs	Super output areas
SPSS	Statistical Package for the Social Sciences
UA	Unitary authority
UK	United Kingdom
US	United States of America
WAG	Welsh Assembly Government
WIMD	Welsh index of multiple deprivation

Chapter 1: Introduction

1.1 Overview (a)

This chapter builds on previous work written by this author (Peconi et al. 2011) for a chapter in a book focusing on Telenursing (Appendix 17). It provides a brief introduction to the National Health Service (NHS) and the history of the NHS Direct services including a profile of current methods of operation. Key points from the major service evaluations are highlighted including issues of public use and the resulting shift in the role of nursing. Variations in outcomes and issues of access to the service are highlighted and inequalities in health and ways of measuring access to healthcare overviewed. The chapter concludes with discussion of some of the important issues regarding NHSD, including the demand for, and outcomes of, contacts with the service, which form the basis for this study. Despite correcting a few typographical errors, the author has not changed the content of this chapter since the original submission; thus all headings are marked by an (a).

1.2 Background (a)

The responsibility for health and wellbeing in the United Kingdom (UK) falls to the NHS. The NHS was established in 1948 to promote "the establishment of a comprehensive health service designed to secure improvement in the physical and mental health of the people of England and Wales and the prevention, diagnosis and treatment of illness" (The National Health Services Act 1946). The service varies from healthcare provision in other western countries in that responsibility falls to the government in power (Rivet 1998). As a result of changes in political administration and alongside changes in health, an ageing population, and advances in technology, over the past sixty years the NHS has experienced many adaptations, not only in the manner of delivery of healthcare services but in the structure and organisation of these services.

In particular, the NHS has recently undergone a series of changes in an attempt to bring the service up to date with economic, technological, medical and social conditions. The explicit aim is to modernise the NHS to meet public expectations (Department of Health 2000). This includes an increased emphasis on the provision of care in the community, self care and prevention, with a parallel shift in the role of the general practitioner (GP). Indeed, policy documents are moving on from trying to change individual behaviour to attempting to address patients' concerns more appropriately through new forms of service provision (Gulliford et al. 2001). There is now a renewed commitment to shared decision making, patient choice of provider and personalised care for every patient, regardless of their background (Department of Health 2007).

In England in the emergency care context, modernisation is also taking place with the 2001 Reforming Emergency Care policy document complementing the wider NHS modernisation agenda (Nicholl 2001). This policy document stresses that services should be designed from the point of view of the user (Department of Health 2001). More currently, the government has announced a shift away from performance targets with no clinical justification (British Government White Paper 2010). For emergency care, this means a better joined up service between all providers and indicators that will look at how well the system is working together.

In Wales, the most recent health policy document to be released by the Welsh Assembly Government (now called the Welsh Government) is Designed for Life, the 10-year strategy for health and social care. This document increases the emphasis on prevention. It includes measures aiming to reduce inequalities in health across Wales and to help improve access to all elements of health and social care (Welsh Assembly Government May 2005). Similarly, the Delivering Emergency Care Services (DECS) strategy, delivered in the context of Designed for Life, aims to ensure that the population better understands the range of unscheduled care services available and how best to access these (Welsh Assembly Government 2008).

Four of the main themes of recent NHS improvements, new forms of service provision, joined up working between services, equal access to healthcare and clarity in terms of which service to contact first, can potentially be addressed by telenursing, the provision of nursing services through means other than face-to-face contact. Telenursing, as a relatively new form of service provision, may be well positioned to allow the shift to provision of care in the community while acting as a gateway to the multilayered NHS. One aspect of telenursing in the UK comes through the medium of 24-hour nurse-led telephone helplines: NHS Direct (NHSD) in England, NHS Direct Wales (NHSDW) and NHS 24 in Scotland. These services provide health information and advice, often in emergencies, and signpost callers to services if needed, for the cost of a local phone call.

More recently an additional, free of charge number, 111, has been introduced in England although this number is not nurse-led and therefore doesn't fall under the umbrella of telenursing. This service however is similar to NHSD in that it has been put in place to guide and direct callers to the most appropriate NHS service to meet their non emergency health needs.

1.3 Introducing NHSD, NHSDW, NHS 24 and 111 (a)

Equity of access has always been one of the fundamental aims of the NHS and access to healthcare remains high on research and policy agendas. Indeed, improving access to health services for those who are disadvantaged is recognised as a prerequisite for improving the health of the population. Thus, in September 1997, the Chief Medical Officer for England's 'Developing Emergency Services in the Community', recommended improving access to the NHS by the provision of emergency help and advice through a telephone helpline (Calman 1997).

Shortly afterwards, the English Government published a White Paper, The New NHS: Modern, Dependable, which highlighted fair access as an important dimension of the new NHS framework: "The NHS contribution must begin by offering fair access to health services in relation to people's needs, irrespective of geography, class, ethnicity, age or sex" (British Government White Paper 1997). In this paper a 24-hour nurse-led telephone healthcare advice and information line - NHSD - was introduced in England. The service was followed quickly by similar services in Wales and Scotland. The aim of NHSD was to provide 'easier and faster advice and information to people about health, illness and the NHS, so that they are better able to care for themselves and their families' (Department of Health 1997). The service, which aims to be accessible to all was to empower patients while acting as a 24-hour signpost to the multi-layered NHS, by directing callers to the most appropriate level of care. The specific objectives for the new service, set out by the Department of Health (DH), the government department responsible for public health issues, included (Munro et al. 2003):

- "To offer the public a confidential, reliable and consistent source of professional advice on healthcare, 24 hours a day, so that they can manage many of their problems at home or know where to turn to for appropriate care;

- To provide simple and speedy access to a comprehensive and up to date range of health and related information;
- To help improve quality, increase cost-effectiveness and reduce unnecessary demands on other NHS services by providing a more appropriate response to the needs of the public;
- To allow professionals to develop their role in enabling patients to be partners in self care, and help them to focus on those patients for whom their skills are most needed.

NHSD was launched in 1998 with three pilot sites. The service rapidly expanded, and the scheme became nationwide in November 2000, with 22 call centres established across the country. The service is the world's first national nurse telephone clinical assessment service (Sadler and Challiner 2008). In December 1999, NHSD Online was introduced, a website where information about clinical conditions and healthcare guidance can be accessed free of charge. Information kiosks and digital television have now also been added.

In Wales, several policy documents (Williams et al. 1998; Gregory and Kennedy 1999) gave a commitment to await research findings from the pilot sites in England before implementing a national health helpline, although in practice comprehensive evidence about costs and impact were not produced before the service was expanded to cover both the whole of England and Wales (McDonnell, et al. 2006). In 1999, the Secretary of State announced the introduction of NHS Direct Wales (NHSDW). The service was to be commissioned by the Specialised Health Services Commission for Wales based in Swansea NHS Trust. It was operational in April 2000 in two areas, with the rest of Wales receiving service by December of the same year. The announced aims of NHSDW were similar to NHSD: 'to help callers by providing the right advice, information and reassurance they require to look after themselves, if appropriate'. It was also designed to ensure that callers who need further care are directed to the right service at the right time (Parker 2001). Although separate services, NHSDW was given the same telephone number as NHSD in England for ease of use by the public.

In Scotland, the service is named NHS 24 and introduction followed a similar pattern to both that in England and Wales. In March 1999, an initial announcement was made by the Secretary of State for the country that an investment was to be made in primary care to pilot the expansion of existing GP out-of-hours services to include 24-hour access to nurse-led health advice. In December 2000, the service was officially named NHS 24 and was rolled out in pilot areas during 2001. However, while the new service in Scotland was to be similar to NHSD in England, in that nurse triage was to play a key role, there was a stronger focus on integration with existing services, including GP out-of-hours, ambulance and pharmacists (Clarke et al. 2005).

Despite these new services in England, a 2006 consultation with the general public revealed confusion over the most appropriate service to access for urgent problems and the need for an easily memorable telephone number to facilitate access to the multilayered NHS (Department of Health 2008). Following this, the DH introduced the NHS 111 service in four pilot sites across the country. In the same way as NHSD, callers can access this service and be guided to a locally available healthcare service or provided with appropriate advice and information. Although evaluations are still ongoing, the NHS '111' will now be rolled out nationwide (Turner et al. 2011). The service aims to be as equally accessible as a 999 emergency call to the ambulance service and hopes to reduce calls to NHSD since it is a free service, with no call backs. In the short term, 111 will provide an additional choice to NHSD in how patients access care in non emergency situations. However, longer term, 111 could become the single number to access non- emergency care although, NHSD plans to compete for future 111 business (NHS Direct 2011). In Wales and in Scotland, NHSDW and NHS 24, respectively remain as intended.

As 111 is still a new service, much of the evaluation work has yet to be published. Therefore this chapter focuses solely on the NHSD services. Although these services (NHSD, NHSDW and NHS 24) are separate in practice, this chapter for simplicity uses the term 'NHSD' to refer to all three, as they are so similar in objectives and organisation. Future chapters use 'NHSDW', as data relate specifically to this service.

1.4 How NHSD works in practice (a)

At the time of writing, NHSD in England has 36 call centres across the country with over 3000 employees- 1200 of whom are nurses. In Wales, there are 3 call centre sites, with approximately 100 nurses employed. All services operate from call centres, in which employees work independently answering continuous calls from the public. Nurses use clinical decision support software (CDSS), a software package that supports the user in assessing and advising others, to handle calls to NHSD. After an introductory period in which different software systems were used in England, all services in England and Wales now use the NHS Clinical Assessment System (NHS CAS) to handle calls. At the time of writing, the CAS system contained over 200 algorithms that consist of a series of questions relating to the caller's problem. There is the option for nurses to discuss calls with colleagues from other specialties although all calls are timed and recorded. As calls may be stressful, staff are given the opportunity to debrief following a shift.

1.4.1 The call handler (a)

When a call is made to NHSD in most sites, the first person the caller will speak to is the call handler. The call handler, who does not necessarily have a medical background, starts a call record by taking important call information according to a predefined 'script'. Following the strict protocol allows the call handler to record all necessary information and perform the initial triage. See Box 1.1.

Box 1.1: Call Handler Protocol (source: email to author from NHSDW data analyst dated 17.02.2005)

1. There is a salutation at the beginning of the call – e.g "Good morning/afternoon/evening, you're through to one of the call handlers, can I take the telephone number of where you're calling from?"
2. The call handler then asks: "Is the call about yourself or somebody else?" *[If the call is about themselves then the call handler asks for the postal code and house number/name of where they are calling from. If the call is for someone else then the call handler determines whether they are with the third party - if so then the third party details would be taken].*
3. The call handler asks for the patient's date of birth and the reason for the call.
4. From here, protocols within the CAS system take over and questions concern caller's present symptoms which would then prioritise the call.
5. The call handler asks for the patient ethnic group ie: white British, white Irish white/black Caribbean, Asian etc. *[this is a tick box]*
6. The call handler then asks the caller if they have rung NHSDW before and either set up new record if they have not rung previously or locate their old record if they have.
7. They would ask the caller to confirm the first line of their address and ask the caller to repeat their telephone number.
8. The call handler would then ask data transfer consent and if in the future NHSDW were to conduct a telephone survey about the service that they have received would they be willing to participate.

The call handler will then direct the call to the most appropriate person - a nurse or health information advisor, depending on the nature of the query. If the condition of the caller or patient is not urgent, the call may then be put in a queue and the caller called back when the next appropriate person is available. By contrast, if the call handler deems the situation to be an emergency, she or he can call an ambulance immediately. Appendix 1 is a flow chart illustrating the path of a call to NHSDW.

1.4.2 Health information referral (a)

Health information advisors deal with enquiries about local services and requests for information about conditions, treatments and procedures. In NHSD, approximately 13% of calls are handled by health information advisors who may or may not be nurses (many come from the social care environment). Health information advisors also offer information on the prevention of ill health, such as referrals to local smoking cessation schemes. Information is supplied to the caller by phone, post or via the internet.

1.4.3 The nurse advisor (a)

Once in contact with the caller it is up to the individual nurse's clinical judgement to select the most appropriate algorithm to use based on the symptoms of the caller. He/she then works through the algorithm asking the caller the questions that appear based on the previous answer until a triage decision or disposition is reached. The system is flexible in that the nurse has the power to over-ride the triage decision at the end of the call, changing the course or place of treatment and or the urgency of the recommendations. However, she or he must note the reasons for doing so.

NHSD nurse advisors come from a variety of backgrounds including midwifery, health visiting, paediatrics, accident and emergency, and community nursing. Nurse advisors do not make diagnoses but triage callers or patients, using the CAS computerised decision support software (CAS Services Limited 2004). At the start of the telephone conversation, from the caller's responses to initial questions, the nurse advisor decides which algorithm, or branch of the system to follow leading the caller through a series of questions. This conversation results in advice to treat the problem at home or, if further healthcare is required, where and when to go for that care. This call outcome is termed the 'disposition' and will be the term used in this thesis to describe the outcome of the NHSD contact. At any stage in the conversation the nurse can override the system's recommended course of action, but should document his or her reasons for doing so.

1.4.4 Telephone interpreting service (a)

In Wales, callers to NHSDW may either speak in English or use the Welsh Language Line to conduct their conversation in Welsh. For those callers who first language is not English or Welsh, NHSDW has immediate access to a telephone translation service, Language Line. This confidential telephone interpreting service is available in over 120 languages and is also available 24 hours, 365 days a year. To use this service, callers must be able to state, in English, the language that they wish to use.

1.5 Research Evidence concerning NHSD (a)

Each of the 3 services (NHSD, NHSDW, NHS 24) has undergone independent evaluations, with some consistent results across services (Munro et al. 2001; Munro et al. 2003; Clarke et al. 2005; Snooks et al. 2006). Although these evaluations have shown that the services are generally well liked by the public, each also indicates that the speed of expansion has left many issues still to be explored. For example, in Scotland, an independent evaluation concluded the service's actual role had changed significantly compared with its intended role and many processes and procedures had not withstood the pressures of operation (Clarke et al. 2005). Key areas highlighted by the research evidence include: the role of nursing in NHSD; service use (including call volume and patterns, impact on the demand for other services, clinical and cost effectiveness, user satisfaction); factors affecting dispositions (the advice given) and issues of demand.

1.5.1 The role of nursing in NHSD (a)

The introduction of NHSD was seen by some as a new career option for nurses and the service has provided employment for those with disabilities who otherwise may have had to leave the profession (Morrell et al. 2002). On the whole, NHSD nurses have been found to be generally satisfied with working for the service and have gained opportunities for skill development and promotion since joining, although a minority also have reported the work to be monotonous (Knowles et al. 2002) and stressful (Snooks et al. 2008), Appendix 16.

Although NHSD nurses use their professional clinical judgement to assess a caller's health and are only *supported* by the CCDS, there has been some debate about whether working in NHSD as a nurse advisor constitutes 'real nursing', with nurses outside the service in particular, expressing doubts (Snooks et al. 2008). This is understandable, given that telenursing differs from the traditional hands-on delivery of nursing care and there is still much work to be done to understand telephone based clinical decision making and nursing practice issues. NHSD, as one of the 'pioneers' for telephone based delivery of public healthcare (Collin-Jacques and Smith 2005), has been the setting for much of this research. Pettinari and Jessop (2001) explored how professional knowledge and experience were used to build skills to manage the absence of visibility. They identified three broad areas in which nurses have adapted to manage the lack of co-presence: 1) gathering information, 2) delivering information and 3) building trust and rapport (Pettinari and Jessop 2001). In this way the nurse is able to build a picture of the client and his or her environment, a process seen as central to the reasoning process (Edwards 1998). Despite this, stresses related to the lack of face-to-face contact with patients were found to be present with telephone nurse advisors both in the UK (Snooks et al. 2008) and in Sweden (Wahlberg et al. 2003).

1.5.2 Service use (a)

The volume of calls to NHSD has increased steadily since its inception with 4.7 million calls taken in England on the direct number and 5.6 million online visitors in 2009/10 (NHS Direct 2011). Evaluations of NHSD and NHSDW found that the callers make contact with appropriate services following their call to NHSD in a large majority of cases (Snooks et al. 2009). Furthermore, serious adverse events resulting from NHSD contact were likely to be rare (Munro et al. 2001). However, evidence in Wales in 2006 deemed the service to be expensive (average marginal cost per call £29 compared with £23 for a consultation with a GP) (Snooks et al. 2006), although this is contrasted by NHSD's own figures in 2010 which suggest that the average cost of contact is £21.01 (NHS Direct Business Plan 2011).

Callers appear to be extremely satisfied with their contacts with NHSD (O'Cathain et al. 2000). Of the callers who followed the advice given, 95% were satisfied (Research Limited 2008) while in a separate study, 95% rated the advice and/or information given as excellent, very good or good (NHS Direct 2007/2008).

Published results indicate that self care advice accounts for the largest proportion of call outcomes, (NHS Direct 2007/2008; Payne and Jessopp 2001) with almost 50% of calls resulting in advice to self care (South Wales Public Health Observatory, p.11). As one of the objectives of NHSD was to ease pressure on emergency and unscheduled care providers (Calman 1997), these data sound promising. However, although methodologically difficult to measure, independent evidence suggests that in its first year in England NHSD did not reduce the demand for other immediate care service providers [Emergency Department (ED), ambulance, and general practitioner (GP) services] although it may have restrained increasing demand on general practitioners' out-of-hours services (NHS Direct 2001). Using a similar methodology, no evidence of any substitution of demand for other service providers was found in Wales (Snooks et al. 2006). In contrast, NHSD claims to have saved 1.6 million unnecessary GP appointments, 1.1 million ED attendances and 999 calls and 0.5 million other face-to-face appointments in 2009/10 (NHS Direct Business Plan 2011).

1.5.3 Factors affecting dispositions given by NHSD (a)

Although the underlying assumption of using CDSS is that disposition given will be consistent regardless of nurse or caller characteristics, several studies have focused on the interaction between the nurse and the system, a concept called 'dual triage' (O'Cathain et al. 2004).

Two studies have explored the link between the CDSS used and consistency of disposition given by NHSD nurse advisors (O'Cathain et al. 2003; 2004). Both studies held case mix constant and presented nurses with scenarios based on potential calls to NHSD. Both studies concluded that variations in dispositions could be attributed to differences in the software used, although neither study accounted for individual nurses' background and experiences. As NHSD has now standardised CDSS across all centres and NHS 24 and NHSDW also use one software system across all sites, these variations in disposition should fall.

Studies which explored the relationship between nurse characteristics and disposition given had varying results. In a mixed methods evaluation, nurses with over 20 years experience were more likely to triage callers to self care than those with less than ten years experience, although there was no evidence that the clinical background of nurses, length or range of experience in NHSD or gender affected triage decisions (O'Cathain et al. 2004). In contrast, Monaghan and colleagues (2003) found that the number of callers referred onto routine GP appointment by Registered Sick Children's Nurses (RSCN) was significantly higher than that of Registered Nurses although these calls focused specifically on calls about children presenting with a 'rash' or 'fever' and results may not be transferable to all calls. Specifically looking at the decision making aspect of nurses using CDSS at NHS 24 decision making was not affected by nurses' attitude to risk and variation remained unexplained (O'Cathain et al. 2007). However, the authors conclude that results may be accounted for by the methodological difficulties in measuring risk. Additionally although case-mix adjustment was made for age and sex of the patient and time of call, data on the type and severity of the health problem were not available and therefore not included in the analysis.

The potential impact of further patient characteristics, such as severity of symptom, level of deprivation or ethnicity, on disposition given has not yet been taken into account in any study exploring the dispositions given by NHSD nurses. Yet, researchers studying variation of outcomes in general practice are emphasising the role of psychological and sociological factors (Reid et al. 1999) and there is a need for further exploration of these in an NHSD setting in order to fully understand reasons why advice given may differ across similar cases.

1.5.4 Issues of demand for NHSD (a)

Perhaps one of the most commonly known statements on access to healthcare is Julian Tudor Hart's inverse care law, first described in 1971. The inverse care law states: "the availability of good medical care tends to vary inversely with the need for it in the population served" (Hart 1971; Watt 2002). With NHSD, in theory, being accessible to all with a telephone, the inverse care law may not apply. Indeed, the service aims to be accessible to everyone (NHS Direct 2001) and issues of location - of either the patient or the provider - are not applicable. Through offering healthcare in this way, there is the potential for equal demand across population groups but at the same time from its very nature, NHSD stands to increase inequalities in access among those with hearing or speech difficulties, those who don't speak English and those without access to a telephone.

Concerns have been raised by evaluators (George 2002), policy makers (Scottish Executive 2004, p.10) and nurses (Snooks et al. 2008) that NHSD is not reaching all of the population. In particular, those who may already be vulnerable, older people, those living in areas of deprivation, and those from ethnic minority backgrounds, generally appear to be making less use of the service than other groups. It is these groups of people, who are often already at a disadvantage in terms of health, a concept known as 'inequalities in health' when health varies according to any, or a number of factors including age, gender, ethnicity, individual socio-economic status, geography and area deprivation who could potentially benefit the most from a healthcare service within their own homes.

Issues of demand for NHSDW, and whether these concerns are justified, will be further explored in the literature review chapter of this thesis, but first it is important to understand exactly what is meant by 'inequalities in health' and 'access to, or demand for, healthcare' and why these concepts are so important.

1.6 Inequalities in health (a)

Although there is evidence to indicate the health of the UK population has substantially improved over the past 150 years, with life expectancy increasing every decade since the 1940s (Office for National Statistics), inequalities in health have not gone away. Indeed, despite this increase, improvements in health have been relatively low in the most disadvantaged groups (Department of Health 1998). The recent Marmot Review quantifies the scale of health inequalities: up to 2.6 million extra years of life could be saved if health inequalities were reduced (Marmot 2010). In Wales, health inequalities are a major issue with people living in the most deprived areas having higher levels of mental illness, hearing and sight problems, and longer-term conditions including chronic respiratory diseases, cardiovascular diseases and arthritis (National Public Health Service for Wales 2004).

Although typically the literature differentiates between health inequalities (socially produced systematic differences in health) and health inequities (unfairness or injustice in these differences) in Britain, and increasingly across Europe, the two terms are interchangeable in that they both represent injustice and unfairness (Whitehead 2007). Causes of these inequalities are not straightforward and can encompass lifestyle factors, and more broad factors such as poverty, housing and education. Although health inequalities are well documented, overall there is still much work to be done in leveling health across the population. The recent World Health Organisation document, Global Commission on Social Determinants of Health (CSDH, 2008) highlights what some of the problems are:

Health inequalities are "caused by the unequal distribution of power, income, goods and services, globally and nationally, the consequent unfairness in the immediate, visible circumstances of people's lives – their access to health care, schools, and education, their conditions of work, and leisure, their homes, communities, towns or cities – and their chances of leading a flourishing life. Poor and unequal living conditions are the consequence of poor social policies and programmes, unfair social arrangements and bad politics" (CSDH, 2008, p1).

The 1998 Acheson report, an independent inquiry into inequalities in health, is a landmark report which aimed to review information on health inequalities and indentify areas for future policy development to tackle these inequalities (Department of Health 1998). The report looked at the determinants of health argument first set out in Dahlgren and Whitehead's rainbow model (Dahlgren and Whitehead 1991). This model proposes that determinants of health are composed of layers of influence. At the centre of the rainbow are individuals with fixed factors such as age and sex. Each 'colour' of the rainbow then represents a layer of influence over the individual.

This model takes into account the fact that individuals do not exist in isolation and emphasizes that interactions which could affect health seeking behaviour (and subsequently inequalities in health) occur frequently. One of these layers is healthcare services. Thus, it could be argued, from both Dahlgren and Whitehead's Rainbow model and the CSDH definition of health inequalities, that to address health inequalities, among other things, it is imperative to improve access to, and use of, healthcare services across disadvantaged groups. Indeed, this rings true historically with improvements in access to services contributing to improvements in the health of the population (Whitehead 2007).

1.7 Defining access to, or demand for, healthcare (a)

Before looking at access issues concerning NHSD, it is worth considering what 'access to healthcare' actually means. In straightforward terms, good access means 'getting the right service at the right time', (Rogers et al. 1999), but in reality, the concept is not easily defined and although several authors have tried to clarify the term, there does not appear to be consensus on a common definition (Penchansky and Thomas 1981; Free 1998; Rogers et al. 1999; Goddard 2001; Gulliford et al. 2002; Jones 2003; Chapman et al. 2004).

Furthermore, in addition to this lack of consensus, there is also no agreement as to what constitutes a *high* degree of access (Chapman et al. 2004). Yet without a clear goal as to what is trying to be achieved or measured, moving forward is difficult. One of the reasons defining or clarifying access to healthcare is not straightforward is because, although in theory a service may be available to all, in reality this does not mean that all groups will use it equally with several potential factors affecting 'access'. Utilisation or receipt of healthcare is not a simple process and all contributing factors need to be fully recognised if access is to be properly understood (Dixon Woods et al. 2006). In particular, the influence of the individual, the community and health service factors play an important role (Andersen et al. 1983).

It is beyond the scope of this study to review all the various definitions of access and so the author will adopt the definition to assess access developed by Macfarlane et al. in the NHS SDO report: Identification and evaluation of standardised datasets for measuring and monitoring access to health care (Macfarlane et al. 2005). This definition was chosen primarily because it was developed from a project which focused specifically on the use of routine data to monitor demand for services in terms of utilisation, taking into account user or patient characteristics. Thus, it is the most relevant definition of access to the work presented here. The authors of this report recognised that to successfully explore the feasibility of routine data to measure access to healthcare across different population groups, they had to define access as broadly, quantifiably and objectively as possible (Macfarlane et al. 2005).

Macfarlane and colleagues argue that much of the conflict surrounding definitions could be avoided if access was approached as a continuum, which would include outcomes as part of the definition. They have defined access as four parts: need, opportunity, utilisation and outcomes see Box 1.2.

Box 1.2: Access continuum dimensions: Need, Opportunity, Utilisation and Outcome

Need: a measure of population-based need is an essential component of a definition of access. This is because access to healthcare should be appropriate to the need.

Opportunity: to use health services, sometimes referred to as availability of health services, is a key component of access. Opportunity could be regarded as a proxy measure of the supply of services-are adequate services available for a given level of need with the population?

Utilisation: is dependent upon availability, or adequate supply of healthcare services and also the affordability of services to patients, the physical accessibility of services and acceptability of users.

Outcome: in terms of either health gain or health maintenance. This is the final component of access in this definition as this is the end result of access to healthcare. The objective is that health services provided are both relevant to individual health needs and effective.

This definition can also be applied to the case of NHSD. Although need is a difficult concept to measure, as discussed previously there are discrepancies in health across different socioeconomic groups. Thus, one could say that there is a need for those who are worse off in terms of health to make more use of new services, such as NHSD. In terms of opportunity and utilisation, with the latest Ofcom figures suggesting that almost 100% of UK households have access to a mobile or landline phone (Ofcom Communications Market Report 2011) and NHSD costing just the price of a local phone call, in theory, the population has equal opportunity to use the service. Traditional supply side issues, such as lack of adequate services or physical accessibility of services should not apply. Outcomes are often overlooked in defining access to healthcare but will play an important role in future issues of demand, an experience, either good or bad will have an effect on future behaviour. Health services must be tailored to individual health needs for them to be effective.

Using this definition, Macfarlane et al. 2005 have proposed a Framework for Access which can be applied to routine datasets to assess their feasibility in measuring access to healthcare, see Table 1.1. The left hand column lists the characteristics of the population and includes any factors which may be associated with inequalities in health (this list is not exhaustive). The next three columns show the level of aggregation which would theoretically be possible when analysing the available data (presumably at individual level) and the level of aggregation at which data are routinely available.

Table 1.1: Framework for measuring access using routine datasets

		Aggregation		**Place on access continuum**			
Dimensions of Access	**Indicators of Access**	**Individ-ual**	**Group/ Popul-ation**	**Need**	**Opport-unity**	**Use**	**Outcomes**
Character is-tics of population							
	Age						
	Sex						
	Ethnicity						
	Education						
	Socio-economic						
	Where care occurred						
	Residence						
	Travel time						
	Morbidity						
	Mortality						
	Health beliefs and knowledge						

The author will apply this framework to the dataset used in this study to evaluate its merit in evaluating access to healthcare for groups within the population. This will be done critically and ways in which the framework fits the data will be discussed; as well as areas in which the author thinks improvements can be made.

Although there will be many factors which contribute to the demand for and outcomes of contacts with healthcare providers, as discussed, variations of healthcare use exist across groups which are considered 'disadvantaged' or deprived. Although several explanations of what makes a person disadvantaged exist, it is beyond the scope of this study to explore all of these groups. Thus, the author has decided to focus on the socioeconomic characteristic of area deprivation.

1.8 Deprived groups (a)

1.8.1 What is deprivation? (a)

To test whether deprivation is linked to demand for, and disposition given by, NHSDW, the author must first define it. Although poverty and deprivation are terms which are often used interchangeably, the literature suggests that a distinction should be made between them. For the most part, poverty concerns a 'lack of money or material possessions' (Atkinson 1998), whereas deprivation is broader and refers to any unmet needs, not just financial (Social Disadvantage Research Centre 2003). Peter Townsend, in his account of poverty in the United Kingdom (Townsend 1987) sets out the case for defining poverty in terms of relative deprivation:

"individuals, families and groups can be said to be in ***poverty*** if they lack the resources to obtain the types of diet, participate in the activities and have living conditions and amenities which are customary, or at least widely encouraged or approved in the societies to which they belong".

Whereas he argues that 'people can be said to be ***deprived*** if they lack the types of diets, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which are customary…" (Townsend 1987)

1.8.2 Ways of measuring deprivation (a)

There are several ways of measuring deprivation and types of codes which can be used to identify and measure levels of deprivation. For example, three commonly used deprivation indices are: The Jarman Underprivileged Area Index (Jarman 1991), The Townsend Material

Deprivation Index (Townsend 1987) and The Welsh Index of Multiple Deprivation (WIMD) (Welsh Index Multiple Deprivation 2000).

The Jarman Index was developed as a measure of the potential workload or pressure on the services of general practitioners. It is calculated using England and Wales as the population base and is composed of eight variables including: 1) unemployment, 2) overcrowding, 3) lone pensioners, 4) single parents, 5) born in New Common-wealth, 6) children aged under five, 7) low social class and 8) one year migrants (Jarman 1991).

The Townsend Index was developed as a measure of material deprivation. Like the Jarman Index it is calculated using England and Wales as the population base but unlike the Jarman Index, the Townsend score consists of four variables: 1) unemployment, 2) overcrowding, 3) non car ownership, and 4) non home ownership (Townsend 1987)

The WIMD was designed to model levels of deprivation in Wales and support policy development and the targeting of resources. The index was to allow more direct measures of deprivation at the small area level (Electoral division) and is made up of different domains of deprivation which can be used on their own or combined to form the Welsh Index of Multiple Deprivation (University of Oxford 2000). The six domains that form the WIMD are assigned different weights and are: 1) income deprivation, 25%, 2) employment deprivation, 25%, 3) health deprivation and disability, 15%, 4) education, skills and training deprivation, 15%, 5) housing deprivation, 10%, 6) geographical access to services, 10%. The author has decided to use this index to represent patient deprivation in this study as it was designed specifically on Welsh data and is thus the most applicable to the present study.

1.9 Chapter summary (a)

This chapter has explored the introduction and first years of NHSD. In its first 10 years of existence, the service has grown in size, scope (expanding to include the website, digital television and information kiosks) and popularity with high levels of caller satisfaction. The service now handles calls to out-of-hours GP services in some parts of the country, as well as various other clinical assessment services, such as 'choose and book' appointments. Work with local providers of urgent care is also underway to strengthen the integration of service provision (Department of Health Access Directorate 2006). Priorities for the future include building on the core service it provides and moving to a contract which would fit the new

NHS environment; with more enhanced services for customers; working more closely with other NHS organisations and integrated services; and being at the forefront to the application of new technologies to healthcare.[26] However, with the introduction of 111 in England, NHSD has also recognised a threat and has vowed to compete for future 111 business (NHS Direct 2011).

Research evidence indicates that nurses are generally satisfied with working in NHSD and have adapted views on traditional 'hands on' nursing to fit the call centre environment. However, it has been argued that NHSD has been introduced without a solid evidence base (McDonnell et al. 2006) and the speed of expansion has often made evaluation difficult, leaving many issues needing further exploration. In particular, in peer-reviewed publications, the service has not been found to reduce the demand for other immediate care service providers and in this way, has failed to meet one of its original intended objectives. Although it has been suggested that NHSD is offering an alternative route into the NHS for those concerned with being considered 'time wasters' by other busy services (Greatbatch et al. 2005) the full reasons why this substitution of demand has not occurred are not yet understood.

Despite a lack of robust evidence concerning the achievement of NHSD's objectives, in practical terms the service is safe and well liked. However in the resource limited NHS environment and with the introduction of 111, concerns about clinical and cost effectiveness have been raised. Despite the use of CDSS, dispositions given by nurse advisors varies and additional concerns regarding access to the service by disadvantaged groups have been raised.

Health inequalities in the UK are a serious problem with those living in areas of deprivation often worse off. Dalhgren and Whitehead's Rainbow Theory argues that individuals do not live in isolation and that there are many factors which contribute to one's overall health. Although those living in deprived areas have been known to experience inequalities in health, they have also shown different patterns of healthcare usage from the general population. It is also highly likely that this group will also experience different health outcomes.

Several definitions exist for measuring "access to healthcare" and for this study, the author has adopted a definition of access as a continuum comprising: need, opportunity, utilisation and outcome (Macfarlane et al. 2005). This framework was chosen as it was developed for use with routine healthcare datasets. The author will apply this framework to the data used in this study, noting any concerns or suggestions for improvements that could be made to the framework.

Demand for, and dispositions of contacts with healthcare, health inequalities and methods for measuring deprivation are all important and continuing areas of research. With almost 100% of UK households owning either a mobile or landline telephone (Ofcom Communications Market Report 2011), the continued investment in telephone-based healthcare seems justified at first sight. Yet research and popular opinion indicate that access to healthcare in this manner will not suit all members of the population.

This study explores the relatively new area of telephone based healthcare, via NHSD. It combines several of the themes mentioned in this chapter and takes these a step further. It focuses on the NHS goal of equity of access (making access to healthcare equal across the population); particularly for unscheduled care services described as 'services that are available for the public to access without prior arrangement where there is an urgent actual or perceived need for intervention by a health or social care professional' (Department of Health 2004). If NHSD is intended to act as a gateway to the multilayered NHS, it is more likely that this will become important when there is confusion over who to contact, as will be the case when healthcare concerns appear unexpectedly.

The next chapter, the literature review, reviews the current knowledge on demand for and outcomes of contacts with telephone based healthcare by patient socioeconomic characteristics.

Chapter 2: Literature Review

2.1 Overview (a and b)

As discussed in Chapter 1, the UK governments are investing heavily in telephone based healthcare, with continued investment in NHSDW and NHS24 and in England, the new 111 number set to become a single point of access to urgent care. In order to understand the impact of these developments on access to healthcare across socioeconomic groups, this chapter reports the results of the systematic review concerning the demand for, and outcomes of contacts with unscheduled telephone based healthcare across patient socio-economic status.

The majority of this chapter contains work done for the original submission; thus most headings are marked with an (a). However, between freezing the literature search (17.02.12) and the viva (27.02.13), the author reopened the search, searching the same information sources as discussed in Section 2.4.3 and using the same search criteria (Section 2.4.4) and inclusion and exclusion criteria (Section 2.4.2). This new activity between thesis submission and viva yielded in four additional studies which met the inclusion criteria for the literature review, all of which concerned demand for telephone based healthcare. No additional studies were uncovered that explored outcomes of telephone based healthcare across socioeconomic characteristics. In order to provide transparency between the initial articles and the new ones, the author has presented results from the new studies separately in Sections 2.5.3 and 2.7 which are indicated by (b). She also has included a brief discussion of the impact of these new studies on the original findings in Section 2.7.

2.2 Rationale (a)

It is well documented that those with lower socioeconomic status, make different use of healthcare services than the general population. Much of the research in this area has focused on established, well-known services such as ED and primary care services:

- Higher rates of general practice consultations are associated with range of socioeconomic factors (Campbell et al. 1996; Scaife et al. 2001; Beale et al. 2005)

- In emergency or unscheduled care similar patterns exist: deprivation played a role in attendance at a children's ED (Beattie et al. 2001), and ED use has been shown higher for those living in rented accommodation, without car access, lower income groups and unskilled manual workers (Shah and Cook 2008)
- Deprivation is associated with higher usage of emergency ambulance services, although this effect is partly due to population density (Peacock and Peacock 2006)
- There are increased contact rates for Glasgow Emergency Medical Service (patient transportation) by those living in deprived areas (O'Donnell et al. 1999)

Similarly, triage or care outcomes across different emergency healthcare services, have been shown to vary according to deprivation or socioeconomic status:

- Of patients attending a children's ED those living in the most deprived areas had an attendance rate five times higher in the most severe triage category then those in the least deprived areas (Beattie et al. 2001)
- In emergency admissions for cancer those living in deprived areas were more likely to be admitted as emergency patients, and less likely to have surgical interventions for breast and lung cancers (Pollock and Vickers 1998)
- Those from deprived areas using the Glasgow Emergency Medical Service were most likely to receive a home visit (O'Donnell et al. 1999)

As discussed in Chapter 1, those with lower socioeconomic status often have worse health; and to address health inequalities among other things access to healthcare by disadvantaged groups must be improved. In the light of this, the findings that those from lower socioeconomic backgrounds are higher users of primary care sound promising. However, as use of emergency care services is also high amongst the same groups, results can also suggest that those from lower socioeconomic backgrounds are experiencing unmet needs in the early stages of healthcare seeking behaviour forcing them to use emergency or unscheduled care services- care which often results in the highest triage outcomes. It is possible that telephone based healthcare services, such as NHSD, can play a role in preventative measures perhaps helping people manage or support illnesses before they reach emergency levels. Additionally, NHSD is also poised to help those who cannot travel to meet their healthcare needs or find it difficult to access GP services in the day.

Yet different groups in society have different preferences for healthcare use including health seeking behaviour (Galdas et al. 2005 and Smith et al. 2006) and will find different types of healthcare easier to access (for example those experiencing language difficulties will likely find face-to-face consultations easier). Indeed, as discussed in Chapter 1, concerns have been raised that NHSD is not being used equally by members of the population (Snooks et al. 2008 and George 2002). With the continued NHS investment in NHSDW and NHS 24 and the introduction of the new '111' emergency number, soon to be rolled out across England, it is essential to get a picture of both current use of telephone based healthcare services and the resulting outcomes across patient socioeconomic factors. If members of the population are not using such services in a consistent manner, continued investment in telephone based methods as one of the first points of access for unscheduled healthcare will not be a panacea.

The author searched medical databases for systematic reviews exploring the relationship between patient socioeconomic or deprivation status and access to telephone based unscheduled healthcare. Although systematic reviews yielded evidence for the benefits of telemedicine (Hailey et al. 2002), and the effects of telephone consultation and triage on healthcare use and patient satisfaction (Bunn et al. 2005), the author could not find any that addressed access, demand or outcomes of telephone based healthcare by socioeconomic characteristics.

However, the author found isolated studies on demand for telephone based unscheduled healthcare although methods and measurements of socioeconomic characteristics varied. The search did not uncover any individual studies which focused on outcomes resulting from these contacts by socioeconomic status. Thus, there is a strong case for collating existing evidence in these areas, and highlighting important areas where research is currently lacking.

2.3 Objectives (a)

Thus, the author undertook a systematic review of the published literature to answer the following research objectives:

1. What is known about the association between patient deprivation or socioeconomic status and a) demand for, b) outcomes of contacts with, telephone based unscheduled healthcare?

2. Do any other factors affect the relationship between demand for, and outcomes of, contacts with any of the unscheduled telephone based healthcare services and thus inform the analysis of this study?

2.4 Methods (a)

The author conducted this systematic literature review in accordance with Prisma guidelines (Preferred reporting items for systematic reviews and meta-analyses) (Moher et al. 2009). Although these guidelines were developed for reporting of reviews, the author has used them as a guide here to help with conducting the review. These guidelines allow for flexibility in the order that items are addressed in the review, although stress that the information for each item needs to be presented somewhere within the report- guidelines to which the author has adhered.

2.4.1 Protocol (a)

This document includes the review protocol.

2.4.2 Eligibility criteria (a)

The author devised inclusion and exclusion criteria based on the PICO method (the identification of participants, intervention, comparison, outcomes).

All types of national and locally based telephone based healthcare services which could be used in an unscheduled care context and could result in advice, information or triage to a more appropriate service given were included. As telephone advice currently exists in the UK as an option for those who contact their GP OOH and as NHSD is still a relatively new service, the author included in the search contacts and outcomes of GP OOH services by telephone. Although the UK 999 or North American 911 numbers are used to access an emergency ambulance and are technically a form of telephoned based healthcare the author decided to exclude this service as typically callers only access these services to get an ambulance - they are not looking for advice, treatment or triage from the call handler.

Scheduled care helplines (such as those used to book appointments) were excluded as it was believed these would not be used in an unscheduled care context. Studies found which were systematic reviews and meta-analyses were excluded from this review although were used to identify relevant primary research.

For articles which did not meet the inclusion criteria, the author recorded the reasons for exclusion. If there were several criteria not met, the primary exclusion criterion was that the paper did not concern telephone based healthcare. Table 2.1 presents the specific inclusion and exclusion criteria that were used for the study.

Table 2.1: Inclusion and exclusion criteria (PICO)

	Inclusion	**Exclusion**
Types of population	General population, broken down by levels of deprivation or socioeconomic status, including demographic or clinical subgroupings	None
Types of intervention	NHS Direct, NHS Direct Wales, NHS 24 National and local telephone health helplines Other telephone based emergency/unscheduled care providers (including GP OOH services) Condition specific health lines for which no appointment is needed (e.g. Cancer lines, smoking cessation lines)	Other telephone helplines, not health related Not unscheduled care health lines such as those used to book appointments Prescheduled care (e.g. for which an appointment is needed) 999 or 911
Comparison	All studies included, whether comparison is with explicit control group or through internal cross-sectional analysis	None
Outcomes	Use of services across different levels of deprivation or socioeconomic status (e.g. number of contacts) Advice/information or triage recommendation given Treatments received Any other outcome provided	None
Study design	Primary research including studies indentified by systematic reviews Secondary research based on analysis of routine data	Reviews including systematic reviews and meta analyses Expert opinions and editorials
Limits	English language Publications and reports since 1998 (the year in which NHSD was introduced) UK and international research	

2.4.3 Information sources (a)

In the search for literature the author used four sources of information: 1) electronic searches of medical databases; 2) hand searching of relevant journals; 3) citations searching including using systematic reviews citations, 'snowballing' and 'cited reference searching' and; 4) contacting well published authors. However, this review did not need to search industrial sites, the traditional fifth source of references.

Electronic searching of medical databases

The author searched six databases including: PubMed (Medline), ASSIA (Applied Social Sciences Index and Abstracts) Web of science, Cochrane, CINAHL (Cumulative Index to Nursing and Allied Health) and HMIC (Health Management Information Consortium). She also searched other electronic sources including the Department of Health website and Google Scholar, entering the search term 'NHS Direct'. The author ran the electronic database searches until 17.02.12 when she 'froze' the search in order to compile results for this review. However, the author 'reopened' the search in June 2012 until February 2013 (when the viva was held) in order to ensure that the most up-to-date articles are included.

Handsearching of journals

The journal of Telemedicine and Telecare is recognised as the leading international journal on telemedicine and e-health and aims to provide a unique perspective on the use of new technologies in healthcare around the world. The author hand searched this journal from 1998 to the present day (31.01.12). She also hand searched the International Journal of Telemedicine and Applications from 2008 to the present day (31.01.12). This journal aims to join science and applications of distant medical practice and supporting technologies, such as communications and telemedicine. As an additional source of information the author also searched the recent book on Telenursing (Kumar and Snooks, 2011).

Citations searching

For those papers which met the inclusion criteria, the author employed the search techniques of 'snowballing'- looking at the references in included studies and online 'cited reference searching' the reverse of this process.

Any relevant systematic literature reviews which were identified in any part of the search strategy were explored to identify potential primary research articles to include in the review. Where the included studies fell outside of the defined study period (pre 1998), the author again used 'cited reference searching' and the 'related studies' functions in Medline to identify any more recent similar publications.

Contacting experts

The author contacted two authors of studies which met the inclusion criteria for more information.

2.4.4 Search strategy (a)

In order to ensure a comprehensive search, the author broke down the review topic into separate elements, or 'facets', a method which has been used successfully in a previous study (Smith et al. 2005). The facets were: 1) the service investigated, 2) 'socioeconomic characteristics', 3) 'emergency or unscheduled care' aspect of access and 4) outcomes of these contacts, see Table 2.2. The author then identified all possible synonyms or associated terms with each facet. For example, there are several possible ways of measuring socioeconomic characteristics including: 'deprivation', 'poverty area', 'disadvantaged' and 'vulnerable population'. The search was further refined by exploding MeSH topics to identify key terms and additional terms identified from relevant papers were added. Guidance on the search strategy was received from a specialist librarian and from experts in the field.

This process was done iteratively and the author undertook successive trial searches to identity terms which would identify the greatest number of relevant hits. For example, originally the term 'poor' was included in the socioeconomic characteristics facet however this was removed as it retrieved studies exploring 'poor health outcomes', 'poor sleep patterns', 'poor accuracy', and 'poor mental health' greatly increasing the number of irrelevant hits. In contrast, originally the author had devised a fifth facet, an 'access or demand' component however this reduced the number of hits received and was thus removed.

Table 2.2: The facets of the literature search and key terms

Facet 1: the service investigated	**Facet 2: socioeconomic characteristics**	**Facet 3: emergency or unscheduled care aspect of access**	**Facet 4: outcomes**
hotline	deprivation/depriv*	unscheduled-care	outcome
call-center/call-centre	poverty	unplanned, unplanned-healthcare/ health-care	treatment
nhs-direct	socioeconomic/socio-economic/socioeconomic factors	immediate-care	disposition
NHS-24	disadvantaged	urgent-care	advice
telemedicine	poverty areas/poverty	out-of-hours	information
telehealth	health status disparities	emergency/emergenc* /emergency treatment	triage
helpline	vulnerable populations	after-hours/afterhours care	delivery of healthcare
hotlines	social class/social-class		treatment outcome
general-practice-out-of- hours/GP Out-of-hours			
telephone			

The author then used the 'OR' operator to include all the possible terms in each facet and the 'AND' operator to divide facets. She set the set search limits to include English language articles from 1998 to the present. Searching was done with key words and MeSH topics. An asterisk indicates where the word was truncated for the search. The main search for access and demand comprised facets 1, 2 and 3, an example of which is shown below. The outcomes searched comprised facets 1, 2 and 4. Although this retrieved citations which were outside the emergency or unscheduled care facet, the author was able to exclude these at a later stage.

Main search for access and demand:

1. *Facet 1:* (telephone OR hotline OR "call-center" OR "call-centre" OR "NHS-direct" OR "NHS-24" OR telemedicine OR telehealth OR helpline OR "Hotlines"[Mesh] OR "Telemedicine"[Mesh] OR "General- practice-out-of-hours" OR "GP Out-of-hours" OR "GP-OOH" OR "primary care out-of-hours" OR "primary care OOH")

AND

Facet 2: (depriv* OR poverty OR socioeconomic OR socio-economic OR disadvantaged OR "Poverty Areas"[Mesh] OR "Socioeconomic Factors"[Mesh] OR "Health Status Disparities"[Mesh] OR "Poverty"[Mesh] OR "Vulnerable Populations"[Mesh] OR "Social Class"[Mesh] OR social-class)

AND

Facet 3: (unscheduled-care OR unplanned-healthcare OR unplanned health-care OR immediate-care OR urgent-care OR out-of-hours OR emergenc* OR after-hours OR "Emergency Treatment"[Mesh] OR "After-Hours Care"[Mesh])

Note: the potential 5th facet: "access or demand" comprising: "Health Services Needs and Demand" [Mesh] OR "Health Services Accessibility"[Mesh] OR demand OR use OR usage OR access OR utilisation OR utilization was removed as it limited the number of hits received.

This search was adapted to the database searched. Appendix 2 has the search strategy in full.

2.4.5 Study selection (a and b)

To check the accuracy of the inclusion and exclusion criteria, the author and an independent researcher, BE, both screened a random selection of one in ten titles uncovered by the search (approximately 130 articles). The two researchers then compared results of the screening and discussed any discrepancies until agreement was reached and the author revised the search criteria accordingly.

By applying these inclusion and exclusion criteria, the author categorised articles into three categories: included, excluded and useful (articles which did not entirely fit the inclusion criteria but that could potentially provide relevant information, either to inform the background to this literature review or other chapters of this study). The author critically appraised only articles categorised as 'included'.

When the author reopened the search strategy between submission and the viva, she completed the process of study selection on her own. Although it would have been desirable to include the opinions of another researcher, this was not possible given time and resource restrictions.

2.4.6 Data collection processes and data items (a)

The author created a data extraction template to record key results of included studies. This template was informed by the Data Extraction Template for Cochrane Reviews (Version 1.5.0. updated 3 May, 2011) and from the Cochrane Handbook for Systematic Reviews of Interventions (Higgins and Green 2008). The author and another independent researcher piloted this template on two randomly selected studies and the author refined the template accordingly particularly adding more structure to the headings to make the process of synthesis easier.

The author divided the data extraction table into two sections: study characteristics and results. A space was left in order to put personal notes, such as if the paper was one of several from one study or if unique methodologies were followed. The additional following headings were included in the data extraction table: study information (ID, first author, year), research question/study aim, service studied, study design, data source(s), statistical methods, setting and date, study site(s), sample size, population, sampling, socioeconomic characteristics, other population characteristics, response rates, study outcome measures, key results, level of evidence and level of reporting. Annex 2.1, found at the end of this chapter holds the data extraction guidelines for each heading.

To make synthesis of results easier, the author extracted data on use of services, advice, information or triage recommendation given, treatments received separately. An additional row in the data extraction table to record information on 'other findings' was added after the review was under way in order to capture additional variables (not socioeconomic) which were significantly associated either with demand or outcomes.

The author extracted all data from the remaining studies. Though the ideal is for an independent researcher to check data extraction as well as study selection, this was not possible.

2.4.7 Risk of bias in individual studies-critical appraisal of articles (a)

Included articles were appraised by the author both on their level of evidence and on their level of reporting. In terms of level of evidence, the author used the Scottish Intercollegiate Guidelines Network (SIGN) 2011 levels of evidence (Sign 2011) to rank studies, see Table 2.3.

Table 2.3: SIGN 2011 Levels of evidence

Level	Description
1++	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is casual
1-	Meta-analyses, systematic reviews, or RCTs with a high risk of bias
2++	High quality systematic reviews of case control or cohort studies
2-	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not casual
3	Non-analytic studies, e.g. case reports, case series (includes all other observational studies)
4	Expert opinion

For RCTs and controlled studies (e.g. those ranked 1 or 2 according to SIGN), the author assessed study quality using a checklist developed by Lewis and colleagues (2009) which refines an existing tool produced by Downs and Black (1998). However, for observational epidemiological studies (e.g. those ranked 2-3 by SIGN) the literature cannot agree on a single 'gold standard' to use (Pladevall-Vila et al. 1996; Juni et al. 2001; Katrak et al. 2004). A recent systematic review recommended the STROBE statement, a checklist of items which should be addressed when reporting the three main study designs of epidemiology: cohort, case-control, and cross sectional studies, as a suitable starting point in the development of such guidelines. (Sanderson et al. 2007). Thus, in the absence of a recommended tool, the author used the STROBE statement to assess the quality of reporting in the included articles (Von Elm et al. 2007).

This checklist breaks down reporting into six levels: 'Title and abstract', 'Introduction', 'Methods', 'Results', 'Discussion' and 'Other information'. Within these levels, there are certain areas which must be reported, for example in the Introduction section authors should clearly state the background or rationale and objectives of the study. A full copy of the guidelines are included in Appendix 3.

These guidelines do not result in an overall 'score' for each study. Thus, to make summarising the quality of reporting for each study more transparent, if an item was present, the author assigned a score of '2' points to this category, if partial information was presented a '1' and if information on an item was missing altogether the author assigned a '0' score. A table was created to record scores and all points were added up within sections and across the study to create an overall quality assessment score for each study.

2.4.8 Summary measures (a)

The author summarised the key points from each study including whether the paper focused on demand, outcomes or both, first author and year, country and service, sample size or number of respondents, outcome measures relevant to socioeconomic measurement, socioeconomic measurement, statement of key results and the study quality in a separate table: Characteristics of included studies, (Table 2.6).

Where possible the author extracted the odds ratio (OR) as the principal summary measure. The OR is a method of comparing the probability of having a particular outcome between two groups, an OR of 1 implies that the outcome is equally likely in each group. An OR of >1 implies that the outcome is more likely in that group, whereas an OR of <1 implies that the outcome is less likely in that group (Last 2001). Where this was not possible, the author extracted additional summary measures, or statistics reported in the study.

2.4.9 Synthesis of results (a and b)

Russell et al (1998) state the main aims of this section are where feasible to: 1) estimate the average effect of the intervention; 2) investigate whether these effects are homogenous across studies, settings and participants; and if not 3) investigate the sources of heterogeneity. They argue that a qualitative assessment of studies is critical, both to provide context of study results and to set the scene for any further analyses.

In this study, the author used a narrative synthesis to combine study findings. This method, which typically divides studies into homogenous groups, involves observations on "study characteristics, context, quality and findings, using the scope, differences and similarities among studies to draw conclusions" (Lucas et al 2007). Popay and colleagues (2006) define narrative synthesis as an approach to summarising findings textually and although this method can involve the manipulation of statistical data, the defining feature is that this synthesis first "tells the story" of the findings.

Here, the author categorised studies into whether they reported on issues of demand, outcomes or both. Within these headings, the author synthesised results by type of services (GP OOH; NHSD and other telephone based healthcare (e.g. subjective specific healthlines).

The data extracted from the individual studies needed some transforming before they were suitable for analysis. Although many of the outcome measures across studies were similar, these were often worded differently. Thus the author summarised outcomes in a consistent manner. Three studies presented deprivation fifths in a reverse order to the other studies (e.g. fifth 1 was most deprived, instead of most affluent) and when reporting these results, the author reversed this to ensure all scales were aligned. There were several different ways of measuring patient characteristics- both socioeconomic and others. The author compiled these characteristics into as few broad categories as possible.

In the studies which were uncovered after the original thesis submission the author used the same methods as above although synthesised the new findings separately from what was presented in the original thesis in order not to cause confusion.

2.4.10 Additional analyses and reporting (a)

The author explored the feasibility of pooling study results into a meta-analysis although no additional analyses were undertaken at this time.

2.5 Results (a and b)

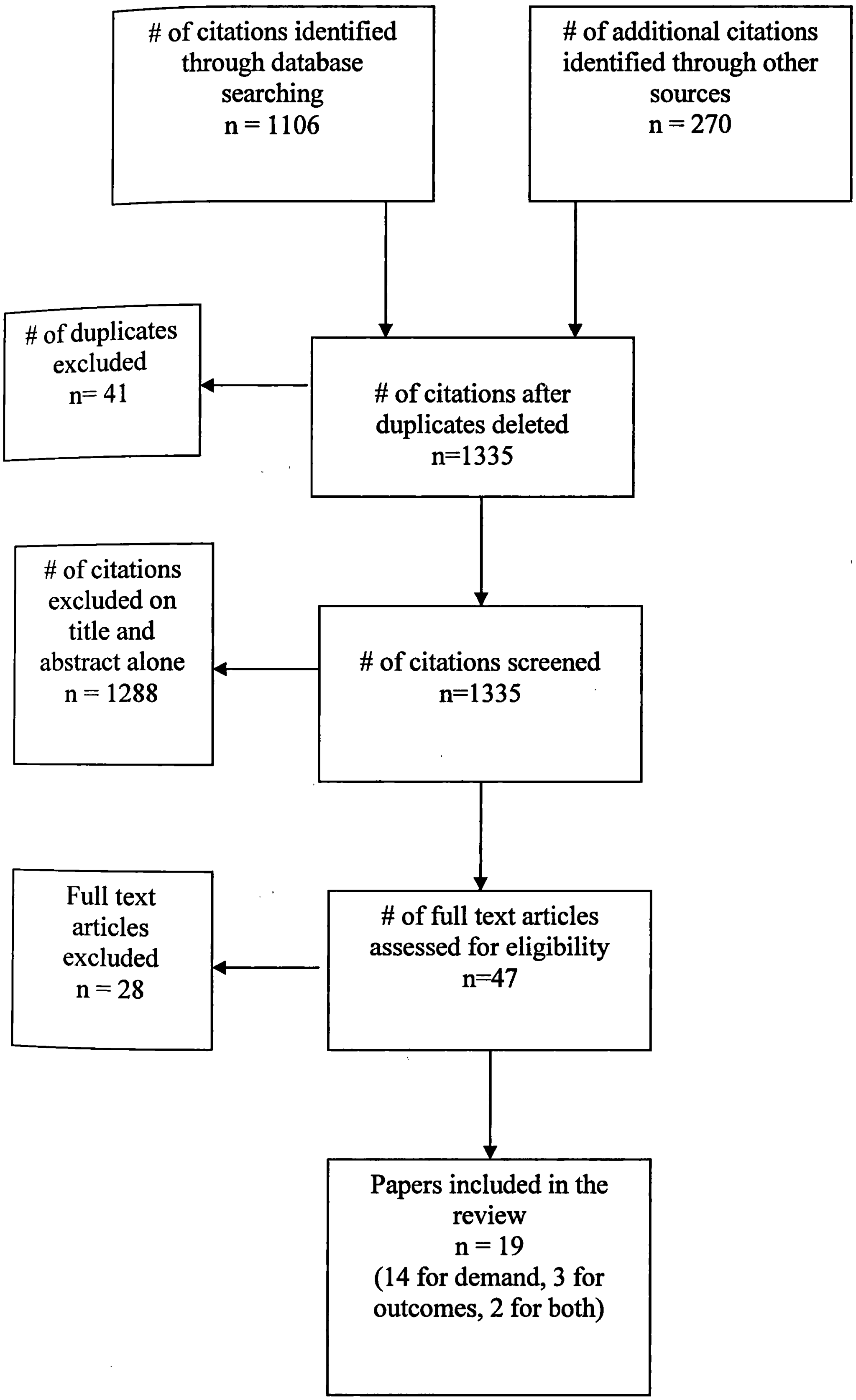
2.5.1 Study selection in the original thesis (a)

In the original submission through the electronic search 1106 records were identified. Additional records were identified from other sources including from key authors and "snowballing". One systematic review in particular, British out-of-hours primary and community care: a review of the literature (Hurst et al 2006), included seven possible studies which met the inclusion criteria. However, five of these were pre 1998 therefore; using the 'related articles' and 'cited reference' search feature in Pubmed the author used these articles to identify 500 more potential publications. Over half (n=294) of these were pre 1998, leaving 206 titles to be examined. An additional potential 64 studies came from the various other information sources resulting in a total of 1376 citations identified.

The author wrote an email enquiring about possible relevant papers to Duncan Cooper, a scientist at the Health Protection Agency, and an author of several papers involving NHSD. He replied sending the reference to a short report by the Eastern Region Public Health Authority (ERPHO) focusing on demand for NHSD by deprivation in Bedfordshire. Subsequently the author also sent an email to the author of this report asking for more information including the full report. Unfortunately due to IT and role changes, the full report was not available.

After deleting duplicate records, the author reviewed the title of 1335 records identified in the search and where the title did not give enough information, consulted the abstract. The full papers of 47 articles were retrieved and of these 19 studies met the inclusion criteria and were included for analysis (Figure 2.1).

Figure 2.1: Study selection flowchart



2.5.2 Excluded studies in the original thesis (a)

As specified at the beginning of this chapter, systematic reviews were excluded from the review but the author explored their references in order to identify potential relevant papers. The author retrieved six reviews during the course of the search, all focusing on a different aspect of telephone based healthcare or OOH care more generally, see Table 2.4. The systematic reviews identified concerning telephone based healthcare focused mainly on evidence concerning the effectiveness, safety and economic impact of such services. No review focused on use and outcomes of telephone based healthcare by patient socioeconomic status or on any inequities in access which may exist.

Table 2.4: summary of systematic literature reviews uncovered in search

Author and year	**Review title**	**Review objectives**
Salisbury, 2000	The demand for out-of-hours care from GPs: a review	1) To review all published work relating to out-of-hours care in UK general practice which included data about the demand for care, and the variation in demand
Hailey, 2002	Systematic review of evidence for the benefits of telemedicine	1) To provide an overview of the evidence of reasonable quality on the efficacy, effectiveness, and economic impact of telemedicine application
Stacey, 2003	Telephone Triage Services: Systematic Review and a survey of Canadian call centre programs	1) To evaluate the effects of teletriage services on health service use, caller safety, satisfaction and health related quality of life; 2) To examine the costs and cost effectiveness of teletriage services; 3) To summarise the characteristics of Canadian teletriage programs and their evaluations
Jennett, 2003	The socio-economic impact of telehealth: a systematic review	1) To review the socio-economic impact of telehealth
Bunn, 2005	Telephone consultation and triage: effects on healthcare use and patient satisfaction	1) To assess the effects of telephone consultation on safety, service usage and patient satisfaction and; 2) to compare telephone consultation by different healthcare professionals
Hurst, 2006	British out-of-hours primary and community care: a review of the literature	1) To highlight out-of-hours service issues that managers need to consider if services are to be modernised and improved

In addition to the reviews, the author retrieved the full text publication for twenty two studies which were subsequently excluded from the review. Table 2.5 contains the main author, study date and key reason for exclusion. As discussed, the primary reason for exclusion was that the paper did not concern telephone based healthcare. The full references for these excluded studies can be found in Appendix 4.

Table 2.5: Excluded studies and reason for exclusion

Author	Year	Study Title	Reason for Exclusion
Baker et al	2011	Characteristics of general practices associated with emergency-department attendance rates: a cross-sectional study	Paper discusses general practice, rather than individual socioeconomic characteristics
Brogan et al	1998	The use of out of hours health services: a cross sectional survey	Service use is not presented by socioeconomic characteristics
Brooker et al	2007	Admission decisions following contact with an emergency mental health assessment and intervention service	Paper does not concern telephone based healthcare
Campbell et al	2010	Out-of-hours care: do we?	Paper is an editorial- not primary research
Carlisle et al	1998	Relation of out of hours activity by general practice and accident and emergency services with deprivation in Nottingham: longitudinal survey	The paper does not separate telephone-based contact from face-to-face visits
Christenson et al	1998	Out of hours service in Denmark: evaluation five years after reform	Service use is not presented by socioeconomic characteristics
Drummond et al	2000	Social variation in reasons for contacting general practice out of hours: implications for daytime service provision?	Paper does not concern the number of contacts but the reasons for contacts
Duffy et al	2002	Variance in practice emergency medical admission rates: can it be explained?	Paper does not differentiate between scheduled and unscheduled healthcare
Gustke et al	2000	Profile of users of real-time interactive teleconference clinical consultations	Paper does not differentiate between scheduled and unscheduled healthcare
Habicht	1999	Social inequalities in health care services utilisation after eight years of health care reforms: a cross-sectional study of Estonia	Paper does not differentiate between scheduled and unscheduled healthcare
Hull et al	1998	The use and overlap of AED and general practice services by patients registered at two inner London general practices	Paper does not differentiate between scheduled and unscheduled healthcare
Lordan	2007	What determines a patient's treatment? Evidence from out of hours primary care co-op data in the Republic of Ireland	Service use is not presented by socioeconomic characteristics
Lordon	2009	Are there treatment variations in triage outcomes across out-of-hours co ops?	Service use is not presented by socioeconomic characteristics
Mercer	2007	The inverse care law: clinical primary care encounters in deprived and affluent areas of Scotland	Paper does not concern telephone based healthcare
O'Donnell	1999	Cross sectional study of social variation in use of an out of hours patient transport service	Paper does not concern telephone based healthcare
Rossdale	2007	An observational study of variation in GPs' out-of-hours emergency referrals	Service use is not presented by socioeconomic characteristics
Saxena	2002	Socioeconomic and ethnic group differences in self reported health	Paper does not differentiate between scheduled and unscheduled

		status and use of health services by children and young people in England: cross sectional study	healthcare
Scaife	2000	Socio-economic characteristics of adult frequent attenders in general practice: secondary anaylsis of data family data	Paper does not differentiate between scheduled and unscheduled healthcare
Shipman	2001	Patient-perceived benefits of and barriers to using out-of-hours primary care centres	Service use is not presented by socioeconomic characteristics
Shipman	1999	Responding to out-of-hours demand: the extent and nature of urgent need	Service use is not presented by socioeconomic characteristics
Wahlberg	2003	Telephone nurses' experience of problems with telephone advice in Sweden	Service use is not presented by socioeconomic characteristics
Wootoon et al	1999	Telemedicine and isolated communities	Service use is not presented by socioeconomic characteristics

2.5.3 Studies found between submission and viva (b)

Between submission and viva the author reopened the study search, using the same strategy as outlined above. Here the author found two new publications and one report which were published between 18.02.12 and 01.02.13. Additionally, the author uncovered one further article which had been published in 2005: "Variation in the usage of NHS Direct by age, gender and deprivation", by Mariam Bibi et al. This paper, which had not been picked up in the initial search was found in the references of one of the new included articles. As a result of this finding the author went back over her previous searches to see if she had erroneously missed this article. However, the article did not appear in any of the previous searches or in any of the databases searched, perhaps because it was published by the Chartered Institute of Environmental Health.

As this additional search was not part of the original thesis, the author has not recorded the total number of citations searched nor the studies which were excluded. Instead, she has focused on the key results found in these studies presented in their own section at the end of this chapter (Section 2.7). The full references and data extraction sheets for each of these new studies has also been added at the end of this Chapter (Annex 2.2).

2.5.4 Study characteristics of original included studies (a)

This section reports only on those studies which were found in the original submission.

The full references and one to two page data extraction sheets for each included study can be found at the end of this chapter. Key information about studies which met the inclusion criteria is presented in Table 2.6, Characteristics of included studies. In the original submission the author found 19 studies overall which met the inclusion criteria: 14 studies which looked at demand for telephone based healthcare only (Salisbury et al. 2000; Burt et al. 2003; ERPHO 2004; Ring and Jones 2004; Cooper et al. 2005; Beale et al. 2006; Knowles et al. 2006; St George et al. 2006; Siahpush et al. 2007; Shah and Cook 2008; Sood et al. 2008; Turnbull et al. 2008; Bush et al. 2010; Turnbull et al. 2010), three studies for outcomes only (Munro et al. 2003; O'Sullivan et al. 2004; Turnbull et al. 2011) and two studies which looked at both aspects (O'Reilly et al. 2001; O'Hara et al. 2011). One of the outcome studies, explored whether or not the patient received a home visit in the year. Although the publication did not specifically state that these home visits were a result of an unscheduled care contact, the author made the assumption that this was the case and included the study in the review (O'Sullivan et al. 2004).

Interventions

Services studied varied: eight explored GP OOH calls, (Salisbury et al. 2000; O'Reilly et al. 2001; Munro et al. 2003; O'Sullivan et al. 2004; Beale et al. 2006; Turnbull et al. 2008; 2010; 2011), six studied NHSD (Burt et al. 2003; ERPHO 2004; Ring and Jones 2004; Cooper at al 2005; Knowles et al. 2006; Shah and Cook 2008), two were smoking cessation hotlines [Quitline (Siahpush et al. 2007) and a National Reactive Telephone Smoking Line (Sood et al. 2008)], one was a Cancer Information Service (CIS) (Bush et al. 2010), one was a "Get Health Information and Coaching service" to encourage a healthier lifestyle (O'Hara et al. 2011) and one was Healthline, a New Zealand service with similar aims to NHSD (St George et al. 2006).

Table 2.6: Characteristics of included studies

ID, First author and year	Country and Service	Sample size/# of respond-ents	Outcome measures (relevant to socioeconomic measurement)	Socioeconomic measurement	Statement of key results
1. Beale, 2006	UK, GP OOH	1297	Use of GP OOH (contact rates per 1000 patients/year)	Council tax housing band (A is the most modest band)	Council tax band predicts OOH GP contact rates, the more modest the home the higher the GP contact rate, irrespective of age and sex.
2. Burt, 2003	UK, NHSD	67 091	Use of NHSD (call rates per 1000 people for each ward)	1) Jarman and 2)Townsend deprivation fifths (1 is least deprived)	There was a significant, non-linear (quadratic) effect of both Jarman and Townsend score. Calls rose with increasing deprivation until at extreme levels of deprivation they declined.
3. Bush, 2010	US, Cancer Information Service (CIS)	825 869	Use of CIS service	1) Level of education, 2) total household income	Telephone callers were well educated compared to general population. Users were more represented in the lowest income category compared with online messenger users and the general population.
4. Cooper, 2005	UK, NSHD	40 345 West York 45 156 West Mids	Use of NHSD (age/sex standardised call rates per 1000 people for each ward)	IMD fifths (1 is least deprived)	For all ages, demand was highest at deprivation levels 3 and 4 and fell in most deprived areas. In WY, call rates for those under 5 were lower in most deprived areas. For those 15-64, call rates were significantly higher in most deprived areas.
5. ERPHO, 2004	UK, NHSD	135,564	Use of NHSD (call rates per 1000 people)	IMD 2004 fifths (1 is least deprived)	Call rates were greater in the deprived fifths than the most affluent.
6. Knowles, 2006	UK, NHSD	8750	Use of NHSD	1) # of vehicles in household, 2) tenure (e.g. owner occupied house), 3) age left education, 4) use of a phone	Respondents were less likely than others to have used NHSD if they lacked access to a car or telephone, did not own their own homes, or had left full-time education at a younger age.
7.Ring 2004	UK, NHSD	461	Service awareness and use of NHSD by parents with children under 5	1) Tenure (owner occupier), 2) car ownership, 3) computer ownership	Those with higher socioeconomic status were more likely to use the service including those who owned their own house, car and computer.
8. Salisbury, 2000	UK, GP co-ops	899 657	Use of GP OOH (numbers, age and sex specific call rates, variation in demand by population characteristic)	Underprivileged area scores, >30 is deprived	Analysis by deprivation was conducted on data from 4 co-ops. Patients living in deprived areas 'made 70% more calls than those in non deprived areas although this had no effect on overall demand'.

ID, First author and year	Country and Service	Sample size/# of respond-ents	Outcome measures (relevant to socioeconomic measurement)	Socioeconomic measurement	Statement of key results
9.Shah, 2008	UK, NHSD	7634	Use of NHSD	1) SEG (socioeconomic group), 2) manager, 3) manual or non manual job in household, 4) use of own car, 5) accommodation tenure, 6) income support received, 7) household income fifth	NHS Direct use was lower in households with low income, no car access and where the head of the household was from a manual occupational group. Living in social housing and receipt of income all significantly reduced the likelihood of contact with NHSD. SEG and manager characteristics did not seem to significantly impact on contact.
10. Siahpush, 2007	Australia, Quitline (smoking hotline)	47 520	Use of Quitline (call volume)	Socioeconomic status (derived from caller's postcode and Index of Socioeconomic Disadvantage)	Call rates were lower among lower socioeconomic groups.
11. Sood, 2008	USA, National reactive telephone smoking line	890	Comparison of characteristics between those who used service and control population	1) Educational status, 2) annual household income (in U.S dollars)	There was a significant overrepresentation of poorer and less educated users in those who contacted the service vs the control population.
12. St George, 2006	NZ, Healthline telephone health, info and triage line	5533	Use of Healthline	NZDep2001 Index of deprivation (1-10, where 1 represents the 10% of areas with least deprived scores)	Call rates increased with increasing levels of deprivation, except at the very highest levels of deprivation where they declined.
13. Turnbull, 2008	UK, GP OOH	27 294	Use of GP OOH: call rates calculated by deprivation, distance and rurality)	IMD, deprivation fifths (1 most deprived)	Overall, there were higher call rates in most deprived fifths. In urban areas, call rates were higher for those in the more deprived fifths.
14. Turnbull, 2010	UK, GP OOH	5697	Use of GP OOH for children 0-4 (call rates per 1000 patients/year)	IMD, deprivation fifths (1 most deprived)	There were higher call rates in the most deprived areas, and the lowest rate in the least deprived fifth. In urban areas, call rates decreased with deprivation (exception fifth 4). In rural areas there was less variation between deprivation fifths.
Outcomes					
15.	UK, GP	31 048	Likelihood of : 1) being	Townsend deprivation	The likelihood of seeing a GP fell with increasing deprivation. For patients who were

ID, First author and year	Country and Service	Sample size/# of respond-ents	Outcome measures (relevant to socioeconomic measurement)	Socioeconomic measurement	Statement of key results
Munro, 2003	OOH		seen face to face or receiving telephone advice only and 2) The likelihood of receiving a home visit or being seen at a Primary Care centre	score fifths (1 is least deprived)	seen, those from more deprived areas were more likely to be seen at home than those from less deprived areas.
16. O'Sullivan, 2004	UK, GP OOH	349 505	Whether or not patient received home visit	Occupation/ employment status similar to 1991 Census	Age, sex, social class and morbidity influence home visits. The Odds of home visits are lowest for the highest social classes.
17. Turnbull, 2011	UK, GP OOH	24 017	Likelihood of: 1) being seen face to face or receiving telephone advice only and 2) of receiving a home visit or being seen at a Primary Care centre	IMD, Deprivation fifths (1 is most deprived)	Deprivation did not strongly predict the likelihood of being seen face to face, although there was an increased likelihood of being seen face to face for patients in fifth 5 (least deprived). For those seen face to face, the likelihood of a home visit decreased for the least deprived fifth.
18. O'Hara, 2011	GHS: Get Healthy Information and Coaching Service	4828	Comparison of participants with general population, and of 'info only' with 'coaching' participants	1) SEIFA- socio-economic index for areas measured in deprivation fifths (where 1st fifth is least deprived) 2) level of education, 3) employment status	Participants were more likely to come from lowest two fifths of socio-economic status although education levels were similar. In terms of outcomes, those with tertiary education, unemployed, from the least disadvantaged fifths 1 and 2 were more likely to enrol in coaching. Although fifth five (most disadvantaged) was also likely to do coaching.
19. O'Reilly, 2001	UK, GP OOH	78 907	1) Use of services, 2) likelihood of being seen face to face or receiving telephone advice only 3) likelihood of being seen face to face or at a Primary Care centre	Townsend score	Levels of Primary Care contacts were positively correlated with deprivation- the higher the deprivation the higher the contact rate. Patients from deprived areas were more likely to be seen by the doctor. Home visits were more likely for patients from deprived backgrounds vs PCC visits, although the overall effect of this was small.

Study design and methodology

The majority (11) of the studies were observational, although one of these (Turnbull et al. 2010) was mixed methods and the quantitative component was observational. Five studies encompassed a cross sectional design, one was a prospective cohort study (O Sullivan et al. 2004) and two conducted secondary data analysis of major surveys (O'Reilly et al. 2001; Shah and Cook 2008). There were no RCTs which met the inclusion criteria.

Levels of evidence ranking can be found in the data extraction tables at the end of this chapter. By the nature of the design of the studies, levels of evidence were quite low with the majority of studies ranked a '-2' or '3'. If authors attempted to control for as many confounders as possible the author ranked it a '-2'. If authors only controlled for one or two confounders and failed to recognise that other factors may also be involved, the author ranked it as a '3'.

Similarly, data sources and sampling procedures also varied with the majority using routine data provided from the service: seven used GP OOH routine data, three NHSD, one Healthline, one CIS and one Quitline. Two studies employed postal questionnaires (Ring and Jones 2004; Knowles et al. 2006), two used telephone surveys (O'Hara et al. 2011; Sood et al. 2008), one conducted a secondary analysis of the General Household survey (GHS) (Shah and Cook 2008) and one study used the 4th National survey of morbidity in general practice (O'Reilly et al.2001).

In terms of sampling, ten used all calls in the time period (O'Reilly et al. 2001; Burt et al. 2003; Munro et al. 2003; EPHRO 2004; Cooper et al. 2005; Beale et al. 2006; St George et al. 2006; Siahpush et al. 2007; Turnbull et al. 2008; Bush et al. 2010; Turnbull et al. 2011), one used all triage calls in the time period (Cooper et al. 2005), and one used all calls about children in the time period (Turnbull et al. 2010). One study used every 3rd child on a GP practice list (Ring and Jones 2004), one study used a convenience sample (Sood et al 2008), one invited all those who enrolled to participate (O'Hara et al. 2011), one used a 1% sample of the population from 60 practices although no information was given on how these were selected (O'Sullivan et al. 2004). One study, looking at patients from GP co-ops, included "all eight co-ops which collected postcode data, and a random selection of 12 others after stratification by region and size" (Salisbury et al. 2000).

Logistic regression was the main statistical method employed in five studies (Munro et al. 2003; Knowles et al. 2006; Shah and Cook 2008; O'Hara et al 2011; Turnbull et al. 2011), three used negative binomial regression (Burt et al. 2003; Cooper et al. 2005; Siahpush et al. 2007) and three used multiple linear regression (O'Reilly et al. 2001; O'Sullivan et al. 2004; Turnbull et al. 2010). Four studies used simpler methods: (Beale at al. 2006; Sood et al. 2008; Bush et al. 2010; Turnbull et al. 2008) and four studies did not state statistical methods used (Salisbury et al. 2000; ERPHO 2004; Ring and Jones 2004; St George 2006), although Salisbury did run a sensitivity analysis based on non-responding practices.

Setting and time period

The majority of studies (14) were set in the UK, two were in the US, two in Australia, one in New Zealand. In the UK, cities or areas in which the studies took place varied considerably. In Australia, the studies analysed data from New South Wales and Victoria and the two American and one New Zealand study analysed country wide data.

The dates of data collection varied from 1997-1998 (Salisbury et al. 2000; Munro et al. 2003) to 2008 (Bush et al. 2010).

Study aims, outcome measurements and response rates

Not all of the studies aimed to explore the relationship between socioeconomic characteristics and demand for, and outcomes of contacts with telephone based healthcare. For example, three studies looked primarily at the effect of distance (Munro et al. 2003; Turnbull et al. 2008; 2011) and used deprivation as a confounding variable to account for. The author extracted information on the aims and or research questions of each study, see Annex 2.1 at the end of this chapter).

Outcome measures also varied across studies and the author has attempted to categorise these into as few categories as possible, Table 2.6. Fourteen studies reported on use of services as their main outcome measure: five use of GP OOH (Salisbury et al. 2000; O'Reilly et al. 2001; Beale et al. 2006; Turnbull et al. 2008;

2010), six use of NHSD (Burt et al. 2003; ERPHO 2004; Ring and Jones 2004; Cooper et al. 2005; Knowles et al. 2006; Shah and Cook 2008), one measured use of Healthline (St George et al. 2006), one CIS (Bush et al. 2010), one of Quitline (Siahpush et al. 2007). Two studies compared the study populations with control populations (O'Hara et al. 2011 and Sood et al. 2008). In terms of outcomes, three studies looked at whether the patient was to be seen face to face or receive telephone advice and whether if the patient was to be seen whether this was a home visit or trip to the Primary Care Centre (PCC) (O'Reilly et al. 2001; Munro et al. 2003; Turnbull et al. 2011). O'Sullivan et al also explored whether the patient received a home visit (2011).

Response rates ranged from 47% (Ring and Jones 2004) to 98.9% (Sood et al. 2008) in the six studies which reported them.

Population- types and size

Seven studies did not state the type of population (Salisbury et al. 2000; EPHRO 2004 O'Sullivan et al. 2004; Cooper et al. 2005; Beale et al. 2006; Knowles et al. 2006; St George et al. 2006), nine were varied (Munro et al. 2003; Siahpush et al. 2007; Shah and Cook 2008; Sood et al. 2008; Bush et al. 2010; Turnbull et al. 2008; 2010; 2011; O'Hara et al. 2011), two were mainly urban (Burt et al. 2003; Ring and Jones 2004), one was mostly rural (O'Reilly et al. 2001).

There was a range of population sizes with 461 being the smallest number of respondents to a questionnaire survey (Ring and Jones 2004), 900 000 the largest in a study of patients using routine data from GP OOH co-ops (Salisbury et al. 2000) and 2 607 000 in total.

Socioeconomic measurements

There was overlap among studies about measurements of socioeconomic status with both individual level (n=10) and area level (n=7) characteristics used. The IMD was the most frequently used area based measurement used in five studies, whereas occupation or employment status was the most frequently used individual level measure, (used five times), see Table 2.7. Whenever deprivation scores were used as an indicator of socioeconomic status, authors presented results according to deprivation fifths.

Table 2.7: Different socioeconomic measurements in included studies

Level	Socioeconomic measurement	Number of times used	References
Area level	IMD fifths	5	Cooper 2005, ERPHO 2004, Turnbull 2008, 2010, 2011
	Townsend fifths	3	Burt 2003, Munro 2003, O'Reilly 2001
	Jarman fifths	1	Burt 2002
	Underprivileged area score	1	Salisbury et al. 2000
	SEIFA* fifths	1	O'Hara 2011
	SES **(socioeconomic status) fifths	1	Siahpush 2007
	NZDep2001 Index of deprivation	1	St George 2006
Total area level		**13**	
Individual level	Occupation or employment status	5	Shah 2008 (3 different measurements), O'Sullivan 2004, O'Hara 2011
	Level of education	4	Bush 2010, Knowles 2006, Sood 2008, O'Hara 2011
	Tenure of house	3	Knowles 2006, Ring 2004, Shah 2008
	No of vehicles in the household	3	Knowles 2006, Ring 2004, Shah 2008
	Household income	3	Bush 2010, Shah 2008, Sood 2007
	Computer ownership	1	Ring 2004,
	Use of phone	1	Knowles 2006,
	Income support received	1	Shah 2008
	Council tax housing band	1	Beale 2006
Total individual level		**22*** **	

*Socioeconomic Index for Areas, **derived from caller's postcode and Index of Socioeconomic Disadvantage, *** this sum is greater than the number of studies as several studies used more than one indicator

Although the author was able to summarise the different ways of measuring socioeconomic status into the above categories for the individual level characteristics, measurements were not homogenous within each category. For example, although five studies measured occupation and employment status, each classification was different:

- *'occupation and employment status similar to the 1991 census'*: Social class 1: professional, etc, 2: intermediate occupations, 3: skilled, non-manual, 4: skilled, manual, 5: partly skilled, 6: unskilled, 7: armed forces, 8: unoccupied (students, housewives, persons of independent means, permanently sick, disabled, not stated, 9: not available/inadequately described (O'Sullivan 2004)

- *'employment status' according to*: full time, part time/casual, home duties, retired, other, unemployed (O'Hara et al. 2011);
- '*Socioeconomic Group'*: professional, employer/manager, inter-junior (Shah and Cook 2008)
- *'manager':* skilled manual, semi-skilled manual, unskilled manual (Shah and Cook 2008)
- *'manual or non-manual job in household'* (Shah and Cook 2008).

Additional characteristics

In addition to socioeconomic characteristics several studies explored whether other variables impacted on either demand for, or outcomes of contacts, with the services. The author also summarised these into overall categories, see Table 2.8.

Three studies (Ring and Jones 2004; Cooper at al 2005; Turnbull et al. 2010), looked specifically at NHSD use by age range. The majority of studies explored use of services standardised call rates by age and sex, taking account of any area level variations of these variables in the population.

Table 2.8: Other variables explored

Variable	**Number of times used**	**References**
Health status	11	EPHRO 2004 (3 ways), O'Reilly 2001 (2 ways), O'Sullivan 2004, Ring 2004 (4 ways), Shah 2008
Gender	6	Cooper 2005, EPHRO 2004,Knowles 2006, Sood 2008, Turnbull 2008, 2011
Age	5	Cooper 2005, EPHRO 2004, Knowles 2006, Sood 2008, Turnbull 2008,
Distance (straight line in km)	5	Munro 2003, O'Reilly 2001, Turnbull 2008, 2010, 2011
Ethnicity	4	EPHRO 2004, Ring 2004, Shah 2008, Sood 2008
Urban/Rural	4	Munro 2003, Turnbull 2008, 2010, 2011
Time of call	3	Beale 2006, Munro 2003, Turnbull 2011
Road travel times	2	Munro 2003, O'Reilly 2001
Smoking status	2	O'Hara 2011, Sood 2007
Child present	1	Shah 2008
Older person present	1	Shah 2008

Variable	Number of times used	References
English as 1st language	1	Ring 2004
Aboriginal status	1	O'Hara 2011
Fruit and veg consumption	1	O'Hara 2011
Alcohol use	1	O'Hara 2011
Weight	1	O'Hara 2011
Day of week	1	Turnbull 2011
Responsiveness to advertising	1	Siahpush 2007

Again, here categories were not homogenous. In particular, health status was presented in 11 different ways: five measures of ill health were calculated at ward-level: 1) self-reported health-status from Census; 2) Ward-level emergency admission data; 3) ward-level mortality data (EPHRO 2004); 4) the limiting long term illness question from the 1991 Census; and 5) standardised mortality ratios (based on five years' deaths from 1993-1997 (O'Reilly et al. 2001). Individual levels of ill health were also reported many ways: inpatient in last 12 months, outpatient or visited ED in last 3 or 12 months, contact with doctor in last 2 weeks, child receiving regular prescribed medication (Ring and Jones 2004), long-term illness in the house (Shah and Cook 2008) and a morbidity class based on one year's diagnostic information using the Johns Hopkins Adjusted Clinical Groups Case Mix System (O'Sullivan et al. 2004).

2.5.5 Risk of bias within studies (a)

As no RCTs were included in this review, the study designs of most included studies were ranked '-2' to '3' according to SIGN (Table 2.3).

As discussed, the author used the STROBE guidelines to assign a quality score to each study; Appendix 3 holds a copy of the guidelines used. Quality according to STROBE was generally high with scores ranging from 24 – 42. The full scoring for each study can be found in Appendix 5. In particular, studies were very good in stating the background, rationale and study objectives in the Introduction sections and as well in concluding their findings, including mentioning limitations and interpretations and the generalisability of findings.

There was also consistency in where points were low, for example, although many studies explicitly addressed measures to address potential sources of bias in the discussion sections this was not done as robustly in the methods sections, as specified by STROBE. Also several studies failed to report justification for the study size and time period, and why these were chosen. Another area where studies lost "points" was in the Results section under 'other analyses'. According to STROBE, a paper should report 'analyses of subgroups and interactions and sensitivity analyses'. Many studies did not do this although it is not possible to tell whether this was a constraint of the study design itself (e.g. it was not done at all) or this was because of a reporting limitation (e.g. the journal restrictions prevented these analyses from being included in the word count). Indeed, it should be remembered that the intention of the guidelines are for reporting only, they are not prescriptions for designing or conducting studies (Von Elm et al. 2007).

Most studies which used area based measures of deprivation, subdivided them into fifths, except the NZ2001 Index of Deprivation which used an ordinal ranking of 1-10. Although this is an easier way to report findings, it is statistically less tractable. For studies which used questionnaire or telephone interviews to gather data, response rates were generally above 60%, except Ring and Jones (2004) in which the response rate was 47%.

2.5.6 Results of individual studies in original thesis- Demand for telephone based healthcare (a)

The key outcomes of each study are reported in Table 2.6: Characteristics of included studies, above. This section expands on these outcomes, providing statistical evidence where possible. For analysis by demand, the author grouped studies by service: GP OOH, NHSD and other telephone based healthcare services.

Studies exploring deprivation and telephone based demand for GP OOH

Of the five studies exploring demand for GP OOH calls, four used area based measures of deprivation: Townsend score (O'Reilly et al. 2001), underprivileged area score (Salisbury et al. 2000), IMD (Turnbull et al. 2008; 2010). The remaining study (Beale et al. 2006) used council tax rates by individual household to assess demand.

Despite differences in measurements, in all studies contacts with GP OOH services were consistently higher among more deprived groups.

O'Reilly et al. found that levels of Primary Care contacts were positively correlated with deprivation- the higher the deprivation the higher the contact rate, (Pearson correlation co-efficient=0.26, $p<0.001$). When other variables were considered this relationship was still statistically significant: in the final linear regression model, the unstandardised co-efficient for the Townsend score was 0.17, T=3.38, $p<0.001$) (O'Reilly et al. 2001). In practice this represents the difference in call rates per unit of change in Townsend score.

Salisbury and colleagues (2000) were the only authors to use the underprivileged area score, a score designed as an indicator of the general practice workload arising from deprivation. Using this index, Salisbury divided the populations up into deprived and non-deprived areas and found that patients living in deprived areas made 70% more calls than those outside these areas. However results arise from only four co-ops out of the original sample of twenty co-ops.

Two papers in this review reported aspects of the same study using the IMD as an indicator of patient deprivation. (Turnbull et al. 2008; 2010). In the first paper, authors explored the effects of distance and rurality on OOH call rates to a GP co-op (Turnbull et al. 2008) and in the second, analysed call rates specifically about children (Turnbull et al. 2010). Although not the main focus of their study, the authors recognised that deprivation is an inevitable confounder when exploring access to health care through geographical variables and therefore attempted to control for its effects.

In the 2008 paper, call rates were higher in the most deprived fifth: age/sex standardised call rates (per 1000 patients/year) for most deprived fifth: 200 (95% confidence interval (CI): 198-201) compared to the least deprived fifth: 128 (95% CI: 127-130). The effect of deprivation was also more evident in rural areas with town/fringe and village output areas having no callers in the least deprived fifths during the study period. (Turnbull et al. 2008).

In the 2010 paper, focusing specifically on calls about children under 4 years, the authors report a similar story: there were higher rates of calls to GP OOH by those living in the most deprived fifths: age/sex standardised call rates (per 1000 patients/year) for most deprived fifth: 759 (95% CI: 750 -767) compared with the least deprived fifth: 486 (95% CI: 476-496). In urban areas, call rates generally decreased with deprivation but in rural areas there was less variation between deprivation fifths (Turnbull et al. 2010).

At an individual level, council tax band was also found to predict contact rates: the more modest the home, the higher the contact rate (Beale et al. 2006). Across all ages, those with houses in Council Band A had a contact rate of 113 per 1000 patients per annum, compared with those in Council Band E+, contact rate 54 per 1000 patients per annum, $p<0.001$). This statistically significant trend persisted when contacts were broken down by age group.

Studies exploring socioeconomic status and demand for NSHD

Of the six studies exploring the use of NHSDW by deprivation or socioeconomic characteristics: three studies used area based measures of deprivation: Townsend and Jarman scores (Burt et al. 2003) and IMD (ERPHO 2004; Cooper at al 2005). Three used a variety of individual level socioeconomic characteristics (Ring and Jones 2004; Knowles et al. 2006; Shah and Cook 2008).

Area based deprivation scores

The areas where studies took place varied across the UK from a highly urban area in South East London (Burt et al. 2003), to more diverse areas: West Yorkshire (YM) and West Midlands (WM) (Cooper et al. 2005), and Bedfordshire and Hertfordshire (EPHRO 2004).

Both Burt and Cooper found across all ages call rates rose with increasing deprivation until the most deprived fifth where they declined (Burt et al. 2003; Cooper et al. 2005), Table 2.9. This finding was contradicted by the EPHRO report which found the highest call rates in the most deprived area (call rates per 1000 people by deprivation fifth were presented by bar chart, there were no actual figures) (EPHRO 2004).

Table 2.9: IRRs* (Burt et al. 2003) and ORs (Cooper et al. 2005) with 95% CI, by deprivation fifth

Study	Index and area (if applicable)	Deprivation fifth					p value
		1	2	3	4	5	
Burt 2002	Townsend	1	1.3 (0.98-1.71)	1.29 (0.92-1.82)	1.32 (0.93-1.87)	1.01 (0.68-1.52)	0.081
Burt 2002	Jarman	1	1.19 (0.9-1.57)	1.44 (1.03-2.0)	1.19 (0.82-1.74)	1.03 (0.69-1.55)	0.080
Cooper 2005	IMD, WY	1	1.27 (1.2-1.33)	1.45 (1.38-1.53)	1.5 (1.43-1.58)	1.31 (1.25-1.38)	Not given
Cooper 2005	IMD, WM	1	1.31 (1.25-1.37)	1.41 (1.36-1.47)	1.40 (1.35-1.45)	1.22 (1.18-1.27)	Not given

*IRRs= Incident rate ratio: the incident rate in the exposed group, divided by the incidence rate in the unexposed group. ORs =Odds ratio is a method of comparing the probability of having a particular outcome between two groups, an OR of 1 implies that the outcome is equally likely in each group. An OR of >1 implies that the outcome is more likely in that group, whereas an OR of <1 implies that the outcome is less likely in that group.

When patient age was explored separately, calls about children under five years of age were lower in the most deprived areas (for calls about children <1, p=0.06, for calls about children 1-5, p=0.03) although this trend reversed for calls concerning those aged 15-64 where call rates were significantly higher in the most deprived wards, p<0.001. (Cooper et al. 2005).

Individual level socioeconomic characteristics

Papers measuring NHSD use at an individual level derived their data from postal questionnaires, with varying response rates: 47% (Ring et al), 60% (Knowles et al) and 87.7% (Shah and Cook 2008). Although studies employed different ways of measuring socioeconomic characteristics, and Ring et al (2004) looked specifically at calls for children under five years, results indicate that use of NHSD is generally associated with higher socioeconomic status.

Respondents were less likely to have used NHSD if they did not own a car (Ring and Jones 2004; Knowles et al. 2006; Shah and Cook 2008), telephone (Knowles et al. 2006) or computer (Ring and Jones 2004). Those who lived in rented or social housing (Ring and Jones 2004; Knowles et al. 2006; Shah and Cook 2008), were also less frequent users. Respondents were also less likely to use the service if they had left education at a young age (Knowles et al. 2006) and where household income was in the lowest fifth, where the head of the household was from a manual occupation group or was an unskilled manual manager (Shah and Cook 2008). The Social Economic Group (SEG) of the household reference person and whether the person was a professional, employer/manager or inter-junior, did not seem to play a role in determining rates of contact (Shah and Cook 2008). [Specific ORs for each measurement are found in the summaries at the end of this chapter].

Studies of demand for other telephone based healthcare by socioeconomic status
These studies concerned two smoking cessation hotlines, a Cancer Information Service (CIS), a 'Get Health Information and Coaching service' to encourage a healthier lifestyle and 'Healthline'- the New Zealand equivalent of NHSD.

In Australia, Siahpush et al. (2007) used a measure of socioeconomic status derived from the caller's postcode and Index of Socioeconomic Disadvantage to characterise call rates to Quitline (a smoking cessation hotline). Call rates were lower among lower socioeconomic groups: the adjusted rate was 57% (95% CI 45-69%) higher in the least deprived fifth. Although the authors fail to mention what call rates were adjusted on. In contrast, looking at call rates to the American Lung Association National Reactive Telephone Smoking Line, Sood et al (2007) reported a statistically significant overrepresentation of poorer and less educated users relative to the control population of smokers in the US. The convenience sample of adult current smokers who called the hotline for the first time, reportedly achieved a very high response rate of 98.9%.

Bush et al. (2010), studying a Cancer Information Service (CIS) explored how new media (defined as live messaging and email) users differed from telephone callers and the general population in the USA. They used CIS electronic records and compared these with US census data and health information trend surveys. Telephone callers were better educated than the general population but more likely to be from the lowest income category.

For the 'Get Health Information and Coaching service' O'Hara et al. compared participants with the general population and found participants were more likely to come from the lowest two fifths of socioeconomic status as measured by the "Socioeconomic Index for Areas Measured (SEIFA) index (46 % compared with 38% in the general population). However education levels of both groups were similar. This study used data from the first 18 months of service operation and used a telephone survey to collect data with a response rate of 93%.

Call rates to Healthline, New Zealand's telephone health advice, information and triage service showed a similar pattern to call rates to NHSD (Burt et al. 2001; Cooper et al. 2005). The NZ2001 Index of Deprivation was used to identify deprivation codes of callers to the service. Call rates generally increased with increasing levels of deprivation but decreased at the highest level (St George et al. 2006).

Identification of other factors impacting demand

Neither patient age, location, nor time of call (between 12:00 and 7:00am) affected the trend for the more modest the home the higher the GP OOH contact rate (Beale et al. 2006).

In calls concerning NHSD, peak call rates were about children under 5 (EPHRO 2004; Cooper et al. 2005). Use was higher in households were there were children [OR for under 5s= 2.83 (95% C.I.: 2.27-3.53)] and lower in households with older residents [older person present aged 65-74, OR=0.47 (95% C.I.: 0.38-0.58), aged 75+ OR=0.27 (95% C.I.: 0.21-0.35)] (Shah and Cook 2008). Call rates were higher about women and for ages 15-44 ($p<0.001$) (Cooper 2005) although this was not true for patients under 15. The majority of callers were white (EPHRO 2004) and call rates were higher for those classified as white ($p<0.001$) and whose first language was English ($p<0.001$) (Ring and Jones 2004).

Measures of health status varied in terms of impact on calls to NHSD. There were weak positive relationships between call rates and: census health status, emergency admission rate and cancer and circulatory disease mortality although whether these are statistically significant findings is not reported (EPHRO 2004). Those with poorer health status (in terms of GP contact or hospitalisation) did not use the service more frequently than the general population. Only parents with children who were outpatients within the last 12 months make greater use of the service ($p<0.04$) (Ring and Jones 2004). Long-standing illness and limiting illness also predicted use (Shah and Cook 2008). However, for GP OOH use, standardised mortality ratios and limiting long term illness were not significantly associated with GP OOH contacts (O'Reilly et al. 2001).

Different socioeconomic groups had similar levels of responsiveness to antismoking advertisements and this did not effect call rates (Siahpush et al. 2007). However in calls to one smoking cessation line (ALA), there was a statistically significant overrepresentation of blacks, non-Hispanics, women, urban residents and those 45 years and older in comparison to the control population ($p<0.001$) (Sood et al. 2008).

Distance from the PCC was found to play a statistically significant role in demand, as distance increased call rates decreased suggesting that those who lived further away were less likely to call (O'Reilly et al. 2001; Turnbull et al. 2008; 2010). This was the case for both measures of distance: in km and by travel time. Similarly, call rates were higher in urban areas and lowest for sparse villages and hamlets (Turnbull et al. 2008).

2.5.7 Studies of outcomes of telephone based healthcare from original thesis (a)

There were only five studies which explored outcomes. For calls to GP OOH co-ops, three studies looked at the likelihood of being seen face to face or receiving telephone advice only and, for those patients seen, the location of the visit. In two studies, the likelihood of being seen by a GP fell with increasing deprivation: the OR in most deprived fifth on the Townsend score was 0.81 (95% C.I.: 0.74-0.88) (Munro et al. 2003); and the OR in most deprived fifth on the IMD was 0.88 (95% C.I. 0.81-0.95 (Turnbull et al. 2011).

However O'Reilly et al. (2001) also using the Townsend score but in a much larger sample, reported that patients from the most deprived areas were only slightly (but significantly) more likely to see a GP with an OR of 1.01 (95% CI 1.01-1.02).

O'Sullivan et al. (2004) explored whether patients received home visits over a year using occupation questions asked in the 1991 Census as an indicator of socioeconomic status; in contrast they found the 'unskilled' social class had the highest OR of receiving a home visit: 1.36 (95% C.I.: 1.3–1.42).

However there were consistent findings for those triaged to see a GP: home visits were more likely for those in deprived areas with: odd ratios for those in the most deprived fifths of: 1.11 (95% C.I. 1.1-1.12) (O'Reilly et al. 2001), 1.98 (95% CI: 1.64-2.4) (Munro et al. 2003) and 1.52 (95% C.I. 1.30 -1.79) (Turnbull et al. 2011).

For the GHS service, outcomes were patient led and concerned whether the participant wanted to receive information only or participate in a coaching based programme. Results according to socio-economic status varied: those with tertiary education (the highest level of education) ($p<0.001$) and those from the least disadvantaged fifths 1 and 2 were more likely to enrol in coaching ($p \leq 0.05$). In contrast, respondents who were unemployed ($p \leq 0.05$) and those from the most disadvantaged fifth were also likely to do coaching ($p \leq 0.05$) (O'Hara et al. 2011).

Identification of other factors impacting outcomes

The likelihood of being seen face to face fell with increasing road travel and straight line distance to the PCC (O'Reilly et al. 2001; Munro et al. 2003; Turnbull et al. 2011). Results were conflicting if the patient was to be seen: with distance not affecting the location (Munro et al. 2003) and increasing the likelihood of receiving a home visit (O'Reilly et al. 2001; Turnbull et al. 2011). Female patients were less likely to be seen in person then men. Patients who called between 12-8am were also less likely to be seen in person, but when seen, this visit was more likely to be at home. Additionally the likelihood of being seen face to face was higher on a weekend (Munro et al. 2003).

Increasing age increased the likelihood of a face-to-face consultation, with the exception of older females who were 20% more likely to receive telephone advice only. Neither mortality, nor long term illness were shown to be significant predictors of seeing a GP (O'Reilly et al. 2001).

2.5.8 Additional analysis (a)

Where possible the author categorised socioeconomic and other characteristics into similar categories. However, this was not tested statistically and involved intuition on the part of the author. Due to heterogeneity in study design, and particularity in assessment and measurement of socioeconomic characteristics, the author did not pool study results into a meta-analysis. However, with more time, this is something that could be explored in the future.

2.6 Discussion (a)

2.6.1 Demand for telephone based healthcare services (a)

Summary of evidence

Nineteen papers were included in the review, covering a variety of services: GP OOH, NHSD, Healthline, Smoking Cessation, cancer services and a healthy eating programme. Essentially these services can be divided into two main types of telephone based healthcare: those used for triage help, advice or information (e.g. GP OOH, NHSD and Healthline) and subject specific healthlines (cancer, smoking and healthy eating). Generally results indicate that those from lower socioeconomic backgrounds use the first services more (with some exceptions discussed below) and the subject specific helplines are used by those from more affluent backgrounds. However, as these telephone lines are unique it is difficult to generalise results beyond what is reported here.

All studies exploring GP OOH services and NHSD took place within the UK and contrasting findings emerged with respect to these services. Use of telephone based GP OOH services was associated with higher deprivation both measured at an individual level (council tax band) and using area based indicators. In contrast, at an individual level, NHSD use was consistently associated with higher socioeconomic status. Using area based indicators, results suggest that NHSD use rises with increasing deprivation but falls off in the most deprived fifths. There are however some contradictions to this, with one report suggesting use continues to rise with deprivation. Also, calls concerning patients 15-64 were highest in the most deprived fifth. For Healthline, use increased with deprivation but declined in the most deprived tenth (St. George 2006).

One possible explanation as to why use of GP OOH services is higher among more deprived groups is because these services are well known while NHSD is still relatively new. Victora and colleagues (2000) refer to the 'inverse equity hypothesis' the phenomenon that exists when new public health interventions lead to widening of inequalities as they are adopted first by the more affluent. Often changes in services to improve access, are less appropriate for those who may already be disadvantaged in terms of healthcare needs (Salisbury and Coulter 2010). Indeed this could be reinforced by existing confusion about which service people should contact in the event of unscheduled but not emergency healthcare needs (e.g. where the problem needs to be treated but doesn't require an ambulance response) (Department of Health 2008; Salisbury and Bell 2010).

One of the components of the access to healthcare definition adopted for this study is need. Health inequalities suggest that need for all types of healthcare should be higher among those with lower socioeconomic status or living in deprived areas. However, results here for NHSD and Healthline, suggest that the services are not being used by groups experiencing extreme deprivation. A potential explanation for this could be healthseeking behaviour and in particular patient's perceptions of medical urgency. However, studies have concluded that it is unlikely that perceptions vary by socioeconomic deprivation (Campbell 1999) and that socio-economic position is not related to patients failing to refer themselves to care (Adamson et al. 2003). However the literature notes that more research identifying influences on callers' perceptions of urgency is needed (Wrigley et al. 2002).

Other significant variables affecting demand

Distance to a PCC and rurality were shown to have a statistically significant impact on demand as did ethnicity, age and gender. There were mixed results amongst the studies in terms of the relationship between measures of health and demand. Measures which were statistically significant included whether a child was an outpatient in the last three months (Ring and Jones 2004); long standing illness and limiting illness (Shah and Cook 2008). However, in another study long term illness and standardised mortality ratios were not statistically significant predictors of demand for telephone based healthcare (O'Reilly et al. 2001).

2.6.2 Outcomes of telephone based healthcare (a)

Summary of evidence

By socioeconomic status

There were no studies reporting NHSD outcomes by socioeconomic characteristics. For GP OOH services, results were conflicting: with increasing deprivation, the likelihood of being seen by a GP both increased (O'Reilly et al. 2001; O'Sullivan et al. 2004) and decreased (Munro et al. 2003; Turnbull et al. 2011). However those from deprived areas were more likely to be seen at home (O'Reilly et al. 2001; Munro et al. 2003; Turnbull et al. 2011). This agrees with outcomes from other healthcare services in which patients from more deprived backgrounds receive higher triage level outcomes (Pollock and Vickers 1998; O'Donnell et al. 1999; Beattie et al. 2001) and could potentially suggest an unmet need in either primary care or a lack of preventative care on behalf of the patient, the so called inverse prevention law, when preventative interventions are more likely to be successful in the more affluent (Department of Health 1998). For the healthy eating programme outcomes were patient chosen and are difficult to generalise beyond that individual study (O'Hara et al. 2011).

Other significant variables affecting outcomes

As above with demand, distance from the PCC, patient gender, time and day of call and age of patient all had a statistically significant impact on outcomes. Standardised mortality ratios and limiting long term illness did not impact on outcomes.

2.6.3 Limitations of studies appraised (a)

Overall quality of the studies as ranked by STROBE was high although certain limitations exist within, and across studies:

- <u>Different units and levels of measurements can give different results</u>

This is true for both measurements of socioeconomic status and for other variables. Studies reviewed here have had competing results, particularly with respect to the socioeconomic measurement used. For example, in the majority of studies using deprivation codes to measure access to NHSD, demand increases with deprivation but tails off in the most deprived fifth. However, using individual socioeconomic characteristics, use by those with lower status is consistently lower.

Similarly between the studies reviewed here there were 11 different ways of measuring health status. Some of which showed a statistically significant impact on demand for telephone based healthcare (for example outpatient status) and some which didn't (standardised mortality ratios). In one study, limiting long term illness measured at individual level showed a statistically significant impact on demand (Shah et al. 2009) while in another study, this was measured at an area level and showed no impact (O'Reilly et al. 2001).

- Difficulties in accounting for all potential confounders

Patients' decisions to seek healthcare are a result of a variety of factors including among many lifestyle factors, health beliefs and access to healthcare. Similarly, a healthcare practitioner will also account for many variables when deciding a consultation outcome. Although some studies did attempt to control for some confounders (e.g such as deprivation, distance and rurality), some studies reviewed here did not look beyond age and gender as potential confounders. However, given the nature of possible impacts on demand for healthcare and outcomes, it is unlikely that any one study will be able to control for all possible cofounders.

One potential confounder however that was missing was patient complaint – no study reviewed took account of either the nature or the severity of caller symptoms and the impact of this on demand or on outcomes. For example, it may be that severity of illness impacts on a patient's willingness to travel (thus encouraging use of telephone based healthcare as a first resort) and subsequently on the perceived need for face-to-face contact thus impacting the advice given.

- No evidence of outcomes from NHSD by socioeconomic status

Several studies included here have shown outcomes of GP OOH contacts to vary by socioeconomic status. However there is a large gap in the evidence concerning the impact, if any, of socioeconomic status on outcomes from NHSD. Perhaps one potential reason why this research has not yet been done is because NHSD uses a

CDSS system (CAS) in which to triage callers to the appropriate levels of care whereas GP's do not rely on such a tool. As CAS is based on algorithms which provide a predetermined pathway of questions leading the nurse to a final outcome, in theory, dispositions should be consistent across all scenarios. However, as discussed in Chapter 1, evidence indicates that the disposition given by NHSD nurses does vary in line with a number of nurse and system factors again reinforcing that there is an evidence gap in exploring variations across patient socioeconomic characteristics.

- Study design and methodological considerations

For studies which use area based measures of deprivation, the ecological fallacy- the error of ascribing characteristics of a group to individuals within that group (Selvin 1958) exists. For example, although an area may have a certain deprivation score, not everyone within that area will experience the characteristics associated with that score. Additionally, all area based studies were presented in fifths, presumably as this is easier to report. However, this often results in a loss of data and results would be more robust if the full range of deprivation scores were included (Royston et al. 2006; Valerii et al. 2009).

Studies which relied on response rates can be subject to responder bias, when respondents answer questions in a way in which they believe they should answer, not based on their true beliefs. Additionally, the recall of healthcare use is subjective and relies on respondents accurately recollecting events that may have taken place many weeks or months previously (Coughlin 1990). As well, low response rates can prevent generalisability of findings, although studies included here generally had high response rates.

- Lack of qualitative research to understand why

Research focusing on the influences of callers' perceptions of urgency in terms of when and where to seek healthcare is essential if knowledge concerning the demand for emergency care is to be improved (Wrigley et al 2002). Yet of the nineteen studies reviewed there was only one study (Turnbull et al. 2010) which attempted to address how and why study results occurred. This study focused mainly on the influence of distance on demand for GP OOH services and concluded that "geographical variation was linked to familiarity with the system (notably previous contact with health services) and the availability of services, legitimacy of demand and negotiation about mode of care".

- Localised services makes generalisability difficult

This was not an issue in all studies as several used country wide data. However for the majority of studies focusing on GP OOH services and NHSD these were concentrated on one or two areas in the country. For example, the three studies by Turnbull et al all took place in Devon, England. Authors note that although pockets of deprivation exist, the area is relatively affluent compared to the rest of the UK and has comparatively good levels of health (Turnbull et al. 2008). Similarly, one study of demand for NHSD took place in inner city London (Burt et a. 2003) which may have different healthcare patterns to the rest of the UK. Indeed, at least two studies showed variations on areas within their study (O'Reilly et al. 2001; Cooper et al. 2005). The exception to this limitation is Salisbury et al. (2000) who stratified selection of co-ops by region and size.

- Lack of data collection over extended periods of time and justification for study time periods

Only five studies justified the period of data collection leaving the author unsure in the other studies as to the significance of the time period chosen and possible implications on the generalisability of results over time. Generally studies reporting on subject specific healthlines had longer periods of data collection, the longest of which was 5 years for a Cancer Information Service (Bush et al. 2010). Studies which focused on GP OOH and NHSDW did not have study periods longer than one year and many were for six months only. By having longer study periods, seasonal variations (for example Christmas) and anomalies in demand get ironed out, allowing a more accurate picture of service use to emerge.

2.6.4 Limitations of this review (a)

- Lack of international studies

The search strategy did not pick up many international articles with respect to the demand for or outcomes of contacts with telephone based healthcare. Although publications were retrieved from the UK, USA, Australia and New Zealand, there were no articles from Canada or Sweden, both areas with programmes of telenursing (Stacey et al. 2003; Kumar and Snooks 2011). It is not known whether there has been no research in the area of demand and outcomes by socioeconomic characteristic in other countries or whether the search strategy should be expanded to include additional databases or search terms.

- Difficulties in extrapolating results for services beyond GP OOH and NHSD

There were only two publications which referenced socioeconomic characteristics and smoking cessation hotlines. This is surprising given the evidence that smoking is a trait typically associated with lower socioeconomic groups. As discussed, the author used the technique of "snowballing" or cited reference searching of the included articles but surprisingly, no additional studies were found. It is therefore possible that there not many similar articles or again, it could be a result of a missing term in the search strategy.

As there were only one Cancer information service and one Get Healthy service it is difficult to extrapolate results beyond these two studies in terms of what results can tell us about other services. As Healthline in New Zealand is very similar in its aims and objectives to NHSD, results from this study could possibly be combined with NHSD results.

- Interpretation of STROBE guidelines and quality appraisal

As discussed, there is not yet a recommended quality appraisal tool to use for observational studies. Thus the author has used the STROBE guidelines which measure the quality of reporting, not the conduct of the study itself. Thus, it is possible that poorly designed studies in which all items as necessitated by STROBE were reported could score a higher quality score than perhaps better designed studies which may not have reported to the STROBE guidelines. It is also possible that using a different tool would result in different quality scores.

There is some degree of personnel interpretation in applying the guidelines (for example, in assessing if all potential confounders have been considered) and as the author applied the checklist to all studies individually, it is likely that someone else may have different results. In hindsight, having another independent researcher verify the application of quality scores would have been beneficial and provided confidence in the appraisal process. That said, no papers were excluded based on their scores and the author has treated all papers equally in terms of their contribution to the review.

2.6.5 Strengths of this review (a)

The six literature reviews concerning various aspects of telemedicine that were uncovered during the course of this review indicate the growing applicability of this technology to healthcare. These reviews highlight the high values of user satisfaction and evidence of safety and effectiveness of this provision of healthcare (Stacey et al. 2003; Bunn et al. 2005). These facts, along with the growing popularity of telenursing internationally (Kumar and Snooks 2011) and combined with the DH's recent announcement to roll out the '111' number for all urgent healthcare needs in England, indicate, that this form of service delivery is likely to increase. This review, to the author's knowledge is the only systematic review which focuses on telephone based healthcare and access and demand issues across socioeconomic characteristics.

The author conducted this review in a systematic transparent manner and followed the PRISMA guidelines for reporting systematic reviews. The search strategy, inclusion and exclusion criteria are explicitly stated making replication of this study possible. The STROBE guidelines have been used to provide an indication of study quality.

The author used a narrative synthesis framework to bring together study results. This is an emerging method of analysis and is less well known than meta-analysis. However it has been used successfully in a number of cross discipline studies (Oliver et al 2005, Hopkins et al 2001 and Garcia et al 2002). Similarly, in an ESRC methods funded study Popay and colleagues (2006) compared results of analyses on the same data using both methods. Results were broadly similar across the two methods with the narrative synthesis framework more strongly highlighting implications for future research. When compared with a textual thematic approach, narrative synthesis was found to better describe the scope of the existing research but was less strong at identifying commonality in the data (Lucas et al 2007). Although with narrative synthesis care must be taken not to 'over interpret' the data, if authors ensure that the decision making process is clear, this method can also provide transparency of study results.

A meta-analysis, pooling the results of individual studies, is outside the scope of this study; however in using a narrative synthesis framework, the author has laid the foundations for such an analysis to take place in the future.

2.7 Additional studies found between submission and viva (b)

This section reports on the four additional studies found between February 2012 and February 2013 and includes a brief discussion on how the addition of these studies affects the earlier conclusions.

Three of the four studies looked at access to NHSD or NHSDW (Bibi et al. 2005; Cook et al. 2012; Hsu et al. 2013) whereas the fourth report highlighted access and awareness of the new England number 111 (Turner et al. 2012). The studies looking at NHSD were all observational in design using routine data to explore use of the service, whereas in the 111 report, the authors used telephone interviews to collect data. Levels of evidence according to SIGN were quite low and the author assigned all studies a score of '3' (Table 2.3) as the study authors controlled for only one or two confounders.

For the studies concerning NHSD and NHSDW, two looked at all calls over one year (Bibi et al. 2005; Hsu et al. 2013) whereas the other looked at all calls within one month (Cook et al. 2012). Turner and colleagues asked respondents if they had ever used 111 (since inception). As with the other included studies in the literature review, study authors gave little or no justification for the sample periods chosen. Not all studies explicitly stated the statistical methods employed but: Hsu et al used correlation tests while Bibi and colleagues used chi square goodness of fit tests to compare call data with population data. Cook et al used negative binomial regression whereas Turner et al. used logistic regression.

All studies took place in the UK and dates of data collection were from 2002 to 2011.

Findings with respect to demand for NHSDW and deprivation were mixed. Bibi and colleagues found no evidence of any relationship between deprivation and use of NHSD (Bibi et al 2005). This was also echoed in another study exploring use of NHSD by age: in Wales, there was not a clear cut relationship between call rates for older callers and deprivation (Hsu et al. 2013). However in England, when age and gender were accounted for, there were significant interactions between call rates and deprivation. For example, call rates were lowest for children in the most deprived areas (Cook et al. 2012) while people aged 65+ living in the most deprived areas had the highest call rates (Hsu et al. 2013). Male call rates were found to be the highest in the most deprived areas and female call rates for those 60+ were lower in the most deprived areas (Cook et al 2012). For 111, respondents were less likely to have used the service if they owned their own home (Turner at al. 2012).

How did these studies affect the earlier conclusions?

The addition of the three studies exploring use of NHSD and deprivation indicate a non-straightforward relationship between demand and deprivation. Indeed some of the new findings have shown higher use of NHSD in the more deprived areas, particularly for men and those aged 65 and older. In particular, the addition of age and gender affected the results, indicating that these two variables may confound or distort the true relationship between deprivation and demand. The finding that use of the new NHS 111 number was lower among those who owned their own homes goes against the original finding that NHSD is used less by those with lower individual socioeconomic indicators. As this is a new service, more research is needed to confirm this finding. Again, no studies were found exploring the effect of deprivation on the disposition given by NHSD, indicating a major gap in the evidence.

Table 2.10 Characteristics of the new included studies found between submission and viva (b)

ID, First author and year	Country and Service	Sample size/# of respond-ents	Outcome measures (relevant to socioeconomic measurement)	Socioeconomic measurement	Statement of key results
20. Bibi, 2005	UK, NHSD	24 973	Use of NHSD compared with population profiles	IMD 2000	There was no relationship between calls made to NHSD and IMD.
21. Turner, 2012	UK, NHS 111	691	Use of 111	Housing tenure- home ownership	Awareness levels were slightly lower for those without home ownership, although these were not statistically significant (site adjusted p=0.447 and site/age/sex adjusted p=0.190 respectively). Respondents were less like likely to have used NHS 111 if they owned their home (adjusted p=0.039).
22. Cook, 2012	UK, NHSD	341 663	Use of NHSD	IMD 2007 fifths	There were significant interactions between call rates, gender, age and deprivation. Call rates were lowest for children (0-15) in the most deprived areas. Male call rates were highest in the most deprived areas and female call rates for those 60+ were lower in the most deprived areas.
23. Hsu, 2013	UK, NHSD and NHSDW	396 171	Use of NHSD and NHSDW of people 65+	IMD 2007 and WIMD 2008	In England, increasing deprivation was associated with more calls: older people living in the most deprived areas had the highest call rates. In Wales, the relationship between deprivation and call rates was not as clear: highest call rates were in fifth 2 and lowest in fifth 3 (least deprived was fifth 1).

2.8 Chapter summary (a and b)

The systematic literature review conducted in this chapter aimed to answer the questions: "what is known about the association between patient deprivation or socioeconomic status and a) demand for and b) outcomes of contacts with telephone based healthcare. The author has used narrative synthesis analysis to summarise the results of 19 studies which met the inclusion criteria (in the original thesis) and discussed the current state of evidence. Gaps in the evidence were identified including limitations inherent within the investigations, justifying both the need for this review and indicating where future research is needed. The addition of the four new studies found between submission and viva showed that the addition of other variables such as age and gender can change the relationship between deprivation and demand. The next chapter takes the knowledge gained both from this systematic review and from Chapter 1 to inform the design of this study and refine the research aim, question and objectives.

Annex 2.1 Data extraction for included studies in original thesis (a)

Data extraction guidelines

Study	**Id, first author and year**
Notes	Demand, outcomes or both and more notes if needed
Study characteristics	
Study aim/research questions	
Service studied	
Study design	
Data source(s)	
Statistical methods	
Setting and date	Country and year of data collection
Study site(s)	
Sample size	
Population	urban, rural, mixed, unknown, age limits, etc
Sampling	random, non-random, total pop, unknown (if applicable)
Socioeconomic characteristics	description and measurement
Other characteristics accounted for	e.g.: gender, age or confounding factors controlled for
Results	
Response rate	if applicable
Study outcomes	principal or secondary, definition, number of subjects, methods for assessing, timing of assessment
Service use: socioeconomic summary	text summary of the association between socioeconomic characteristics and demand for telephone based healthcare
Service use: key socioeconomic statistics	e.g. odds* or incidence rates ratio, significance levels, etc
Outcomes: socioeconomic summary	Text summary of the association between deprivation and advice or information, treatments, etc from telephone based healthcare
Outcomes: key socioeconomic statistics	e.g. odds or incidence rates ratio, significance levels, etc
Other findings	List of statistical and non-statistical influential variables for service use or outcomes of telephone based healthcare
Level of evidence	According to SIGN 2011 level of evidence hierarchy
Quality of evidence	Lewis and Black for RCTs and controlled studies, STROBE guidelines for observational studies

*The Odds ratio is a method of comparing the probability of having a particular characteristic between two groups. An odds ratio of 1 implies that the characteristic is equally likely in each group. And odd ratio greater than 1 implies that the characteristic is more likely in that group. An odds ratio of 1 implies that the characteristic is less likely in that group.

Study	**ID1, Beale, 2006**
Notes	Demand
Study characteristics	
Study aim/research questions	Can council tax valuation bands predict GP out-of-hours demand
Service studied	GP OOH
Study design	Cross sectional study
Data source(s)	GP OOH routine data
Statistical methods	Chi-squared tests
Setting and date	UK, Jan-April 2004
Study site(s)	North Wiltshire: Calne, Corsham, Malmesbury
Sample size	1335, but 1297 assigned council tax band (97%)
Population	Not stated
Sampling	All calls in time period
Socioeconomic characteristics	Patients assigned council tax band
Other characteristics accounted for	Age, area and calls between 12:00 am and 7:00am
Results	
Response rate	n/a
Study outcomes	GP OOH contact rates
Service use: socioeconomic summary	Council tax band predicts OOH GP contact rates, the more modest the home the higher the GP contact rate, irrespective of age and sex.
Service use: key socioeconomic statistics	OOH contact rates per 1000 patients per annum, p<0.001 **Council Tax Band** **A B C D E+ chi-squared** All ages 113 84 74 47 54 105.0 0-15 143 118 126 63 91 23.2 16-44 91 72 53 31 33 55.2 45-64 75 46 43 16 27 27.7 ≥65 190 129 102 104 99 19.4
Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic statistics	Not stated
Other findings	There was lower overall demand in Malmesbury but the council band vs contact rates trend remained in all three areas. Results for contacts between midnight and 7:00 were also statistically significant. OOH contact rates per 1000 patients per annum, p<0.001 **Council Tax Band** **A B C D E+ chi-squared** Calne 118 103 92 64 60 38.1 Cors. 138 89 95 46 59 52.2 Malm. 103 54 44 39 56 20.2 Whole study contacts between 12-7am 18 15 12 8 8 18.6
Level of evidence	**3**
Quality of evidence	**35**

Study	ID 2, Burt J, 2003
Notes	Demand, Inner city setting, London may have different healthcare patterns to rest of population
Study characteristics	
Study aim/research questions	What is the relationship between use of NHSD and deprivation?
Service studied	NHSD
Study design	Observational study
Data source(s)	NHSD Clinical Advice System
Statistical methods	Negative binomial regression
Setting and date	England: South East London (SEL), 2001 - 2002
Study site(s)	Lambeth, Southwark and Lewisham (LSL) and Bexley, Bromley and Greenwhich (BBG)
Sample size	75 928 downloaded but due to missing data: 67 091 final number of calls
Population	Mainly urban (inner city)
Sampling	All calls to NHSD SEL from 1 Sept 2001 to 28 Feb 2002 (6 months)
Socioeconomic characteristics	Jarman and Townsend Deprivation indices
Other characteristics accounted for	Analyses adjusted for proportion of under 5s and over 65s in each ward and for area
Results	
Response rate	Not applicable
Study outcomes	6 monthly call rates to NHSD SEL, linked with deprivation codes
Service use: socioeconomic summary	Call rates to NHSD varied across wards. Six monthly call rates per 1000 population ranged from 0.1 to 64.3 (median 34.7, interquartile range 26.2 to 45.9). Call rates were lower in both the most affluent and most deprived wards. Calls rose with increasing deprivation until at extreme levels of deprivation they declined. There was a significant non-linear (quadratic) effect of both indices on call rates. Jarman (chi-squared=30.8, df=2, p<0.001), Townsend (chi-squared=19.1, df=2, p<0.01).
Service use: key socioeconomic statistics	**Townsend** **IRR*** **(95% CI)** **p value** fifth 1 1 p=0.081 fifth 2 1.3 (0.98-1.71) fifth 3 1.29 (0.92-1.82) fifth 4 1.32 (0.93-1.87) fifth 5 1.01 (0.68-1.52) **Jarman** **IRR*** **(95% CI)** **p value** fifth 1 1 p=0.080 fifth 2 1.19 (.9-1.57) fifth 3 1.44 (1.03-2.0) fifth 4 1.19 (.82-1.74) fifth 5 1.03 (.69-1.55) *Adjusted for region, proportions of under 5s and over 65s
Outcomes: socioeconomic summary	None reported
Outcomes: key socioeconomic statistics	None reported
Other findings	n/a
Level of evidence	3
Quality of evidence	35

Study	**ID3, Bush, 2010**
Notes	Demand
Study characteristics	
Study aim/research questions	To determine how new media (live messaging and email) users differ from telephone callers and US pop in general
Service studied	Cancer Information Service (CIS)
Study design	Observational study
Data source(s)	CIS electronic records, US census data and health information trend surveys for comparison
Statistical methods	Parametric or non parametric tests
Setting and date	US, 2003-2008
Study site(s)	Not applicable
Sample size	825,869
Population	Varied- all of US
Sampling	Not applicable
Socioeconomic characteristics	Education, total household income
Other characteristics accounted for	Gender, ethnicity, race
Results	
Response rate	All calls in time period
Study outcomes	Use of services
Service use: socioeconomic summary	Telephone callers were predominantly female, white and well educated compared with general population. CIS users were more represented in the lowest income category compared with LiveHelp users and the general population.
Service use: key socioeconomic statistics	**Characteristic / % of tele users / % Livehelp users / % gen pop** College grad or higher: 40 / 49 / 24 **Total household income** <$39k (b) or <$35k (c): 55 / 35 / 33 $39k-$80k (b) or $35k-$75k (c): 26 / 32 / 30 >80k (b) or>$75k (c): 19 / 32 / 28 corresponding income ranges: b= from CIS, c=US census
Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic statistics	Not stated
Other findings	Total Live messenger users were younger, more affluent and more educated then telephone users and the general pop.
Level of evidence	**3**
Quality of evidence	**28**

Characteristic	% of tele users	% Livehelp users	% gen pop
College grad or higher	40	49	24
Total household income			
<$39k (b) or <$35k (c)	55	35	33
$39k-$80k (b) or $35k-$75k (c)	26	32	30
>80k (b) or>$75k (c)	19	32	28

Study	**ID 4, Cooper D, 2005**
Notes	Demand
Study characteristics	
Study aim/research questions	Assess the effect of deprivation on call rates and to additionally explore the impact of age and sex
Service studied	NHSD
Study design	Observational study (ecological analysis)
Data source(s)	NHSD routine data
Statistical methods	Negative binomial regression model
Setting and date	July 2001- Jan 2002
Study site(s)	West Yorkshire, West Midlands
Sample size	included calls, : 70% (40,345) of calls to West Yorkshire, 86% (45 156) to West Midlands
Population	not stated
Sampling	Triage calls to NHSD
Socioeconomic characteristics description and measurement	IMD was used as an indicator of deprivation
Other population characteristics accounted for	Independent variables included in model: age group, sex, deprivation fifth, edge ward.
Results	
Response rate	Not applicable
Study outcomes	call rates to NHSD (age, sex standardised)
Service use: socioeconomic summary	For all ages, demand was highest at deprivation levels 3 and 4 and fell in most deprived areas. In WY, call rates for those under 5 were lower in most deprived areas (>1 p=.06; 1-4, p=0.3). For those 15-64, call rates were significantly higher in most deprived areas (p<0.001)
Service use: key socioeconomic statistics	**WY Dep** / **OR (CI)** / **WM** / **OR (CI)** 1 least dep / 1 / 1 / 1 2 / 1.27 (1.2-1.33) / 2 / 1.31 (1.25-1.37) 3 / 1.45 (1.38-1.53) / 3 / 1.41 (1.36-1.47) 4 / 1.5 (1.43-1.58) / 4 / 1.40 (1.35-1.45) 5 most dep / 1.31 (1.25-1.38) / 5 / 1.22 (1.18-1.27) **WY <1** / **OR (CI)** / **1-4** / **OR (CI)** 1 / 1 / 1 / 1 2 / 1.02 (0.8-1.3) / 2 / 0.85 (-1.32) 3 / 1.16 (0.91-1.48) / 3 / 1.28 (1.03-1.59) 4 / 1.09 (0.85-1.39) / 4 / 1.1 (0.87-1.37) 5 / 0.8 (0.63-1.01) / 5 / 0.8 (0.65-0.99)* **5-14** / **OR (CI)** / **15-44** / **OR (CI)** 1 / 1 / 1 / 1 2 / 1.24 (0.98-1.59) / 2 / 1.26 (1.03-1.54)* 3 / 1.63 (1.29-2.08)* / 3 / 1.4 (1.15-1.71)* 4 / 1.61 (1.27-2.06)* / 4 / 1.61 (1.31-1.97)* 5 / 1.32 (1.05-1.67)* / 5 / 1.56 (1.29-1.89)* **45-64** / **OR (CI)** / **65+** / **OR (CI)** 1 / 1 / 1 / 2 / 1.28 (1.02-1.62)* / 2 / 1.07 (0.83-1.37) 3 / 1.49 (1.19-1.89)* / 3 / 1.12 (0.87-1.43) 4 / 1.43 (1.13-1.81)* / 4 / 1.16 (0.91-1.5) 5 / 1.48 (1.18-1.85)* / 5 / 0.97 (0.76-1.23) *=significant p value

Outcomes: socioeconomic summary	None reported
Outcomes: key socioeconomic statistics	None reported
Other findings	Call rates were highest for children <5 and overall the ratio of female to male calls was higher, although this trend did not continue when age levels were broken down. Call rates about boys were higher than concerning girls although this was not statistically significant. Call rates were higher about women than men, especially for 15-44 year old ($p<0.001$).
Level of evidence	**2-**
Quality of evidence	**37**

Study	**ID5, ERPHO, Eastern Region Public Health Observatory**
Notes	Demand, report-don't think it has been peer reviewed
Study characteristics	
Study aim/research questions	What are the characteristics of patients using NHSD Beds and Herts? Is there a relationship between call rates and deprivation and between call rates and need for health care?
Service studied	NHSD
Study design	Observational study
Data source(s)	NHSD routine data
Statistical methods	Not stated
Setting and date	UK, 1 Nov 2003 – 31 Oct 2004
Study site(s)	Bedfordshire and Hertfordshire NHSD
Sample size	135,564 calls
Population	not stated
Sampling	All calls within the year
Socioeconomic characteristics	IMD 2004 fifths
Other characteristics accounted for	age and sex standardised call rates, ethnicity, all cause, cancer, circulatory disease and emergency admission data, self reported health status from 2001 census
Results	
Response rate	n/a
Study outcomes	Call rates
Service use: socioeconomic summary	In terms of deprivation, call rates were greater in the deprived fifths than the most affluent.
Service use: key socioeconomic statistics	Report shows fifths and call rates but no figures, therefore these are estimates: approximate call rate per 1000 people, fifth 1 is 70, fifth 2: 80, fifth 3: 85, fifth 4: 93, fifth 5 (most deprived): 97.
Outcomes: socioeconomic summary	None reported
Outcomes: key socioeconomic statistics	None reported
Other findings	Peak call rates were for children aged 0-4. After 10-14 years, call rates were higher in females. The majority of callers reported their ethnic group as white. There was a very weak positive linear relationship between census health status and call rate (R^2=0.0526). There was a weakly positive linear association between emergency admission rate and call rate (R^2=0.1594). Plots for cancer and circulatory disease mortality show a very weak positive relationship (R^2=0.0844).
Level of evidence	**3**
Quality of evidence	**24**

Study	**ID6, Knowles, 2006**
Notes	Demand, one of a few studies at individual not area level
Study characteristics	
Study aim/research questions	Are there any socio-economic characteristics associated with NHSD use at individual level
Service studied	NHSD
Study design	Cross sectional
Data source(s)	Self reported from postal survey. Addresses supplied from health authority registers (3) and electoral roll (1)
Statistical methods	Logistic regression
Setting and date	England, UK, 2002
Study site(s)	4 sites: Preston/Chorley, Sheffield , Northumbria and North Tyneside
Sample size	15 004
Population	Unknown, health authority registers included all age groups, electoral roll limited to those 18+
Sampling	Random sample
Socioeconomic characteristics	Number of cars and vans used by household, tenure (owner or non owner), age left education, use of phone at home, difficulties reported in using a phone
Other characteristics accounted for	OR standardised by: age group, sex and survey area, also looked at gender and age separately, difficulty using phone
Results	
Response rate	60% (8750/14,516)
Study outcomes	Use of NHSD
Service use: socioeconomic summary	A quarter of respondents had used NHSD. Respondents were less likely than others to have used NHSD if they were male, aged 65+, lacked access to a car or telephone, did not own their own homes, or had left full-time education at a younger age.
Service use: key socioeconomic statistics	**# vehicles** / **OR (CI)*** / **Tenure** / **OR (CI)*** 0 / 1 / Owner / 1 1 / 1.27 (1.09,1.47) / Non owner / 0.93 (0.82,1.05) 2+ / 1.35 (1.17,1.58) **Age left ed** / **OR (CI)*** / **use of phone** / **OR (CI)*** 12-14 / 1 / yes / 1 15-16 / 1.12 (0.85,1.47) / no / 0.58(0.38,0.89) 17-18 / 1.39 (1.03,1.87) 19+ / 1.46 (1.09,1.96) ***Adjusted OR (age group, sex, survey area)**
Outcomes:	None reported
Outcomes: key socioeconomic statistics	None reported
Other findings	There were more females who used the service and those 65+ used the service less. Respondents were less likely to use service if they had difficulty in using a phone as a result of language (OR for those with language difficulties: 0.49 (0.22-1.08) or hearing difficulties (OR: 0.65, CI 0.643-0.97). **Sex** / **OR, CI** / **Age (yrs)** / **OR,CI** Male / 1 / 0-4 / 1 Female / 1.63, (1.47-1.80) / 5-17 / 0.34 (0.27-0.45) 18-34 / 0.88 (0.69-1.12) 35-64 / 0.56 (0.45-0.70) 65+ / 0.22 (0.17-0.28)
Level of evidence	**2-**
Quality of evidence	**33**

Study	ID7, Ring 2004
Notes	Demand, looks at awareness and usage
Study characteristics	
Study aim/questions	To determine if NHSD is being used by those with the greatest need
Service studied	NHSD
Study design	Cross-sectional
Data source(s)	Self-reported from postal questionnaire
Statistical methods	Not stated
Setting and date	UK, North London
Study site(s)	2 general practices in Edgware and Burnt Oak
Sample size	1000
Population	Urban, with moderate to high Jarman deprivation levels
Sampling	Every 3rd child aged less than 5
Socioeconomic characteristics	Owner occupier (accommodation status), Car ownership Computer ownership
Other characteristics accounted for	Inpatient (<12 months), outpatient or ED (<3 months), contact with doctor (<2 weeks), child receiving regular prescribed medication. Ethnicity and language: white ethnic groups, English as first language
Results	
Response rate	47% (461/976)
Study outcomes	Service awareness and usage
Service use: socioeconomic summary	79.6% (367/461) were aware of NHSD and 62.7% (289/461) had used the service, with 53.5% (247/461) having contacted about a child aged 0-5. Higher socioeconomic status appears to be associated with greater usage. Results also suggest that those with poorer health status do not contact NHSD more frequently than the general population. However, parents of children who have been out patients within the last 12 months make greater use of the service.
Service use: key socioeconomic statistics	**Socioeconomic status** — **OR (CI) (not adjusted)** — **p value** Owner occupier — 1.92 (1.30-2.82) — <0.001 Car ownership — 2.30 (1.41-3.73) — <0.001 Computer ownership — 1.01 (0.67-1.51) — 0.97
Outcomes: socioeconomic summary	None reported
Outcomes: key socioeconomic statistics	None reported
Other findings	There was low usage among people of ethnic minority and for those whose first language was not English. Those with poorer health status (in terms of GP contact or hospitalisation do not use service more frequently than general pop. Only parents with children who have been outpatients within last twelve months make greater use of the service. **OR (CI) (not adjusted)** — **p value** White ethnic — 2.09 (1.44-3.01) — <0.001 English 1st language — 1.41 (1.30-2.94) — 0.001 Inpatient (<12 months) — 1.2 (0.70-2.06) — 0.5 Outpatient/ED (<3 mos) — 1.5 (1.01-2.4) — 0.04 Contact with GP (<2 wks) — 1.2 (0.77-1.88) — 0.41 Child receiving prescribed meds — 1.33 (0.78-2.28) — 0.33
Level of evidence	2-
Quality of evidence	33

Study	**ID8, Salisbury, 2000**
Notes	Demand
Study characteristics	
Study aim/research questions	To determine the level of demand and supply of OOH care from a nationally representative sample of general practice cooperatives
Service studied	OOH GP co-ops
Study design	Observational study
Data source(s)	GP co-op routine data
Statistical methods	Not stated but did sensitivity analysis based on non-responding practices
Setting and date	UK, 1 Sept 1997 – 31 August 1998
Study site(s)	20 Co-ops in England and Scotland
Sample size	899 657 OOH calls over 12 months
Population	Not stated but assumed mixed
Sampling	All 8 co-ops which collected postcode data, random selection of 12 others after stratification by region and size
Socioeconomic characteristics	Underprivileged area scores, >30 is deprived
Other characteristics accounted for	Age and sex standardised call rates
Results	
Response rate	87% (to recruit 20 co-ops, authors approached 23), due to missing data, etc some co-ops excluded, final response rate for request for pop details was 88%
Study outcomes	Numbers, age and sex specific call rates, variation in demand by population characteristic, timing of calls, outcomes from contacts (proportion of patients consulting at home, at a PCC, by telephone), response times, hospital admissions
Service use: socioeconomic summary	OOH call rate was 159 calls per 1000 patients/year. Analysis by deprivation was conducted on data from 4 co-ops. Patients living in deprived areas made 70% more calls than those in deprived areas although this had no effect on overall demand. Overall call rate deprived areas 239 (235-242), non deprived area 141 (141-142).
Service use: key socioeconomic statistics	Table: Annual call rates per 1000 pop for co-ops covering dep pops Rate per 1000 pop / Co-op: A, B, C, D, Overall (CI) Deprived areas: 286, 201, 267, 193, 239 (235-242) Non-deprived: 190, 127, 177, 131, 141 (141-142)
Outcomes: socioeconomic summary	Not stated by deprivation
Outcomes: key socioeconomic statistics	Not stated by deprivation
Other findings	Not stated in relation to deprivation
Level of evidence	**+1**
Quality of evidence	**40**

Study	ID9, Shah, 2008
Notes	Demand, Not just about NHSD use, about casualty as well, NHSD use only came from interviews, not GHS itself.
Study characteristics	
Study aim	To describe use of casualty and NHSD in same population
Service studied	NHSD, casualty
Study design	Secondary data analysis of General Household Survey (GHS)
Data source(s)	GHS is annual survey of private households in UK undertaken by ONS to support government planning
Statistical methods	Logistic regression (sampling design of study including weighting, clustering at area and household level and regional stratification accounted for)
Setting and date	UK: 2004-05
Study site(s)	UK wide
Sample size	12 149 households sampled
Sampling	Households selected using probability stratified clustered sampling to ensure they represented the general population
Population	General population
Socioeconomic characteristics description and measurement	Lack of access to a car, low-equivalised household income, living in social housing, manual occupation group, receipt of income support
Other population characteristics accounted	Whether a child or older person was present, ethnicity and country of birth of HRP (household reference person), region, long-term illness, cigarette smoking
Results	
Response rate	In total, 16 175 adults and 4246 children included. (all those taking part:20,421). For NHSD data: 7634 (87.7%) answered questions
Study outcomes	Casualty and NHSD use (use not distinguished by interviewee or any other household member). Therefore NHSD use was analysed at household level based on whether any adult in the house had used the service
Service use: socioeconomic summary	87.7% (n=7634) households had adults who answered the question regarding NHSD use with 1624 (20.7%, 19.7 – 21.8) reporting using the service. Measures of material deprivation and social status significantly reduced the likelihood of using NHSD.
Service use: key socioeconomic statistics	**Household** **OR (CI)*** **Own or use car** **OR (CI)*** Non manual 1 yes 1 Manual 0.72 (6.4-0.82) no 0.64 (0.54-0.75) **Accom tenure** **OR (CI)*** **Income support** **OR (CI)*** Owner 1 no 1 Social 0.64 (0.55-0.76) yes 0.65 (0.51-0.82) Private 1.15 (0.96-1.38) **Household income quintile** **OR (CI)** Highest 1 4 0.98 (0.82-1.17) 3 0.80 (0.66-0.96) 2 0.77 (0.63-0.94) Lowest 0.58 (0.48-0.71) **HRP SEG** **OR (CI)*** **manager** **OR (CI)*** Professional 1 skilled manual 0.82 (0.63-1.07) Employer/manager semi-skilled man 0.65

	(0.48-0.88) 0.92 (0.71-1.2) unskilled manual 0.62 (0.42-0.91) Inter-junior 1.09 (0.85-1.39) * OR adjusted for children, older people, illness and region
Outcomes: socioeconomic summary	None reported
Outcomes: key socioeconomic statistics	None reported
Other findings	Use was higher in households where there were children, and lower where there were older people. Use was lower where the head of household was not white or UK born. Long-standing illness and limiting illness predicted NHSD use. Use also varied by region (not shown) **Child present** **OR (CI)*** **older person present** **OR (CI)*** None 1 none 1 Under 5 2.83 (2.27-3.53) 65-74 0.47 (0.38-0.58) 5-15 1.13 (0.92-1.39) 75+ 0.27(0.21- 0.35) **Ethnicity HRP** **OR (CI)*** **Long-term illness** **OR (CI)*** White 1 no 1 Asian 0.57 (0.38-0.85) yes not limiting 1.36 (1.16-1.59) Black 0.38 (0.21-0.70) limiting illness 1.54 (1.34-1.77) Non UK born 0.52 (0.41-1.11)
Level of evidence	**2-**
Quality of evidence	**37**

Study	**ID10, Siahpush, 2007**
Notes	Demand. Smoking hotlines may show different patterns of use
Study characteristics	
Study aim/research questions	To assess the socioeconomic variations in call rates to Quitline and the impact of anti-tobacco television advertising on quit rates
Service studied	Quitline
Study design	Observational study
Data source(s)	Quitline routine data, SES complied by Australian Bureau of statistics
Statistical methods	Negative binomial regression
Setting and date	Victoria, Australia, January 2001 and March 2004
Study site(s)	As above
Sample size	47 520
Population	Mixed
Sampling	All calls during study period
Socioeconomic characteristics	Socioeconomic status (SES) derived from caller's postcode and Index of Socioeconomic Disadvantage
Other characteristics accounted for	(e.g.: gender, age) or confounding factors controlled for
Results	
Response rate	(if applicable)
Study outcomes	Quitline call volume
Service use: socioeconomic summary	SES and call rates were positively associated. Adjusted call rate was 57% (95% CI 45% to 69%) higher in the highest than the lowest SES.
Service use: key socioeconomic statistics	SES fifth / Adjusted RR (95% CI) / p value 1 (most disadvantaged) 1.00 <0.001 2 1.15 (1.07-1.24) 3 1.17 (1.08-1.27) 4 1.23 (1.04-1.21) 5 (low disadvantage) 1.57 (1.45-1.69)
Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic statistics	Not stated
Other findings	Different SES groups had similar level of responsiveness to advertising-there was no socioeconomic variation on the effect of call rates of anti-tobacco television advertising.
Level of evidence	**3**
Quality of evidence	**31**

Study	**ID 11, Sood, 2007**
Notes	Demand
Study characteristics	
Study aim/research questions	To describe the characteristics of current smokers calling a national reactive telephone helpline
Service studied	American Lung Association (ALA) national reactive telephone helpline
Study design	Cross-sectional study comparing helpline users with a theoretical control population of smokers in the US
Data source(s)	Data obtained telephonically from callers
Statistical methods	Two tailed one proportion test
Setting and date	USA, January 2003 to October 2005
Study site(s)	Illinois and Iowa chapter but provides assistance across the US
Sample size	899 eligible adult smokers contacted the service
Population	Pregnant women, minors (under 18), those with diagnosis of psychiatric conditions (other than depression or anxiety), those who couldn't speak English were excluded
Sampling	Convenience sample of adult current smokers who called for first time who consented to participate
Socioeconomic characteristics	Annual household income (US $), educational status
Other characteristics accounted for	Sex, age, race, place of residence, ethnicity, number of daily cigarettes (all examined independently)
Results	
Response rate	890 (98.9%)
Study outcomes	Comparison of above factors with control population
Service use: socioeconomic summary	There was a significant overrepresentation of poorer and less educated users (p<.01) in those who contacted the service vs the control population.
Service use: key socioeconomic statistics	Comparison of proportions: **Educational status** — **Study pop** — **Control pop** — **p** Up to high school — 0.55 (0.52-0.58) — 0.49 — <0.01 Some college — 0.31 (0.28-0.34) — 0.29 — 0.20 College degree — 0.13 (0.11-0.15) — 0.22 — <0.01 **Annl household income** — **Study pop** — **Control pop** — **p** <$35,000 — 0.62 (0.59-0.65) — 0.52 — <0.01 $35,000-$49,999 — 0.11 (0.09-0.13) — 0.17 — <0.01 ≥$50,000 — 0.18 (0.16-0.21) — 0.31 — <0.01
Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic statistics	Not stated
Other findings	There was a significant overrepresentation of heavier smokers, blacks, non-Hispanics, women, and urban residents as well as those 45 or older, p<0.01) in those who contacted the service vs the control population. Results in study state proportions between two populations.
Level of evidence	**3**
Quality of evidence	**37**

Study	ID12 St George, 2006
Notes	Demand
Study characteristics	
Study aim/research questions	"To show the deprivation indices of addresses of callers to Healthline"
Service studied	Healthline, New Zealand's telephone health advice, information and triage service
Study design	Retrospective analysis of routinely collected callers' addresses
Data source(s)	Routine data
Statistical methods	Not stated
Setting and date	New Zealand
Study site(s)	Healthline
Sample size	7618 calls, of these 6415 gave address, of these 5533 were geocoded
Population	mixed
Sampling	Included all calls in 2 week period- 25 July 24 August 2005
Socioeconomic characteristics	NZ Dep2001 deprivation scale
Other characteristics accounted for	none
Results	
Response rate	Not applicable
Study outcomes	Access to service
Service use: socioeconomic summary	Call rates increased with increasing deprivation except at the highest levels where there was a decrease.
Service use: key socioeconomic statistics	Results are presented graphically
Outcomes: socioeconomic summary	None reported
Outcomes: key socioeconomic statistics	None reported
Other findings	None reported
Level of evidence	3
Quality of evidence	42

Study	**ID13, Turnbull, 2008**
Notes	Demand, Possible one of several papers from same study? Geographical variation main focus not deprivation
Study characteristics	
Study aim/research questions	To examine the effects of distance and rurality on rates of out-of-hours service use
Service studied	Out of hours provider
Study design	Observational study (geographical analysis)
Data source(s)	Routinely collected data by OOH provider
Statistical methods	Kruskal-Wallis method used to examine differences
Setting and date	UK, all calls received in June and December 2003
Study site(s)	Devon
Sample size	34 226 patient calls but 27 294 with complete data
Population	Mixed
Sampling	Not applicable
Socioeconomic characteristics	IMD 2004, assigned to super output areas
Other characteristics accounted for	Age and sex standardised call rates , straight line distance from patient's addresses to nearest open PCC, calculated rurality measured by ONS classifications: urban, small town and fringe, village, hamlet and isolated dwellings. Each area allocated to 'sparse' or 'less sparse' (8 categories in total)
Results	
Response rate	Not applicable
Study outcomes	Rates of OOH calls by deprivation, distance and rurality
Service use: socioeconomic summary	There were higher rates for each fifth of increasing deprivation. In urban areas, call rates were higher for those in the more deprived fifths. Town/fringe and village output areas had no callers from the least deprived fifth.
Service use: key socioeconomic statistics	**IMD fifth** / **age/sex standardised call rates** 1 (most deprived) 200 (198-201) 2 175 (173-177) 3 141 (139-142) 4 149 (147-150) 5 (least deprived) 128 (127-130) **Dep fifth** / **Rate (95% CI)** Urban 1 (most dep) 200 (199-202) 2 191 (189-193) 3 151 (149-153) 4 164 (162-167) 5 126 (125-128) Town&Fringe 1 -- 2 122 (119-126) 3 165 (162-168) 4 142(139-145) 5 122(118-126) Village/hamlet/isolated dwellings 1 -- 2 109 (106-113) 3 122 (120-125) 4 142(139-145) 5 125(121-128)
Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic	Not stated
Other findings	Call rates decreased with increasing distance to PCC.
Level of evidence	**2-**
Quality of evidence	**38**

Study	ID 14, Turnbull, 2010
Notes	Part of same study as ID4, mixed methods, extracted relevant quantitative data, study presents fifth 1 as most deprived.
Study characteristics	
Study aim/research questions	To examine if telephones overcome geographical barriers to accessing primary care OOH by parents with young children
Service studied	GP OOH
Study design	Mixed methods including quantitative geographical analysis
Data source(s)	Routine data on calls to GP OOH service
Statistical methods	Multiple linear regression
Setting and date	UK, 2003
Study site(s)	Devon
Sample size	5697 calls about children
Population	Not stated, although assumed mixed as covers all Devon
Sampling	Calls to service in time period concerning children 0-4
Socioeconomic measurement	Index of Multiple Deprivation (IMD)
Other characteristics considered	Area classification, straight line distance to PCC
Results	
Response rate	Not applicable
Study outcomes	Call rates
Service use: socioeconomic summary	There were higher rates of use in the most deprived areas, fifth 1, (759 (95% CI 750-767)) and fifth 2, (654 (CI 644-664)) and the lowest rate in the least deprived fifth (486 (CI 476-496). In urban areas, call rates decreased with deprivation (exception fifth 4), in rural areas there was less variation between deprivation fifths.
Service use: key socioeconomic statistics	Dep fifth / Rate (95% CI) Urban: 1 (most dep) 761 (753-770); 2 730 (719-741); 3 572 (558-586); 4 733 (720-746); 5 471 (459-483) Town&Fringe: 1 --; 2 537 (512-562); 3 582 (559-605); 4 525 (505-546); 5 508 (487-529) Village/hamlet/isolated dwellings: 1 --; 2 598 (572-624); 3 327 (312-343); 4 537 (519-556); 5 526 (498-554)
Outcomes: socioeconomic statistics and summary	Not stated
Other findings	Call rates decreased with each decreasing distance quintile. Linear regression suggests that there was a reduction in the SOA call rate per 1000 /patient year of 9.9 for each unit km of straight distance (parameter estimate of -9.91 (95% CI, -14.33 to -5.47). When adjusting for deprivation this reduced to -8.78 (CI -13.31 to -4.25, p=0.025). When only distance was included, the variance explains 2.7% of variation in rates, when deprivation was added this increases to 3.5%, suggesting distance is significant after adjusting for deprivation.
Level of evidence	**2-**
Quality of evidence	**38**

	Dep fifth	Rate (95% CI)
Urban	1 (most dep)	761 (753-770)
	2	730 (719-741)
	3	572 (558-586)
	4	733 (720-746)
	5	471 (459-483)
Town&Fringe	1	--
	2	537 (512-562)
	3	582 (559-605)
	4	525 (505-546)
	5	508 (487-529)
Village/hamlet/isolated dwellings		
	1	--
	2	598 (572-624)
	3	327 (312-343)
	4	537 (519-556)
	5	526 (498-554)

Study	**ID15, Munro, 2003**
Notes	Outcomes, Didn't account for symptom severity
Study characteristics	
Study aim/research questions	To examine the effect of the distance of the patient from the primary care centre on the GP's decision to see the patient face to face
Service studied	GP Co-operative (co-op)
Study design	Observational study
Data source(s)	Routine data from the co-op
Statistical methods	Logistic regression analysis
Setting and date	Northwest England, 1997-1998
Study site(s)	As above
Sample size	31,048
Population	Mixed: urban, suburban and rural
Sampling	All calls from 20 May 1997 – 30 July 1998
Socioeconomic characteristics	Townsend deprivation score
Other characteristics accounted for	Urban/rural classification, straight line distance and road travel from patient postcode, time of call
Results	
Response rate	Not applicable
Study outcomes	Influence of distance on triage decision to see patient in person and for calls in which patient was to be seen, the influence of distance on location of visit (home or centre)
Service use: socioeconomic	Not stated
Service use: key socioeconomic s	Not stated
Outcomes: socioeconomic summary	The likelihood of seeing a GP fell with increasing deprivation, however if a patient was to be seen, those from more deprived areas were more likely to be seen at home (vs centre) than those from less deprived areas.
Outcomes: key socioeconomic statistics	**Dep category** — **OR (CI) decision to see patient** 1 (least deprived) — 1 2 — 0.96 (0.89-1.03) 3 — 0.88 (0.81-0.95) 4 — 0.81 (0.75-0.88) 5 (most deprived) — 0.81 (0.74-0.88) **Dep category** — **OR (CI) (all patients to be seen, decision to be seen at home)** 1 (least deprived) — 1 2 — 0.88 (0.74-1.05) 3 — 1.2 (0.99-1.45) 4 — 1.48 (1.23-1.78) 5 (most deprived) — 1.98 (1.64-2.4)
Other findings	The likelihood of being seen face to face fell with increasing road travel distance to PCC. However if patient was to be seen, distance didn't seem to effect where. There were similar results with straight line distances. Female patients were less likely to be seen in person than males. Rurality had no significant effect on whether or where to see patient. Patients calling between 12-8am were less likely to be seen in person but when seen more likely to be seen at home. The likelihood of being seen face to face was higher on weekends. Haven't inserted all ORs here.
Level of evidence	**2-**
Quality of evidence	**33**

Study	**ID16, O Sullivan, 2004**
Notes	Outcomes. This was borderline included as it doesn't specifically say unscheduled care but have assumed that home visits are more likely to arise in an unscheduled care context
Study characteristics	
Study aim/research questions	Does adjusting for clinical case mix and social class explain more variation in home visits between general practices then adjusting for just age and sex
Service studied	General practice
Study design	Prospective cohort study
Data source(s)	4th National Survey of Morbidity in General Practice
Statistical methods	Multilevel regression models
Setting and date	UK, not stated
Study site(s)	60 general practices in England and Wales
Sample size	349 505
Population	Not
Sampling	1% sample of pop'n from 60 practices (doesn't say how)
Socioeconomic char.	Occupation and employment status similar to 1991 Census
Other characteristics accounted for	Clinical case mix (morbidity class) using John Hopkins Adjusted Clinical Groups (ACG) Case Mix System
Results	
Response rate	Not applicable
Study outcomes	Whether or not patient received home visit in the year
Service use: socioeconomic	Not stated
Service use: key socioeconomic statistics	Not stated
Outcomes: socioeconomic summary	17% of patients received home visit in year. Age, sex, social class and morbidity influence home visits. Together morbidity and social class reduced variation in home visits between practices to 1.5% (95% CI 1.1-2.2%), social class alone explained 1.6% of variability (95% CI 1.1-2.8).
Outcomes: key socioeconomic statistics	**ORs for receiving home visit** **Social Class** — **Unadjusted OR (95% CI)** — **adjusted for morbidity and social class OR** 1 — 1 — 1 2 — 1.18 (1.13-1.24) — 0.81 (0.78-0.84) 3 — 1.43 (1.37-1.5) — 0.94 (0.90 -0.97) 4 — 1.57 (1.51-1.64) — 0.98 (0.95-1.01) 5 — 1.90 (1.82-1.99) — 1.14 (1.1 -1.18) 6 — 2.46 (2.33-2.59) — 1.36 (1.3-1.42) 7 — 1.63 (1.47-1.8) — 1.09 (0.98-1.21) 8 — 2.42 (2.3-2.55) — 1.6 (1.53-1.67) 9 — 1.53 (1.46-1.61) — 1.18 (0.92-1.52) Social class 1: professional, etc, 2:intermediate occupations, 3: skilled, non-manual, 4: skilled, manual, 5: partly skilled, 6: unskilled, 7: armed forces, 8: unoccupied (students, housewives, persons of independent means, permanently sick, disabled, not stated, 9: not available/inadequately described
Other findings	The percentage of the total variation in home visits attributable to differences between practices was 2.5% (95% CI: 1.4-3.2%). This reduced to 1.6% when taking into account morbidity class.
Level of evidence	**2-**
Quality of evidence	**37**

Study	**ID17, Turnbull, 2011**
Notes	Outcomes. Updates Munro 2007 analysis
Study characteristics	
Study aim/research questions	To examine the effect of distance and rurality on the GPs' decision to manage the call by phone or face to face
Service studied	GP co-operative
Study design	Geographical analysis of routine calls
Data source(s)	GP Co-op routine data
Statistical methods	Logistic regression
Setting and date	UK, 2003
Study site(s)	Devon
Sample size	34,229
Population	Urban and rural
Sampling	All calls to co-op in June and December 2003, n=34,229
Socioeconomic characteristics	IMD 2004
Other characteristics accounted for	Distance, rurality, gender, age, time of call, day of week
Results	
Response rate	24 017 calls with complete data
Study outcomes	Effects of distance on: 1. Being seen face to face or receiving telephone advice only and 2. The likelihood of being seen face to face or at a Primary Care centre
Service use: socioeconomic summary	Not stated
Service use: key socioeconomic statistics	Not stated
Outcomes: socioeconomic summary	Deprivation did not strongly predict the likelihood of receiving a face-to-face consultation (model 1), although there was an increased likelihood of receiving a face-to-face consultation for patients in fifth five (least deprived). In Model 2, for those seen face to face, the likelihood of a home visit decreased for the least deprived fifth.
Outcomes: key socioeconomic statistics	Deprivation OR to see face to face versus telephone advice 1 (most) 1.0 2 1.06 (0.98-1.15) 3 1.07 (0.98-1.16) 4 1.01 (0.93-1.11) 5 1.14 (1.05-1.24) Deprivation OR for home visit vs PCC attendance 1 1.0 2 0.94 (0.81-1.08) 3 0.79 (0.67-0.92) 4 0.74 (0.63-0.87) 5 0.66 (0.56-0.77)
Other findings	"For distances >6 km the likelihood of receiving telephone advice only increased with increasing distance from the PCC. For those to be seen at all, there was an increased likelihood of being seen at home with increasing distance"
Level of evidence	**2-**
Quality of evidence	**35**

Study	**ID18, O'Hara, 2011**
Notes	Demand and outcomes. Patient contacts service and chooses outcome either information only or coaching programme
Study characteristics	
Study aim/research questions	To report on GHS service usage in the first 18 months of operation and assess its generalisability and popl'n reach.
Service studied	GHS: Get Healthy Information and Coaching Service
Study design	Cross sectional
Data source(s)	Telephone survey
Statistical methods	forced entry logistic regression models
Setting and date	New South Wales, Australia, 23.02.2009 -03.09.2010
Study site(s)	As above
Sample size	5174
Population	Mixed
Sampling	All those who enrolled invited to participate
Socioeconomic characteristics	SEIFA (Socio-economic indexes for areas),
Other characteristics	ARIA (Accessibility remoteness index of Australia)
Results	
Response rate	4828 (93.3%)
Study outcomes	Comparison of participants with general pop, and of 'info only' with 'coaching' participants
Service use: socioeconomic summary	The level of educational attainment among participants was representative of the general pop. Participants were more likely to come from lowest two quintiles of socio-economic status (46.1% vs 38% in general pop).
Use: key socioeconomic stats	Not stated
Outcomes: socioeconomic summary	Females and those with tertiary education were more likely to enrol in coaching (p<0.001). Those from more advantaged socio-economic backgrounds were more likely to enrol in coaching then quintiles 3 and 4, although quintile 5 was also more likely to do coaching (p<0.05). Those unemployed also more likely to do coaching.
Outcomes: key socioeconomic statistics	**Education level** / **% information** / **% coaching** / **p value** ≤year 10 / 28.5 / 24.1 / <0.001 Yrs 11 and 12 / 16.8 / 15.2 Diploma/cert / 25.6 / 25.8 Degree or higher / 29.1 / 34.9 **Employment** / **% information** / **% coaching** / **p value** FT / 37.8 / 34.6 / ≤0.05 PT/casual / 22.1 / 25.3 Home duties / 9.3 / 8.5 Retired / 17.0 / 15.9 Other / 8.4 / 9.4 Unemployed / 5.4 / 6.2 **SEIFA index** / **% information** / **% coaching** / **p value** 1 (advantaged) / 11.1 / 12.2 / ≤0.05 2 / 17.3 / 20.0 3 / 23.9 / 22.2 4 / 29.7 / 26.3 5 (disadvantaged) / 17.8 / 19.1
Other findings	Results show GHS users were representative of general pop in terms of aboriginal status, fruit and veg consumption and alcohol use. Coaching participants were more likely to be overweight and to be ex-smokers than general pop.
Level of evidence	**3**
Quality of evidence	**40**

Study	**ID19, O'Reilly, 2001**
Notes	Demand and outcomes
Study characteristics	
Study aim/research questions	To examine geographical variations in rates of OOH calls and to see if there is variation in how co-ops respond to calls
Service studied	GP OOH co-op- with 4 centres
Study design	Secondary data analysis
Data source(s)	Co-op routine data
Statistical methods	Multiple linear regression
Setting and date	Northern Ireland,1998
Study site(s)	One co-op with 4 PCCs: Coleraine, Moneymore, Ballymena, Whiteabbey
Sample size	78 907
Population	Mostly rural
Sampling	All calls in 1998, second year of operation
Socioeconomic characteristics	Townsend deprivation score
Other characteristics accounted for	Standardised mortality ratios (based on 5 years deaths from 1993-97), limiting long term illness question from 1991 census, distance to PCC (km), travel times (min by car), age and sex standardised call ratios
Results	
Response rate	Not applicable
Study outcomes	Age and sex standardised call ratios and outcomes of calls
Service use: socioeconomic summary	Levels of PCC contact were positively correlated with deprivation score (pearson correlation coeffiecient=.26, $p<0.001$). With all other things equal, more deprived areas had higher call ratios, ORs not given.
Service use: key socioeconomic statistics	Final linear regression mode, dependent variable standardised call ratios **Unstandardised coeff (se)** **T** **p value** Townsend score 0.17 (0.03) 5.38 <0.001
Outcomes: socioeconomic summary	Patients from deprived areas were more likely to be seen by the doctor OR: 1.01 (1.01-1.02). Home visits were more likely for patients from deprived backgrounds (vs PCC visits), OR: 1.11 (1.10-1.12).
Outcomes: key socioeconomic statistics	PCC response, pearson correlation coefficients sig at $p<0.01$ **tel advice** **PCC visit** **home visit** Townsend score 0.16 0.11 0.31 **face to face v phone** **home v PCC visit** **OR** 1.01 (1.01-1.02) 1.11 (1.10-1.12)
Other findings	Levels of PCC contact were negatively correlated with proximity to PCC centre (correlation co-efficient=-0.2, $p<0.01$). The final linear regression model shows that areas further away from PCC tend to call less. Neither indicators of need were significantly associated with OOH call rates. **Unstandardised co-eff (se)** **T** **p value** Dist from PCC -0.68 (0.08) -8.43 <0.001 Increasing age was associated with increased likelihood of face-to-face consultation. Older females were approx 20% more likely to receive phone advice only. Likelihood of face-to-face contact decreased with distance. A large area effect was also observed. Neither mortality or long term illness was shown to be a sig predictor of seeing GP as was travel time. Age (yrs) **face to face v phone** **home vs PCC visit**

	0-14	1	1
	15-34	0.82 (0.79-0.86)	2.75 (2.56-2.94)
	35-64	1.11 (1.06-1.16)	6.61 (6.21-7.04)
	65+	1.86 (1.77-2.95)	40.11 (36.93-43.56)
	Female (>15yrs)	0.79 (0.76-0.82)	NS (not sig)
	Distance (km)	0.98 (0.97-0.99)	1.02 (1.01-1.02)
Level of evidence	**2-**		
Quality of evidence	**29**		

Annex 2.2 Data extraction for additional studies found between submission and viva (b)

Study	ID20, Bibi 2005
Notes	Demand
Study characteristics	
Study aim/research questions	To determine, which, if any population subgroups, showed the greatest potential for increased use of NHSD.
Service studied	NHSD
Study design	Observational study
Data source(s)	NHSD routine data and 1991 census data
Statistical methods	Chi square goodness of fit test was used to compare call data with pop data
Setting and date	City of Preston, Lancashire, September 1, 2001 – August 31, 2002 (1 year)
Study site(s)	NHSD Northwest Coast (one call centre)
Sample size	24 973
Population	Not stated
Sampling	All calls within the year
Socioeconomic characteristics	IMD 2000 was used as an indicator of deprivation
Other characteristics accounted for	Age, gender
Results	
Response rate	Not applicable
Study outcomes	Use of NHSD compared with population profiles
Service use: socioeconomic summary	There were no significant differences in use among socioeconomic groups.
Service use: key socioeconomic statistics	Not stated. Call rates for the different electoral wards were shown, with some wards having a higher observed number of calls than expected. The authors then compared the call rates across wards and noted: "more calls were made for patients in local electoral ward 16, which had a high IMD than for local electoral ward 18 which had an even higher index of IMD. There was no relationship between calls made to NHSD and IMD".
Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic statistics	Not stated
Other findings	NHSD is used less by younger people, older people and males. There were higher proportions of calls for children aged 0-4 and use was higher in females particularly between ages 20-34. The least proportions of calls were made by teenagers and older people.
Level of evidence	3
Quality of evidence	24

Study	**ID21, Turner 2011**
Notes	Demand
Study characteristics	
Study aim/research questions	To understand the population awareness and use of 111 overall and within different groups of the population.
Service studied	NHS 111
Study design	Cross sectional
Data source(s)	Telephone questionnaires
Statistical methods	Logistic regression
Setting and date	UK, June –September 2011
Study site(s)	Durham and Darlington, Lincolnshire and Nottingham
Sample size	8010
Population	Not stated
Sampling	Recent users of the emergency care system, selected to match the age/sex profile of the PCT
Socioeconomic characteristics	Housing tenure
Other characteristics accounted for	Site, age, gender, ethnicity, health status
Results	
Response rate	28% (28,071/100,408), but 691 had reported use of 111
Study outcomes	Reported use of NHS 111
Service use: socioeconomic summary	Respondents were less like likely to have used NHS 111 if they owned their home (adjusted p=0.039).
Service use: key socioeconomic statistics	Site Adjusted OR (95% CI)* Adjusted OR** Housing tenure Owner 1 1 Non-owner 1.26 (1.05 – 1.52) 1.21 (1.01 – 1.46) **adjusted for site only, **adjusted for site, sex and age group*
Outcomes: socioeconomic summary	Not applicable
Outcomes: key socioeconomic statistics	Not applicable
Other findings	Awareness levels were slightly lower for those without home ownership, although these were not statistically significant (site adjusted p=0.447 and site/age/sex adjusted p=0.190 respectively). Respondents were *less likely* to have used NHS 111 if they were male (site adjusted p=0.001), were older (site adjusted p=0.001), did not have a disability or limiting long term illness (adjusted p=0.001). Reported use was lower for black and ethnic minority groups; a statistically significant difference was found when adjusting for site only (p=0.05) but not when adjustment was made for site, age group, and sex (p=0.354). Use also varied with area: reported use was highest in Durham & Darlington (14%, 272/2003) and Lincolnshire (10%, 208/2000) and lowest in Nottingham (3%, 62/2006).
Level of evidence	3
Quality of evidence	Not completed because this was a small section in a large report

Study	ID22, Cook, 2012
Notes	Demand
Study characteristics	
Study aim/research questions	To determine if age, deprivation and gender impact on the utilization of NHSD
Service studied	NHSD
Study design	Observational study
Data source(s)	NHSD routine data
Statistical methods	Negative binominal regression
Setting and date	England, UK, July 2010
Study site(s)	all NHSD sites in England
Sample size	359 758 calls (all calls in that month) but 341 663 included for analysis
Population	England wide- mixed
Sampling	1 month (reason why not stated)
Socioeconomic characteristics	IMD 2007 quintile used as an indicator of deprivation
Other characteristics accounted for	Age structure (>15, 16-29, etc) and gender
Results	
Response rate	Not applicable
Study outcomes	1 month call rate per 1000 population in 10 age/gender subgroups
Service use: socioeconomic summary	Call rates were lowest for children 0-15 in the most deprived groups. Male call rates were higher in the most deprived areas for all age groups. Female call rates for older females (60+) were lower in areas of extreme deprivation.
Service use: key socioeconomic statistics	**Call rate ratios by Males by age group by IMD (*comparison group call rates per thousand are in parentheses)**

Quintile	Call Rate Ratio	95% CI	P value
Age group <15			
1*	1.00 (6.07)		
2	1.08	0.94-1.20	>0.50
3	1.12	1.02-1.23	<0.05
4	1.14	1.03-1.26	<0.01
5	1.03	0.94-1.14	>0.50
Age group 16-29 years old			
1*	1.00 (4.94)		
2	0.96	0.85-1.08	>0.50
3	1.07	0.95-1.20	>0.50
4	1.16	1.03-1.30	<0.05
5	1.23	1.10-1.38	<0.001
Age group 30-44 years old			
1*	1.00 (4.04)		
2	1.09	0.97-1.22	>0.50
3	1.16	1.03-1.30	<0.01
4	1.27	1.14-1.43	<0.001
5	1.37	1.23-1.54	<0.001
Age group 45-64 years old			
1*	1.00 (2.80)		
2	1.13	1.00-1.27	<0.001
3	1.29	1.14-1.45	<0.001
4	1.42	1.26-1.61	<0.001
5	1.59	1.41-1.80	<0.001
Age group 65+ years old			
1*	1.00 (4.23)		
2	0.99	0.85-1.15	>0.50
3	1.02	0.88-1.20	>0.50
4	1.11	0.95-1.29	>0.50
5	1.12	0.96-1.30	>0.50

Call rate ratios by Females by age group by IMD (*comparison

group call rates per thousand are in parentheses)

Quintile	**Call Rate Ratio**	**95% CI**	**P value**
Age group <15			
1*	1.00 (8.26)		
2	0.90	0.82-1.00	>0.50
3	0.85	0.77-0.94	<0.01
4	0.77	0.70-0.86	<0.001
5	0.70	0.63-0.78	<0.001
Age group 16-29 years old			
1*	1.00 (10.62)		
2	1.06	0.99-1.15	>0.50
3	1.06	0.99-1.14	>0.50
4	1.17	1.08-1.26	<0.001
5	1.17	1.08-1.26	<0.001
Age group 30-44 years old			
1*	1.00 (6.52)		
2	1.10	1.01-1.19	<0.05
3	1.19	1.10-1.30	<0.001
4	1.30	1.20-1.14	<0.001
5	1.31	1.21-1.43	<0.001
Age group 45-60 years old			
1*	1.00 (4.08)		
2	1.08	0.97-1.21	>0.50
3	1.28	1.14-1.43	<0.001
4	1.42	1.27-1.59	<0.001
5	1.54	1.37-1.71	<0.001
Age group 60+ years old			
1*	1.00 (4.79)		
2	1.06	0.96-1.17	>0.50
3	1.08	0.98-1.20	>0.50
4	1.22	1.10-1.34	<0.001
5	1.19	1.08-1.31	<0.001

Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic statistics	Not stated
Other findings	The pattern of calls was highest for children 5 years old and under, with lowest call rates for males and those who were 65 and older.
Level of evidence	**3**
Quality of evidence	**40**

Study	**ID23, Hsu, 2013**
Notes	Demand
Study characteristics	
Study aim/research questions	To describe the geographic pattern of older people's use of NHSD and examine the relationship between service use and deprivation
Service studied	NHSD
Study design	Descriptive, exploratory, cross-sectional, population based study
Data source(s)	NHSD routine data
Statistical methods	Not stated but Spearman's correlation co-efficient used
Setting and date	England and Wales, December 2007-November 2008 (1 year)
Study site(s)	Calls to all 32 NHS Direct contact centres in England and Wales
Sample size	402 959 (396 171 included for analysis)
Population	Patients of NHSD aged 65+ who used NHSD or NHSDW during study period
Sampling	All calls from those over 65+ in study period
Socioeconomic characteristics	Deprivation measured using Index of Multiple Deprivation 2007 (England) and Welsh Index of Multiple Deprivation 2008 (Wales)
Other characteristics accounted for	Geographical variations by country and region
Results	
Response rate	Not applicable
Study outcomes	Geographical and deprivation patterns of NHSD use derived from call rates
Service use: socioeconomic summary	Call rates in England increased with increasing deprivation (Spearman's correlation coefficient= 0.16). In Wales, the pattern was a less clear linear relationship (Spearman's correlation coefficient =0.075).
Service use: key socioeconomic statistics	England: highest call rates in most deprived areas (0.052 pppa) and the lowest in the least deprived areas (0.040 pppa). In Wales, the highest call rate was in quintile 2 and the lowest in quintile 3. The call rate in the most deprived areas in England was higher than the call rate in the most deprived areas of Wales (0.052 pppa vs 0.044 pppa) but the call rates were almost the same in the two countries in the least deprived areas (England: 0.040 pppa, Wales: 0.041 pppa)
Outcomes: socioeconomic summary	Not stated
Outcomes: key socioeconomic statistics	Not stated
Other findings	In England, there were cluster areas of high use at postcode area: Yorkshire, Humber, East Midlands and London and in Wales: Swansea and Llandudno had higher call rates.
Level of evidence	**3**
Quality of evidence	**38**

Chapter 3: Research aim, question and objectives

3.1 Overview (a)

This brief chapter brings together what was learned in Chapters 1 and 2 and builds the case for the current study. It summarises why this research is needed given the current policy background and existing literature. Amidst this supporting evidence the author sets out the research aim, questions and objectives of this study. The author has made no adjustments to this chapter since the original thesis was submitted.

3.2 Knowledge gained from the background and context (Chapter 1) (a)

Recent policy developments have highlighted the continuing need to reduce health inequalities and to improve access to all elements of health and social care. These documents recognise the need for a more joined up service with clear points of access for the user. As well, there is an increased emphasis on prevention suggesting the need for a greater patient role in self care and health management. These main themes of recent policy guidance: joined up working, equal access to healthcare, and prevention and clarity over how best to enter the multilayered NHS, can all potentially be addressed by services such as NHSD, NHSDW, NHS 24 and more recently '111'.

However, one component of policy agendas: access to healthcare is not a straightforward issue and there is a need for definitions of the concept to be defined on a continuum from need to outcome. The access framework adopted for this study states access in terms of four dimensions: need, opportunity, utilisation and outcomes (Macfarlane et al. 2005). In particular, with need, access to healthcare should be highest in areas where health is poorer. Yet shortly after the introduction of NHSD concerns were raised that the service was meeting the needs of the 'worried and well middle classes' (George 2002). These concerns were echoed by both policy makers (Scottish Executive 2004, pg 10) and raised several times in a focus group with nurses outside the service, with one nurse in particular stating: "it is more accessible to middle class type England than it is to...the ordinary working class" (Snooks et al. 2008, Appendix 16). In the literature review, the author explored these concerns, reviewing the current evidence on demand for, and outcomes of contacts with telephone based healthcare.

3.3 Knowledge gained from the literature review (Chapter 2)

(a)

Findings substantiated these opinions and provided evidence that use of NHSD is associated with higher individual socioeconomic status (Ring and Jones 2004; Knowles et al. 2006; Shah and Cook 2008). Similarly, using area level indicators, although use of the service initially rises with deprivation, it drops off in the most deprived areas (Burt et al. 2003; Cooper et al. 2005). This was in contradiction to access to GP OOH services in which access was higher by deprived groups (Salisbury et al. 2000; Beale et al. 2006; Turnbull et al. 2008; 2010). Therefore it appears that NHSD is not being used by those who may need it most as defined by inequalities in health. However, the longest study of NHSD use was one year, in concentrated areas of England- there was no long term study of NHSD use at a national level.

Additionally, there was a large gap in the evidence exploring outcomes by NHSDW by socioeconomic characteristic and conflicting evidence as to the role of deprivation in predicting outcomes from GP OOH care. However, across both access and demand, the literature mostly recognised that there were likely to be other confounding factors which would contribute to variations. Despite this, the list of confounding variables in the studies were small, with in particular no studies accounting for patient presenting complaint (symptom), or variables such as temperature or air quality.

These findings, alongside the recent developments, have informed the research aims, question and objective of this study. Although as discussed previously, health and healthcare usage are known to vary by a number of factors, this study will focus specifically on patient socioeconomic characteristic, and specifically on deprivation level as an indicator of this. As set out in the definition of access adopted here, the author will explore the role of deprivation both on access to NHSDW and on the outcomes of these contacts. Through exploring these issues, one will be able to better understand the value of NHSD and how the service can be developed in such a way that its effectiveness and reach across different population groups can be maximised.

3.4 Study aims (a)

Research aim

To explore the relationships between deprivation and both demand and outcomes of calls to a national telephone health helpline.

Research question

How does deprivation affect the demand for, and the outcome of direct calls to NHSDW, controlling for other factors?

Research objectives

1. To identify factors associated with the demand and outcome of calls to NHSDW in order to build a model to explore the association between deprivation, demand and outcome of calls.

2. To model the relationship between deprivation and demand, controlling for other variables which affect demand.

3. To model the relationship between deprivation and call outcome, controlling for other variables which affect outcome.

3.5 Chapter summary (a)

This chapter has brought together the background and current context of NHSD with the gaps in knowledge highlighted from the literature review. The research aims, questions and objectives have been presented. The next chapter sets out how these will be accomplished.

Chapter 4: Methods

4.1 Overview (a, b, c)

This chapter lays out the methodology of this thesis including the rationale behind the study design, the setting and participants, and ethical approval. In this chapter, the author goes into detail concerning data collection, linkage and cleaning. An overview of the three types of study variables (NHSDW; Area based; and Climatic) is given and the chapter concludes with the analysis plan and chapter summary. The author has made several improvements to this chapter both between submission and oral (b) and between the oral and resubmission (c). These are clearly indicated after each relevant heading but include the addition of a new variable, the day of the week the call occurred, to the analysis. Additional changes also include transforming individual level call variables to ward level proportions to enable them to be used accurately in analysis. The author has also revised the analysis plan at the end of this chapter, discussing briefly the possibility of taking the logarithm or square root of call rates if early analysis shows that the distribution of residuals is not normal. Again, these changes are explained in detail throughout this chapter.

4.2 Study design (a)

This study takes an ecological approach to exploring demand and disposition. Ecology can be defined as "the study of living organisms in relation to their environment" (Bhopal 2002, pg 261). Epidemiology is an ecological discipline as the majority of epidemiological studies are ecological. In short, if a study helps to shed light on living organisms in relation to their environment, it can be said to be ecological, and if it additionally reveals information on the population pattern of disease it is also epidemiology.

In many ecological studies, it is the mode of data analysis rather than the design which is ecological - population level data has replaced individual level data (Bhopal 2002, pg 241). Last (2001) describes an ecological study as a "study in which the units of analysis are populations or groups of people, rather than individuals". Yet, this accepted definition does not apply to the ecological study presented here. This study will analyse data at an individual level based on contact with NHSDW and aggregate them to summarise demand at ward level - the level to which sources like the Census, produced by the Office for National Statistics (ONS), aggregate data. Thus the author proposes to enhance Last's definition to include: "studies which collect data at individual and group level and aggregate them to group level for most analyses". Similarly, as analysis in this study will start from individual calls, the "unit of analysis" will be the unit 'into which data are aggregated for analysis'.

In this study, the author will use multiple regression techniques to explore the relationship between a dependent variable and a number of independent variables. The analysis will seek to understand whether, the independent variable of deprivation is able to predict two outcomes, the dependent variables of demand for NHSDW and dispositions given, when the effects of other variables are controlled for.

Often in this type of study it can be difficult to separate the effects of different variables on outcomes. As discussed in Chapter 2, in addition to deprivation, the literature review identified many other potential contributing factors to the demand for healthcare and the outcomes of healthcare contacts. In addition, there may be other variables that are more applicable to those living in areas of deprivation, for example, these areas may or may not be closer to hospitals, may be more heavily populated or may experience more problems with air quality. It is important to also remember that statistical associations don't always indicate causal relationships (Hennekens et al 1987).

Therefore, in order to disentangle the effect that deprivation in itself has on demand for NHSDW from the effect that health has on deprivation and similarly for the dispositions resulting from such demand, the author will incorporate as many variables as possible into the multiple regression models. This will allow shed light on the relationships between all variables.

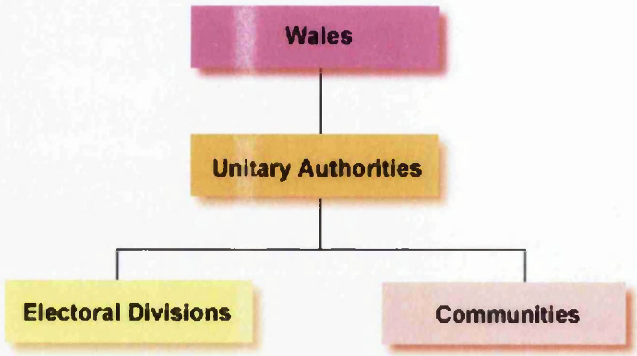
4.3 The setting and participants (a)

The study period was from January 2002 to June 2004. NHSDW was introduced in 2000, giving approximately two years for the service to "settle in" in terms of management and operational delivery and for the population to become aware of the service. As the author collected data in July 2004, the June data was the most up to date at the time. In terms of service evaluation, Jacobs has constructed a five stage model for linking types of evaluation with methods of data collection and with the stage or level of development the service has reached (Jacobs 1988). The timing of this study corresponds with the second stage in this model, the process stage, at which point, the use of a service and the extent to which it has reached those in need should be explored (Barnes, Stein and Rosenberg 1999). Methods of data collection employed in this stage are typically those which are collected routinely by the service, as is the case in this study.

The author defined the catchment area as all calls to NHSDW originating in Wales. There are both rural and urban areas and a range of levels of deprivation although the population is not ethnically diverse, with according to the 2001 census, 96% of the population classified as 'white British'. In 2001, the population of Wales is 2 903 085 with approximately 52% of residents female and 48% male (http://www.ons.gov.uk/census/index.html, accessed 09.02.06).

Wales is governed by both the UK Government in Westminster and the National Assembly for Wales in Cardiff. Concerning health matters, the Welsh Government is responsible, although funding comes from Westminster. The country is divided into 22 unitary authorities (UAs) which have responsibility for all aspects of local government. Each UA is in turn composed of electoral divisions (referred to as wards in Wales) and communities. Electoral wards are often referred to as the building blocks of administrative geography as these areas form the basis for which governments are elected and from which all higher administrative units are built up. In contrast, the smallest type of administrative area in Wales are communities. These areas used to be significant local government areas but now have limited functions, Figure 4.1 below.

Figure 4.1: Breakdown of geographical units in Wales



(http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/administrative/wales/index.html, accessed 24.01.12)

Welsh unitary authorities contain an average of approximately 39 electoral wards with a total, according to 1998 figures, of 865 electoral divisions in Wales. Population counts can vary substantially even within a single unitary authority (from less than 1,000 to over 20,000) with the bigger electoral wards tending to occur in large urban areas.

4.4 Ethical approval (a)

Initial approval from NHSDW for this study was granted on June 4, 2004 by email from the Director of Nursing at the time. Approval was granted conditional on receiving ethical approval from a local research ethics committee and maintaining close communication with NHSDW throughout the project.

The author applied for ethical approval in July 2004. As the study would be taking place from one site (Swansea) but using information from across Wales, Multi-centre research ethics committee (MREC) approval was sought. As MRECs were very busy at the time of application and because the project was not a clinical trial the project was examined by the Southeast Local Ethics Committee (LREC). Approval was granted by the Chairman on September 13, 2004. On the advice of the Ethics committee, an honorary contract for the author was arranged with NHSDW.

In addition to LREC approval, the author sought study approval from the NHSDW Caldicott guardian who refused on the grounds that patient postcode information, essential data which was needed to link call records with patient deprivation codes, could be considered patient identifiable. As a result it was agreed with NHSDW that instead of providing the postcodes, a data analyst would link the postcode with the WIMD scores (to be provided by the author) and then remove the postcode before returning the dataset. Although this was a necessary step for approval, it meant that the author lost the ability to identify repeat callers in the dataset.

4.5 NHSDW data collection and linkage (a)

As discussed in Chapter 1, Section 1.4.1 for every call to NHSDW a call record is created. By the end of the interaction with NHSDW, the call record should include: the patient's name, age, gender, address, date of birth, date and time of call, details on the call reason, algorithm used, and final disposition. There may also be notes and decisions recorded by the nurse advisor while working through the algorithm. Although the call record contains a great deal of data, the author had to narrow down which data to use for this study and requested the following variables from the NHSDW call record:

- date of call
- call type
- call symptom
- age of patient
- gender of patient
- ethnic background of patient
- relationship of caller to patient
- disposition given

A data analyst at Health Solutions Wales (HSW) and since renamed NHS Wales Informatics Services (NWIS) sent a file to the author relating postcodes to area based information including deprivation fifths, unitary authority and ward names. The author then passed this file on to an NHSDW data analyst who did the linking and removed the postcodes from each call record, replacing it with this new information.

The final database therefore contained no postcode information but the following additional fields provided by HSW:

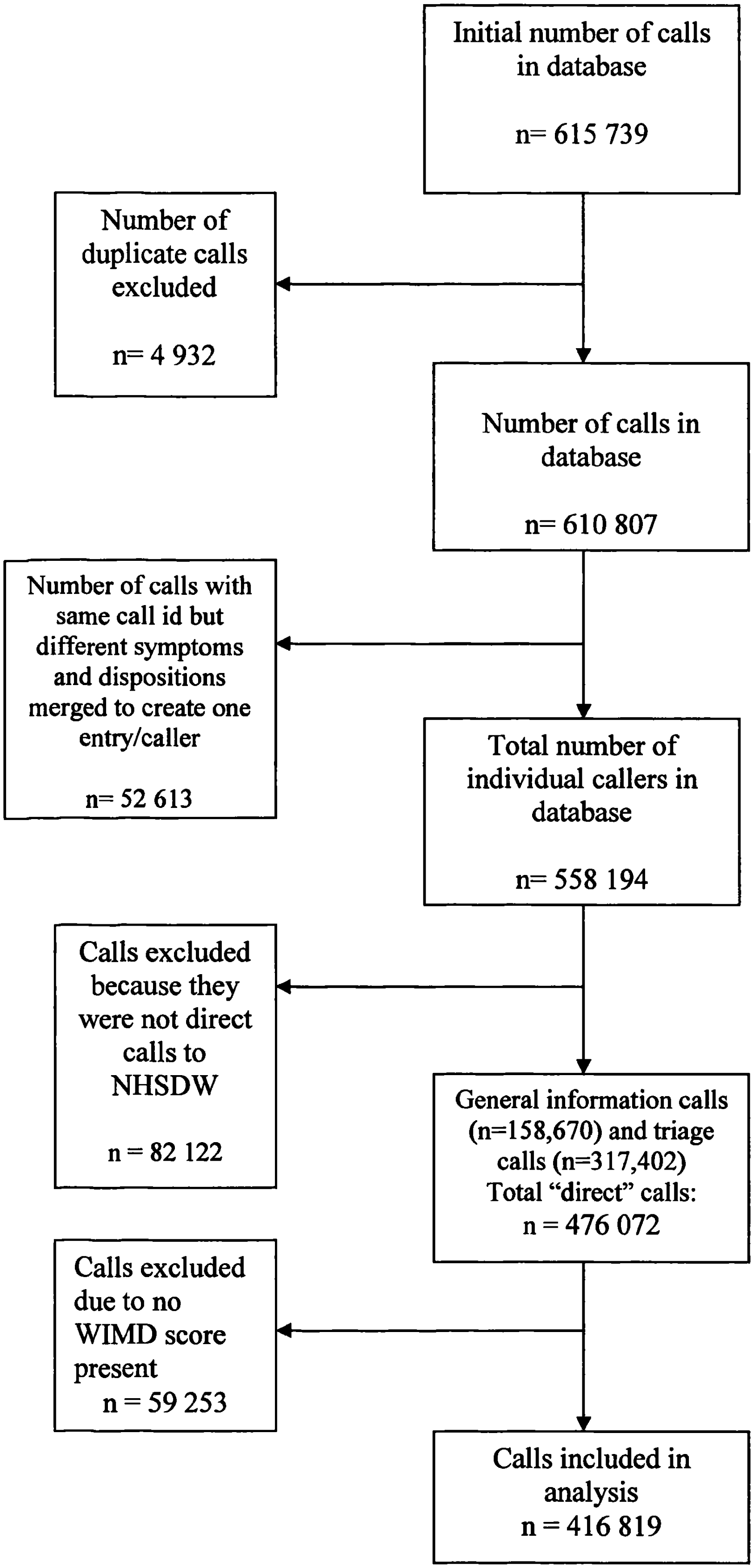
- UA (unitary authority) code
- UA name
- Ward code
- Ward name
- WIMD fifths

As explained in Section 4.3, all calls to NHSDW between January 2002 and June 2004 were included (30 months). The author received all data from NHSDW in a Microsoft Access database and then transferred the data to SPSS Version 16.0.

4.6 Study size (a)

To arrive at the final study size, the author had to do extensive data cleaning and recoding. Flowchart 4.2 presents a breakdown of this data management process and shows how the author arrived at the final figure for analysis which is explained in detail in this section.

Figure 4.2: Flowchart of calls in study database



4.6.1 Data cleaning (a)

The total number of initial call records received from NHSDW was 615 739. However upon receipt, the data needed extensive cleaning and categorising. As a first step, a technical problem in an earlier version of CAS had created a number of duplicate entries in the database (n = 4 932). The author removed these duplicates by running syntax in SPSS bringing the number of cases down to 610 807.

Secondly, a caller may have more than one symptom when calling the service and similarly, be assigned more than one disposition by a nurse advisor. For example, if a caller rang in with a stomach ache, the symptom would be recorded as such. If through the dialogue with the nurse, it was discovered the caller was also pregnant, this may have resulted in an additional symptom being recorded (under the same call id) with potentially a different outcome. So although only one call was placed, several call records all using the same id could be created. This was the case in 52 613 (8.6%) of calls.

This double entry of call ids only occurred in earlier versions of CAS, in the later versions, only the most 'important' symptom or disposition per call was recorded. However, in order not to lose potential data, the author used an additional SPSS syntax which merged cases with the same call id, allowing for four potential symptoms and four potential dispositions per call. Although a high percentage of calls (40.9%) were missing symptom information, 329 954 calls had one symptom, 33 234 had two symptoms, 3 155 had three symptoms and 782 had four symptoms. In terms of dispositions: all calls (558 194) had one disposition recorded, even if this was "not assessed by a nurse" or "no answer/no contact" 45 755 had two dispositions, 5 194 had three and 1 016 had four dispositions.

After merging call ids with more than one symptom or disposition, 558 194 individual call records remained, which represented the final number of unique calls in the database.

4.6.2 Determining the number of calls for analysis (a)

Call type

Only calls made directly to NHSDW from the general public are relevant to the research questions addressed in this study. The 'call type' data field indicates where the call originated from- if it was a direct call to NHSDW via the 0845 line for either triage advice or for general information, or if it was a call transferred via another route such as a GP out-of-hours co-op or an ED department. In the data set provided by NHSDW, there were originally 78 different call types. There were many miscodings within these, for example some call types were coded as symptoms such as pregnancy and ankle, and there were seven different codes used for general information. The author categorised these 78 call type codes into seven categories. For example all the calls originating from the different GP out of hours co-ops were grouped as one variable called 'GP out-of-hours'. Similarly all different codes with general information where categorised into one general information code and so on. See Table 4.1 for a summary of the recodings used and Appendix 6 for a full breakdown of all recodings.

Table 4.1: Summary of call type recodings

If code contained:	Then recoded as	Frequency	Percentage
Name of hospital then 'ED'	ED	4 859	0.9
'Dental' then name of Area	Dental	4 350	0.8
Name of GP surgery then 'Out of hours' or 'out of hours'	GP OOH	64 940	11.6
'Information' or 'General Information'	Information	158 670	28.4
From another service (e.g. Childline) or part of a campaign (e.g Obesity campaign)	Other	6 754	1.2
Triage or Welsh triage	Triage	317 402	56.9
Unknown, missing/misdirected, no data entered, or the name of a symptom (e.g. sore throat, coughing)	Unknown	1 219	0.2
Total		**558 194**	**100**

For inclusion in the analysis, the author selected general information and triage calls only. Although some of the other call types may also represent direct calls to the service, these were excluded as they likely represented one off campaigns (for example, an obesity information drive) and would not reflect true use over time. Calls transferred via ED or a GP OOH service would also not reflect true calls to the service as it was likely that the caller tried to contact another service first. By selecting only those call types of general information and triage, 82 122 calls were excluded from analysis.

Final number of calls included in analysis

Of the 476 072 calls remaining, the NHSDW data analyst was unable to link the postcode information in the original database with the file sent by HSW for 59 253 calls (12.4%). This could be for several reasons: 1) the postcode was unspecified by the caller and therefore was unknown to NHSDW, 2) the postcode was incorrect or 3) the postcode given by the caller related to a non-Wales region. As a result, in 416 819 calls the data analyst was able to assign a WIMD score and this figure represents the final number of calls included for analysis. See Flowchart 4.2.

4.7 Overview of study variables (a, b, c)

The dependent variables in this study were call rates and dispositions. The author grouped variables into three main categories: 1) NHSDW call variables, 2) area based variables and 3) climatic variables. Table 4.2 describes these variables with their corresponding units of measurements if applicable. The dependent and explanatory variables are indicated, all other variables are independent.

Table 4.2: Description of study variables

Study Variable	**Description (if needed) and units of measurement (if applicable)**
NHSDW call variables	
Disposition (dependent variable)	Advice given by NHSDW
Call type	Whether call was recorded as general information or triage
Patient age	Age of patient
Patient gender	Gender of patient
Patient symptom	Reason for call
Patient ethnicity	Ethnic background of patient
Relationship	Relationship of caller to patient
Day of week	Day of week the call occurred
Area based variables	
Ward level call rates: triage, general information and total (dependent variable)	Calculated by number of calls from each ward divided by the mid year population estimates from that ward
Monthly call rates	Ward level call rates by month
Deprivation (explanatory variable)	Measured using WIMD
Patient distance to ED department	Measured using the geographical centriod of each ward, using straight line distance to nearest ED
Population density	Number of people per hectare in each ward
Climatic variables	
Air quality- SO2	$\mu g/m^3$ measured in daily mean

Air quality -PM10	μg/m³ measured in 24 hour running mean
Air quality –O3	μg/m³ measured in 8 hour running mean
Air quality –NO2	μg/m³ measured in hourly mean
Temperature	Measured in degrees Celsius
Snowfall	Measured in centimeters

To be used in analysis, the author had to convert several of the individual level variables (age, gender, relationship, symptom and day of week) to ward level proportions or measurements. For age, based on the individual calls within each ward, the author calculated a mean age for each ward. For the other variables, which were dichotomous, the author calculated a proportion for each ward, for example, the proportion of calls by those who called for themselves (the number of 'self callers' per ward divided by the population of that ward). Although for the multiple regression analysis, these variables have essentially become ward level or area based variables, the author has explained them in detail below as NHSDW variables.

As well, during the viva, the examiners recommended using Census values for age and gender in replacement of patient values as these would most accurately reflect the true values of the ward.

These changes resulted in a slightly revised version of Table 4.2 below:

Table 4.2.a Revised description of study variables

Variable	**Description (if needed) and units of measurement (if applicable)**	**Area level (ward) equivalent**
NHSDW call variables		
Type of call	For triage; for general information	n/a
Patient's age	Age in completed years	Mean age of the population in each ward derived from Census 2001
Patient's gender	Male; female	Proportion of females resident in the ward derived from Census 2001
Patient's main symptom	International Classification of Primary Care 2	Proportion of patients with digestive symptoms per ward
Patient's ethnicity	White; other specified ethnicity; not specified	Proportion of 'white' residents per ward derived from Census 2001
Relationship of patient to caller	Self caller; surrogate caller	Proportion of self callers per ward
Day of week when call occurred	Sunday; Monday; Tuesday; Wednesday; Thursday; Friday; Saturday	Proportion of calls on a Sunday; Monday; Tuesday; Wednesday; Thursday; Friday; Saturday
Area based variables		
Call rates (dependent variable)	n/a	Calculated by dividing the number of calls from each ward by the 2001 Census population estimates from that ward
Deprivation score (explanatory variable)	n/a	Measured by Welsh Index of Multiple Deprivation (WIMD)

Variable	Description (if needed) and units of measurement (if applicable)	Area level (ward) equivalent
Distance to ED	n/a	Measured by straight line from geographic centroid of ward to nearest Emergency Department (ED)
Population density	n/a	Number of people per hectare in ward derived from Census 2001
Climatic variables		
Air quality- SO2	µg/m³ measured in daily mean	Min and max monthly averages by ward
Air quality -PM10	µg/m³ measured in 24 hour running mean	Min and max monthly averages by ward
Air quality –O3	µg/m³ measured in 8 hour running mean	Min and max monthly averages by ward
Air quality –NO2	µg/m³ measured in hourly mean	Min and max monthly averages by ward
Temperature	Measured in degrees Celsius	Min and max monthly averages by ward
Snowfall	Measured in centimeters	Total monthly snowfall by ward

4.8 NHSDW variables (a and c)

Once the author determined the final number of calls in the database, the next step was to "clean" the other NHSDW variables (disposition, patient age, gender, symptom, ethnicity and relationship to caller) to allow for a more manageable number of categories for analysis and where possible, to correct the obvious miscodings. The author went through each of the remaining variables reducing the total number of unique codes by grouping similar items. Where possible, groupings were made according to NHSDW reporting categories and then further summarised if necessary. Table 4.3 presents a brief summary of the groupings made with each variable explained in detail below; see Appendices 6-9 for the full re-categorisations.

Table 4.3: NHSDW variables: summary of new codings

Variable	Original number of unique entries	New number of categories
Call type	78	7
Call symptom	966	257 (based on NHSDW algorithm) then 17 categories based on ICPC-2
Age of patient	106	19
Ethnic background of patient	19	17
Relationship of caller to patient	159	16
Disposition given	244	30 (based on NHSDW algorithm) then 6 (based on hierarchy of care)

4.8.1 Patient symptoms (a)

This data field concerns the issue or issues behind the call to NHSDW. Although callers could have up to 4 symptoms, 37.2% of all calls in the database were missing this information. When the researcher queried with NHSDW as to why there were so many missing symptoms, reasons given included that some calls were requests for information rather than an illness, others may have been missed off due to an error caused either by the call handler or were a result of early NHSDW procedures which have since been upgraded.

Of the 416 819 calls to be analysed, 264 963 (63.6%) callers had one symptom, 26 294 (6.3%) callers had two symptoms, 2 563 (0.61%) had three and 639 (0.15%) had four. Therefore as a first step, the author had to determine the primary reason for the call. In an attempt to try and organise symptoms into a hierarchy, the author explored severity scores. Although recognised severity scores exist for specific conditions, such as, for example, the Clinical Global Impression Scale (mental disorders), Patient Management Category (hospitalised patients' illnesses), and the Fatigue Severity Scale, there did not appear to exist a severity scale that could be easily applied to NHSD derived data. Therefore, the author made the pragmatic decision to accept symptom 1 as the primary symptom for the call. It is likely that the caller would have felt this to be the most important concern as this was the symptom first reported to NHSDW.

In order to ensure that selecting the first symptom only would not alter results; the author first compared frequency distributions across the four symptoms. In some cases, the symptoms repeated each other, in other cases the subsequent symptoms would expand on symptom 1, for example if symptom 1 was insect bite, then symptom 2 would be rash. Frequency distributions for each of the four symptoms were similar across all groups, justifying the decision to accept symptom 1 as the primary symptom for the call and exclude the remaining symptoms from analysis. Once this was complete, the author had to categorise the number of remaining symptoms.

Recoding patient symptoms

Originally there were 966 different ways of coding symptoms in the dataset, using free text and many of these were similar, for example: "back pain", "back pain, lower", "back pain, upper". NHSDW provided their symptom grouping algorithm which reduced the number of symptom categories down to 257, grouped mainly according to body part- either by injury, or pain/swelling, or if there was no body part mentioned, by other presenting complaint (e.g. fever). At the time of data collection, this algorithm was what the service used to provide performance and summary reports. In the example above, using the NHSDW algorithm all three symptoms were combined into the one category: "back pain".

In order to make the number of symptoms more manageable and suitable for analysis, the author sought out other methods of coding clinical symptoms. This included undertaking a review of internationally recognised systems, reading the works of leading researchers in this area and contacting experts in the area of clinical coding.

Universally recognised coding systems

There are several internationally recognised coding systems, including the International Classification of Diseases (ICD-10), the International Classification of Primary Care-2 (ICPC-2), the Systematised Nomenclature of Medicine Clinical Terms (SNOMED CT) and READ codes.

Research in the area of NHSDW Clinical Coding

In an appendix to one of their evaluation reports, the Sheffield team who were responsible for the Evaluation of NHSD in England also evaluated the suitability of medical coding systems for recording NHSD encounters. The team reviewed and assessed the four current leading classification systems: ICD- 9/10, Read Codes, ICPC and SNOMED, according to the following criteria: complexity, scope, level of abstraction, acceptance, availability and compatibility (Munro et al. 2001). The authors recognised that coding systems were in a period of transition but concluded that there was currently no "best" coding system to use for NHSD encounters. Pragmatically they recommended ICPC-2 Plus, with the use of ICD-10 when required. Although this report was published 10 years ago, the author was unable to identify any updated system in use or more applicable to this dataset. (personal communication: emails to author from ME, business manager at Clinical Solutions, dated 09.08.2011 and 22.07.2011).

Despite their conclusions, in order to provide a casemix of the problems people contacted NHSD about, the Sheffield team attempted to code symptoms in several ways: 1) by algorithm used; 2) identification of key issue as discussed in the call in order to identify the proportion of calls which may affect impact on additional services; and 3) ICPC-2 coding of the key issue based on an analysis of call transcripts from 300 randomly selected calls. When describing the reason for encounter based on algorithm used, two sites presented their results by the top 20 algorithms used only (out of a possible 400 available). The third site presented results by categorising algorithms used into 11 broad categories as determined by the nurse advisor.

The team ran into several issues when attempting to identify the reason for the call to assess the impact on other services, as there was disagreement between coders as to what constituted the primary issue for the call given several "problems" could be discussed in one call. In addition, classifying the key issues from mental health, medication and health information related calls were problematic in terms of identifying exactly what the caller was seeking from the call (Munro et al. 2001).

Employing different methods to better understand why patients contacted the service, two independent coders also coded the "reason for encounter" as stated at the beginning of the call according to the second version of the ICPC (ICPC-2). However, again the Sheffield team experienced difficulties with multiple reasons behind calls (up to four problems were coded per call) and coders reported complications in selecting a primary reason requiring a third coder to be brought in.

In other studies involving NHSD data, authors tended to classify calls mainly on the algorithm used rather than the symptom or reason for encounter. For example, Baker and colleagues (2003) when examining the relevance of employing NHSD data for community surveillance, examined calls for ten key algorithms, and Chin Wen (2011) condensed the category of algorithms used into 22 broad categories to analyse calls by older people. Other studies focused on key "syndromes" relevant to their research aims. For example, Cooper (2004) and Doroshenko (2005) when looking at the applicability of using NHSD data to identify potential terrorist activity reviewed calls on 10 key respiratory and gastrointestinal syndromes, which could occur naturally in the community or could be a result of early stages of illness caused by terrorist activity.

Contacting clinical coding experts and data managers

To understand better the possibilities for clinical coding of the present dataset and to see if it was possible to gain any assistance in this area, the author contacted a Senior Research Analyst from the Health Informatics Research Unit (HIRU) at Swansea University to determine whether the Unit had any information regarding coding of symptoms. HIRU holds anonymous routine data from several healthcare units in Wales in their Secure Anonymised Information Linkage Database (SAIL) (Lyons et al 2009). SAIL contained one extract from NHSDW with records from 01.01.2006 to 31.05.2008, with the "call reason" and "algorithm use" variables captured. According to the research analyst questioned, the information in the "call reason" field "appeared to be free-text and had no structured coding system" (personal communication: email from CB, senior research analyst, dated 17.07.2011).

The author then contacted a business manager from Clinical Solutions, the company behind CAS that NHSDW use to triage their calls. According to the business manager, the call centre application of CAS currently does not use clinical coding but instead produces summary reports (for example, the top ten reasons for calling/month) based on, amongst other items, the top 20 algorithms used. The service also uses other data items such as call type and disposition to produce reports without categorising every call using a recognised classification system. In order to clinically code the symptoms in the dataset, the business manager recommended using the SNOMED CT code set and focus on presenting complaint (personal communication email from ME, business manager at Clinical solutions, 09.08.2011).

Symptom coding methods employed in this study

Thus there is no adopted clinical coding system currently in place for NHSDW data and other researchers using NHSDW data have used a variety of methods to code patient symptoms. Although NHSDW did provide their current algorithm for combining symptoms, through applying this system, there were still 257 different categories. However the author used this as a first step to recode symptoms.

In their work on evaluating NHSD, Munro et al put forward the ICPC-2 as one of the leading systems to use for coding NHSD symptoms and in one of their reports to the Department of Health, they categorised symptoms according to ICPC-2 successfully. This is a hierarchical coding structure with a 2 axal system. One axis represents the 17 body systems (chapters) and the other, one of seven possible natures of the complaint (Lambert 1987). In this way, the system allows for the classification of patients' reasons for healthcare encounters as well as problems identified and any diagnoses and interventions recommended. The system is unique in that it uses reason for encounter from a patient's perspective as a key element (www.globalfamilydoctor.com, accessed 07.2011).

The seventeen ICPC- 2 chapter codes, based on body systems are defined in Table 4.4.

Table 4.4 ICPC-2 chapter codes

Chapter	**Examples Include**
A: General and unspecified	Weakness/tiredness general, fever, trauma/injury
B : Blood, blood forming organs and immune	Lymph gland(s) enlarged/painful, leukemia, anemia
D: Digestive	Abdominal pain/cramps general, teeth/gum symptom/complaint, mumps
F: Eye	Eye Pain, contact lens symptom,/complaint, injury eye other
H: Ear	Ear pain/earache, foreign body in ear, hearing complaint
K: Cardiovascular	Heart pain, swollen ankles/oedema, hemorrhoids
L: Musculoskeletal	Neck symptom/complaint, foot/toe symptom/complaint, muscle pain
N: Neurological	Headache, restless legs, convulsion
P: Psychological	Feeling anxious/nervous/tense, medication abuse, suicide
R: Respiratory	Shortness of breath, cough, foreign body nose/larynx/bronch
S: Skin	Warts, laceration/cut, animal/human bite
T: Endocrine, metabolic and nutritional	Loss of appetite, weight gain, feeding problems
U: Urological	Dysuria/painful urination, incontinence urine, cystitis/urinary infection other
W: Pregnancy, child bearing, family planning	Question of pregnancy, contraception other, abortion

Chapter	Examples Include
X: Female genital	Genital pain female, menstrual pain, breast pain female
Y: Male genital	Pain in penis, prostate symptom/complaint, infertility/sub fertility male
Z: Social problems	Assault/harmful event problem, work problem, relationship problem

Although through the ICPC-2 system it is possible to code symptoms according to one of seven possible natures of the complaint, due to limited information in the dataset, the author used ICPC-2 at chapter level only as the next level of coding to apply to the present data set. As this recoding involved a degree of individual opinion a random sample of 10% (n=26) of the symptoms were selected. The author and another independent researcher each applied the ICPC-2 chapter level headings to these symptoms and compared coding results. There were no discrepancies between the two and the author therefore proceeded to code the rest of the symptoms. Once coded, a general practitioner with 17 years clinical experience then checked over the data for clinical accuracy and suggested six changes which the author then corrected in the database. For "breast symptoms", the GP also suggested going back to the original symptoms and patient gender to determine whether the complaint was for a male or female.

In the NHSDW symptom algorithm, there was one category called 'other' which picked up all those symptoms that did not fall into one of the other 256 categories. In order not to lose any potential data, for these symptoms the author went back to the original symptom data to see if these could be categorised directly into ICPC-2 codes. There were 8 symptoms involving pregnancy concerns in this category and an additional two symptoms which were "chicken pox" and "measles". The author was able to categorise these into Chapter W: Pregnancy, child bearing and family planning and Chapter A: General and Unspecified respectively. Therefore through applying these two levels of recodings, the author was able to reduce the number of symptoms down to 17. Appendix 8 lists the NHSDW coding algorithms and their conversion to ICPC-2.

4.8.2 Age of patient (a)

To allow for ease of analysis and in order to compare the age of the patient with Welsh population statistics, the author grouped age 'into the under 1 year olds, 1-4 and then in 5 year intervals, for example 5-9, 10-14, up to 85+. The author also calculated the mean age of patients per ward.

4.8.3 Ethnic background of patient (a)

NHSDW did not start collecting this information until June 2003. There were 19 categories used to record this data which were broadly set out according to the 16 ethnic group categories used by the Department of Health and other NHS bodies in line with those developed by the Office for National statistics (ONS) and the Commission for Racial Equality (Department of Health 2005). However, 'Welsh', instead of being recorded under 'White –British' was recorded separately and there were two categories saying 'Asian or Asian British - Any other Asian background' and two categories saying 'Black or Black British - Any other Black background'. There were also five different categories for saying the data was either not known or not collected. Thus, in order to make comparisons with Welsh population data, the author recoded the 19 categories into the 16+1 categories set out by the ONS with one unknown/not collected category.

4.8.4 Relationship of caller to patient (a)

The caller will not always be the patient and there were 159 different types or ways of explaining the relationship of the caller to the patient. Again many of these were miscoded, for example a caller calling for themselves was coded as 'self' but in four different ways. The author recoded the relationship of caller to patient data into 15 categories, see Table 4.5 below.

Table 4.5: Summary of relationship of caller to patient recodings

If code contained:	Then recoded as
"self"	self
"aunt", " auntie", "cousin", "niece", "nephew", "uncle"	aunt/uncle/cousin/ niece/nephew
"babysitter", "care", "caregiver", "carer", "deputy matron", "duty manager", "foster", "guardian", "senior care worker", "warden"	caregiver/guardian
"daughter", "daughter-in-law", "stepdaughter"	daughter/daughter in law/ step daughter
"son", "son-in-law", "step son"	son/son in law/step son
"call aborted"	call aborted
"colleague", "employer", "expartner"," flat mate", "friend", "neighbor", " boss, manager", "receptionist"	colleague/friend/neighbour
"Father", "father-in-law"," step dad"	father/father in law/stepfather
"grandfather", "grandmother", "grandparent"	grandparent

If code contained:	Then recoded as
"granddaughter", "grandson"	granddaughter/son
"brother", "brother-in-law", "sibling", "sister", "sister-in-law"	Sibling/half sibling/step sibling
"coordinator", "hostel manager", "housekeeper", "midwife", "nurse", "north Wales ambulance service", "officer", "other", "police", " social services", "support worker", "teacher"," ward manager"	Other
"mother", "mum", "mother-in-law", "stepmother"	Mum/mum in law/step mum
"boyfriend", "girlfriend", "husband", "partner", "spouse", "wife"	Partner/spouse
"person's name", "symptom", "emergency call-data not collected"	Unknown

4.8.5 Day of week (c)

This variable concerns the day of the week on which the call occurred (for example, Monday). The original dataset from NHSDW contained information concerning the date the call was received in the format (day number/month/year, e.g. 11/7/2003). Therefore the author had to assign what day of the week the call was received. She determined that the very first call in the dataset 1/1/2002 was a Tuesday. Using this information, and SPSS syntax, the author created a new variable for 'Day of the Week' in which each call was assigned the day in which it was made.

4.8.6 Disposition given (a)

There were 244 different types of dispositions recorded in the dataset. NHSDW provided their disposition algorithm which reduced the number to 30. Some calls did not appear to have been assessed using an algorithm, for example, 'line busy' and 'no answer, try again'.

The author regrouped NHSDW dispositions into a new hierarchy of care, derived from the hierarchy created and used in the national evaluations of NHSD (Munro et al. 2003) and of NHSDW (Snooks et al. 2009). The new hierarchy is based on resource use with the most expensive services at the top and self-care at the bottom. It has six main categories, with 999 calls (the only way of calling an ambulance in the UK) at the top followed by ED or other hospital attendance, GP or dentist in emergency, GP or dentist routinely, other healthcare and self-care. Calls which reported disposition as not assessed have been put into a residual seventh category.

Although NHSDW nurse advisors may give more than one piece of advice in a phone call, in the majority of cases, only one disposition, or final piece of advice was recorded. However the technical issues in CAS noted earlier meant that some 52 613 calls had more than one disposition. Therefore, in order to create consistency in the database and to allow for ease of analysis, the next step was to reduce the number of dispositions down to one per person. This was done from the new hierarchy of care mentioned above. The author manually went through the database and assigned to each call with more than one disposition the highest level of disposition for that call in the new hierarchy of care; for example, if a call was assigned two dispositions, 'contact GP' and 'self-care', the final disposition became 'contact GP'.

This method differs from that used to reduce symptoms to one symptom per call, which chose only the first symptom mentioned. Here the first disposition mentioned was often a note to the nurse, for example to call the patient back, and the subsequent dispositions contained the actual advice given. Therefore, in order not to lose any outcome data, it was essential that the author assigned the "highest" level of disposition given as the outcome of each call.

Table 4.6 reports how the author converted the resulting NHSDW dispositions to the new hierarchy of care: she classified any disposition to contact a service within four hours as an "emergency". For example, "contact dentist in 1 hour" became "emergency dentist". Appendix 9 includes the full list of 244 original dispositions, the resulting list of 30 NHSDW dispositions, and the final new list of 7 dispositions.

Table 4.6: Summary of disposition recodings

If code contained:	**Recoded according to NHSDW algorithm**	**Recoded to new hierarchy of care**
"999"	Call 999	Call 999
"accident and emergency", "casualty"	ED	ED or hospital
"administration only"	Administration only	Not assessed
"non-assessed", "not assessed", "triage refused"	Call unassessed as per policy	Not assessed
"caller not wishing to proceed"	Caller not wishing to proceed	Not assessed
"contact dentist..routine appointment"	Contact dentist for routine appt	Dentist
"contact dentist..24 hours"	Contact dentist next	Dentist

If code contained:	Recoded according to NHSDW algorithm	Recoded to new hierarchy of care
	working day	
"contact dentist ..12 hours"	contact dentist within 12 hours	Dentist
"contact dentist..urgently or within 1 hour"	Contact dentist within 1 hour	Emergency Dentist
"Contact dentist within 4 hours"	Contact dentist within 4 hours	Emergency Dentist
"Contact GP service within 36 hours"	Contact GP service within 36 hours	GP
"contact GP practice within 4hours"	Contact GP practice within 2 hours	Emergency GP
"contact GP practice within 12 hours"	Contact GP within 6 hours	GP
"practice nurse", "toxbase or local poisons centre", "community crisis line", "district nurses", "family planning clinic", "genitor-urinary medicine clinic", "health visitor", "community mental healthcare team", "midwife", "optician", "orthodontist", "emergency contraception"	Contact other healthcare professional	Other
"social worker"	Contact other professional	Other
"pharmacist"	Contact pharmacist	Other
"police"	Contact police now	Other
"walk in centre"	Contact walk in centre	Other
"direct admission"	Direct transmission to hospital	ED/hospital
"GP to ring"	GP to ring	Emergency GP
"dentist info given", "follow-up" "measles health scare info", "health alert-MMR", "help line numbers given", "info provided or given"	Health information provided	Self-care
"Home care"	Home care	Self-care
"advice nurse will call back notifications in X days/hours/minutes", "follow up cancelled", "go to specific algorithm", "health information referral", "left message notification in X hours/minutes, " line busy", "maximum 3 attempts", "message handling only", "no answer", "send to ..queue"	Not assessed	Not assessed
"appt with hospital", "home visit required", "no action required", "nurse to call poisons centre", "other", "PCC visit", "public health emergency"	Other	Other
"contact GP in 48 hrs", "contact GP practice on Monday", "Routine appt with GP"	Routine Appt with GP	GP
"speak to doctor next working day or within 12 hours"	Speak to GP next working day	GP
"speak to doctor within 4 hours"	Speak to GP within 2 hours	Emergency GP
"speak to doctor within 1 hour (as soon as possible)"	Speak to GP within 1 hour	Emergency GP

As advice could thus take one of six forms, to use it in the logistic regression analysis, the author summarised disposition by two binary variables: (1) whether the patient received advice to phone 999 or contact an emergency ambulance versus any other care (contact GP, dentist, other or self-care); and (2) whether the advice was to contact any healthcare professional face to face versus self-care. Thus calls that received advice to contact 999 or emergency healthcare were always in the most urgent category. Following a previous study (O'Cathain et al. 2004) the author chose these variables to represent the riskiest decisions for the nurse. In this classification, the author treated calls which had been coded as 'not assessed' as self-care as they had not received any other advice from NHSDW.

4.9 Area based variables (a, b, c)

Area based variables include call rates, WIMD, population density, and distance to ED as well as the individual level variables converted to ward level proportions (age, gender, ethnicity, symptom, relationship, day of week). During the viva, the examiners also put forward the idea of using Census 2001 population values for age, gender and ethnicity instead of patient values. Although call rates could also have been defined as an NHSDW variable because the author knew the frequency of individual calls, they have been included as an area based variable because they are assigned at ward level.

4.9.1 Call rates (a, b)

As the author believed that calls for triage differ in purpose and practice from calls only for general information she specified three dependent variables all of which were at ward level: advice; information and total call rates. The author calculated call rates by dividing the number of calls made in each ward by the corresponding population estimates for each ward, according to the 1998 administrative boundaries. If for example, in the study period there were 1500 callers from the West Cross ward in Swansea, this would be divided by the population of West Cross (6475) to produce a call rate of 0.23. If for example, 1200 of these calls were for triage, the triage call rate for West Cross would be 0.19 (1200/6475). This method of calculating call rates does not take into account the gender split in an area or the proportion of those from different age groups. In this way, the author created three variables: triage call rates, general information call rates and total call rates.

To obtain the population estimates used in the denominators, the author used the 1998 administrative boundaries as they matched up to the wards used in constructing the WIMD codes. However, since the WIMD was constructed there have been several ward changes in Wales and ward population estimates using these were difficult to obtain. The author eventually used figures provided by the Office for National Statistics, ONS website, through, the Neighbourhood Statistics (NeSS) 'Custom' route. (http://www.neighbourhood.statistics.gov.uk/dissemination/AreaList.do, last accessed 20.01.2012). Although there were at least two different routes to obtain population data from the ONS site, the author accessed data via this route, choosing the 1998 Administrative Hierarchy which is based on the administrative structure of Wales, as at 31/12/1998. Again, this meant that ward population figures linked up with the ward structures used in the WIMD. However, when the author added up the population figures from each ward, they did not match the total numbers as listed in each UA, see Table 4.7.

Table 4.7: Summary of population differences by UA

UA name	Total UA populations listed on ONS site	Total UA populations when directly adding up ward populations	Difference
Anglesey	66829	66833	+4
Blaenau Gwent	70064	70064	0
Bridgend	128645	128647	+2
Caerphilly	169519	169517	-2
Cardiff	305353	305353	0
Carmarthenshire	172842	173633	+791
Ceredigion	74941	75230	+289
Conwy	109596	109594	-2
Denbighshire	93065	93066	+1
Flintshire	148594	148596	+2
Gwynedd	116843	116845	+2
Merthyr Tydfil	55981	55980	-1
Monmouthshire	84885	84884	-1
Neath Port Talbot	134468	134466	-2
Newport	137011	137011	0
Pembrokeshire	114131	114029	-102
Powys	126354	126355	+1
Rhondda Cynon Taff	231946	231945	-1
Swansea	223301	223303	+2
Torfaen	90949	90949	0
Vale of Glamorgan	119292	119291	-1
Wrexham	128476	128480	+4
Wales	2903085	2904071	+986

The author went over the figures several times but still the differences persisted, however this error is less than 0.4%. Personal communications with ONS revealed that this could be for a number of reasons including: "I think the most likely reason for the difference that you report is that the data reported have been disseminated against different administrative boundaries and there have been subsequent boundary changes. Data may also be affected by rounding and other quality issues and by suppression to prevent disclosure of an individual or household. There may also be other factors, such as best fitting, with any NeSS data, which could produce differences in data obtained from differing places." (personal communication email received from ONS 20.01.12). However, numbers are accurate when rounded to three significant digits, with the exception of Carmarthenshire and the author has used her numbers when calculating call rates.

Once the author had established and inputted call rates for each ward for the study period she mapped call rates using a choropleth map, displaying each area on the map by shading or colouring the areas based on their values. Monthly call rates for each of the 30 study months were also calculated and added to the database.

4.9.2 Deprivation score (a)

The main deprivation index used in Wales is the Welsh Index of Multiple Deprivation. The index was developed by researchers from the Social Disadvantage Research Centre at Oxford University and is based on 1998 administrative data from electoral divisions. It replaced the Welsh Index of Socioeconomic Conditions and has two main aims: 1. to identify levels of deprivation across Wales in order to support both local and national policies and 2. to rank areas within Wales to allow for the targeting of resources, including regeneration funds (Welsh Assembly Government 2000).

Indeed, one of the first uses of the WIMD was to identify the 100 most deprived areas in Wales to provide funding. The least deprived ward is Cyncoed in Cardiff, with a score of 1.13 and the most deprived is Rhyl West, Denbighshire with a score of 74.87. Deprivation scores cannot be compared across UK countries as they are all separate indexes using different indicators of deprivation. (Welsh Assembly Government 2008).

The WIMD 2000 represented a chance to move toward more direct measures of deprivation using smaller area data and is made up of six different domains of deprivation. Each domain index which can also be used on its own is weighted to form the overall WIMD: 1. income (25%), 2. employment (25%), 3. health and disability (15%), 4. education, skills and training (15%), 5. housing (10%), 6. geographical (10%). Several considerations were given to the way in which the variables were combined to form the score and the relationships between the different forms of deprivation. Although having the domains allows the identification of electoral divisions with certain kinds of deprivation, the domains couldn't just be added together because of the way they may interact and the impact which can be caused by different combinations. Each domain uses a different unit of measurement and therefore needed to be standardised to allow for comparisons between domains and across electoral divisions. This was done by ranking the scores in a domain and then transforming the ranks to a standard Normal distribution. Within a domain, the higher the score, the more deprived the area; although a rank of 1 indicates the most deprived. To create the overall WIMD, the 6 domains were combined in two stages: each domain was ranked and then transformed to a standard Normal distribution and then combined using domain weights. As with the individual domains, the higher the WIMD score, the more deprived the area, although a rank of 1 is the most deprived (Welsh Assembly Government 2000).

Both income and employment are weighted more heavily as they are deemed to be more important (Carr-Hill and Chalmers 2005). There is also a supplementary child Poverty Index which accompanies the WIMD. However, the index was not originally intended to be used as a uni-dimensional index with the individual domains offering the advantage of investigating several aspects of deprivation (Welsh Assembly Government 2000).

Indeed, an important point to consider when using any indices of multiple deprivation is the concept of multiple deprivation itself- essentially, that 'multiple deprivation' is not a separate form of deprivation- it is a combination of more specific forms of deprivation. Different groups will experience different types of deprivation. It is for this reason that the domains of deprivation were created. Domain indices can be validated either because they directly measure a specific item or through references to relationships or ratings by other research studies (Welsh Assembly Government 2008).

The WIMD 2000 was constructed using data at the electoral ward level, the smallest area at the time for which an index could be generated. Although the population size of wards varies, the differences in absolute terms are smaller than that between unitary authorities, the next unit of geography. This is beneficial because it means deprivation can be measured regardless of population size and there is no need to take account gross differences in the size of areas (Welsh Assembly Government 2000).

The breakdown of each ward into WIMD fifth (e.g. each ward was assigned 1-5 according to which deprivation fifth it fell into) were provided by HSW along with ward and unitary authority name. However, once the ward codes were in the database, the author was then able to input the exact WIMD 2000 score for each ward. This allowed analysis to be done by WIMD score, in addition to by deprivation fifth. The WIMD scores were taken as constructed by the Index Team at Oxford University. WIMD scores were also mapped using a choropleth map.

4.9.3 Population density (a)

The literature review revealed that the rurality of an area often affected the demand and outcomes of unscheduled telephone based healthcare. The author wanted to therefore include this variable in the study dataset. Unfortunately, although Wales now has an urban/rural classification this was produced in 2004 using super output areas and can not be applied to the wards in this dataset. An additional way of measuring rurality is based around different settlements, for example, in the UK, the figure of 10 000 is often used as an indicator: settlements of less than 10 000 people are considered 'rural' while settlements with more than 10 000 are 'urban'. There are difficulties however with this method due to a lack of consensus as to what constitutes a settlement (Welsh Assembly Government 2008). To avoid these problems, the author decided to use population density as an indicator of the concentration of people in a ward.

Again, difficulties were encountered due to ward changes which were explained by a variety of reasons "ranging from boundary changes to the fact that the ward may have changed, ceased to exist or come into existence since the day the data was collected" (personal communication: email to the author from ONS 26.01.12). Therefore the author derived population density figures from the 2003 Administrative boundaries according to the Office for National Statistics (ONS) and converted these to 1998 boundaries using geoconvert (Geoconvert: *UK* Data Service Census Support. www.*geoconvert.mimas.ac.uk*. Accessed 6 December 2013). All population density figures were added to the database and mapped using a choropleth map.

4.9.4 Distance to ED (a)

Distance to services (particularly to a GP OOH co-op or PCC) was another variable that the literature review revealed could impact on demand and dispositions and the author wanted to include this in the final dataset. Due to the number of GP OOH services and the various arrangements locally it was not possible to include distances to these services as a study variable. However the author was able to incorporate distance to ED departments into the dataset.

As it was not possible to have patient postcode data, the author could not calculate the distance for each patient to the nearest ED department. Thus, a way to measure patient distance to ED needed to be devised. This was achieved by computing the straight line distance from the geographical centroid of each ward to the closest ED department, either in Wales or on the border.

Ward level centroid information

Although ideally, the author wanted to measure distance to ED from the centre of gravity of the population, for each ward, this was not possible as information on the geographic location of each dwelling is not available. Instead the author used a widely accepted method for measuring distance to health services (Hanigan et al. 2006) –the centroid, the geometric centre of the ward's shape. This may or may not correspond with the population distribution in the ward. The centroid, for each of the wards was provided to the author by a Lecturer in Spatial Epidemiology based in the Health Informatics Research Unit (HIRU), the College of Medicine (SR).

Data source: ED locations

To identify hospitals with ED departments in Wales the author searched both the NHSDW website and each of the seven health boards in Wales. In order not to miss any potential hospitals, the author then emailed NHSDW directly through their health information remit. The service provided a list of major and minor ED departments in Wales. This resulted in 13 major and two minor ED departments.

The author then supplemented this data by using the NHSDW Evaluation Project Final Report (Snooks et al. 2006). This report contains information on the Welsh ED departments in operation during the study period and also English hospitals on the border. This resulted in seven hospitals (five in England and two which have since been closed following the study period) being added, bringing the total up to 23.

The author then used Google Earth to collect the x and y coordinates of each of the study hospitals. Although a relatively new source of geographical data in scientific inquiries the horizontal accuracy of this service has been tested and determined sufficient (Potere 2008). Hospital addresses were entered into the programme and hospital coordinates in degrees, minutes, seconds, were recorded see Table 4.8. These were then converted to NGR through an excel spreadsheet provided by SR. Table 4.8: ED departments in Wales and on the Welsh English border.

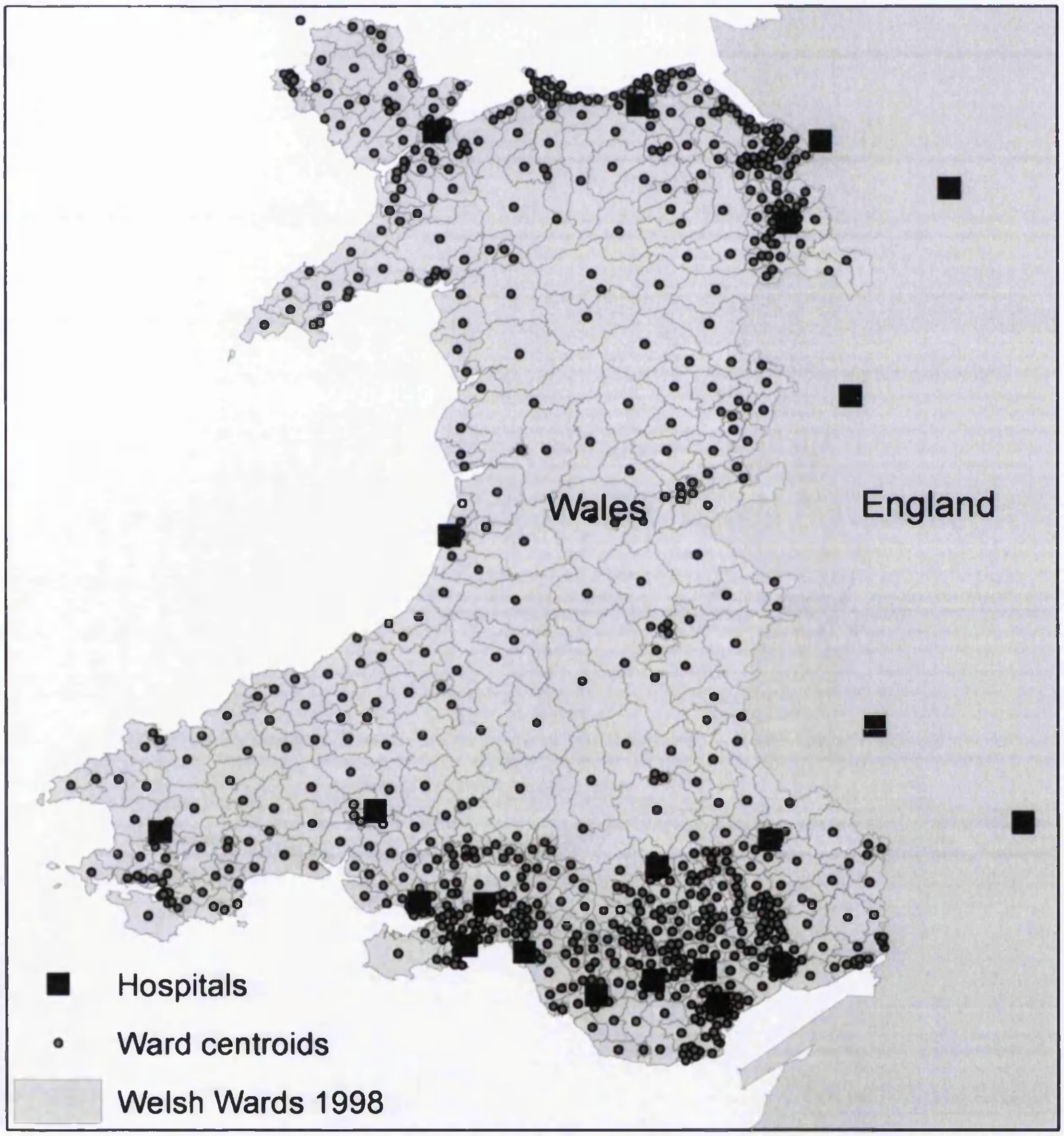
Table 4.8: ED locations in Wales and on the Welsh English border

Identifier	Hospital Name	N_deg	N_min	N_sec	S_deg	S_min	S_sec	N_dd	S_dd
1	Singleton	51	36	33.57	3	59	7.05	51.60933	3.985292
2	University Hospital of Wales	51	30	24.9	3	11	21.51	51.50692	3.189308
3	Countess of Chester	53	12	30.27	2	53	54.9	53.20841	2.898583
4	Gloucestershire Royal	51	51	59.56	2	13	51.94	51.86654	2.231094
5	Glan Clywd	53	16	25.04	3	29	49.57	53.27362	3.497103
6	Hereford County Hospital	52	3	22.38	2	42	17.11	52.05622	2.704753
7	Leighton	53	7	6.93	2	28	35.17	53.11859	2.476436
8	Neath Port Talbot	51	35	56.1	3	48	3.73	51.59892	3.801036
9	Morriston	51	41	26.42	3	55	53.31	51.69067	3.931475
10	Nevill Hall	51	49	43.86	3	2	4.94	51.82885	3.034706
11	Prince Charles	51	46	18.53	3	23	12.06	51.77181	3.386683
12	Prince Philip (minor)	51	41	31.42	4	8	8.81	51.69206	4.135781
13	Princess of Wales	51	31	3.56	3	34	18.28	51.51766	3.571744
14	Royal Glamorgan	51	32	56.28	3	23	32.3	51.54897	3.392306
15	Royal Gwent	51	34	49.53	2	59	40.7	51.58043	2.994639
16	Royal Shrewsbury	52	42	27.86	2	47	33.16	52.70774	2.792544
17	West Wales General	51	52	1.81	4	17	2.18	51.86717	4.283939
18	Withybush	51	48	44.58	4	57	45.7	51.81238	4.962694
19	Wrexham Maelor	53	2	52.54	3	0	24.23	53.04793	3.006731
20	Ysbyty Gwynedd	53	12	38.7	4	9	37.39	53.21075	4.160386
21	Bronglais General Hospital	52	24	58.86	4	4	18.09	52.41635	4.071692
22	Caerphilly and District Miner's Hospital (minor)	51	34	18	3	13	49.01	51.57167	3.230281

Calculating distance to ED

SR then reprojected these coordinates onto the British National Grid and added centroid information (Figure 4.3). She then used ArcToolBox within ArcMap10 to generate the distances from each ward to all of the 23 included hospitals. Distance information for each ward to the closest ED department were added to the database by the author.

Figure 4.3: ED departments and ward centroids



4.9.5 Individual level variables at ward level and Census variables (b and c)

As previously mentioned, the author calculated ward level variables for the individual level variables: age, gender, relationship, ethnicity and day of week. For age, based on the individual calls within each ward, the author calculated a mean patient age for each ward. For the other variables, which were dichotomous, the author calculated a proportion for each ward, for example, the proportion of calls by those who called for themselves (the number of 'self callers' per ward divided by the population of that ward).

During the viva, the examiners requested that the Census 2001 population values for age gender and ethnicity be used to represent these variables in the analysis instead of the patient values as these values should be a more accurate reflection of the ward characteristics. However, as many months had passed since submission and viva, age and ethnicity variables were only available for 2003 wards (some wards in Wales had changed between 1998 and 2003). Hence the author used the available values based on the 2003 administrative boundaries and converted them to 1998 wards using Geoconvert: the UK Data Service Census Support (www.*geoconvert.mimas.ac.uk*. Accessed 6 December 2013.)

4.10 Climatic variables (a)

Although none of the studies uncovered in the literature review incorporated climatic variables, health has been shown to vary according to weather and air quality levels. For instance, there is evidence of increased mortality with heat (Hajat et al. 2006; Gasparrini et al. 2012) and cold (Hajat et al. 2006). Additionally calls to NHSD have been found to be sensitive to daily temperature and extreme weather, heat and sun stroke calls to the service are now monitored as part of the UK Heat-wave plan. (Leonardi et al. 2006). Recent NHSD research also suggests that there may be variation in calls attributable to air quality: for respiratory calls to NHSD it was estimated that respiratory viruses, in particular RSV and influenza, were responsible for at least 50% of seasonal variation in these calls to NHSD (Cooper et al. 2007).

The latest version of the Committee on the Medical effects of Air Pollutants (COMEAP) Air Quality Index provides detailed information on the health effects of various pollutions (COMEAP 2011). Access to healthcare has also been shown to vary with these variables whereby, for example, increased levels of ozone have been associated with increased respiratory and cardiovascular visits to emergency departments in the US. (Choi et al. 2011). Climatic variables used in this study include temperature readings and measurements of snow fall, as well as air quality information for the pollutants Ozone (O3), Particulate Matter 10 (PM10), Sulphur Dioxide (SO2) and Nitrogen Dioxide (NO2), discussed further below.

4.10.1 Temperature and snow information (a)

Data sources

The MET office is the UK's national weather service and holds archives of past weather information. Temperature data was available from 24 weather stations in Wales and five weather stations in England on the Welsh/England border. Twelve of these stations also recorded snow data. Again, using Google Earth, the author derived the National Grid References (NGR), 'Northings and Eastings' for the stations in which climatic data were available (Table 4.9). Weather station locations were accurate to 100 metres.

Table 4.9: Weather stations in Wales and on the Welsh English border

Location of station	Altitude (metres)	NGR (Eastings, Northings)	Latitude	Longitude	Measures snow
Aberporth	133	2241E 2521N	52:14 N	04:57 W	Yes
Capel Curig	216	2701E 3570N	53:09 N	03:94 W	
Hawarden	5	3314E 3694N	53:22 N	03:03 W	Yes
Lake Vyrnwy	360	3012E 3188N	52:76 N	03:46 W	
Valley	10	2309E 3758N	53:25 N	04:54 W	Yes
Milford Haven	44	1891E 2055N	51:71 N	05:05 W	
Mumbles Head	43	2627E 1871N	51:57 N	03:98 W	
Rhyl	77	2994E 3747N	53:26 N	03:51 W	
Sennybridge	307	2894E 2418N	52:06 N	03:61 W	
St Athan	49	2999E 1684N	51:40 N	03:44 W	
Prestatyn	4	3061E 3837N	53:34 N	03:41 W	Yes
Llandeillo	80	2597E 2199N	51:86 N	04:04 W	Yes
Pembrey Sands	3	2365E 2044N	51:71 N	04:37 W	
Tredegar Bryn Bach Park No 2	360	3126E 2102N	51:78 N	03:27 W	Yes
Cardiff Weather Centre	52	3182E 1761N	51:48 N	03:18 W	
Cardiff Bute Park	9	3176E 1773N	51:49 N	03:19 W	Yes
Penhow	100	3412E 1907N	51:61 N	02:85 W	Yes
Llanishan	180	3486E 2037N	51:73 N	02:74 W	
Aberdaron	95	2152E 3248N	52:79 N	04:74 W	
Alwen	345	2960E 3528N	53:06 N	03:55 W	Yes
Trawsgoed	63	2674E 2736N	52:34 N	03:95 W	
Shawsbury	72	3553E 3221N	52:79 N	02:66 W	Yes
Ross on Wye (England)	67	3598E 2238N	51:91 N	02:58 W	Yes
Ness Gardens, Cheshire (England)	38	3303E 3755N	53:27 N	03:05 W	Yes
Hereford, Credenhill	76	3451E 2427N	52:08 N	02:80 W	

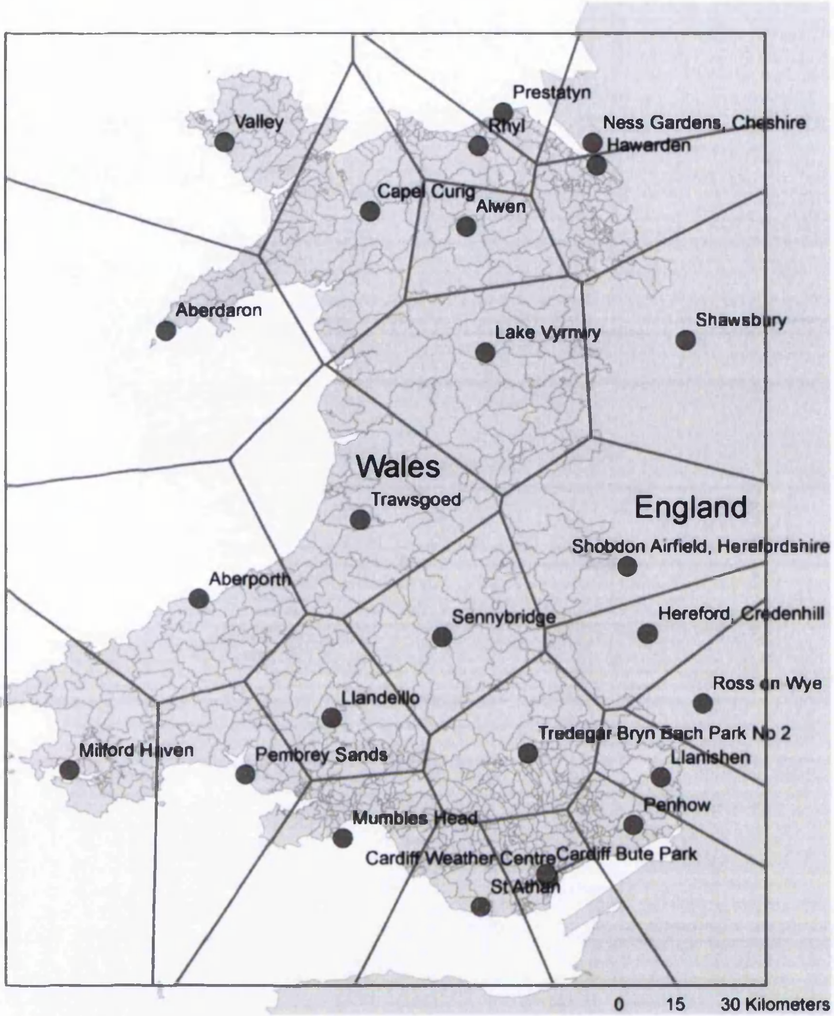
(England)					
Shobdon Airfield, Herefordshire (England)	99	3396E 2609N	52:24 N	02:88 W	

Mapping values

As in this study, the literature recognises that it is not always possible to collect data at every location and often one will need to estimate unknown values using observed values at known locations, a concept called 'spatial interpolation' (Burrough 1998). One such method of spatial interpolation frequently employed when analysing climatic data is Thiessen polygons. Thiessen polygons, also known as Dirichlet Tessellations or Voronoi Diagrams, are a precise method of interpolation that assumes the values of unsampled locations are equal to the value of the nearest sample point (Tatalovich date unknown). They define 'areas of influence' around a point to form groups of irregular convex polygons. Thus, to account for the lack of weather stations in Wales, the author used Thiessen polygons to estimate data for areas where stations do not exist.

As with the ED locations, SR then mapped the weather stations NGR references, using ARCmap onto Wales and England. The lecturer then created Thiessen polygons using ArcGIS10, a mapping programme and mapped the polygons over the ward. Using the centroid of each ward already determined, the lecturer was able to assign each ward into a polygon and thus assign each ward to the closest study weather station (Figure 4.4).

Figure 4.4: Thiessen polygons and weather stations in Wales and on the Welsh English border



Temperature and snow units of measurement

The author collected daily minimum and maximum temperatures from all available weather stations in the study period: January 1, 2002 – June 30, 2004. To analyse these temperature data efficiently, the author aggregated data by month and calculated two averages from the daily information for each station over the 30 study months: an average of the minimum recorded temperature; and an average of the maximum recorded temperature. Snow was measured in centimetres and the author added these up to create an aggregate for each month.

4.9.2 Air quality data (a)

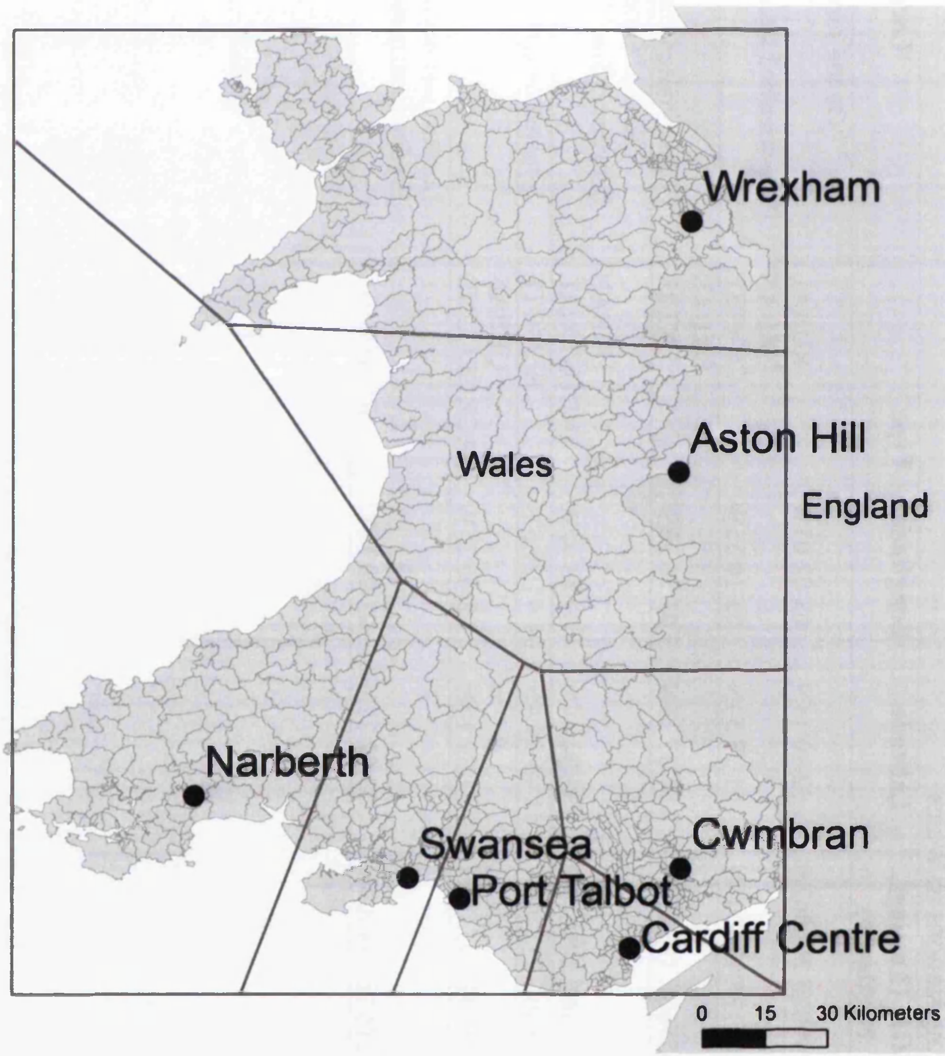
The author had extensive conversations with a Consultant in Environmental Health Protection from Public Health Wales (HB) concerning the best way to measure air quality data. HB informed the author that there were seven air quality monitoring stations in Wales and sent information regarding each station including the NGR grid references (Table 4.10).

Table 4.10: Air quality monitoring stations in Wales

Location of station	Altitude (metres)	NGR (Eastings, Northings)	Latitude	Longitude	Type	Location of station
Aston Hill	370	329902E 290062N	52 30 14N	03 02 03W	RURAL	On the summit of a hill with clear views of surrounding arable farmland
Cardiff Centre	12	318417E 176505N	51 28 54N	03 10 35W	URBAN CENTRE	Pedestrianised street (Frederick Street) 190 m from major road
Swansea	26	265566E 193158N	51 37 16N	03 56 36W	URBAN CENTRE	Pedestrianised area of Princess Way in city centre
Port Talbot	88	278036E 188249N	51 34 48N	03 45 42W	URBAN INDUSTRIAL	Rear of Groeswen Hospital grounds midway between B Steel Port Talbort Works and the M4 - bordering residential area
Pembrokeshire	169	214640E 212700N	51 46 54.4N	04 41 29.3W	REMOTE	Situated on arable farmland in South West Wales
Cwmbran	71	330510E 195436N	51 39 14N	03 00 25W	URBAN BACKGROUND	Not available
Wrexham	70	332862E 349904N	53 02 32N	03 00 10W	ROADSIDE	Located just beyond perimeter of school grounds. Predominantly residential area approximately 5m from Victoria Road

As before, using the NGR grid references, SR mapped the air quality monitoring stations using ArcMap. As with weather stations, SR created Thiessen polygons to attribute air quality data to those wards in which no station was present. See Figure 4.5.

Figure 4.5: Thiessen Polygons for air quality monitoring stations



Air quality measured

On HB's advice the author decided to use data from these sites on four of the main pollutants known to affect health: O3 (Halonen et al. 2010), NO2 (Weinmayr et al. 2010), SO2 (Sunyer 2002), PM10 (Weinmayr et al. 2010).

O3 is a secondary pollutant gas formed by chemical reactions caused by sunlight in the lower atmosphere (called photochemical reactions) (COMEAP 2011). Once formed, O3 can travel long distances accumulating in areas often far away from its original source. This means that O3 generated in areas with a great deal of traffic or industrial emissions may show up in less polluted areas. O3 is measured using an eight hour running mean.

NO2 is also a gas which is produced by the oxidation of nitric oxide by oxygen in the air. (COMEAP 2011). It is directly emitted from vehicle exhausts and by the burning of fossil fuels. However indoor levels caused by cooking with gas and cigarette smoking, are the more important source of exposure. NO2 is measured using a daily mean.

SO2 exists as a gas but when dissolved in water can produce sulphuric acid droplets in the atmosphere (COMEAP 2011). Most SO2 in the UK comes from industrial sources such as the burning of fossil fuels from power stations or from domestic sources such as boilers and gas stoves. SO2 is measured using a daily mean.

PM10 is composed of a mixture of substances arising from a variety of both man-made and natural particles. It refers to the mass concentration of particulate matter (expressed in Ugm-3) that is generally less than 10 millionths of a metre (10 ugm) in diameter (COMEAP 2011). The main source of particles is from combustion due to traffic and power stations although other sources include quarrying and mining, dust from construction and industrial processes and natural sources such as windblown dust, sea salt, soil particles and pollen. PM10 can be measured in different ways for example as an eight or 24 hour running mean.

On advice from a consultant from AEAT, an energy & climate change consultancy, the author downloaded data for each of the four pollutants from: http://www.welshairquality.co.uk/data_and_statistics.php. (accessed 09.02.2012). He recommended downloading "measured data" for NO2 and SO2, "daily mean" and "hourly measured" for PM10 and "8-hour running mean" for ozone. For all pollutants data were received as daily maximum hourly and daily minimum hourly values. The author used these readings to calculate a monthly average of the daily maximum readings and a monthly average of the daily minimums. This resulted in two values per month for each pollutant.

4.11 Analysis plan overview (a,b,c)

As the author wrote this analysis plan before undertaking analysis, this section is written in the future tense. Data analysis took place according to the three objectives:

Objectives

1. To identify factors associated with the demand and outcome of calls to NHSDW in order to build a model to explore the association between deprivation, demand and outcome of calls.

2. To model the relationship between deprivation and demand, controlling for other variables which affect demand.

3. To model the relationship between deprivation and call outcome, controlling for other variables which affect outcome.

4.11.1 Outcome measures (a)

The two primary outcome measures of this study are call rates (triage, general information and total) to NHSDW (demand) and the disposition given by the NHSDW nurse advisor (call outcome), defined in two ways as: (1) whether the patient received advice to phone 999 or contact an emergency ambulance versus any other care (contact GP, dentist, other or self-care); and (2) whether the advice was to contact any healthcare professional face to face versus self-care.

4.11.2 Data preparation (a and b)

Tests for normality

The term normal distribution describes a symmetrical, bell shaped curve, with the majority of scores in the middle and smaller numbers around either extreme (Gravetter and Wallnau, 2000, pg 52). The author will test whether call rates (dependent variable) and WIMD (explanatory variable) follow the normal distribution. This will be done at ward level. First, the author will report the skewness and kurtosis values of each. The skewness value provides an indication of the symmetry of the distribution whereas kurtosis provides information about the 'peakedness' – if the distribution is perfectly normal these values will be zero. The Kolmogorov-Smirnov test provides an assessment of normality. A significant result suggests that the assumption of normality has been violated.

Though regression techniques assume a normal distribution, they are fortunately robust to this assumption (Heeren and D'Agostino, 1987). Hence the author will use parametric tests throughout analysis. If there are large departures from normality the author will consider taking the logarithm or square root of call rates. These well known transformations generally bring skewed data closer to the assumption of normality.

Categorising variables

As discussed, the author categorised the 24 study variables into 3 categories: NHSDW variables [including: call characteristics (call types, dispositions given, day of week) and patient characteristics (gender, age, ethnicity, relationship of caller to patient, symptom)]; area based variables (call rates, deprivation score, distance to ED, population density); and climatic variables (air quality, temperature and snow).

To inform the analysis the author listed each study variable with its data source, variable type and coding structure see Table 4.11. Variables were classified as one of three main types:

- Categorical -data which in which data values are non-numerical, for example: gender is male 1, female 2
- Ordinal- data values are categorical and are ranked numerically in a meaningful way, for example, dispositions are ranked according to the hierarchy of care, with 999/ambulance as 1 and self care as 6
- Continuous data- data are presented along a spectrum, e.g. temperature in degrees Celsius.

Table 4.11: Breakdown of study variables

Categorisation	**Study Variable and description**	**Data source(s)**	**Variable type**	**Coding structure or unit of measurement (if applicable)**
	Dependent variables			
Area based variables	Call rates (triage, general information and total)	# of calls: NHSDW, population data: Office for National Statistics (ONS)	Continuous	# of calls in each ward/population of ward
Area based variables	Monthly call rates	As above	Continuous	as above
NHSDW variables	Disposition (advice given by NHSDW)	NHSDW	Ordinal	hierarchy of care used in NHSD and NHSDW evaluation summary, n=6
	Explanatory variable			
Area based variables	Deprivation	NHSDW Health Solutions Wales (HSW)and Oxford ref	Continuous	WIMD 2000
Area based variables	Deprivation fifth	NHSDW Health Solutions Wales (HSW)and Oxford ref	Ordinal	WIMD 2000
	Independent variable			
NHSDW variables	Call type	NHSDW	Categorical	2 categories: general information or triage
NHSDW variables	Patient age	NHSDW	Continuous	years of age
NHSDW variables	Patient gender	NHSDW	Categorical	2 categories: male or female
NHSDW variables	Patient symptom (reason for call)	NHSDW	Categorical	ICPC-2
NHSDW variables	Relationship of	NHSDW	Categorical	16 categories

Categorisation	Study Variable and description	Data source(s)	Variable type	Coding structure or unit of measurement (if applicable)
	caller to patient			
NHSDW variables	Patient ethnicity	NHSDW	Categorical	ONS ethnicity coding system 16+1
NHSDW variables	Day of week	NHSDW	Categorical	7 categories: one for each day
Area based variables	Patient distance to ED department	British National Grid and NHS sources	Continuous	in kilometers
Area based variables	Population density	ONS	Continuous	# of people/hectare
Climatic variables	Air quality- SO2 (min and max values)	Air Quality in Wales website*	Continuous	µg/m³
Climatic variables	Air quality -PM10 (min and max values)	Air Quality in Wales website	Continuous	µg/m³
Climatic variables	Air quality –O3 (min and max values)	Air Quality in Wales website	Continuous	µg/m³
Climatic variables	Air quality –NO2 (min and max values)	Air Quality in Wales website	Continuous	µg/m³
Climatic variables	Temperature (min and max values)	MET office	Continuous	in degrees Celsuis
Climatic variables	Snowy conditions	MET office	Continuous	in centimeters

* http://www.welshairquality.co.uk/data_and_statistics.php., last accessed 06.03.2012

4.11.3 Statistical analysis (a and c)

Analysis needs to identify and explore variables in addition to deprivation which may influence both demand and the disposition of calls and could thus be used in the regression model. The author will employ univariate analysis (concerned with the description of a single variable), bivariate analysis (concerned with the association between two variables) and multivariate analysis (techniques for datasets with more than two variables) in turn.

Objective 1

For Objective 1, the author will initially use univariate analysis to explore each variable separately, looking at the range of values and describing the pattern of responses.

Simple descriptive analysis such as frequency distributions will be carried out to provide a summary of the data. In order to provide meaning and context, where possible, results will be compared against Welsh population data derived from the 2001 Census. This will allow comparisons to be made between observed and expected values (e.g. for age, sex, ethnicity). Where applicable, chi-squared tests will be undertaken with the p value set at <0.05, to determine whether a finding was significant or if it had occurred by chance.

The author will then undertake bivariate analysis (exploration between two variables) to further explore the relationship between: the explanatory variable (deprivation) and all other independent variables; and the dependent variables (call rates and disposition) and other independent variables. Again throughout the anlaysis, parametric tests will be used, however if the data is clearly not normally distributed these will be validated by the appropriate non parametric test. Table 4.12 summarises the key statistical tests which are further outlined below.

Table 4.12: Bivariate statistical tests to be used

To explore types of variables	**Example**	**Statistical tests**
2 continuous	Call rates and WIMD score	Pearson (parametric) or Spearman (non parametric) correlation coefficients, scatter or box plots
1 continuous and 1 ordinal or categorical (2 categories)	WIMD score and gender	Scatter or box plots, Independent samples t test, Mann-Whitney test
1 continuous and 1 ordinal or categorical (3 or more categories)	Age and disposition	Scatter or box plots, ANOVA (parametric) or Kruskal-Wallis test (non parametric)

Correlation refers to the broad statistical relationships between variables. The Pearson correlation coefficient will lie between +1 (a perfect increasing linear relationship) and -1 (a perfect decreasing relationship). A score of 0 indicates no correlation. The non-parametric alternative is Spearman's correlation coefficient.

Independent T tests are statistical tests which will be used to compare the mean scores of a continuous variable of two different groups or conditions. Levene's test for equality of variances will be used to test whether the variation in mean scores is the same between the two groups. The non parametric alternative to the T test is the Mann-Whitney test.

Where the author wants to compare the mean scores of more than two groups, analysis of variance (ANOVA) will be used. This statistical method involves one dependent continuous variable and one independent variable which is categorised in a number of different ways or levels (corresponding to the different groups or conditions). It is called analysis of variance because it "compares the variability in scores between different groups (believed to be due to the independent variable) with the variability between groups (believed to be a result of chance)" (Pallant 2005).

An F ratio is used to represent the variance between groups divided by the variance within groups. If this ratio is large, the author will assume that there is more variability between groups (caused by the independent variable) than there is within each group. If an F test is significant, the null hypothesis can be rejected (for this analysis, the null hypothesis is that the population groups means are equal). The non parametric alternative is the Kruskal-Wallis test.

As statistical inference in general, and SPSS in particular, takes into account large sample sizes, the criterion whether a result is statistically significant or occurred by chance, will be 5%.

Objectives 2 and 3

Multiple regression techniques will be used to explore the relationship between one continuous dependent variable and several independent variables. In particular, these techniques help explain how well a set of variables (the independent variables) can predict a particular outcome (the dependent variable). These techniques also provide information on the strength of each variable. In this study it could be argued that statistical analysis of demand and outcomes is unnecessary because we know what happened in NHSDW between January 2002 and June 2004. In contrast we are trying to analyse observed behaviour in our population as if it were one of many potential samples from the 'superpopulation' of all possible scenarios (Moser and Kalton 1985).

Linear regression analysis works to find the best-fitting straight line for the linear equation that relates the dependent variable (Y) to the independent variables (X). The criterion that is used to find this best-fitting straight line is that of 'least squares'. The equation of the line is often represented as $Y = b_0 + b_1 X$, where b_0 is the intercept of the line on the Y axis when X=0 and b_1 is the slope of the line. By applying this equation to each of the dependent variable values (i.e. the Y values) one obtains a predicted value of Y based on the constants (b_0 and b_1) and the independent variable values (X values). The residual is the difference between the observed value of Y and the value predicted by the equation.

Statistical output provides information about the model as a whole (how well all the variables work together) and information about the relative contribution of each variable. There are four main types of multiple regression analyses which can be used depending on the nature of the question to be asked: simultaneous; sequential; hierarchical; and stepwise. Simultaneous methods, in which deprivation affects healthcare which affects deprivation, need sophisticated data and thus are not an option for this study. Sequential, also known as time series, in which early calls affect late calls, needs data linkage so are also ruled out. Thus the author has two choices for type of regression to use: stepwise which aims to select those independent variables that best predict the dependent variable; or hierarchical which aims to estimate the marginal effects of dependent variables chosen in accordance with some natural hierarchy. Depending on results of the exploratory univariate and bivariate analysis, the author will combine these methods of analysis to achieve the best model of the effect of deprivation on call rates.

As the second dependent variable in this study is ordinal, multiple regression techniques are not suitable here. Thus, the author will employ logistic regression, analysis which is used to model the effects of independent variables on a categorical outcome (the dependent variable). As with multiple regression, there are several types of analyses to use but the main choice lies between hierarchical and stepwise. As a main operational guide the author will use the guidance by Russell and Gregson (1981). The author will also use the results of the exploratory analysis to highlight the way forward in terms of which analysis to use. With logistic regression, the dependent variable can take one of two categories. What we want to know is not the predicted numerical value of a dependent variable (as in a linear regression equation) but the predicted probability that the dependent variable belongs to one group rather than the other.

With multiple regression there is a great deal of statistical output and the author will focus on three main outputs, explained below:

- Beta (standardised regression coefficients): This value allows one to assess the strength of the relationship between each independent variable and the dependent variable, or in other words how strongly each independent variable influences the dependent variable. Beta is measured in units of standard deviation. For example, a beta value of one third implies that a change of three standard deviations in the independent variable will cause a change of one standard deviation in the dependent variable.

- R, R^2, Adjusted R^2: R is a measure of the correlation between the observed and the predicted value of the dependent variable. R^2 indicates the proportion of the variance in the dependent variable which is accounted for by the model. In other words, R^2 is a measure of how well one can predict the dependent variable by knowing the independent variables. The Adjusted R^2 takes into account the numbers of variables in the model, and of observations in the population yielding the model. The author will report this statistic.

- Residuals: the differences between the obtained and the predicted scores for the dependent variable.

Multiple regression techniques make a number of assumptions about the data which should be met:

- Sample size: regression should not be used on small samples as results may not be generalisable. Although guidelines on the number to be used differ, Tabachnick and Fidell (2001, pg. 117) recommend using the formula: $N>50+8m$ (where m=number of independent variables). For stepwise regression, there should at least 40 cases for every independent variable (Pallant 2005). As there are over 400 000 cases in this study, the dataset has easily achieved the criteria; however care will be taken when reporting findings, to report both the statistical significance of results and the significance clinically and socially.

- Multicollinearity and singularity: multicollinearity exists when the independent variables are highly correlated. Singularity occurs when one independent variable is deducible from other independent variables. Both of these concepts can cause problems in multiple regression. In both models, collinearity diagnostics in SPSS, including 'Tolerance' levels will help identify variables which are heavily correlated. For example, the closer to zero the Tolerance level is for a variable, the stronger the relationship between this and other independent variables. In these circumstances, the author will consider removing these from the model. Both multicollinearity and singularity are real dangers in this study, especially with the climatic variables.

- Outliers: Regression techniques are sensitive to extreme data values (either high or low). Outliers may be removed from the dataset or replaced with a similar but more moderate score and the author will explore these options.

- With multiple regression results, normality, homoscedasticity, and independence of residuals describe the distribution of scores and underlying relationships between variables. Pallant (2005, pg 143) describes these terms as follows:
    - Normality: residuals should be normally distributed about the predicted dependent variable scores
    - Linearity: residuals should have a straight-line relationship with the predicted dependent variable scores
    - Homoscedasticity: variance of the residuals about the predicted dependent variable scores should be the same for all predicted scores

Specifically with logistic regressions the assumptions are:

- The dependent variable must be dichotomous (e.g. have two categories)
- The independent variables do not need to be normally distributed, or have equal variance in each group
- The categories for the variables must be mutually exclusive – a participant can be in only one group and exhaustive – every participant must be in a group.
- The sample size needed is even larger than for multiple regression.

The author will check these assumptions through exploratory analysis and regression output to ensure that multiple and logistic regression analyses can be undertaken rigorously.

4.11.4 Missing values (a and c)

In regression techniques there are three options for excluding variables:

- Listwise: only cases with valid values for all variables are included in the analyses, also known as complete case analysis.
- Pairwise: uses cases with complete data for the pair of variables being correlated to calculate the correlation coefficient on which the regression analysis is based.
- Replace missing value with the mean: all cases are used with the mean substituting for missing observations.

In addition to these, there are other methods of handling missing data (Carpenter and Kenward, 2007) including imputation of missing values (Briggs et al, 2003). Based on the results of the exploratory analysis and the degree of missing data, the author will assess which is the best method to use.

4.12 Chapter summary (a,b,c)

This chapter has described the methods to be used for exploring relationships between patient deprivation and demand for, and outcome of, contacts with NHSDW using an epidemiological approach. While many of the variables to be included in analysis can be attributed directly to an individual (for example, age and ethnicity), using a ward deprivation score as a measurement of patient socio-economic status is typical of an ecological analysis – a study in which a group is used as the unit of analysis. In this study analysis will be done at individual level (e.g the call to NHSDW) and then combined at group level (e.g. ward). Thus the unit of analysis is the "unit into which the data is aggregated for analysis". In this chapter the author has outlined potential regression approaches. The next chapter presents the results of Objective 1, relating to univariate and bivariate analysis, and uses these results to inform the building of the models.

Chapter 5: Results of Objective 1 – relationships between variables

5.1 Overview (a, b, c)

This chapter presents the result of objective 1:

To identify factors associated with the demand and outcome of calls to NHSDW in order to build a model to explore the association between deprivation, demand and outcome of calls.

This chapter is divided into five sections, 1) Data overview; 2) Preliminary exploration of low call rates; 3) Univariate analysis; 4) Bivariate analysis; and 5) Building the regression models. Under data overview, the author reports tests for determining whether the sample is normally distributed and presents a summary of the data in terms of missing records. Secondly, she presents the results of an exploration of call rates in Flintshire, where they were found to be particularly low. In Section 3, the author reports on the exploration of all study variables individually. Here, for relevant variables, the author also sought to understand how these variables varied from what would be expected if each member of the general population was equally likely to contact NHSDW. In Section 4, the author sought to identify any interactions between these variables which could have a confounding effect on deprivation, demand and dispositions. The chapter concludes with Section 5, including a summary of which variables will be taken forward to include in the regression models and the methods used to construct these models.

This chapter has changed since the original submission. In particular, between the original thesis and the viva (b) the author reran tests for normality using the values at ward level rather than at individual call level. She also corrected several of the bivariate correlations which should have been done at ward level (for example, the relationship between deprivation score and distance to ED) and included summary statistics for the new individual variables converted to ward level, including correlations between these new variables and deprivation and call rates. These changes are all indicated by (b).

Additionally, following the viva (c), the author has added the results of the initial explorations of the new variable requested by the examiners: day of the week. As requested, she has also included a summary of the Census 2001 ward level population values for age, gender and ethnicity and provided a brief summary of these variables including a comparison with the corresponding patient values. She has also explored further the differences between triage and general information call rates and presented results here. In Section 5.8, the author presents a detailed explanation of how these changes affected the proposed models for multiple linear and logistic regression. These changes are all indicated by (c).

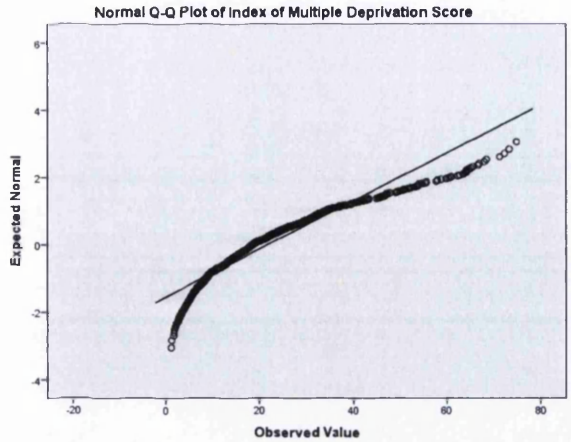
5.2 Tests for normality (a and b)

The author did tests for normality on the WIMD (explanatory variable) and call rates (dependent variable). This was done at ward level (n=865).

Assessing WIMD for normality

The mean WIMD score was 21.75 and the 5% trimmed mean was 20.64 suggesting there are no extreme values for WIMD score which exert a strong influence on the mean. Skewness was 1.163, se= 0.083 and kurtosis was 1.252, se=0.166. The Kolmogorov-Smirnov statistic was: 0.101, df=865 and $p<0.001$. As the p value is significant, WIMD scores violate the assumption of normality. This is also supported by the normal probability plot (where a reasonably straight line represents a normal distribution), as both the lower and higher WIMD scores stray from the straight line, Figure 5.1.

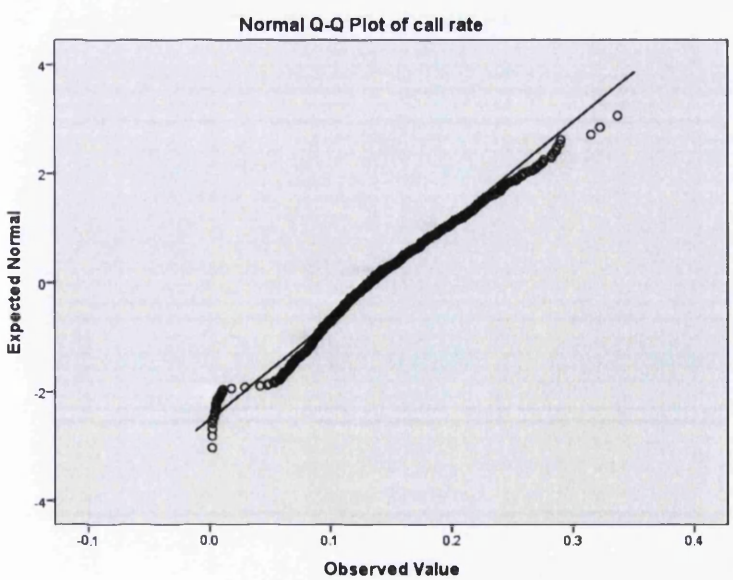
Figure 5.1: Normal Probability Plot for WIMD



Assessing call rates for normality

The mean for ward level call rates was 0.139 and the 5% trimmed mean was 0.138, again suggesting that there are no extreme values which exert a strong influence on the mean. The skewness statistic was 0.334, se= 0.083 and kurtosis statistic was 0.360, se=0.166. The Kolmogorov-Smirnov statistic was: 0.058, df=865 and p<0.001. As the p value is significant, call rates violate the assumption for normality. This is also supported by the normal probability plot, which indicates that wards with the lowest and highest call rates both have lower call rates than expected, Figure 5.2.

Figure 5.2 Normal probability plot of call rates per head of population/year



Although the middle of the normal probability plot looks much as expected, the tails suggest that something untoward is happening.

To explore this further, the author examined call rates in more detail. The mean for call rates was 0.139 with a standard deviation of 0.05 and although call rates varied across the country with a maximum 0.337 in Gorseinon East, Swansea, five wards in Flintshire (Saltney, Higher Kinnerton, Broughton North and East, Hawarden and Broughton South) had the lowest call rates, each with 0.002. Furthermore, 21 out of the 25 wards with the lowest call rates were in Flintshire (Appendix 10, A) and all wards in Flintshire had rates below the mean. The author mapped call rates by ward to see the extent of this trend and if any further trends existed with respect to call rates. Figure 5.3 is a reference map showing the 22 Unitary Authorities (UAs) in Wales, while Figure 5.4 is a choropleth map showing the variation in call rates by Welsh wards.

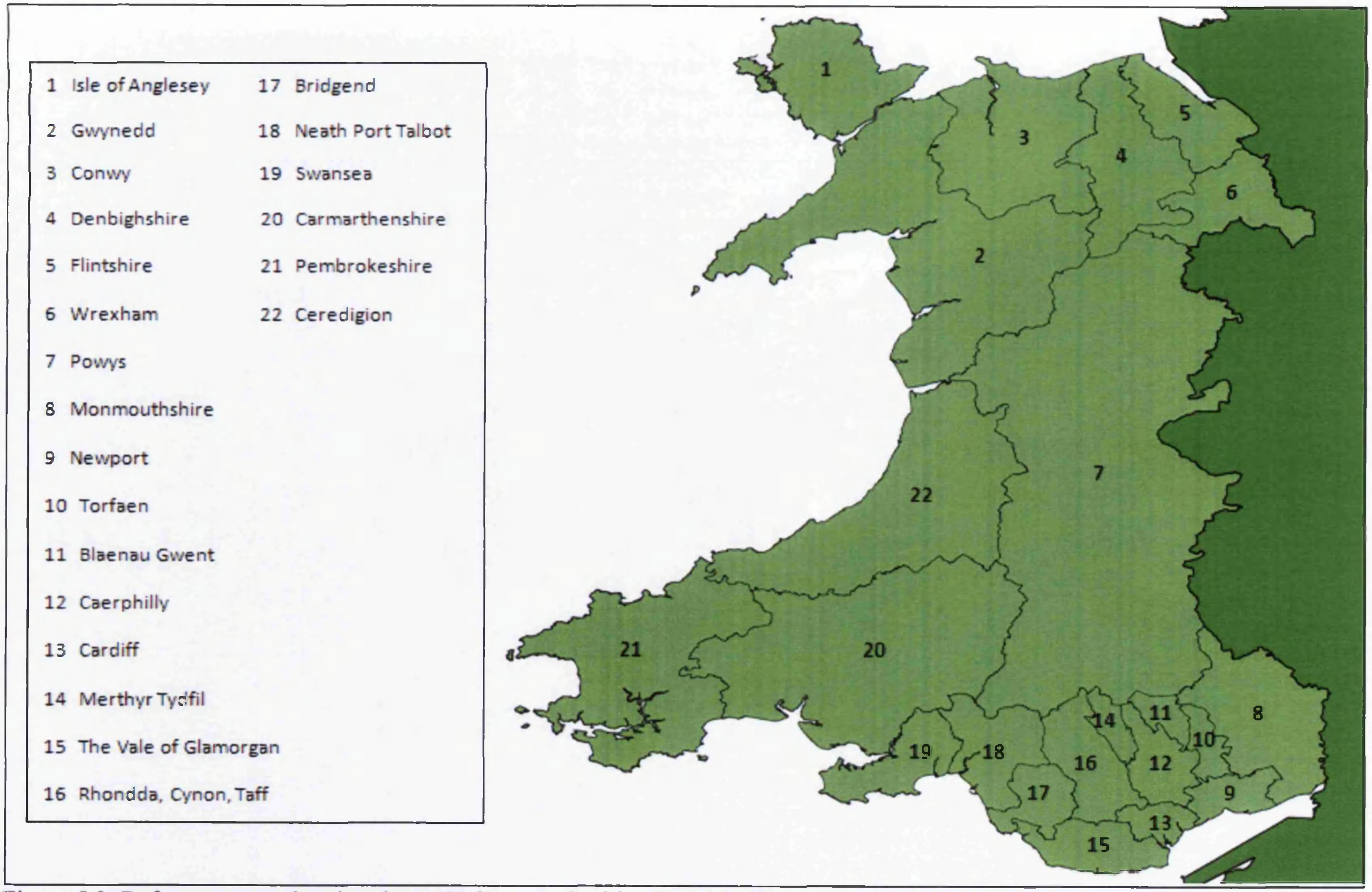
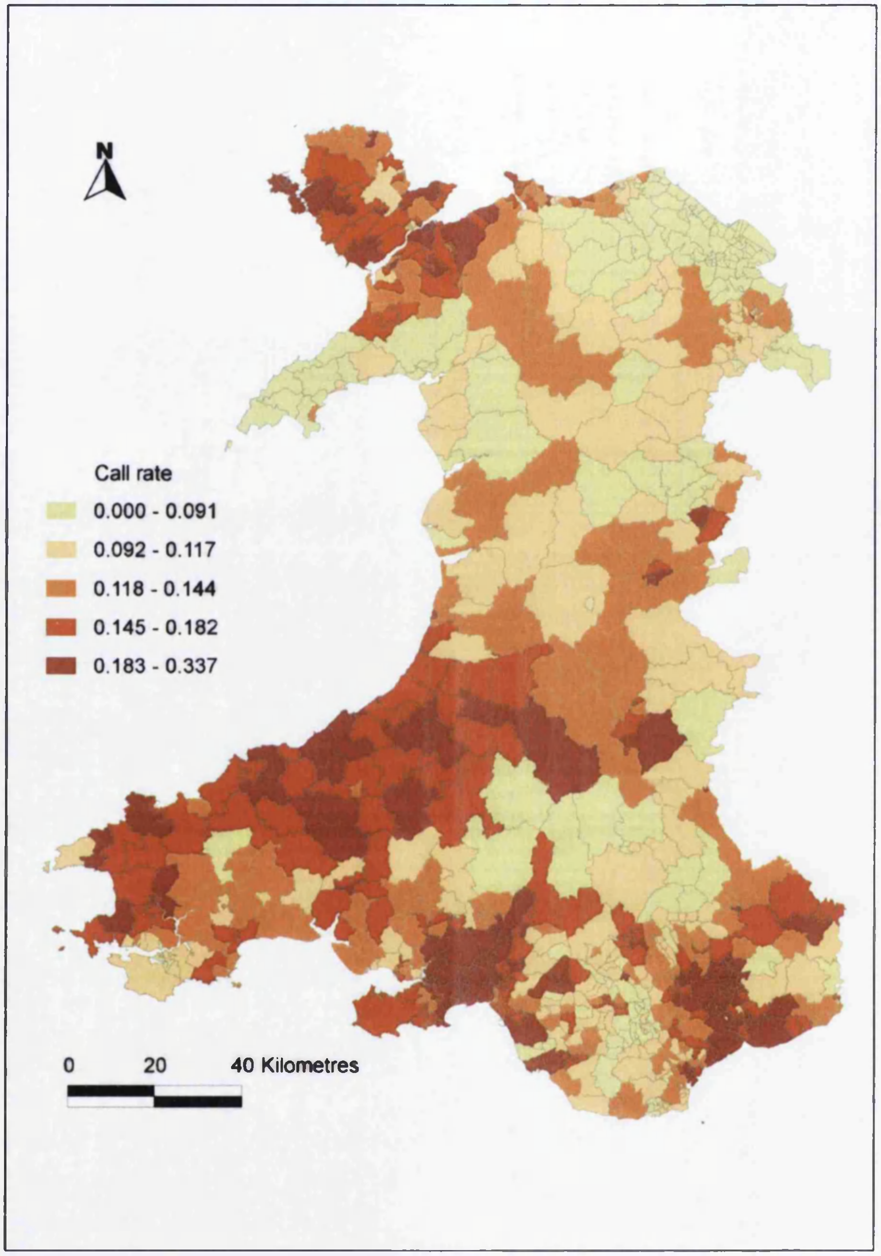


Figure 5.3: Reference map showing the 22 Unitary Authorities (UAs) in Wales

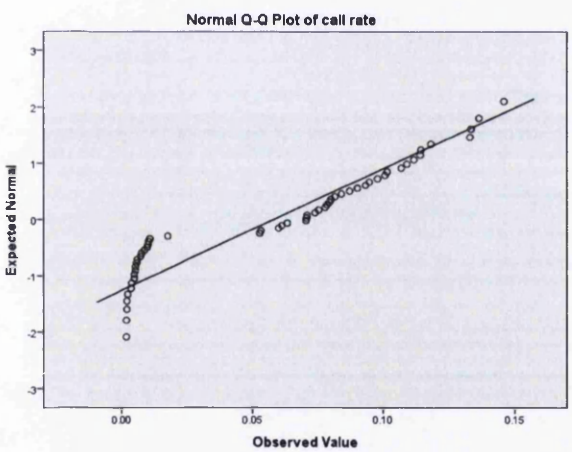
Figure 5.4: Choropleth map showing the variation in call rates by Welsh wards



The map reinforces the low call rates in Flintshire with several of the wards appearing in the lowest call rate fifth with call rates in the 0.00 - 0.093 range. Although these wards are small in size, there is a cluster close to the English border. There appears to be also low call rates on the west coast of Gwynedd whereas wards in Anglesey, Swansea and Carmarthenshire had high call rates.

To understand better if the inclusion of Flintshire wards was skewing the distribution of data, the author assessed Flintshire call rates for normality. Results did not follow a normal distribution. The mean was 0.059 and the trimmed mean 0.057. The skewness statistic was 0.070, se=0.325 and kurtosis statistic was -1.40, se=0.639. The Kolmogorov-Smirnov statistic was: 0.219, df=54 and $p<0.001$. As the p value is significant, call rate scores for Flintshire violate the assumption of normality. This is very apparent in the Normal Probability plot, in which call rates do not lie on a straight line, Figure 5.5.

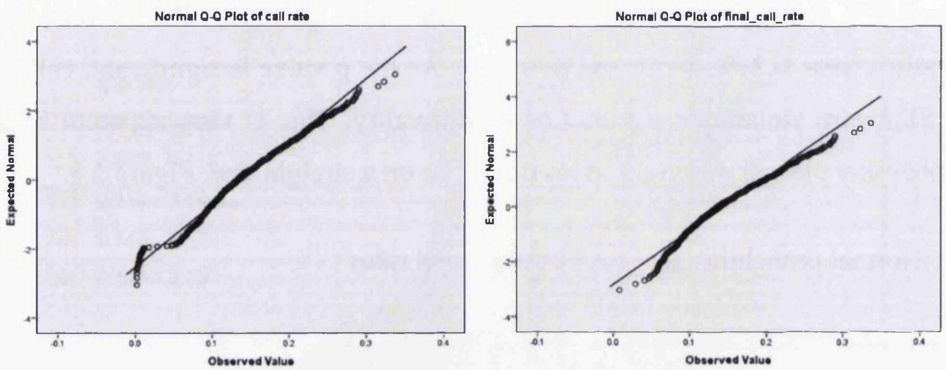
Figure 5.5: Normal probability plot for Flintshire call rates



The author then excluded Flintshire and reran the tests for normality on call rates. The mean was 0.144 and the 5% trimmed mean was 0.142, again suggesting that there are no extreme values which exert a strong influence on the mean. There was a little change in the skewness and kurtosis statistics (skewness value= 0.630, se=0.086 and kurtosis= 0.179, se=0.171). The Kolmogorov-Smirnov statistic was also similar: 0.074, df=811 and p<0.001. As the p value is significant, call rate scores still violate the assumption of normality.

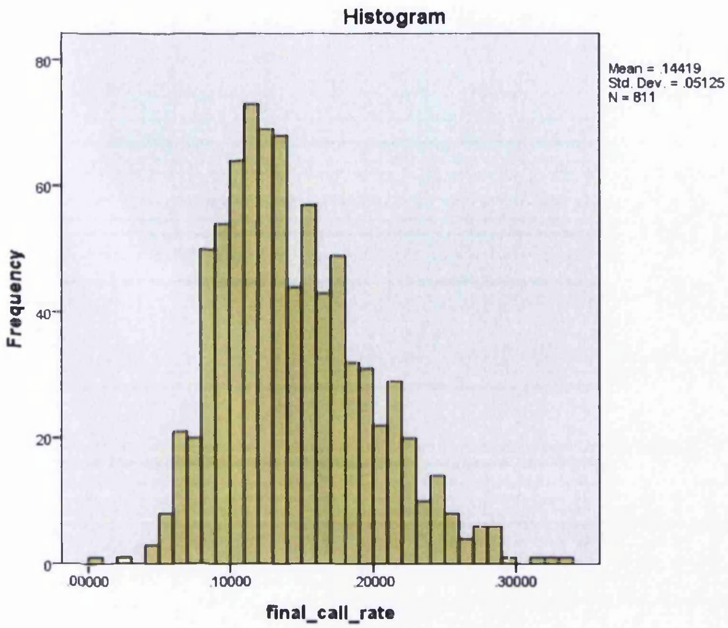
However when the author compared the first normal probability plot including all cases (n = 865) with the normal probability plot with Flintshire excluded (n= 811), there was a clear improvement on the tail of the plot, again reinforcing that Flintshire wards were influencing the data (Figure 5.6).

Figure 5.6: Comparison of normality plots: 1) full dataset 2) excluding Flintshire



The author then explored the histogram for the distribution of call rates outside Flintshire, Figure 5.7; although there are some deviations, this suggests normality.

Figure 5.7: Histogram for distribution of call rates

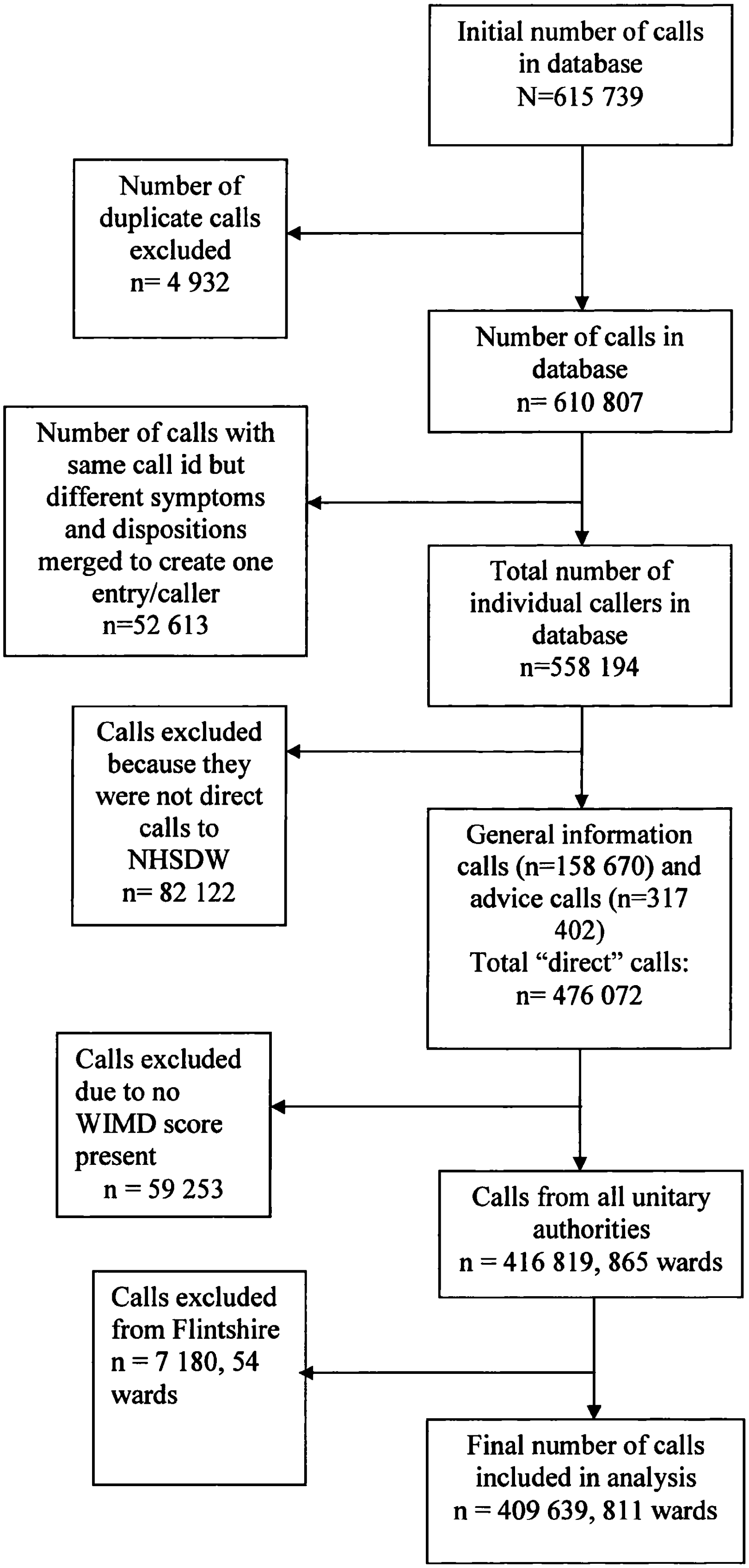


Therefore, the author decided to remove calls made from wards within Flintshire (n= 54) from the dataset, and to explore findings using qualitative methods (Section 5.3) in an attempt to understand what may be influencing low call rates in this region.

For completeness, the author checked whether removing Flintshire had an effect on the distribution of WIMD scores. Results were consistent with Flintshire included: mean WIMD = 22.2, 5% trimmed mean=21.1, skewness statistic =1.150 Se=0.086, kurtosis statistic =1.187, se=0.171. The Kolmogrov-Smirnov statistic changed slightly from 0.101 to 1.02, df=811 and $p<0.001$. The normal probability plots looked very similar (Appendix 10, B). As the boundary problem in Flintshire affects only call rates, this came as no surprise.

Excluding Flintshire brought the new number of cases to be included in the analysis to 409 639 in 811 wards, Figure 5.8.

Figure 5.8: Flowchart showing selection of calls for analysis



As indicated in the analysis plan (Section 4.11.2), the author used parametric tests throughout analysis with a stated intention to validate these as necessary by the non-parametric alternative. However, although neither WIMD scores nor call rates are normally distributed, the histogram for the distribution of call rates, Figure 5.6 above had elements of normality. The author therefore decided that this, in conjunction with the robustness of parametric tests (Heeren and D'Agostino 1987) was enough evidence to indicate that results of the regression analysis would be valid. Thus the decision was made to conduct parametric tests on the data in line with the assumptions of multiple regression.

However, as discussed, the author explored whether the decision to exclude Flintshire was justified and whether qualitative based research methods could help explain why call rates were so low in this area.

5.3 Preliminary exploration of low call rates in Flintshire using qualitative approaches (a)

5.3.1 Overview (a)

The importance of supplementing results from quantitative studies with data obtained from qualitative research methods has been well documented in the literature (Petticrew and Roberts, 2003; Dixon-Woods et al, 2004; Harden et al, 2004 and Thomas et al, 2004). Qualitative methods allow for insight into people's experiences placing results in a social context, which may otherwise be missing. Pettigrew and Roberts (2003) in particular, note that qualitative studies alone are best for answering process questions or questions concerning "how does an intervention work in practice".

As stated in the analysis plan, large, unexplained phenomena in the data would cause the author to explore further, perhaps using qualitative methods. As discussed above the author assessed the distribution of call rates for normality, call rates in East Flintshire were particularly low in comparison with the rest of Wales. Five wards in Flintshire

(Saltney, Higher Kinnerton, Broughton North and East, Hawarden and Broughton South) shared the lowest call rates and of the 25 lowest call rates, 21 were in Flintshire. These wards are all very close to the Welsh English border and the English city of Chester.

When the author excluded Flintshire from the dataset, the fit of data to a normal distribution improved. Rather than speculate what may be going on in this part of Wales, the author decided to carry out a small number of interviews with healthcare professionals and service users in Flintshire or Chester. Thus this section presents a preliminary exploration of low call rates using qualitative approaches. However this is less a piece of qualitative work in its own right, more an exploration using qualitative approaches in an attempt to understand what may be happening in Flintshire.

Objective

The objective of this qualitative arm is to add clarity to the quantitative findings from this study and by exploring possible reasons why call rates in North East Flintshire are so low in comparison to the rest of the country.

Selection of participants

The author decided to conduct semi-structured telephone interviews with three general practitioners (GPs) and 2 service users. Interviewees were purposively sampled and identified through personal contacts. Each was contacted by email to seek their consent and make interview arrangements. As interviewees were not contacted through the NHS, it was not necessary to obtain ethical approval.

Before the start of each interview, the author collected background information on: the interviewee's role; location of role; number of years experience including the number of years experience in the area; and where the interviewee lived. This last piece of data was collected for practitioners in particular so that, if they also lived in the area, their views as a patient could also be collected.

Interview schedules and data collection

The author designed a semi-structured interview schedule which was amended following circulation to two experienced qualitative researchers (Appendix 11). The first interview was used as a pilot. No revisions were made and data are included in the results.

The author used the interview schedule to design a proforma on which to make written notes recording responses and any other important notes related to the interview. All interviews were recorded with the consent of the participant to allow for key quotes to be used verbatim. All direct quotes are reported anonymously.

Analysis

The author undertook thematic analysis based loosely on a framework provided by the interview schedule. This is a flexible approach which involves a five step process to analysis: familiarisation, identify a thematic framework, indexing, charting and mapping and interpretation (Srivastava and Thomson 2009 and Ritchie and Spencer 2002). The author and another independent researcher discussed possible themes emerging from the data. However all final analysis was undertaken by the author.

Quotations are used to support the key themes which emerged from the interviews.

Interview results

Three people took part in the study: two general practitioners and one service user. Of the two GPs, one was too busy to be available for interview and filled out the proforma by email. The other invitees, a GP and a service user, did not respond to the invitations to participate.

Respondents identified two key reasons why calls rates in North East Flintshire could be lower than other parts of Wales:

1) the excellent local OOH service in that area
2) the fact that some wards in North East Flintshire share English telephone area codes and postcodes.

Excellent out-of-hours services

All respondents praised the OOH service in NE Flintshire. They judged the service as of high quality, managed and staffed locally. This contrasted with a perception that NHS Direct was geographically centralised and delivered from out of the area.

> "I don't know, because I don't know how it is in the rest of Wales. I think that OOH service in NE Wales has been traditionally been perceived as a good one, in that it is run by local health boards and is staffed by local doctors. So it's not like a commercial or private agency or deputising service or anything like that. It is, and all doctors that work there are local doctors and as OOH services go it's probably quite a good one and has a good reputation. So it's maybe that people tend to use OOH services instead of NHSDW as they feel they get quite a good service form OOH service and all calls are triaged so if they just need advice from a nurse, that's all they'll get. People will know that if they ring the out of hours, they will get a locally based nurse, who knows geography well, and the local practices and local services rather than a nondescript person sat in an office in Cardiff or Milton Keynes or wherever they live I don't know." Interviewee1- GP1

Respondents also identified the accessible and seamless quality of the services between the English and Welsh NHS as another reason not to ring NHS Direct. Interviewee 3-GP2 pointed out that GP practices in that area had extended opening hours while the hospital in Chester was nearer than hospitals in Wales and near enough for people to travel when they needed unscheduled care. This was brought up in particular as a possible reason why these border wards may be different from other border wards which may have the same issue of sharing services between England and Wales. Interviewee 2-Service User1 also felt that people preferred contact face to face rather than by telephone.

> "Guess that there are groups of people who see themselves as close enough to go to a walk in centre in England as we don't have them in Wales. One of the things that Flintshire does have is Minor Injury Units, people may feel more comfortable about going there then ringing NHS Direct." Interviewee2- Service User1

Wards in Flintshire with English telephone area and postcodes

The second reason identified for affecting call rates in East Flintshire to NHSDW was the designation of English postcodes and telephone dialling codes in border wards. For example, respondent 2 pointed out that although they lived in Wales, their household address had a Chester postcode and their telephone dialling code was the same as used in Chester numbers. Thus, if this pattern was also the case for the other wards in Flintshire, incoming calls from these border areas would look like they were coming from England rather than Wales as they would show up as English numbers on the database, as suggested in this quote:

> "I live in Flintshire about two or three miles from the border and my postcode starts with CH, [which is the same as Chester postcodes] and my telephone dialling code is the same as the Chester dialling code (01244) but I definitely live in Wales ...If they were gauging where the person lived from the telephone number, I'm just wondering if this is something to do with it. " Interviewee2- Service User

5.3.1 Steps taken to follow up interview results (a)

Based on the results of the interviews, the author contacted both NHSDW via their general information email enquiry service and wrote to the Research, Service Evaluation and Clinical Audit team NHSD in England . The letter and email explained the issue of low call rates in North East Flintshire and asked, given that NHSD and NHSDW have the same telephone number how calls were allocated between the two services.

NHSDW replied via email, key points of which are outlined below: stating:

- Telephone calls are routed to NHS Direct in England or Wales according to the telephone dialling code. "All calls with an exchange dialling code in England will enter a call plan for NHSD in England and from there are allocated to their call centres. If the call has an exchange dialling code in Wales...they will be directed to NHSDW."

- Certain areas of Wales including some in East Flintshire are routed to NHSD England because they have a Chester dialling code
- Wards with Chester dialling codes include Aldford, Buckley, Christleton, Connah's Quay, Great Mollington, Hawarden, Kinnerton, Mickle Trafford, Rossett, Saughall and Seahall
- Mobile calls are non-geographic and callers are asked to choose between NHSD England and NHSD Wales
- NHSD England takes calls to NHSD Wales when they cannot answer calls for technical reasons but this is rare

(personal communication: email to the author, dated 12.04.12).

When the author checked the call rates of the other wards mentioned in this email- the majority which were in Flintshire: Buckley, Connah's Quay, Hawarden, and Kinnerton, all had relatively low call rates. Rossett, the most northerly ward in Wrexham also had low call rates. The other wards- Aldford, Christleton, Great Mollington, Mickle Trafford, Saughall and Seahall - were not in the dataset meaning that they were wards which came into existence post 1998. The author did not look further into what these wards were in 1998 but it is likely that the same issues were encountered in these wards.

The author also queried NHSDW as to whether this situation could exist in other border wards. NHSDW did a search of the major towns and confirmed that the majority are connected to Welsh exchanges, with the exception of Rhosllanerchrugog which has an English exchange and is covered by Shrewsbury. NHSDW did note however, that it is likely that some of the smaller villages on the border would have English exchanges. However, as noted previously from the mapping of call rates, this does not seem to happen elsewhere on the border.

NHSD in England did not reply to the author's queries.

5.3.2 Discussion and conclusion of preliminary exploration (a)

Two main ideas emerged from the interviews undertaken to explore why call rates in North East Flintshire were so low: 1. exceptional out-of-hours services in this area and 2. the fact that some areas have the Chester, English exchange dialling code. This was confirmed by NHSDW in a personal email to the author stating that callers from these wards would be automatically routed to NHSD in England. In this email NHSDW also pointed out that mobile callers are given a choice between the English or Welsh NHSD services and that, in times of technical failure, the English service will pick up all calls. However, as it is unlikely that all calls in these areas will come from mobile callers choosing one service over the other and times of technical failure are rare, neither of these factors seem plausible explanations as to why these wards had such low call rates. It therefore appears that call rates in NE Flintshire are low because they are automatically being routed to NHSD in England.

This however does not explain why all wards in the Flintshire have call rates below the mean. The other theme brought up through the interviews about the quality of services in this area should not be overlooked. It may be that there are dual effects going on in this area. As Interviewee 1 pointed out, it would be beneficial to speak to practitioners directly responsible for OOH care in this area in order to understand the situation fully.

It should also be noted that findings here are the results of three people's opinions and this section is not a qualitative study in its own right but rather a brief exploration using qualitative based methods. Although respondents all concurred in their opinions, a more comprehensive picture of the reasons for low call rates in these wards could be obtained through further interviews or focus groups with a wider sample of participants. Nonetheless, the information provided by the small number of qualitative interviews here would not have been picked up by routine data alone. This additional piece of research has added strength to study findings by explaining what happens in one area of Wales. Additionally, it has reinforced the argument that qualitative research is a valuable supplement to quantitative findings. The next section continues with the analysis of objective 1.

5.4 Missing values (a and c)

In this section, the author has added the day of the week variable to the original table. For five variables, data collection was complete: each call in the sample had a value. Several other variables were missing data, with the air quality readings having the most missing data (Table 5.1).

Table 5.1: Summary of missing data

Study Variable and (n)	Number of missing values	% of missing values
Dependent variables		
Call rates (n= 811 wards)	0	0.0%
Monthly call rates (811 wards x 30 months)	0	0.0%
Disposition (n=409 639)	0	0.0%
Explanatory variable		
Deprivation (n=811 wards)	0	0.0%
Independent variable		
Call type (n=409 639)	0	0.0%
Patient age (n=409 639)	4468	1.1%
Patient gender (n=409 639)	489	0.1%
Patient symptom (n=409 639)	162230	39.6%
Relationship of caller to patient (n=409 639)	191	0.1%
Patient ethnicity (n=409 639)	225389	55.0%
Day of week (n=409 639)	0	0.0%
Patient distance to ED department (n=811 wards)	0	0.0%
Population density (n=811 wards)	0	0.0%
Air quality- SO2 (measured in 6 stations, therefore 180 months)	19 months	10.6%
Air quality -PM10 (measured in 6 stations, therefore 180 months)	40 months	22.2%
Air quality –O3 (measured in 6 stations, therefore 180 months)	22 months	12.2%
Air quality –NO2 (measured in 7 stations therefore 210 months)	24 months	11.4%
Temperature- monthly min (750 months)	8 months	1.1%
Temperature- monthly max (750 months)	14 months	1.9%
Snowy conditions (360 months)	0 months	0.0%

Every call in the dataset has an assigned WIMD score because the author decided early in the analysis to exclude those for which a WIMD score was not present (Section 4.6.2). This meant that for each call the author knew the ward from which the call originated. The author was able to obtain population data for every ward in the dataset, thus allowing a call rate and a monthly call rate to be calculated for every ward in the dataset (call rate= number of calls in that ward/by the population of that ward).

For the majority of variables collected as part of the NHSDW routine dataset, data were nearly complete: there were full data for call type, and only 1% missing for gender, age and relationship of caller to patient. The exceptions to this were the high percentage of missing information for symptoms (almost 40%) and ethnicity (55%). As indicated previously, NHSDW did not start collecting data on ethnicity until June 2003, meaning that there is only one year of these data available. In this year, only 6.2% of data on ethnicity are missing.

The author asked NHSDW why there was such a high percentage of missing symptoms and whether some information could have been lost during data transfer. A NHSDW data analyst looked into this and concluded that data had not been lost and there were several possible explanations why this information was missing: "some will be requests for information rather than an illness; others may have been missed through an error by the call handler or due to procedures used soon after inception" (personal communication, dated 16.02.05).

The author tested some of these reasons in the database. When the author explored missing symptoms by month, the month with the lowest percentage of missing cases was December 2002, with 35.0 % missing and the month with the highest percentage of missing cases was April 2003 with 44.9% of symptoms missing. The percentage of missing symptoms seemed to increase by month suggesting that missing data did not result from early procedures.

When the author isolated general information calls to see if any of the missing symptoms could be computed, 96.9% of these calls were missing symptoms. In contrast, triage symptoms were missing 13.4% of symptoms. Thus, it seems that ringing for general information represents the most likely explanation for missing symptoms. The author took account of this in her analysis plan.

For every ward the author was able to assign a distance to the closest ED and a population density. However air quality data had the highest percentage of missing values ranging from 10.6% for SO2 measurements to 22.2% for O3. The author asked a representative of AEAT, an energy & climate change consultancy who work with these data, why these data were missing and what could cause this. Apparently missing data result from problems with the measuring instruments, which are not always reliable; sometimes data which do not meet the strict quality criteria have to be removed. The sites with missing data are all sites where AEAT have experienced problems, notably in Pembrokeshire and Wrexham. Although there is always an instrument at each site they can fail to deliver accurate data for many reasons including overheating, leaking, poor calibration, faulty electronics or software, and power or communications failures. AEAT commented: "I'm afraid there's little we can do about these; they happen occasionally, a fact of life in automatic monitoring systems" (personal communication: email to the author dated 27.03.12).

5.5 Exploration of individual variables (univariate analysis) (a and c)

In the methods chapter, the author categorised variables into NHSDW, area based (which also includes those individual level variables calculated at ward level) and climatic variables. These sections are retained here; NHSDW variables are further broken down into call characteristics and patient characteristics.

5.5.1 NHSDW variables: call characteristics (a and c)

Call characteristics are variables which describe the call and include call types, day of week the call occurred and dispositions given.

Call types

The majority of calls, 68.7% were classified by NHSDW as triage calls (n=281 240), while 31.3% (n=128 399) were for general information.

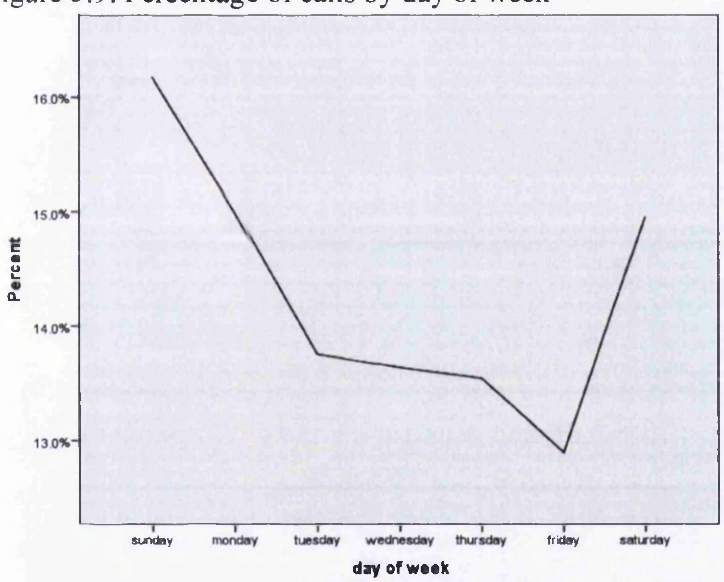
Day of week

There was a differential pattern across the week with Sunday, Monday and Saturdays being the most busiest, Table 5.2 and Figure 5.9.

Table 5.2 Day of the week the call was made

	Frequency	Percent
Sunday	66302	16.2
Monday	61503	15.0
Tuesday	56344	13.8
Wednesday	55868	13.6
Thursday	55491	13.5
Friday	52841	12.9
Saturday	61290	15.0
Total	409639	100.0

Figure 5.9: Percentage of calls by day of week



Dispositions given

There was at least one disposition recorded for all calls (n=409 639), with 36 078 calls having two dispositions, 4207 with three and 830 with four. The dispositions were not necessarily unique to symptoms; for example one caller had symptoms of 'abdominal pain' and 'chest pain' and two dispositions to 'contact 999/ambulance'.

The author coded all dispositions using the algorithm supplied by NHSDW (Table 5.3).

Table 5.3: Dispositions given as coded by NHSDW algorithm

Total dispositions	Frequency	Percent
not assessed	23 750	5.3
999/ambulance	13 441	3.0
ED	32 675	7.2
contact GP within 2 hours	85 182	18.9
contact GP within 6 hours	30 811	6.8
contact GP within 36 hours	28 435	6.3
routine appt. with GP	13 792	3.1
speak to GP within 1 hour	4 272	0.9
speak to GP within 2 hours	5 255	1.2
speak to GP next working day	7 373	1.6
home care	26 508	5.9
contact dentist within 1 hour	442	0.1
contact dentist within 4 hours	3 352	0.7
contact dentist within 12 hours	3 088	0.7
contact dentist next working day	3 573	0.8
contact dentist for routine appt	3 150	0.7
contact pharmacist	4 144	0.9
contact police now	49	0.0
contact walk in centre	8	0.0
contact other professional	42	0.0
direct transmission to hospital	12	0.0
health information provided	134 539	29.8
caller not wishing to proceed	673	0.1
policy direct transfer	552	0.1
out of SLA time	12	0.0
administration only	3	0.0
contact other healthcare professional	4 591	1.0
call unassessed as per policy	2 648	0.6
GP to ring	33	0.0
Contact other (includes: other, no action required)	18 349	4.1
Total	450 754	100.0

The author then recoded all dispositions into the hierarchy of care as described earlier (Section 4.8). Frequencies were tabulated before and after the number of dispositions were reduced to one per call (following the highest resource use rule), see Table 5.4.

Table 5.4 Dispositions given according to hierarchy of care

Disposition	Frequency (all dispositions)	Percent (all dispositions)	Frequency (one disposition/call)	Percent (one disposition/call)
999/ambulance	13 441	3.0	12 792	3.1
ED/hospital	32 687	7.3	29 867	7.3
emergency GP/dentist	98 536	21.9	89 907	21.9
GP/dentist	90 222	20.0	82 154	20.1
Other	27 735	6.2	27 135	6.6
self care	161 047	35.7	154 594	37.7
not assessed	27 086	6.0	13 190	3.2
Total	450 754	100.0	409 639	100.0

When the author used the categories as defined for logistic regression, 3.1% (n=12 792) of callers were advised to phone 999 or contact an emergency ambulance versus 96.9% advised to seek other care (contact GP, dentist, other or self-care); and 59% (n=241 885) were advised to contact a healthcare professional versus 41% advised to care for themselves.

5.5.2 Patient characteristics (a)

Patient characteristics are those variables which describe the patient and his or her relationship to the caller. These include gender, age, ethnicity, relationship to caller and symptom. For many patient characteristics, it was possible to compare results with the 2001 census; these are reported alongside the univariate analysis of each variable.

Gender

The majority of the calls to NHSDW, n= 253 861, (62.0%) were about female patients. This differed from the proportions of men and women making up the Welsh population, which were approximately equal, Table 5.5.

Table 5.5 Gender of patient compared with the Welsh population

Gender	Frequency of patients	Percentage of patients	Welsh Population	Percentage in Wales
Male	155 289	37.9	1 403 900	48.4
Female	253 861	62.0	1 499 185	51.6
Total (known)	409 150	100.0	2 903 085	100.0
Unknown	489			
Total	409 639		2 903 085	100.0

Age

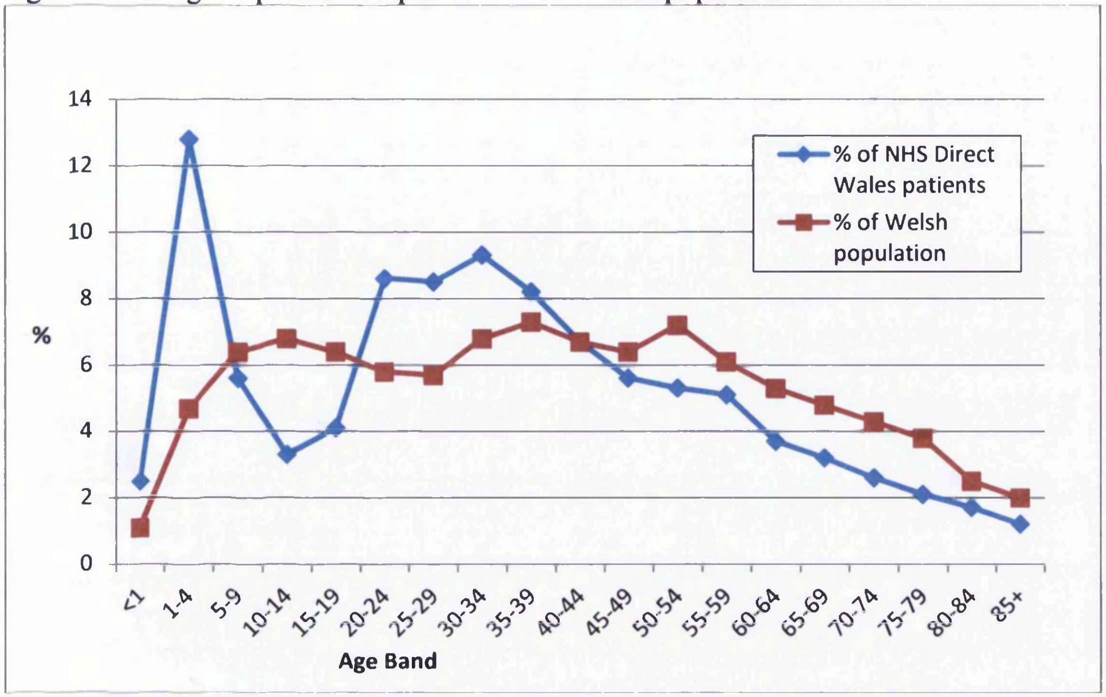
The mean age of NHSDW patients was 33.4, SD=22.8 and the age range was from 0 to 105 years. The author grouped ages into 5 year intervals and compared these with the Welsh population, (Table 5.6). As with gender, the age distribution of NHSDW patients differed from the Welsh population. While there are 136 118 (4.7%) children aged 1-4 in Wales, 51 987 calls were about this age group (12.8%), the most about any age group. Calls about older people were fewer than expected from their proportion in the general population.

Table 5.6 Age of patient compared with the Welsh population

Age Group	Frequency of patients	Percentage of patients	Welsh Population	Percentage in Wales
<1	10 223	2.5	31 779	1.1
1-4	51 987	12.8	136 118	4.7
5-9	22 499	5.6	185 326	6.4
10-14	13 252	3.3	195 977	6.8
15-19	16 430	4.1	184 711	6.4
20-24	34 726	8.6	169 494	5.8
25-29	34 314	8.5	166 348	5.7
30-34	37 860	9.3	198 298	6.8
35-39	33 089	8.2	212 174	7.3
40-44	27 035	6.7	195 486	6.7
45-49	22 603	5.6	184 493	6.4
50-54	21 386	5.3	208 337	7.2
55-59	20 802	5.1	176 844	6.1
60-64	15 118	3.7	152 920	5.3
65-69	12 785	3.2	138 461	4.8
70-74	10 655	2.6	125 731	4.3
75-79	8 654	2.1	109 831	3.8
80-84	6 916	1.7	72 373	2.5
85+	4 837	1.2	58 384	2.0
Total (known)	405 171	100	2 903 085	100.0
Unknown	4 468			
Total	409639		2 903 085	

These differences become more apparent when displayed in graphical format, Figure 5.10.

Figure 5.10: Age of patient compared with the Welsh population



Ethnicity

There were twelve months of data on patient ethnicity. Ethnic origin of patients was mainly congruent with the Welsh population, with calls about white British people comprising the vast majority of calls, n=177 364 (96.3%), (Table 5.7).

Table 5.7: Ethnicity of patient compared with the Welsh population

Ethnicity	Frequency of patients	Percentage of patients	Welsh Population	Percentage in Wales
Asian or Asian British – Any other Asian background	201	0.1	3 464	0.1
Asian or Asian British – Bangladeshi	168	0.1	5 436	0.2
Asian or Asian British – Indian	653	0.4	8 261	0.3
Asian or Asian British – Pakistani	261	0.1	8 287	0.3
Black or Black British – African	166	0.1	3 727	0.1
Black or Black British - Any other Black background	92	0.0	745	0.0
Black or Black British – Caribbean	118	0.1	2 597	0.1
Mixed - Any other mixed background	616	0.3	4 307	0.1
Mixed - White and Asian	317	0.2	5 000	0.1

Mixed - White and Black African	181	0.1	2 400	0.1
Mixed - White and Black Caribbean	283	0.2	6 000	0.2
Other ethnic groups - Any other ethnic group	631	0.3	5 135	0.2
Other ethnic groups – Chinese	242	0.1	6 267	0.2
White – British	177 364	96.3	2 786 605	96.0
White – Any other White background	1734	0.9	37 211	1.3
White – Irish	1223	0.7	17 689	0.6
Total (known)	184 250	100.0	2 903 805	100.0
Unknown	225 389			
Total	409 639			

As data were so limited for this variable, the author grouped this variable into two categories for analysis: white background [includes White British, White- any other white background and White-Irish (n=180 321, 97.9%); and any other ethnicity (n=3 929, 1.9%). This again corresponds to the proportions of those with 'white background' in Wales (97.9%) and with 'any other ethnicity' background (1.7%)].

Again as data were so limited for this variable, during the viva, the examiners gave some helpful feedback about how to include ethnicity throughout the analysis. For the multiple regression, as discussed, the author was to use the 2001 Census population values corresponding to the proportion of white residents per ward. For the logistic regression, the author created two dummy variables consistent with categories in the 2001 Census: 'white or unknown ethnicity' versus 'any other ethnicity'; and 'known' (white or other) versus 'unknown'. This allowed ethnicity to be included in the regression equations without having to undertake a sensitivity analysis.

Other patient characteristics which could not be compared with Welsh population data were the relationship of caller to patient and patient symptom.

Relationship of caller

Almost 60% of patients (n= 237 372) called the service about themselves, while almost a quarter of all calls were made by mothers (n=90 789), (Table 5.8).

Table 5.8: Relationship of caller to patient

Relationship of caller to patient	Frequency	Percentage of callers
aunt/uncle/cousin/niece	1315	0.3
caregiver/guardian	3184	0.8
colleague/friend/neighbor	5647	1.4
daughter/daughter in law	7215	1.8
father/father in law/step father	16 525	4.0
Grandparent	4 393	1.1
grandson/daughter	395	0.1
mother/mother in law/step mother	90 789	22.2
Other	2 789	0.7
Self	237 372	58.0
sibling/sibling in law	2 321	0.6
son/son in law	2 367	0.6
spouse/partner	35 136	8.6
Total (known)	409 448	100.0
Unknown	191	
Total	409 639	

As percentages were so low in some of these categories, the author also grouped this variable into two main categories: those calling about themselves (n=237 372, 58.0%); and those calling on behalf of someone else, (n= 172 267, 42.0%).

Patient symptom

Over a quarter of calls with symptoms present were about digestive symptoms (n=67 194, 27.2%), while social (n=32) and endocrine (n=72) problems were reportedly rare (Table 5.9). As percentages were also so low in some categories the author combined the patient symptom variable into two categories, digestive symptoms (27.2%) vs all other symptoms and missing.

Table 5.9: Symptoms according to ICPC-2 chapter codes

Symptom 1	Frequency	Percentage
Digestive	67 194	27.2
General and unspecified	32 160	13.0
Skin	30 308	12.3
Musculoskeletal	27 982	11.3
Respiratory	27 326	11.0
Neurological	21 262	8.6
Female genital	6 929	2.8

Symptom 1	Frequency	Percentage
Eye	6 391	2.6
Ear	6 410	2.6
Psychological	6 106	2.5
Urological	5 964	2.4
Pregnancy, childbearing and family planning	4 266	1.7
Cardiovascular	2 620	1.1
Male genital	2 387	1.0
Endocrine/metabolic and nutritional	72	0.0
Social problems	32	0.0
Total (known)	247 409	100.0
Unknown	162 230	
Total	409 639	

5.3.3 Area based variables (a, c)

Key area based variables include: call rates, deprivation scores, distance to ED and population density. The author created a ward level summary table for these variables (call rates, deprivation, distance to ED, and population density). Table 5.10 shows this for the Unitary Authority, Blaenau Gwent, while Appendix 13 holds the full table. To ensure data confidentiality, where the number of calls in the study period is under 5, this has been represented by <5 (Office for National Statistics 2006).

Table 5.10: Ward level summary information

Electoral Division	Ward name	Number of calls in study period	Population	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Pop density	Nearest ED	Distance to ED in km
Blaenau Gwent									
PLMA	Abertillery	694	4490	0.155	32.08	164	9.76	Nevill Hall	12.6
PLMB	Badminton	368	3155	0.117	23.45	317	11.79	Prince Charles	11.9
PLMC	Beaufort	402	3876	0.104	30.26	197	11.27	Nevill Hall	11.9
PLMD	Blaina	632	4830	0.131	39.44	98	6.08	Nevill Hall	11.0
PLME	Brynmawr	610	5599	0.109	34.22	137	9.62	Nevill Hall	9.7
PLMF	Cwm	540	4350	0.124	38.35	104	4.45	Nevill Hall	14.3
PLMG	Cwmtillery	648	4749	0.136	40.78	89	4.81	Nevill Hall	10.8
PLMH	Ebbw Vale North	566	4745	0.119	37.37	108	19.06	Prince Charles	12.0
PLMJ	Ebbw Vale South	573	4199	0.136	38.30	105	6.32	Prince Charles	12.9
PLMK	Georgetown	350	3491	0.100	23.58	314	8.55	Prince Charles	11.2
PLML	Llanhilleth	648	4776	0.136	50.40	47	6.45	Nevill Hall	15.3
PLMM	Nantyglo	475	4293	0.111	57.82	25	5.84	Nevill Hall	10.5
PLMN	Rassau	359	3297	0.109	41.11	87	6.84	Prince Charles	11.2
PLMP	Sirhowy	535	5520	0.097	49.44	50	3.34	Prince Charles	8.5
PLMQ	Six Bells	351	2648	0.133	32.64	155	6.22	Nevill Hall	13.5
PLMR	Tredegar Central and West	525	6046	0.087	51.04	43	5.46	Prince Charles	10.0

Call rates (triage, general information, total)

As shown in Figure 5.4 total call rates varied widely across the country with a range from 0.01 in Rossett, Wrexham to 0.34 in Gorseinon East, Swansea. The mean for total call rates was 0.14 with a standard deviation of 0.05. As would be expected, triage and general information call rates followed a similar pattern although the top end of the range was not as high: triage call rates ranged from 0.01 to 0.26, mean of 0.09 with a standard deviation of 0.04 and general information call rates: range 0.02 to 0.15, mean 0.05, standard deviation, 0.02.

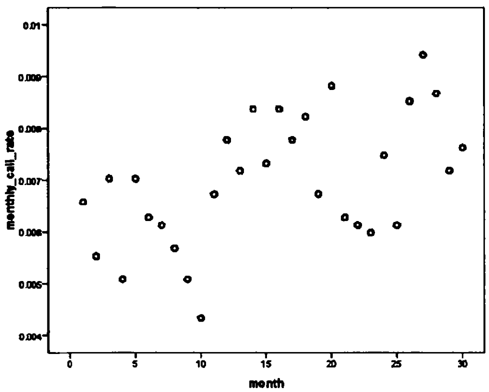
The author calculated monthly call rates (for total calls) to see if the calls followed a seasonal trend, Figure 5.11 There were too many data points to do this on the dataset as a whole so, as indicated in the analysis plan, the author randomly chose 10 wards representing different aspects of Wales to explore this:

1. urban (Victoria in Newport with population density of 70.94)
2. rural (Ledrod, Ceredigion with a population density of 0.1)
3. north (Pentraeth, Anglesey)
4. south (Dinas Powys, Vale of Glamorgan)
5. east (Welshpool Castle, Powys)
6. west (Garth, Pembrokeshire)
7. high deprivation (Gurnos, Merthyr Tydfil with a WIMD rank of 4)
8. middle deprivation (Risca East, Caerphilly with a WIMD rank of 435)
9. low deprivation (Usk, Monmouthshire with a WIMD rank of 863)
10. Welsh speaking (Llanllyfni, Gwynedd).

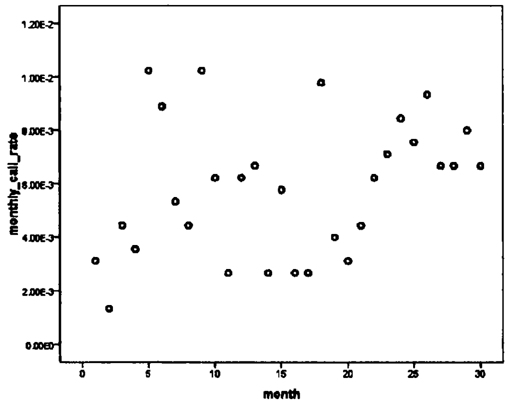
Month 1 is Jan 2002, Month 2 is February 2002, and so on (Appendix 10, C).

Figure 5.11: Monthly call rates in a sample of wards

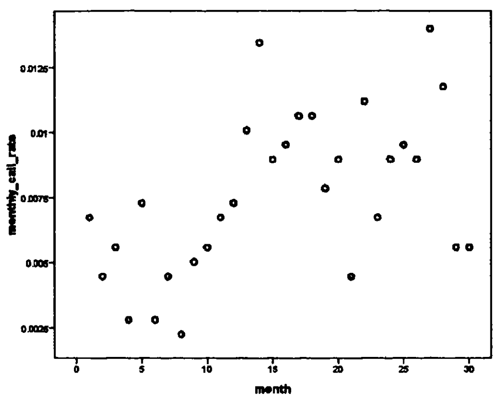
Victoria monthly call rates



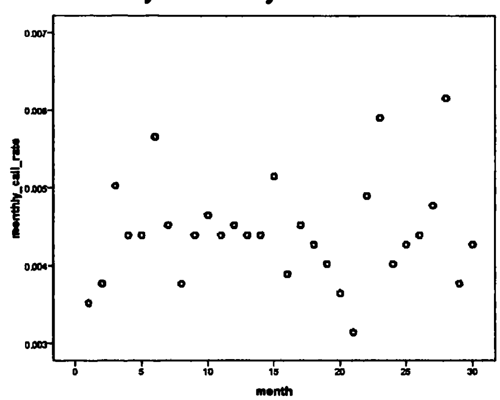
Lledrod monthly call rates



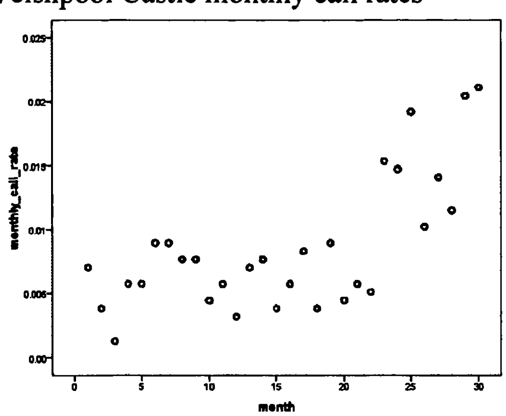
Pentraeth monthly call rates



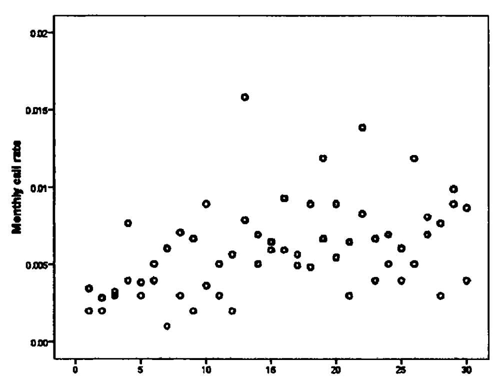
Dinas Powys monthly call rates



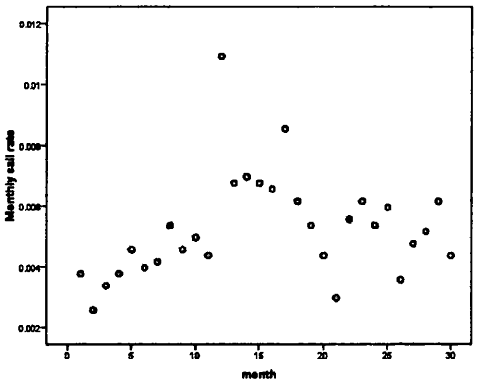
Welshpool Castle monthly call rates



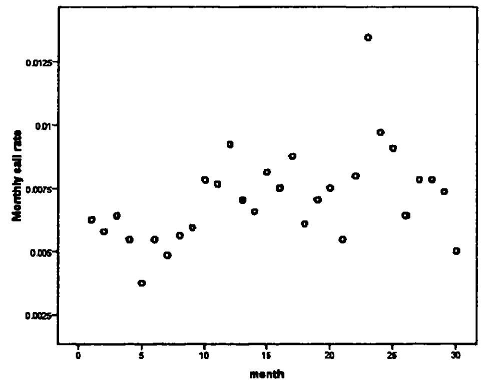
Garth monthly call rates



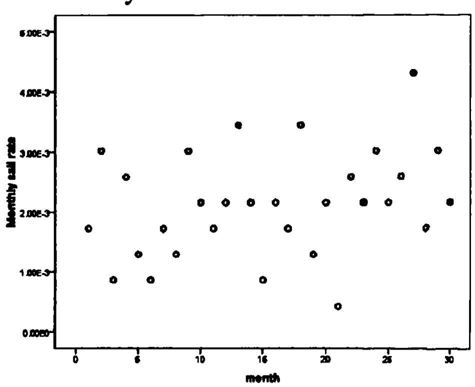
Gurnos monthly call rates



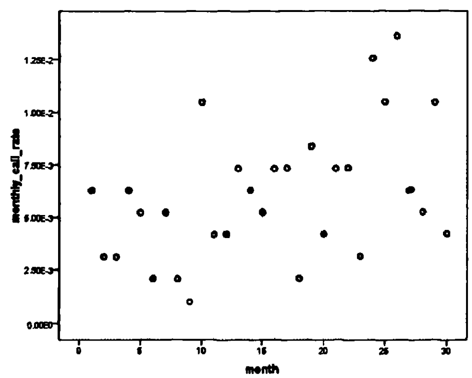
Risca East monthly call rates



Usk monthly call rates

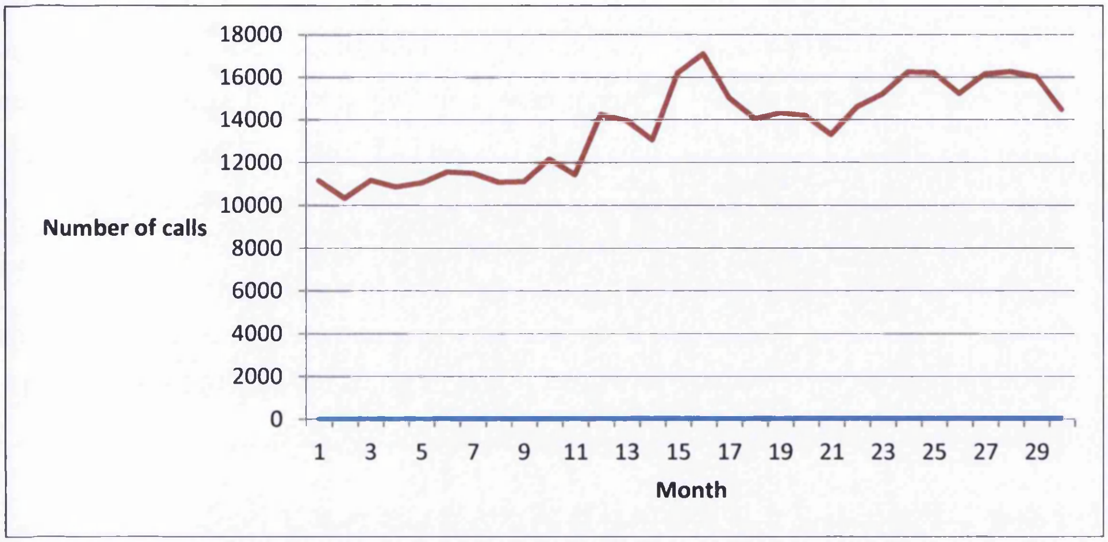


Llanllyfni monthly call rates



There did not seem to be any seasonal variations in the data although most of the graphs showed a slight upward trend. The author therefore graphed the number of calls (not rates) over time in Figure 5.12. Though there are slight dips in calls over time the upward trend in the data is clear to the naked eye.

Figure 5.12: Calls over time



Deprivation score

Although Flintshire was excluded from the analysis, every other ward in Wales was represented in the dataset, n=811. WIMD deprivation scores varied from 1.13 (the least deprived ward: Cyncoed in Cardiff) to 74.87 (the most deprived ward: Rhyl West, Denbighshire, Figure 5.13. The mean score was 22.2 (this falls into the fourth deprived fifth) and the standard deviation was 14.2.

The most calls came from deprivation fifth five (the most deprived), Table 5.11.

Table 5.11: Calls by deprivation fifth

Deprivation (from WIMD)	N	%
Least deprived fifth	83 071	20.3
2nd least deprived fifth	64 652	15.8
3rd least deprived fifth	74 167	18.1
4th least deprived fifth	85 024	20.8
Most deprived	102 697	25.1

Distance to ED

The author derived this for every ward. The closest ward to an ED was Aberystwyth East in Ceredigion with a distance of 0.2 km (closest hospital Bronglais General Hospital) and the furthest ward away from an ED was Aberdaron in Gwynedd with a distance of 56 km (closest to Ysbytwy Gwynedd), Figure 5.14. The mean distance to ED was 13.8 km and the standard deviation was 11.4 km.

Population density

The ward with the minimum population density was Llanuwchllyn, in Gywnedd with 0.04 and the ward with the maximum was Plasnewydd in Cardiff with 100.3, Figure 5.15. The mean was 9.7 and the standard deviation was 13.2.

Figure 5.13: Choropleth map showing variation in WIMD scores by Welsh wards

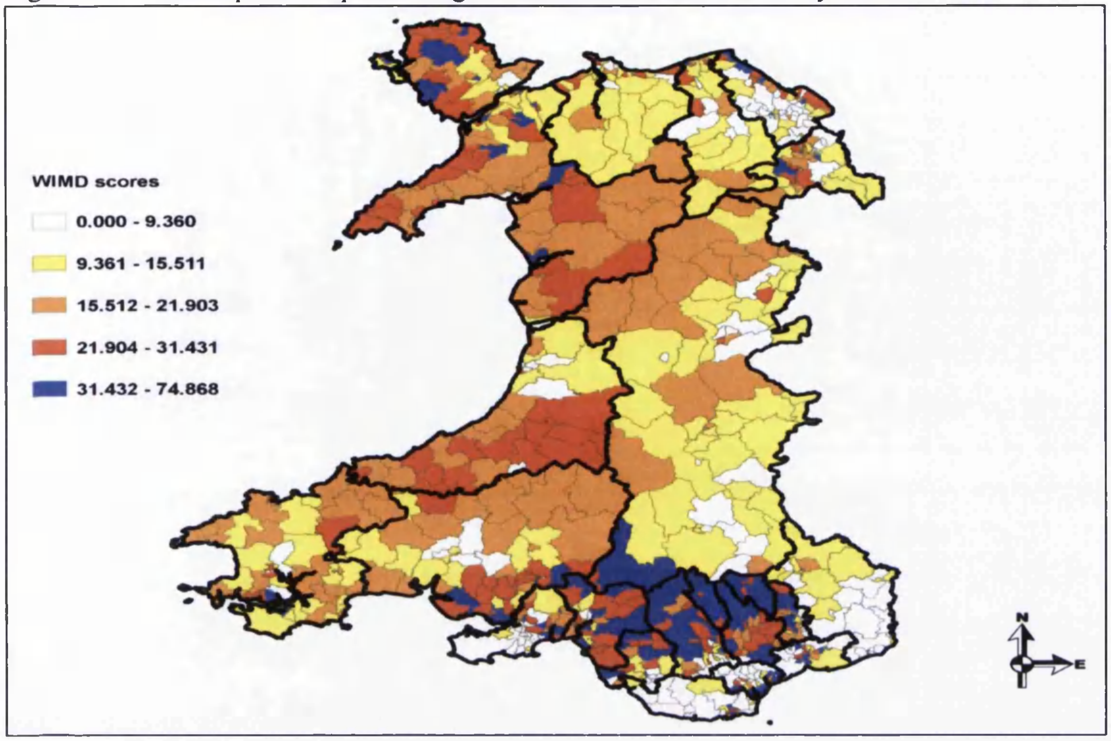


Figure 5.14: Choropleth map showing variation in distance by Welsh wards

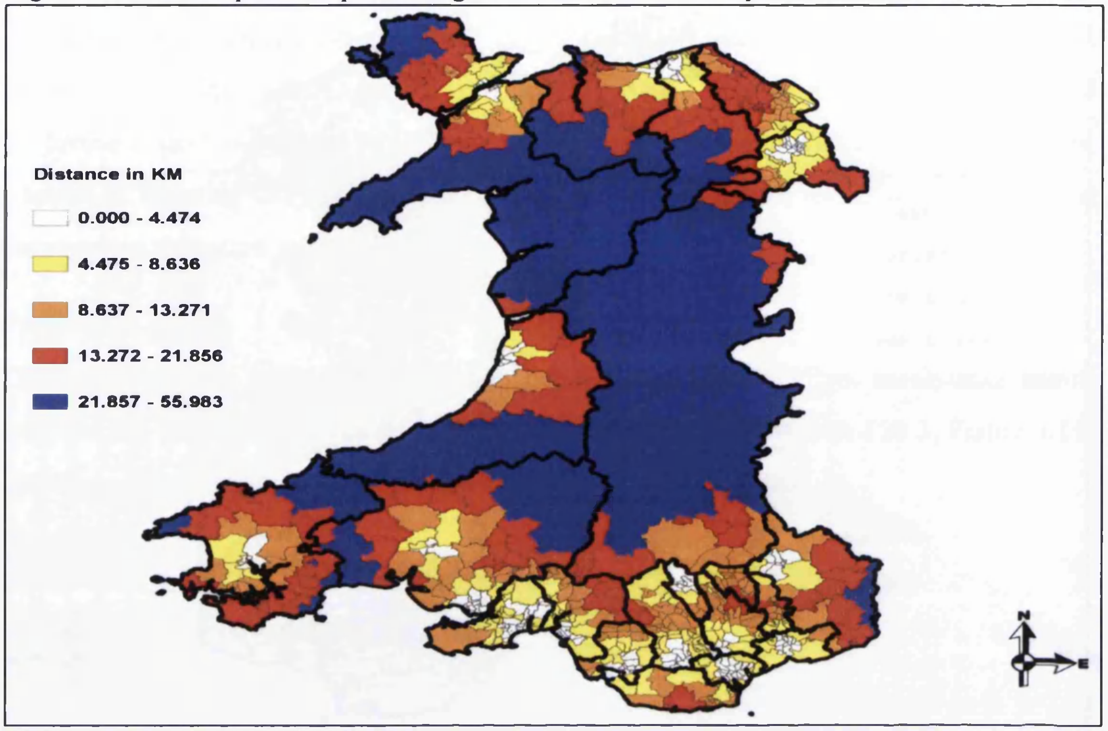
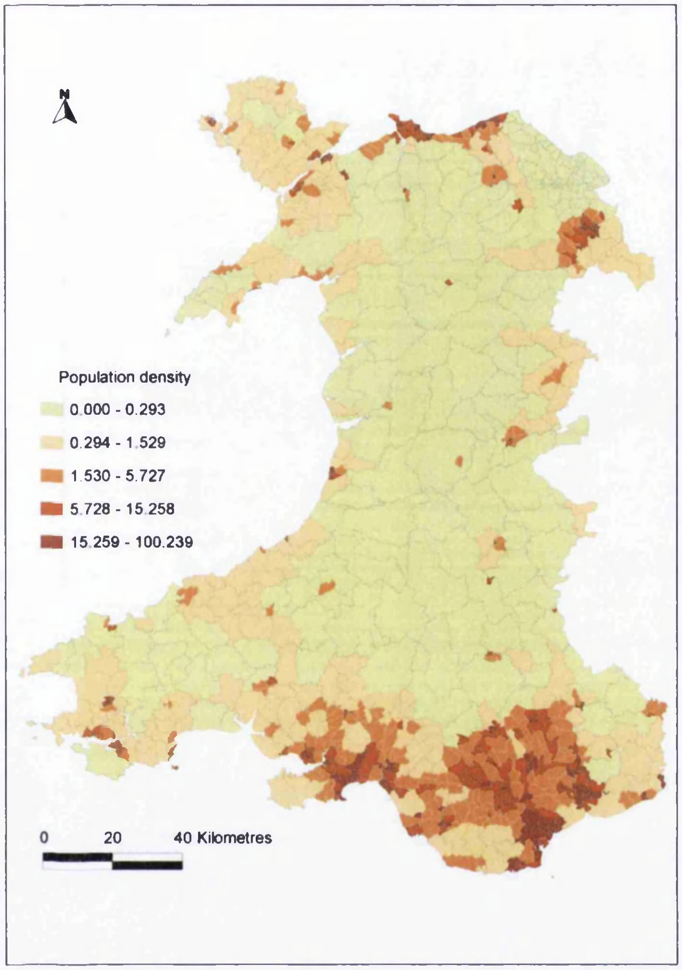


Figure 5.15: Choropleth map showing variation in population density by Welsh wards



Individual level variables at ward level including Census 2001 variables

The proportion of female *patients* in each ward ranged from 0.44 to 0.81, the mean was 0.62 and the standard deviation 0.044. There was much less spread in the proportion of female *residents* in each ward according to the 2001 Census, which ranged from 0.46 to 0.57 with a mean of 0.51 and s.d. 0.01. When these variables were mapped, there appeared to be less female residents in the middle (the more rural areas) of Wales, Figure 5.16. While calls about female patients followed less of a pattern, Figure 5.17.

Figure 5.16: Choropleth map showing variation in proportion of females resident in Welsh wards

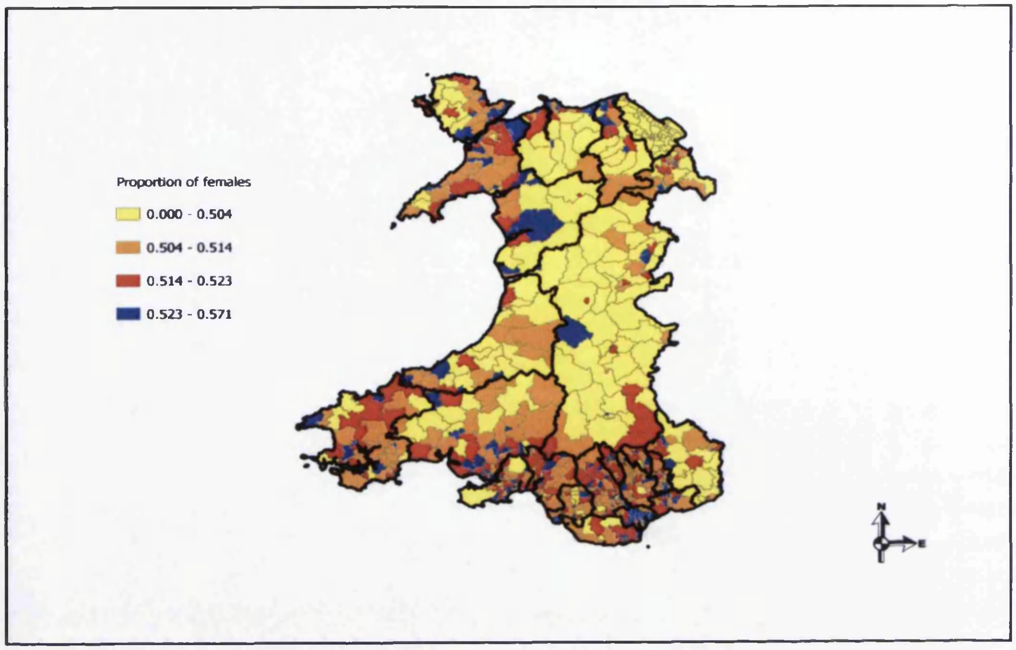
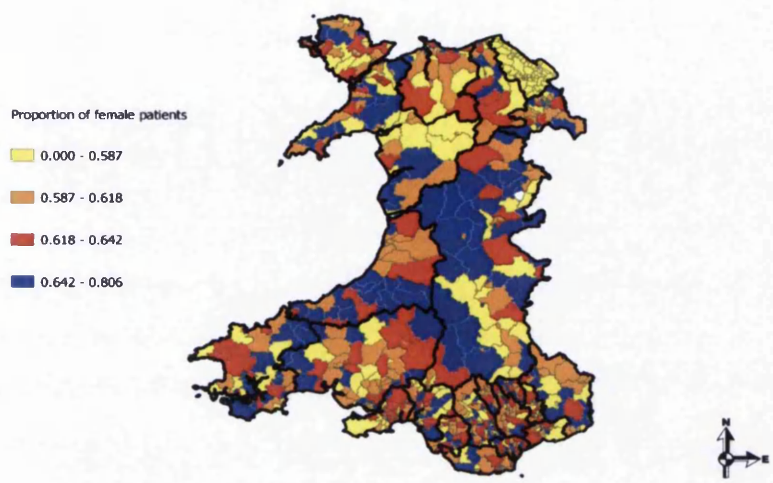

Proportion of females
0.000 - 0.504
0.504 - 0.514
0.514 - 0.523
0.523 - 0.571
N
E

Figure 5.17: Choropleth map showing variation in proportion of female patients resident in Welsh wards



The mean age of *patients* per ward ranged from 25 to 49 years, with the average mean age per ward 35 years and a standard deviation of 5 years. While in contrast the mean age of the *residents* per ward according to the 2001 Census, ranged from 29 to 52 years with an average mean age of 40 and a standard deviation of 3.23 years.

The proportion of white residents per ward as derived from the 2001 Census, ranged from 0.68 to 1.0 with a mean proportion of 0.99 and a standard deviation of 0.02. The proportion of self-callers per ward ranged from 0.36 to 0.90, with a mean of 0.62 and a standard deviation of 0.11. The proportion of digestive callers ranged from 0.11 to 0.66, with a mean of 0.31 and a standard deviation of 0.10.

The proportions of calls by day of week per ward were relatively consistent: Monday was the most popular day to call with a mean of 0.16 (Table 5.12) unlike individual calls.

Table 5.12: Proportion of calls by day of week per ward

Variables	Minimum	Maximum	Mean	s.d.
Calls on a Sunday	0.036	0.273	0.148	0.046
Calls on a Monday	0.065	0.289	0.159	0.033
Calls on a Tuesday	0.056	0.237	0.144	0.028
Calls on a Wednesday	0.060	0.267	0.141	0.027
Calls on a Thursday	0.034	0.243	0.137	0.024
Calls on a Friday	0.053	0.245	0.133	0.026
Calls on a Saturday	0.036	0.280	0.139	0.041

5.5.4 Climatic variables (a)

These variables relate to conditions in the atmosphere and include temperature, snow and air quality variables. Thiessen polygons were used to attribute the readings of stations to wards in which there were no recorded measurements, Table 5.13 shows which stations were assigned to each ward in the Unitary Authority of Caerphilly and Appendix 14 shows the full table for all included wards.

Table 5.13: Sample of summary table concerning weather and monitoring stations

Electoral Division	Ward name	weather station-temperature	weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Caerphilly							
PKMD	Aber Valley	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cwmbran	Cwmbran	Cwmbran
PKMA	Aberbargoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMB	Abercarn	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMC	Abertysswg	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cardiff	Cardiff	Cardiff
PKME	Argoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMF	Bargoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMG	Bedwas and Trethomas	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
PKMH	Blackwood	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMJ	Cefn Fforest	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMK	Crosskeys	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKML	Crumlin	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMM	Darran Valley	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMN	Gilfach	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMP	Hengoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMQ	Llanbradach	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
PKMR	Machen	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMS	Maesycwmmer	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMT	Morgan Jones	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
PKMU	Moriah	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMW	Nelson	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cardiff	Cardiff	Cardiff	Cardiff
PKMY	New Tredegar	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMX	Newbridge	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKMZ	Pengam	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKNA	Penmaen	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKNB	Penyrheol	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
PKNC	Pontllanfraith	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
PKND	Pontlottyn	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran

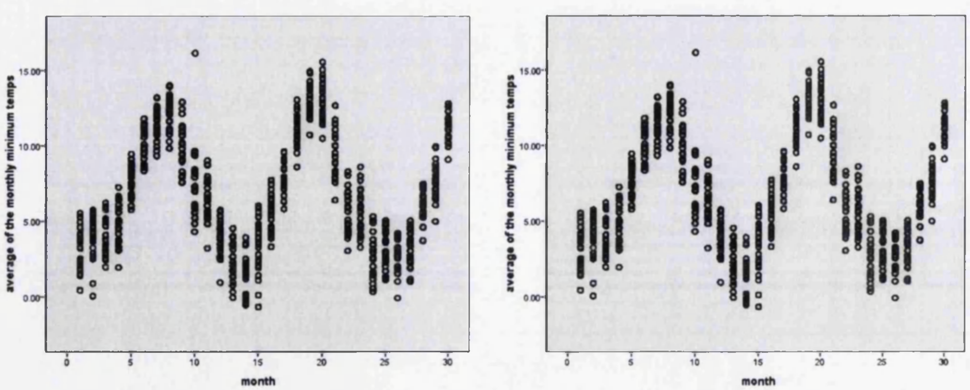
For temperature, all values in the dataset are in degrees Celsius and the monthly averages of daily minimum readings and the daily maximum readings are reported. Snow is measured in centimeters. Air quality data includes information on the pollutants NO2, SO2, O3 and PM10. Each is measured differently; as with temperature, the author calculated the monthly average of the daily minimum and maximum scores.

Temperature: monthly minima and maxima

Only four of the 25 weather stations were missing data: Alwen (missing 5 months of minimum temperatures), Hawarden Bridge (missing 1 month minimum and 2 months maximum), Tredegar (missing 2 months minimum and 4 months maximum) and Cardiff Bute Park (missing 8 months maximum).

The lowest *minimum* monthly temperature was -0.66 degrees Celsius in March 2003, recorded at Alwen weather station and the highest *minimum* monthly temperature was 16.15 degrees Celsius recorded at Llanishen weather station in October 2002. For maximum temperatures, the lowest monthly *maximum* was 5.0 degrees Celsius recorded at Lake Vyrnwy in February 2003 and the highest monthly *maximum* was 24.8 degrees Celsius, recorded at Cardiff Weather station in August 2003. As expected, temperature showed a strong seasonal effect, with higher temperatures recorded in the summer months (Figure 5.18).

Figure 5.18: Scatterplots of monthly temperature values



Snow

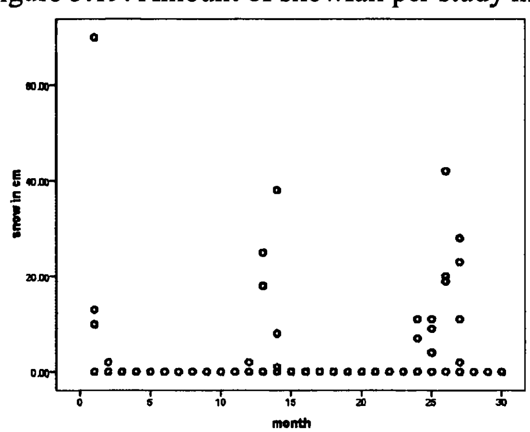
There was not a lot of snowfall in the study period, with several stations reporting no snowfall at all over the two and a half years, see Table 5.14. The weather station with the most snow recorded in a month was Alwen in January 2002, with 70 centimetres.

Table 5.14: Amount of snowfall in Wales during study period

Location of station	Number of months with snowfall	Month, year and amount of snowfall
Aberporth	0	n/a
Hawarden	0	n/a
Valley	1	Jan 04: 4 cm
Prestatyn	0	n/a
Llandeillo	2	Feb 04: 19 cm; Mar 04: 2cm
Tredegar Bryn Bach Park No 2	9	Jan 02: 13 cm; Feb 02: 2 cm; Dec 02: 2 cm; Jan 03:25 cm; Feb 03: 25 cm; Dec 03: 7 cm; Jan 04: 11 cm; Feb 4: 20 cm; Mar 04: 23 cm
Cardiff Bute Park	0	n/a
Penhow	2	Feb 03: 1 cm; Mar 04: 11 cm
Alwen	7	Jan 02: 70 cm; Jan 03: 18 cm; Feb 03:38 cm; Dec 03: 11 cm; Jan 04: 9 cm; Feb 04: 42 cm; Mar 04: 28 cm
Shawbury	0	n/a
Ross on Wye	3	Jan 04:1 cm; Feb 04: 2 cm; Mar 04: 5 cm;
Ness Gardens, Cheshire	1	Feb 04

Snowfall also followed a seasonal cycle with more in the winter months: months 12-14 are December 2002 – February 2003 and months 24-27 are December 2003 – March 2004 (Figure 5.19).

Figure 5.19: Amount of snowfall per study month



Air quality

The ranges for each of the monthly averages for the daily minimum and daily maximum readings, including where these measurements were recorded and when, can be found in Table 5.15.

Table 5.15: Range and location of air quality readings

	Lowest	Month	Station	Highest	Month	station
PM10						
Daily min	3.6	July 2002	Pembrokeshire	23.5	March 2003	Cardiff
Daily max	15.1	July 2002	Pembrokeshire	171.5	Jan 2003	Cardiff
NO2						
Daily min	0.6	June 2002	Pembrokeshire	12.6	Feb 2003	Cardiff
Daily max	3.1	June 2002	Pembrokeshire	51.1	Dec 2002	Cardiff
SO2						
Daily min	0.0	Various	Various	4.3	Aug 2002	Pembrokeshire
Daily max	1.2	June 2004	Wrexham	18.3	April 2004	Cardiff
O3						
Daily min	2.8	Oct 2002	Cardiff	32.5	Jan 2002	Aston Hill
Daily max	20	Dec 2002	Cardiff	54	Aug 2003	Cwmbran

To put these results into context, the author compared air quality readings in the study period with the Air Quality Objectives provided by the DH (Table 5.16). Using this table, the DH has allocated a 'health descriptor' to each band with advice about when both the general population and individuals at risk (those with heart or lung problems) should moderate their daily activities. The highest values in this study recorded for NO2 (51.1) and SO2 (18.3) both fall in the lowest band, index 1. For O3 (highest value 54) this also falls in the low band, index 2. The highest value for PM10 was 171.5 which falls into the very high band, index 10. It is important to remember when comparing these readings that the periods of measurement are slightly different. For example, in this study calculates the monthly average of the maximum daily measurements for PM10, which is different from the measurement using a 24 hour running mean in the DH table.

Table 5.16: Department of Health Air pollution bands and indices µg/m³

Pollutants	Band	Low			Moderate			High			Very High
	Index	1	2	3	4	5	6	7	8	9	10
Ozone - running 8 hourly mean	µg/m³	0-33	34-65	66-99	100-120	121-140	141-159	160-187	188-213	214-239	240 or more
Nitrogen Dioxide - hourly mean	µg/m³	0-66	67-133	134-199	200-267	268-334	335-399	400-467	468-534	535-599	600 or more
Sulphur Dioxide - 15-minute mean	µg/m³	0-88	89-176	177-265	266-354	355-442	443-531	532-708	709-886	887-1063	1064 or more
PM_{10} Particles - 24 hour running mean	µg/m³	0-16	17-33	34-49	50-58	59-66	67-74	75-83	84-91	92-99	100 or more

(from: http://www.welshairquality.co.uk/moreinfo.php?n_action=band&t=6, last accessed 01.04.2012).

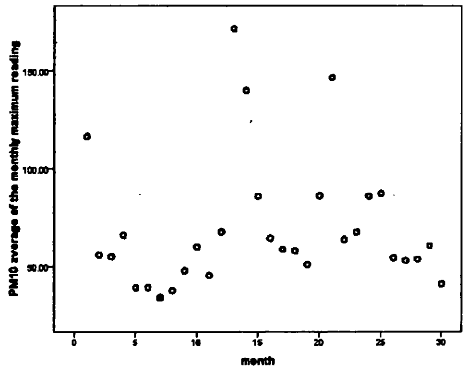
As some areas will have higher recorded values for air quality, the author examined the monthly average of daily maximum values for each station individually for seasonal trends. The maximum values are most likely to impact on health. Only the values for PM10 are shown here; other stations are included in Appendix 10, D.

PM10

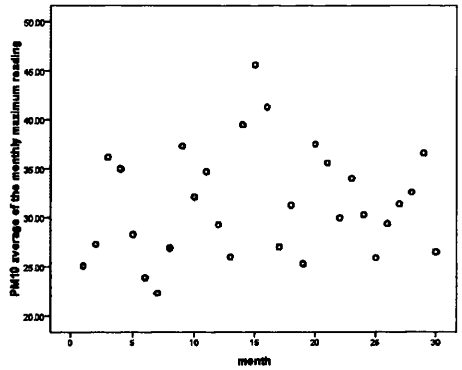
Although Wrexham station was supposed to record PM10, maximum and minimum hourly values were missing, so this station could not be included in analysis. Of the remaining stations, Pembrokeshire (4 months) and Swansea (6 months) were the only ones missing data. Figure 5.20 shows the maximum readings for PM10 by month.

Figure 5.20: Monthly maximum readings

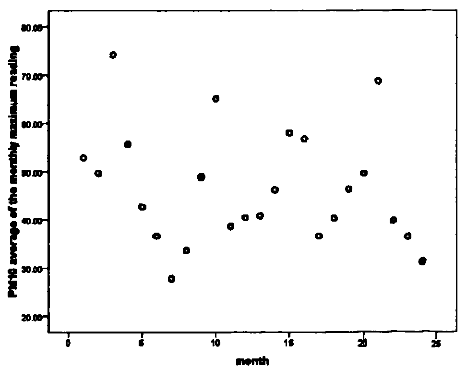
Cardiff Station



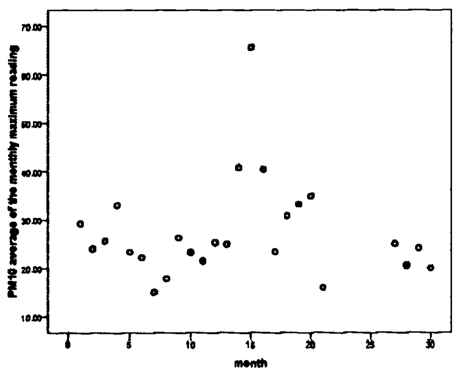
Cwmbran Station



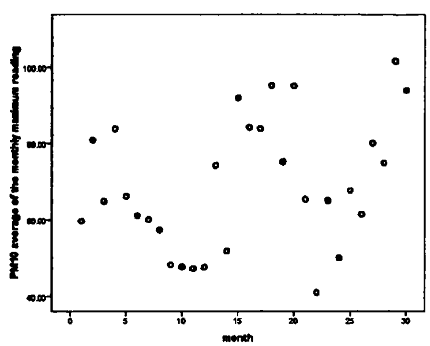
Swansea Station



Pembrokeshire



Port Talbot Station



Cardiff station appears to have four outliers in the data, although this makes sense as Cardiff is a heavily populated urban area which is likely to experience high levels of PM10. Pembrokeshire also has one outlier although reasons for this are not as clear.

5.6 Exploration of two variables – Bivariate analysis (a and c)

As proposed in the analysis plan, the author used bivariate analysis to explore the relationships between the explanatory (deprivation) and dependent variables (call rates and dispositions) and the independent variables in order to identify which variables to feed into the regression models and to identify any strong correlations between variables. Where needed, data were aggregated to monthly values.

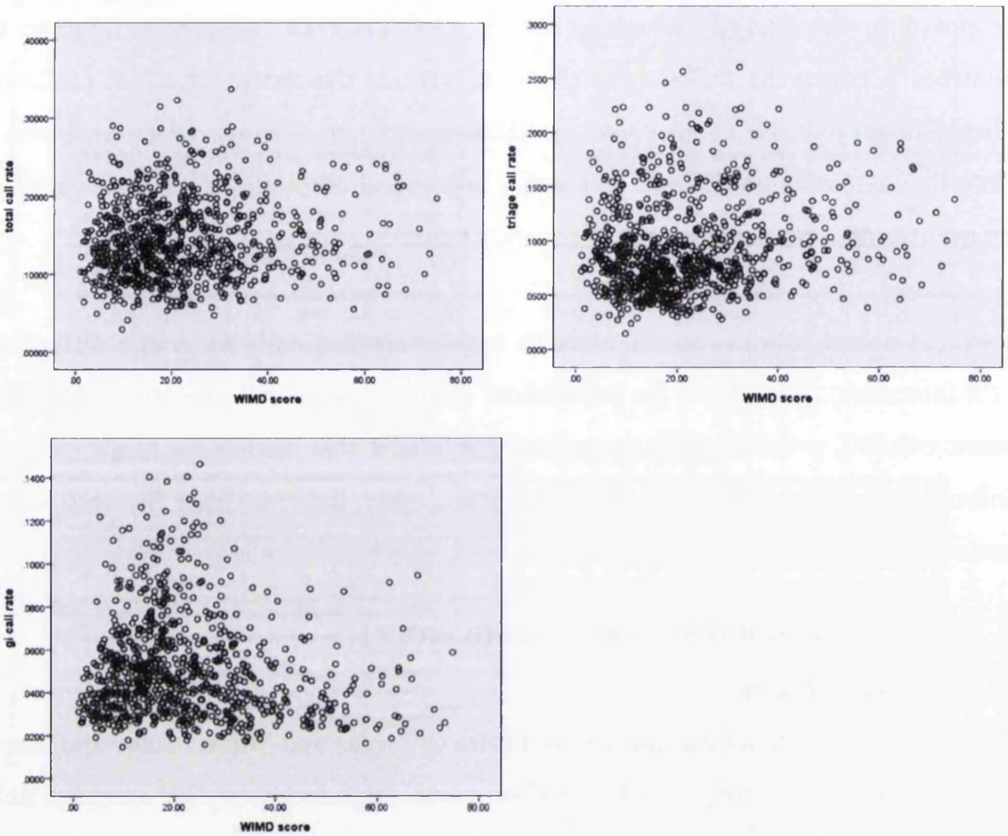
However, as a first step to test the author's hypothesis that calls for triage differ from calls for information, she tested the correlations between triage call rates and information call rates: $r=0.097$, $p=0.006$. This supports the argument that models for triage call rates and information call rates are likely to differ considerably, thus justifying the need to look at these variables separately.

5.6.1 Deprivation and other variables (a and c)

Deprivation and call rates

The Pearson correlation coefficient between total call rates and WIMD score indicates a statistically significant, very small positive correlation between the two variables [$r=0.086$, $n=811$, $p=0.02$] suggesting that calls to NHSDW increase with deprivation. Similarly, the Pearson correlation coefficient between triage call rates and WIMD score indicates a statistically significant, small positive correlation between the two variables [$r=0.168$, $n=811$, $p<0.001$] suggesting that triage calls to NHSDW increase with deprivation. This was reversed in call rates for general information with a small negative correlation suggesting that those from more deprived areas are less likely to use NHSDW for information. [$r=-0.119$, $n=811$, $p=0.001$]. Again, in real terms the size of all these relationships is small, which is supported by the scatterplots in Figure 5.21.

Figure 5.21: Scatterplots of call rates (total, triage and general information) and WIMD



Deprivation and disposition

The box plot showed that there was a relatively consistent WIMD median across the different dispositions. However, results of a one-way between-groups analysis of variance (ANOVA) indicate that there are statistically significant differences between mean WIMD scores by disposition [F (df 6, 409 632) =278.9, p<0.001]. The null hypothesis that the mean scores for all population groups are equal is rejected and the large F value suggests that there is more variability between groups than within groups. The actual difference in mean WIMD scores between the dispositions of 999/ambulance (26.4) and self-care (22.3) is 4.1 (Table 5.17).

Table 5.17: Mean WIMD scores by disposition

Disposition given	N	WIMD mean	WIMD std. deviation	95% Confidence interval for mean	
				Lower bound	Upper bound
999/ambulance	12 792	26.4	16.3	26.1	26.7
ED/hospital	29 867	23.3	15.3	23.1	23.5
Emergency GP/dentist	89 907	24.3	15.8	24.2	24.4
GP/dentist	82 154	23.1	15.3	23.0	23.2
Other	27 135	23.4	15.4	23.2	23.6
Self-care	154 594	22.3	14.4	22.2	22.3
Not assessed	13 190	23.3	15.2	23.0	23.5
Total	409 639	23.2	15.2	23.1	23.2

When broken down by WIMD fifth, this difference becomes starker (Table 5.18). In particular, with the disposition to call 999 there was an increasing trend with deprivation. Those living in the least deprived area (WIMD 1) were given this advice in 2.5% (n= 2118) of cases versus 4.2% (n=4273) from the most deprived. The disposition to contact an emergency GP or dentist was also highest in the most deprived. However advice to go to ED remained relatively consistent across fifths. There was a 4.6% difference between WIMD 1 (least deprived) and WIMD 5 in self-care with those in the least deprived fifth more likely to receive this disposition (χ^2=2631.2, df=24, p<0.001).

Table 5.18: disposition by WIMD deprivation fifth

	1 (least deprived)	**2**	**3**	**4**	**5 (most deprived)**	**P value**
Call disposition	n (%)	n (%)	n (%)	n (%)	n (%)	
999/ambulance	2118 (2.5)	1564 (2.4)	2134 (2.9)	2703 (3.2)	4273 (4.2)	P<0.001
ED/hospital	6382 (7.7)	4387 (6.8)	5133 (6.9)	6115 (7.2)	7850 (7.6)	
emergency GP/dentist	17690 (21.3)	12616 (19.5)	15503 (20.9)	18331 (21.6)	25767 (25.1)	
GP/dentist	17639 (21.2)	12645 (19.6)	14426 (19.5)	16462 (19.4)	20982 (20.4)	
other	5700 (6.9)	4158 (6.4)	4652 (6.3)	5597 (6.6)	7028 (6.8)	
self care	31033 (37.3)	27083 (41.9)	29838 (40.2)	33073 (38.9)	33567 (32.7)	
not assessed	2537 (3.1)	2199 (3.4)	2481 (3.3)	2743 (3.2)	3230 (3.1)	
Total Call Disposition	83099 (100.0)	64652 (100.0)	74167 (100.0)	85024 (100.0)	102697 (100.0)	

Appendix 19 contains further analysis of disposition and deprivation separated into calls for triage and for general information. Results follow a similar pattern.

Deprivation and gender

Again a boxplot indicated that the WIMD means for both sexes of patients were similar. An independent-samples t-test between the genders confirmed there was no significant difference in mean deprivation scores for male patients (mean=23.2, SD=15.2) and female patients [mean=23.2, SD=15.2; t (409 148) =0.612, p=0.743].

There was small positive correlation between deprivation and the 2001 Census proportion of female residents per ward suggesting that as the proportion of females increased so did deprivation [r=0.118, n=811, p=0.001].

Deprivation and age

The Pearson product-moment correlation coefficient for the relationship between WIMD and patient age was [r= -0.027, n=405 171, p<0.001]. This statistically significant, weak negative correlation between the two variables suggests that as the age of patient decreased, WIMD score increased. A scatter plot of these two variables did not reveal anything more about the relationship. At ward level there was also a small negative correlation between the mean age of the ward and WIMD score, suggesting that as the mean age of the ward residents increased, deprivation decreased [r=-0.334, n=811, p<0.001].

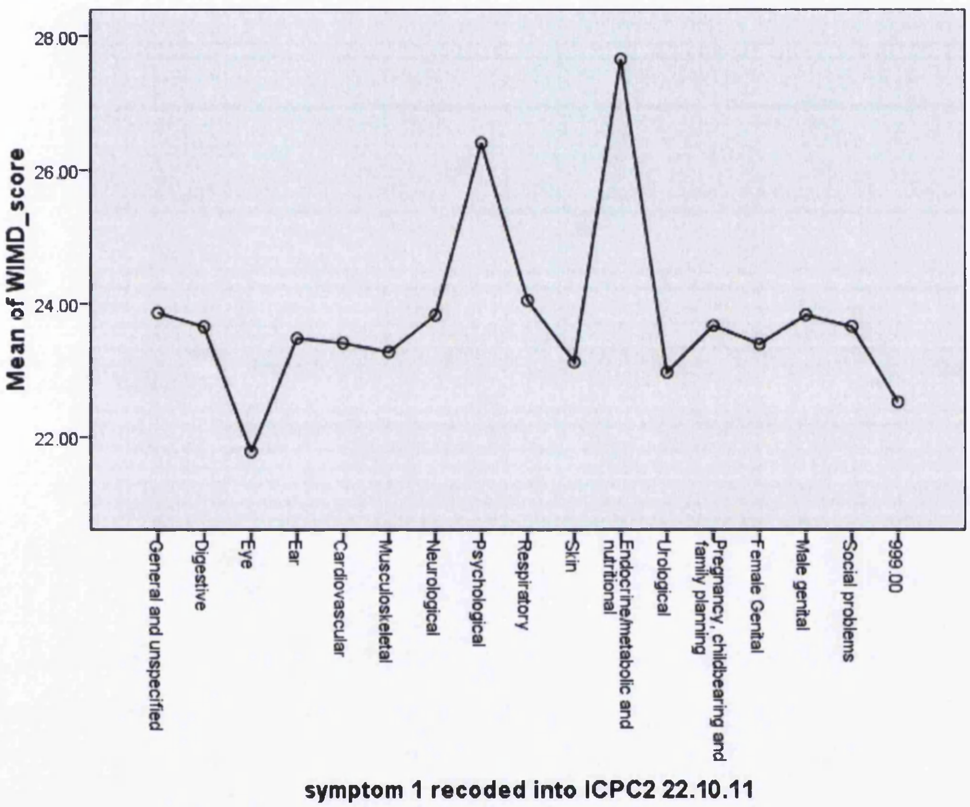
Deprivation and call type

The author ran an independent t test which showed there was a significant difference in WIMD means for triage calls (mean 23.6, SD=15.5) and general information calls [mean=22.2, SD=14.3; t (268523.6) =29.6, p<0.001].

Deprivation and symptom

Results of an ANOVA test were statistically significant suggesting mean scores are not equal between dispositions [F (df 16, 409 622 =57.2, p<0.001], Figure 5.22. There are 5.8 points separating the symptom with the highest WIMD mean score (27.6 for endocrine/metabolic and nutritional) and the lowest (21.8 for eye). Although this difference sounds large, both of these symptoms have a low percentage of patients in each category: 2.6% of patients for eye and less than 1% for endocrine.

Figure 5.22: Graph of mean WIMD scores by symptom



To explore this further, the author looked at the number of patients with each symptom by deprivation fifth. Although results were significant, (χ^2=2166.8, df=64, p<0.001) there did not appear to be large differences in the numbers of different symptoms across deprivation fifths, Table 5.19.

Table 5.19: Symptoms by WIMD deprivation fifth

	1 (least deprived)	2	3	4	5 (most deprived)	P value
Symptom1	n (%)	n (%)	n (%)	n (%)	n (%)	
General and unspecified	6618 (8.0)	4601 (7.1)	5559 (7.5)	6409 (7.5)	8973 (8.7)	P<0.001
Digestive	12682 (15.3)	10251 (15.9)	12554 (16.9)	14532 (17.1)	17175 (16.7)	
Eye	1516 (1.8)	1038 (1.6)	1177 (1.6)	1212 (1.4)	1448 (1.4)	
Ear	1415 (1.7)	904 (1.4)	1058 (1.4)	1264 (1.5)	1769 (1.7)	
Cardiovascular	548 (0.7)	417 (0.6)	426 (0.6)	531 (0.6)	698 (0.7)	
Musculoskeletal	6139 (7.4)	4255 (6.6)	4672 (6.3)	5508 (6.5)	7408 (7.2)	
Neurological	4431 (5.3)	3090 (4.8)	3556 (4.8)	4315 (5.1)	5870 (5.7)	
Psychological	1003 (1.2)	765 (1.2)	988 (1.3)	1397 (1.6)	1953 (1.9)	
Respiratory	5689 (6.8)	3826 (5.9)	4707 (6.3)	5295 (6.2)	7809 (7.6)	
Skin	6648 (8.0)	4485 (6.9)	5194 (7.0)	5971 (7.0)	8010 (7.8)	
Endocrine/metabolic and nutritional	13 (0.000)	7(0.000)	15(0.000)	12(0.00)	25(0.000)	
Urological	1381 (1.7)	876 (1.4)	1019 (1.4)	1126 (1.3)	1562 (1.5)	
Pregnancy, childbearing and family planning	875 (1.1)	659 (1.0)	730 (1.0)	814 (1.0)	1188 (1.2)	
Female Genital	1509 (1.8)	1081 (1.7)	1108 (1.5)	1385 (1.6)	1846 (1.8)	
Male genital	475 (0.6)	327 (0.5)	440 (0.6)	493 (0.6)	652 (0.6)	
Social problems	6 (0.0)	4 (0.0)	4 (0.0)	12 (0.0)	6 (0.0)	
Missing	32151 (38.7)	28066 (43.4)	30960 (41.7)	34748 (40.9)	36305 (35.4)	
Total (known)	83099 (100.0)	64652 (100.0)	4167 (100.0)	85024 (100.0)	102697 (100.0)	

At ward level, there was a very small correlation between the proportion of digestive patients per ward and WIMD [r= -0.078, n=811, p<0.001].

Deprivation and relationship of caller to patient

An independent samples t test showed differences in WIMD means by patient relationship to caller. For those calling about themselves the mean WIMD score was 22.6, SD=14.9) and for those calling as a surrogate caller the mean WIMD score was 24, SD=15.5, t(362300.6)=-29.0, p<0.001). At ward level, there was a small negative correlation between WIMD score and the proportion of self-callers per ward [r=-0.273, n=811, p<0.001] suggesting that as deprivation score decreased, the proportion of self callers in a ward increased.

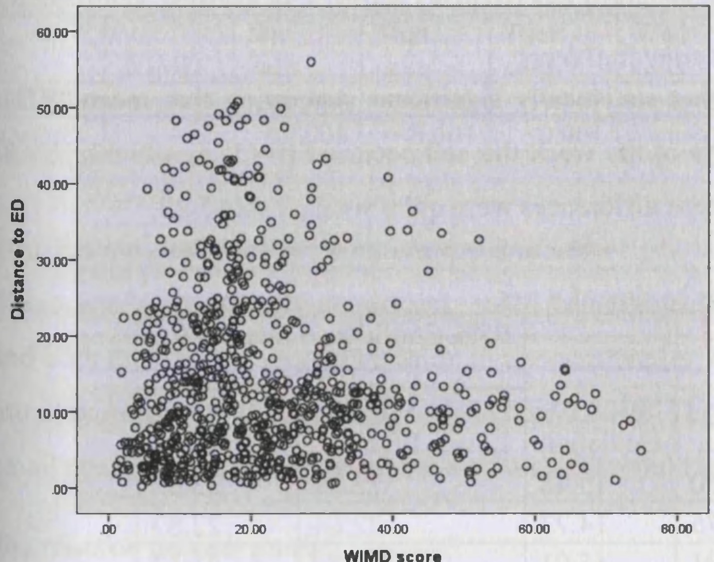
Deprivation and ethnicity

Next the author conducted an independent samples t test to compare mean WIMD scores for patients with a white background with those from any other ethnic background. Results were not statistically significant with 'white background' patients having a mean WIMD score of 23.3, SD=15.2 and those with 'any other background' having a mean of 22.8, SD=16.1, t(4081.8)=1.9, p=0.063. Similarly, at ward level, there was not a statistically significant relationship between the proportion of white residents in a ward and WIMD score [r=-0.009, n=811, p=0.803].

Deprivation and distance to ED

The Pearson Correlation co-efficient between deprivation and distance was [r= -0.097, n=811, p=0.006] suggesting that, as distance to hospital decreases, deprivation increases. Although this is statistically significant, the relationship is very small. A scatter plot also confirmed this, with no clear direction of points (Figure 5.23).

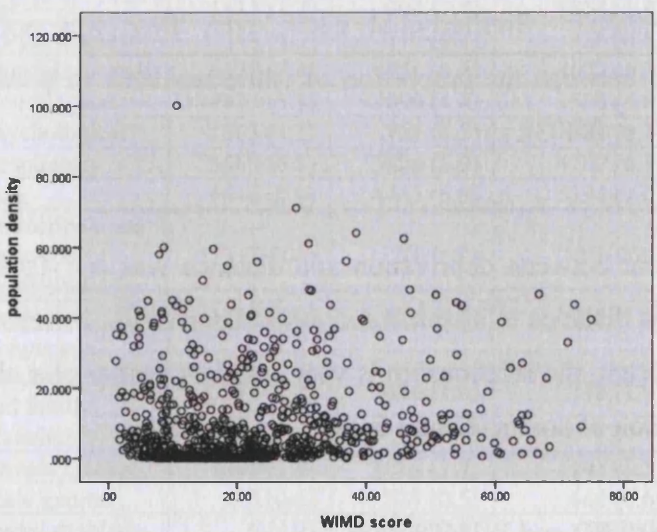
Figure 5.23: Scatterplot of distance to ED and WIMD score



Deprivation and population density

The Pearson product-moment correlation coefficient for the relationship between WIMD and population density was 0.146 [n=811, p<0.001]; again, although this was statistically significant, suggesting a weak positive relationship, the correlation is small. This is supported by the scatter plot, with the majority of points corresponding to the 0-15 population density numbers (Figure 5.24). There was one outlier – the densest area of Cardiff.

Figure 5.24: Scatterplot of population density and WIMD



Deprivation and day of week- individual level

Results of an ANOVA test were statistically significant suggesting that mean WIMD scores are not equal on the days of the week the call occurred [F (df 6, 409 632=29.88, p<0.001]. However in reality these differences were quite small, Table 5.20.

Table 5.20: Mean WIMD scores by day of week

Day of week	N	Mean	Std. Deviation	95% Confidence Interval for Mean Lower Bound	Upper Bound
Sunday	66 302	23.50	15.48	23.39	23.62
Monday	61 503	22.75	14.77	22.64	22.87
Tuesday	56 344	23.01	15.01	22.89	23.13
Wednesday	55 868	22.95	14.95	22.83	23.08
Thursday	55 491	23.55	15.31	23.42	23.68
Friday	52 841	22.96	15.01	22.83	23.08
Saturday	61 290	23.55	15.51	23.43	23.6
Total	409 639	23.19	15.16	23.14	23.24

Deprivation and proportion of calls by day of week- ward level

However, at ward level, the differences were more obvious. Table 5.21 shows variation in the correlations between deprivation scores and the proportion of calls by day of the week, suggesting that the more deprived are more likely to phone NHS Direct at weekends.

Table 5.21: Pearson correlation coefficients between deprivation and the ward level proportion of calls by day of week for triage, general information and total calls

Correlations between deprivation (WIMD) and proportion of triage calls by day of week								
	WIMD	Sun calls	Mon calls	Tues calls	Wed calls	Thurs calls	Fri calls	Sat calls
WIMD	1	0.048	-0.082	-0.076	-0.055	0.161	-0.105	0.082
p value		0.171	0.019	0.03	0.118	<0.001	0.003	0.02
Correlations between deprivation (WIMD) and proportion of information calls by day of week								
	WIMD	Sun calls	Mon calls	Tues calls	Wed calls	Thurs calls	Fri calls	Sat calls
WIMD	1	0.167	-0.151	-0.034	-0.102	-0.017	-0.042	0.145
p value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Correlations between deprivation (WIMD) and proportion of total calls by day of week								
	WIMD	Sun calls	Mon calls	Tues calls	Wed calls	Thurs calls	Fri calls	Sat calls
WIMD	1	0.154	-0.166	-0.117	-0.127	0.078	-0.130	0.162
p value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Deprivation and weather: temperature and snow

There was a statistically significant, small negative relationship between WIMD score and both the average monthly minimum temperature [$r=-0.031$, $p<0.001$] and the average monthly maximum temperature [$r=-0.032$, $p<0.001$]. There was a statistically significant, small positive relationship for snow and WIMD [$r=0.085$, $p<0.001$].

Deprivation and air quality

For the most part, deprivation had a small, statistically significant positive relationship between the monthly maximum values for the air quality measured; suggesting that as deprivation score increased so did pollution levels. In contrast, the opposite was true for the monthly minimum readings, in which the direction of the relationship reversed suggesting that as deprivation increased, the monthly minimum values decreased. The exception to this was for the pollutant PM10 which showed a negative relationship between WIMD and the monthly maximum readings while that with monthly minimum readings was not statistically significant. Again although these are statistically significant results, the actual size of the correlation is very small (Table 5.22).

Table 5.22: Correlation matrix between WIMD and air quality

	PM10		NO2		SO2		O3	
WIMD	Max	Min	Max	Min	Max	Min	Max	Min
r value	-0.022*	0.000	0.004*	-0.031*	0.062*	-0.043*	0.039*	-0.042*
p value	<0.001	0.824	0.005	<0.001	<0.001	<0.001	<0.001	<0.001

*correlation is significant at the 0.01 level (2 tailed)

5.6.2 Call rates and other variables (a and c)

For the most part this section has been analysed using total call rates only, although the same correlations and relationships could also be studied for triage and general information calls, the author deemed that through exploring the relationships between the independent variables and total call rates only that this would indicate any relationships that needed to be further explored in the full regression models.

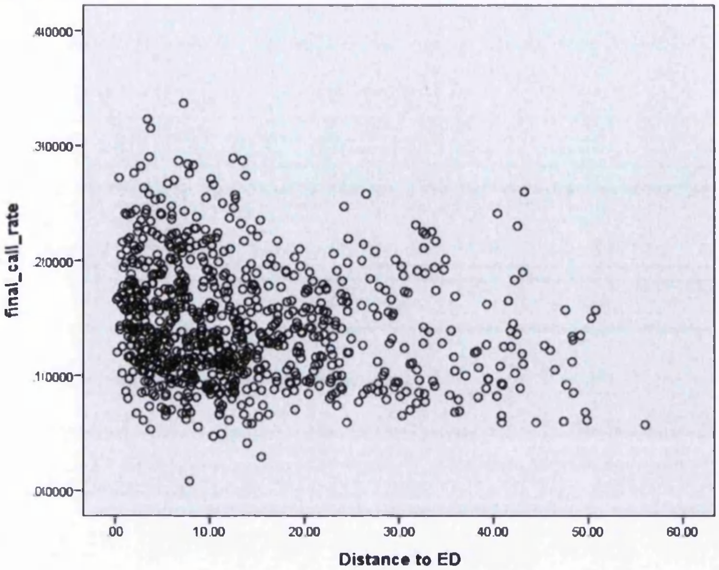
Call rates and age, gender

The univariate analysis showed that calls to NHSDW varied by both patient age and gender, however, when these variables were compared with the call rate variable, the relationship was less pronounced. The Pearson correlation coefficient for patient age and call rate was -0.04 [n=405 171, p<0.001] and the results of an independent t test showed that the mean call rate for each patient gender was the same [t (409 148)=0.95, p=0.73]. This is a result of the method the author used to calculate call rates in which, the number of people calling from a ward was divided by the total population of the ward. In this way, call rates do not take into account the gender and age composition of each ward.

Call rates and distance to ED

The Pearson correlation co-efficient between call rates and distance to ED departments [r=-0.183, n=811, p<0.001] suggests a small, negative, relationship. This indicates that call rates increase as distance to ED decreases (Figure 5.25).

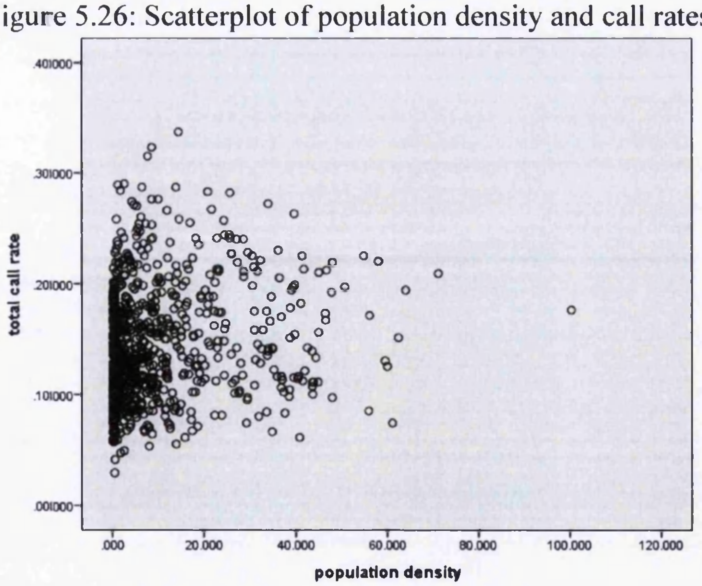
Figure 5.25: Scatterplot of distance to ED and call rates



Call rates and population density

There was a statistically significant small, negative relationship between call rates and population density [r=-0.155, n=811 p<0.001], suggesting that call rates to NHSDW decreased with increasing density, although this is difficult to see (Figure 5.26).

Figure 5.26: Scatterplot of population density and call rates



Call rates and temperature, snow

There was a statistically significant, small positive relationship between monthly call rates and both the average of the monthly minimum temperatures [r=0.09, n=811, p<0.001] and the average of the monthly maximum temperature [r=0.008, p<0.001]. Monthly call rates and the level of snowfall had a very small, statistically significant negative relationship [r=-0.007, n=811, p<0.001], suggesting that as snowfall increased, calls to NHSDW decreased.

Call rates and air quality

Table 5.23 shows the Pearson correlation co-efficient for the relationship between call rates and air quality variables. The strength and the direction of these relationships varied, with the highest correlation existing as a negative relationship between the monthly maximum reading for PM10 and monthly call rates [r=-0.15, n=811, p<0.001], suggesting that as PM10 increased, calls to NHSDW decreased.

Table 5.23: Correlation matrix between monthly call rates and air quality

	PM10		NO2		SO2		O3	
Monthly call rates	Max	Min	Max	Min	Max	Min	Max	Min
r value	-0.151*	-0.032*	0.040*	-0.055*	-0.072*	0.000	0.012*	-0.048*
p value	<0.001	<0.001	<0.001	<0.001	<0.001	.573	<0.001	<0.001

*correlation is significant at the 0.01 level (2 tailed)

5.6.3 Disposition and other variables (a and c)

Disposition and gender

When disposition and gender were explored together, patient gender was found to have an impact on disposition. Results were statistically significant with 3.7% (n=5 734) of male patients were told to contact an ambulance vs 2.7% of females (n=6 958), while a higher percentage of females were told to self care (39.9% females (n=101 232) vs 34.2% of males (n=53 177), (χ^2 =2072.4, df =6, p <0.001), (Table 5.24).

Disposition and call type

The higher level dispositions (from 999/ambulance to contact GP/dentist) were more likely to occur when the call was recorded as triage (χ^2 =190 947.8, df =6, p <0.001), Table 5.24.

Disposition and relationship

Surrogate callers were more likely to be given more urgent advice: 47.4% of caller calling for themselves were given self-care advice in comparison to 24.4% for surrogate callers (χ^2 =35 018.4, df =6, p<0.001), Table 5.24.

Disposition and ethnicity

Whether the patient was 'white' or from any other ethnic background was not statistically associated with the type of disposition given (χ^2 = 8.91, df = 6, p = 0.18), with both advised to contact a GP or dentist in the highest percentage of cases (Table 5.24).

Table 5.24: Comparisons of dispositions by gender, call type, relationship and ethnicity

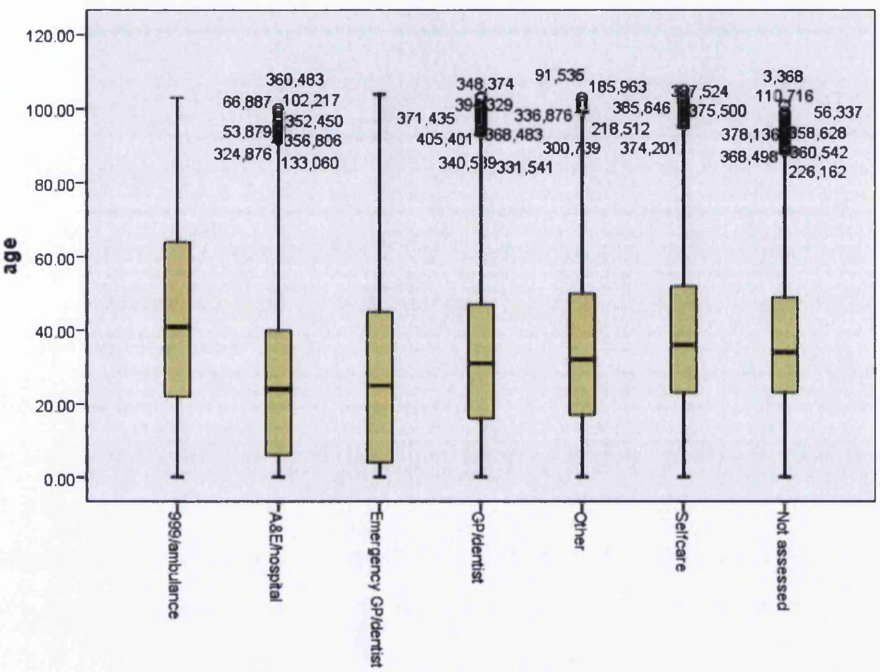
	Gender			Call type			Relationship			Ethnicity		
Call disposition	**Male n (%)**	**Female n (%)**	**Total n (%)**	**Triage n (%)**	**GI n (%)**	**Total n (%)**	**Self n (%)**	**Surrogate n (%)**	**Total n (%)**	**white background n (%)**	**any other background n (%)**	**Total n (%)**
999/ambulance	5734 (3.7)	6958 (2.7)	12889 (3.1)	12647 (4.5)	145 (0.1)	12992 (3.1)	4398 (1.9)	8275 (4.8)	12673 (3.1)	6060 (3.4)	123 (3.1)	6183 (3.4)
ED/hospital	13667 (8.8)	16174 (6.4)	30343 (7.3)	29551 (10.5)	316 (0.2)	30370 (7.3)	11519 (4.9)	18342 10.7)	29861 (7.3)	13823 (7.7)	276 (7.0)	14099 (7.7)
emergency GP/dentist	35841 (23.1)	53996 (21.3)	91419 (22.0)	87980 (31.3)	1927 (1.5)	91490 (21.9)	35332 (14.9)	54569 (31.7)	89901 (22.0)	38287 (21.2)	824 (21.0)	39111 (21.2)
GP/dentist	31994 (20.6)	50091 (19.7)	83611 (20.1)	79448 (28.2)	2706 (2.1)	83680 (20.1)	48242 (20.3)	33910 (19.7)	82152 (20.1)	36649 (20.3)	777 (19.8)	37426 (20.3)
other	9935 (6.4)	17173 (6.8)	27590 (6.6)	17131 (6.1)	10004 (7.8)	27617 (6.6)	16261 (6.9)	10866 (6.3)	27127 (6.6)	12983 (7.2)	293 (7.5)	13276 (7.2)
self care	53177 (34.2)	101232 (39.9)	157106 (37.7)	46707 (16.6)	107887 (84.0)	157296 (37.7)	112678 (47.5)	41903 (24.4)	154581 (37.8)	66660 (37.0)	1484 (37.8)	68144 (37.0)
not assessed	4941 (3.2)	8237 (3.2)	13362 (3.2)	7776 (2.8)	5414 (4.2)	13374 (3.2)	8942 (3.8)	4211 (2.4)	13153 (3.2)	5859 (3.2)	152 (3.9)	6011 (3.3)
Total Call Disposition	155289 (100.0)	253861 (100.0)	409150* (100.0)	281240 (100.0)	128399 (100.0)	409639 (100.0)	237372 (100.0)	172076 (100.0)	409448 (100.0)	180321 (100.0)	3929 (100.0)	184250* (100.0)

*489 calls are missing gender information, 191 missing relationship data, 225 389 calls were missing ethnicity data

Disposition and age

There appeared to be a significant interaction between patient age and disposition, Figure 5.27. If the medians for each disposition were the same, the lines in the box plot would align; however the median age for 999/ambulance is clearly higher.

Figure 5.27: Boxplot exploring the relationship between age and disposition given



To explore this, the author conducted a one-way analysis of variance with null hypothesis that there were no differences in mean ages across dispositions given. Results were statistically significant, [F (6, 405 164) =2387, p<0.001]. The large F value suggests that there is much more variability between groups than there is within groups. The mean age for the disposition 999/ambulance was 42.4, the highest for any disposition. The lowest mean age was 26.5 for the disposition to go to ED or hospital (Table 5.25).

Table 5.25: Descriptive summary of dispositions by age

Disposition given	N	Mean age	Std. deviation	95% Confidence interval Lower bound	95% Confidence interval Upper bound
999/ambulance	12 618	42.4	26.1	42.0	42.9
ED/hospital	29 765	26.5	21.4	26.2	26.7
Emergency GP/dentist	89 687	28.4	24.6	28.2	28.5
GP/dentist	82 044	32.4	21.9	32.2	32.5
Other	26 713	33.8	23.4	33.6	34.1
Self-care	151 381	37.3	21.1	37.2	37.4
Not assessed	12 963	36.0	20.5	35.7	36.4
Total	405 171*	33.4	22.8	33.3	33.5

*4 468 calls were missing age information

Dispositions and symptoms

Patients with 'general and unspecified' symptoms were told to contact 999/ambulance in the highest percentage of cases, while 34.4% of patients calling with 'eye' symptoms were told to contact ED. At the opposite end of the hierarchy, over three quarters of those who were told to care for themselves were missing symptoms. Results were statistically significant (χ^2 = 304900, df = 96, p <0.001) suggesting that the proportions of dispositions given in response to certain symptoms were significantly different; Table 5.26 shows the percentages of dispositions for each symptom.

Table 5.26 Comparison of dispositions and symptoms
Disposition 1=999/ambulance, 2=ED/hospital, 3=Emergency GP/dentist, 4=GP/dentist, 5=other, 6=self-care, 7=not assessed

	General and unspecified	Digestive	Eye	Ear	Cardiovascular	Musculoskeletal	Neurological	Psychological	Respiratory	Skin	Endocrine/metabolic and nutritional	Urological	Pregnancy, childbearing and family planning	Female Genital	Male genital	Social problems	missing	Total
1	12.7	1.8	0.9	0.3	4.4	3.7	7.0	8.2	8.8	1.4	6.9	0.5	1.8	0.7	0.4	6.2	0.8	3.10
2	11.4	6.1	34.3	2.6	6.3	22.8	25.6	7.6	7.1	13.0	1.4	1.4	3.2	1.9	13.0	6.2	0.5	7.3
3	40.9	42.1	26.0	30.6	44.4	23.9	34.6	36.8	35.3	22.3	54.2	50.7	53.4	21.1	33.1	28.1	2.1	21.9
4	15.3	30.3	25.5	53.1	37.3	36.4	21.0	31.4	35.2	44.7	26.4	38.1	21.9	62.9	41.8	6.2	1.6	20.1
5	4.6	2.2	5.6	1.8	1.4	1.0	0.9	3.6	2.7	6.2	0.0	1.5	13.3	6.4	6.4	40.6	11.8	6.6
6	14.8	15.5	7.4	11.4	6.0	11.9	10.6	11.1	10.6	12.1	9.7	7.5	6.2	6.7	4.8	12.5	76.4	37.7
7	0.3	2.0	0.2	0.3	0.2	0.3	0.4	1.4	0.3	0.3	1.4	0.3	0.2	0.3	0.5	0.0	7.0	3.2
total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Disposition and day of week

There was a slightly higher proportion of calls being told to contact 999/ambulance on Saturday and Sunday. At the opposite end of the hierarchy, there was a higher percentage of being told to self-care during the week (Table 5.27). Results were statistically significant (χ^2 = 10302 df = 36, p <0.001) confirming that dispositions vary by day of the week. As this analysis was on total calls, results may be slightly different when broken down by call type (triage and general information).

Table 5.27: Comparisons of dispositions by day of week

Disposition	Day of week							
	Sunday n (%)	Monday n (%)	Tuesday n (%)	Wednesday n (%)	Thursday n (%)	Friday n (%)	Saturday n (%)	Total n (%)
999/ambulance	2652 (4.0)	1708 (2.8)	1497 (2.7)	1577 (2.8)	1695 (3.1)	1518 (2.9)	2145 (3.5)	12792 (3.1)
A&E/hospital	5885 (8.9)	4097 (6.7)	3715 (6.6)	3714 (6.6)	3695 (6.7)	3612 (6.8)	5149 (8.4)	29867 (7.3)
Emergency GP/dentist	19057 (28.7)	11452 (18.6)	10616 (18.8)	10622 (19.0)	10946 (19.7)	10233 (19.4)	16981 (27.7)	89907 (21.9)
GP/dentist	15030 (22.7)	11711 (19.0)	10554 (18.7)	10710 (19.2)	10970 (19.8)	10055 (19.0)	13124 (21.4)	82154 (20.1)
Other	4630 (7.0)	3821 (6.2)	3464 (6.1)	3561 (6.4)	3803 (6.9)	3299 (6.2)	4557 (7.4)	27135 (6.6)
Self-care	17196 (25.9)	26551 (43.2)	24526 (43.5)	23774 (42.6)	22497 (40.5)	22400 (42.4)	17650 (28.8)	154594 (37.7)
Not assessed	1852 (2.8)	2163 (3.5)	1972 (3.5)	1910 (3.4)	1885 (3.4)	1724 (3.3)	1684 (2.7)	13190 (3.2)
Total	66302 (100.0)	61503 (100.0)	56344 (100.0)	55868 (100.0)	55491 (100.0)	52841 (100.0)	61290 (100.0)	409639 (100.0)

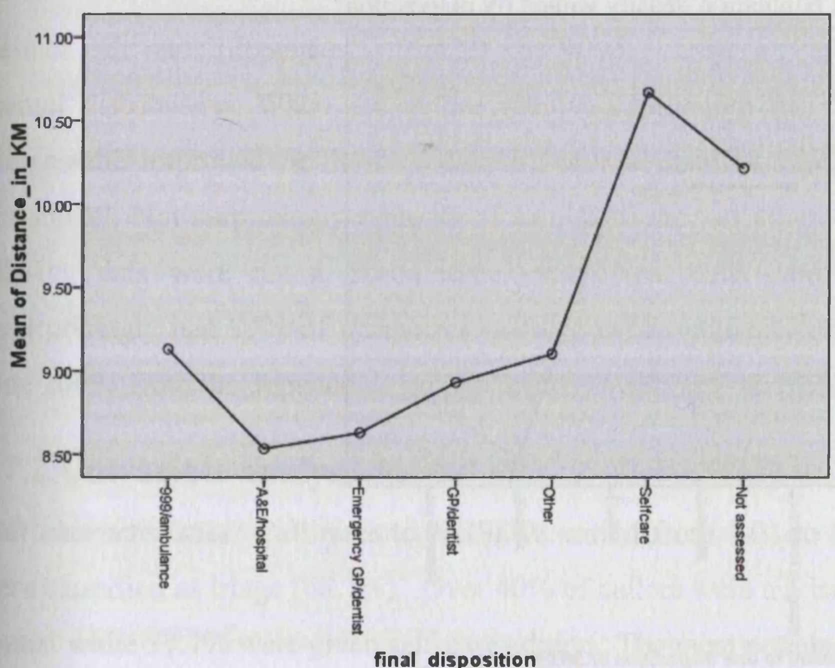
Disposition and distance

The author conducted an ANOVA test. Results were statistically significant, [F (6, 409 632 =716.9, p<0.001] but there was only 2.2 km difference between the closest mean (8.5 km for ED/hospital) and the furthest mean (10.7 km for self-care), Table 5.28. In addition, when the author plotted the means, there seemed to be a linear trend, with mean distances increasing as the urgency of dispositions decreased (exception 999/ambulance), Figure 5.28.

Table 5.28: Bivariate analysis of disposition and distance to ED

Disposition given	N	Mean distance (km)	Std. deviation (km)	95% Confidence interval for mean Lower bound	Upper bound
999/ambulance	12 792	9.1	8.2	9.0	9.3
ED/hospital	29 867	8.5	7.8	8.4	8.6
Emergency GP/dentist	89 907	8.6	7.9	8.6	8.7
GP/dentist	82 154	8.9	8.5	8.9	9.0
Other	27 135	9.1	8.7	9.0	9.2
Self-care	154 594	10.7	10.0	10.6	10.7
Not assessed	13 190	10.2	9.7	10.0	10.4
Total	409 639	9.6	9.0	9.5	9.6

Figure 5.28: Graph of mean distance to ED by disposition



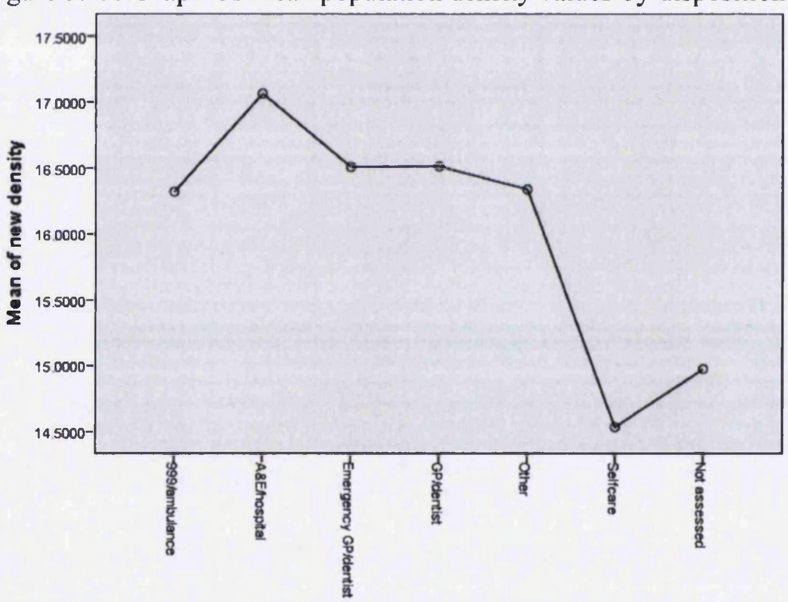
Disposition and population density

Results of an ANOVA test indicate that there are statistically significant differences between mean population density scores by disposition group [F (6, 409 632) =239, p<0.001]. The actual difference in mean population density scores between the dispositions of ED/hospital and self-care is 2.54 people/hectare, Table 5.29 (range 0.04 – 100.31). With the exception of the disposition to contact 999/ambulance there appears to be a decreasing urgency of dispositions according to mean population density, Figure 5.29.

Table 5.29: Bivariate analysis of disposition and population density

Dispostion	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound
999/ambulance	12 792	16.32	16.14	0.14	16.04	16.60
ED/hospital	29 867	17.07	17.37	0.10	16.87	17.26
Emergency GP/dentist	89 907	16.51	16.57	0.06	16.40	16.62
GP/dentist	82 154	16.51	17.10	0.06	16.40	16.63
Other	27 135	16.34	16.84	0.10	16.14	16.54
Self-care	154 594	14.53	16.58	0.04	14.45	14.62
Not assessed	13 190	14.98	16.66	0.15	14.69	15.26
Total	409 639	15.74	16.78	0.03	15.69	15.79

Figure 5.29: Graph of mean population density values by disposition



Disposition and temperature

Although an ANOVA test indicated that there were significant differences in the mean of the averages of the monthly *maximum* temperatures across dispositions, [F (df 6,) =118.2, p<0.001], there was only 1 degree Celsius difference between the highest temperature (not assessed = 14.2) and the lowest (999/ambulance = 13.2). Similarly, for the mean of the average monthly minimum temperature there was less than one degree difference between the lowest mean minimum of 6.6 for 999/ambulance and 7.4 for not assessed [F (6) =120.2, p<0.001], For snow, F (6) =25.8, p<0.001; although results are statistically significant, the mean snowfalls for each disposition were all 1cm to one significant digit, (Appendix 10, E).

Disposition and air quality

The author ran ANOVA tests to compare the mean air quality scores for each disposition for all minimum and maximum monthly averages of all pollutants and although all results were statistically significant in all cases there was only 1-2 μg/m³ between mean scores. As each index in the DH's Air Quality pollution bands, consists of a range of 30 ug/m3 these differences in practice are small, Appendix 10, E.

5.7 Key results of exploratory analysis (a, b, c)

5.7.1 Data overview (a, b, c)

Neither call rates (dependent variable) nor WIMD score (explanatory variable) followed a normal distribution. When the author removed Flintshire (n= 7180, 54 wards) from the analysis this improved the fit of the data to a normal distribution, although data still did not fit this model. Not surprisingly removal of Flintshire did not affect the distribution of WIMD. Missing data were not a major issue except that calls categorised as for information unsurprisingly had 97% of symptoms missing whilst ethnicity data were not collected until June 2003. Both the dependent and explanatory variables were complete.

5.7.2 Univariate analysis (a and c)

Call characteristics: Call rates to NHSDW varied from 0.01 to 0.34. The majority of calls were classified as triage (68.7%). Over 40% of callers were advised to contact either a GP or dentist while 37.7% were given self-care advice. The most popular day to call was Sunday.

Patient characteristics: Both the age and gender of patients differed significantly from proportions in the Welsh population: 62% of patients were female and many calls related to patients within the 1-4 years category (12.8%). In line with the Welsh population, 97.9% of patients were of white background. Over half of callers called the service about themselves. Over a quarter of calls cited digestive problems (n=67 194, 27.2 %) while social (n=32) and endocrine (n=72) represented a minute proportion of patient symptoms.

Area based variables: WIMD scores ranged from 1.13 (least deprived) to 74.87 (most deprived). Distances to the nearest ED ranged from 0.2 km to 56.0 km. Population density ranged from 0.04 to 100 people/hectare.

Climatic variables: Monthly average temperatures ranged from -0.66 to 24.8. There was not a great deal of snowfall at weather stations in Wales or near the border during the study period with five out of the ten stations recording no snow. The most snow recorded in any one month was 70 centimetres at Alwen weather station in January 2002. Generally measurements of pollutants were low, with only PM10 scoring in the highest band according the Department of Health's Air Quality Objectives.

5.7.3 Bivariate analysis (a and c)

Summary of deprivation and other variables

Deprivation did not differ significantly by gender or ethnicity, although there was a small statistically significant negative relationship between age and deprivation. There were very small positive correlations between deprivation scores and call rates for total calls and for triage calls but negative for information calls. There were also significant interactions between deprivation and day of the week, suggesting that the more deprived are more likely to phone NHSDW at weekends.

Mean deprivation score varied with disposition: highest mean was 26.4 for 999/ambulance and the lowest was 22.3 for self care; and with symptom: highest mean was 27.6 for endocrine/metabolic and nutritional and the lowest was 21.8 for eye. Mean WIMD scores were significantly higher for triage calls and for surrogate callers although the differences between means was small.

There was a very small positive relationship between deprivation and population density ($r=0.146$) suggesting that as WIMD increased so did population density. In contrast, there was a small negative relationship between WIMD and distance to hospital ($r=-0.097$). The monthly average readings for air quality indicated a positive relationship between the maximum readings and WIMD, with the exception of PM10. Relationships between deprivation and both temperature and snow were also statistically significant.

Summary of call rates and other variables

There was a small statistically significant relationship between call rates and age (r=-0.04). Call rates increased slightly as both distance to ED and population density decreased. Though these two variables both reflect an aspect rurality, they appear to contradict each other. Call rates were also significantly associated with climatic variables although the direction and size of the relationships again varied.

Summary of disposition and other variables

Male callers, those calling for triage advice and those calling on behalf of someone else (surrogate callers) were all more likely to receive more urgent advice ($p<0.001$). There was a statistically significant relationship between disposition and age, with the highest mean age (42.4 years) in the disposition category of 999/ambulance and the lowest (26.5 years) for ED/hospital. Ethnicity was not significantly associated with disposition however there was a higher percentage of being told to contact 999/ambulance on Saturday and Sunday.

There appeared to be a linear trend with respect to disposition and mean distance to ED: as mean distance from ED increased, the level of urgency of dispositions decreased (exception 999/ambulance). In contrast, there were higher mean population density values in the more urgent level dispositions with the exception of 999/ambulance. Disposition was also significantly associated with all climatic variables although the differences were small.

5.8 Building the models (a, b, c)

The purpose of the analyses in this chapter was to lead the author toward the correct design of a model in order to explore the effects of deprivation on both call rates and disposition, controlling for other variables. In this section the author explains the foundations for model construction including improvements which were added after the viva. The bivariate analysis above has shown that there are significant interactions between almost all the variables (with the exception of ethnicity). However the univariate analysis showed that there are differences in the number of calls by ethnic background. As a result, the author decided to incorporate all variables into the regression models, though conscious that the different levels of aggregation can distort findings.

The author first tested whether all the assumptions of multiple and logistic regression had been met. The sample size is over 300 000 cases (even with missing data for some variables).

There were no high inter-correlations between variables identified in the bivariate analysis, but as indicated in the analysis plan the author also used tolerance levels provided by the regression package to assess multicollinearity. The closer to zero the tolerance level is for a variable, the stronger the relationship between this and other independent variables. For values that are very low (e.g. less than 0.1) the author considered removing one or more of the highly inter-correlated variables.

This chapter has already suggested which variables may influence call rates the most. However, as the list of variables is quite long (n=24), the author decided in the original thesis to use stepwise regression to construct the model. In stepwise regression SPSS enters each variable in sequence and assesses its significance. The equation starts empty and independent variables that meet the statistical criteria are added one at a time. If the addition of the variable contributes significantly to the model it is retained and all other variables are retested to see if their contribution has been altered. If they no longer contribute significantly, then they are removed. In this way stepwise regression leads to models with the smallest possible subset of independent variables. This is one of the strengths of this method in that it aims for the most parsimonious model. Thus the author felt using this method would allow her to identify the best, and smallest, subset of independent variables.

However, stepwise regression selects variables on statistical criteria. For example, one variable may be included over another because of random variation in the data. Therefore it is important to select variables for possible inclusion in the model only after reviewing the theoretical and practical cases for doing so. Therefore before constructing the models the author made key decisions concerning which variables to include.

For example, the paucity of weather stations (n=24) and air quality measuring stations (n=7) in Wales and on the border unfortunately meant the author had to assign climatic variables to wards which were missing this information. It was also prudent to aggregate variable daily data to monthly readings. The author felt that these assumptions and aggregations would reduce the value of these data in analysis and possibly distort the impact of climatic variables on the dependent variables. Therefore she decided to exclude these variables from the main regression analyses but to explore the feasibility of including them in sensitivity analyses.

Similarly, another important consideration was the high percentage of missing values for symptoms: 96.6% of general information calls were missing symptoms. As the author has already shown here, calls for triage and calls for general information behave differently, she therefore decided to include the symptom variable only for triage calls and total calls.

Additionally, as discussed during the viva, to enhance the validity of stepwise regression the author also performed hierarchical regression using the SPSS command "enter". This type of regression is appropriate when there are theoretical or empirical reasons for the order in which independent variables or blocks of independent variables are entered. In particular, the finding that deprivation affects the timing of calls suggests that day of the week should precede deprivation in the hierarchy. Therefore, using this method, the author entered: all relevant variables with the exception of deprivation and day of the week in Block 1; day of the week as a group of variables in Block 2; and deprivation in Block 3. In this way, the focal variable deprivation was entered last to test whether it adds anything to the prediction equation. This method of regression includes all variables in the final model whether they are statistically significant or not.

Another improvement to the regression models that stemmed from the viva was how to incorporate ethnicity. As this variable was collected for 2003 only, in the original submission the author had considered it only in sensitivity analysis. However the author has since used the 2001 Census ward-specific proportions of white residents in the multiple regression; and two dummy variables – 'white or unknown ethnicity' versus 'any other ethnicity' and 'known' versus 'unknown' – to represent ethnicity in the logistic regression.

These major decisions, explained in more detail in the following two chapters, have resulted in several new models. The next chapter presents the results of the linear regression.

Chapter 6: Results of Objective 2 – call rates

6.0 Overview (a, b, c)

In Chapter 5, the author explored each variable individually and investigated the relationships between both the dependent variables and the independent variables; and the explanatory variable (deprivation) and the independent variables. This chapter further explores those relationships with respect to demand for NHSD and sets out to answer Research Objective 2:

> To model the relationship between deprivation and demand, controlling for other variables which affect demand.

As discussed previously, multiple regression techniques help explain how well a set of variables together can predict a particular outcome. Statistical output provides information concerning:

1. the model as a whole (e.g. how much of the variation in the dependent variable can be explained by the subset of variables); and
2. the contribution of each variable, either in competition with other variables (stepwise) or in absolute terms after controlling for more influential variables (hierarchical).

The author addresses both these aims. Through attempting to understand the relative influence of each variable, and deprivation in particular, on call rates (e.g. how much call rates can be explained by the subset of variables), the author employed both stepwise and hierarchal methods. As shown in Chapter 5, calls for triage and calls for general information behave differently. Therefore the author has defined the dependent variable in three ways: triage call rates, general information call rates and total call rates (triage and general information combined).

This chapter has thus improved significantly both between submission and the oral (b) and between the oral and resubmission (c). In particular, while waiting for the oral, the author improved on the original models presented in the thesis in four main ways:

1. Substituting ward level variables in place of the individual level variables presented earlier, notably the proportion of female patients in a ward, the mean age of patients per ward and the proportion of self-callers per ward.
2. Excluding Rossett ward in Wrexham, identified by NHSDW as having English dialling codes and therefore generating calls to NHSD in England (the call rate for Rossett was 0.01).
3. Adding analysis of total call rates (triage and general information added together) which was missing from the original thesis.
4. Taking the log and square root of call rates, two well known transformations which seek to improve the distribution of the residuals towards a normal distribution. Although both transformations yielded similar findings, the log transformation resulted in a more normal distribution of residuals. Thus the author has presented only these results here, along with the untransformed results.

These changes, which were all undertaken using stepwise regression are all indicated with a (b) in this chapter.

Building on feedback during the viva discussed in Section 5.8, the author has further improved on the models making three key adjustments:

1. Ward level population values based on the 2001 Census were used over patient values. These variables are the mean age of the ward, the proportion of females per ward and the proportion of 'white' residents. It was felt that using these values over patient values would be more indicative of ward characteristics that may help predict demand from that ward. This also allowed the ethnicity variable to be included in the main analysis for the whole study period (as the 2001 Census population proportion of 'white' residents per ward was used)
2. The proportions of calls by days of the week were added to the analysis
3. The method of regression used was hierarchical, with deprivation added last to test its marginal contribution to the model after taking account of all potential biasing variables.

As these changes occurred after the viva but before resubmission, they are labelled (c). They have improved the models, starting with the substitution of ward-level variables, then taking the log of call rates, then using the hierarchical method. In this chapter, to show the progression of the models, the author has first presented triage calls, followed by general information calls, then all calls. Table 6.1 presents a summary of the different models proposed. Though patients with missing data were generally excluded listwise (Section 4.11.4), the author reran Model 1 by excluding them pairwise. Model 1 was also rerun excluding the population density outlier.

Ideally the author would have liked to run one model including the climatic variables (temperature, snow and pollution levels). For reasons discussed in Chapter 5, however, she concluded that the quality of the data would not make this worthwhile. This decision is primarily due to the lack of weather and pollution monitoring stations, so that the author had to attribute values to areas in which there were no stations. Also many of the air quality stations were missing readings (e.g up to 22% for PM10), further reducing the reliability of these data (Table 5.1). Finally, to include climatic variables in the analysis, the author would have had to calculate monthly call rates, some very small. The total number of triage calls per ward ranged from 31 to 3110 with a mean of 347 calls per ward and the total number of information calls was even smaller (range 18-1030, mean 158). This yields averages of less than 12 triage calls per ward per month and 5 information calls per ward per month. The author therefore did not include climatic variables in the final multiple regression analysis.

Each of the included models is summarised and explained and the chapter concludes with a summary of the key points learned.

Table 6.1: Summary of models for linear regression (Y indicates potentially included variable)

Call type Dependent variable:	1.Triage Call rates	2.Triage Log call rates	3.Triage Log call rates	4.GI Call rates	5.GI Log call rates	6.GI Log call rates	7.Total Call rates	8.Total Log call rates	9.Total Log call rates
Method of regression	stepwise	stepwise	hierarch	stepwise	stepwise	hierarch	stepwise	stepwise	hierarch
Independent variables at ward level									
WIMD score (continuous variable)	Y	Y	Y	Y	Y	Y	Y	Y	Y
distance to ED (km)	Y	Y	Y	Y	Y	Y	Y	Y	Y
population density (people per hectare)	Y	Y	Y	Y	Y	Y	Y	Y	Y
mean age (per year) of patients	Y	Y		Y	Y		Y	Y	
mean age (per year) of residents (Census 2001)			Y			Y			Y
proportion of females patients	Y	Y		Y	Y		Y	Y	
proportion of female residents (Census 2001)			Y			Y			Y
proportion of digestive callers	Y	Y	Y				Y	Y	Y
proportion of self-callers per ward	Y	Y	Y	Y	Y	Y	Y	Y	Y
proportion of white residents (Census 2001)			Y			Y		Y	Y
proportions of calls per day of week (6 variables)			Y			Y		Y	Y

6.1A Model 1: untransformed triage call rates (b)

- Dependent variable: **triage call rates**
- Method: **stepwise**
- Potential independent variables: deprivation (WIMD score), mean patient age per ward, proportion of female patients per ward, distance to ED, population density, proportion of self-callers per ward, proportion of digestive patients per ward.

The proportion of self-callers was the first variable to enter the stepwise model. This was followed by population density, distance to ED, the proportion of digestive patients and then the proportions of female patients per ward. No variables were removed, meaning that each variable contributes in some statistically significant way to predicting call rates. The variables of deprivation and of the mean age of triage patients per ward were not entered at all indicating that these variables did not contribute significantly to predicting triage call rates.

The author compared the correlations between the independent variables and the dependent variables. The variable of proportion of self callers was the most highly correlated with the dependent variable ($r=-0.399$, $p<0.001$). Other correlations were both negative and positive and although some were very small, were statistically significant, $n=810$. Relationships among independent variables were also explored with for the most part similar results: small, statistically significant relationships. The most highly correlated variables were the proportion of digestive patients and the proportion of self-callers per ward ($r=0.512$, $p<0.001$). The variables of distance and population density were also moderately correlated ($r=-0.373$, $p<0.001$) indicating that as distance to hospital increased, population density decreased. As in the bivariate analysis (Chapter 5) between WIMD and distance to ED there was a very small negative correlation ($r=-0.097$, $p=0.003$). Tolerance levels were all close to 1 indicating that multicollinearity is unlikely to be a problem. Table 6.2 summarises these findings.

Table 6.2: Correlation between dependent (DV) and independent variables (IV) for Model 1

	triage call rate	WIMD score	Distance to ED	prop self-callers	prop digestive patients	pop density	mean age patients	prop female patients
triage call rate	1	0.166	*-0.326	-0.399	-0.377	0.263	-0.241	0.112
WIMD score		1	-0.097	-0.206	**-0.077	0.146	-0.142	^0.048
Distance to ED			1	0.194	0.366	-0.373	0.348	-0.129
proportion self-callers				1	0.512	^-0.011	0.455	*0.096
proportion digestive patients					1	-0.247	0.290	-0.147
population density						1	-0.262	0.181
mean age patients							1	^-0.035
proportion female patients								1

P<0.001 except: *P=0.003; **P=0.014; ^P>0.05, non-significant correlation

The final Model 1 consisted of five independent variables which produced an adjusted R^2 = 0.265 [F (5,804) = 59.3; p<0.001. As the analysis plan discusses, the dataset in this study covers the whole of Wales; so there is arguably no variability, as we know what happened. In the 'superpopulation' of all possible scenarios (Moser and Kalton 1985), however, these five variables explain 26.5% of the variability in triage call rates.

The standardised Beta (β), measured in standard deviations, is an indication of the contribution of each variable to the model. In stepwise regression this reflects predictive contribution rather than substantive contribution. In this subset of variables, the proportion of self-callers made the strongest unique contribution to explaining triage call rates (β= -0.322). This means that a change of one standard deviation in the proportion of self-callers will result in a change of -0.322 standard deviations in triage call rates. Table 6.3 summarises the contribution of each variable. The 't' and 'p' values give an indication of the effect of a variable on the model; for example a large absolute 't' and a small 'p' suggest that the independent variable has a large effect on the dependent variable. The statistically significant results obtained here indicate that the Beta values are all statistically different from zero. As shown in the table, although the Beta and 't' values get progressively smaller with each additional variable, each variable contributes in a statistically significant manner and has therefore been retained. However the variable of interest in this study, deprivation as measured by WIMD score, was not statistically significant in predicting call rates and was therefore not included in the model.

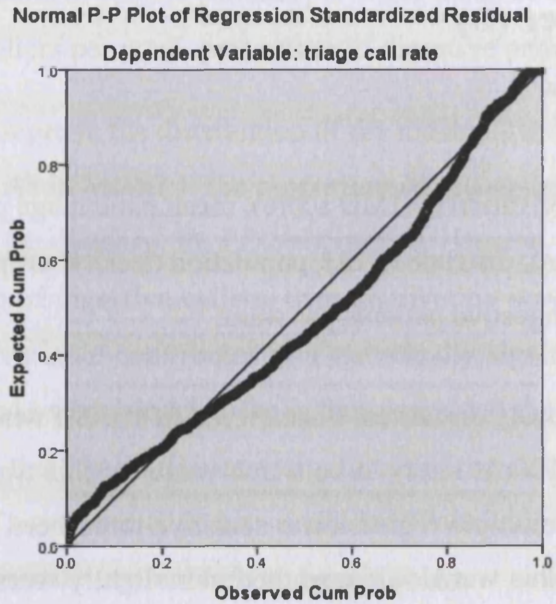
Table 6.3: Coefficients for multiple regression of triage call rates (Model 1)

	Unstandardised Coefficients		Standardised Coefficients			95.0% Confidence Interval fo[illegible] β	
Independent variables	β	Std. Error	β	t	p value	Lower Bound	Upper Bound
(Constant)	0.146	0.015		9.701	<0.001	0.117	0.17[illegible]
proportion self callers	-0.148	0.017	-0.322	-8.900	<0.001	-0.181	-0.11[illegible]
population density	0.001	<0.001	0.161	4.842	<0.001	<0.001	0.00[illegible]
distance to ED	-0.001	<0.001	-0.156	-4.564	<0.001	-0.001	<0.00[illegible]
proportion digestive patients	-0.043	0.016	-0.103	-2.707	0.007	-0.074	-0.01[illegible]
proportion female patients	0.060	0.024	0.079	2.501	0.013	0.013	0.10[illegible]

The Beta score for distance to ED is negative while the Beta score for population density is positive. As both of these variables summarise the rurality of a ward, it may appear odd that the direction of the Beta values are opposed. However, they are measuring different elements of rurality: there are some wards, like Holyhead Town in Anglesey, with a relatively high population density (42.1 people/hectare) and a comparatively long distance to hospital (33.5km to Ysbyty Gwynedd); and other wards, like Bodelwyddan in Denbighshire with a low population density (1.26 people/hectare) and a short distance to a hospital (0.2 km to Glan Clywd). Call rates for atypical wards such as these, will be much better predicted when both the distance to hospital and population density variables are included in the model.

A key assumption in linear regression is that the errors will be normally distributed. The normal P-P plot of the standardised residuals from the regression model can be used to assess this assumption. If the residuals are normally distributed, the actual values will coincide with the line of expected values. As shown in Figure 6.1, the residuals in this model fit close to the line, with a slight deviation between the observed values of 0.2 and 0.5. Although this generally meets the expectation that the residuals are normally distributed, the author attempted to improve on this by taking the log of triage call rates as presented in Model 2.

Figure 6.1 Normal P-P plot of standardised residuals for Model 1



To summarise, Model 1 with the dependent variable of call rates for triage calls, across the whole study period, has an adjusted R^2=0.265. The subset includes five independent ward level variables: distance to ED, population density, the proportion of self-callers per ward, the proportion of digestive patients and the proportion of female patients. The proportion of self-callers made the highest unique contribution in this subset of variables (β= -0.322), with the variance of all other variables accounted for. The residuals satisfy the assumption of normality, although the author felt that they could be improved upon.

To test the method of excluding cases listwise the author also ran Model 1 but excluding cases pairwise. As the adjusted R^2 was unchanged at 0.265 [F (5,803) = 59.3; p<0.001] the author decided to continue excluding missing cases listwise.

The author has explained the key statistics for multiple regression in detail for Model 1. For future models, the same statistical tests will be reported with the same principles applying. However, the author has not gone into as much detail unless results required it.

6.1B Sensitivity analysis of Model 1: untransformed triage call rates excluding densest outlier (b)

- Dependent variable: **triage call rates**
- Method: **stepwise**
- Potential independent variables: deprivation (WIMD score), mean patient age per ward, proportion of female patients per ward, distance to ED, population density, proportion of self-callers per ward, proportion of digestive patients per ward.

The outlier for population density previously discussed, Plasnewydd in Cardiff which had the highest value for population density at 100, is likely to be a true value for this ward and not an error in measurement. However, as multiple regression is sensitive to outliers, the author reran Model 1 excluding all calls from this ward. This resulted in a slightly worsened R^2 = 0.264 [F (5,803) =59.2; p<0.001]. Similarly there was not much change in the standardised β, so the author decided to keep this ward in for further analysis.

Table 6.4: Coefficients for multiple regression of triage call rates excluding Plasnewydd

	Unstandardised Coefficients		Standardised Coefficients			95.0% Confidence Interval for β	
	β	Std. Error	β	t	p value	Lower Bound	Upper Bound
(Constant)	0.146	0.015		9.69	<0.001	0.117	0.176
proportion self-callers	-0.148	0.017	-0.321	-8.866	<0.001	-0.181	-0.115
population density	0.001	<0.001	0.157	4.705	<0.001	<0.001	0.001
distance (in KM)	-0.001	<0.001	-0.156	-4.556	<0.001	-0.001	<0.001
proportion digestive patients	-0.043	0.016	-0.103	-2.704	0.007	-0.074	-0.012
proportion female patients	0.06	0.024	0.079	2.499	0.013	0.013	0.108

6.2 Model 2: transformed triage call rates (b)

- Dependent variable: **logarithms of triage call rates**
- Method: **stepwise**

- Potential independent variables: deprivation (WIMD score), mean patient age per ward, proportion of female patients per ward, distance to ED, population density, proportion of self-callers per ward, proportion of digestive patients per ward.

To try to improve the distribution of the residuals in Model 1, the author took the log of triage call rates. As in Model 1, the proportion of self-callers was the first variable to enter Model 2, followed by distance to ED, population density, the proportion of female patients, the proportion of digestive callers, then deprivation score. No variables were removed, meaning that each variable contributes in a statistically significant way to predicting the log of triage call rates. As with Model 1, the author examined the correlation statistics and tolerance levels to ensure that the variables were suitably correlated for multiple regression results to be reliable. There were 810 cases included. Tolerance levels were all close to 1 indicating that multicollinearity was unlikely to be a problem.

The final model consisted of six independent variables which produced an adjusted R^2 = 0.298 [$F(6, 803) = 58.3$; $p<0.001$]. In practice these six variables explain 29.8% of the variability in the log of triage call rates. This was an improvement of 3.3% from the R^2 presented in Model 1, with untransformed call rates.

Using this subset of variables as in Model 1, the proportion of self-callers (β=-0.316, $p<0.001$) and distance to ED (β=-0.204, $p<0.001$) were the strongest predictors of the log of triage call rates, controlling for all other variables. Again the opposing signs of population density and distance to ED indicate the model will account for wards which are atypical in their expected values for these variables. The variable of interest in this study, deprivation had a small statistically significant contribution (β=0.061, p=0.048). Table 6.5 summarises the contribution of each variable. The statistically significant results obtained here indicate that the Beta values are all statistically significant from zero.

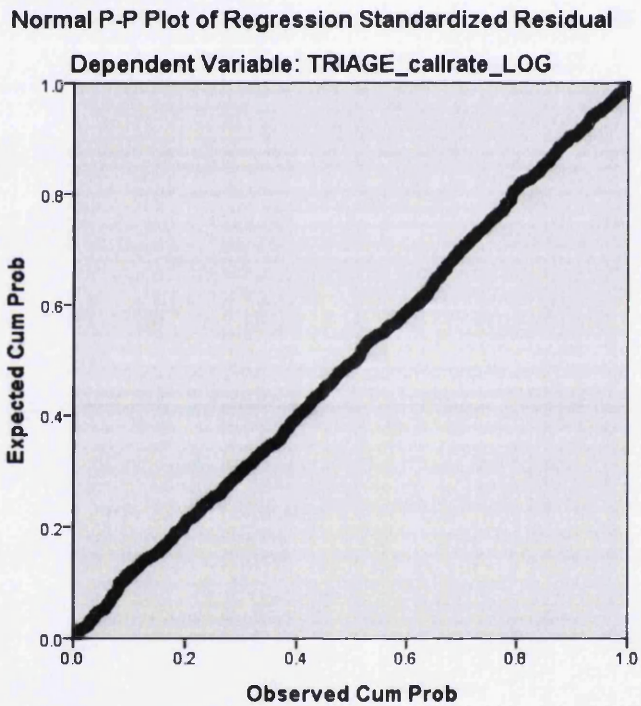
Table 6.5: Coefficients for multiple regression of log of triage call rates (Model 2)

Independent variables	Unstandardised Coefficients		Standardised Coefficients			95.0% Confidence Interval for β	
	β	Std. Error	β	t	p value	Lower Bound	Upper Bound
(Constant)	-1.976	0.156		-12.70	<0.001	-2.282	-1.670
Proportion self-callers	-1.519	0.174	-0.316	-8.74	<0.001	-1.861	-1.178
distance to ED	-0.008	0.001	-0.204	-6.10	<0.001	-0.011	-0.005
population density	0.005	0.001	0.161	4.91	<0.001	0.003	0.008

	Unstandardised Coefficients		Standardised Coefficients			95.0% Confidence Interval for β	
Independent variables	β	Std. Error	β	t	p value	Lower Bound	Upper Bound
proportion female patients	0.637	0.246	0.080	2.59	0.010	0.154	1.121
proportion digestive patients	-0.371	0.163	-0.085	-2.280	0.023	-0.691	-0.051
WIMD score	0.002	0.001	0.061	1.982	0.048	0	0.004

The normal P-P plot of the standardised residuals in Figure 6.2, shows a great improvement on the distribution of the residuals, indicating that taking the logarithm of triage call rates has improved the model.

Figure 6.2: Normal P-P Plot of standardised residuals for Model 2



6.3 Model 3: the log of triage call rates – hierarchical method (c)

- Dependent variable: **logarithms of triage call rates**
- Method**: hierarchical**
- Potential independent variables: Block 1: mean Census 2001 population age per ward, Census 2001 proportion of females per ward, Census 2001 proportion of white residents per ward, distance to ED, population density, proportion of self-callers per ward, proportion of digestive patients per ward; Block 2: proportion of Monday calls per ward, proportion of Tuesday calls per ward, proportion of Wednesday calls per ward, proportion

of Thursday calls per ward; proportion of Friday calls per ward, proportion of Saturday calls per ward; Block 3: deprivation (WIMD score)

Stimulated by feedback from the examiners, the author again attempted to improve on the previous models. In particular, she replaced patient values with population values thus including a variable for ethnicity; added in day of the week and used the hierarchical method to add in deprivation last. Once again there was improvement on the Adjusted R^2 values, both from the previous two models and with the addition of each block of variables: the known confounding variables ('Block 1') achieved an Adjusted R^2 of 0.307 while adding the proportions of calls on each day of the week ('Block 2') explained a further 2.2%. Although the highest adjusted R^2 occurred in 'Block 3', (0.330), adding deprivation did not increase the adjusted R^2 by more than 0.1%, and was an non significant predictor of call rates (β=0.045, p=0.158).

As with Model 2, the proportion of self-callers per ward (β= -0.256, p<0.001) and distance to ED (β = -0.169, p<0.001) were strong predictors of the log of triage call rates, as these variables increased, triage call rates decreased. The proportions of days of the week were all statistically significant contributors, suggesting that triage call rates increased with the proportion of Sunday calls (Table 6.6).

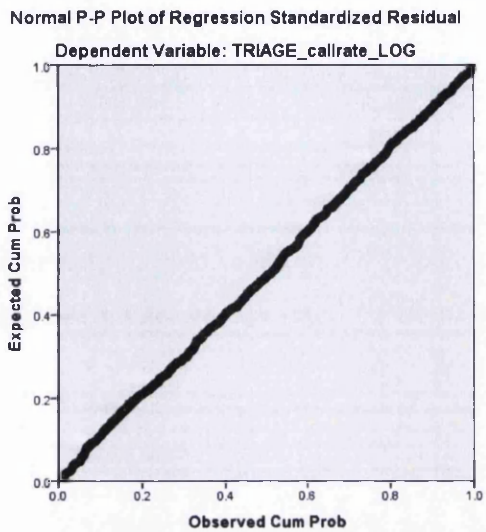
Table 6.6: Coefficients for multiple regression of log of triage call rates (Hierarchical Model 3)

	BLOCK 1[a]				BLOCK 2[b]				BLOCK 3[c]			
Adjusted R^2				0.307				0.329				0.330
	Unstandardised Coefficients		**Standardised Coefficients**		**Unstandardised Coefficients**		**Standardised Coefficients**		**Unstandardised Coefficients**		**Standardised Coefficients**	
	β	**Std Error**	**β**	**Sig level**	**β**	**Std Error**	**B**	**Sig level**	**B**	**Std Error**	**β**	**Sig level**
distance	-0.006	0.001	-0.157	<0.001	-0.006	0.001	-0.165	<0.001	-0.007	0.001	-0.169	<0.001
pop density	0.004	0.001	0.105	0.004	0.003	0.001	0.092	0.010	0.003	0.001	0.089	0.012
mean age (Census)	-0.011	0.005	-0.076	0.023	-0.011	0.005	-0.080	0.016	-0.009	0.005	-0.064	0.067
proportion females (Census)	2.408	1.017	0.077	0.018	2.225	1.005	0.071	0.027	2.009	1.016	0.064	0.048
proportion 'white' (Census)	-0.023	0.006	-0.121	<0.001	-0.025	0.006	-0.133	<0.001	-0.025	0.006	-0.135	<0.001
proportion digestive	-0.391	0.162	-0.090	0.016	-0.041	0.179	-0.010	0.817	-0.047	0.179	-0.011	0.794
proportion self callers	-1.656	0.174	-0.345	<0.001	-1.273	0.192	-0.265	<0.001	-1.228	0.194	-0.256	<0.001
proportion Mon calls				Not entered	-1.814	0.560	-0.136	0.001	-1.847	0.560	-0.139	0.001
proportion Tues calls				Not entered	-2.477	0.583	-0.162	<0.001	-2.490	0.583	-0.163	<0.001
proportion Wed calls				Not entered	-1.584	0.547	-0.106	0.004	-1.617	0.547	-0.108	0.003
proportion Thurs calls				Not entered	-1.509	0.560	-0.096	0.007	-1.610	0.564	-0.102	0.004
proportion Fri calls				Not entered	-2.832	0.565	-0.185	<0.001	-2.837	0.564	-0.185	<0.001
proportion Sat calls				Not entered	-1.595	0.542	-0.138	0.003	-1.630	0.542	-0.141	0.003
WIMD score				Not entered				Not entered	0.001	0.001	0.045	0.158

[a]$F(7, 802) = 52.2$; $p<0.001$ [b] $F(13, 796) = 31.5$; $p<0.001$ [c] $F(14, 795) = 29.5$; $p<0.001$

The Normal P-P plot of the standardised residuals shows that the residuals follow a normal distribution (Figure 6.3).

Figure 6.3: Normal P-P plot of standardised residuals for Model 3



The next three models focus on calls for general information.

6.4. Model 4: untransformed information call rates (b)

- Dependent variable: **information call rates**
- Method: **stepwise**
- Potential independent variables: deprivation (WIMD score), mean patient age per ward, proportion of female patients per ward, distance to ED, population density, proportion of self-callers per ward.

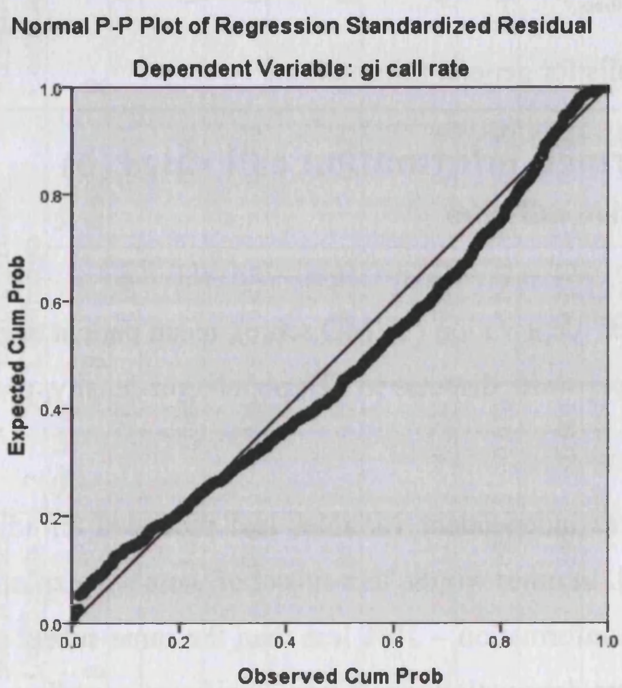
The final model consisted of three independent variables and produced an adjusted R^2 of 0.163 [$F(3, 806) = 53.5$; $p<0.001$]. In other words, this subset of variables explains 16.3% of the variability in calls for general information – 10% less than the same subset explained of variations in triage call rates. Here deprivation was a non-significant contributor to general information call rates and was excluded from the model. The strongest predictor was the proportion of self-callers per ward ($\beta=0.318$, $p<0.001$) which, in contrast to triage calls, showed a positive association with call rates (as one increased, so did the other), Table 6.7.

Table 6.7: Coefficients for multiple regression of information call rates (Model 4)

	Unstandardised Coefficients		Standardised Coefficients			95.0% Confidence Interval for β	
Independent variables	β	Std. Error	β	t	p value	Lower Bound	Upper Bound
Constant	-0.060	0.015		-3.936	<0.001	-0.090	-0.03
Proportion of self callers	0.131	0.015	0.318	8.815	<0.001	0.102	0.16
patient mean age	0.001	<0.001	0.124	3.416	0.001	0.0	0.0
Proportion of female patients	-0.040	0.014	-0.094	-2.92	0.004	-0.066	-0.0

The normal P-P plot of the standardised residuals in Figure 6.4, shows elements of a normal distribution but again the author felt that this could be improved by taking the logarithm of information call rates, reported in the next Model.

Figure 6.4: Normal P-P plot of standardised residuals for Model 4



6.5. Model 5: transformed information call rates (b)

- Dependent variable: **logarithms of general information call rates**
- Method: **stepwise**
- Potential independent variables: deprivation (WIMD score), mean patient age per ward, proportion of female patients per ward, distance to ED, population density, proportion of self-callers per ward.

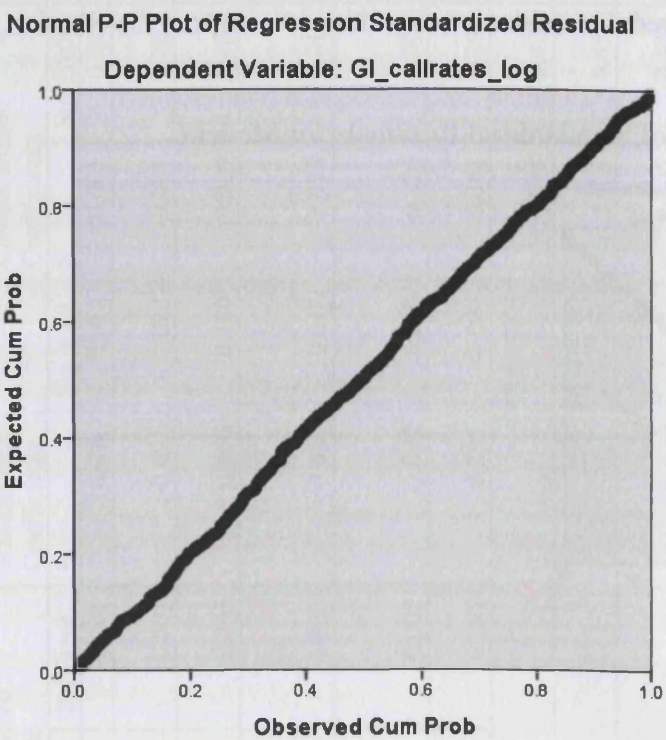
In contrast to triage call rates, the regression explained less variance after transformation [Adjusted R^2 = 0.146; F (3,806) = 47.1; p<0.001]. However deprivation was still a non-significant contributor, and the proportion of self-callers was again the strongest (Table 6.8).

Table 6.8: Coefficients for multiple regression of log of information call rates (Model 5)

	Unstandardised Coefficients		Standardised Coefficients			95.0% Confidence Interval for β	
	β	Std. Error	B	T	p value	Lower Bound	Upper Bound
(Constant)	-4.842	0.284		-17.08	<0.001	-5.399	-4.286
Proportion self-callers	2.181	0.277	0.287	7.867	<0.001	1.637	2.726
Mean age of patients	0.013	0.004	0.127	3.456	0.001	0.006	0.020
Proportion female patients	-0.868	0.254	-0.112	-3.419	0.001	-1.366	-0.370

However the residuals were not far from normally distribution, thus providing some justification for taking the logarithms of general information call rates (Figure 6.5).

Figure 6.5 Normal P-P plot of standardised residuals for Model 5



6.6. Model 6: transformed information call rates – hierarchical method (c)

- Dependent variable: **logarithms of information call rates**
- Method: hierarchical

- Potential independent variables: Block 1: mean Census 2001 age per ward, Census 2001 proportion of females per ward, Census 2001 proportion of white residents per ward, distance to ED, population density, proportion of self-callers per ward. Block 2: proportion of Monday calls per ward, proportion of Tuesday calls per ward, proportion of Wednesday calls per ward, proportion of Thursday calls per ward; proportion of Friday calls per ward, proportion of Saturday calls per ward. Block 3: deprivation (WIMD score)

Building on the examiners' feedback the author used the hierarchical method of regression incorporating the additional variables for proportions of calls by day of week and using the Census 2001 population values. The known confounding variables ('Block 1') achieved an Adjusted R^2 of 0.141 while adding the proportions of calls on each day of the week ('Block 2') explained a further 13.3% of the variance in the log of information call rates. When the author added deprivation in ('Block 3') this did not increase the adjusted R^2 by more than 0.1%. Thus the final models explained 27.5 % of the variability in information call rates, which was an 11% improvement from Model 4 (untransformed general information call rates). Again deprivation was a non significant contributor (standardised β=-0.039, $p<0.001$), Table 6.9. The P-P plot showed the residuals were close to a normal distribution, (Figure 6.6).

Figure 6.6: Normal P-P Plot of Standardised Residuals for Model 6

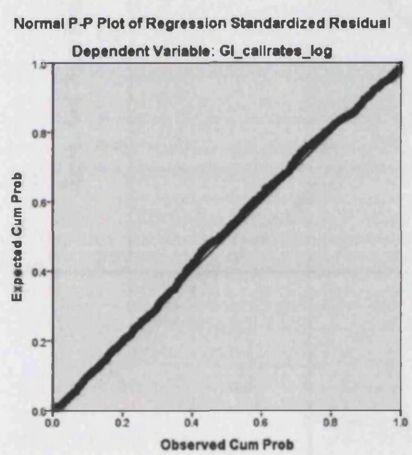


Table 6.9: Coefficients for multiple regression of log of information call rates (Hierarchical Model 6)

	BLOCK 1[a]				BLOCK 2[b]				BLOCK 3[c]			
Adjusted R^2				0.141				0.274				0.275
	Unstandardised Coefficients		Standardised Coefficients		Unstandardised Coefficients		Standardised Coefficients		Unstandardised Coefficients		Standardised Coefficients	
	β	Std Error	β	Sig level	β	Std Error	B	Sig level	β	Std Error	β	Sig level
distance	0.004	0.001	0.096	0.013	<0.001	0.001	-0.003	0.945	<0.001	0.001	0.002	0.951
pop density	-0.003	0.001	-0.091	0.022	-0.001	0.001	-0.037	0.315	-0.001	0.001	-0.036	0.324
mean age (Census)	0.008	0.005	0.060	0.110	0.009	0.005	0.064	0.065	0.007	0.005	0.050	0.169
proportion females (Census)	2.664	1.103	0.086	0.016	1.978	1.016	0.064	0.052	2.149	1.027	0.070	0.037
proportion 'white' (Census)	-0.018	0.007	-0.097	0.009	-0.020	0.006	-0.108	0.002	-0.019	0.006	-0.105	0.002
proportion self callers	2.245	0.267	0.295	<0.001	0.368	0.293	0.048	0.209	0.298	0.299	0.039	0.320
proportion Mon calls	Not entered				2.916	0.423	0.309	<0.001	2.899	0.423	0.307	<0.001
proportion Tues calls	Not entered				2.521	0.458	0.232	<0.001	2.550	0.459	0.235	<0.001
proportion Wed calls	Not entered				2.805	0.474	0.256	<0.001	2.792	0.474	0.255	<0.001
proportion Thurs calls	Not entered				2.654	0.474	0.224	<0.001	2.665	0.473	0.225	<0.001
proportion Fri calls	Not entered				1.568	0.476	0.132	0.001	1.575	0.476	0.133	0.001
proportion Sat calls	Not entered				0.188	0.578	0.019	0.745	0.187	0.578	0.019	0.747
WIMD score	Not entered				Not entered				-0.001	0.001	-0.039	0.244

a $F(6, 803) = 23.1; p<0.001$ b $F(12, 797) = 26.5; p<0.001$ c $F(13, 796) = 24.6; p<0.001$

6.7. Model 7: untransformed total call rates (b)

- Dependent variable: **total call rates**
- Method: **stepwise**
- Potential independent variables: deprivation (WIMD score), mean patient age per ward, proportion of female patients per ward, distance to ED, population density, proportion of self-callers per ward, proportion of digestive patients per ward.

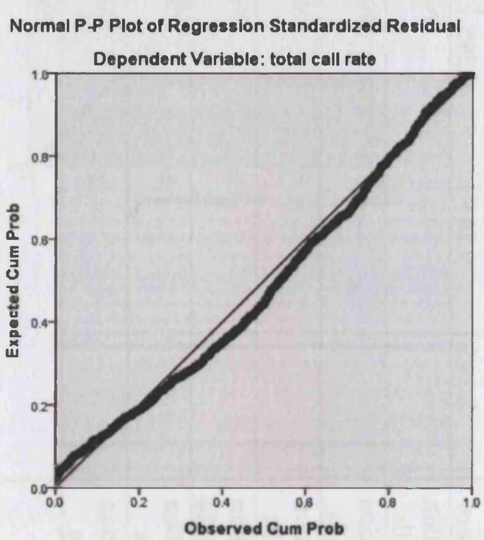
This model, combining calls for triage and general information was missing from the original submission. Here $R^2=0.110$ [$F(4,805)=25.9$; $p<0.001$] which is lower than that of triage and information calls. Deprivation was a non-significant predictor of total call rates, while the proportion of self-callers was again the strongest predictor (Table 6.10).

Table 6.10: Coefficients for multiple regression of total call rates (Model 7)

	Unstandardised Coefficients		Standardised Coefficients			95.0% Confid Interval for
	β	Std. Error	B	t	p value	Lower Bound
(Constant)	0.202	0.010		19.641	<0.001	0.182
proportion self-callers	-0.168	0.022	-0.353	-7.689	<0.001	-0.211
proportion digestive callers	0.151	0.023	0.311	6.66	<0.001	0.107
distance to ED in km	-0.001	<0.001	-0.133	-3.491	0.001	-0.001
population density	<0.001	<0.001	0.124	3.422	0.001	0.0

The residual distribution, although close to normal, showed some deviation (Figure 6.7); thus the author also considered the log of total call rates in Model 8.

Figure 6.7 Normal P-P plot of standardised residuals for Model 7



6.8. Model 8: transformed total call rates (b)

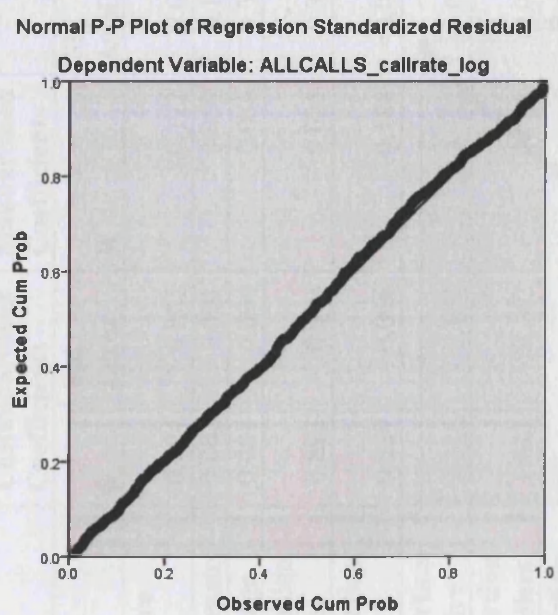
- Dependent variable: **logarithms of total call rates**
- Method: **stepwise**
- Potential independent variables: deprivation (WIMD score), mean patient age per ward, proportion of female patients per ward, distance to ED, population density, proportion of self-callers per ward, proportion of digestive patients per ward.

There was an improvement in the percentage of the variance explained by the model from the untransformed call rates: R^2=0.123; F (5,804) = 23.7; p<0.001. Again deprivation was not significant, while the proportion of self-callers was the strongest contributor (Table 6.11).

Table 6.11: Coefficients for multiple regression of log of total call rates (Model 8)

Independent variables	Unstandardised Coefficients β	Unstandardised Coefficients Std. Error	Standardised Coefficients B	t	p value	95.0% Confidence Interval for β Lower Bound	95.0% Confidence Interval for β Upper Bound
(Constant)	-1.777	0.103		-17.257	<0.001	-1.979	-1.575
Proportion of self-callers	-1.413	0.180	-0.419	-7.867	<0.001	-1.765	-1.060
Proportion of digestive patients	1.201	0.160	0.348	7.516	<0.001	0.887	1.514
Distance to ED in km	-0.005	0.001	-0.172	-4.448	<0.001	-0.008	-0.003
population density	0.004	0.001	0.144	3.886	<0.001	0.002	0.006
Mean age of patients	0.008	0.004	0.110	2.269	0.024	0.001	0.016

Figure 6.8 Normal P-P plot of regression standardised residuals for Model 8



6.9 Model 9: transformed total call rates - hierarchical method (c)

- Dependent variable: **logarithms of total call rates**
- Method: **hierarchical**
- Potential independent variables: Block 1: mean Census 2001 population age per ward, Census 2001 proportion of females per ward, Census 2001 proportion of white residents per ward, distance to ED, population density, proportion of self-callers per ward, proportion of digestive patients per ward, proportion of triage calls per ward. Block 2: proportion of Monday calls per ward, proportion of Tuesday calls per ward, proportion of Wednesday calls per ward, proportion of Thursday calls per ward; proportion of Friday calls per ward, proportion of Saturday calls per ward. Block 3: deprivation (WIMD score)

The adjusted R^2 values for total call rates were not as high as when calls for triage and general information were analysed separately. 'Block 1' achieved an adjusted $R^2 = 0.141$ for combined call rates while adding the proportions of calls on each day of the week ('Block 2') explained a further 1.2%. As with triage call rates and general information call rates, adding deprivation ('Block 3') did not increase the adjusted R^2 by more than 0.1%. Thus the final models explained only 15.3% of variability in combined call rates. Again, deprivation was a non significant contributor (Table 6.12). The residuals followed a relatively normal distribution (Figure 6.9).

Figure 6.9 Normal P-P plot of standardised residuals for Model 9

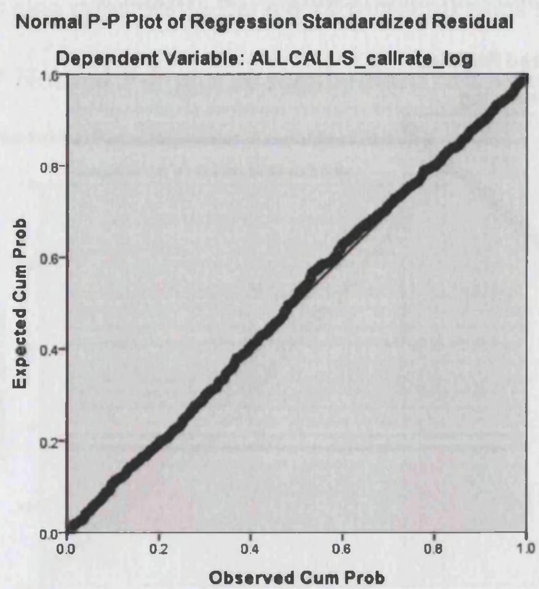


Table 6.12: Coefficients for multiple regression of log of total call rates (Hierarchical Model 9)

	BLOCK 1[a]				BLOCK 2[b]				BLOCK 3[c]			
Adjusted R^2				0.141				0.153				0.153
	Unstandardised Coefficients		Standardised Coefficients		Unstandardised Coefficients		Standardised Coefficients	Sig level	Unstandardised Coefficients		Standardised Coefficients	Sig level
	β	Std Error	B	Sig level	β	Std Error	β	Sig level	β	Std Error	β	Sig level
distance	- 0.004	0.001	-0.122	0.002	-0.004	0.001	-0.119	0.003	-0.004	0.001	-0.115	0.004
pop density	0.002	0.001	0.059	0.140	0.001	0.001	0.050	0.211	0.001	0.001	0.051	0.201
mean age	0.004	0.004	0.036	0.350	0.005	0.004	0.040	0.287	0.003	0.004	0.031	0.437
proportion females	0.893	0.914	0.035	0.329	0.699	0.911	0.028	0.443	0.810	0.921	0.032	0.379
proportion 'white'	- 0.029	0.006	-0.188	<0.001	-0.029	0.006	-0.189	<0.001	-0.028	0.006	-0.188	<0.001
proportion digestive	1.348	0.164	0.391	<0.001	1.472	0.186	0.427	<0.001	1.485	0.187	0.431	<0.001
proportion self callers	- 1.443	0.162	-0.428	<0.001	-1.094	0.223	-0.325	<0.001	-1.135	0.228	-0.337	<0.001
proportion Mon calls	Not entered				-1.227	0.635	-0.113	0.054	-1.213	0.636	-0.112	0.057
proportion Tues calls	Not entered				-1.357	0.662	-0.105	0.041	-1.316	0.664	-0.102	0.048
proportion Wed calls	Not entered				-0.888	0.652	-0.067	0.174	-0.865	0.653	-0.066	0.186
proportion Thurs calls	Not entered				-0.401	0.629	-0.027	0.523	-0.337	0.634	-0.023	0.595
proportion Fri calls	Not entered				-2.428	0.654	-0.171	<0.001	-2.408	0.655	-0.170	<0.001
proportion Sat calls	Not entered				-1.343	0.667	-0.152	0.044	-1.315	0.668	-0.149	0.049
WIMD score	Not entered				Not entered				-0.001	0.001	-0.030	0.405

[a] $F(7, 802)=20.0$; $p<0.001$ [b] $F(13, 796)=12.2$; $p<0.001$ [c] $F(14, 795)=11.40$; $p<0.001$

6.10 Prediction: Testing the Models (b)

Until now the models have been used to explain the variability in the dependent variables. However the author also wanted to understand the predictive power of the whole model, how well it could be used in practice to predict call rates across wards. Thus for Model 1 (triage call rates), she used the multiple regression equation and applied it to the dataset. She then analysed the residuals better to understand wards for which the model was not a good fit. This section was done for the original submission and was updated using the correct values between submission and the viva (b).

If the model is accurate, the author hypothesised that wards who may be particularly anxious about their health will have higher residuals (e.g. higher than expected call rates to NHSDW) for example such wards may be adjacent to large factories and fear the resulting contamination. In contrast, wards where perhaps a more relaxed attitude to health prevails, for example in high student areas, should have lower residuals.

As discussed in Chapter 4 the linear regression equation takes the form of $Y = b_0 + b_1 X$, where Y equals the dependent variable, b_0 is the intercept of the line on the Y axis when $X=0$ (and is a constant) and b_1 is the slope of the line. For equations where there is more than one independent variable the equation can be extended. To run the regression equation, the unstandardised coefficient scores are used, see Table 6.13.

Table 6.13: Unstandardised coefficients and constant for Model 1

	Unstandardized Coefficients	
	B	Std. Error
(Constant)	0.146	0.015
proportion self-callers	-0.148	0.017
pop density	0.001	<0.001
distance to ED	-0.001	<0.001
prop digestive patients	-0.043	0.016
prop female patients	0.06	0.024

Thus the multiple regression equation becomes:

Call rate = 0.146 + [-0.148(prop of self callers)] + [0.001(population density)] [-0.001 (distance to hospital)] +[-0.043(proportion of digestive patients)] + [0.006(proportion of female patients)]

The author used the ward level values for each ward to populate the equation. So for example, the Ward of Aberffraw in Anglesey has the following information:

ward	prop self-callers	pop density	distance in km	prop digestive patients	prop of female patients
Aberfraww	0.4776	0.3300	20.4000	0.3504	0.4925

Using the multiple regression equation, above for Aberffraw:

Call rate = 0.146 + [-0.148(0.4776)] + [0.001(0.3300)] [-0.001(20.4000)] + [-0.043(0.3504)] + [0.006(0.4925)]

The predicted value of call rates for Aberffraw is 0.043133. The actual (observed) value from the study dataset is 0.1036, which results in a residual of 0.06047. Thus for Aberffraw, the model is not effective in predicting call rates, although some wards were better and some were worse.

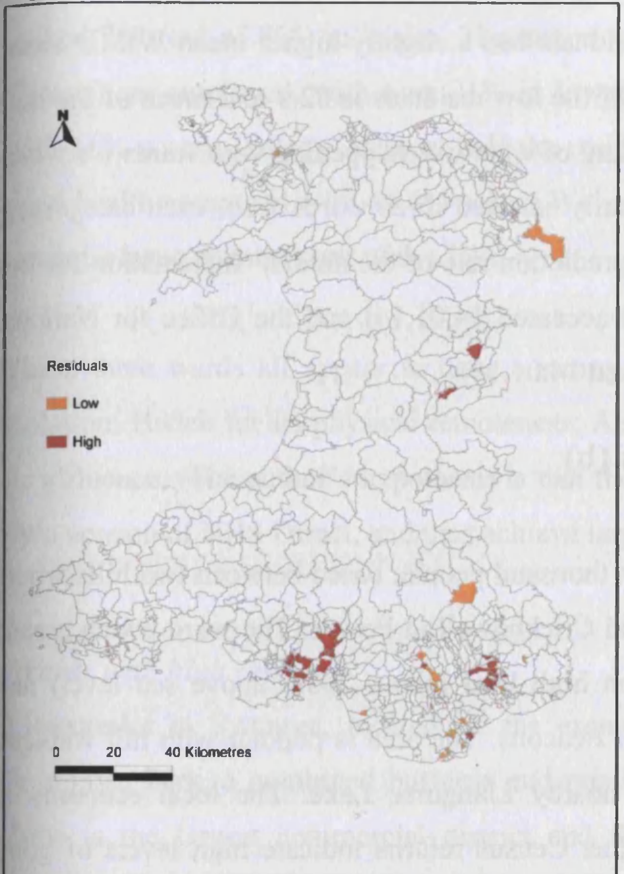
6.12.1 Understanding the residuals (b)

To understand which wards were not explained by the model the author summarised the residuals of wards with the 30 highest and the 30 lowest residuals (approximately 3% on either side) and added in the corresponding WIMD scores, see Table 6.14. These wards were then mapped, see Figure 6.7.

Table 6.14: Wards with the lowest and highest residuals

Wards with the lowest residuals				Wards with the highest residuals			
UA	**Ward**	**WIMD**	**residuals**	**UA**	**Ward**	**WIMD**	**residuals**
RCT	Tyn-y-nant	22.17	-0.072	Swansea	Penyrheol	19.24	[illegible]
Glamorgan	Court	31.10	-0.059	RCT	Mountain Ash West	51.67	[illegible]
Glamorgan	Buttrills	23.05	-0.052	Cardiff	Butetown	53.40	[illegible]
Anglesey	Braint	8.66	-0.049	Torfaen	Greenmeadow	26.04	[illegible]
Wrexham	Maesydre	22.12	-0.045	Anglesey	Kingsland	33.56	[illegible]
RCT	Glyncoch	57.71	-0.044	Swansea	Lower Loughor	22.87	[illegible]
RCT	Trallwng	13.04	-0.040	Swansea	Cockett	24.08	[illegible]
Wrexham	Little Acton	6.06	-0.039	Torfaen	Two Locks	18.70	[illegible]
Cardiff	Ely	46.72	-0.038	Powys	Newtown East	17.59	[illegible]
Wrexham	Plas Madoc	72.33	-0.036	Torfaen	Upper Cwmbran	32.30	[illegible]
Glamorgan	Gibbonsdown	34.32	-0.036	Caerphilly	Newbridge	24.52	[illegible]
Wrexham	Rhosnesni	4.91	-0.035	Torfaen	Cwmyniscoy	35.32	[illegible]
Powys	Bwlch	9.35	-0.035	NPT	Trebanos	26.39	[illegible]
Wrexham	Bronington	9.79	-0.035	NPT	Godre'r graig	37.78	[illegible]
Monmouthshire	Dewstow	16.23	-0.035	Torfaen	St. Dials	31.49	[illegible]
Newport	Malpas	8.48	-0.034	Swansea	Mayals	2.83	[illegible]
Glamorgan	Cornerswell	7.03	-0.034	Torfaen	Pontnewynydd	21.63	[illegible]
RCT	Cwmbach	37.02	-0.033	Torfaen	Pontypool	17.70	[illegible]
Bridgend	Pyle	27.03	-0.032	Torfaen	Llanyrafon North	8.55	[illegible]
Monmouthshire	St. Christopher's	6.98	-0.032	Swansea	Gowerton West	9.28	[illegible]
Cardiff	Caerau	45.61	-0.032	Swansea	Graigfelen	40.08	[illegible]
Monmouthshire	Lansdown	24.27	-0.032	Swansea	Llangyfelach	7.71	[illegible]
Glamorgan	Illtyd	8.36	-0.031	NPT	Pontardawe	24.26	[illegible]
Wrexham	Borras Park	4.67	-0.030	NPT	Allt-wen	14.39	[illegible]
Cardiff	Heath	1.93	-0.030	Powys	Newtown South	30.50	[illegible]
Glamorgan	Stanwell	10.44	-0.030	NPT	Cwmllynfell	32.59	[illegible]
RCT	Penrhiwceiber	54.01	-0.030	Swansea	Llansamlet	17.56	[illegible]
Monmouthshire	Usk	1.79	-0.029	Swansea	Vardre	21.05	[illegible]
RCT	Abercynon	34.52	-0.029	Swansea	Gorseinon East	32.31	[illegible]
Pembrokeshire	Neyland East	25.48	-0.028	Powys	Welshpool Castle	23.95	[illegible]

Figure 6.10: Choropleth map wards with the lowest and highest residual values



The above map shows there is a group of wards with low residuals in the Vale of Glamorgan, Cardiff, Rhondda Cynon Taf and in Wrexham by the border with England. In the qualitative exploration presented earlier, the author learned that some wards in Wales had English based dialing codes and were thus routed automatically to England. Although the author attempted to control for this by removing all calls from Flintshire and Rossett in Wrexham from the analysis, there were five wards which NHSDW also mentioned as having English dialing codes: Aldford, Christleton, Great Mollington, Mickle Trafford, Saughall and Seahall. These wards were not in the author's dataset meaning that they were wards which came into existence post 1998 either through merging with, or splitting from an existing ward. The author did not look further into what these wards were in 1998 but it is highly possible that the same issues were encountered in these 1998 wards and thus could explain wards with low residuals up by the border (this of course would not be the case for every ward with low residuals).

Wards with high residuals seemed condensed with several in Swansea and in Neath Port Talbot. In Table 6.14, wards with high residuals had a slightly higher mean WIMD score, indicating they were more deprived: mean of the low residuals is 22.5 and mean of the high residuals is 25.3. To get a better understanding of what was happening with wards for which the model was a poor fit, the author randomly selected three wards from each category to further explore the reasons behind the low prediction rate of the model. Information for this was derived from www.wikipedia.org (last accessed 14.01.14) and the Office for National Statistics (www.statistics.gov.uk, last accessed 14.01.14).

6.12.2 Further exploration of wards (b)

Wards with low residuals

Bwlch is a rural community of fewer than a thousand people, based between two hills where the main A40 road runs between Brecon and Crickhowell in Powys. The word bwlch means 'pass' or 'col' in Welsh. The village is on high land (about 200m above sea level) and overlooks the Black Mountains and Brecon Beacons. The area is popular with hill walkers, cyclists, horse riders and people visiting nearby Llangorse Lake. The local economy is dependent on tourist and agricultural income. Census returns indicate high levels of good health (71.4% compared with 65.1% across Wales) and a low number of people with a limiting long term illness (19.1% compared with 23.3% across Wales). Qualifications, housing tenure and number of vehicles owned are also better than the Welsh averages.

Abercynon is a typical post-mining community in the Cynon Valley about 16 miles north of Cardiff. The area's rich mining and industrial history created a strong social network originally developed in response to physical hardship and material deprivation since the Abercynon colliery closed in 1988. The average weekly household income is below the county average (£450 vs £540) and 36% of households' income is below 60% of the median income. Nearly one in 10 households with dependent children have no adult in employment (8.8% versus 6.0% across Wales). There is a higher than average incidence of long term illness: 28.3% of residents report a limiting long term illness, compared with 23.3% across Wales; half of households have one or more residents with a limiting long term condition (52.3% compared with 42.0% across Wales). The number of vehicles owned is lower than the Welsh average, while the number of people in routine jobs is higher.

Little Action in Wrexham is an affluent community in the North East part of the Authority, ranked 769 (out of 865) in Wales. The majority of those aged 16-74 (according to the 2001 Census) are employed, with over 21% in lower managerial or professional jobs (compared with 16% across Wales). Almost half the residents (49%) describe themselves as being in good health compared with 46.6% across Wales. The ward is largely residential and is built around a large country park with a lake.

These three wards all appear to have a strong sense of community, perhaps borne out of isolation: Bwlch for its physical remoteness; Abercynon for its history; and Little Acton for its affluence. The author's hypothesis is that these three communities in effect provide their own version of NHS Direct, and thus achieve large negative residuals.

Wards with high residuals

Llansamlet in Swansea, located on the eastern side of Swansea, includes the Swansea Enterprise Park, a combined business and retail park and industrial estate. The Enterprise Zone is the largest commercial district and the largest out-of-town shopping district of Swansea. Before the park was built, for many years, Llansamlet was considered a post-industrial wasteland.

Mountain Ash West ward, in Rhonda Cynon Taff, is separated from Mountain Ash East by the River Cynon. It is a ward with a history of coal mining however it fell into economic hardship by the end of the 20th century when the last coal mines had closed along with many of the town's factories. The area is one of the most deprived wards according to the WIMD 2000, ranked 42/865. The area also has a strong Welsh history, and was predominantly a Welsh speaking Valley up until the 19th century.

Butetown is a community in the south of the city of Cardiff, the capital of Wales. It was originally a model housing estate built in the early nineteenth century. Commonly known as "Tiger Bay", this area became one of the UK's first multicultural communities with people from over 50 countries settled here by the outbreak of World War I and working in the docks and allied industries. Ethnic communities included Somalis, Yemenis and Greeks, still influential today. The docks area of Butetown has been redeveloped with the Senedd (home of the National Assembly of Wales), Millennium Centre, restaurants, shopping and leisure facilities. While limiting long term illness is 23.8%, close to the average 23.3% in Wales, house and car ownership are lower than across Wales.

These three wards are very different. All they appear to have in common is that each is atypical in a different way: Butetown has one of the most heterogeneous racial mixes across Wales; Llansamlet has the Enterprise shopping and industrial zone; and Mountain Ash West is very deprived. While it is not surprising that residuals are high in these areas, it will need more qualitative work to pinpoint reasons.

6.13 Chapter Summary (a, b, c)

This chapter sets out to answer Research Objective 2: to model the relationship between deprivation and demand, controlling for other variables which affect demand.

The author produced nine multiple regression models with varying adjusted R^2. The highest (0.330) was for the logarithms of triage calls using the hierarchical method of regression and using the day of the week variable. This means the variables in this model explain 33.0% of the variability in triage calls rates to NHSDW. Though there were differences between using stepwise and hierarchical regression methods, this was probably due to the addition of day of the week, which created the biggest improvement in adjusted R^2 for all types of call rates. Two sensitivity analyses – removing the densely populated outlying ward, and for excluding cases pairwise rather than listwise, yielded no real change in results. The author did not include the ill-defined climatic variables in analysis.

Table 6.15 summarises each model, including the standardised regression coefficients. All values are significant at the $p<0.05$ level unless otherwise indicated. Deprivation appears as a significant contributor in only one model – that of the logarithm of triage call rates. For all other models, across all three types of call rates, deprivation did not contribute to explaining the variation in call rates.

Other variables generally appeared consistently across models. However there were differences in the direction of these variables between triage and information calls. In particular, triage call rates decreased with both the proportions of self-callers in a ward and calls not on Sundays. In contrast, information call rates increased with the proportion of self-callers and calls during the week. When included in models, distance to ED was always negative, indicating that as distance to an ED department increased, call rates decreased.

The author used Model 1 to predict triage call rates for all wards in the database. The wards with the 30 lowest and 30 highest residuals were reported and the author chose six wards at random to investigate why the model wasn't a good predictor for these wards. Although results warrant further investigation using qualitative methods, the wards with low residuals are more isolated and close knit. The author's hypothesis is that these wards effectively provide their own NHSDW. Wards with high residuals all seemed atypical although it was difficult to pinpoint the exact reasons for high residuals.

This chapter has explored the effect of deprivation on demand for NHSDW, Chapter 7 will explore the impact of this variable on the disposition given by the nurse advisor.

Table 6.15: Standardised coefficients for multiple regression models 1-9

Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Call type:	Triage	Triage	Triage	GI	GI	GI	Total	Total	Total
Dependent variable :	Call rates	Log call rates	Log call rates	Call rates	Log call rates	Log call rates	Call rates	Log call rates	Log call rates
Method of regression	stepwise	stepwise	hierarch	stepwise	stepwise	hierarch	stepwise	stepwise	hierarch
R^2	0.265	0.298	0.330	0.163	0.146	0.275	0.110	0.123	0.153
Independent variables at ward level									
WIMD score (continuous variable)	NS	0.061	*0.045	NS	NS	*-0.039	NS	NS	*-0.030
distance to ED (km)	-0.156	-0.204	-0.169	NS	NS	*0.002	-0.133	-0.172	-0.115
population density (people per hectare)	0.161	0.161	0.089	NS	NS	*-0.036	0.124	0.144	*0.051
mean age (per year) of patients	NS	NS		0.124	0.127		NS	0.110	*0.031
mean age of residents (Census 2001)			*-0.064			*0.050			
proportion of females patients	0.079	0.080		-0.094	-0.112		NS	NS	
proportion of female residents (Census 2001)			0.064			0.070			*0.032
proportion of digestive callers	-0.103	-0.085	*-0.011				0.311	0.348	0.431
proportion of self-callers per ward	-0.322	-0.316	-0.256	0.318	0.287	*0.039	-0.353	-0.419	-0.337
proportion of white residents (Census 2001)			-0.135			-0.105			-0.188
proportions of calls on Monday			-0.139			0.307			*-0.112
proportions of calls on Tuesday			-0.163			0.235			-0.102
proportions of calls on Wednesday			-0.108			0.255			*-0.066
proportions of calls on Thursday			-0.102			0.225			*-0.023
proportions of calls on Friday			-0.185			0.133			-0.170
proportions of calls on Saturday			-0.141			*0.019			-0.149

NS =excluded from the model fitting using stepwise regression; *=a non significant p value using hierarchical methods

Chapter 7: Results of Objective 3 – disposition

7.1 Overview (a and c)

Chapter 5 presented an initial exploration of the relationships between deprivation and the dependent variables of call rates and dispositions. Chapter 6 modelled the relationship between demand for NHSDW and deprivation using multiple linear regression. This chapter models the relationship between the disposition proposed by NHSDW and deprivation using multiple logistic regression. Thus this chapter addresses Research Objective 3:

> To model the relationship between deprivation and call outcome, controlling for other variables which affect outcome.

While linear regression predicts mean call rates from available independent variables, logistic regression estimates probabilities of specified dispositions from essentially the same independent variables. As stated in the analysis plan, there are two main aims of logistic regression: 1) prediction of binary outcomes and 2) characterising the underlying relationships among variables. In line with Objective 3, results presented here will focus on understanding the relationship between deprivation and disposition in two forms – face-to-face care versus self-care and "Call 999" versus any other.

The author made no changes to this chapter between submission and oral examination. However the examiners' suggestions during the viva have stimulated her to make several improvements between oral and resubmission. These revisions, which are labelled (c) and explained in more detail later, comprise:

1. Converting the ethnicity variable into two dummy variables.
2. Adding the day of the week on which the call occurred to the models.
3. Dividing the distribution of WIMD scores into fifths to represent deprivation, rather than treating it as a continuous variable.
4. Adding the hierarchical method of logistic regression and deprivation at the final stage.

To prepare for logistic regression, the author implemented the first three of these changes by recoding variables as in Table 7.1. Firstly, in order not to lose any data from the year and a half where ethnicity was not collected, the author created two dummy variables for ethnicity – ethnicity known (combining white and other) and other ethnicity. Secondly she added six new dummy variables for the day of the week on which the call occurred. Finally she converted deprivation into fifths in two alternate forms – as an ordinal variable and as four dummy variables.

Table 7.1: Coding of dummy variables for logistic regression

Study variable	**Zero**	**One**
Advice to seek emergency care	all other care	999 call or emergency care
Advice to seek care face to face	self-care	care face to face (including emergency care)
Gender	male	female
Main symptom (from ICPC-2)	not digestive	digestive*
Relationship of patient to caller	surrogate caller	self
Other ethnic background	white or unknown	other
Ethnicity known	unknown	known (white or other)
Call occurred on Monday	all other days	Monday
Call occurred on Tuesday	all other days	Tuesday
Call occurred on Wednesday	all other days	Wednesday
Call occurred on Thursday	all other days	Thursday
Call occurred on Friday	all other days	Friday
Call occurred on Saturday	all other days	Saturday
Resident in 2nd least deprived 5th of wards [a]	all other fifths	2nd least deprived
Resident in 3rd least deprived 5th of wards [a]	all other fifths	3rd least deprived
Resident in 4th least deprived 5th of wards [a]	all other fifths	2nd most deprived
Resident in most deprived 5th of wards [a]	all other fifths	most deprived

*as calls concerning digestive symptoms were the most frequent, these were coded as 1

a Alternative ordinal coding: (0) least deprived (1) 2nd least deprived (2) 3rd least deprived (3) 4th least deprived (5) most deprived [a]

As calls for triage advice differ in purpose and practice from calls only for information, the author analysed these two types of call separately. This yielded four separate models for: the likelihood of advice to seek face-to-face care (including emergency care) rather than self-care; or to seek emergency care rather than routine care (Models 10-13). The author also created Model 14, in which she reran Model 10 (whether triage calls advised face-to-face care rather than self-care) adding climatic variables. As these models were all reported in the original thesis (a), they do not include day of the week or the new ethnicity variables and include deprivation as a continuous variable. As analysis focused on individual calls, it used patients' own ages and genders.

In the original thesis, the author chose to use stepwise regression (called Forward Wald in SPSS) for all Models 10-14. In principle this technique includes a variable if its significance level is the smallest of all the competing variables and less than 5%. Because the development of each logistic equation thus uses many significance tests or 'multiple comparisons', it errs on the side of including too many independent variables.

Responding to the feedback received in the viva, the author attempted to improve these models. She converted Models 10-13 into Models 10a, 11a, 12a and 13a using the hierarchical method: first entering all variables except day of the week and deprivation; then adding weekday; and finally 'deprivation fifth'. By adding deprivation to the statistical model at the final step the author was able to estimate its true contribution after accounting for known potential confounding variables.

With no shortage of data she used complete case analysis throughout by excluding participants with any missing data 'listwise'. To facilitate comparison between similar models, the author has reported models for the same call types and dependent variables in order, again using the coding system (a) or (c) to indicate when the work was done. In this way, triage calls are first examined across the two types of disposition followed by calls for information. Table 7.2 summarises the key components of each model and full details follow. The chapter concludes with a summary of the key points.

Table 7.2: Summary of models for logistic regression (Y indicates potentially included variable)

Model	**10**	**10a**	**11**	**11a**	**12**	**12a**	**13**	**13a**	**14**
Call type	Triage	triage	triage	triage	GI	GI	GI	GI	triage
Dependent variable: disposition	face-face v self	face-face v self	emerg'y v other	emerg'v v other	face-face v self	face-face v self	emerg'y v other	emerg'y v other	face-face v self
Method of regression	stepwise	hierarch	stepwise	hierarch	stepwise	hierarch	stepwise	hierarch	stepwise
Independent variables									
WIMD score (continuous variable)	Y		Y		Y		Y		Y
distance to ED (per km)	Y	Y	Y	Y	Y	Y	Y	Y	Y
population density (people per hectare)	Y	Y	Y	Y	Y	Y	Y	Y	Y
age (per year)	Y	Y	Y	Y	Y	Y	Y	Y	Y
gender (female)	Y	Y	Y	Y	Y	Y	Y	Y	Y
symptom (digestive)	Y	Y	Y	Y					Y
relationship (self caller)	Y	Y	Y	Y	Y	Y	Y	Y	Y
ethnicity: non white background		Y		Y		Y		Y	
ethnicity known (white or other)		Y		Y		Y		Y	
day of week (6 variables)		Y		Y		Y		Y	
WIMD fifth (ordinal variable)		Y		Y		Y		Y	
average of the monthly maximum temperature									Y
average of the monthly minimum temperature									Y
snow in cm									Y
PM10 average of the monthly maximum reading									Y
PM10 average of the monthly minimum reading									Y
O3 average of the monthly maximum reading									Y
O3 average of the monthly minimum reading									Y
SO2 average of the monthly maximum reading									Y
SO2 average of the monthly minimum reading									Y
NO2 average of the monthly maximum reading									Y
NO2 average of the monthly minimum reading									Y

7.2 Model 10 (a) triage calls; face-to-face care versus self-care

- Dependent variable: **disposition – face-to-face care versus self-care**
- Dataset: **triage calls** only
- Method: **stepwise** (Forward Wald)
- Potential independent variables: deprivation (WIMD score as continuous variable) patient age, patient gender, relationship of patient to caller, distance to ED, population density, patient symptom.

This fulfils the assumptions for logistic regression discussed in Chapter 4: the sample size is large, the dependent variable is dichotomous; and the categories for each variable are mutually exclusive and exhaustive (i.e. every participant is in exactly one group).

Table 7.3: Logistic regression of triage calls advising face-to-face rather than self-care (Model 10)

				95% CI for Exp (β)	
Variable	**β**	**p value**	**Exp(β)**	**Lower**	**Upper**
Patient age (years)	0.011	<0.001	1.011	1.011	1.012
WIMD score (continuous)	0.006	<0.001	1.006	1.005	1.006
Distance to ED (km)	-0.009	<0.001	0.991	0.989	0.992
Gender (female patients)	0.093	<0.001	1.098	1.069	1.128
Relationship (self callers)	-0.118	<0.001	0.888	0.861	0.917
Symptom (digestive patients)	-0.335	<0.001	0.715	0.695	0.735
Constant	1.705	<0.001	5.502		

A test of the full model displayed in Table 7.3 against the default model of constant likelihood was statistically significant, showing that the set of independent variables help to predict whether a patient will receive advice to seek care face to face (chi-squared = 2108; df = 6; $p < 0.001$). Nevertheless the predictive power for the fitted model was little more than the 87.8% that the constant model achieves by predicting that all participants seeking triage will receive advice to seek care face to face! Furthermore Hosmer and Lemeshow's Test showed the model was a poor fit (chi squared =78; df = 8; $p < 0.001$). Similarly Nagelkerke's R^2 of 0.018 showed a very weak link between predictors and disposition.

The β values in logistic regression are similar to the β values in multiple regression, in that they are the values one would use in an equation to calculate the probability of a patient getting a specific category of advice – to seek care face to face in this model. The sign of β gives information about the direction of the relationship. For example, negative β values show that an increase in the independent variable will result in a decreased probability of the patient getting case recording a score of 1 in the dependent variable category. In this model a β of –0.009 for the distance to ED shows that the further patients live from an ED, the less likely they are to receive advice to seek care face to face. Similarly the binary relationship variable also has a negative β showing that those calling about themselves, and therefore coded as 1, were less likely to receive advice to seek care face to face.

The Exp(β) column shows the resulting effects on the odds ratio of receiving advice to seek care face to face. Table 7.3 shows that the majority of values are close to one, indicating that the variables have very little effect on the probability of receiving care face to face. There were two exceptions: those calling about digestive symptoms (coded 1) had a decreased probability of receiving the disposition for face-to-face care than those calling for all other symptoms [Exp(β) = 0.715; 95% CI 0.695 to 0.735; $p < 0.001$]. Similarly, callers ringing on behalf of themselves also had a decreased probability of receiving advice to seek care face to face [Exp(β) = 0.888; 95% CI 0.861 to 0.917, $p < 0.001$]. In this model, as WIMD score increases, so does the probability of receiving a face-to-face disposition.

For Model 10 the author has reported key statistics for the whole logistic regression model, including the parameter estimates needed to predict future cases. These results are consistent with the author's earlier hypothesis that regression models will be poor predictors of dispositions given the inherent variability in the sample that we cannot quantify, notably true morbidity. To address objective 3, the main results of interest are the parameter estimates for each independent variable included in the models. Therefore, in subsequent models, only outputs which illuminate the predictive power of each variable will be reported.

Next is Model 10a. This is essentially the same as Model 10 but using hierarchical regression rather than stepwise. The author also added day of week and ethnicity to the analysis and used deprivation fifths rather than the continuous variable.

7.3 Model 10a (c) triage calls; face-to-face versus self-care; hierarchical

- Dependent variable: **disposition – face-to-face care versus self-care**
- Dataset: **triage** calls only
- Method: **hierarchical**
- Potential independent variables: Block 1 – patient age, patient gender, relationship of patient to caller, distance to ED, population density, patient symptom, known ethnicity?, other ethnic background?; Block 2 – day of call (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday or Sunday by default); Block 3 – WIMD deprivation fifth.

There were 242 731 patients included in analysis. A test of the full model in Table 7.4 was statistically significant against the default model of constant likelihood (chi squared = 3380; df=15; $p<0.001$), showing that the set of independent variables help to predict whether a patient receives a disposition for face-to-face or self-care. However Nagelkerke's R^2 of 0.026 showed a very weak relationship between predictors and disposition.

This method of regression includes all variables in the model whether or not they are statistically significant. Table 7.4 shows that several Exp(β) estimates column are ***farther*** from one than those in Table 7.3, showing that the combination of this method of regression and additional variables (viz days of week, ethnicity and deprivation fifth) has enhanced the model. As we see from Block 3 in particular, an increase in deprivation from one fifth to the next fifth, has increased the probability of receiving advice to seek care face to face rather than self-care by nearly 5% (OR = 1.049; 95% CI 1.041 to 1.058). Those calling other than on Sunday had less chance of being advised to seek face-to-face care. Those with ethnicity known had a higher chance of being advised to seek face-to-face care, while non-whites had a lower chance. As in Model 10, self callers had a lower chance of receiving the face-to-face disposition [Exp(β) = 0.864, 95% CI: 0.840 - 0.890 $p<0.001$].

Table 7.4: Logistic regression of triage calls advising care face to face rather than self-care (Hierarchical Model 10a)

	Block 1	Block 2	Block
Variable	**Exp(β) (95% CI)*** **	**Exp(β) (95% CI)*** **	**Exp(β) (95% CI)*** **
Distance to ED (per km)	0.990 (0.988 - 0.991)	0.990 (0.988 - 0.991)	0.990 (0.988 - 0.991)
Population density (people per hectare)	1.001 (1.001 - 1.002)**	1.001 (1.001 - 1.002)**	1.001 (1.001 - 1.002)**
Patient age (year)	1.010 (1.010 – 1.011)	1.010 (1.009 - 1.011)	1.010 (1.009 – 1.011)
Gender			
Male	1.00	1.00	1.0
Female	1.128 (1.100 - 1.156)	1.126 (1.099 - 1.154)	1.125 (1.098 - 1.153)
Relationship			
Surrogate caller	1.00	1.00	1.0
Self caller	0.845 (0.821 - 0.869)	0.860 (0.836 - 0.885)	0.864 (0.840 - 0.890)
Non-white race			
White or unknown	1.00	1.00	1.0
Non-white	0.806 (0.718 - 0.905)	0.813 (0.725 - 0.913)	0.818 (0.729 - 0.918)
Known race			
Unknown	1.00	1.00	1.0
Known (white or other)	1.169 (1.141 - 1.198)	1.170 (1.142 - 1.199)	1.169 (1.140 - 1.197)
Symptom			
All other symptoms	1.00	1.00	1.0
Digestive symptom	0.627 (0.612 - 0.643)	0.632 (0.616 - 0.648)	0.631 (0.616 – 0.648)
Day of call			
Sunday	Not entered	1.00	1.0
Monday	Not entered	0.778 (0.745 - 0.812)	0.779 (0.746 - 0.813)
Tuesday	Not entered	0.779 (0.745 - 0.814)	0.778 (0.745 - 0.813)
Wednesday	Not entered	0.774 (0.740 - 0.809)	0.774 (0.740 - 0.809)
Thursday	Not entered	0.832 (0.796 - 0.870)	0.830 (0.794 - 0.867)
Friday	Not entered	0.740 (0.708 - 0.773)	0.740 (0.708 - 0.773)
Saturday	Not entered	0.844 (0.810 - 0.880)	0.844 (0.810 - 0.879)
Deprivation fifth (ordinal)	Not entered	Not entered	1.049 (1.041 - 1.058)

*** $p < 0.001$ unless otherwise indicated ** $p < 0.01$.

Models 10 and 10a have analysed the probability of receiving advice to seek face-to-face versus self-care for triage calls. The next two Models (11 and 11a) also look at triage calls but with the dependent variable of "Call 999" versus other advice.

7.4 Model 11 (a) triage calls; call 999 versus other advice

- Dependent variable: **disposition – Call 999 versus other advice**
- Dataset: **triage calls** only
- Method: **stepwise** (Forward Wald)
- Potential independent variables: deprivation (WIMD score), patient age, patient gender, relationship of patient to caller, distance to ED, population density, patient symptom.

There were 213 667 patients included in analysis. A test of the full model in Table 7.5 against the default model of constant likelihood was statistically significant showing that the set of independent variables help to predict whether a patient receives advice to call 999 (chi squared = 6722; df = 7; p<0.001). Though this model is stronger than both face-to-face triage models Nagelkerke's R^2 is only 0.097, still not strong.

In contrast to the analogous Model 10 for face-to-face dispositions, population density was statistically significant (p<0.001). Nevertheless, along with age, deprivation and distance to ED, this had Exp (β) close to 1, showing little effect on the likelihood of receiving the 999 disposition. However females, those calling for themselves, and those calling with digestive symptoms all had a decreased probability of receiving advice to call 999.

Table 7.5: Logistic regression of triage calls advising 999 call (Model 11)

				95% CI for Exp (β)	
Variable	**β**	**p value**	**Exp(β)**	**Lower**	**Upper**
Patient age (years)	0.026	<0.001	1.027	1.026	1.027
WIMD score (continuous)	0.011	<0.001	1.011	1.010	1.012
Distance to ED (km)	0.008	<0.001	1.008	1.005	1.010
Population density (people/hectares)	0.002	<0.001	1.002	1.001	1.003
Gender (female patients)	-0.139	<0.001	0.870	0.835	0.907
Relationship (self callers)	-0.850	<0.001	0.428	0.409	0.447
Symptom (digestive patients)	-1.149	<0.001	0.317	0.297	0.338
Constant	-3.635	<0.001	0.026		

As with Model 10, the author reran this model using the hierarchical method, entering deprivation as fifths rather than as a continuous variable and similarly incorporating day of week and also ethnicity as the two dummy variables.

7.5 Model 11a (c) triage calls; call 999 versus other advice

- Dependent variable: **disposition – call 999 versus other advice**
- Dataset: **triage calls** only
- Method: hierarchical
- Potential independent variables: Block 1 – patient age, patient gender, relationship of patient to caller, distance to ED, population density, symptom, ethnicity known, other ethnic background; Block 2 – Day of week: (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday or Sunday by default); Block 3 – WIMD deprivation fifth

There were 242 731 patients included in analysis. A test of the full model in Table 7.6 against the default model of constant likelihood was statistically significant, showing that the set of independent variables help to predict whether a patient receives advice to call 999 (chi squared= 7674; df=15; $p < 0.001$). Though this model is also stronger than both face-to-face triage models, Nagelkerke's R^2 is only 0.099, still not strong.

Again this method of regression includes all variables in the model whether or not they are statistically significant. Table 7.6 shows that, as in Model 11, the Exp(β) estimates for age, distance to ED and population density were close to one showing little effect of these variables on the likelihood of receiving advice to call 999. However, the combination of this method of regression and additional variables (viz days of week, ethnicity and deprivation fifth) has again increased the effect of moving from one deprivation fifth to the next fifth increasing the probability of receiving advice to call 999 by nearly 13% (OR 1.127; 95% CI from 1.113 to 1.143). In contrast to Model 10a, those calling on a Monday or Thursday had a significantly increased chance of being told to call 999. While those with known ethnicity had a higher chance of being advised to seek face-to-face care, there was no longer significant bias against non-whites. However, those calling for themselves had a much reduced probability of receiving the 999 disposition [Exp(β) = 0.420; 95% CI from 0.403 to 0.438; $p < 0.001$).

Table7.6: Logistic regression of triage calls advising 999 call rather than other care (Hierarchical model 11a)

Variable	Block 1 Exp(β) (95% CI)***	Block 2 Exp(β) (95% CI)***	Block 3 Exp(β) (95% CI)***
Distance to ED (per km)	1.006 (1.004 – 1.009)	1.006 (1.004 – 1.009)	1.006 (1.003 - 1.008)
Population density (people per hectare)	1.002 (1.001 – 1.004)	1.002 (1.001 - 1.004)	1.002 (1.001 - 1.003)**
Patient age (per year)	1.026 (1.026 – 1.027)	1.027 (1.026 - 1.027)	1.027 (1.026 - 1.027)
Gender			
Male	1.00	1.00	1.00
Female	0.873 (0.839 -0.908)	0.874 (0.840 - 0.909)	0.871 (0.837 - 0.906)
Relationship			
Surrogate caller	1.00	1.00	1.00
Self caller	0.418 (0.401-0.436)	0.414 (0.397 - 0.432)	0.420 (0.403 - 0.438)
Non-white race			
White or unknown	1.00	1.00	1.00
Non-white	1.123 (0.923 - 1.366)*	1.122 (0.922 - 1.364)*	1.13 (0.929 - 1.375)*
Known race			
Unknown	1.00	1.00	1.00
Known (white or other)	1.212 (1.166 - 1.260)	1.213 (1.166 - 1.260)	1.211 (1.165 - 1.259)
Symptom			
All other symptoms	1.00	1.00	1.00
Digestive symptom	0.307 (0.289 - 0.326)	0.305 (0.287 - 0.325)	0.305 (0.287 - 0.324)
Day of call			
Sunday	Not entered	1.00	1.00
Monday	Not entered	1.075 (1.004 - 1.150)**	1.076 (1.005 - 1.151)**
Tuesday	Not entered	1.058 (0.986 - 1.135)*	1.058 (0.986 - 1.135)*
Wednesday	Not entered	1.062 (0.991 - 1.138)*	1.063 (0.991- 1.139)*
Thursday	Not entered	1.136 (1.061 - 1.215)	1.126 (1.053 - 1.205)**
Friday	Not entered	1.054 (0.983 - 1.131)*	1.056 (0.984 - 1.133)*
Saturday	Not entered	0.903 (0.848 -0.962)**	0.902 (0.847 - 0.961)**
Deprivation fifth (ordinal)	Not entered	Not entered	1.127 (1.113 - 1.143)

*** $p<0.001$ unless otherwise indicated ** $p < 0.05$ * $p > 0.05$ (NS)

The next four models repeat Models 10, 10a, 11 and 11a with calls for information only.

7.6 Model 12 (a) information calls; face-to-face versus self-care

- Dependent variable: **disposition – face-to-face care versus self-care**
- Dataset: **information calls** only
- Method: **stepwise** (Forward Wald)
- Potential independent variables: deprivation (WIMD score), patient age, patient gender, relationship of patient to caller, distance to ED, population density (but not patient symptom for information calls)

There were 102 400 patients included in analysis. A test of the full model in Table 7.7 was statistically significant against the default model of constant likelihood, suggesting that the independent variables marginally help to predict whether a patient receives a disposition for face-to-face care (chi squared = 605; df = 5; $p < 0.001$). However Nagelkerke's R^2 of 0.011 indicates a very weak relationship between predictors and disposition.

Table 7.7 shows that, as in Model 10, most estimates of Exp(β) are close to one, showing that the variables have very little effect on the probability of receiving advice to seek face-to-face care. Deprivation again had a small but statistically significant effect [Exp(β) = 1.004; 95% CI: 1.003 to 1.005; $p < 0.001$) while those calling for themselves had a lower probability of receiving face-to-face care [Exp(β) = 0.679; 95% CI 0.648 to 0.712; p=0.004).

Table 7.7: Logistic regession of information calls advising face-to-face care rather than self-care (Model 12)

				95% CI for Exp (β)	
Variable	β	p value	Exp (β)	Lower	Upper
Patient age (years)	0.001	0.004	1.001	1.000	1.002
WIMD score (continuous)	0.004	<0.001	1.004	1.003	1.005
Distance to ED (per km)	-0.014	<0.001	0.986	0.984	0.988
Population density (people per hectare)	0.003	<0.001	1.003	1.002	1.004
Relationship (self caller)	-0.387	<0.001	0.679	0.648	0.712
Constant	-1.682	<0.001	0.186		

7.7 Model 12a (c) information calls; face-to-face versus self-care; hierarchical

- Dependent variable: **disposition – face-to-face care versus self-care**
- Dataset: **information calls only**
- Method: **hierarchical**
- Potential independent variables: Block 1: patient age, patient gender, relationship of patient to caller, distance to ED, population density, ethnicity known, ethnicity: other ethnic background; Block 2: Day of week (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday or Sunday by default); Block 3: WIMD deprivation fifth

There were 124 682 patients included in analysis. A test of the full model in Table 7.7 was statistically significant against the default model of constant likelihood (chi-squared = 1242;

df=12; p<0.001) suggesting that the independent variables help to predict whether a patient receives a disposition for face-to-face or self-care. However Nagelkerke's R^2 of 0.019 indicates a weak relationship between predictors and disposition.

Table 7.8 shows that the additional variables (day of week, ethnicity and deprivation fifth) have again enhanced the model. In particular moving from one deprivation fifth to the next has increased the probability of receiving advice to seek care face-to-face rather than self-care by 3.4% (OR 1.034; 95% CI from 1.022 to 1.047). Information calls on weekdays had a reduced probability of receiving advice to seek care face to face. Self-callers again had less chance of receiving face-to-face care [Exp(β) = 0.716; 95% CI 0.685 to 0.749; p < 0.001].

Table 7.8: Logistic regression of information calls advising face-to-face care rather than self-care (Model 12a)

	Block 1	Block 2	Block 3
Variable	**Exp (β) (95% CI)*** **	**Exp (β) (95% CI)*** **	**Exp (β) (95% CI)*** **
Distance to ED (per km)	0.986 (0.984 – 0.988)	0.988 (0.986 – 0.990)	0.988 (0.986 - 0.990)
Population density (people per hectare)	1.003 (1.002 – 1.005)	1.003 (1.002 – 1.004)	1.003 (1.002 – 1.004)
Patient age (per year)	1.001 (1.000 -1.002)**	1.001 (1.000 – 1.002)**	1.001 (0.973 - 1.049)**
Gender			
Male	1.00	1.00	1.00
Female	1.018 (0.980 – 1.057)*	1.011 (0.973 – 1.050)*	1.010 (0.973 – 1.049)*
Relationship			
Surrogate caller	1.00	1.00	1.00
Self caller	0.673 (0.644 – 0.704)	0.713 (0.682 – 0.746)	0.716 (0.685 - 0.749)
Non-white race			
White or unknown	1.00	1.00	1.00
Non-white	0.794 (0.655 – 0.963)**	0.811 (0.669 -0.983)**	0.815 (0.672 – 0.988)**
Known race			
Unknown	1.00	1.00	1.00
Known (white or other)	0.950 (0.917 – 0.983)**	0.955 (0.922 - 0.989)**	0.954 (0.921 – 0.988)**
Symptom			
All other symptoms	Not entered	Not entered	Not entered
Digestive symptom	Not entered	Not entered	Not entered
Day of call			
Sunday	Not entered	1.00	1.00
Monday	Not entered	0.598 (0.560 - 0.639)	0.599 (0.561 – 0.639)
Tuesday	Not entered	0.590 (0.551 - 0.630)	0.590 (0.552 – 0.631)
Wednesday	Not entered	0.625 (0.585 - 0.668)	0.625 (0.585 – 0.669)
Thursday	Not entered	0.669 (0.626 - 0.715)	0.670 (0.627 – 0.716)
Friday	Not entered	0.626 (0.585 - 0.670)	0.627 (0.585 – 0.670)
Saturday	Not entered	1.007 (0.941 - 1.078)*	1.007 (0.941 – 1.078)*
Deprivation fifth (ordinal)	Not entered	Not entered	1.034 (1.022 – 1.047)

*** p<0.001 unless otherwise indicated ** p < 0.05 * p>0.05 (NS)

7.8 Model 13 (a) information calls; call 999 versus other advice

- Dependent variable: **disposition – Call 999 versus other advice**
- Dataset: **information calls only**
- Method: **stepwise** (Forward Wald)
- Potential independent variables: deprivation (WIMD score), patient age, patient gender, relationship of patient to caller, distance to ED, population density

There were 102 400 patients included in analysis. A test of the full model in Table 7.9 against the default model of constant likelihood was statistically significant confirming, if only just, that the two independent variables help to predict whether a patient will receive advice to call 999 (chi squared = 25.8; df = 2; $p < 0.001$). Nagelkerke's R^2 of 0.014 indicates another very weak relationship between predictors and disposition.

Table 7.9 shows that only two variables were statistically significant – patient age and relationship to caller: those calling on behalf of themselves again have less chance of advice to call 999 while the probability of receiving this disposition increases slowly with age. However deprivation was not in the parsimonious model.

Table 7.9: Logistic regression of information calls advising 999 call (Model 13)

				95.0% C.I. for Exp (β)	
Variable	β	Sig.	Exp (β)	Lower	Upper
Relationship (self caller)	-0.947	<0.001	0.388	0.264	0.570
Patient age (per year)	0.014	<0.001	1.014	1.006	1.023
Constant	-6.611	<0.001	0.001		

7.9 Model 13a (c) information calls; call 999 versus any other advice; hierarchical

- Dependent variable: **disposition: call 999 versus any other advice**
- Dataset: **information calls only**
- Method: **hierarchical**
- Potential independent variables: Block 1 – patient age, patient gender, relationship of patient to caller, distance to ED, population density, ethnicity known, other ethnc

background; Block 2 – Day of week (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday or Sunday by default); Block 3 – WIMD deprivation fifth.

There were 124 682 patients included in analysis. A test of the full model against the default model of constant likelihood was statistically significant confirming, if only just, that the independent variables as a subset provide useful information regarding whether a patient receives advice to call 999 (chi squared = 33.5, df = 2, p<0.001). However Nagelkerke's R^2 of 0.015 indicates another very weak relationship between predictors and disposition.

Table 7.9 shows that only two variables were statistically significant – patient age and relationship to caller: those calling on behalf of themselves again have less chance of advice to call 999 while the probability of receiving this disposition increases slowly with age. Neither deprivation nor day of the week was in the parsimonious model.

Table 7.10: Logistic regression of information calls advising 999 call (Model 13a)

	Block 1	Block 2	Block 3
Variable	**Exp (β) (95% CI)***	**Exp (β) (95% CI)***	**Exp (β) (95% CI)***
Distance to ED (per km)	0.989 (0.970 - 1.009)*	0.991 (0.972 -1.010)*	0.991 (0.971 - 1.01)*
Population density (people per hectare)	1.003 (0.993 - 1.014)*	1.003 (0.992 - 1.014)*	1.003 (0.992 - 1.014)*
Patient age (per year)	1.013 (1.005 - 1.021)**	1.013 (1.005 - 1.021)**	1.013 (1.005 - 1.021)**
Gender			
Male	1.00	1.00	1.00
Female	1.036 (0.726 - 1.479)*	1.03 (0.721 - 1.470)*	1.029 (0.721 - 1.470)*
Relationship			
Surrogate caller	1.00	1.00	1.00
Self caller	0.431 (0.296 - 0.627)	0.458 (0.314 - 0.669)	0.460 (0.315 - 0.672)
Non-white race			
White or unknown	1.00	1.00	1.00
Non-white	0.888 (0.122 - 6.449)*	0.904 (0.124 - 6.566)*	0.906 (0.125 - 6.585)*
Known race			
Unknown	1.00	1.00	1.00
Known (white or other)	0.762 (0.542 - 1.070)*	0.766 (0.546 - 1.076)*	0.766 (0.545 - 1.076)*
Symptom			
All other symptoms	Not entered	Not entered	Not entered
Digestive symptom	Not entered	Not entered	Not entered
Day of call			
Sunday	Not entered	1.00	1.00
Monday	Not entered	0.734 (0.388 - 1.389)*	0.735 (0.388 - 1.390)*
Tuesday	Not entered	0.622 (0.316 - 1.224)*	0.623 (0.317 - 1.225)*
Wednesday	Not entered	0.912 (0.487 - 1.705)*	0.912 (0.488 - 1.706)*
Thursday	Not entered	0.591 (0.294 - 1.187)*	0.591 (0.294 - 1.188)*
Friday	Not entered	0.889 (0.470- 1.680)*	0.889 (0.470 -1.681)*
Saturday	Not entered	1.349 (0.724 - 2.513)*	1.349 (0.724 - 2.513)*
Deprivation fifth (ordinal)	Not entered	Not entered	1.024 (0.912- 1.149)*

*** p < 0.001 unless otherwise indicated ** p < 0.05 * p>0.0! (NS)

7.10 Model 14 (a) triage calls; face-to-face versus self-care including climatic variables

No previous model has included climatic variables essentially because weather and polution monitoring stations are sparse. However the author still wanted to test whether these variables had anything to contribute. Therefore she reran Model 10 for triage calls advising face-to-face care with the climatic variables. Results will hint whether climatic vaiables affect disposition.

- Dependent variable: **disposition: face-to-face care versus self-care**
- Dataset: **triage calls** only
- Method: **stepwise** (Forward Wald)
- Potential independent variables: deprivation (WIMD score), patient age, patient geıder, relationship of patient to caller, distance to ED, population density, patient sympton, snowy conditions, monthly mean daily minimum temperatures, monthly mean daily maximum temperatures, monthly mean daily minimum PM10, monthly mean daily maximum PM10, monthly mean daily minimum O3, monthly mean daily maximurr O3, monthly mean daily minimum NO2, monthly mean daily maximum NO2, monthly nean daily minimum SO2, monthly mean daily maximum SO2.

There were 121 997 cases included in analysis. A test of the full model in Table 7.11 was statistically significant against the default model of constant likelihood, suggesting tlat the independent variables help to predict disposition for face-to-face contact (chi squared =1350; df=14; p < 0.001),. However Nagelkerke's R^2 of 0.022 indicated a very weak relatiblnship between predictors and disposition.

Table 7.11 shows that, 14 of the 18 potential predictors entered the model: only maximum mean temperatures, population density, snowfall and mean monthly maximum PM10 temperatures were not statistically significant. However most variables had estimated Exp (β) values close to one showing little effect on the chance of receiving a face-to-face dispcsition. However those calling for digestive symptoms or for themselves again had less chace of receiving this disposition. All but one climatic variable entered the model: the most efective was the monthly mean minimum SO2 which reduced the probability of callers receiving a disposition for face-to-face care by 16%. Increasing deprivation very slightly increased the probability of receiving advice to seek face-to-face care.

7.11: Logistic regression of triage calls advising face-to-face care rather than self-care, climatic variables included (Model 14)

				95.0% C.I. for Exp (β)	
Variable	**B**	**p value**	**Exp (β)**	**Lower**	**Upper**
WIMD score (continuous)	0.004	<0.001	1.004	1.003	1.005
Distance to ED (km)	-0.006	0.002	0.994	0.991	0.998
Age (years)	0.013	<0.001	1.013	1.012	1.014
Symptom (digestive)	-0.177	<0.001	0.838	0.805	0.872
Gender (female)	0.083	<0.001	1.087	1.048	1.127
Relationship (self caller)	-0.069	0.002	0.933	0.894	0.974
Mean min temperature	-0.034	<0.001	0.967	0.961	0.973
PM10 average min	-0.018	<0.001	0.982	0.975	0.989
O3 average max	0.034	<0.001	1.035	1.030	1.040
O3 average min	-0.051	<0.001	0.950	0.942	0.959
SO2 average max	-0.007	0.017	0.993	0.987	0.999
SO2 average min	-0.175	<0.001	0.840	0.801	0.880
NO2 average max	-0.016	<0.001	0.985	0.980	0.989
NO2 average min	0.028	<0.001	1.028	1.013	1.044
Constant	1.813	<0.001	6.130		

7.11 Chapter Summary (a and c)

This chapter set out to model the relationship between deprivation and call outcome, controlling for other relevant variables. The author produced nine logistic regression models to understand the relationships between variables and the probability of receiving advice to call 999 or seek face-to-face care. Table 7.12 summarises the estimated odds ratios of all statistically significant variables included in stepwise models and Blocks 3 of hierarchical models; and shows variables which were not statistically significant in hierarchical models.

Increasing deprivation always increased the probability of receiving the more dynamic disposition, significantly in 7 of the 9 models. The exceptions were in information calls with the dependent variable of disposition for advice to call 999, in which WIMD score did not contribute significantly whatever statistical method the author used. Generally, using the hierarchical method of regression and deprivation as an ordinal variable yielded greater effects than using deprivation as a continuous variable.

For variables which consistently appeared in the models, there was little change in the direction or size of the standardised coefficients. For example, patients who called NHSD for themselves always had less chance of receiving the higher disposition – face-to-face care or calling 999. Those calling with digestive symptoms also had a decreased probability of receiving the higher disposition. The least consistent variable was day of the week, which estimated a lower probability of receiving advice to seek face-to-face care during the week and a higher probability of receiving advice to call 999 for triage calls on Monday, Thursday and Saturday. Also for triage calls, those with known ethnicity had more chance of receiving the higher disposition. Finally including climatic variables in the regression equation increased the probability of receiving the higher disposition.

This, the last analytical chapter, has explored the effect of deprivation on dispositions given by NHSDW. The next chapter is the discussion which brings together the findings of this study, puts them in the context of relevant literature and explores the implications for policy, practice and research.

Table 7.12: Summary of the included and excluded variables and Exp (β) scores for logistic regression Models 10-14

Model number and call type	**10 triage**	**10a triage**	**11 triage**	**11a triage**	**12 info**	**12a info**	**13 info**	**13a info**	**14 triage**
Dependent variable: disposition	face-to-face v self	face-to-face v self	999 v other	999 v other	face-to-face v self	face-to-face v self	999 v other	999 v other	face-to-face v self
Method of regression	stepwise	hierarchy	stepwise	hierarchy	stepwise	Hierarchy	stepwise	hierarchy	stepwise
Independent variables									
WIMD score (continuous variable)	1.006		1.011		1.004		*		1.004
distance to ED (per mile)	0.991	0.990	1.008	1.006	0.986	0.988	*	0.991*	0.994
population density (people per hectare)	*	1.001	1.002	1.002	1.003	1.003	*	1.003*	*
age (per year)	1.011	1.010	1.027	1.027	1.001	1.001	1.014	1.013	1.013
gender (female)	1.098	1.125	0.870	0.871	*	1.010 *	*	1.029 *	1.087
symptom (digestive)	0.715	0.631	0317	0.305					0.838
relationship (self caller)	0.888	0.864	0.428	0.420	0.679	0.716	0.388	0.460	0.933
ethnicity: non white background		0.818		1.13*		0.815		0.906*	
ethnicity known (white or other)		1.169		1.211		0.954		0.766*	
Monday		0.779		1.076		0.599		0.735*	
Tuesday		0.778		1.058*		0.590		0.623*	
Wednesday		0.774		1.063*		0.625		0.912*	
Thursday		0.830		1.126		0.670		0.591*	
Friday		0.740		1.056*		0.627		0.889*	
Saturday		0.844		0.902		1.007*		1.349*	
WIMD fifth (ordinal variable)		1.049		1.127		1.034		1.024*	
average of the monthly maximum temperature									*
average of the monthly minimum temperature									0.967
snow in cm									*
PM10 average of the monthly maximum reading									*
PM10 average of the monthly minimum reading									0.982
O3 average of the monthly maximum reading									1.035
O3 average of the monthly minimum reading									0.950
SO2 average of the monthly maximum reading									0.993
SO2 average of the monthly minimum reading									0.840
NO2 average of the monthly maximum reading									0.985
NO2 average of the monthly minimum reading									1.028

* Not statistically significant (therefore excluded from stepwise models)

Chapter 8: Discussion

8.1 Overview (a, b, c)

In this study, the author set out to answer the research question:

How does deprivation affect the demand for, and the outcome of, direct calls to NHSDW after controlling for other factors?

To address these questions, the author has successfully used multiple linear and logistic regression methods, controlling for a wide range of confounding variables. This chapter is divided into five sections. Firstly, the author presents a brief summary of study findings. The internal strengths and the limitations of the study are then summarised and critiqued. Thirdly, these strengths and weaknesses, and study findings and methodology, are compared with the existing literature in this area, notably studies appraised in Chapter 2. Fourthly, the author explores and interprets possible reasons why findings reported here agree or disagree with the existing body of evidence. This chapter concludes with the implications of study findings for research, policy and practice. The author has supplemented the original findings and discussion in this chapter with the new results from the research undertaken between original submission and oral examination (b) and between oral and resubmission (c).

8.2 Summary of main findings (a, b, c)

8.2.1 Measuring access: the feasibility of using NHSDW data (a)

To measure demand for NHSDW, the author adopted the theoretical framework of access in the NIHR SDO report "Identification and evaluation of standardised datasets for measuring and monitoring access to health care". This defined access as a continuum with four key elements: need, opportunity, utilisation and outcome (Section 1.7). Macfarlane and colleagues, the authors of the SDO report, developed a framework based on this definition to enable researchers to use routine datasets to evaluate access to healthcare for different groups. This framework lists characteristics of the population, factors which may be associated with inequalities in health; the level of aggregation theoretically possible when analysing the available data and the level of aggregation at which data are routinely available. The author successfully applied this framework critically to the NHSD routine dataset used in this study (Table 8.1).

Table 8.1: Framework for Access as applied to NHSDW routine data

		Aggregation		Place on access continuum			
Dimension of Access	**Indicators of Access**	**Individ-ual**	**Popul-ation**	**Need**	**Opport-unity**	**Use**	**Outcomes**
Characteristics of population			Wales – ward				
	Age	Yes	Yes	Yes		Yes	Yes
	Sex	Yes	Yes	Yes		Yes	Yes
	Ethnicity	Yes	Yes	Yes		Yes	Yes
	Education	No	No				
	Socio-economic	No	Yes				
	Care location	No	No				
	Residence	Yes*	Yes	Yes*		Yes*	Yes*
	Travel time	No	Distance = proxy				
	Morbidity	No	No				
	Mortality	No	No				
	Health beliefs	No	No				

*but to protect data confidentiality, not made available for this study

The author did not find this straightforward. Macfarlane and colleagues give little guidance reported and the author found it difficult to understand how to interpret the framework. Indeed another researcher may have a different understanding. Nonetheless, under 'Aggregation' NHSDW data was available at individual level for several patient characteristics and the majority of these could be aggregated to create ward level information.

Although Macfarlane and colleagues are to be commended for including several aspects of access in their definition, 'need' and 'opportunity' were both difficult concepts to measure using the routine dataset here. For NHSDW data the patient symptom could be used as an indicator of need and that is how the author has interpreted it. However, this framework only accounts for needs of patients and fails to account for needs in the wider community; for example it does not account for those who may have health issues but do not make contact. Put another way, inequalities in health suggest that need should be higher in more deprived areas but within this dataset there is no way of assessing this. Indeed 'need' may be higher in certain areas but patients may have gone elsewhere with their health issues. Similarly 'opportunity' has been left blank as there is no way of judging from the available data who had the opportunity to use the service and how this relates to access. The disposition given has been used as an outcome, and that was available for several characteristics.

8.2.2 Results of Objective 1 (a and c)

The goal of Objective 1 was to:

Identify factors associated with the demand and outcome of calls to NHSDW in order to build a model to explore the association between deprivation, demand and outcome of calls.

Characteristics of study population

Call rates to NHSDW over the whole study period varied across wards from 0.01 to 0.34 with a mean of 0.17. Over half the callers contacted the service about themselves. Demand was higher for triage advice (68.7%) over general information calls. While 38% of patients were given advice or information on how to treat their symptoms at home (self care), over 40% were advised to contact either a GP or dentist. The majority (62%) of patients were female while the mean age of patients was 33. When ages were grouped, most calls related to patients within the 1-4 years category (12.8%). There was only one year of data collection on ethnicity and the vast majority (97.9%) of patients had a 'white' background. Over a quarter of calls were about digestive problems (n=67 194, 27.2 %) while social (n=32) and endocrine (n=72) represented a minute proportion of patient symptoms. Sunday was the most popular day for calls (16%).

WIMD scores ranged from 1.13 (least deprived) to 74.87 (most deprived) with a mean of 22.2 (standard deviation 14.2). Distance to an Accident & Emergency department (ED) ranged from 0.2 km to 56.0 km, with a mean distance of 13.8 km (standard deviation 11.4 km). Population density ranged from 0.04 to 100 people/hectare, with a mean of 7.7 (standard deviation 13.2).

Average monthly temperatures ranged from -0.66 to 24.8 degrees Celsius. There was not much snowfall in Wales in the study period with half of the stations recording no snow. Generally measurements of pollutants were at low levels, with only PM10 scoring in the highest band according to the Department of Health's Air Quality Objectives.

When the author used bivariate techniques to explore the relationships between variables, the majority of results were statistically significant but differences are small.

Summary of the relationship between deprivation and other variables

There was no difference between mean deprivation scores for gender ($p=0.743$) or ethnicity ($p=0.063$), although there was a statistically significant negative relationship between age and deprivation suggesting that as age increased, deprivation score decreased ($r=-0.27$, $p<0.001$).

There was a four-point difference in the mean scores of WIMD across disposition with the highest mean of 26.4 associated with the disposition of 999 call and the lowest of 22.3 associated with self-care ($p < 0.001$). The mean WIMD scores were significantly higher for those calling for triage and for surrogate callers although the differences were small ($p<0.001$ in each case). There was a difference of almost six points in mean scores between the endocrine, metabolic and nutritional symptoms (27.6), and eye symptoms (21.8). However the number of calls in each of these categories was small. There were very small positive relationships between deprivation and call rates ($r=0.086$, $p<0.001$) and deprivation and population density ($r=0.146$, $p<0.001$), suggesting that as WIMD increased so did these variables. In contrast, there was a small negative relationship between WIMD and distance to hospital ($r=-0.097$, $p<0.001$). There was a negative correlation between deprivation and the proportions of weekday calls, suggesting that those who are more deprived are more likely to phone NHSDW at weekends.

The monthly average readings for air quality indicated a positive relationship between the maximum readings and WIMD, with the exception of PM10. There were also statistically significant relationships between deprivation and temperature readings and snow.

Summary of the relationship between call rates and other variables

There was a small statistically significant negative relationship between call rates and age ($r=-0.04$, $p<0.001$) suggesting that call rates fell as the age of the patient decreased; but call rates did not interact significantly with gender. Call rates increased slightly as distance to ED decreased, signifying that those who lived closer to an ED were more likely to phone. Call rates and population density also had a negative relationship, meaning that call rates were slightly higher in areas where population density was lower. At first sight these two results, both related to rurality, are inconsistent: the negative relationship between call rates and distance to ED suggesting that those who live in more rural areas are less likely to call is opposed by the negative relationship between call rates and population density in which, as population density decreases (e.g. the ward is more rural), call rates increase. In a heterogeneous country like Wales, however, there many crowded wards away from hospitals and sparsely populated wards close to hospitals.

Summary of the relationship between disposition and other variables

Male callers, those calling for triage advice and those calling on behalf of someone else (surrogate callers) received more urgent advice. In contrast, females, those calling for general information and those calling for themselves were all more likely to receive self-care as a disposition ($p<0.001$). There was a statistically significant relationship between disposition and age, with the highest mean age (42.4 years) in the disposition category of 999 call and the lowest (26.5 years) for ED (or other hospital department). There was no statistically significant relationship between disposition and ethnicity. There was a statistically significant relationship between disposition and day of week suggesting a higher proportion of advice to contact 999 at the weekend ($p < 0.001$)

As mean distance from ED increased, the urgency of dispositions decreased; for example, those told to go to ED had a mean distance of 8.5 km while those told to care for themselves had a mean distance of 10.7 km; 999 calls were an exception to this trend. Population density was generally higher for more urgent dispositions except 999 calls. For instance the mean population density for the ED disposition was 18.2 people/hectare while that for self-care was 15.7. Disposition also responded significantly to climatic variables, although the differences are small in practice.

8.2.3 Results of Objective 2 (b and c)

The goal of objective 2 was to:

Model the relationship between deprivation and demand, controlling for other variables which affect demand.

The author developed nine multiple regression models with call rates as dependent variables – for information and triage calls separately; and combined. Models started with stepwise regression, validated by hierarchical regression in which deprivation appeared last.

The highest adjusted R^2 values resulted from the hierarchical approach. For example, the known confounding variables ('Block 1') achieved the highest adjusted R^2 of 30.7% for advice calls, compared with 14.1% for information calls and 14.4% for combined calls (all significant at 0.1% level). Adding the proportions of calls on each day of the week ('Block 2') explained a further 2.2% of variability in advice call rates, 13.3% in information call rates and 1.0% in combined call rates. However adding deprivation ('Block 3') could not increase the adjusted R^2 by more than 0.1% in any of the three models. Thus the final models explained 33.0% of the variability in advice call rates, 27.5% of that in information call rates, but only 15.4% of that in combined call rates. However in all cases deprivation could not significantly improve the prediction of any call rate: the significance levels were 0.158 for advice calls, 0.244 for information calls and 0.331 for combined calls. This was also consistent across the other models constructed using stepwise regression: deprivation did not contribute significantly to predicting call rates.

It is worth highlighting other characteristics of the models to contextualise these findings. Generally the same variables appeared in all the models, although there was change in the direction and size of the standardised coefficients between models for triage and for general information, particularly with respect to the relationship of the caller to the patient and for day of the week. However the standardised coefficient for distance to ED was always negative: as distance to ED increased, call rates decreased.

The author used Model 1 for triage calls to explore residual variation around the fitted equation. For six wards (three with high residuals and three with low), the author investigated potential reasons why the observed value differed from the expected. For the sample of wards in which there were low residuals, all were isolated in some way but appeared close knit. The author hypothesised that members of these wards in effect provide their own versions of NHSD. In contrast, wards with high residuals were atypical, not close knit, and perhaps more in need of a service like NHSD.

8.2.4 Results of Objective 3 (a and c)

The goal of objective 3 was to:

Model the relationship between disposition and deprivation controlling for the other variables which affect dispositions.

The author developed nine logistic regression models to explore the effect of the independent variables on the probability of receiving face-to-face care rather than self-care; or 999 call rather than any other dispositions.

In the original submission all models were constructed using deprivation as a continuous variable. However, following the examiners' feedback the author supplemented these analyses with the same models incorporating deprivation as an ordinal variable in fifths. This changed the role of deprivation in these models. In all but one model increasing continuous deprivation had a positive effect on the probability of receiving advice to seek face-to-face or call 999, both for triage and for general information calls. Although this finding was almost always highly significant, differences in practice are quite small with odds ratios ranging from 1.003 to 1.011. The exception was for information calls advising respondents to call 999, in which WIMD score did not enter the model. When deprivation was included in fifths its effect on the probability of receiving higher dispositions was greater: after adjustment for covariates, an increase in deprivation from one fifth to the next fifth increased by 13% the probability of those people receiving advice to call 999 within calls for advice. Deprivation also increased the probability of those receiving advice to seek care face-to-face rather than self-care by 5% and within calls for information by 3%.

Generally the same variables appeared consistently across models with no change in the direction, and minimal change in size of the standardised coefficients. For example, callers who rang NHSDW for themselves had a decreased probability of receiving the higher level dispositions (face-to-face care or 999 call). Possible reasons for this are that they can better explain their symptoms. For those calling for digestive symptoms, there was also a decreased probability of receiving the higher dispositions. However odds ratios were often close to 1, showing little change in the probability of receiving the higher dispositions. The day of the week also affected the probability of receiving higher dispositions although this varied by day and across call type.

8.3 Strengths and limitations of the study (a and c)

8.3.1 Strengths (a and c)

This study has brought together elements of epidemiology, statistics, geography and qualitative methods to report the findings of a large scale project analysing two and a half years of calls to NHSDW across Wales. It includes 410 000 cases in analysis and presents a comprehensive picture of NHSDW demand and dispositions between January 2002 and June 2004. There are no issues with sample selection; we know what happened during this time from this dataset. The study has several additional strengths:

- <u>Analysing calls for triage and general information separately</u>

The author has shown throughout this thesis that calls for triage and calls for general information behave in different ways. This was evident from the simple bivariate analysis to the more complex regression models in which the size and the direction of the various confounding variables changed with the type of call – general information or triage. Similarly, the percentage of variance explained when total call rates was the dependent variable was a lot less than when triage and general information calls were analysed separately.

- <u>Disentangling relationships: the inclusion of up to 24 potential independent variables</u>

Health inequalities imply that need, and presumably demand, for healthcare services are higher in areas where health is poorer. Therefore to try to disentangle the effect that deprivation has on demand and dispositions from the effect that health has on deprivation, the author incorporated 24 potential confounding variables in the regression models. Although several of these variables were within the NHSDW routine dataset, many of these were from additional sources. Variables were selected both for their potential interaction with deprivation – for example the relationships between socioeconomic position and air quality have been well documented (O'Neill et al. 2003) – and for their interaction with demand for healthcare: for example, call rates to NHSD increase with hot weather (Leonardi et al. 2006).

Almost all variables needed cleaning, recoding or otherwise managing before their use in this study. The author did this transparently and justifying decisions in line with the current literature. For example, symptom and disposition data originating from NHSDW were recoded by the author according to recognised systems. This was especially important for symptom data as an indicator of morbidity and disposition as a key study outcome. As data lacked individual patient addresses and population distribution within a ward, distance to ED was calculated from the geographical centroid of each ward, the next best option. The shortage of weather and pollution monitoring stations in Wales and on the Welsh-English border led the author to use Theissen polygons to impute readings where no stations were present. These methodological decisions facilitated the inclusion of several additional variables with the potential to affect demand or dispositions, either through a relationship with deprivation or in their own right

Additionally, the feedback from the examiners during the viva and their suggestion of a variable for day of the week, greatly improved the adjusted R^2 values for models which sought to predict call rates and the estimated relationships between dependent and independent variables.

- Rigorous testing of study methods

From the first exploration of the relationship between call rates and WIMD score by scatter plot (Section 5.6.1) and Pearson correlation coefficient ($r = 0.086$, $p < 0.001$) results indicated that there was a very weak relationship between deprivation and call rates.

The author strove to elaborate this relationship by accounting for differences in healthcare-seeking behaviour across deprivation levels, mainly by exploring calls for triage and infomation separately. Responding to limitations in attributing temperature and air quality readings to wards in which there were no monitoring stations, the author ran the logistic regression models with and without climatic variables. She also ran sensitivity analyses excluding the population density outlier and using a different method of analysing missing data. The author also used two types of regression methods – stepwise and hierarchical – to seek findings with consistent results across both methods.

Throughout these detailed explorations findings have remained consistent: in this population, using the best available set of variables, there is no relationship between deprivation and demand; and a moderate positive relationship between deprivation and disposition.

- Strengths of study design

This study has taken an ecological approach to studying demand for and dispositions of NHSDW. An ecological analysis studies behaviour in natural settings allowing for a more realistic depiction of events and preventing inaccuracies which could occur from abnormal settings (McLaren 2005). Because ecological analyses, can be undertaken using existing datasets, often readily available (Lane 2004), are generally less expensive and time consuming than studies in which the individual remains the unit of analysis (Morgenstern 1982). Increasingly, owing to a range of factors including the link between social and health inequalities and of the effect of home location on health, authors in the public health literature are emphasising the need for an ecological perspective on research and intervention (McLaren and Hawe 2005). Ecological analysis, as used in this study, provides a good start towards a broad overview of the relationships between patient deprivation and demand for and the dispositions of contacts with NHSDW.

Routine data, as used here, generally provides large amounts of information to be analysed, often quickly and cost-effectively. These not only offer helpful pictures of sample or population but, when analysed and interpreted carefully, also provide a lot of statistical power (Bowling and Ebrahim 2005) – sometimes too much! However care must be taken to ensure that associations are not spurious (Schulz and Grimes 2002). Routine data sometimes identify patient outcomes that may be missed in designed data collection (Dale et al. 2003).

Although still relatively new, NHSD routine data are increasingly recognised as a reliable source of health data. They have been used to describe call activity and health trends in general (Payne and Jessop 2001; Munro et al. 2001). As well monitoring health trends (Leonardi et al. 2006), NHSD data are being used increasing for communicable disease and community surveillance. Routine NHSD data provided a timely and unique description of the evolution of influenza outbreaks (Cooper et al. 2008) and can provide advance warning of such outbreaks (Dixon-

Woods et al. 2006; Cooper et al. 2007). Several other papers support this view and suggest that tracking NHSD data can provide reassurance during times of perceived high risk through the identification of early stages of illness caused by the deliberate release of a biological or chemical agent (Baker et al. 2003; Cooper et al. 2004; Doroshenko et al. 2005; Dixon-Woods et a. 2006).

Deprivation indices are useful for measuring constructs for which there is no simple or direct measure (Carr-Hill and Chalmers-Dixon, 2005). Many of the advantages of using deprivation codes in a research study are similar to the advantages of using routine data previously mentioned: they are relatively easy to obtain and apply and allow for the analysis of large amounts of data. Deprivation codes are objective and do not rely on individual interpretation.

In addition to these strengths, the author has also made several decisions which improved the validity of findings:

- Limiting analysis to direct calls only

To reflect the true nature of calls to NHSDW, the author limited the analysis to call types for triage advice and general information only. Calls that were transferred from other immediate care service providers (for example GP OOH and ED) were excluded because most callers would not have expected their call being transferred to NHSDW. These calls are therefore do not reflect true demand for the service.

- Excluding calls with no WIMD

To protect patient confidentiality, the author was not permitted to link the call postcode to the WIMD. As a result, she received a final database with each call either assigned or missing the deprivation score of the ward in question. The number of calls available for analysis (n=476 072) led the author to remove the 12.5% of cases which did not have a WIMD score (n=59 523). However this small percentage of removed cases could represent a slightly different group of callers, for example genuine emergencies when it was not possible to collect all information or uncooperative callers who refused to give their address.

- Excluding Flintshire

The Unitary Authority (UA) of Flintshire contained 21 of the 25 wards with the lowest call rates and all wards in Flintshire had call rates below the national mean. The author conducted a preliminary exploration of the reasons for low call rates, finding that some wards had dialling codes which were automatically routed to NHSD in England. However this did not explain why all wards had call rates below the average. Although the author considered excluding wards with low call rates, the decision was made to remove the whole UA as it was difficult to draw an objective boundary around the biased area. Additionally there may be policies or beliefs which span the whole of Flintshire, not applicable to other UAs. Indeed, when the author removed Flintshire from the dataset, the fit of data towards a normal distribution was better, although still not perfect. Between the viva and resubmission the author also removed the Rossett ward in Wrexham, the other ward in which calls were directly routed to NHSD in England.

- Recoding the variables

To address the large number of categories within variables the author recoded several variables. Where possible she used existing coding systems; recodings are listed as appendices to provide transparency.

Symptoms

Currently there is no formal clinical coding system in place at NHSD and the author found it difficult to choose the best method for symptom coding. Although categorising calls by algorithm seems a useful method of grouping symptoms, the author did not receive these data from NHSDW. Furthermore the algorithm generates only a proxy for the actual reason for the encounter; for example, if the algorithm alights on 'flu', that does not necessarily mean that the patient has flu. Hence the author used NHDSW's own classification system as a first step and then applied the international ICPC-2 system to these codes as recommended by Munro and colleagues (2001) and used successfully in a similar study (Lordan 2009).

Dispositions

As the original dataset contained 244 unique dispositions, and several calls had up to 4 dispositions, it was essential to reduce these to a more manageable number. The author grouped dispositions according to the hierarchy of care used successfully in the evaluations of NHSD in

England (Munro et al. 2003) and Wales (Snooks et al. 2009). She then reduced each call to the highest disposition in this hierarchy. It ranks dispositions according to likely resource use, thus ordering them roughly in terms of financial impact on the NHS.

8.3.2 Limitations of the study (a and c)

Potential limitations of this study can be categorised broadly as measurement, data type and source, statistical techniques, bias and confounding.

Measurement

- Lack of indicator of morbidity severity

Although this study has used the ICPC-2 coding system to code symptoms, this classification does not account for severity of presenting complaint. It is not possible to tell from this system whether those calling from deprived areas had worse health and the role this may have played in demand and dispositions. In the bivariate analysis (Section 5.6.1) there was a 6-point range of mean WIMD scores with the highest mean for endocrine, metabolic and nutritional symptoms and the lowest for eye symptoms ($p<0.001$). In the logistic regression, there was also an association between symptom and disposition with those patients experiencing digestive complaints having a lower probability of being given more urgent dispositions. Without an accurate indicator of severity, however, it is difficult to understand the meaning of these relationships.

- Area based measures of deprivation – the ecological fallacy

Professor Peter Townsend recognised that "not all deprived people live in deprived wards, just as not everybody in a ward ranked as deprived are themselves deprived" (Townsend et al. 1988). This illustrates the major limitation of an ecological analysis – the ecological fallacy, that is flawed inferences about individual attributes from aggregate or ecological data (Selvin 1958) or "causal inference about individual phenomena on the basis of observations of the group" (Morgenstern 1982). Slogett and Joshi (1994) express caution about the ecological fallacy in the use of deprivation codes:

> "deprivation indices may be gainfully used to identify areas of relative concentration of disadvantage, the absence of data at the personal level, or where the fact of geographic concentration is pertinent...but disadvantaged people also live elsewhere and could be excluded in large numbers if interventions were planned purely on the basis of a local, census-based, deprivation scores"

The dataset analysed in this thesis lacks data on personal socioeconomic characteristics like home ownership. For example, one of the least deprived areas in the Unitary Authority of Swansea, is Gower, with a WIMD rank of 724 (a ranking of 865 represents the least deprived). Although this ward contains a high percentage of people who own their own homes, 4% of housing is rented from the local authority, a form of public or social housing for those who are deprived of employment or earning low wages. Thus not all patients from this affluent area possess the characteristics associated with living in Gower and care must therefore be exercised when interpreting results. All area-based variables are at risk of the ecological fallacy!

- Use of deprivation codes and the WIMD as an indicator of deprivation

All indices of multiple deprivation are also at risk of "reification' – substituting a definition for the meaning of which it is only an approximate measure (Carr-Hill and Chalmers-Dixon, 2005). The danger is that reification leads one to forget that what is being measured is not deprivation but a combination of chosen factors combined to represent deprivation. Indeed the WIMD is composed of six different domains of deprivation which have not been examined separately here.

The WIMD is based on electoral divisions or wards as a unit for analysis. One of the drawbacks of using wards for presenting small area statistics is that in Wales these vary in size (Carr-Hill and Chalmers 2005) from less than 1000 people to more than 20,000. Indeed some large electoral divisions have 'pockets' of deprivation larger than smaller electoral divisions. The problem is that varying sizes make comparisons difficult and may even inhibit the release of data for smaller electoral divisions to protect confidentiality.

Another disadvantage of using electoral divisions as a unit of geography for statistical analysis is that they are subject to boundary changes according to the needs of the electoral system. This can create problems when trying to compare datasets over time and this caused difficulties in this study. For example, the WIMD was constructed for 865 wards using the 1998 administrative boundaries. Since then there have been several boundary changes, and there are now 891 wards in Wales. It was difficult for the author to track down all the 1998 information, particularly population, shape for mapping and thus population density.

To overcome many of these limitations, the Office for National Statistics, when updating the WIMD to the WIMD 2005 created Super Output Areas (SOAs), the new smallest statistical geographical unit for which information can be accessed. The update aimed to make more transparent how WIMD scores were derived. The WIMD 2005 was to be much more applicable to specific policy areas and cover a more comprehensive range of deprivation. Crime and social order and the physical environment are now both included as domain indices, though they were not considered strong enough to include as domains in the WIMD 2000 (Welsh Assembly Government 2005). The WIMD 2005 has since been updated to the WIMD 2008. Despite these two changes during this work, the author decided to use the WIMD 2000 as the indicator of deprivation as it was valid at the time of data collection.

- Use of proxy measurements

This study included distance to ED as a confounding variable. As the physical proximity of each patient to ED is not known, distance from the geographical centroid of each ward to the nearest ED has been used to represent this variable. The author did not have the distribution of population within each ward, so could not identify a population weighted centre. Thus the centroid, the geographic centre of each ward polygon, was used as a proxy; although unlikely to coincide with the centre of the population, this was the best estimate for calculating distances between ward resident and the nearest ED.

In using this method, the author has again attributed area-level measures to an individual. Furthermore this method does not account for the type of journey, for example whether by motorway or mountainous route. Moreover the multitude of GP OOH services made it impossible to include the distance to these services.

Theissen polygons were used to assign observed temperature, snow and pollution data to wards in which there was no monitoring station. Thus the assigned values are only estimates of what the real data would have been in each ward. This is a recognised technique for estimating values where no local measurements are available. Though any analysis which relies on the interpolation of observed data is subject to uncertainty (Chiles and Delfiner 1999), interpolations undertaken using Theissen polygons are comparable with other known GIS packages (Siska and Hung 2005).

The limitations of this approach are that both pollution and weather values are known to change within short distances; yet values are assumed to be homogenous within the polygon shape and to change only at their borders! The method also does not account for the mountainous regions of Wales or for increased pollution in urban areas. However, without more weather or pollution monitoring stations in Wales, there is no other way of estimating data for wards without stations.

To use the vast number of data that came with these variables, the author calculated monthly averages. It is therefore possible that the true effects of these variables have been underestimated as extreme values will be tempered by using averages.

- Measurements of access

In this study, demand and outcome are indicated by a patient's contact with NHSDW. Chapter 1 recognised that there are many ways to measure access, with some arguing that "utilisation is a generally unhelpful measure of equity of access and that utilisation or receipt of healthcare is not a simple process and all contributing factors need to be fully recognised if access is to be properly understood". (Dixon Woods et al. 2006). In an attempt to overcome this, the author attempted to apply Macfarlane's (2005) definition of access encompassing need, opportunity, utilisation and outcomes. In particular, the demand for NHSDW considered in this study – "willingness or ability to seek, use and, in some settings, pay for services" is *'expressed demand'* (Last 2001). In other words, the 'demand' considered here is the actual number of people who established contact with NHSDW. However, what is not known from this dataset is the *'potential demand'* for NHSDW, including those who did not have the number or tried to phone the service but gave up when their call was not answered quickly.

Data type and source

- Limitations of routine data

This study relied on routine data – data normally collected by a service. However such data can have specific limitations when used in health services research. For example, data are usually collected for another purpose, such as management reporting; there are often difficulties in identifying, accessing and extracting routine data; and problems arise from lack of uniformity in coding systems and structure (Dale et al. 2003). In addition routine data are often input manually and thus subject to human error. This can result in inaccuracies in the data, neglect of coding systems and missing data, as in this study. Furthermore routine data does not yield immediate understanding how or why results have occurred. For example, reasons behind the low call rates in Flintshire became apparent only with further exploration.

Moreover, as Macfarlane and colleagues note (2005), routine datasets may not contain detailed information on the socioeconomic characteristics of those accessing healthcare services, making them difficult to use in measuring differences in access across population groups. When these variables are present there may be restrictions on access to protect patient confidentiality, as in this study with postcode data. Although this was not insurmountable here, it may not be so easy for other researchers to overcome these issues.

- Limitations of routine data from NHSD

It is important to remember that call reporting systems used in NHSD are designed for performance management purposes rather than as epidemiological tools (Cooper et al. 2004). Studies using NHSD data have expressed concerns over the accuracy and completeness of call data (Munro et al. 2001; Payne and Jessop 2001). These concerns have been justified in this study as the data required a great deal of cleaning and recoding to prepare them for analysis (Section 4.7.1).

One of the major limitations of the NHSD dataset used in this study is the inability to follow patients over time; thus repeat callers cannot be identified. Some wards had very small numbers of callers; for example there were only 49 callers in Tudweiliog in Gwynedd over the study period. These could be 49 individual callers or represent several calls from fewer callers. Thus the true number of service users is unknown.

One of the difficulties in analysing dispositions using routine data from NHSD is the focus on a single outcome. Many aspects of the call, for example the time or the conversation, especially if the patient was alone or distressed could have influenced the final disposition. Although the most urgent disposition is noted, any other advice given within the phone call is lost unless recorded specifically. For analysis the author used the hierarchy of care created by Munro and colleagues for the evaluation of NHSD (Section 4.8). This did not alter the aggregated dispositions: both before and after categorising, advice to care for oneself was given in the highest percentage of calls, followed by advice to contact a GP (Section 5.5.1).

- Statistical techniques (a and c)

Stepwise regression is a limited procedure. As the order of entry of variables into the model is based solely on statistical criteria and not on the meaning of the variables, small differences in the sample can have a large effect on the apparent importance of an independent variable (Tabachinck and Fiddell 1997). Indeed this is the major limitation of stepwise regression: variables are chosen according to statistical criteria alone. To address this the author used the hierarchical method. Results slightly improved in all hierarchical analyses; as this method was associated with the additional variables for day of the week, however, it is likely that these variables improved the models more than the method of statistical analysis. Similarly, using deprivation in fifths estimated the probability of receiving more urgent dispositions better than as a continuous variable.

As highlighted by one of the examiners to this thesis, consideration must be given to the manner in which SPSS implements a hierarchal analysis - which is only a limited version of a true hierarchical analysis. For example, with stepwise procedures, only the statistically significant variables from each step will be carried through to subsequent steps (for example significant variables from step 1 will be carried to step 2). Yet with using the 'Enter' method (as hierarchical is called in SPSS) at each step, the final model will be identical to an analysis undertaken using the same method with no steps. In a 'true' hierarchical analysis, the coefficients from step 1 would remain the same in further steps. In this way, we would be able to get a more accurate indication of the effects of the WIMD after all other covariates had been considered. However, with SPSS, and as reported here, the WIMD score is seen to influence all of the other coefficients even when entered at step 3. In this way, the author has reported the effects of deprivation in parallel with the other variables, not the effects of deprivation after the other variables have been considered. This does not mean that results reported here are not valuable as they serve to quantify the additional explanatory values both of day of the week and of WIMD but that it should be remembered that this is a weakness of SPSS in that it does not implement a true hierarchical analysis.

Other concerns with regression include multicollinearity – high correlations between variables which make it difficult to draw inferences about the relative contribution of each variable to the model. The author checked this assumption several times both in the bivariate exploration and in the multiple regression tolerance levels output. Most variables were sufficiently independent to be included in the model. Outliers can also influence results of multiple regression and the author ran sensitivity analyses to check on this.

As missing values were unlikely to be at random, imputation was not a reliable method of handling missing data in this study. Hence the author excluded cases listwise in SPSS, thus using 'complete case analysis'. Although this method may be biased (Briggs et al 2002), for example more emergency calls may lack data, the author judged this the safest way to handle calls. As SPSS can also exclude pairwise, the author reran Model 1 in this way as a sensitivity analysis with no changes in results.

With all types of multiple regression, one must avoid applying the model outside the range of values of the independent variables in the original dataset. Moreover successful prediction does not imply causation; because distance to ED was the best predictor of call rates, that does not mean this is the reason why patients contact NHSDW.

Confounding and bias

- Confounding

Confounding variables are those whose relationship with both dependent and independent variables obscure true associations or create spurious associations (Darlington 1990; Hosmer 2000). Studies must therefore take into account other factors which may be related to the dependent variables (Lecky and Driscoll 1998).

The author attempted to tease out the independent effect of deprivation on call rates and dispositions by including as many additional variables as possible. Multivariate statistical techniques as used here enhance the internal validity of a study by adjusting the analysis for the possibility of confounding variables. However the effects of confounders do not decrease or increase with sample size (Clancy 2011). Despite these best efforts, a significant proportion of the variance in call rates remained unexplained by the model, suggesting the influence of hidden variables. It is possible that unmeasured variables associated with deprivation, such as nutrition and alcohol and drug use (Walsh et al. 2010; George 2010), may have been influential.

- <u>Bias</u>

Although large datasets provide greater confidence in the results, this will be irrelevant if results are caused by spurious statistical associations – associations which occur as a result of bias, selection or chance (Grimes and Schulz 2002). Bias typically occurs as a result of study design and should be considered and addressed before data collection commences. The main source of bias in this study is information bias, which stems from shortcomings in data collection and recording (Lecky and Driscoll 1998). Examples of information bias include the exclusion of calls with no WIMD score: parameters may be underestimated if calls missing a WIMD score were from more deprived areas. The reliance on an average score for temperature and air quality readings may also result in underestimation of the effects of these variables. To address bias the author has incorporated as many additional variables into the analysis as feasible. Comparing findings with other literature can also help to shed light on casual associations.

8.4 Comparison with current literature (a and b)

Chapter 2 reviewed 19 studies comparing access to, and outcomes of, telephone-based healthcare by socioeconomic status. In this section, the author discusses the methods and findings of this study in relation to the existing evidence, highlighting any similarities or differences observed. Between the original submission and the viva, the author found another four studies which met the inclusion criteria. These have now been worked into the discussion below.

8.4.1 Study design (a and b)

Like this study, 16 studies relied on routine data to measure access to healthcare. The remaining studies primarily relied on questionnaires or interviews as data sources (O'Reilly et al. 2001; Ring and Jones 2004; Knowles et al. 2006; Shah and Cook 2008; Sood et al. 2008; O'Hara et al. 2011, Turner et al. 2012), however due to the sheer number of cases in this study (n=409 639) these methods of data collection at an individual level were not feasible. Of the studies reviewed using routine data, the longest study of calls to NHSD was one year (EPHRO 2004) and the most areas accounted for in any one study was two (West Yorkshire and West Midlands, Cooper et al. 2005). In contrast, a major strength of this study is its scope – exploring use and outcomes of NHSDW at a national level over two and a half years. It is still the largest study of NHSD use.

All other studies looked solely at combined call rates: there was no differentiation between calls for triage and calls for general information. Similarly all studies which looked at deprivation in the literature divided results into fifths. This is beneficial in simplifying results for reporting but it can lead to losses of large amounts of data (Fedorov et al. 2009) and of statistical power (Royston et al. 2006). Here the author has used deprivation scores both as a continuum and divided into fifths, yielding slightly different results. Thus the author has presented a fuller picture of the relationships between deprivation and demand and deprivation and outcome.

Of all 23 papers reviewed only one used qualitative research methods to explore findings. Although this study is primarily epidemiological, the author has used qualitative methods to help illuminate anomalies in the data, first to understand potential reasons behind the low call rates in Flintshire and second to explore six wards whose triage call rates were poorly explained by multiple regression. Although this was not a full piece of qualitative research, using these techniques has helped to illuminate findings which would otherwise have remained unexplained.

- Use of confounding variables

The most confounders used in any one study were ten although these were collected by questionnaire (Shah and Cook 2008). Using routine data the most confounders was six (gender, urban-rural classification, straight line distance and travel time to PCC, time of call, day of call) used in a study of outcomes by Munro and colleagues (2003).

The study reported here used as many as possible of the variables reviewed in the literature and added other variables which the literature failed to mention but which could also affect call rates and outcomes regardless of deprivation status. These variables included day of the week, the relationship of caller to patient, symptoms and climatic variables including snowfall, minimum and maximum average monthly temperatures, and minimum and maximum average monthly readings for four well known pollutants that affect on health – PM10, O3, NO2 and SO2. This brought the potential number of independent variables in the models to 24.

8.4.2 Demand for telephone based healthcare (a and b)

- Comparison of findings by socioeconomic characteristic

Evidence using individual markers of socioeconomic status suggests NHSD is used by those with higher socioeconomic status (Ring and Jones 2004; Knowles et al. 2006; Shah and Cook 2008) while use of the new 111 number was used more by those with lower socioeconomic status (Turner et al. 2012). This type of data was collected by questionnaires and therefore comparison with these results using the routine data in this study is not possible.

Area-based measures of socioeconomic status generated conflicting findings in the literature, particularly between use of GP OOH services and NHSD. Use of GP OOH services was higher among patients with lower socioeconomic status or living in areas of deprivation (Salisbury et al. 2000; O'Reilly et al. 2001; Turnbull et al. 2008; 2010). In contrast use of NHSD increased with deprivation but tailed off in the most deprived fifth (Burt et al. 2003; Cooper et al. 2005). This was however contradicted in one report where deprivation continued to rise (EPHRO 2004). The addition of the four new studies found after the original submission also show a mixed relationship between deprivation and demand, particularly when age and gender were brought in (Bibi et al 2005; Cook et al. 2012; Hsu et al. 2013).

Findings here suggest that deprivation does not play a role in demand for NHSD, either in triage calls or information calls, because other confounding variables such as the relationship of the caller to the patient, day of the week and distance to ED explained much variation in demand. This study has also shown that calls for triage and calls for general information behave in different ways, thus suggesting that demand for telephone-based healthcare, and NHSD in particular, is complex and depends on many different variables. Most important the role of deprivation in predicting demand for telephone-based healthcare may not be as strong as previously believed.

- Comparison of findings using other variables

Studies generally found that call rates were higher for females (Cooper et al. 2005) and for younger children (EPHRO 2004; Cooper et al. 2005; Shah and Cook 2008). This study found similar results in patient-level analyses. However the relationship between call rates and sex in particular was much weaker in ward-level analyses, because the process of aggregating data into wards which have similar proportions of males and females inevitably attenuates the true effect of sex on call rate. As the study data set is very large, however, it is still possible for sex to yield significant findings in ward-level analyses since sex ratios differ slightly between wards. In these circumstances it is important to distinguish between individual sex effects, which characterise the difference between a typical male and a typical female, and ward-level sex effects, which characterise the difference between wards with an excess of males and wards with an excess of females. Thus there is scope to analyse the relationship between call-rates and sex in three complementary ways – individual, aggregated by ward and aggregated by ward but standardised by sex. Such an analysis could try to assess the relative contributions to call rates of sex, age, rurality, climate and deprivation.

Unlike the existing literature which showed mixed results for the effect of health status on demand, this study did not look at measures of health. However it confirmed that call rates generally decreased with increasing distance (O'Reilly et al. 2001; Turnbull et al. 2008; 2010).

Finally the literature suggests that call rates are higher in urban areas (Turnbull et al. 2008); this was echoed here by a positive relationship between call rates and population density. However no other study in the literature review adjusted relationships between deprivation and demand by symptoms, day of the week, relationship between caller and patient or climate.

8.4.3 Outcomes of telephone-based healthcare (a and c)

- Lack of studies looking at outcomes from NHSD

One of the evidence gaps summarised in the literature review was the lack of information on variations in NHSD outcomes by patients' socioeconomic characteristics. Indeed the author could not find any studies that looked at variation by patient characteristics let alone climatic variables. Chapter 1 discussed evidence suggesting that dispositions varied by nurse and system characteristics (Monaghan et al. 2003; O'Cathain et al. 2003). To the author's knowledge this is the first study which reports on the likelihood of receiving a particular disposition according to patient and climatic variables.

- Comparison of findings

The bivariate analysis suggests that patients with higher deprivation scores receive more urgent dispositions (Section 5.4.1). This was echoed in the logistic regression: in all but one model, increasing deprivation increased the probability of receiving more urgent dispositions – seek face-to-face care or call 999 (Section 7.13). However, although these were statistically significant findings, the effect of deprivation is minimal when used as a continuous variable. When the author used deprivation in fifths, the effect on the probability of receiving higher dispositions increased.

These findings are generally consistent with the literature which suggests that those from more deprived backgrounds receive more urgent triage outcomes, both from other emergency healthcare services (Pollock and Vickers 1998; O'Donnell et al. 1999; Beattie et al. 2001) and from telephone-based healthcare (O'Reilly et al. 2001; O'Sullivan et al. 2004). In particular, findings here are very similar to those by O'Reilly and colleagues, who reported that the probability of seeing a GP is only slightly increased by deprivation with an odds ratio of 1.01 (95% C.I. 1.01-1.02). However two studies suggested that the likelihood of seeing a GP fell with increasing deprivation (Munro et al. 2003; Turnbull et al. 2011).

In this study, callers phoning about themselves and those calling with digestive symptoms had a decreased probability of receiving the most urgent dispositions. None of the reviewed studies incorporated these variables, nor day of the week. Hence the reported role of deprivation in health outcomes may depend on the rigorous identification of confounding variables.

8.5 Interpretation of study findings (a and c)

Occam's Razor, a scientific and philosophic rule, requires that "the simplest of competing theories be preferred to the more complex or that explanations of unknown phenomena be sought first in terms of known quantities" (Merriam-Webster dictionary). Unfortunately the evidence presented here is consistent with increasing need for healthcare with deprivation being obscured by decreasing demand for healthcare with deprivation. Fortunately Occam supports the simpler explanation that the role of deprivation is less important than previously believed.

Nevertheless findings here do suggest complex relationships between deprivation and call rates; and deprivation and the other independent variables. The bivariate analysis showed a highly statistically significant but very small correlation between call rates and deprivation; and in Model 2 alone deprivation does help to explain call rates with high statistical significance. However the size of the standardised coefficients, and the changeable direction and lack of statistical significance in all other models, show it is not a strong predictor of variation in call rates, either for triage or for general information. Indeed the contribution of each variable to explaining variation in call rates depends on the subset of variables included in the model. This is illustrated by differences in standardised coefficients between models with or without specific variables. Thus the use of more confounding variables may be one reason why the role of deprivation in explaining call rates reported is less strong here than the literature suggests. Yet Occam's Razor prefers the simplest explanation: deprivation has little to contribute to this field.

At first glance, the relationship between deprivation and dispositions also appears straightforward: using deprivation as a continuous variable showed a small increase on the probability of receiving the more urgent dispositions. For example, for triage calls, the odds ratio for receiving advice to seek care face to face was 1.006 (95% CI 1.005 to 1.006, $p < 0.001$). Although this is a very statistically significant result in practice 1.006 is very close to 1. However one must remember that this figure does not take into account the potential range of WIMD values. For example, if there was a 70 point difference in WIMD scores, then the odds ratio will be (70β) which is approximately 1.5. This is also illustrated when the author grouped deprivation in fifths instead of using the actual WIMD value. Using deprivation fifths increased the probability of receiving more urgent dispositions as it accounts for the wide range of deprivation scores. Therefore, as finding the best functional form for continuous deprivation needs a range of datasets, deprivation fifths provides a useful interim solution.

With the addition of climatic variables to the model, there was little change in the increased probability of receiving the more urgent dispositions. Similarly, for general information calls, deprivation did not enter the model of 999 dispositions. In these models, the strongest predictors of dispositions were symptoms and the relationship of caller to patient. The increased likelihood of those calling for themselves receiving less urgent dispositions may be due to their better ability to explain their symptoms. Even so, an important conclusion is that valid indicators of symptom severity are essential if we are to understand disposition better.

8.6 Implications of the study (a and c)

The outcomes of this study are far reaching and can be divided into implications for policy and practice, and implications for research.

8.6.1 Implications for policy and practice (a, b, c)

Results of this study suggest that NHSDW is one of the least discriminatory healthcare services, and that the role of deprivation particularly on demand has been overestimated in previous studies. Deprivation was not found to be a significant variable in explaining the variance in call rates to NHSDW while distance to ED and population density were. Hence, if one of the goals of the NHS is to balance access across the population, efforts should focus on improving access for those in rural areas, rather than material deprivation.

Despite this, the trend for those with lower deprivation scores to have an increased likelihood of receiving the more urgent dispositions has important consequences for policy and practice. Although these differences are generally small, and never more than moderate, results were highly significant suggesting that deprivation does affect the probability of receiving a particular outcome. Whether these outcomes reflect health inequalities or weakness in the early stages of healthcare-seeking behavior is not known. NHSDW itself needs to explore this issue. In particular, is this trend the result of poorer communication between nurse advisor and caller? Are callers from more affluent areas more likely to be able to express their concerns more clearly, thus avoiding the need for face-to-face care?

Although bivariate analysis showed that calls for general information were lower among the more deprived groups, deprivation could not predict call rates for either triage or information. This is inconsistent with the inverse prevention law which states that preventative interventions are more likely to be successful in the more affluent (Department of Health 1998). The implications of this for long-term health are unknowable. However this finding is consistent with recent policy to encourage patients to play a more active role in their health (Welsh Assembly Government 2005) changing their behaviour.

This study has revealed many weaknesses in NHSDW data, in particular the lack of a useful clinical coding system. However our data are several years old and it is possible that many of the problems encountered have been resolved. However, to the author's best knowledge, NHSD still does not have a useful clinical coding system. Such a system is needed, not only for operational purposes, but also to compare health-related data both within NHSDW and with other healthcare providers.

Weather and air quality showed significant associations with deprivation and call rates and were significant contributors to explaining the variation in outcomes. Indeed, even using crude methods such as Thiessen polygons and monthly averages, these variables often contributed more strongly to the model than traditional predictors of demand like deprivation and distance to services (Chapter 7). Since using data from only 29 weather and seven permanent air quality monitoring stations (which often experience problems in data collection) yielded good relationships, it is possible that the true effect of these variables is much greater.

The implications for policy and practice are twofold. If policymakers seriously want to estimate and ameliorate the effects of climate on health, demand for healthcare and a wide range of social issues, we need more weather and monitoring stations across Wales. For the stations that do exist, especially pollution monitoring stations, several gaps in the data existed; for example Wrexham was missing all minimum and maximum PM10 recordings. This suggests that more robust systems are needed to collect data. As both temperature and air quality can vary markedly in short distances, though the methods used here are accepted techniques for extrapolating values (Burroughs 1998), they will never be as accurate as true readings. Secondly, knowing that how demand depends on temperature and air quality can help NHS and NHSD plan staffing and resources to meet demand.

8.6.2 Implications for research (a and c)

Many of the implications for policy and practice discussed above will need further research and evaluation. This study has raised several other issues which can benefit from further exploration:

- Cost implications of these results

There was a trend for those in the most deprived fifths to be given more urgent dispositions. Additionally there was a six-point difference in mean WIMD scores between those with endocrine, metabolic or nutritional symptoms (27.6) and those with eye symptoms (21.8). There is a need to characterise and quantify these types of results in terms of financial effects on the NHS and individual patients. One way of doing so is to use Diagnosis Related Groups (DRGs) [http://health.utah.gov/opha/IBIShelp/codes/DRGCode.htm – last accessed 20.05.12] to code symptoms. These groups, developed for the Health Care Financing Administration, provide a means of relating the case mix, that is type of patients, treated by a hospital to the costs incurred by that hospital. The basic concept is that, although all patients are unique, groups of patients have similar attributes which determine their resource needs and hospital costs. The NHSDW evaluation project quantified dispositions via the Personal Health Services Research Unit (Snooks et al. 2006) and this is another possible option.

- Review of wards which don't fit the model

The author has hypothesised that some wards have low residuals because they are close knit communities which may provide their own version of NHSDW. She has undertaken a brief exploration of some wards with high residuals. However, to understand what is happening in these areas needs a more detailed exploration using qualitative research methods.

- Age and sex standardised call rates

Although preliminary analysis showed that *calls* to NHSDW varied by both patient gender and age, these variables were not strong predictors of call rates. This is a natural consequence of the ecological fallacy. Hence future analyses should characterise the relationship between call-rates and sex in three complementary ways – individual, aggregated by ward and aggregated by ward but standardised by age and sex. Such analyses should seek to assess the relative contributions to call rates of sex, age, rurality, climate and deprivation.

- Meta analysis of literature review

The narrative synthesis within the systematic literature review has laid the foundation for meta-analysis – the next logical step in analysis. The author has summarised the key characteristics and outcomes across included studies, thus simplifying decisions about which studies to include in such an analysis. In total there were some 3 million patients from 23 studies, more than sufficient for meta-analysis.

- Need for further research using different methods

For logistic regression, the author combined dispositions: call 999 versus all other dispositions; and face-to-face care versus self care. So, although the bivariate analysis showed that the urgency of the disposition increased with deprivation, these logistic regressions may not reflect this subtle trend. Instead we recommend that future researchers model the full range of dispositions with similar subsets of independent variables but more sophisticated techniques like ordinal logistic regression.

Nevertheless findings reported here provide a good starting point for exploring patterns of NHSDW use. Indeed one could address many of the limitations discussed through two follow-on studies: a qualitative exploration including analysis of call transcripts and interviews or focus groups with patients and nurse advisors; and further analysis of routine data using the SAIL (Secure Anonymised Information Linkage) databank (Lyons et al, 2009).

The preliminary use of qualitative methods in this study has illustrated the scope for using these methods to supplement quantitative findings. Further exploration with callers and nurse advisors and analysis of call transcripts could explore the reasons for contact with NHSDW, identify possible explanations for variations in outcomes across groups, and give insight into the relationship and negotiation between nurse advisors and patients. Indeed the author originally intended to complement this ecological analysis with qualitative research. However time constraints and the amount of data to be analysed led to the decision to focus solely on quantitative analysis and recommend qualitative work to explore the results.

Two of the major limitations of the present dataset – inability to trace a caller through the dataset and thus identify unique callers to the service, and lack of individual patient information including socioeconomic circumstances and proximity to other healthcare services – could be overcome using the SAIL databank (Lyons et al. 2009). Although this study defines patient proximity to ED departments using the centroid of each ward, SAIL combines several datasets and undertakes anonymous data linkage of individuals across different services. Patients who contact any service during the time period studied would be traceable throughout the dataset, yielding a more accurate picture of service use. The author therefore recommends anonymous data linkage study using SAIL as an important early step.

- <u>Implications of NHSDW as a data source for measuring access to healthcare</u>

The framework for measuring access that underpinned this study was not developed as a monolithic tool but rather as a 'guide to thinking critically about the potential for routine data to measure and monitor access to healthcare' (Macfarlane et al. 2005). They recommend that, to improve monitoring and use of healthcare, data about individual socioeconomic status and area of residence should be included in routine datasets. We know that NHSDW does include information on household addresses, but this was not made available to the author to protect patient confidentiality. Linking postcode data to deprivation codes automatically within the dataset may address this and avoid the loss of one call in eight which did not have an attached WIMD score. This could also improve the reliability of data by limiting human error, while saving research time and costs.

NHSD does not currently collect information on individual socioeconomic characteristics. As many users complain about the large amount of information requested, often several times as the call is passed from call handler to nurse advisor (Porter et al. 2008), it is important to balance the collection of more data with time constraints. However the inclusion of individual data would avoid the ecological fallacy - the attribution of area traits to individuals living there (Selvin 1958).

The author judges that the Macfarlane framework would improve with dimensions on the quality and completeness of data. Without complete data it is not possible rigorously to monitor equity in accessing healthcare services. Despite several coding errors the NHSDW data were generally complete and would score acceptably on this dimension.

NHSDW already provides data which are national, fairly comprehensive and continuous. Thus it is already useful for monitoring access to healthcare. With the addition of individual socioeconomic characteristics, it has potential for greater use. Even with the addition of outside variables as in this study, it can generate good evidence about demand and outcomes.

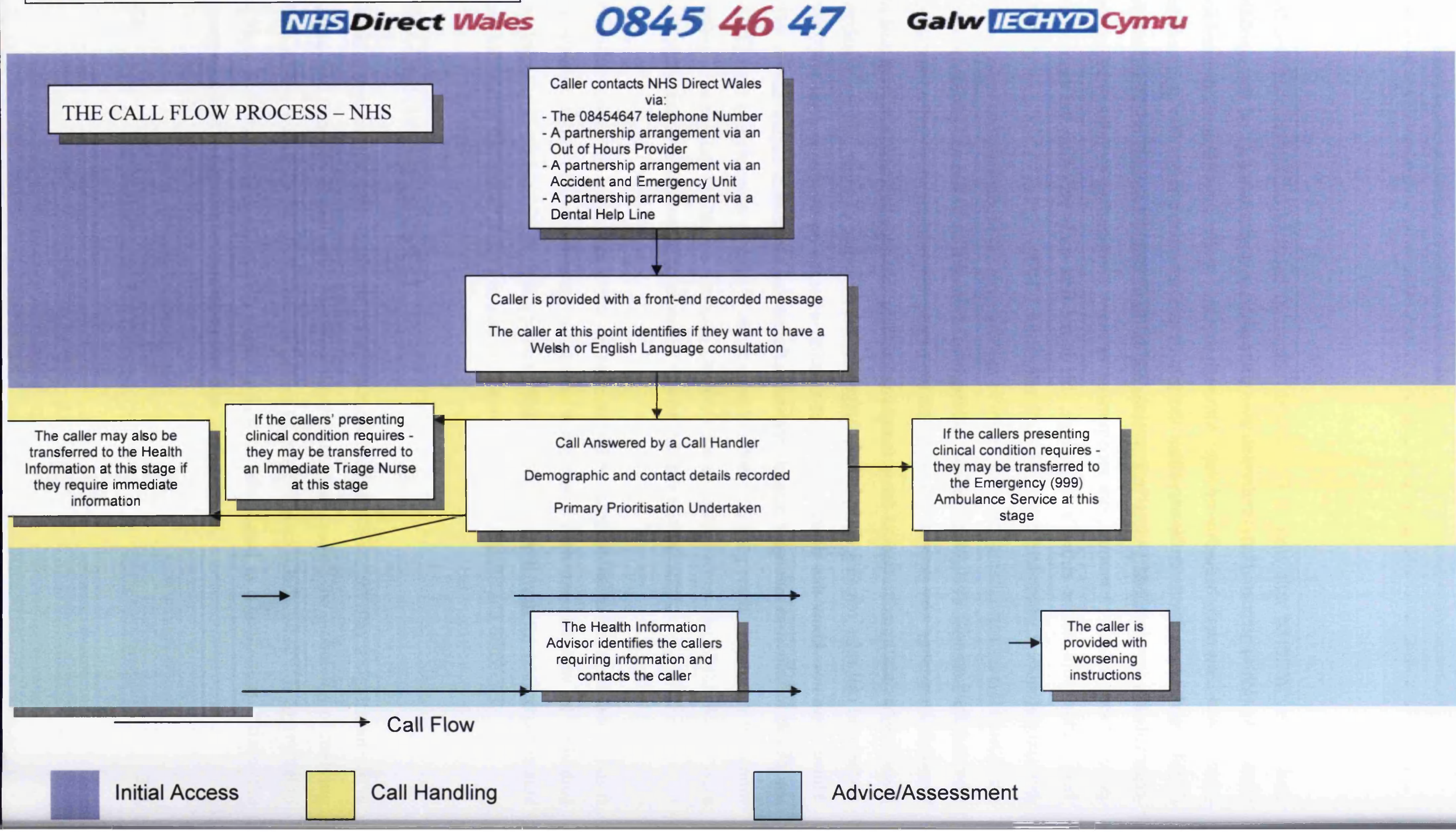
8.7 Conclusion (a and c)

Results suggest that deprivation, as measured by the WIMD, does not play a significant role in explaining variation in call rates. However deprivation does modify the probability of receiving both advice to seek face-to-face care and advice to call 999, particularly when it is aggregated to fifths. Although highly statistically significant, even when used as a continuous variable, the practical effect of deprivation on disposition is generally small.

Skrabanek (1994) argues that epidemiology must advance understanding of the specific phenomenon. This study has achieved that. Although previous studies have explored demand for NHSD, results have been conflicting about the role of socioeconomic status. No studies have separated calls for triage and general information, nor explored demand at a national level over a period of longer than 12 months, nor incorporated as many confounding variables as reported here. Furthermore, to the author's knowledge, this is the first study reporting the association between patient deprivation and the outcome of calls within NHSD.

Human behaviour will always be variable, making predictions difficult. We will probably never know all the reasons why patients contact NHSDW or why dispositions vary. Indeed, although the author has attempted to control for as many confounding variables as feasible, a great deal of variation in call rates remains unexplained, suggesting the influence of other, hidden variables. However we now know that deprivation is not a major influence on the demand for NHSDW; and that its influence on outcomes is moderate and in the desired direction.

Appendix 1: Flow of caller



Appendix 2: Systematic literature review search strategy

Handsearching

Literature reviews: British OOH primary and community care, identified 7 possible articles but they were all pre 1998, from these I identified 500 more but this was reduced to 250 by date.

The searches below are the final searches only. The author performed several trial searches in order to arrive at these search terms but these have not been included.

<u>Access and Demand Search:</u>

Keyword and MeSH search (PUBMED)

2. 'NHS direct' OR 'NHS 24'

3. (telephone OR hotline OR "call-center" OR "call-centre" OR "nhs-direct" OR "NHS-24" OR telemedicine OR telehealth OR helpline OR "Hotlines"[Mesh] OR "Telemedicine"[Mesh] or "General- practice-out-of-hours", "GP Out-of-hours" OR "GP-OOH" OR "primary care out-of-hours" or "primary care OOH")

4. *Facet 1:* (telephone OR hotline OR "call-center" OR "call-centre" OR "NHS-direct" OR "NHS-24" OR telemedicine OR telehealth OR helpline OR "Hotlines"[Mesh] OR "Telemedicine"[Mesh] OR "General- practice-out-of-hours" OR "GP Out-of-hours" OR "GP-OOH" OR "primary care out-of-hours" OR "primary care OOH")

   AND

   Facet 2: (depriv* OR poverty OR socioeconomic OR socio-economic OR disadvantaged OR "Poverty Areas"[Mesh] OR "Socioeconomic Factors"[Mesh] OR "Health Status Disparities"[Mesh] OR "Poverty"[Mesh] OR "Vulnerable Populations"[Mesh] OR "Social Class"[Mesh] OR social-class)

   AND

   Facet 3: (unscheduled-care OR unplanned-healthcare OR unplanned health-care OR immediate-care OR urgent-care OR out-of-hours OR emergenc* OR after-hours OR "Emergency Treatment"[Mesh] OR "After-Hours Care"[Mesh])

Keyword search (WEB of Science, CHINAL, HMIC, ASSIA)

1. 'NHS Direct' OR 'NHS 24'

2. *Facet 1:* (telephone OR hotline OR call-center OR call-centre OR NHS-Direct OR NHS-24 OR telemedicine OR telehealth OR helpline OR "General- practice-out-of-hours" OR "GP Out-of-hours" OR "GP-OOH" OR "primary care out-of-hours" OR "primary care OOH")

   AND

   Facet 2: (depriv* OR social-class OR poverty OR socioeconomic OR socio-economic OR disadvantaged OR vulnerable)

   AND

   Facet 3: ("unscheduled-care" OR "unplanned-healthcare" OR "unplanned health-care" OR "immediate-care" OR "urgent-care" OR out-of-hours OR emergenc* OR after-hours)

Notes:

CHINAL: but limited by major subjects: Emergency Patients, Wounds and Injuries, Health Resource Utilization, Emergency Care, Emergency Medical Services, Socioeconomic Factors, Health Services Accessibility, Emergency Service

Outcomes search:

PUBMED

1. telephone triage AND (depriv* OR poverty OR socioeconomic OR socio-economic OR disadvantaged OR "Poverty Areas"[Mesh] OR "Socioeconomic Factors"[Mesh] OR "Health Status Disparities"[Mesh] OR "Poverty"[Mesh] OR "Vulnerable Populations"[Mesh] OR "Social Class"[Mesh] OR social-class)

2. *Facet 1:* ("telephone" OR "hotline" OR "call-center" OR "call-centre" OR "nhs-direct" OR "NHS-24" OR "telemedicine" OR "telehealth" OR "helpline" OR "Hotlines"[Mesh] OR "Telemedicine"[Mesh] OR "General- practice-out-of-hours" OR "GP Out-of-hours" OR "GP-OOH" OR "primary care out-of-hours" OR "primary care OOH")

   AND

   Facet 2: (depriv* OR poverty OR socioeconomic OR socio-economic OR disadvantaged OR "Poverty Areas"[Mesh] OR "Socioeconomic Factors"[Mesh] OR "Health Status Disparities"[Mesh] OR "Poverty"[Mesh] OR "Vulnerable Populations"[Mesh] OR "Social Class"[Mesh] OR social-class)

   AND

   Facet 4: (outcome* OR treatment OR disposition* OR advice OR advised OR information OR triage OR "Triage"[Mesh] OR "Delivery of Health Care"[Mesh] "treatment outcome"[MeSH])

Keyword search (WEB of Science, CHINAL, HMIC, ASSIA)

1. *Facet 1:* (telephone OR hotline OR call-center OR call-centre OR NHS-Direct OR NHS-24 OR telemedicine OR telehealth OR helpline OR " General- practice-out-of-hours" OR "GP Out-of-hours" OR "GP-OOH" OR "primary care out-of-hours" OR "primary care OOH")

   AND

   Facet 2: (depriv* OR social-class OR poverty OR socioeconomic OR socio-economic OR disadvantaged OR vulnerable)

   AND

   Facet 4: (outcome* OR treatment OR disposition* OR advice OR advised OR information OR triage)

Notes:

In Web of Science: due to the large number of irrelevant hits, the author limited the major subject areas to:

- Public environmental occupational health (201)
- General internal medicine
- Health care sciences services
- Psychology
- Psychiatry
- Nursing
- Social sciences other topics
- Medical informatics
- Communication
- Emergency medicine
- Family studies
- Social work
- Telecommunications
- Demography

CHINAL: limited it to special interest areas:

- Advanced nursing practice
- Consumer health
- Critical care
- Emergency care
- Evidence based practice

- Home health care
- Nursing administration
- Nursing language/classification
- Public health

Appendix 3: STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eigible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measires of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates anc their precision (eg, 95% confidence interval). Make clear which confounders were adjused for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological backgound and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initative is available at www.strobe-statement.org.

Appendix 4: References for excluded papers

1. Baker, R., Bankart, M., Rashid, A., Banerjee, J., Conroy, S., Habiba, M., Hsu, R., Wilson, A., Agarwal, S., Camosso-Stefinovic, J. (2011) Characteristics of general practices associated with emergency-department attendance rates: a cross-sectional study. Bmj Quality & Safety. **20**(11): p. 953-958.
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Appendix 5: STROBE ratings of studies included in the systematic literature review

The numbers in the first row represent the included studies: 1=Beale (2006), 2=Burt (2002), 3=Bush (2010), 4=Cooper (2005), 5=ERPHO (2004), 6=Knowles (2006), 7=Ring (2004), 8=Salisbury (2000), 9=Shah (2008), 10=Siahpush (2007), 11=Sood (2007), 12=St George (2006), 13=Turnbull (2008), 14=Turnbull(2010), 15=Munro (2003), 16=O'Sullivan (2004), 17=Turnbull (2011), 18=O'Hara (2011), 19=O'Reilly(2001)

STROBE guidelines	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Title and abstract (possible score of 2)																			
1	2	2	2	1	0	1	1	2	1	1	1	2	2	2	1	2	1	2	1
Total	**2**	**2**	**2**	**1**	**0**	**1**	**1**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**
Introduction (possible score of 4)																			
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	1
Total	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**3**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**3**
Methods (possible score of 18)																			
4	2	2	2	2	0	0	2	2	2	0	2	2	2	2	0	2	1	2	2
5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2
7	2	1	1	2	2	2	1	1	2	0	2	2	2	2	2	2	2	2	1
8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	0	1	1	0	0	1	1	2	0	1	1	2	0	0	0	1	2	2	1
10	1	1	2	2	0	0	2	0	2	0	1	2	0	0	0	0	0	2	0
11	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0
12	2	2	0	2	0	1	0	1	2	2	2	2	2	2	2	2	1	2	1
Total	**15**	**15**	**12**	**16**	**10**	**12**	**14**	**14**	**16**	**10**	**16**	**18**	**14**	**14**	**12**	**15**	**14**	**18**	**11**
Results (possible score of 10)																			
13	2	2	0	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
14	1	1	1	2	1	2	2	2	2	0	2	2	2	2	2	0	2	2	0
15	2	2	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1
16	2	1	0	2	0	2	1	2	2	2	2	2	2	2	2	2	2	2	1
17	2	0	2	2	2	0	0	2	0	2	0	2	2	2	0	2	2	2	2
Total	**9**	**6**	**4**	**10**	**5**	**8**	**7**	**10**	**8**	**8**	**8**	**10**	**10**	**10**	**8**	**8**	**10**	**10**	**6**
Discussion (possible score of 8)																			
18	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2

STROBE guidelines	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
19	0	2	1	2	0	2	2	2	2	2	2	2	2	2	2	2	1	2	2
20	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
21	2	2	1	0	1	2	1	2	2	2	2	2	2	2	2	2	1	2	2
Total	**5**	**8**	**6**	**6**	**5**	**8**	**7**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**6**	**6**	**8**
Other information (possible score of 2)																			
22	2	2	0	0	0	2	2	2	2	0	2	2	2	0	2	2	2	0	0
Sum of Totals	**35**	**35**	**28**	**37**	**24**	**33**	**33**	**40**	**37**	**31**	**37**	**42**	**38**	**38**	**33**	**37**	**35**	**40**	**29**

Appendix 6: Summary of NHSDW variable recoding: call type

Call type coded as in original database	Call type recoded
0	Unknown
0	Unknown
2	Unknown
.F.A.O. WAYNE	Unknown
?	Unknown
ANKLE	Unknown
ASTHMA PROBLEM	Unknown
BREATHING	Unknown
COUGHING	Unknown
DIZZY	Unknown
DRUG ADVICE	Unknown
DRUG ENQUIRY	Unknown
EAR WAX REMOVAL	Unknown
EARACHE	Unknown
FEVER	Unknown
HIGH TEMP/40.6	Unknown
HYST/BLEEDING	Unknown
INFECTION	Unknown
NHS DENTIST	Unknown
NIL	Unknown
NITS/ PREGNANT	Unknown
NOT GIVEN	Unknown
NOT KNOWN	Unknown
OPNED IN ERROR	Unknown
OTHER	Unknown
PAIN AFTER EXAM /INTESTINE	Unknown
PAIN IN ARMS AND CHEST	Unknown
SINUSES	Unknown
SORE THROAT	Unknown
TABLET INJESTION	Unknown
THRUSH - CYSTITUS	Unknown
TOOTHACHE	Unknown
UNKNOWN	Unknown
UNSURE	Unknown
`TRIAGE	Triage
TRIAGE	Triage
Triage	Triage
WELSH TRIAGE	Triage
Welsh Triage	Triage

Call type coded as in original database	Call type recoded
Category C	Category C
Child Line	Child Line
Deedoc Triage English	GP OOH
GUPC Out Of Hours	GP OOH
MMD	GP OOH
MMD Out of Hours	GP OOH
Welsh Deedoc Triage	GP OOH
Welsh MMD Out Of Hours	GP OOH
Dental - North Wales	Dental
Dental - Out of Area	Dental
Dental - Swansea	Dental
DENTIST INFORMATION	General Information
GENERAL INFO	General Information
GENERAL INFORMATION	General Information
General Information	General Information
General Information IN	General Information
General Information AFTER 4PM	General Information
General Information/LD	General Information
General Information/UNSURE	General Information
INFORMATION	General Information
W General Information	General Information
W General Information	General Information
W. General Information	General Information
Welsh General Information	General Information
Gwent A & E	A & E
Morriston A & E	A & E
Prince Charles A&E	A & E
Singleton A & E	A & E
HEALTH COSTS	Health Costs Call - ask if this is direct
Health Costs Call	Health Costs Call - ask if this is direct
Health Information	Health Information - ask if this is direct
Health Information Quick Call	Health Information - ask if this is direct
HI Medicines Enquiry	Health Information - ask if this is direct
Local Alert	Local Alert
Obesity Campaign	Obesity Campaign

Call type coded as in original database	Call type recoded
Out of Hours	Out of Hours - is this from a GP's?
Welsh Blood Service	Welsh Blood Service
Misdirected	999 Missing/Misdirected
Missing Data	999 Missing/Misdirected

Appendix 7: Summary of NHSDW variable recoding: relationship of caller to patient

Relationship as coded in original database	Relationship recoded as
self	SELF
self	self
self	Self
self	SELF
self	SELF AND DAUGHTER
self	Self/THIRD PARTY
aunt/uncle/cousin/niece/nephew	Aunt
aunt/uncle/cousin/niece/nephew	AUNT
aunt/uncle/cousin/niece/nephew	AUNTIE
aunt/uncle/cousin/niece/nephew	Cousin
aunt/uncle/cousin/niece/nephew	NEICE
aunt/uncle/cousin/niece/nephew	Nephew
aunt/uncle/cousin/niece/nephew	NEPHEW
aunt/uncle/cousin/niece/nephew	Nephew IN LAW
aunt/uncle/cousin/niece/nephew	Niece
aunt/uncle/cousin/niece/nephew	Uncle
caregiver/guardian	BABYSITTER
caregiver/guardian	CARE
caregiver/guardian	Caregive
caregiver/guardian	Caregiver
caregiver/guardian	CAREGIVER
caregiver/guardian	Caregiver R.G.N.
caregiver/guardian	Caregiver/
caregiver/guardian	Caregiver/LEGAL GUARDIAN
caregiver/guardian	Caregiver/MANAGER
caregiver/guardian	CARER
caregiver/guardian	DEPUTY MATRON
caregiver/guardian	DUTY MANAGER
caregiver/guardian	FOSTER CARER
caregiver/guardian	FOSTER MOTHER
caregiver/guardian	FOSTER MUM
caregiver/guardian	FOSTERMUM
caregiver/guardian	GUARDIAN
caregiver/guardian	Legal Guardian
caregiver/guardian	SENIOR CARE WORKER
caregiver/guardian	WARDEN
daughter/daughter-in-law	Daughter
daughter/daughter-in-law	DAUGHTER
daughter/daughter-in-law	Daughter/SON
daughter/daughter-in-law	Daughter-in-law
daughter/daughter-in-law	STEP DAUGHTER
daughter/daughter-in-law	STEPDAUGHTER
son/son-in-law,etc	Son

Relationship as coded in original database	Relationship recoded as
son/son-in-law,etc	SON
son/son-in-law,etc	Son-in-law
son/son-in-law,etc	STEP SON
call aborted	Call Aborted - Data Not Collected
colleague/friend/neighbour	COLLEAGUE
colleague/friend/neighbour	EMPLOYER
colleague/friend/neighbour	EXPartner
colleague/friend/neighbour	FLAT MATE
colleague/friend/neighbour	Friend
colleague/friend/neighbour	FRIEND
colleague/friend/neighbour	Friend - NEIGHBOUR
colleague/friend/neighbour	Friend/NEIGHBOUR
colleague/friend/neighbour	HIS BOSS
colleague/friend/neighbour	MANAGER
colleague/friend/neighbour	Neighbour
colleague/friend/neighbour	NEIGHBOUR
colleague/friend/neighbour	NEIGHBOUR.
colleague/friend/neighbour	RECEPTIONIST
not collected	Emergency Call - Data Not Collected
father/father-in-law/stepfather	Father
father/father-in-law/stepfather	FATHER
father/father-in-law/stepfather	Father-in-law
father/father-in-law/stepfather	STEP DAD
father/father-in-law/stepfather	STEP Father
father/father-in-law/stepfather	STEP FATHER
father/father-in-law/stepfather	STEPFATHER
father/father-in-law/stepfather	STEP-Father
father/father-in-law/stepfather	STEP-FATHER
grandparent	Grandfather
grandparent	GRANDFATHER
grandparent	Grandmother
grandparent	GRANDMOTHER
grandparent	Grandparent
granddaughter/son	Grand-daughter
granddaughter/son	Grand-son
sister/sister in law/stepsister/sibling/brother, etc	Brother
sister/sister in law/stepsister/sibling/brother, etc	Brother-in-law
sister/sister in law/stepsister/sibling/brother, etc	Half Brother
sister/sister in law/stepsister/sibling/brother, etc	Half Sister
sister/sister in law/stepsister/sibling/brother, etc	Sibling
sister/sister in law/stepsister/sibling/brother, etc	Sister
sister/sister in law/stepsister/sibling/brother, etc	SISTER
sister/sister in law/stepsister/sibling/brother, etc	Sister-in-law
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	HOME MANAGER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	CO ORDINATOR
other includes hostel manager, housekeeper, midwife, nurses, police,	CONSULTANT

Relationship as coded in original database	Relationship recoded as
dentist	
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	HOSTEL MANAGER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	HOUSEKEEPER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	MID WIFE
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	NIGHT NURSE
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	NORTH WALES AMBULANCE SER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	NURSE
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	NURSE IN CHARGE
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	OFFICER IN CHARGE
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	Other
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	OTHER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	Other - Distant
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	Other - DISTANT
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	Other Relative
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	POLICE WOMAN
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	SOCIAL SERVICES
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	SOCIAL SERVICES COORD
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	SOCIAL WORKER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	STAFF NURSE
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	SUPPORT WORKER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	TEACHER
other includes hostel manager, housekeeper, midwife, nurses, police, dentist	WARD MANAGER
Mom/mom in law	Mother
Mom/mom in law	MOTHER
Mom/mom in law	Mother (STEP)
Mom/mom in law	Mother (STEP)
Mom/mom in law	MOTHER EX PARTNER
Mom/mom in law	Mother-in-law
Mom/mom in law	MUM
Mom/mom in law	MUM .
Mom/mom in law	STEP MOTHER

Relationship as coded in original database	Relationship recoded as
Mom/mom in law	STEP MUM
Mom/mom in law	STEPMOTHER
Mom/mom in law	STEP-Mother
Mom/mom in law	STEPMUM
partner/spouse/girl/boyfriend/wife/husband	Boyfriend
partner/spouse/girl/boyfriend/wife/husband	BOYFRIEND
partner/spouse/girl/boyfriend/wife/husband	GIRLFRIEND
partner/spouse/girl/boyfriend/wife/husband	HUSBAND
partner/spouse/girl/boyfriend/wife/husband	Partner
partner/spouse/girl/boyfriend/wife/husband	PARTNER
partner/spouse/girl/boyfriend/wife/husband	Spouse
partner/spouse/girl/boyfriend/wife/husband	SPOUSE
partner/spouse/girl/boyfriend/wife/husband	WIFE
unknown	
unknown	ANGELA
unknown	ANN
unknown	ANON
unknown	CAROL
unknown	CLAIRE COLLINS
unknown	ELEN
unknown	GLYN
unknown	HOWARD STUBBS
unknown	KERRIE LEE
unknown	LEANNE
unknown	LIFELINE CO-ORDINATOR
unknown	LOUISE
unknown	MRS DAVIES
unknown	MRS HUGHES
unknown	MRS ROBERTS
unknown	NHS DENTIST IN AREA
unknown	PAMELA UGWUDIKE
unknown	PETER WILLIAMS
unknown	RE DAUGHTER
unknown	RE PARTNER
unknown	RUTH
unknown	SPOTS ON FACE
unknown	THIRD PARTY
unknown	TOOTHACHE
unknown	UNKNOWN
unknown	VERONICA MILES
unknown	VOMITING/FEVER/CRYING

Appendix 8: Summary of NHSDW variable recoding: symptom

NHSDW coded symptom	Recoded into ICPC-2
abdominal pain	D: Digestive
sexual abuse	Z: Social problems
abuse	Z: Social problems
acne	S: Skin
aggressive	P:Psychological
agitated	P:Psychological
allergic reaction	A: General and unspecified
allergies	A: General and unspecified
period absent	X: Female Genital
angry	P:Psychological
animal bite	S: Skin
ankle pain	L: Musculoskeletal
ankle injury	L: Musculoskeletal
swollen ankle	K: Cardiovascular
anxiety	P:Psychological
arm injury	L: Musculoskeletal
arm pain	L: Musculoskeletal
asthma	R: Respiratory
back pain/pregnancy	W: Pregnancy, child bearing, family planning
back pain	L: Musculoskeletal
back injury	L: Musculoskeletal
bed wetting	P:Psychological
belching	D: Digestive
behaviour change	P:Psychological
bites animal/human	S: Skin
cat bite	S: Skin
dog bite	S: Skin
insect bites	S: Skin
snake bite	S: Skin
blisters	S: Skin
blood in semen	Y: Male genital
blurred vision	F: Eye
haematuria	U: Urological
blood sugar levels	T: Endocrine/metabolic and nutritional
breast discharge	X: Female genital or Y: Male genital
breast lump	X: Female genital or Y: Male genital
breast pain	X: Female genital or Y: Male genital
breast problems	X: Female genital or Y: Male genital

NHSDW coded symptom	Recoded into ICPC-2
breast swelling	X: Female genital or Y: Male genital
breathing difficulties	R: Respiratory
bruising	S: Skin
burns	S: Skin
buttock pain	L: Musculoskeletal
calf pain	L: Musculoskeletal
calf swelling	L: Musculoskeletal
chest injury	L: Musculoskeletal
chest pain	A: General and unspecified
colds and flu	R: Respiratory
confusion	P:Psychological
constipation	D: Digestive
contact lens problem	F: Eye
convulsion	N: Neurological
coughing up blood	R: Respiratory
cough/wheeze	R: Respiratory
cough	R: Respiratory
crisis call	P:Psychological
croup	R: Respiratory
crying child	A: General and unspecified
cuts	S: Skin
decreased hearing	H: Ear
delusions	P:Psychological
dementia	P:Psychological
dental bleeding	D: Digestive
dental crown filling dentures or braces	D: Digestive
tooth ache	D: Digestive
dental trauma	D: Digestive
dental swelling	D: Digestive
dental problems	D: Digestive
depression	P:Psychological
despair	P:Psychological
diarrhoea	D: Digestive
diabetes mellitus	T: Endocrine/metabolic and nutritional
difficulty swallowing	D: Digestive
urinary retention	U: Urological
double vision	F: Eye
discharge ear	H: Ear
disoriented	N: Neurological
dizziness	P:Psychological

NHSDW coded symptom	Recoded into ICPC-2
menstrual problems	X: Female genital
urinary burning	U: Urological
ear ache	H: Ear
elbow pain/swelling	L: Musculoskeletal
electric shock	A: General and unspecified
emergency contraception	W: Pregnancy, child bearing, family planning
fit	N: Neurological
eye discharge	F: Eye
foreign body in eye	F: Eye
eye pain	F: Eye
eye injury	F: Eye
eyelid lump	F: Eye
eye redness	F: Eye
eye stye	F: Eye
facial injury	A: General and unspecified
facial pain/swelling	N: Neurological
fainting spells	A: General and unspecified
falls non traumatic	A: General and unspecified
fatigue	A: General and unspecified
fever	A: General and unspecified
finger injury	L: Musculoskeletal
finger paini/swelling	L: Musculoskeletal
flank pain	L: Musculoskeletal
visual disturbance	F: Eye
flatulence	D: Digestive
flu like symptoms	R: Respiratory
flu	R: Respiratory
food poisioning	D: Digestive
foot injury	L: Musculoskeletal
foot pain/swelling	L: Musculoskeletal
foreign body in ear	H: Ear
foreign body in nose	R: Respiratory
foreign body in vagina	X: Female genital
memory loss	P:Psychological
general skin problems	S: Skin
grazes	S: Skin
groin pain/swelling	L: Musculoskeletal
vomiting blood	D: Digestive
haemorrhoids	K: Cardiovascular

NHSDW coded symptom	Recoded into ICPC-2
hair loss	S: Skin
hallucinations	P:Psychological
hand injury	L: Musculoskeletal
hand pain/swelling	L: Musculoskeletal
swollen hands	L: Musculoskeletal
hay fever	R: Respiratory
head injury	N: Neurological
head ache	N: Neurological
head lice	S: Skin
hearing loss	H: Ear
heart burn	D: Digestive
heat stroke	A: General and unspecified
heel pain	L: Musculoskeletal
hiccups	D: Digestive
hip pain	L: Musculoskeletal
hoarseness	R: Respiratory
hopelessness	P:Psychological
human bite	S: Skin
hyperventilation	R: Respiratory
hypothermia	A: General and unspecified
indigestion	D: Digestive
ingestion foreign body	D: Digestive
ingestion toxic	A: General and unspecified
inhalation injury	R: Respiratory
impotence	Y: Male genital
urinary incontinence	U: Urological
injury needlestick	A: General and unspecified
injury stabbing	A: General and unspecified
ingrown nail	S: Skin
insomnia	P:Psychological
itching	S: Skin
itching vaginal	X: Female genital
itchy scalp	S: Skin
jaw pain	L: Musculoskeletal
kidney pain	U: Urological
knee injury	L: Musculoskeletal
knee pain/swelling	L: Musculoskeletal
lacerations	S: Skin
leg cramps	L: Musculoskeletal
leg injury	L: Musculoskeletal

NHSDW coded symptom	Recoded into ICPC-2
leg numbness	L: Musculoskeletal
leg pain	L: Musculoskeletal
loss of smell	N: Neurological
lumps testicle	Y: Male genital
lumps skin	S: Skin
lumps	S: Skin
missed pill	W: Pregnancy, child bearing, family planning
mole change	S: Skin
mood swings	P:Psychological
mouth problems	D: Digestive
mouth sores	D: Digestive
muscle weakness	L: Musculoskeletal
muscle problems	L: Musculoskeletal
nail injury	S: Skin
nail problems	S: Skin
nausea	D: Digestive
nasal congestion	R: Respiratory
neck injury	L: Musculoskeletal
neck pain	L: Musculoskeletal
neck swelling	L: Musculoskeletal
night cramps	L: Musculoskeletal
night sweats	A: General and unspecified
no algortihm problem	can't do- recoded as symptom missing
nosebleeds	R: Respiratory
numbness arm	N: Neurological
numbness generalised	N: Neurological
numbness leg	N: Neurological
overdose	P:Psychological
palpitations	K: Cardiovascular
panic attacks	P:Psychological
paranoid	P:Psychological
penile discharge	Y: Male genital
penile pain/swelling	Y: Male genital
painful period	X: Female genital
tingling arm	N: Neurological
post op symptoms	A: General and unspecified
pregnancy vaginal bleeding	W: Pregnancy, child bearing, family planning
pregnancy vaginal discharge	W: Pregnancy, child bearing, family planning

NHSDW coded symptom	Recoded into ICPC-2
puncture wound	A: General and unspecified
rape	Z: Social problems
rash	S: Skin
rib pain	L: Musculoskeletal
rectal bleeding	D: Digestive
rectal discharge	D: Digestive
rectal lumps	D: Digestive
rectal pain	D: Digestive
tinnitus	H: Ear
savlivary gland pain/swelling	D: Digestive
scrotal pain swelling	Y: Male genital
seizures	N: Neurological
unprotected sex	W: Pregnancy, child bearing, family planning
shoulder pain/swelling	L: Musculoskeletal
sinus pain	R: Respiratory
skin problems	S: Skin
sleep problems	P:Psychological
sore throat	R: Respiratory
spinning	N: Neurological
splinters	S: Skin
stings	S: Skin
stress	P:Psychological
stuffy nose	R: Respiratory
suicide ideation	P:Psychological
sun stroke	A: General and unspecified
sun burn	S: Skin
sweating	A: General and unspecified
swollen feet	L: Musculoskeletal
swollen penis	Y: Male genital
swollen testicle	Y: Male genital
testicular pain	Y: Male genital
testicular swelling	Y: Male genital
throat problems	R: Respiratory
tingling	N: Neurological
tingling leg	N: Neurological
tiredness	A: General and unspecified
toe injury	L: Musculoskeletal
toe pain/swelling	L: Musculoskeletal
urinary frequency	U: Urological

NHSDW coded symptom	Recoded into ICPC-2
urinary urgency	U: Urological
urogenital problems	U: Urological
vaginal bleeding	X: Female genital
vaginal discharge	X: Female genital
vaginal problems	X: Female genital
vaginal itching	X: Female genital
vaginal prolapse	X: Female genital
vertigo	N: Neurological
violent	Z: Social problems
vision loss	F: Eye
voice loss	R: Respiratory
vomiting	D: Digestive
weakness due to fatigue	A: General and unspecified
weakness of muscles	L: Musculoskeletal
weakness	A: General and unspecified
wheezing	R: Respiratory
wound laceration/cut	S: Skin
wound infection	S: Skin
wrist injury	L: Musculoskeletal
wrist pain/swelling	L: Musculoskeletal
other: "vomiting, pregnancy", "pregnancy back pain", "pregnancy nausea/vomiting", "pregnancy, back pain", pregnancy, "nausea or vomiting", "pregnancy nausea/vomiting", "pregnancy labour"	W: Pregnancy, child bearing, family planning
other: "measles", "chicken pox"	A. General and unspecified
999 (missing data)	999 (missing data)

Appendix 9: Summary of NHSDW variable recoding: disposition

Original NHSDW coding: Disposition (n = 244)	New codings (n=33)	Frequency
999 - Ambulance as soon as possible	999/ambulance	21825
Accident & Emergency as soon as possible	A&E	30481
Accident and Emergency within 4 Hours	A&E	11601
CASUALTY 24 HOURS	A&E	1
Administration Only	Administration only	6
Non - Assessed / Triage Refused	Call unassessed as per policy	1700
Not Assessed By A Nurse	Call unassessed as per policy	1796
Triage Refused - Direct Transmission to GP	Call unassessed as per policy	1489
Caller Not Wishing to Proceed	Caller not wishing to proceed	1503
Contact Dentist Next Routine Appointment Over 24 Hours	Contact Dentist for routine appt	3801
Routine Appointment with Dentist	Contact Dentist for routine appt	206
Contact Dentist within 24 Hours	Contact Dentist next working day	4470
Contact Dentist within 12 Hours	Contact Dentist within 12 hours	3957
Contact Dentist Urgently	Contact Dentist within 1hour	268
Contact Dentist within 1 Hour	Contact Dentist within 1hour	308
Contact Dentist within 4 Hours	Contact Dentist within 4 hours	4515
Contact GP Practice within 36 Hours (next day appointment)	Contact GP service within 36 hours	33897
Contact GP Practice within 4 Hours (as soon as possible)	Contact GP within 2 hours	121358
Contact GP Practice within 12 Hours (same day)	Contact GP within 6 hours	36230
Contact GP Practice within 12 Hours (Same Day)	Contact GP within 6 hours	2396
ADVISED TOSEE PRACTICE NURSE	Contact other healthcare professional	2
Consult Toxbase or Local Poisons Centre	Contact other healthcare professional	1304
Contact Community Crisis Line	Contact other healthcare professional	7
Contact District Nurses	Contact other healthcare professional	179
Contact Family Planning Clinic	Contact other healthcare professional	207
CONTACT FRACTURE CLINIC	Contact other healthcare professional	1
Contact Genito-Urinary Medicine Clinic	Contact other healthcare professional	681
Contact Health Visitor	Contact other healthcare professional	1343
Contact Local Community Mental Healthcare Team	Contact other healthcare professional	65
Contact Mental Healthcare Team	Contact other healthcare professional	83
Contact Midwife	Contact other healthcare	1186

	professional	
Contact Optician	Contact other healthcare professional	84
Contact Orthodontist Next Working Day	Contact other healthcare professional	5
CONTACT PRACTICE NURSE	Contact other healthcare professional	1
Emergency Contraception	Contact other healthcare professional	379
PRACTICE NURSE	Contact other healthcare professional	1
Contact Social Worker	Contact other professional	57
Contact Pharmacist	Contact Pharmacist	4834
Contact Police	Contact Police now	37
Contact Police Now	Contact Police now	49
Walk-in Centre	Contact Walk in centre	38
Direct Addmission	Direct Transmission to hospital	5
Direct Admission	Direct Transmission to hospital	24
Direct Transmission to Hospital	Direct Transmission to hospital	73
GP To Ring	GP to ring	362
Dentist Information Given	Health Information provided	43670
Follow-up	Health Information provided	5429
Follow up Completed	Health Information provided	1025
Gwent Measles Health Scare Information	Health Information provided	2
Health Alert - MMR	Health Information provided	151
HELP LINE NUMBERS GIVEN.	Health Information provided	2
Information provided	Health Information provided	117471
Mens Health Information Given	Health Information provided	3
Mumps Outbreak Information	Health Information provided	6
Postal Information Sent	Health Information provided	117
Testicular Campaign Information	Health Information provided	30
Waiting Times Information Provided	Health Information provided	47
Home Care	Home Care	31877
Advice Nurse Will Call Back Notification In x minutes/hours/days*	Not assessed	16355
Follow up Cancelled	Not assessed	2203
Go To Specific Algorithm	Not assessed	32
Health Information Referral	Not assessed	4027

Left Message	Not assessed	1
Left Message Notification in x minutes/hour(s)*	Not assessed	130
Line busy	Not assessed	193
Maximum 3 Attempts - No Answer Notification In x minute(s)*	Not assessed	6529
Message Handling Only	Not assessed	57
No Answer Try Again	Not assessed	59
No Answer/No Contact	Not assessed	1675
Send to Health Information Queue	Not assessed	431
Send to The First Advice Queue	Not assessed	7
APPOINTMANT WITH HOSPITAL IN 2 DAYS	Other	1
Home Visit Required	Other	122
No Action Required	Other	3904
Nurse to Call Poisons Centre	Other	2
Nurse to Call Poisons Centre Notification In x minutes/hours/days*	Other	17
Other	Other	34038
PCC Visit Necessary	Other	13
Public Health Emergency	Other	6
Out Of SLA Time	Out of SLA	94
Policy - Direct Transfer	Policy direct transfer	6922
CONTACT GP IN 48 HOURS FROM SEEING GP LAST.	Routine appt with GP	1
CONTACT GP PRACTICE ON MONDAY	Routine appt with GP	1
Routine Appointment with GP	Routine appt with GP	16327
Speak to Doctor Next Working Day	Speak to GP next working day	2877
Speak to Doctor Within 12 Hours (Same Day)	Speak to GP next working day	6095
Speak to Doctor Within 4 Hours	Speak to GP within 2 hours	9110
Speak to Doctor Within the Hour (as soon as possible)	Speak to GP within hour	11865
	Total	615739

*Advice Nurse Will Call Back Notification In x minutes/hours/days, there were 135 different times represented here ranging from 1 minute-8 days, Left Message Notification in x minutes/hour(s) there were 16 different times here ranging from 10 minutes to 2 hours, Maximum 3 Attempts - No Answer Notification In x minute(s), there were five different times here ranging from 10-30 minutes, Nurse to Call Poisons Centre Notification In x minutes/hours/days, there were 4 different times here ranging from 15 minutes to 1 day.

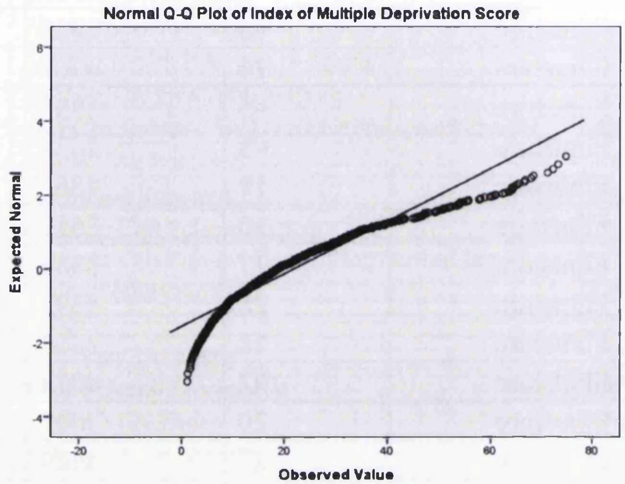
Appendix 10: Additional Analysis from Chapter 5 (b)

A: Wards with the lowest call rates

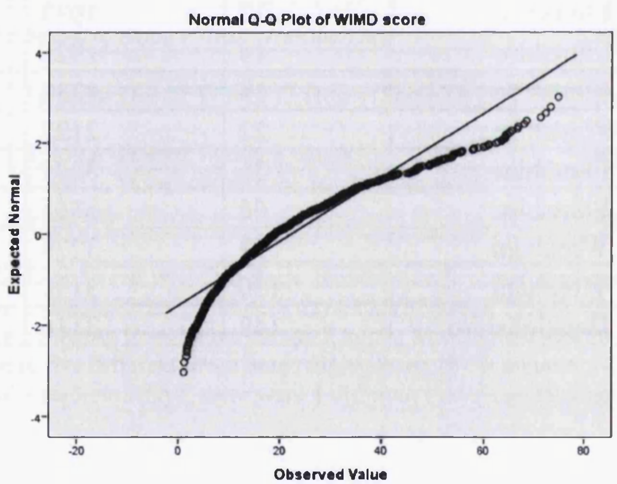
Electoral Division	Ediv name	UA name	Frequency	population	call rate
NJME	Broughton South	Flintshire	7	3703	0.002
NJMD	Broughton North and East	Flintshire	<5	2088	0.002
NJPC	Saltney	Flintshire	10	4769	0.002
NJNE	Hawarden	Flintshire	<5	1858	0.002
NJNG	Higher Kinnerton	Flintshire	<5	1634	0.002
NJMS	Ewloe	Flintshire	18	4862	0.004
NJMH	Buckley Mountain	Flintshire	10	2518	0.004
NJMF	Buckley Bistre East	Flintshire	17	3463	0.005
NJMQ	Connah's Quay South	Flintshire	28	5697	0.005
NJMA	Aston	Flintshire	18	3357	0.005
NJMJ	Buckley Pentrobin	Flintshire	22	4078	0.005
NJNN	Mancot	Flintshire	20	3462	0.006
NJMG	Buckley Bistre West	Flintshire	27	4509	0.006
NJPD	Sealand	Flintshire	20	2746	0.007
NJMP	Connah's Quay Golftyn	Flintshire	42	5486	0.008
NLNQ	Rossett	Wrexham	28	3336	0.008
NJPG	West Shotton	Flintshire	17	1933	0.009
NJPB	Queensferry	Flintshire	19	1923	0.010
NJNF	Higher and East Shotton	Flintshire	44	4332	0.010
NJMR	Connah's Quay Wepre	Flintshire	22	2122	0.010
NJMN	Connah's Quay Central	Flintshire	35	3221	0.011
NJPA	Penyffordd	Flintshire	66	3715	0.018
NLMC	Bronington	Wrexham	93	3224	0.029
NLNH	Overton	Wrexham	130	3139	0.041
NGME	Denbigh Upper/Henllan	Denbighshire	148	3116	0.047

B: Normal Q-Q plot for WIMD with and without Flintshire

With Flintshire



Without Flintshire



C: Monthly coding

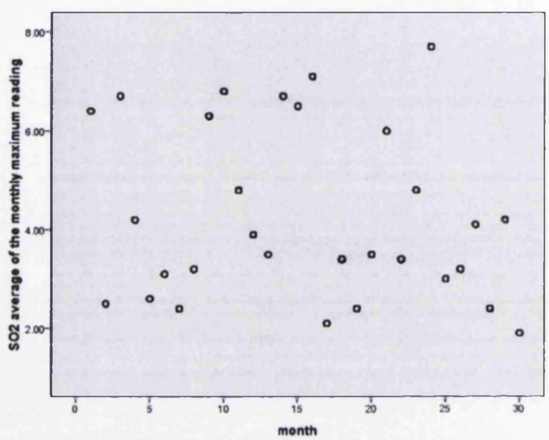
month identifier	month
1	Jan-02
2	Feb-02
3	Mar-02
4	Apr-02
5	May-02
6	Jun-02
7	Jul-02
8	Aug-02
9	Sep-02
10	Oct-02
11	Nov-02
12	Dec-02
13	Jan-03
14	Feb-03
15	Mar-03
16	Apr-03
17	May-03
18	Jun-03
19	Jul-03
20	Aug-03
21	Sep-03
22	Oct-03
23	Nov-03
24	Dec-03
25	Jan-04
26	Feb-04
27	Mar-04
28	Apr-04
29	May-04
30	Jun-04

D: Air quality monthly plots

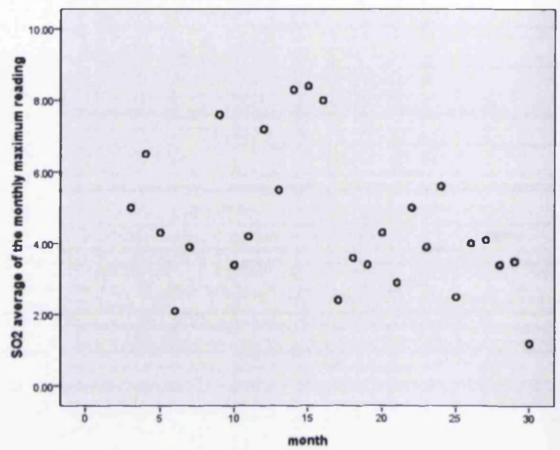
SO2

SO2 was measured in six stations. Pembrokeshire (16 months) and Wrexham (3 months) were the only stations missing data. The author plotted the monthly average of the daily maximum readings for each station. Data seemed to follow a seasonal pattern, with the exception of Port Talbot, see Figures X-X. As Pembrokeshire Station was missing values for over half of the data collection period, this was not plotted.

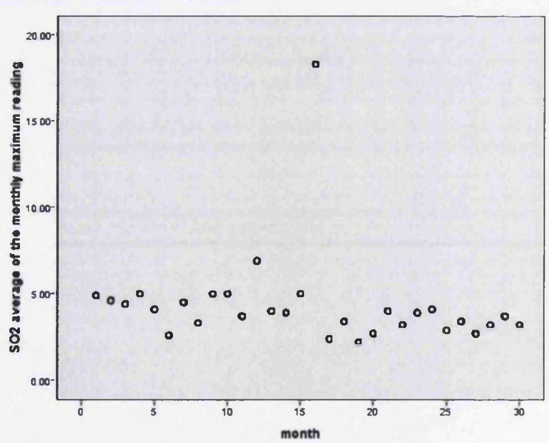
Swansea Station SO2



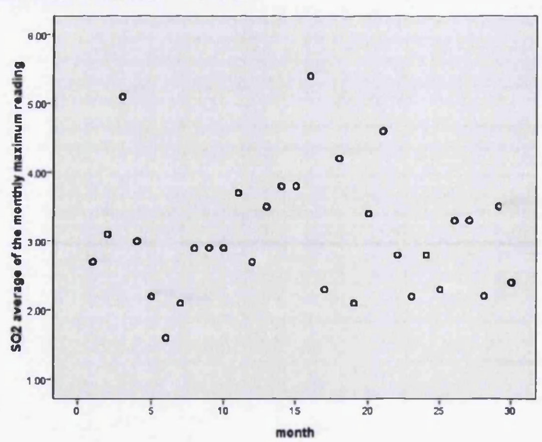
Wrexham Station SO2



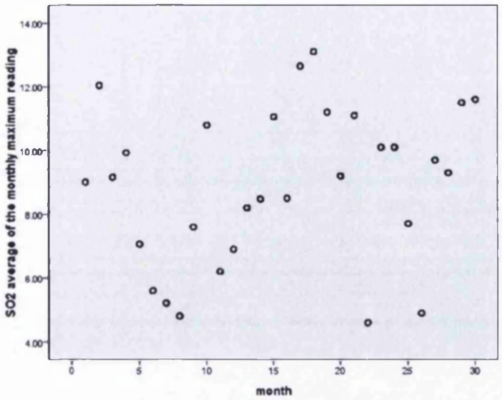
Cardiff Station- SO2



Cwmbran Station – SO2



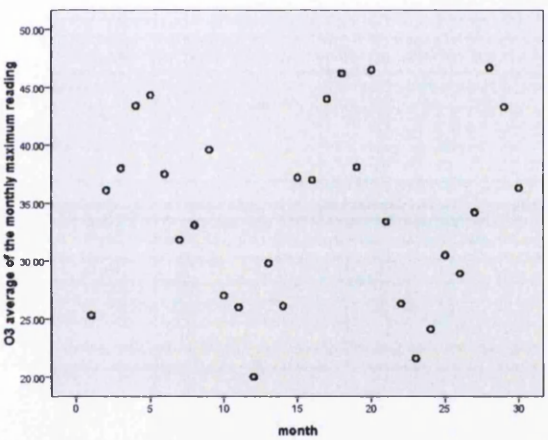
Port Talbot- SO2



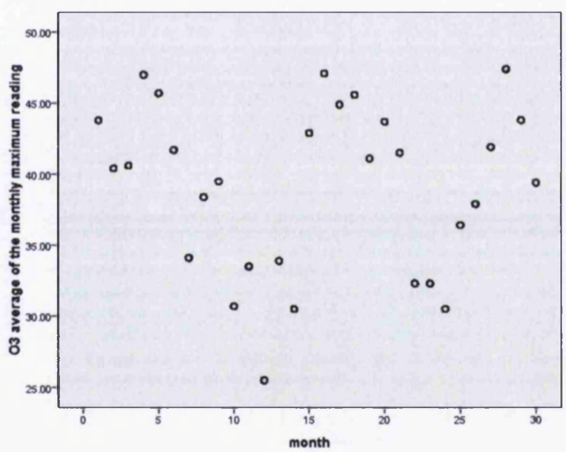
O3

O3 was measured in 6 stations, with Pembrokeshire station missing 6 months of data and Cwmbran station missing 16. (Cwmbran not shown due to missing data).

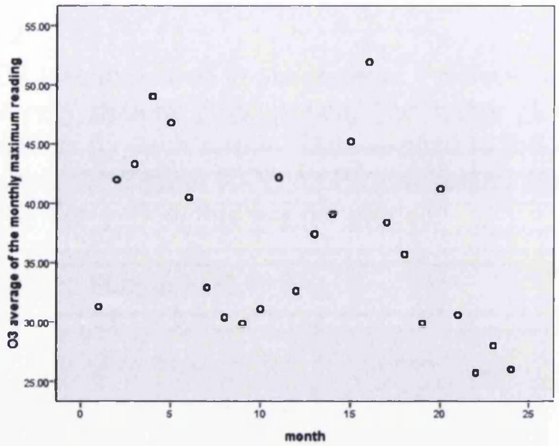
Cardiff O3



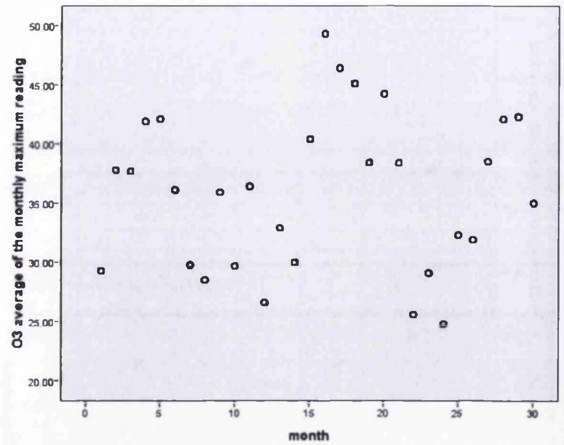
Aston Hill O3



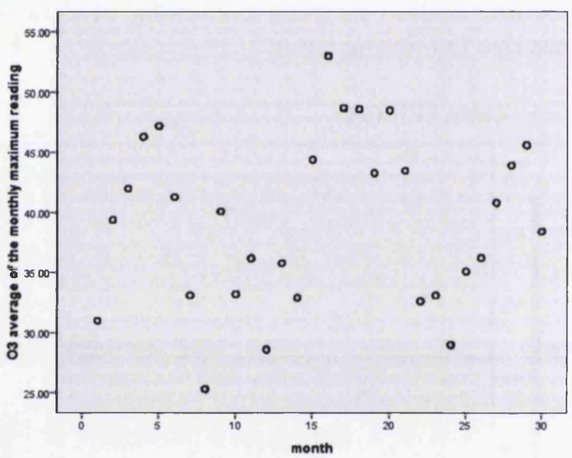
Pembrokeshire – O3



Swansea – O3



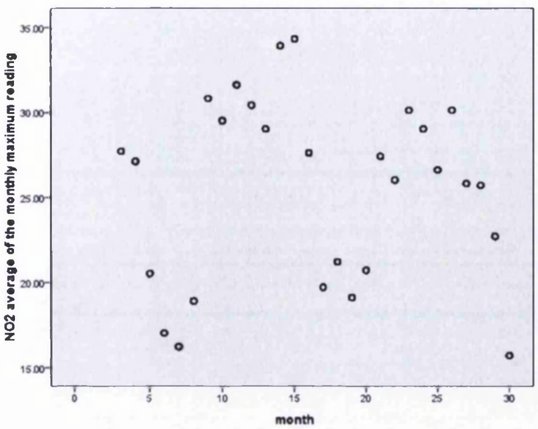
Port Talbot –O3



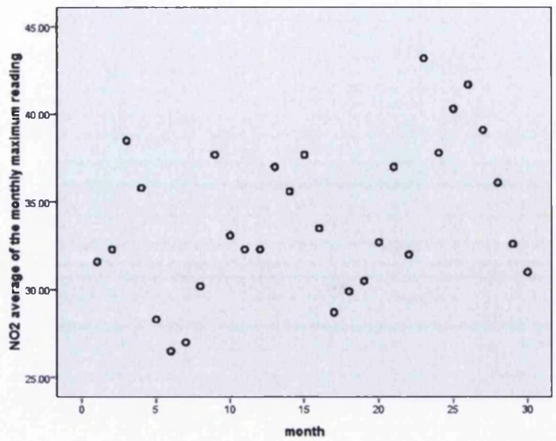
NO2

NO2 was measured in all seven stations. Aston Hill (22 months not shown) and Wrexham (2 months) were the only stations missing data.

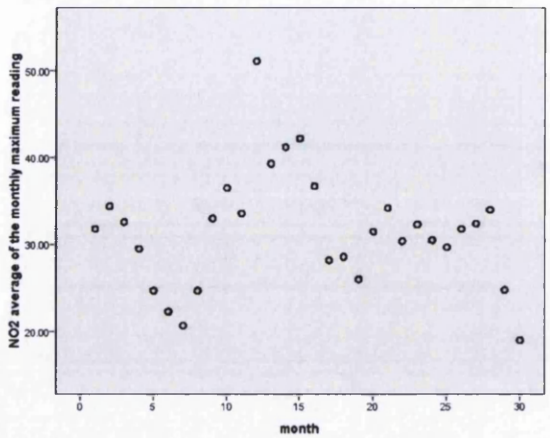
Wrexham NO2



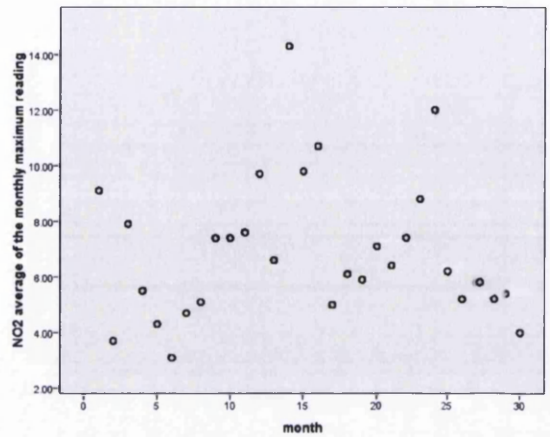
Swansea NO2



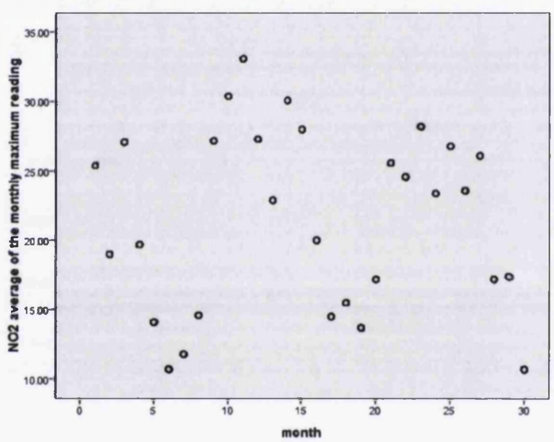
Cardiff NO2



Pembrokeshire NO2



Cwmbran NO2



E. Descriptives

average of the montlhy maximum temps

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	12070	13.1717	4.49040	.04087	13.0916	13.2519	5.03	24.80
A&E/hospital	28109	13.8067	4.57175	.02727	13.7533	13.8602	5.03	24.80
Emergency GP/dentist	84362	13.3607	4.47670	.01541	13.3305	13.3909	5.03	24.80
GP/dentist	77271	13.6150	4.52539	.01628	13.5830	13.6469	5.03	24.80
Other	25617	13.8957	4.67709	.02922	13.8384	13.9529	5.03	24.80
Selfcare	147177	13.5702	4.43841	.01157	13.5475	13.5928	5.03	24.80
Not assessed	12500	14.1540	4.33526	.03878	14.0780	14.2300	5.03	24.80
Total	387106	13.5786	4.49250	.00722	13.5645	13.5928	5.03	24.80

Descriptives

average of the monthly minimum temperature

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	12559	6.5966	3.73805	.03336	6.5312	6.6620	-.52	16.15
A&E/hospital	29479	7.0714	3.81533	.02222	7.0278	7.1150	-.66	16.15
Emergency GP/dentist	88694	6.7437	3.75406	.01261	6.7190	6.7684	-.66	16.15
GP/dentist	81167	6.9576	3.79678	.01333	6.9315	6.9837	-.66	16.15
Other	26795	7.1792	3.95479	.02416	7.1318	7.2265	-.66	16.15
Selfcare	153091	6.9047	3.74305	.00957	6.8860	6.9235	-.66	16.15
Not assessed	13065	7.4429	3.67096	.03212	7.3800	7.5059	-.66	16.15

Descriptives

average of the monthly minimum temperature

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	12559	6.5966	3.73805	.03336	6.5312	6.6620	-.52	16.15
A&E/hospital	29479	7.0714	3.81533	.02222	7.0278	7.1150	-.66	16.15
Emergency GP/dentist	88694	6.7437	3.75406	.01261	6.7190	6.7684	-.66	16.15
GP/dentist	81167	6.9576	3.79678	.01333	6.9315	6.9837	-.66	16.15
Other	26795	7.1792	3.95479	.02416	7.1318	7.2265	-.66	16.15
Selfcare	153091	6.9047	3.74305	.00957	6.8860	6.9235	-.66	16.15
Not assessed	13065	7.4429	3.67096	.03212	7.3800	7.5059	-.66	16.15
Total	404850	6.9182	3.77679	.00594	6.9065	6.9298	-.66	16.15

Descriptives

snow in cm

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	12792	1.4307	5.08156	.04493	1.3427	1.5188	.00	70.00
A&E/hospital	29867	1.0457	4.38912	.02540	.9960	1.0955	.00	70.00
Emergency GP/dentist	89907	1.1616	4.64510	.01549	1.1313	1.1920	.00	70.00
GP/dentist	82154	1.0440	4.56344	.01592	1.0128	1.0752	.00	70.00
Other	27135	.9844	4.34027	.02635	.9328	1.0361	.00	70.00
Selfcare	154594	1.0713	4.97687	.01266	1.0465	1.0961	.00	70.00

Not assessed	13190	.8217	4.28897	.03734	.7485	.8949	.00	70.00
Total	409639	1.0812	4.72431	.00738	1.0667	1.0957	.00	70.00

Descriptives

NO2 average of the monthly maximum reading

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	12479	26.4287	8.38729	.07508	26.2816	26.5759	3.10	51.10
A&E/hospital	29221	26.2380	8.56257	.05009	26.1398	26.3362	3.10	51.10
Emergency GP/dentist	87735	26.3585	8.59803	.02903	26.3016	26.4154	3.10	51.10
GP/dentist	79561	25.9201	9.02665	.03200	25.8574	25.9828	3.10	51.10
Other	26365	26.0413	8.87968	.05469	25.9341	26.1484	3.10	51.10
Selfcare	146829	24.5238	9.93283	.02592	24.4730	24.5746	3.10	51.10
Not assessed	12619	24.0960	9.90777	.08820	23.9231	24.2689	3.10	51.10
Total	394809	25.4876	9.28952	.01478	25.4586	25.5166	3.10	51.10

Descriptives

NO2 average of the monthly minimum reading

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	12479	4.5154	2.27948	.02041	4.4754	4.5554	.60	12.60
A&E/hospital	29221	4.5413	2.33395	.01365	4.5145	4.5680	.60	12.60

Emergency GP/dentist	87735	4.5777	2.38214	.00804	4.5620	4.5935	.60	12.60
GP/dentist	79561	4.5124	2.38416	.00845	4.4958	4.5289	.60	12.60
Other	26365	4.5101	2.39307	.01474	4.4812	4.5390	.60	12.60
Selfcare	146829	4.2743	2.37797	.00621	4.2621	4.2865	.60	12.60
Not assessed	12619	4.1275	2.32963	.02074	4.0868	4.1681	.60	12.60
Total	394809	4.4281	2.37748	.00378	4.4207	4.4356	.60	12.60

Descriptives

SO2 average of the monthly maximum reading

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
999/ambulance	12464	4.5391	2.61421	.02342	4.4932	4.5850	1.20	18.30
A&E/hospital	28949	4.5648	2.68695	.01579	4.5338	4.5957	1.20	18.30
Emergency GP/dentist	87161	4.6181	2.67464	.00906	4.6004	4.6359	1.20	18.30
GP/dentist	78574	4.6141	2.70078	.00963	4.5952	4.6330	1.20	18.30
Other	25984	4.6672	2.78481	.01728	4.6333	4.7011	1.20	18.30
Selfcare	141173	4.7061	2.78629	.00742	4.6916	4.7206	1.20	18.30
Not assessed	12321	4.5229	2.68040	.02415	4.4756	4.5703	1.20	18.30
Total	386626	4.6432	2.72835	.00439	4.6346	4.6518	1.20	18.30

Descriptives

SO2 average of monthly minimum reading

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	12464	.4325	.34970	.00313	.4264	.4386	.00	4.30
A&E/hospital	28949	.4399	.36658	.00215	.4357	.4442	.00	4.30
Emergency GP/dentist	87161	.4480	.37409	.00127	.4455	.4505	.00	4.30
GP/dentist	78574	.4523	.40232	.00144	.4495	.4551	.00	4.30
Other	25984	.4586	.40071	.00249	.4538	.4635	.00	4.30
Selfcare	141173	.4863	.49215	.00131	.4838	.4889	.00	4.30
Not assessed	12321	.4455	.45532	.00410	.4374	.4535	.00	4.30
Total	386626	.4624	.42969	.00069	.4610	.4638	.00	4.30

Descriptives

PM10 average of the monthly minimum reading

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	9961	10.9938	3.19135	.03198	10.9311	11.0565	3.60	23.50
A&E/hospital	23719	11.1747	3.36663	.02186	11.1318	11.2175	3.60	23.50
Emergency GP/dentist	71226	11.0718	3.37928	.01266	11.0470	11.0966	3.60	23.50
GP/dentist	63199	11.0870	3.46955	.01380	11.0600	11.1141	3.60	23.50
Other	20659	11.2927	3.50070	.02436	11.2449	11.3404	3.60	23.50
Selfcare	110783	10.8087	3.63491	.01092	10.7873	10.8301	3.60	23.50
Not assessed	9388	10.6134	3.54691	.03661	10.5417	10.6852	3.60	23.50
Total	308935	10.9868	3.50169	.00630	10.9744	10.9991	3.60	23.50

Descriptives

PM10 average of the monthly maximum reading

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	9961	49.0805	25.03949	.25088	48.5887	49.5723	15.10	171.50
A&E/hospital	23719	50.4655	26.29595	.17074	50.1308	50.8001	15.10	171.50
Emergency GP/dentist	71226	49.5109	25.37150	.09507	49.3246	49.6972	15.10	171.50
GP/dentist	63199	50.0196	25.94633	.10321	49.8173	50.2219	15.10	171.50
Other	20659	50.3074	25.70780	.17886	49.9569	50.6580	15.10	171.50
Selfcare	110783	48.1426	25.61677	.07696	47.9917	48.2934	15.10	171.50
Not assessed	9388	47.1364	24.43167	.25215	46.6421	47.6307	15.10	171.50
Total	308935	49.1648	25.65088	.04615	49.0744	49.2553	15.10	171.50

Descriptives

O3 average of the monthly maximum reading

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
999/ambulance	10971	37.4286	7.23002	.06903	37.2933	37.5639	20.00	54.00
A&E/hospital	25646	37.6239	7.34100	.04584	37.5341	37.7138	20.00	54.00
Emergency GP/dentist	75480	37.2965	7.33924	.02671	37.2442	37.3489	20.00	54.00
GP/dentist	70914	37.4322	7.31616	.02747	37.3783	37.4860	20.00	54.00

Other	23870	37.7026	7.62934	.04938	37.6058	37.7994	20.00	54.00
Selfcare	135267	37.5414	7.20825	.01960	37.5030	37.5799	20.00	54.00
Not assessed	11316	37.7953	6.90765	.06494	37.6681	37.9226	20.00	54.00
Total	353464	37.4887	7.28920	.01226	37.4647	37.5127	20.00	54.00

Appendix 11: Interview schedule

The epidemiology of demand for and outcomes of contacts with telephone based healthcare by patient deprivation status: Analysis of calls to NHS Direct Wales 2002 – 2004

Telephone interview schedule- Healthcare professionals

Telephone interviews will take place with a sample of healthcare professionals and service users either in North East Flintshire, or in Chester, on the English Welsh border. Interviews will be recorded with the consent of the interviewee.

Introduction:
Thank you for taking the time to speak to me. As you are aware, I am studying for a PhD at Swansea University, looking at the epidemiology of calls to NHS Direct Wales over 2002-4, I am especially interested in the influence of patient deprivation on call rates and outcomes. When analysing call rates by ward across the country I noticed something a bit different going on up in East Flintshire.
Rather than going into what I've found right now, I'd be really grateful if I could ask you a few questions to help me determine how NHSDW may or may not be being used in this part of Wales. In my analysis and write up I will record all quotes anonymously but would you mind if I ask you some background information briefly? (If I'm taping ask for consent to record).
Background information:
Role:
Location:
Number of years experience:
Number of years experience in this area:

Questions:

For unscheduled healthcare events, what service do you think people in East Flintshire first contact? Do you think that whether the service is in England or Wales matters? *Note: I may need to probe more about who they contact when it is not urgent enough to phone 999.*

Why do you think that this is so? What are the influences on this decision? *(Probes: e.g. family, friends, advertising, where they live, availability of services (eg is there a local A&E they go to first)*

My data suggests that people in EF may be using NHSDW, differently from the rest of Wales. Could you suggest any reasons why this has happened? *(Probe about NHSD in England, urban/rural, deprived/well off, proximity to England)*

If people need out of hours health advice, do you think, given the choice, that patients would contact NHSD in England or NHSD in Wales? Why do you think that this may be the case?

Are you, or were you aware of any past partnership or call sharing between NHSD in Wales and NHSD in England?

If I were to tell you now that out of 865 wards in Wales, the 20 with the lowest call rates to NHSDW were in Flintshire and that the 5 lowest call rates of all were in East Flintshire, in Saltney, Higher Kinnerton, Broughton North and East, Hawarden and Broughton South, would you be surprised?

Can you think of any other influences which we haven't yet discussed that may be playing a part in these low call rates?

Have you experienced in your own role people from these areas behaving differently to the rest of the population?

Would you be able to indicate a boundary where you think that people's use of NHSDW changes? Why do you put it there?

Thank you again for your time, this has been very helpful.

Appendix 12: Letter to NHSD

Julie Peconi

College of Medicine, ILS2 building

Swansea University,

Swansea, Wales

SA2 8PP

Research, Service Evaluation and Clinical Audit team, NHS Direct
Berrywood Business Village
Tollbar Way
Hedge End
Southampton
SO30 2UN

13.04.2012

To whom it may concern,

My name is Julie Peconi and I am a PhD student at Swansea University. My research topic is about the epidemiology of demand for NHSD in Wales and I am particularly interested in the role that patient deprivation plays in calls to the service and the dispositions given.

For my thesis, I have two and a half years of anonymous call records to the service. When mapping call rates, I have noticed that calls in North East Flintshire in Wales are extremely low in comparison with the rest of the country.

I know that NHSD in England and NHSDW have the same telephone number. How do calls get allocated between the two services? Was it possible that calls in East Flintshire went to NHSD in England during this time?

I'd be grateful for any information that you could provide with respect to this. I have also contacted NHSDW to see if they can help. If it's easier to discuss this, I would be happy to give someone a call.

I look forward to hearing from you.

With thanks

Julie Peconi
339735@swansea.ac.uk

Appendix 13: Summary table of area based variables by ward

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
Blaenau Gwent									
PLMA	Abertillery	694	4490	0.155	32.08	164	9.76	12.6	Nevill Hall
PLMB	Badminton	368	3155	0.117	23.45	317	11.79	11.9	Prince Charles
PLMC	Beaufort	402	3876	0.104	30.26	197	11.27	11.9	Nevill Hall
PLMD	Blaina	632	4830	0.131	39.44	98	6.08	11.0	Nevill Hall
PLME	Brynmawr	610	5599	0.109	34.22	137	9.62	9.7	Nevill Hall
PLMF	Cwm	540	4350	0.124	38.35	104	4.45	14.3	Nevill Hall
PLMG	Cwmtillery	648	4749	0.136	40.78	89	4.81	10.8	Nevill Hall
PLMH	Ebbw Vale North	566	4745	0.119	37.37	108	19.06	12.0	Prince Charles
PLMJ	Ebbw Vale South	573	4199	0.136	38.30	105	6.32	12.9	Prince Charles
PLMK	Georgetown	350	3491	0.100	23.58	314	8.55	11.2	Prince Charles
PLML	Llanhilleth	648	4776	0.136	50.40	47	6.45	15.3	Nevill Hall
PLMM	Nantyglo	475	4293	0.111	57.82	25	5.84	10.5	Nevill Hall
PLMN	Rassau	359	3297	0.109	41.11	87	6.84	11.2	Prince Charles
PLMP	Sirhowy	535	5520	0.097	49.44	50	3.34	8.5	Prince Charles
PLMQ	Six Bells	351	2648	0.133	32.64	155	6.22	13.5	Nevill Hall
PLMR	Tredegar Central and West	525	6046	0.087	51.04	43	5.46	10.0	Prince Charles
	Totals	8276	70064						
Bridgend									
PBMA	Bettws	223	2034	0.110	59.873	22	4.34	6.2	Princess of Wales
PBMB	Blackmill	233	2327	0.100	47.114	58	1.39	8.2	Princess of Wales
PBMC	Blaengarw	183	1895	0.097	34.896	128	2.34	12.4	Princess of Wales
PBMD	Brackla	1839	10113	0.182	8.227	742	41.11	1.5	Princess of Wales

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PBME	Caerau	341	4003	0.085	62.797	17	4.83	12.0	Neath Port Talbot
PBMF	Cefn Cribwr	126	1546	0.082	22.331	340	2.07	5.4	Princess of Wales
PBMG	Coity Higher	774	5773	0.134	6.004	798	7.67	1.4	Princess of Wales
PBMH	Cornelly	503	5982	0.084	33.389	150	3.60	10.1	Princess of Wales
PBMJ	Coychurch Lower	208	1206	0.172	6.297	793	1.77	3.0	Princess of Wales
PBMK	Laleston/Merthyr Mawr	1941	8731	0.222	14.911	543	3.51	4.5	Princess of Wales
PBML	Llangeinor	204	1161	0.176	41.852	84	0.98	7.3	Princess of Wales
PBMM	Llangynwyd	384	2843	0.135	20.436	385	2.10	8.6	Princess of Wales
PBMN	Maesteg East	567	4987	0.114	25.736	268	9.02	10.7	Princess of Wales
PBMP	Maesteg West	673	5846	0.115	33.305	151	8.22	9.1	Neath Port Talbot
PBMQ	Morfa	873	4263	0.205	31.920	168	36.44	0.7	Princess of Wales
PBMR	Nantyffyllon	337	3025	0.111	31.589	174	4.83	10.8	Neath Port Talbot
PBMS	Nant-y-moel	268	2322	0.115	29.840	204	2.28	12.5	Princess of Wales
PBMT	Newcastle	795	5025	0.158	14.073	568	30.95	1.6	Princess of Wales
PBMU	Newcastle Higher	484	4162	0.116	10.199	679	2.68	4.5	Princess of Wales
PBMW	Ogmore Vale	276	3151	0.088	22.794	327	2.75	9.8	Princess of Wales
PBMX	Oldcastle	752	4662	0.161	8.326	736	12.57	2.6	Princess of Wales
PBMY	Pencoed	1119	9458	0.118	9.719	687	3.95	5.5	Princess of Wales
PBMZ	Pontycymmer	322	2480	0.130	30.595	191	3.93	10.2	Princess of Wales
PBNA	Porthcawl East	1356	6762	0.201	16.284	502	10.6	8.0	Princess of Wales
PBNB	Porthcawl West	1750	9107	0.192	8.932	716	12.99	9.7	Princess of Wales
PBNC	Pyle	584	7205	0.081	27.030	248	22.3	7.8	Princess of Wales
PBND	St. Bride's Minor	527	5575	0.095	31.148	184	5.39	3.2	Princess of Wales
PBNE	Ynysawdre	356	3003	0.119	20.162	390	15.69	3.7	Princess of Wales
	Totals	17998	128647						
Caerphilly									

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PKMD	Aber Valley	871	6696	0.130	41.110	86	5.03	4.5	Caerphilly and District Miner's
PKMA	Aberbargoed	424	3558	0.119	63.501	16	10.48	13.5	Caerphilly and District Miner's
PKMB	Abercarn	894	4793	0.187	22.745	329	2.9	11.5	Royal Gwent
PKMC	Abertysswg	162	1505	0.108	40.207	92	8.06	9.1	Prince Charles
PKME	Argoed	451	2515	0.179	45.476	72	1.6	14.6	Prince Charles
PKMF	Bargoed	889	6247	0.142	49.272	52	22.91	13.1	Caerphilly and District Miner's
PKMG	Bedwas and Trethomas	830	6269	0.132	28.707	222	5.69	4.0	Caerphilly and District Miner's
PKMH	Blackwood	1546	8162	0.189	19.244	409	19.29	11.7	Caerphilly and District Miner's
PKMJ	Cefn Fforest	613	3589	0.171	36.884	116	56.17	10.9	Caerphilly and District Miner's
PKMK	Crosskeys	615	3092	0.199	21.952	350	5.39	9.4	Caerphilly and District Miner's
PKML	Crumlin	1125	5724	0.197	28.088	233	4.41	14.4	Caerphilly and District Miner's
PKMM	Darran Valley	321	2545	0.126	60.814	20	1.29	9.4	Prince Charles
PKMN	Gilfach	260	2059	0.126	40.845	88	20.12	11.8	Caerphilly and District Miner's
PKMP	Hengoed	749	5044	0.148	42.352	80	24.35	9.1	Caerphilly and District Miner's
PKMQ	Llanbradach	616	4622	0.133	19.161	411	7.42	4.5	Caerphilly and District Miner's
PKMR	Machen	660	4159	0.159	33.647	147	5.69	7.0	Caerphilly and District Miner's
PKMS	Maesycwmmer	402	2141	0.188	18.107	447	2.85	7.1	Caerphilly and District Miner's
PKMT	Morgan Jones	1034	6513	0.159	20.098	393	24.45	1.6	Caerphilly and District Miner's
PKMU	Moriah	355	3075	0.115	49.172	53	8.63	7.8	Prince Charles

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PKMW	Nelson	533	4577	0.116	22.349	339	4.17	8.4	Caerphilly and District Miner's
PKMY	New Tredegar	411	3676	0.112	65.501	9	5.13	11.7	Prince Charles
PKMX	Newbridge	1522	6000	0.254	24.516	290	5.79	12.8	Caerphilly and District Miner's
PKMZ	Pengam	618	3842	0.161	27.325	242	16.23	10.5	Caerphilly and District Miner's
PKNA	Penmaen	826	4478	0.184	17.237	476	9.34	12.3	Caerphilly and District Miner's
PKNB	Penyrheol	1657	11530	0.144	24.251	297	21.25	1.5	Caerphilly and District Miner's
PKNC	Pontllanfraith	1379	7773	0.177	23.746	310	13.52	9.3	Caerphilly and District Miner's
PKND	Pontlottyn	183	1803	0.101	53.677	35	7.42	7.9	Prince Charles
PKNE	Risca East	1362	6384	0.213	18.499	435	23.24	7.1	Royal Gwent
PKNF	Risca West	1098	5071	0.217	20.878	379	9.87	8.0	Royal Gwent
PKNG	St. Cattwg	1037	7452	0.139	36.898	114	6.18	10.9	Caerphilly and District Miner's
PKNH	St. James	806	5912	0.136	34.405	134	2.23	5.4	Caerphilly and District Miner's
PKNJ	St. Martins	1210	7293	0.166	8.301	739	10.58	1.2	Caerphilly and District Miner's
PKNK	Tir-Phil	144	1269	0.113	55.443	28	5.13	11.5	Prince Charles
PKNL	Twyn Carno	296	2374	0.125	60.372	21	1.71	5.6	Prince Charles
PKNM	Ynysddu	766	3698	0.207	24.551	289	2.61	7.2	Caerphilly and District Miner's
PKNN	Ystrad Mynach	740	4077	0.182	15.860	518	6.51	7.5	Caerphilly and District Miner's
	Totals	27405	169517						
Cardiff									
PTMA	Adamsdown	1327	6850	0.194	38.415	103	64.21	3.2	Heath

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PTMB	Butetown	1083	4487	0.241	53.400	37	8.82	4.8	Heath
PTMC	Caerau	854	10189	0.084	45.614	70	33.6	5.4	Heath
PTMD	Canton	1852	13086	0.142	11.499	647	42.43	3.4	Heath
PTME	Cathays	2966	13940	0.213	8.202	743	41.69	2.0	Heath
PTMF	Creigiau	257	2762	0.093	2.264	857	2.41	6.0	Royal Glamorgan
PTMG	Cyncoed	1062	10310	0.103	1.127	865	27.74	1.9	Heath
PTMH	Ely	1434	14751	0.097	46.717	63	47.95	6.0	Heath
PTMJ	Fairwater	1405	12366	0.114	22.065	345	40.4	4.1	Heath
PTMK	Gabalfa	954	7619	0.125	8.543	729	60.01	0.8	Heath
PTML	Grangetown	1944	14367	0.135	32.439	160	33.8	4.8	Heath
PTMM	Heath	1200	11770	0.102	1.928	860	37.38	0.8	Heath
PTMN	Lisvane and St. Mellons	1672	11356	0.147	2.596	856	6.98	4.8	Heath
PTMP	Llandaff	1096	8988	0.122	1.220	864	35.19	2.9	Heath
PTMQ	Llandaff North	924	8257	0.112	24.969	282	41.49	2.2	Heath
PTMR	Llanishen	2052	16019	0.128	4.788	826	32.32	2.8	Heath
PTMS	Llanrumney	1185	11226	0.106	35.100	125	36.81	4.4	Heath
PTMT	Pentwyn	2253	14643	0.154	14.820	548	39.81	3.2	Heath
PTMU	Pentyrch	377	3535	0.107	2.838	852	3.13	6.0	Caerphilly and District Miner's
PTMW	Plasnewydd	2880	16339	0.176	10.527	669	100.31	2.2	Heath
PTMX	Radyr and St. Fagans	871	6138	0.142	1.724	862	5.46	5.7	Heath
PTMY	Rhiwbina	1144	11249	0.102	1.652	863	17.53	3.6	Heath
PTMZ	Riverside	2078	12021	0.173	21.700	360	46.49	2.3	Heath
PTNA	Roath	1652	11672	0.142	2.175	858	34.84	2.5	Heath
PTNB	Rumney	1222	8964	0.136	21.544	364	25.89	4.6	Heath
PTNC	Splott	1976	12074	0.164	41.408	85	24.72	4.3	Heath

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PTND	Trowbridge	2994	14801	0.202	34.867	129	16.06	6.4	Heath
PTNE	Whitchurch and Tongwynlais	1941	15574	0.125	6.493	786	18.17	3.9	Heath
	Totals	42655	305353						
Carmarthenshire									
NUMA	Abergwili	335	2271	0.148	8.838	719	0.36	5.8	West Wales General
NUMB	Ammanford	201	1280	0.157	29.021	220	15.05	12.1	Morriston
NUMC	Betws	290	1834	0.158	23.898	306	1.64	10.3	Morriston
NUMD	Bigyn	899	6347	0.142	37.068	111	27.15	1.7	Prince Philip
NUME	Burry Port	390	4209	0.093	33.736	143	10.00	7.2	Prince Philip
NUMF	Bynea	322	3091	0.104	35.962	119	5.04	3.1	Prince Philip
NUMG	Carmarthen Town North	940	5291	0.178	13.519	584	9.43	1.3	West Wales General
NUMH	Carmarthen Town South	826	3526	0.234	15.069	539	5.36	3.8	West Wales General
NUMJ	Carmarthen Town West	741	4313	0.172	8.385	734	4.98	4.6	West Wales General
NUMK	Cenarth	380	1995	0.190	14.550	554	0.43	20.5	West Wales General
NUML	Clynderwen	189	1516	0.125	14.689	549	2.11	19.4	Withybush
NUMM	Cross Hands	205	1298	0.158	27.087	247	1.30	10.0	Prince Philip
NUMN	Cynwyl Elfed	288	1548	0.186	17.310	473	0.23	10.1	West Wales General
NUMP	Cynwyl Gaeo and Llanwrda Talley	361	2380	0.152	17.889	453	0.12	29.3	West Wales General
NUMQ	Dafen	490	3433	0.143	31.443	177	14.21	0.5	Prince Philip
NUMR	Elli	445	3156	0.141	29.188	214	32.41	2.4	Prince Philip
NUMS	Felinfoel	304	1948	0.156	46.653	64	8.17	1.3	Prince Philip
NUMT	Garnant	257	1965	0.131	35.682	121	1.29	13.4	Morriston
NUMU	Glanamman	241	2261	0.107	37.308	109	1.84	11.7	Morriston
NUMW	Glanymor	801	4888	0.164	65.057	10	12.37	3.1	Prince Philip

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NUMX	Glyn	226	2032	0.111	23.271	320	0.87	6.4	Prince Philip
NUMY	Gorslas	498	3724	0.134	16.653	496	2.25	13.3	Prince Philip
NUMZ	Hendy	606	3039	0.199	13.971	573	2.03	6.7	Prince Philip
NUNA	Hengoed	439	3829	0.115	25.873	265	2.16	3.7	Prince Philip
NUNB	Kidwelly	407	3289	0.124	34.486	132	2.82	12.5	Prince Philip
NUNC	Laugharne Township	166	1320	0.126	19.654	399	0.51	17.8	West Wales General
NUND	Llanboidy	229	1681	0.136	13.712	583	0.24	22.1	West Wales General
NUNE	Llanddarog	234	1833	0.128	9.244	706	0.41	9.4	West Wales General
NUNF	Llanddowror	233	1622	0.144	17.523	467	0.22	22.0	West Wales General
NUNG	Llandeilo-Tywi and Castle	178	1730	0.103	17.217	479	0.62	19.0	West Wales General
NUNH	Llandovery Town/Cilycwm and Llanfair-ar-y-bryn	275	3342	0.082	18.738	424	0.21	40.3	West Wales General
NUNJ	Llandybie and Heolddu	429	3738	0.115	22.020	347	1.51	15.0	Morriston
NUNK	Llandyfaelog	159	1273	0.125	14.552	552	0.37	7.7	West Wales General
NUNL	Llanegwad and Llanfynydd	212	1926	0.110	20.151	391	0.16	12.3	West Wales General
NUNM	Llanfihangel Aberbythych and Llangathen	235	1716	0.137	13.989	572	0.35	15.4	West Wales General
NUNN	Llanfihangel-ar-Arth	366	2051	0.178	19.297	406	0.31	14.8	West Wales General
NUNP	Llangeler	627	3222	0.195	22.981	322	0.53	17.0	West Wales General
NUNQ	Llangennech	623	4510	0.138	21.907	353	3.69	3.1	Prince Philip
NUNR	Llangunnor	336	2282	0.147	8.729	721	0.99	3.2	West Wales General
NUNS	Llangyndeyrn	469	2953	0.159	28.350	229	0.63	9.7	West Wales General
NUNT	Llansadwrn and Llangadog Myddfai and Llanddeusant	213	2412	0.088	19.024	417	0.10	26.6	Morriston
NUNU	Llansteffan	332	2209	0.150	10.664	666	0.38	10.1	West Wales General
NUNW	Llanybydder/Llanllwni	507	2594	0.195	18.310	438	0.28	19.6	West Wales General
NUNX	Lliedi	732	5036	0.145	25.900	264	31.62	1.2	Prince Philip

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NUNY	Llwynhendy	543	4276	0.127	51.838	41	10.99	2.4	Prince Philip
NUNZ	Manordeilo and Salem Ffairfach	253	2793	0.091	14.235	565	0.34	21.6	West Wales General
NUPA	Myddynfych	172	1302	0.132	26.473	254	22.06	12.8	Morriston
NUPB	Newchurch	137	1195	0.115	8.533	730	0.23	5.0	West Wales General
NUPC	Pantyffynnon	211	1384	0.152	42.902	78	15.05	11.3	Morriston
NUPD	Pembrey	453	3748	0.121	30.834	188	0.99	12.0	Prince Philip
NUPE	Pencarreg	208	1344	0.155	16.837	490	0.24	28.9	West Wales General
NUPF	Penygroes	312	2429	0.128	23.289	319	3.42	13.5	Prince Philip
NUPG	Pontamman	147	1327	0.111	12.573	620	17.5	12.0	Morriston
NUPH	Pontyberem	386	2829	0.136	25.864	266	2.12	9.8	Prince Philip
NUPJ	Quarter Bach Llynfell Brynamman	419	2933	0.143	30.539	193	0.92	16.6	Morriston
NUPM	Saron	505	3467	0.146	27.506	239	3.51	12.8	Prince Philip
NUPK	St. Clears	354	3421	0.103	12.617	618	0.51	14.0	West Wales General
NUPL	St. Ishmael	235	1319	0.178	19.576	402	0.71	16.2	Prince Philip
NUPN	Swiss Valley	253	2434	0.104	10.243	678	2.40	3.0	Prince Philip
NUPP	Trelech	248	1491	0.166	15.910	513	0.17	14.9	West Wales General
NUPQ	Trimsaran	307	2533	0.121	32.475	159	1.27	8.7	Prince Philip
NUPR	Tumble	481	3701	0.130	28.107	232	1.30	7.6	Prince Philip
NUPS	Tycroes	280	2156	0.130	17.626	462	1.92	10.9	Morriston
NUPT	Tyisha	605	3995	0.151	45.790	69	62.79	2.4	Prince Philip
NUPU	Whitland	165	1643	0.100	18.789	421	0.92	23.4	West Wales General
	Totals	24310	173633						
Ceredigion									
NQMA	Aberaeron	291	1520	0.191	13.433	586	9.59	23.4	Bronglais General Hospital

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NQMB	Aberporth	433	2485	0.174	21.400	367	1.51	33.9	West Wales General
NQMC	Aberystwyth East	320	1928	0.166	4.668	828	34.60	0.2	Bronglais General Hospital
NQMD	Aberystwyth North	507	2951	0.172	7.847	754	15.30	0.7	Bronglais General Hospital
NQME	Aberystwyth South	443	3347	0.132	29.965	201	17.00	1.8	Bronglais General Hospital
NQMF	Aberystwyth West	601	3381	0.178	11.376	649	38.80	0.9	Bronglais General Hospital
NQMG	Beulah	287	1617	0.177	19.586	401	0.32	27.9	West Wales General
NQMH	Borth	297	2258	0.132	18.259	440	0.89	7.6	Bronglais General Hospital
NQMJ	Capel Dewi	251	1381	0.182	23.346	318	0.23	24.0	West Wales General
NQMK	Cardigan	761	4494	0.169	26.114	258	1.67	35.9	West Wales General
NQML	Ceulanamaesmawr	223	1917	0.116	11.299	651	0.14	14.0	Bronglais General Hospital
NQMM	Ciliau Aeron	312	2003	0.156	21.452	366	0.50	24.5	Bronglais General Hospital
NQMN	Faenor	303	2422	0.125	6.385	792	3.83	2.4	Bronglais General Hospital
NQMP	Lampeter	497	2894	0.172	7.747	757	2.29	31.0	West Wales General
NQMQ	Llanarth	270	1564	0.173	24.651	285	0.34	30.6	Bronglais General Hospital
NQMR	Llanbadarn Fawr	405	2899	0.140	6.155	794	9.24	1.4	Bronglais General Hospital
NQMS	Llandyfriog	326	1821	0.179	25.823	267	0.61	22.0	West Wales General
NQMT	Llandysiliogogo	369	1953	0.189	18.556	431	0.29	32.7	West Wales General
NQMU	Llandysul Town	215	1521	0.141	25.047	280	2.58	20.7	West Wales General
NQMW	Llanfarian	231	1442	0.160	12.266	629	0.43	4.5	Bronglais General Hospital
NQMX	Llanfihangel Ystrad	437	2043	0.214	22.578	332	0.28	26.2	Bronglais General Hospital
NQMY	Llangeitho	278	1597	0.174	29.126	217	0.11	28.6	Bronglais General Hospital
NQMZ	Llangybi	352	1750	0.201	24.286	294	0.24	29.6	Bronglais General Hospital
NQNA	Llanrhystud	223	1490	0.150	16.133	508	0.25	12.5	Bronglais General Hospital
NQNB	Llansantffraid	362	2482	0.146	18.138	444	0.41	19.2	Bronglais General Hospital
NQNC	Llanwenog	299	1883	0.159	16.664	495	0.28	27.3	West Wales General
NQND	Lledrod	394	2249	0.175	24.616	287	0.10	20.2	Bronglais General Hospital

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NQNE	Melindwr	299	2173	0.138	10.800	660	0.11	16.3	Bronglais General Hospital
NQNF	New Quay	217	1115	0.195	21.970	349	4.84	30.3	Bronglais General Hospital
NQNG	Penbryn	397	2079	0.191	23.694	313	0.39	31.9	West Wales General
NQNH	Penparc	452	2351	0.192	15.908	514	0.50	34.7	West Wales General
NQNJ	Tirymynach	235	1888	0.124	11.078	653	1.30	3.9	Bronglais General Hospital
NQNK	Trefeurig	174	1675	0.104	8.270	741	0.64	8.1	Bronglais General Hospital
NQNL	Tregaron	224	1217	0.184	21.974	348	0.14	26.9	Bronglais General Hospital
NQNM	Troedyraur	282	1408	0.200	24.388	292	0.43	26.1	West Wales General
NQNN	Ystwyth	228	2032	0.112	8.868	718	0.29	9.8	Bronglais General Hospital
	Totals	12195	75230						
Conwy									
NEMA	Betws yn Rhos	82	944	0.087	11.820	640	0.21	12.4	Glan Clwd
NEMB	Bro Machno/Betws-y-Coed	255	1812	0.141	15.162	538	0.08	23.9	Ysbyty Gwynedd
NEMC	Bryn	207	1320	0.157	29.908	203	2.04	13.3	Ysbyty Gwynedd
NEMD	Bryn Rhys	169	1025	0.165	9.655	689	5.15	18.6	Glan Clwd
NEME	Caerhun	258	1894	0.136	14.197	567	0.25	18.3	Ysbyty Gwynedd
NEMF	Capelulo	199	1454	0.137	17.926	452	2.86	19.7	Ysbyty Gwynedd
NEMG	Colwyn	496	4246	0.117	18.888	419	24.35	12.9	Glan Clwd
NEMH	Conwy	605	4080	0.148	11.930	637	6.64	22.5	Ysbyty Gwynedd
NEMJ	Craig-y-Don	507	3385	0.150	12.574	619	11.77	20.8	Glan Clwd
NEMK	Crwst	255	1928	0.132	15.281	532	4.84	24.9	Glan Clwd
NEML	Deganwy	547	3699	0.148	8.936	715	13.76	22.0	Glan Clwd
NEMM	Dinarth	356	2670	0.133	5.075	821	23.01	17.6	Glan Clwd
NEMN	Eglwysbach	156	1502	0.104	12.416	627	0.28	21.0	Glan Clwd
NEMP	Eirias	394	3380	0.117	12.386	628	15.40	13.8	Glan Clwd
NEMQ	Ffforddlas	127	1265	0.100	8.027	746	0.82	19.1	Glan Clwd

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NEMR	Gele	560	4403	0.127	7.381	766	3.46	4.2	Glan Clwd
NEMS	Glyn	749	3971	0.189	29.262	213	13.82	15.0	Glan Clwd
NEMT	Gogarth	710	3586	0.198	22.921	324	6.74	24.5	Glan Clwd
NEMU	Gower	133	1109	0.120	20.212	389	8.78	24.7	Glan Clwd
NEMW	Kinmel Bay	672	5625	0.119	26.896	251	12.03	3.5	Glan Clwd
NEMX	Llanddulas	236	1572	0.150	10.044	681	3.08	8.7	Glan Clwd
NEMY	Llanfair Talhaiarn	118	1542	0.077	12.974	607	0.18	7.5	Glan Clwd
NEMZ	Llangernyw	124	1321	0.094	15.195	537	0.11	20.6	Glan Clwd
NENA	Llansannan	75	1291	0.058	12.136	631	0.15	14.5	Glan Clwd
NENB	Llysfaen	325	2652	0.123	24.200	298	4.68	11.0	Glan Clwd
NENC	Marl	499	3736	0.134	9.589	691	15.27	21.0	Glan Clwd
NEND	Mochdre	245	1862	0.132	20.881	378	6.63	17.6	Glan Clwd
NENE	Mostyn	732	3555	0.206	22.436	337	28.68	23.1	Glan Clwd
NENF	Pandy/Lafan	538	2433	0.221	13.028	601	2.12	15.1	Ysbyty Gwynedd
NENG	Pant-yr-afon/Penmaenan	521	2403	0.217	31.173	182	2.37	17.2	Ysbyty Gwynedd
NENH	Penrhyn	681	4777	0.143	4.116	838	6.17	19.3	Glan Clwd
NENJ	Pensarn	418	2693	0.155	16.534	498	9.44	19.8	Glan Clwd
NENK	Pentre Mawr	909	5613	0.162	24.579	288	14.00	5.6	Glan Clwd
NENL	Rhiw	737	5771	0.128	13.289	591	11.73	16.2	Glan Clwd
NENM	Rhos	656	4440	0.148	14.253	563	23.01	17.2	Glan Clwd
NENN	Towyn	289	2239	0.129	28.541	224	3.95	3.7	Glan Clwd
NENP	Trefriw	146	1337	0.109	17.363	471	0.26	21.1	Ysbyty Gwynedd
NENQ	Tudno	836	4787	0.175	31.089	186	22.31	22.3	Glan Clwd
NENS	Uwch Conwy	108	869	0.124	15.263	533	0.08	30.6	Glan Clwd
NENR	Uwchaled	131	1403	0.093	17.176	481	0.11	27.8	Glan Clwd
	Totals	15761	109594						

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
Denbighshire									
NGMA	Bodelwyddan	253	2106	0.120	24.722	284	1.26	0.2	Glan Clwd
NGMB	Corwen	233	2398	0.097	20.430	386	0.34	22.8	Wrexham Maelor
NGMC	Denbigh Central	141	1997	0.071	22.639	331	18.7	11.2	Glan Clwd
NGMD	Denbigh Lower	216	4415	0.049	4.478	833	2.54	11.2	Glan Clwd
NGME	Denbigh Upper/Henllan	148	3116	0.047	28.901	221	1.78	10.4	Glan Clwd
NGMF	Dyserth	290	2566	0.113	14.885	546	3.36	6.6	Glan Clwd
NGMG	Efenechtyd	116	1294	0.090	9.414	695	0.23	23.8	Glan Clwd
NGMH	Llanarmon-yn-Ial/Llandegla	361	2583	0.140	10.526	670	0.26	14.0	Wrexham Maelor
NGMJ	Llanbedr Dyffryn Clwyd	150	1539	0.097	5.219	817	0.54	20.6	Glan Clwd
NGMK	Llandrillo	96	1116	0.086	13.005	604	0.12	30.8	Wrexham Maelor
NGML	Llandyrnog	75	1289	0.058	19.750	397	0.45	14.0	Glan Clwd
NGMM	Llanfair Dyffryn Clwyd Gwyddelwern	246	2255	0.109	10.481	672	0.24	22.9	Wrexham Maelor
NGMN	Llangollen	469	3884	0.121	13.291	590	0.65	14.0	Wrexham Maelor
NGMQ	Llanrhaeadr-yng-Nghinmeirch	93	1411	0.066	7.938	749	0.17	16.2	Glan Clwd
NGMR	Llanynys	120	1268	0.095	10.409	675	0.27	19.2	Glan Clwd
NGMS	Meliden	185	2175	0.085	30.222	198	13.65	7.7	Glan Clwd
NGMT	Prestatyn Central	289	3578	0.081	15.893	515	23.80	8.7	Glan Clwd
NGMU	Prestatyn East	592	4334	0.137	12.791	612	7.66	10.4	Glan Clwd
NGMW	Prestatyn North	520	5131	0.101	21.555	363	27.59	8.3	Glan Clwd
NGMX	Prestatyn South West	330	3278	0.101	18.527	432	26.66	7.7	Glan Clwd
NGMY	Rhuddlan	400	4296	0.093	12.984	606	3.14	3.8	Glan Clwd
NGMZ	Rhyl East	516	4553	0.113	27.915	235	26.82	6.2	Glan Clwd
NGNA	Rhyl South	405	3634	0.111	19.034	416	43.99	4.5	Glan Clwd

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NGNB	Rhyl South East	761	7298	0.104	18.578	430	38.6	5.4	Glan Clwd
NGNC	Rhyl South West	660	5152	0.128	49.884	49	28.7	4.5	Glan Clwd
NGND	Rhyl West	837	4252	0.197	74.868	1	39.37	4.8	Glan Clwd
NGNE	Ruthin	613	5218	0.117	6.735	779	6.38	21.7	Wrexham Maelor
NGNF	St. Asaph East	147	1796	0.082	6.406	790	4.89	4.3	Glan Clwd
NGNG	St. Asaph West	146	1695	0.086	14.945	542	6.10	3.3	Glan Clwd
NGNH	Trefnant	120	1849	0.065	13.020	602	0.72	5.4	Glan Clwd
NGNJ	Tremeirchion	98	1590	0.062	10.181	680	0.35	7.6	Glan Clwd
		9626							
Gwynedd									
NCMA	Aberdaron	58	1019	0.057	28.387	228	0.21	56.0	Ysbyty Gwynedd
NCMB	Aberdovey	100	781	0.128	14.422	556	0.21	15.6	Bronglais General Hospital
NCMC	Abererch	97	1436	0.068	16.188	507	0.58	35.9	Ysbyty Gwynedd
NCMD	Abersoch	118	901	0.131	21.741	358	1.55	48.4	Ysbyty Gwynedd
NCME	Arthog	139	1010	0.138	28.169	231	0.24	33.2	Bronglais General Hospital
NCMF	Bala	248	1980	0.125	19.588	400	8.18	41.0	glan clwd
NCMG	Barmouth	168	2437	0.069	42.708	79	1.52	36.3	Bronglais General Hospital
NCMH	Bethel	345	2112	0.163	13.002	605	1.40	4.6	Ysbyty Gwynedd
NCMJ	Bontnewydd	119	1165	0.102	13.219	594	1.16	13.0	Ysbyty Gwynedd
NCMK	Botwnnog	58	955	0.061	24.078	301	0.28	49.8	Ysbyty Gwynedd
NCML	Bowydd and Rhiw	190	1837	0.103	44.925	74	0.71	28.5	Ysbyty Gwynedd
NCMM	Cadnant	435	2148	0.203	35.507	122	10.1	9.2	Ysbyty Gwynedd
NCMN	Clynnog	145	860	0.169	24.761	283	0.19	24.3	Ysbyty Gwynedd
NCMP	Conglywal and Maenofferen	199	2124	0.094	30.850	187	1.18	29.9	Ysbyty Gwynedd
NCMQ	Corris/Mawddwy	253	1973	0.128	28.469	226	0.09	34.6	Bronglais General Hospital

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NCMR	Criccieth	156	1826	0.085	18.026	450	2.72	32.1	Ysbyty Gwynedd
NCMS	Cynfal and Teigl	67	869	0.077	25.285	277	0.66	32.7	Ysbyty Gwynedd
NCMT	Deiniol	384	1360	0.282	23.932	304	25.61	2.7	Ysbyty Gwynedd
NCMU	Deiniolen	284	1194	0.238	31.859	170	1.00	8.7	Ysbyty Gwynedd
NCMW	Dewi	332	1535	0.216	18.507	434	13.99	0.8	Ysbyty Gwynedd
NCMX	Dolbenmaen/Beddgelert	141	1917	0.074	18.231	441	0.14	23.4	Ysbyty Gwynedd
NCMY	Dolgellau/Llanelltyd/Brithdir and Llanfachreth	363	4086	0.089	17.050	484	0.18	42.8	Bronglais General Hospital
NCMZ	Dyffryn Ardudwy	153	1667	0.092	16.732	492	0.37	41.0	Bronglais General Hospital
NCNA	Efail-newydd/Buan	75	1277	0.059	20.956	376	0.23	40.9	Ysbyty Gwynedd
NCNB	Garth	175	1011	0.173	6.386	791	20.61	3.3	Ysbyty Gwynedd
NCNC	Gerlan	208	1338	0.155	26.787	252	8.54	8.3	Ysbyty Gwynedd
NCND	Glyder	432	1793	0.241	9.274	704	18.31	1.1	Ysbyty Gwynedd
NCNE	Harlech	201	1931	0.104	17.107	483	0.33	35.9	Ysbyty Gwynedd
NCNF	Hendre	298	1423	0.209	25.443	273	14.27	2.1	Ysbyty Gwynedd
NCNG	Hirael	270	1355	0.199	27.004	250	40.04	3.6	Ysbyty Gwynedd
NCNH	Llanaelhaearn/Pistyll	118	1559	0.076	30.400	196	0.32	31.9	Ysbyty Gwynedd
NCNJ	Llanarmon/Llanystumdwy	204	1949	0.105	16.942	487	0.32	31.9	Ysbyty Gwynedd
NCNK	Llanbedr	103	1005	0.102	20.908	377	0.15	42.3	Ysbyty Gwynedd
NCNL	Llanbedrog	60	1020	0.059	21.942	352	1.10	44.5	Ysbyty Gwynedd
NCNM	Llanberis	298	2018	0.148	22.094	344	0.44	13.0	Ysbyty Gwynedd
NCNN	Llandderfel	179	1478	0.121	19.876	396	0.07	38.2	Glan Clwd
NCNP	Llandwrog	315	2466	0.128	18.851	420	0.94	16.7	Ysbyty Gwynedd
NCNQ	Llandygai	451	2522	0.179	15.484	523	0.56	7.2	Ysbyty Gwynedd
NCNR	Llanengan	76	1123	0.068	17.211	480	0.40	49.7	Ysbyty Gwynedd
NCNS	Llangelynin/Bryn-crug	164	1637	0.100	19.074	415	0.15	23.9	Bronglais General Hospital

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NCNT	Llanllechid/Aber	212	1107	0.192	10.914	657	0.17	9.9	Ysbyty Gwynedd
NCNU	Llanllyfni	174	955	0.182	27.580	238	0.36	20.9	Ysbyty Gwynedd
NCNW	Llanrug	377	2755	0.137	21.749	357	1.75	8.4	Ysbyty Gwynedd
NCNX	Llanuwchllyn	77	834	0.092	18.276	439	0.04	47.6	Glan Clwd
NCNY	Llanwnda	294	1893	0.155	17.336	472	1.20	14.3	Ysbyty Gwynedd
NCNZ	Marchog	647	2690	0.241	62.353	18	25.57	3.3	Ysbyty Gwynedd
NCPA	Menai (Bangor)	624	2560	0.244	7.909	752	25.59	2.2	Ysbyty Gwynedd
NCPB	Menai (Caernarfon)	288	2136	0.135	13.052	599	8.44	9.0	Ysbyty Gwynedd
NCPC	Nefyn	171	2619	0.065	21.102	371	1.72	40.8	Ysbyty Gwynedd
NCPD	Ogwen	312	2269	0.138	32.008	166	17.99	7.1	Ysbyty Gwynedd
NCPE	Peblig	490	2304	0.213	67.930	6	22.82	10.3	Ysbyty Gwynedd
NCPF	Penisarwaun	244	1579	0.155	22.210	341	1.17	6.2	Ysbyty Gwynedd
NCPG	Penrhyndeudraeth	195	2467	0.079	18.161	443	0.60	28.6	Ysbyty Gwynedd
NCPH	Pentir	525	2403	0.218	11.063	654	1.27	1.3	Ysbyty Gwynedd
NCPJ	Penygroes	244	1770	0.138	31.159	183	2.43	19.7	Ysbyty Gwynedd
NCPK	Porthmadog East	73	1043	0.070	17.309	474	3.81	31.2	Ysbyty Gwynedd
NCPN	Porthmadog West	82	742	0.111	14.901	545	2.07	31.4	Ysbyty Gwynedd
NCPL	Porthmadog-Gest	89	1056	0.084	7.219	770	2.07	32.7	Ysbyty Gwynedd
NCPM	Porthmadog-Tremadog	87	1346	0.065	20.023	395	0.26	30.3	Ysbyty Gwynedd
NCPP	Pwllheli North	185	1906	0.097	28.527	225	5.00	39.4	Ysbyty Gwynedd
NCPQ	Pwllheli South	181	1955	0.093	39.279	100	12.65	40.8	Ysbyty Gwynedd
NCPR	Rachub	164	908	0.181	38.415	102	8.54	7.0	Ysbyty Gwynedd
NCPS	Seiont	538	3023	0.178	27.868	237	8.17	11.8	Ysbyty Gwynedd
NCPT	Talysarn	196	1194	0.164	46.613	65	0.94	18.2	Ysbyty Gwynedd
NCPU	Trawsfynydd	136	1534	0.089	23.704	312	0.10	39.2	Ysbyty Gwynedd
NCPW	Tudweiliog	49	810	0.060	24.617	286	0.23	47.4	Ysbyty Gwynedd

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NCPX	Tywyn	273	3227	0.085	20.288	387	1.16	18.1	Bronglais General Hospital
NCPY	Waunfawr	227	1582	0.143	15.253	534	0.30	14.5	Ysbyty Gwynedd
NCPZ	Y Felinheli	333	2081	0.160	16.231	505	3.53	5.6	Ysbyty Gwynedd
	Totals	15666	116845						
Isle of Anglesey									
NAMA	Aberffraw	225	1293	0.174	35.025	127	0.33	20.4	Ysbyty Gwynedd
NAMB	Amlwch Port	343	1391	0.247	40.458	90	5.20	24.2	Ysbyty Gwynedd
NAMC	Amlwch Rural	156	1237	0.126	25.468	272	0.80	26.2	Ysbyty Gwynedd
NAMD	Beaumaris	343	2040	0.168	20.449	384	2.38	7.8	Ysbyty Gwynedd
NAME	Bodffordd	243	1535	0.158	17.950	451	0.44	16.6	Ysbyty Gwynedd
NAMF	Bodorgan	269	1542	0.174	23.743	311	0.40	15.0	Ysbyty Gwynedd
NAMG	Braint	155	1487	0.104	8.660	723	7.88	2.8	Ysbyty Gwynedd
NAMH	Bryngwran	352	1679	0.210	30.550	192	0.71	19.5	Ysbyty Gwynedd
NAMJ	Brynteg	318	1822	0.175	15.985	511	3.45	13.5	Ysbyty Gwynedd
NAMK	Cadnant	215	1068	0.201	11.484	648	9.58	1.8	Ysbyty Gwynedd
NAML	Cefni	314	1427	0.220	9.732	686	3.82	10.7	Ysbyty Gwynedd
NAMM	Cwm Cadnant	309	2222	0.139	5.378	812	0.95	5.2	Ysbyty Gwynedd
NAMN	Cyngar	302	1741	0.173	21.238	368	3.31	12.0	Ysbyty Gwynedd
NAMP	Gwyngyll	173	1553	0.111	5.743	805	8.76	2.9	Ysbyty Gwynedd
NAMQ	Holyhead Town	242	1076	0.225	46.835	62	42.13	33.5	Ysbyty Gwynedd
NAMR	Kingsland	321	1442	0.223	33.562	149	12.15	32.8	Ysbyty Gwynedd
NAMS	Llanbadrig	178	1392	0.128	29.910	202	1.01	29.0	Ysbyty Gwynedd
NAMT	Llanbedrgoch	221	1586	0.139	16.743	491	1.61	11.7	Ysbyty Gwynedd
NAMU	Llanddyfnan	135	1300	0.104	12.480	624	0.24	13.3	Ysbyty Gwynedd
NAMW	Llaneilian	302	2248	0.134	23.478	315	0.49	21.5	Ysbyty Gwynedd
NAMX	Llanfaethlu	260	1565	0.166	23.762	308	0.44	29.2	Ysbyty Gwynedd

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NAMY	Llanfair-yn-Neubwll	604	2762	0.219	17.564	465	0.75	24.6	Ysbyty Gwynedd
NAMZ	Llanfihangel Ysgeifiog	338	2021	0.167	15.306	531	0.6	7.5	Ysbyty Gwynedd
NANA	Llangoed	220	1275	0.173	17.165	482	1.38	11.6	Ysbyty Gwynedd
NANB	Llanidan	291	1678	0.173	21.790	355	0.61	6.9	Ysbyty Gwynedd
NANC	Llannerch-y-medd	315	1791	0.176	36.886	115	0.28	22.3	Ysbyty Gwynedd
NAND	London Road	337	1497	0.225	31.710	172	30.26	32.5	Ysbyty Gwynedd
NANE	Maeshyfryd	482	2219	0.217	42.007	83	16.26	33.9	Ysbyty Gwynedd
NANF	Mechell	184	1532	0.120	28.416	227	0.4	38.0	Ysbyty Gwynedd
NANG	Moelfre	200	1130	0.177	29.493	206	0.81	17.5	Ysbyty Gwynedd
NANH	Morawelon	328	1554	0.211	52.084	40	23.08	32.6	Ysbyty Gwynedd
NANJ	Parc a'r Mynydd	230	1145	0.201	22.753	328	5.45	34.9	Ysbyty Gwynedd
NANK	Pentraeth	407	1787	0.228	18.114	446	0.58	8.6	Ysbyty Gwynedd
NANL	Porthyfelin	446	2304	0.194	39.598	96	39.14	33.7	Ysbyty Gwynedd
NANM	Rhosneigr	170	994	0.171	33.672	144	4.02	23.8	Ysbyty Gwynedd
NANN	Rhosyr	401	2171	0.185	22.949	323	0.54	13.8	Ysbyty Gwynedd
NANP	Trearddur	542	2342	0.231	12.909	608	0.83	31.8	Ysbyty Gwynedd
NANQ	Tudur	243	1494	0.163	45.247	73	7.09	10.0	Ysbyty Gwynedd
NANR	Tysilio	332	2078	0.160	13.241	593	8.26	2.9	Ysbyty Gwynedd
NANS	Valley	501	2413	0.208	17.397	469	2.67	27.5	Ysbyty Gwynedd
	Totals	11947	66833						
Merthyr Tydfil									
PHMA	Bedlinog	437	3399	0.129	46.391	66	2.23	10.0	Prince Charles
PHMB	Cyfarthfa	1070	6141	0.174	43.001	77	8.71	3.2	Prince Charles
PHMC	Dowlais	1069	6646	0.161	50.719	46	6.15	2.1	Prince Charles
PHMD	Gurnos	795	5034	0.158	71.241	4	32.86	1.0	Prince Charles
PHME	Merthyr Vale	455	3924	0.116	47.882	55	4.74	9.9	Prince Charles

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PHMF	Park	778	4307	0.181	27.504	240	20.89	2.0	Prince Charles
PHMG	Penydarren	878	5253	0.167	50.764	45	46.52	1.7	Prince Charles
PHMH	Plymouth	814	5005	0.163	35.747	120	2.37	5.8	Prince Charles
PHMJ	Town	1232	6554	0.188	34.180	139	8.56	4.1	Prince Charles
PHMK	Treharris	706	6252	0.113	27.021	249	7.74	12.1	Caerphilly and District Miner's
PHML	Vaynor	568	3465	0.164	36.068	118	1.25	2.4	Prince Charles
	Totals	8802	55980						
Monmouthshire									
PPMA	Caerwent	366	2709	0.135	5.211	819	0.65	17.3	Royal Gwent
PPMB	Caldicot Castle	308	2440	0.126	3.898	840	16.62	17.2	Royal Gwent
PPMC	Cantref	431	3065	0.141	13.878	581	4.16	1.8	Nevill Hall
PPMD	Castle and Grofield	441	2230	0.198	10.016	682	15.36	1.1	Nevill Hall
PPME	Croesonen	226	1607	0.141	17.671	460	35.05	2.0	Nevill Hall
PPMF	Crucorney	275	1930	0.142	10.368	677	0.16	9.2	Nevill Hall
PPMG	Dewstow	194	1488	0.130	16.232	504	58.81	16.2	Royal Gwent
PPMH	Goetre Fawr	309	2335	0.132	6.651	782	1.07	10.2	Nevill Hall
PPMJ	Lansdown	183	1581	0.116	24.273	295	43.77	1.4	Nevill Hall
PPMK	Larkfield	107	1341	0.080	3.895	841	32.16	22.7	Royal Gwent
PPML	Llanbadoc	121	1348	0.090	10.760	663	0.32	14.7	Nevill Hall
PPMM	Llanelly Hill	370	3810	0.097	13.921	577	2.09	5.8	Nevill Hall
PPMN	Llanfoist Fawr	232	1663	0.140	6.604	784	0.57	3.8	Nevill Hall
PPMP	Llangybi Fawr	193	1688	0.114	5.966	799	0.26	11.0	Royal Gwent
PPMQ	Llanover	361	2251	0.160	13.060	598	0.29	7.5	Nevill Hall
PPMR	Llantilio Crossenny	239	1635	0.146	11.982	634	0.17	13.9	Nevill Hall
PPMS	Llanwenarth Ultra	170	1354	0.126	10.598	667	1.63	3.7	Nevill Hall

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PPMT	Magor with Undy	1015	6070	0.167	4.164	837	3.96	11.8	Royal Gwent
PPMU	Mardy	325	2357	0.138	21.476	365	1.26	3.8	Nevill Hall
PPMW	Mitchel Troy	221	1159	0.191	7.970	748	0.26	18.1	Nevill Hall
PPMX	Overmonnow	401	2300	0.174	12.459	625	9.14	21.5	Nevill Hall
PPMY	Portskewett	247	2041	0.121	5.773	803	2.75	19.2	Royal Gwent
PPMZ	Priory	516	2752	0.188	10.404	676	24.16	1.7	Nevill Hall
PPNA	Raglan	220	1706	0.129	5.215	818	0.46	16.2	Nevill Hall
PPNB	Rogiet	284	1620	0.175	6.702	780	1.91	14.5	Royal Gwent
PPNG	Severn	535	4159	0.129	6.453	787	16.70	17.2	Royal Gwent
PPNH	Shirenewton	251	2382	0.105	7.531	761	0.32	18.2	Royal Gwent
PPNC	St. Arvans	122	1442	0.085	5.767	804	0.49	23.3	Royal Gwent
PPND	St. Christopher's	156	1880	0.083	6.979	777	37.73	22.9	Royal Gwent
PPNE	St. Kingsmark	393	2540	0.155	2.091	859	17.56	22.4	Royal Gwent
PPNF	St. Mary's	256	1741	0.147	8.171	744	20.99	23.3	Royal Gwent
PPNJ	Thornwell	391	3319	0.118	14.311	561	15.58	22.9	Royal Gwent
PPNK	Trellech United	270	2428	0.111	6.413	789	0.56	23.6	Nevill Hall
PPNL	Usk	148	2318	0.064	1.794	861	8.7	15.2	Royal Gwent
PPNM	Vauxhall	708	4513	0.157	5.596	809	3.06	21.5	Nevill Hall
PPNN	West End	252	1618	0.156	9.883	683	45.28	16.1	Royal Gwent
PPNP	Wyesham	339	2064	0.164	14.551	553	1.96	24.4	Nevill Hall
	Totals	11576	84884						
Neath Port Talbot									
NZMA	Aberavon	926	5335	0.174	34.219	138	23.72	1.6	Neath Port Talbot
NZMB	Aberdulais	386	1942	0.199	35.041	126	2.03	11.0	Neath Port Talbot
NZMC	Allt-wen	625	2318	0.270	14.388	558	5.29	6.3	Morriston
NZMD	Baglan	1198	6654	0.180	14.315	560	7.35	1.9	Neath Port Talbot

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NZME	Blaengwrach	174	1985	0.088	31.380	179	1.33	16.8	Prince Charles
NZMF	Briton Ferry East	520	2895	0.180	22.535	334	5.82	4.0	Neath Port Talbot
NZMG	Briton Ferry West	393	2864	0.137	49.096	54	10.32	4.5	Neath Port Talbot
NZMH	Bryn and Cwmavon	785	6516	0.120	30.798	189	2.81	5.3	Neath Port Talbot
NZMJ	Bryn-coch North	360	2275	0.158	7.104	773	3.95	8.2	Morriston
NZMK	Bryn-coch South	1114	5274	0.211	15.551	522	28.65	7.9	Neath Port Talbot
NZML	Cadoxton	296	1623	0.182	8.694	722	3.91	9.4	Neath Port Talbot
NZMM	Cimla	664	4172	0.159	11.645	644	10.69	6.3	Neath Port Talbot
NZMN	Coedffranc Central	820	3894	0.211	24.156	299	31.67	7.0	Neath Port Talbot
NZMP	Coedffranc North	472	2348	0.201	15.892	516	13.82	6.0	Morriston
NZMQ	Coedffranc West	418	2066	0.202	16.337	500	1.56	5.9	Neath Port Talbot
NZMR	Crynant	276	1883	0.147	28.231	230	0.87	13.1	Morriston
NZMS	Cwmllynfell	325	1123	0.289	32.589	157	1.21	12.5	Morriston
NZMT	Cymmer	646	2883	0.224	66.570	8	1.22	10.9	Neath Port Talbot
NZMU	Dyffryn	692	3188	0.217	29.178	215	4.62	6.9	Morriston
NZMW	Glyncorrwg	235	1166	0.202	57.961	24	0.59	16.5	Neath Port Talbot
NZMX	Glynneath	385	3531	0.109	29.689	205	1.36	18.5	Prince Charles
NZMY	Godre'r graig	388	1434	0.271	37.781	106	4.67	10.2	Morriston
NZMZ	Gwaun-Cae-Gurwen	347	2826	0.123	37.781	107	4.93	11.1	Morriston
NZNA	Gwynfi	352	1495	0.235	64.180	13	1.2	15.4	Princess of Wales
NZNB	Lower Brynamman	186	1307	0.142	40.365	91	1.65	13.0	Morriston
NZNC	Margam	459	2389	0.192	25.150	279	0.49	6.8	Neath Port Talbot
NZND	Neath East	1033	5933	0.174	45.979	68	19.04	5.7	Neath Port Talbot
NZNE	Neath North	671	3848	0.174	25.904	263	23.19	7.2	Neath Port Talbot
NZNF	Neath South	814	4651	0.175	33.964	141	31.11	5.9	Neath Port Talbot
NZNG	Onllwyn	171	1214	0.141	53.687	34	1.12	19.0	Prince Charles

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NZNH	Pelenna	110	1173	0.094	39.604	95	0.59	8.1	Neath Port Talbot
NZNJ	Pontardawe	1433	5043	0.284	24.261	296	1.74	7.8	Morriston
NZNK	Port Talbot	834	5277	0.158	23.754	309	13.43	2.5	Neath Port Talbot
NZNL	Resolven	353	3128	0.113	25.200	278	1.05	13.7	Neath Port Talbot
NZNM	Rhos	543	2488	0.218	9.748	685	1.53	9.7	Morriston
NZNN	Sandfields East	1043	6118	0.170	50.963	44	36.77	0.8	Neath Port Talbot
NZNP	Sandfields West	1008	6665	0.151	60.967	19	38.78	1.5	Neath Port Talbot
NZNQ	Seven Sisters	202	2032	0.099	39.516	97	1.74	17.0	Morriston
NZNR	Taibach	729	4583	0.159	26.344	256	8.32	3.8	Neath Port Talbot
NZNS	Tonna	374	2465	0.152	19.320	405	3.27	8.8	Neath Port Talbot
NZNT	Trebanos	355	1397	0.254	26.388	255	7.27	4.9	Morriston
NZNU	Ystalyfera	645	3065	0.210	50.123	48	4.51	12.2	Morriston
	Totals	23760	134446						
Newport									
PRMA	Allt-yr-yn	1729	8583	0.201	8.553	727	22.39	1.8	Royal Gwent
PRMB	Alway	1858	8492	0.219	31.186	181	48.1	3.0	Royal Gwent
PRMC	Beechwood	1499	7594	0.197	14.647	551	50.61	2.4	Royal Gwent
PRMD	Bettws	1486	8278	0.180	49.310	51	16.12	4.0	Royal Gwent
PRME	Caerleon	1361	8708	0.156	3.291	849	6.25	4.7	Royal Gwent
PRMF	Gaer	1697	8568	0.198	25.674	269	30.57	1.9	Royal Gwent
PRMG	Graig	1211	5492	0.221	3.337	846	3.83	5.9	Royal Gwent
PRMH	Langstone	855	3905	0.219	4.583	830	1.29	10.1	Royal Gwent
PRMJ	Liswerry	2384	10616	0.225	20.635	383	7.01	2.4	Royal Gwent
PRMK	Llanwern	636	3027	0.210	13.924	576	0.82	6.6	Royal Gwent
PRML	Malpas	936	8148	0.115	8.481	732	39.5	3.8	Royal Gwent
PRMM	Marshfield	902	4245	0.212	7.213	771	1.20	6.0	Royal Gwent

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PRMN	Pillgwenlly	882	5333	0.165	63.710	15	9.72	1.7	Royal Gwent
PRMP	Ringland	1589	8470	0.188	42.064	82	34.78	4.9	Royal Gwent
PRMQ	Rogerstone	1803	8807	0.205	5.860	800	10.17	4.5	Royal Gwent
PRMS	Shaftesbury	959	5488	0.175	22.465	335	33.74	2.3	Royal Gwent
PRMR	St Julians	1829	8729	0.210	12.514	621	44.98	2.4	Royal Gwent
PRMT	Stow Hill	1213	4453	0.272	27.096	246	33.88	0.5	Royal Gwent
PRMU	Tredegar Park	795	3387	0.235	58.790	23	18.91	2.8	Royal Gwent
PRMW	Victoria	1401	6688	0.209	29.125	218	70.94	1.2	Royal Gwent
	Totals	27025	137011						
Pembrokeshire									
NSMA	Amroth	194	1243	0.156	18.518	433	0.68	22.0	Withybush
NSMB	Begelly	320	2011	0.159	16.203	506	1.03	17.2	Withybush
NSMC	Brawdy	210	1175	0.179	14.422	557	0.28	14.5	Withybush
NSMD	Burton	208	1495	0.139	8.481	731	0.73	9.2	Withybush
NSME	Camrose	394	2323	0.170	11.174	652	0.33	6.1	Withybush
NSMF	Carew	140	1389	0.101	12.839	611	0.62	16.0	Withybush
NSMG	Castle	468	1946	0.240	25.033	281	28.59	1.2	Withybush
NSMH	Cilgerran	360	1930	0.187	17.219	478	0.44	30.5	West Wales General
NSMJ	Clydau	235	1425	0.165	20.962	375	0.22	24.0	West Wales General
NSMK	Crymych	374	2328	0.161	17.269	475	0.24	26.0	Withybush
NSML	Dinas Cross	223	1536	0.145	15.461	524	0.15	16.9	Withybush
NSMM	East Williamston	312	2327	0.134	18.727	426	0.88	15.5	Withybush
NSMN	Fishguard	507	3192	0.159	17.824	454	8.21	20.1	Withybush
NSMP	Garth	908	4957	0.183	29.312	210	16.36	1.7	Withybush
NSMQ	Goodwick	302	1850	0.163	26.281	257	5.04	21.8	Withybush
NSMR	Hakin	506	4699	0.108	27.417	241	8.39	12.4	Withybush

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NSMS	Hundleton/Stackpole	155	1651	0.094	13.174	595	0.17	18.5	Withybush
NSMT	Johnston	364	2249	0.162	21.090	372	0.90	6.9	Withybush
NSMU	Lampeter Velfrey	174	1445	0.120	15.218	535	0.32	19.5	Withybush
NSMW	Lamphey	170	1565	0.109	15.446	526	0.64	15.9	Withybush
NSMX	Letterston	322	2047	0.157	17.046	485	0.35	10.4	Withybush
NSMY	Llangwm	290	1984	0.146	13.355	588	1.34	5.9	Withybush
NSMZ	Maenclochog	199	2862	0.070	22.440	336	0.23	19.0	Withybush
NSNA	Manorbier	334	1939	0.172	18.581	429	0.78	20.1	Withybush
NSNB	Martletwy	160	1329	0.120	20.149	392	0.16	9.5	Withybush
NSNC	Merlin's Bridge	389	2184	0.178	22.869	326	3.23	3.3	Withybush
NSND	Milford Central and East	494	4253	0.116	23.924	305	6.86	10.9	Withybush
NSNE	Milford North and West	534	4134	0.129	28.640	223	11.64	10.8	Withybush
NSNF	Narberth Rural	136	1297	0.105	11.624	645	0.51	15.1	Withybush
NSNG	Narberth Urban	263	2058	0.128	21.027	374	4.21	32.6	West Wales General
NSNH	Newport	150	1122	0.134	15.397	529	0.63	23.0	Withybush
NSNJ	Neyland East	182	2170	0.084	25.480	271	17.20	11.0	Withybush
NSNK	Neyland West	186	2010	0.093	32.023	165	1.83	10.3	Withybush
NSNL	Pembroke Dock: Central	170	1527	0.111	34.464	133	43.59	13.2	Withybush
NSNM	Pembroke Dock: Llanion	278	2553	0.109	43.197	76	9.93	13.4	Withybush
NSNP	Pembroke Dock: Pennar	261	2969	0.088	27.126	244	13.08	14.0	Withybush
NSNN	Pembroke Dock:Market	164	1627	0.101	27.913	236	13.85	13.6	Withybush
NSNQ	Pembroke: Monkton	125	1683	0.074	64.141	14	12.24	15.6	Withybush
NSNR	Pembroke: St. Mary	294	3372	0.087	33.654	146	11.75	15.5	Withybush
NSNS	Pembroke: St. Michael	206	2159	0.095	12.126	632	2.90	17.1	Withybush
NSNT	Penally	205	1586	0.129	11.741	642	0.77	22.2	Withybush
NSNU	Prendergast	297	1770	0.168	14.479	555	12.04	0.3	Withybush

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NSNW	Priory	358	2134	0.168	9.282	703	10.73	2.4	Withybush
NSNX	Rudbaxton	326	1633	0.200	5.288	815	0.39	2.9	Withybush
NSPB	Saundersfoot	440	2784	0.158	12.455	626	4.11	20.6	Withybush
NSPC	Scleddau	256	1369	0.187	18.371	437	0.19	18.9	Withybush
NSPD	Solva	270	1420	0.190	17.235	477	0.28	18.1	Withybush
NSNY	St. David's	209	1797	0.116	17.445	468	0.39	21.9	Withybush
NSNZ	St. Dogmaels	329	2138	0.154	21.898	354	0.27	29.4	Withybush
NSPA	St. Ishmael's	215	1406	0.153	17.807	455	0.30	17.2	Withybush
NSPE	Tenby	711	4933	0.144	18.104	448	7.97	23.2	Withybush
NSPF	The Havens	252	1328	0.190	15.208	536	0.31	10.4	Withybush
NSPG	Wiston	219	1716	0.128	14.251	564	0.24	9.2	Withybush
	Totals	15748	114029						
Powys									
NNMA	Aber-craf	218	1401	0.156	32.925	153	1.46	18.8	Morriston
NNMB	Banwy	80	936	0.085	19.273	407	0.06	48.4	Royal Shrewsbury
NNMC	Berriew	126	1306	0.096	14.017	571	0.28	32.1	Royal Shrewsbury
NNMD	Builth	388	2352	0.165	9.056	709	7.76	41.5	Prince Charles
NNME	Bwlch	61	918	0.066	9.355	698	0.2	13.6	Nevill Hall
NNMF	Caersws/Carno	272	2172	0.125	15.834	519	0.24	41.8	Bronglais General Hospital
NNMG	Churchstoke	141	1571	0.090	13.893	580	0.29	29.5	Royal Shrewsbury
NNMH	Clyro/Painscastle	111	1171	0.095	9.047	710	0.16	33.6	Nevill Hall
NNMJ	Crickhowell/Vale of Grwyney	247	2767	0.089	9.697	688	0.36	10.0	Nevill Hall
NNMK	Cwm-twrch	372	1884	0.197	29.362	209	1.45	16.1	Morriston
NNML	Disserth and Trecoed	183	1166	0.157	13.964	575	0.37	47.6	Prince Charles
NNMM	Dolforwyn	229	1643	0.139	9.061	708	0.35	35.5	Royal Shrewsbury

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NNMN	Felin-fach	95	1226	0.077	8.980	714	0.13	25.7	Prince Charles
NNMP	Forden	216	1320	0.164	9.624	690	0.38	24.5	Royal Shrewsbury
NNMQ	Glantwymyn/Cadfarch	195	1955	0.100	18.115	445	0.09	28.3	Bronglais General Hospital
NNMR	Glasbury	85	902	0.094	10.772	661	0.16	29.6	Nevill Hall
NNMS	Glascwm/Llanelwedd	207	1134	0.183	10.673	665	0.10	42.2	Nevill Hall
NNMT	Guilsfield Within	70	1178	0.059	6.670	781	0.38	24.4	Royal Shrewsbury
NNMU	Guilsfield Without	84	971	0.087	8.560	726	0.38	28.3	Royal Shrewsbury
NNMW	Gwernyfed	185	1510	0.123	13.913	579	0.22	22.7	Nevill Hall
NNMX	Hay	224	1469	0.152	13.497	585	9.81	27.7	Nevill Hall
NNMY	Kerry	245	1922	0.127	8.393	733	0.22	39.2	Royal Shrewsbury
NNMZ	Knighton	326	3043	0.107	10.761	662	1.16	38.4	Hereford County Hospital
NNNA	Llanafanfawr/Erwood	229	1815	0.126	15.352	530	0.08	45.4	Prince Charles
NNNB	Llanbadarn Fawr	111	1057	0.105	12.014	633	0.20	46.5	Hereford County Hospital
NNNC	Llanbister/Beguildy	162	1441	0.112	16.397	499	0.08	48.3	Royal Shrewsbury
NNND	Llanbrynmair	96	958	0.100	21.226	369	0.07	37.0	Bronglais General Hospital
NNNE	Llandinam	128	942	0.136	13.968	574	0.15	42.4	Bronglais General Hospital
NNNF	Llandrindod East Llandrindod West	176	1124	0.157	18.060	449	11.07	50.8	Bronglais General Hospital
NNNG	Llandrindod North	277	1848	0.150	17.667	461	5.23	50.3	Hereford County Hospital
NNNH	Llandrindod South	278	2052	0.135	15.417	528	2.52	49.1	Hereford County Hospital
NNNJ	Llandrinio	164	1760	0.093	11.671	643	0.40	18.5	Royal Shrewsbury
NNNK	Llandysilio	221	1561	0.142	16.994	486	0.83	20.5	Royal Shrewsbury
NNNL	Llanfair Caereinion	156	1616	0.097	14.381	559	0.26	39.4	Royal Shrewsbury
NNNM	Llanfihangel	85	1055	0.081	19.657	398	0.14	38.3	Royal Shrewsbury
NNNN	Llanfihangel Rhydithon Llangunllo	135	1231	0.110	12.684	615	0.09	43.1	Hereford County Hospital

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NNNP	Llanfrynach/Talybont-on-Usk	205	1895	0.108	10.832	659	0.09	12.5	Prince Charles
NNNQ	Llanfyllin	163	1407	0.116	16.315	501	0.34	35.8	Royal Shrewsbury
NNNR	Llangamarch/Llanwrtyd Wells	328	1727	0.190	17.387	470	0.07	43.1	Bronglais General Hospital
NNNS	Llangattock	91	1006	0.090	16.013	509	0.32	9.7	Nevill Hall
NNNT	Llangors	99	1045	0.095	7.507	763	0.29	20.2	Nevill Hall
NNNU	Llangynidr	90	1005	0.090	7.266	769	0.20	10.6	Prince Charles
NNNW	Llanidloes	223	2807	0.079	8.293	740	5.20	36.2	Bronglais General Hospital
NNNX	Llanrhaeadr-ym-Mochnant Llansilin	199	1776	0.112	12.720	614	0.14	27.7	Wrexham Maelor
NNNY	Llansantffraid	154	1736	0.089	18.736	425	0.41	27.1	Royal Shrewsbury
NNNZ	Llanwddyn	159	1467	0.108	17.590	464	0.08	40.7	Wrexham Maelor
NNPA	Llanyre	142	1061	0.134	9.416	694	0.36	48.3	Bronglais General Hospital
NNPB	Machynlleth	258	2147	0.120	19.265	408	4.24	24.5	Bronglais General Hospital
NNPC	Maescar/Llywel	157	1786	0.088	12.743	613	0.07	23.9	Prince Charles
NNPD	Meifod	108	1323	0.082	18.208	442	0.22	30.1	Royal Shrewsbury
NNPE	Mochdre	112	920	0.122	10.977	656	0.16	46.0	Royal Shrewsbury
NNPF	Montgomery	166	1257	0.132	13.917	578	0.92	29.3	Royal Shrewsbury
NNPG	Newtown Central	750	3258	0.230	29.269	212	36.05	42.5	Royal Shrewsbury
NNPH	Newtown East	477	1983	0.241	17.594	463	2.48	40.4	Royal Shrewsbury
NNPJ	Newtown Llanllwchaiarn North	313	1937	0.162	5.372	813	2.75	39.3	Royal Shrewsbury
NNPK	Newtown Llanllwchaiarn West	252	1734	0.145	7.903	753	2.13	42.0	Royal Shrewsbury
NNPL	Newtown South	486	1871	0.260	30.504	195	6.24	43.3	Royal Shrewsbury

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NNPM	Old Radnor New Radnor Gladestry	131	1570	0.083	15.422	527	0.10	35.3	Hereford County Hospital
NNPN	Presteigne	223	2463	0.091	11.054	655	0.99	33.8	Hereford County Hospital
NNPP	Rhayader Town/Llansantffraed-Cwmdeuddwr	295	2075	0.142	14.300	562	0.15	32.6	Bronglais General Hospital
NNPQ	Rhiewcynon	197	1419	0.139	15.461	525	0.17	41.8	Royal Shrewsbury
NNPR	St. David Within	144	1652	0.087	13.414	587	5.20	18.9	Prince Charles
NNPS	St. Harmon/Nantmel	174	1467	0.119	16.690	494	0.08	43.0	Bronglais General Hospital
NNPT	St. John	283	3375	0.084	13.853	582	14.7	20.4	Prince Charles
NNPU	St. Mary	331	2874	0.115	5.838	801	5.16	19.6	Prince Charles
NNPW	Talgarth/Bronllys	270	2461	0.110	11.962	635	0.24	21.5	Nevill Hall
NNPX	Tawe-Uchaf/Ystradfellte	316	2065	0.153	37.004	113	0.18	18.3	Prince Charles
NNPY	Trefeglwys/Llangurig	235	2131	0.110	14.911	544	0.08	31.2	Bronglais General Hospital
NNPZ	Trewern	140	1167	0.120	14.683	550	0.36	19.2	Royal Shrewsbury
NNQA	Welshpool Castle	403	1563	0.258	23.946	303	0.87	26.5	Royal Shrewsbury
NNQB	Welshpool Gungrog	245	2597	0.094	14.962	541	1.84	22.7	Royal Shrewsbury
NNQC	Welshpool Llanerchyddol	178	2109	0.084	12.494	623	3.03	26.2	Royal Shrewsbury
NNQD	Ynyscedwyn	361	2195	0.164	24.380	293	5.78	14.1	Morriston
NNQE	Yscir	95	1104	0.086	10.440	674	0.07	27.8	Prince Charles
NNQF	Ystradgynlais	517	2543	0.203	39.605	94	0.89	19.0	Morriston
	Totals	16048	126355						
Rhondda, Cynon, Taff									
PFMA	Aberaman North	589	5109	0.115	33.617	148	11.86	9.1	Prince Charles
PFMB	Aberaman South	479	4724	0.101	46.947	61	3.77	10.3	Prince Charles
PFMC	Abercynon	426	6428	0.066	34.522	131	7.02	11.0	Caerphilly and District Miner's

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PFMD	Aberdare East	626	6527	0.096	25.407	274	9.69	6.4	Prince Charles
PFME	Aberdare West/Llwydcoed	847	9312	0.091	21.602	362	4.27	8.1	Prince Charles
PFMF	Beddau	384	4498	0.085	14.040	569	8.87	2.8	Royal Glamorgan
PFMG	Brynna	334	3683	0.091	10.756	664	2.96	5.1	Royal Glamorgan
PFMH	Church Village	339	3320	0.102	12.645	617	18.18	5.2	Royal Glamorgan
PFMJ	Cilfynydd	194	2853	0.068	26.094	259	6.88	8.1	Caerphilly and District Miner's
PFML	Cwm Clydach	404	3164	0.128	53.564	36	6.52	10.9	Royal Glamorgan
PFMK	Cwmbach	288	4283	0.067	37.024	112	7.04	7.1	Prince Charles
PFMM	Cymmer	887	5925	0.150	47.326	56	11.49	6.4	Royal Glamorgan
PFMN	Ferndale	380	4419	0.086	36.486	117	11.61	12.6	Prince Charles
PFMP	Gilfach Goch	370	3434	0.108	52.461	39	5.69	6.5	Royal Glamorgan
PFMQ	Glyncoch	160	2930	0.055	57.708	26	13.97	8.8	Royal Glamorgan
PFMR	Graig	172	2474	0.070	22.707	330	7.85	5.3	Royal Glamorgan
PFMS	Hawthorn	121	2281	0.053	19.114	414	8.06	3.8	Caerphilly and District Miner's
PFMT	Hirwaun	367	3995	0.092	32.610	156	10.23	9.8	Prince Charles
PFMU	Llanharan	230	3421	0.067	19.148	412	3.11	2.3	Royal Glamorgan
PFMW	Llanharry	244	2919	0.084	29.401	208	3.95	4.0	Royal Glamorgan
PFMX	Llantrisant Town	360	4205	0.086	5.053	822	4.34	1.2	Royal Glamorgan
PFMY	Llantwit Fardre	562	6214	0.090	4.166	836	6.27	4.7	Royal Glamorgan
PFMZ	Llwyn-y-pia	398	2253	0.177	55.298	29	8.72	10.5	Royal Glamorgan
PFNA	Maerdy	275	3440	0.080	68.431	5	3.24	12.4	Prince Charles
PFNB	Mountain Ash East	338	2711	0.125	28.077	234	3.19	9.4	Prince Charles
PFNC	Mountain Ash West	891	4328	0.206	51.671	42	12.34	10.4	Prince Charles
PFND	Penrhiwceiber	598	6265	0.095	54.015	31	12.36	11.5	Prince Charles
PFNE	Pentre	574	5424	0.106	31.856	171	8.89	15.3	Princess of Wales

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PFNF	Pen-y-graig	670	5877	0.114	45.574	71	29.37	8.0	Royal Glamorgan
PFNG	Pen-y-waun	418	3322	0.126	73.340	2	9.36	8.7	Prince Charles
PFNH	Pont-y-clun	549	5794	0.095	7.613	760	4.96	3.5	Royal Glamorgan
PFNJ	Pontypridd Town	209	2919	0.072	5.829	802	12.53	7.7	Royal Glamorgan
PFNK	Porth	997	5944	0.168	30.140	199	16.04	7.5	Royal Glamorgan
PFNL	Rhigos	166	1721	0.096	31.603	173	0.23	8.3	Prince Charles
PFNM	Rhondda	383	4690	0.082	22.034	346	6.83	6.8	Royal Glamorgan
PFNN	Rhydfelen Central/Ilan	324	4672	0.069	52.935	38	12.6	5.4	Caerphilly and District Miner's
PFNP	Rhydfelen Lower	96	1371	0.070	30.785	190	8.06	6.0	Caerphilly and District Miner's
PFNQ	Taffs Well	408	3564	0.114	9.041	711	5.30	2.6	Caerphilly and District Miner's
PFNR	Talbot Green	197	2457	0.080	17.748	456	11.54	1.4	Royal Glamorgan
PFNS	Ton-teg	323	4459	0.072	4.497	832	7.59	4.9	Caerphilly and District Miner's
PFNT	Tonypandy	540	3495	0.155	35.150	124	10.38	9.5	Royal Glamorgan
PFNU	Tonyrefail East	424	5801	0.073	33.976	140	3.92	3.7	Royal Glamorgan
PFNW	Tonyrefail West	550	5234	0.105	46.218	67	5.37	4.7	Royal Glamorgan
PFNX	Trallwng	267	3971	0.067	13.043	600	17.52	7.6	Caerphilly and District Miner's
PFNY	Trealaw	604	3908	0.155	46.991	60	13.61	8.9	Royal Glamorgan
PFNZ	Treforest	475	5072	0.094	11.307	650	13.44	6.8	Royal Glamorgan
PFPA	Treherbert	953	6011	0.159	53.843	33	2.79	15.1	Prince Charles
PFPB	Treorchy	795	8105	0.098	29.297	211	6.08	15.2	Royal Glamorgan
PFPC	Tylorstown	402	4715	0.085	64.661	11	8.01	11.1	Royal Glamorgan
PFPD	Tyn-y-nant	228	3755	0.061	22.169	342	40.79	3.0	Royal Glamorgan
PFPE	Ynyshir	464	3442	0.135	47.049	59	7.81	9.2	Royal Glamorgan

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PFPF	Ynysybwl	363	4787	0.076	22.539	333	2.45	11.0	Royal Glamorgan
PFPG	Ystrad	575	6320	0.091	37.231	110	8.82	12.0	Royal Glamorgan
	Totals	23217	231945						
Swansea									
NXMA	Bishopston	584	3341	0.175	5.096	820	5.6	5.3	Singleton
NXMB	Bonymaen	1359	6342	0.214	39.126	101	7.51	5.8	Morriston
NXMC	Castle	3137	11933	0.263	39.305	99	39.59	3.1	Singleton
NXMD	Clydach	764	3021	0.253	16.865	489	8.63	4.3	Morriston
NXME	Cockett	3250	12586	0.258	24.083	300	14.64	3.6	Singleton
NXMF	Cwmbwrla	1848	8217	0.225	18.418	436	54.65	4.0	Singleton
NXMG	Dulais East	345	1541	0.224	29.989	200	3.40	6.5	Morriston
NXMH	Dunvant	877	4679	0.187	5.586	810	19.41	3.9	Singleton
NXMJ	Fairwood	377	2774	0.136	9.298	701	2.03	5.3	Singleton
NXMK	Gorseinon Central	284	1566	0.181	21.171	370	33.24	6.7	Prince Philip
NXML	Gorseinon East	576	1709	0.337	32.308	162	9.57	7.3	Prince Philip
NXMM	Gower	585	3654	0.160	8.613	724	0.32	12.2	Prince Philip
NXMN	Gowerton East	405	2515	0.161	7.287	768	6.45	5.3	Singleton
NXMP	Gowerton West	692	2413	0.287	9.285	702	6.45	6.8	Singleton
NXMQ	Graigfelen	486	1764	0.276	40.079	93	8.63	2.0	Morriston
NXMR	Killay North	527	3436	0.153	2.678	854	17.76	2.9	Singleton
NXMS	Killay South	348	2297	0.152	4.956	823	17.82	2.6	Singleton
NXMT	Kingsbridge	981	4089	0.240	8.997	713	8.49	6.1	Singleton
NXMU	Landore	1341	6121	0.219	33.909	142	27.36	5.0	Singleton
NXMW	Llangyfelach	1284	4426	0.290	7.711	758	2.59	3.7	Morriston
NXMX	Llansamlet	3782	12003	0.315	17.560	466	7.71	3.8	Morriston
NXMY	Lower Loughor	574	2146	0.267	22.870	325	21.76	5.6	Prince Philip

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NXMZ	Mawr	358	1800	0.199	13.161	596	0.31	4.5	Morriston
NXNA	Mayals	651	2834	0.230	2.834	853	6.28	2.4	Singleton
NXNB	Morriston	4044	16781	0.241	16.900	488	22.86	1.7	Morriston
NXNC	Mynyddbach	2134	8756	0.244	23.819	307	24.51	3.3	Morriston
NXND	Newton	596	3150	0.189	2.637	855	13.3	4.8	Singleton
NXNE	Oystermouth	811	4315	0.188	6.441	788	21.12	4.4	Singleton
NXNF	Penclawdd	635	3672	0.173	12.660	616	2.6	6.9	Prince Philip
NXNG	Penderry	2634	10981	0.240	64.183	12	27.11	4.9	Morriston
NXNH	Penllergaer	520	2434	0.214	24.041	302	4.05	5.8	Morriston
NXNJ	Pennard	446	2648	0.168	7.377	767	2.27	7.0	Singleton
NXNK	Penyrheol	1365	5780	0.236	19.243	410	6.79	6.0	Prince Philip
NXNL	Pontardulais	320	1425	0.225	18.783	422	3.40	7.7	Morriston
NXNN	Sketty	2675	13799	0.194	5.432	811	20.28	0.9	Singleton
NXNM	St. Thomas	1225	6373	0.192	31.381	178	10.8	5.1	Singleton
NXNP	Tal-y-bont	432	2327	0.186	15.965	512	3.40	7.4	Prince Philip
NXNQ	Townhill	1791	8443	0.212	66.785	7	46.7	2.7	Singleton
NXNR	Uplands	2937	13355	0.220	7.827	755	58.09	1.6	Singleton
NXNS	Upper Loughor	634	2846	0.223	14.822	547	17.62	6.1	Prince Philip
NXNT	Vardre	818	2536	0.323	21.055	373	8.63	3.5	Morriston
NXNU	West Cross	1471	6475	0.227	13.265	592	26.02	3.3	Singleton
	Totals	50903	223303						
The Vale of Glamorgan									
PDMA	Alexandra	1203	10785	0.112	7.993	747	22.57	8.7	Heath
PDMB	Baruc	442	5750	0.077	9.021	712	17.26	14.2	Heath
PDMC	Buttrills	514	6034	0.085	23.050	321	56.11	12.7	Heath
PDMD	Cadoc	919	8343	0.110	26.054	260	26.19	11.2	Heath

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PDME	Castleland	335	3675	0.091	34.715	130	14.99	12.6	Heath
PDMF	Cornerswell	534	5471	0.098	7.034	775	38.61	7.4	Heath
PDMG	Court	357	4827	0.074	31.100	185	60.74	11.4	Heath
PDMH	Cowbridge	563	6317	0.089	3.582	845	1.71	9.7	Royal Glamorgan
PDMJ	Dinas Powys	1058	7959	0.133	3.739	843	4.06	7.9	Heath
PDMK	Dyfan	310	5051	0.061	13.143	597	15.87	12.1	Heath
PDML	Gibbonsdown	385	5818	0.066	34.321	136	34.83	11.0	Heath
PDMM	Illtyd	622	8365	0.074	8.357	735	29.24	13.4	Heath
PDMN	Llandough	255	1920	0.133	4.244	834	11.86	6.3	Heath
PDMP	Llandow/Ewenny	299	2606	0.115	4.551	831	0.61	6.6	Princess of Wales
PDMQ	Llantwit Major	1022	10791	0.095	5.662	807	3.12	12.7	Princess of Wales
PDMR	Peterston-super-Ely	254	2249	0.113	12.890	609	0.51	7.6	Royal Glamorgan
PDMS	Rhoose	664	5612	0.118	7.426	765	1.30	15.0	Royal Glamorgan
PDMT	St. Athan	468	3836	0.122	8.582	725	3.30	15.2	Royal Glamorgan
PDMU	St. Bride's Major	324	2703	0.120	5.255	816	1.00	7.1	Princess of Wales
PDMW	Stanwell	444	4138	0.107	10.444	673	43.47	8.2	Heath
PDMX	Sully	492	4239	0.116	4.115	839	6.01	11.0	Heath
PDMY	Wenvoe	310	2802	0.111	3.296	848	0.90	10.2	Heath
	Totals	11774	119291						
Torfaen									
PMMA	Abersychan	1239	6826	0.182	32.946	152	2.76	10.4	Nevill Hall
PMMB	Blaenavon	585	5763	0.102	25.933	262	3.23	7.1	Nevill Hall
PMMC	Brynwern	348	1815	0.192	31.502	175	47.71	13.9	Royal Gwent
PMMD	Coed Eva	530	2395	0.221	13.018	603	32.20	7.5	Royal Gwent
PMME	Croesyceiliog North	739	3430	0.215	12.498	622	30.99	9.3	Royal Gwent
PMMF	Croesyceiliog South	384	1804	0.213	8.304	738	16.74	8.6	Royal Gwent

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
PMMG	Cwmyniscoy	315	1283	0.246	35.321	123	1.92	12.6	Royal Gwent
PMMH	Fairwater	1265	5559	0.228	13.326	589	29.51	8.4	Royal Gwent
PMMJ	Greenmeadow	1132	4439	0.255	26.040	261	17.02	9.7	Royal Gwent
PMMK	Llantarnam	1160	4688	0.247	19.129	413	6.05	6.0	Royal Gwent
PMML	Llanyrafon North	558	2021	0.276	8.547	728	10.05	7.9	Royal Gwent
PMMM	Llanyrafon South	405	2664	0.152	6.123	795	6.00	6.4	Royal Gwent
PMMN	New Inn Lower	757	3022	0.250	7.517	762	5.55	11.4	Royal Gwent
PMMP	New Inn Upper	723	3327	0.217	5.638	808	5.55	13.7	Nevill Hall
PMMQ	Panteg	1429	6882	0.208	11.533	646	21.35	11.5	Royal Gwent
PMMR	Pontnewydd	347	1527	0.227	20.645	382	25.97	9.6	Royal Gwent
PMMS	Pontnewynydd	1683	6132	0.274	21.627	361	4.23	13.8	Nevill Hall
PMMT	Pontypool	486	1696	0.287	17.695	459	13.86	13.5	Royal Gwent
PMMX	Snatchwood	495	1923	0.257	29.140	216	24.35	12.7	Nevill Hall
PMMU	St. Cadocs and Penygarn	373	1605	0.232	47.120	57	7.81	13.3	Nevill Hall
PMMW	St. Dials	1073	3796	0.283	31.490	176	20.80	8.4	Royal Gwent
PMMY	Trevethin	873	3684	0.237	55.616	27	12.64	12.1	Nevill Hall
PMMZ	Two Locks	1600	6572	0.243	18.701	427	5.25	7.4	Royal Gwent
PMNA	Upper Cwmbran	1512	5674	0.266	32.298	163	11.96	10.4	Royal Gwent
PMNB	Wainfelin	550	2422	0.227	16.232	503	3.16	14.4	Royal Gwent
	Totals	20561	90949						
Wrexham									
NLMA	Acton	425	3023	0.141	21.761	356	34.02	2.1	Wrexham Maelor
NLMB	Borras Park	305	2517	0.121	4.666	829	41.46	2.8	Wrexham Maelor
NLMC	Bronington	93	3224	0.029	9.788	684	0.50	15.5	Wrexham Maelor
NLMD	Brymbo	277	2653	0.104	31.339	180	3.78	4.8	Wrexham Maelor
NLME	Bryn Cefn	200	1974	0.101	18.996	418	9.47	3.7	Wrexham Maelor

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NLMF	Caia Park	693	5194	0.133	53.927	32	44.30	1.9	Wrexham Maelor
NLMG	Cefn	450	4866	0.092	30.518	194	6.38	9.0	Wrexham Maelor
NLMH	Ceiriog Ganol Ceiriog Ucha	269	2310	0.116	15.734	520	0.20	21.2	Wrexham Maelor
NLMJ	Chirk North	224	2505	0.089	16.639	497	4.53	10.8	Wrexham Maelor
NLMK	Chirk South	174	1870	0.093	9.379	697	1.38	12.5	Wrexham Maelor
NLML	Coedpoeth	513	4721	0.109	15.620	521	8.80	3.1	Wrexham Maelor
NLMM	Esclusham	363	3401	0.107	15.867	517	7.17	3.9	Wrexham Maelor
NLMN	Garden Village	234	2073	0.113	4.792	825	36.86	2.0	Wrexham Maelor
NLMP	Gresford East and West	344	2876	0.120	6.633	783	4.83	4.2	Wrexham Maelor
NLMQ	Grosvenor	378	2334	0.162	19.534	404	22.28	0.7	Wrexham Maelor
NLMR	Gwenfro	205	1801	0.114	42.095	81	20.14	2.5	Wrexham Maelor
NLMS	Gwersyllt East and South	575	4370	0.132	10.491	671	10.97	2.9	Wrexham Maelor
NLMT	Gwersyllt North	323	2623	0.123	27.194	243	11.69	4.3	Wrexham Maelor
NLMU	Gwersyllt West	342	3063	0.112	17.740	457	18.56	2.1	Wrexham Maelor
NLMW	Holt	377	2828	0.133	9.413	696	0.74	6.4	Wrexham Maelor
NLMX	Johnstown	441	3372	0.131	20.752	381	31.15	5.2	Wrexham Maelor
NLMY	Little Acton	263	2376	0.111	6.065	796	44.92	2.5	Wrexham Maelor
NLNU	Llangollen Rural	210	2001	0.105	14.981	540	3.75	11.2	Wrexham Maelor
NLMZ	Llay	644	4905	0.131	18.760	423	5.41	5.4	Wrexham Maelor
NLNA	Maesydre	195	2003	0.097	22.116	343	29.55	1.5	Wrexham Maelor
NLNB	Marchwiel	266	2420	0.110	8.060	745	0.64	5.6	Wrexham Maelor
NLNC	Marford and Hoseley	318	2458	0.129	3.760	842	7.83	5.8	Wrexham Maelor
NLND	Minera	295	2437	0.121	9.529	692	1.62	6.6	Wrexham Maelor
NLNE	New Broughton	399	3173	0.126	19.569	403	18.46	1.7	Wrexham Maelor
NLNF	Offa East	657	5620	0.117	20.753	380	28.39	1.6	Wrexham Maelor
NLNG	Offa West	593	4232	0.140	20.223	388	14.88	0.5	Wrexham Maelor

Electoral Division	Ward name	# calls in study period	Popl'n	Call rate	Index of Multiple Deprivation Score	Rank of Index of Multiple Deprivation	Popl'n density	Distance to A&E in KM	Hospital
NLNH	Overton	130	3139	0.041	10.879	658	0.57	14.0	Wrexham Maelor
NLNJ	Pant	244	2263	0.108	32.404	161	30.96	5.7	Wrexham Maelor
NLNK	Penycae	434	3463	0.125	31.986	167	2.06	8.0	Wrexham Maelor
NLNL	Plas Madoc	183	1833	0.100	72.335	3	44.07	8.2	Wrexham Maelor
NLNM	Ponciau	408	3804	0.107	21.946	351	2.40	5.7	Wrexham Maelor
NLNN	Queensway	653	4698	0.139	54.692	30	43.50	2.6	Wrexham Maelor
NLNP	Rhosnesni	353	3041	0.116	4.910	824	40.79	2.8	Wrexham Maelor
NLNQ	Rossett	28	3336	0.008	7.036	774	1.31	7.9	Wrexham Maelor
NLNR	Ruabon	379	3515	0.108	23.476	316	1.40	7.6	Wrexham Maelor
NLNS	Stansty	252	2175	0.116	12.189	630	36.87	1.4	Wrexham Maelor
NLNT	Whitegate	277	1990	0.139	25.664	270	33.92	1.9	Wrexham Maelor
	Totals	14386	128480						

Appendix 14: Summary table of assigned weather and air quality monitoring stations by ward

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Blaenau Gwent						
Abertillery	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Badminton	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Beaufort	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Blaina	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Brynmawr	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Cwm	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Cwmtillery	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Ebbw Vale North	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Ebbw Vale South	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Georgetown	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanhilleth	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Nantyglo	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Rassau	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Sirhowy	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Six Bells	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Tredegar Central and West	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Bridgend						
Bettws	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Blackmill	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Blaengarw	St Athan	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Brackla	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Caerau	Mumbles Head	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Cefn Cribwr	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Coity Higher	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Cornelly	Mumbles Head	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Coychurch Lower	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Laleston/Merthyr Mawr	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Llangeinor	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Llangynwyd	Mumbles Head	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Maesteg East	Mumbles Head	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Maesteg West	Mumbles Head	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Morfa	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Nantyffyllon	Mumbles Head	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Nant-y-moel	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Newcastle	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Newcastle Higher	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Ogmore Vale	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Oldcastle	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pencoed	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pontycymmer	St Athan	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Porthcawl East	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Porthcawl West	Mumbles Head	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pyle	Mumbles Head	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
St. Bride's Minor	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Ynysawdre	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Caerphilly						
Aber Valley	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cwmbran	Cwmbran	Cwmbran
Aberbargoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Abercarn	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Abertysswg	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cardiff	Cardiff	Cardiff
Argoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Bargoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Bedwas and Trethomas	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Blackwood	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Cefn Fforest	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Crosskeys	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Crumlin	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Darran Valley	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Gilfach	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Hengoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanbradach	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Machen	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Maesycwmmer	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Morgan Jones	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Moriah	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Nelson	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cardiff	Cardiff	Cardiff	Cardiff
New Tredegar	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Newbridge	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Pengam	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Penmaen	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Penyrheol	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Pontllanfraith	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Pontlottyn	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Risca East	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Risca West	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Cattwg	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. James	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
St. Martins	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Tir-Phil	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Twyn Carno	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Ynysddu	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Ystrad Mynach	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Cardiff						
Adamsdown	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Butetown	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Caerau	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Canton	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Cathays	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Creigiau	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Cyncoed	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Ely	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Fairwater	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Gabalfa	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Grangetown	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Heath	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Lisvane and St. Mellons	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llandaff	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llandaff North	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llanishen	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llanrumney	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Pentwyn	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Pentyrch	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Plasnewydd	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Radyr and St. Fagans	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Rhiwbina	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Riverside	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Roath	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Rumney	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Splott	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Trowbridge	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Whitchurch and Tongwynlais	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Carmarthenshire						
Abergwili	Llandeillo	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Ammanford	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Betws	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Bigyn	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Burry Port	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Bynea	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Carmarthen Town North	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Carmarthen Town South	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Carmarthen Town West	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Cenarth	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Clynderwen	Pembrey Sands	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Cross Hands	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Cynwyl Elfed	Llandeillo	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Cynwyl Gaeo and Llanwrda Talley	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Dafen	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Elli	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Felinfoel	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Garnant	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Glanamman	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Glanymor	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Glyn	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gorslas	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Hendy	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Hengoed	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Kidwelly	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Laugharne Township	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llanboidy	Pembrey Sands	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llanddarog	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llanddowror	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llandeilo-Tywi and Castle	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llandovery Town/Cilycwm and Llanfair-ar-y-bryn	Sennybridge	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llandybie and Heolddu	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llandyfaelog	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llanegwad and Llanfynydd	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llanfihangel Aberbythych and Llangathen	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llanfihangel-ar-Arth	Llandeillo	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llangeler	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llangennech	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llangunnor	Llandeillo	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llangyndeyrn	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llansadwrn and Llangadog Myddfai and Llanddeusant	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llansteffan	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Llanybydder/Llanllwni	Llandeillo	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Lliedi	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llwynhendy	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Manordeilo and Salem Ffairfach	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Myddynfych	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Newchurch	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Pantyffynnon	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Pembrey	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Pencarreg	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Penygroes	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Pontamman	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Pontyberem	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Quarter Bach Llynfell Brynamman	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Saron	Llandeillo	Llandeillo	Swansea	Pembrokeshire	Pembrokeshire	Pembrokeshire
St. Clears	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
St. Ishmael	Pembrey Sands	Llandeillo	Pembrokeshire	Swansea	Swansea	Swansea
Swiss Valley	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Trelech	Pembrey Sands	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Trimsaran	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Tumble	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Tycroes	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Tyisha	Pembrey Sands	Llandeillo	Swansea	Swansea	Swansea	Swansea
Whitland	Pembrey Sands	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Ceredigion						
Aberaeron	Trawsgoed	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Aberporth	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Aberystwyth East	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Aberystwyth North	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Aberystwyth South	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Aberystwyth West	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Beulah	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Borth	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Capel Dewi	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Cardigan	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Ceulanamaesmawr	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Wrexham	Wrexham
Ciliau Aeron	Trawsgoed	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Faenor	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Lampeter	Trawsgoed	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llanarth	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llanbadarn Fawr	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Llandyfriog	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llandysiliogogo	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llandysul Town	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llanfarian	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Llanfihangel Ystrad	Trawsgoed	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llangeitho	Trawsgoed	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llangybi	Trawsgoed	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llanrhystud	Trawsgoed	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llansantffraid	Trawsgoed	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llanwenog	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Lledrod	Trawsgoed	Llandeillo	Aston Hill	Aston Hill	Swansea	Swansea
Melindwr	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Swansea	Swansea
New Quay	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Penbryn	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Penparc	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Tirymynach	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Trefeurig	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Tregaron	Trawsgoed	Llandeillo	Aston Hill	Aston Hill	Swansea	Swansea
Troedyraur	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Ystwyth	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Pembrokeshire	Pembrokeshire
Conwy						
Betws yn Rhos	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Bro Machno/Betws-y-Coed	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Bryn	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Bryn Rhys	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Caerhun	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Capelulo	Capel Curig	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Colwyn	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Conwy	Capel Curig	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Craig-y-Don	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Crwst	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Deganwy	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Dinarth	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Eglwysbach	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Eirias	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Fforddlas	Rhyl	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Gele	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Glyn	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Gogarth	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Gower	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Kinmel Bay	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Llanddulas	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Llanfair Talhaiarn	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Llangernyw	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llansannan	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llysfaen	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Marl	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Mochdre	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Mostyn	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Pandy/Lafan	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Pant-yr-afon/Penmaenan	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Penrhyn	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Pensarn	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Pentre Mawr	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Rhiw	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Rhos	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Towyn	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Trefriw	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Tudno	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Uwch Conwy	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Uwchaled	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Denbighshire						
Bodelwyddan	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Corwen	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Denbigh Central	Rhyl	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Denbigh Lower	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Denbigh Upper/Henllan	Rhyl	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Dyserth	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Efenechtyd	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llanarmon-yn-Ial/Llandegla	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Llanbedr Dyffryn Clwyd	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Llandrillo	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llandyrnog	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Llanfair Dyffryn Clwyd Gwyddelwern	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llangollen	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llanrhaeadr-yng-Nghinmeirch	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llanynys	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Meliden	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Prestatyn Central	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Prestatyn East	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Prestatyn North	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Prestatyn South West	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Rhuddlan	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Rhyl East	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Rhyl South	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Rhyl South East	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Rhyl South West	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Rhyl West	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Ruthin	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
St. Asaph East	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
St. Asaph West	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Trefnant	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Tremeirchion	Rhyl	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Flintshire						
Aston	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Bagillt East	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Bagillt West	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Broughton North and East	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Broughton South	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Buckley Bistre East	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Buckley Bistre West	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Buckley Mountain	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Buckley Pentrobin	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Caergwrle	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Caerwys	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Cilcain	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Connah's Quay Central	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Connah's Quay Golftyn	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Connah's Quay South	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Connah's Quay Wepre	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Ewloe	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Ffynnongroyw	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Flint Castle	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Flint Coleshill	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Flint Oakenholt	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Flint Trelawny	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Greenfield	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Gronant	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Gwernaffield	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Gwernymynydd	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Halkyn	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Hawarden	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Higher and East Shotton	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Higher Kinnerton	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Holywell East	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Holywell West	Ness Gardens, Cheshire	Ness Gardens, Cheshire	Wrexham	Aston Hill	Wrexham	Wrexham
Hope	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Leeswood	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Llanfynydd	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mancot	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mold Bron Coed	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mold Central	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mold East	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mold North	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mold South	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mold West	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Mostyn	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Mynydd Isa East	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
New Brighton	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Northop	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Penyffordd	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Queensferry	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Saltney	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Sealand	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Trelawnyd and Gwaenysgor	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham
Treuddyn	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
West Shotton	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Whitford	Prestatyn	Prestatyn	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Gwynedd						
Aberdaron	Aberdaron	Valley	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Aberdovey	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Wrexham	Wrexham
Abererch	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Abersoch	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Arthog	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Bala	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Barmouth	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Bethel	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Bontnewydd	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Botwnnog	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Bowydd and Rhiw	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Cadnant	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Clynnog	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Conglywal and Maenofferen	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Corris/Mawddwy	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Criccieth	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Cynfal and Teigl	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Deiniol	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Deiniolen	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Dewi	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Dolbenmaen/Beddgelert	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Dolgellau/Llanelltyd/Brithdir and Llanfachreth	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Dyffryn Ardudwy	Capel Curig	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Efail-newydd/Buan	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Garth	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Gerlan	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Glyder	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Harlech	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Hendre	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Hirael	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanaelhaearn/Pistyll	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanarmon/Llanystumdwy	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanbedr	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llanbedrog	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanberis	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llandderfel	Alwen	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llandwrog	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llandygai	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanengan	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llangelynin/Bryn-crug	Trawsgoed	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Llanllechid/Aber	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llanllyfni	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanrug	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanuwchllyn	Lake Vyrnwy	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llanwnda	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Marchog	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Menai (Bangor)	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Menai (Caernarfon)	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Nefyn	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Ogwen	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Peblig	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Penisarwaun	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Penrhyndeudraeth	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Pentir	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Penygroes	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Porthmadog East	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Porthmadog West	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Porthmadog-Gest	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Porthmadog-Tremadog	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Pwllheli North	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Pwllheli South	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Rachub	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Seiont	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Talysarn	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Trawsfynydd	Capel Curig	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Tudweiliog	Aberdaron	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Tywyn	Trawsgoed	Aberporth	Aston Hill	Aston Hill	Wrexham	Wrexham
Waunfawr	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Y Felinheli	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Isle of Anglesey						
Aberffraw	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Amlwch Port	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Amlwch Rural	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Beaumaris	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Bodffordd	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Bodorgan	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Braint	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Bryngwran	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Brynteg	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Cadnant	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Cefni	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Cwm Cadnant	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Cyngar	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Gwyngyll	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Holyhead Town	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Kingsland	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanbadrig	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanbedrgoch	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanddyfnan	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llaneilian	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanfaethlu	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanfair-yn-Neubwll	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llanfihangel Ysgeifiog	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llangoed	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Llanidan	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Llannerch-y-medd	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
London Road	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Maeshyfryd	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Mechell	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Moelfre	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Morawelon	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Parc a'r Mynydd	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Pentraeth	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Porthyfelin	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Rhosneigr	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Rhosyr	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Trearddur	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Tudur	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Tysilio	Capel Curig	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Valley	Valley	Valley	Wrexham	Aston Hill	Wrexham	Wrexham
Merthyr Tydfil						
Bedlinog	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Cyfarthfa	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Dowlais	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Gurnos	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Merthyr Vale	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Park	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Penydarren	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Plymouth	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Town	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Treharris	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Vaynor	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Monmouthshire						
Caerwent	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Caldicot Castle	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Cantref	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Castle and Grofield	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Croesonen	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Crucorney	Hereford, Credenhill	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Dewstow	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Goetre Fawr	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Lansdown	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Larkfield	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanbadoc	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanelly Hill	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanfoist Fawr	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llangybi Fawr	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanover	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llantilio Crossenny	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanwenarth Ultra	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2 snow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Magor with Undy	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Mardy	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2 snow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Mitchel Troy	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Overmonnow	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Portskewett	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Priory	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2 snow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Raglan	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Rogiet	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Severn	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Shirenewton	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Arvans	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Christopher's	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Kingsmark	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Mary's	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Thornwell	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Trellech United	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Usk	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Vauxhall	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
West End	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Wyesham	Llanishen	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Neath Port Talbot						
Aberavon	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Aberdulais	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Allt-wen	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Baglan	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Blaengwrach	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Briton Ferry East	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Briton Ferry West	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Bryn and Cwmavon	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Bryn-coch North	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Bryn-coch South	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Cadoxton	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Cimla	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Coedffranc Central	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Coedffranc North	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Coedffranc West	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Crynant	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Cwmllynfell	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Cymmer	Mumbles Head	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Dyffryn	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Glyncorrwg	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Glynneath	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Godre'r graig	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gwaun-Cae-Gurwen	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gwynfi	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Lower Brynamman	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Margam	Mumbles Head	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Neath East	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Neath North	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Neath South	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Onllwyn	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pelenna	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pontardawe	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Port Talbot	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Resolven	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Rhos	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Sandfields East	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Sandfields West	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Seven Sisters	Llandeillo	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Taibach	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Tonna	Mumbles Head	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Trebanos	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Ystalyfera	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Newport						
Allt-yr-yn	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Alway	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Beechwood	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Bettws	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Caerleon	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Gaer	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Graig	Cardiff Bute Park	Cardiff Bute Park	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Langstone	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Liswerry	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanwern	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Malpas	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Marshfield	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Pillgwenlly	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Ringland	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Rogerstone	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Shaftesbury	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
St Julians	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Stow Hill	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Tredegar Park	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Victoria	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Pembrokeshire						
Amroth	Pembrey Sands	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Begelly	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Brawdy	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Burton	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Camrose	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Carew	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Castle	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Cilgerran	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Clydau	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Crymych	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Dinas Cross	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
East Williamston	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Fishguard	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Garth	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Goodwick	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Hakin	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Hundleton/Stackpole	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Johnston	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Lampeter Velfrey	Pembrey Sands	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Lamphey	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Letterston	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Llangwm	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Maenclochog	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Manorbier	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Martletwy	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Merlin's Bridge	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Milford Central and East	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Milford North and West	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Narberth Rural	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Narberth Urban	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Newport	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Neyland East	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Neyland West	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Pembroke Dock: Central	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Pembroke Dock: Llanion	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Pembroke Dock: Pennar	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Pembroke Dock:Market	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Pembroke: Monkton	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Pembroke: St. Mary	Milford Haven Conservancy	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
	Board					
Pembroke: St. Michael	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Penally	Milford Haven Conservancy Board	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Prendergast	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Priory	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Rudbaxton	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Saundersfoot	Pembrey Sands	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Scleddau	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Solva	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
St. David's	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
St. Dogmaels	Aberporth	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
St. Ishmael's	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Tenby	Pembrey Sands	Llandeillo	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
The Havens	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Wiston	Milford Haven Conservancy Board	Aberporth	Pembrokeshire	Pembrokeshire	Pembrokeshire	Pembrokeshire
Powys						
Aber-craf	Llandeillo	Llandeillo	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Banwy	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Berriew	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Builth	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Bwlch	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Caersws/Carno	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Churchstoke	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Clyro/Painscastle	Shobdon Airfield,	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
	Herefordshire					
Crickhowell/Vale of Grwyney	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Cwm-twrch	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Disserth and Trecoed	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Dolforwyn	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Felin-fach	Sennybridge	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Forden	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Glantwymyn/Cadfarch	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Glasbury	Sennybridge	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Glascwm/Llanelwedd	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Guilsfield Within	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Guilsfield Without	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Gwernyfed	Hereford, Credenhill	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Hay	Hereford, Credenhill	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Kerry	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Knighton	Shobdon Airfield, Herefordshire	Shawbury	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Llanafanfawr/Erwood	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Llanbadarn Fawr	Shobdon Airfield, Herefordshire	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Llanbister/Beguildy	Shobdon Airfield, Herefordshire	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Llanbrynmair	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Llandinam	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Llandrindod East Llandrindod West	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Llandrindod North	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Llandrindod South	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Llandrinio	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Llandysilio	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Llanfair Caereinion	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Llanfihangel	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Llanfihangel Rhydithon Llangunllo	Shobdon Airfield, Herefordshire	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Llanfrynach/Talybont-on-Usk	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanfyllin	Lake Vyrnwy	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Llangamarch/Llanwrtyd Wells	Sennybridge	Llandeillo	Aston Hill	Aston Hill	Swansea	Swansea
Llangattock	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llangors	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llangynidr	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanidloes	Trawsgoed	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Llanrhaeadr-ym-Mochnant Llansilin	Lake Vyrnwy	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llansantffraid	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Llanwddyn	Lake Vyrnwy	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Llanyre	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Machynlleth	Trawsgoed	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Maescar/Llywel	Sennybridge	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Meifod	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Mochdre	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Montgomery	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Newtown Central	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Newtown East	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Newtown Llanllwchaiarn North	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Newtown Llanllwchaiarn West	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Newtown South	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Old Radnor New Radnor Gladestry	Shobdon Airfield, Herefordshire	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
Presteigne	Shobdon Airfield, Herefordshire	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Rhayader Town/Llansantffraed-Cwmdeuddwr	Trawsgoed	Llandeillo	Aston Hill	Aston Hill	Swansea	Swansea
Rhiewcynon	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
St. David Within	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Harmon/Nantmel	Sennybridge	Tredegar Bryn Bach Park No 2	Aston Hill	Aston Hill	Cwmbran	Cwmbran
St. John	Sennybridge	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Mary	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Talgarth/Bronllys	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Tawe-Uchaf/Ystradfellte	Sennybridge	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Trefeglwys/Llangurig	Trawsgoed	Alwen	Aston Hill	Aston Hill	Wrexham	Wrexham
Trewern	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Welshpool Castle	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Welshpool Gungrog	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Welshpool Llanerchyddol	Lake Vyrnwy	Shawbury	Aston Hill	Aston Hill	Wrexham	Wrexham
Ynyscedwyn	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Yscir	Sennybridge	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Ystradgynlais	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Aberaman North	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Aberaman South	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Abercynon	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cardiff	Cardiff	Cardiff	Cardiff
Aberdare East	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Aberdare West/Llwydcoed	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Beddau	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Brynna	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Church Village	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Cilfynydd	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Cwm Clydach	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Cwmbran	Cwmbran	Cwmbran
Cwmbach	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Port Talbot	Port Talbot	Port Talbot
Cymmer	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Ferndale	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Gilfach Goch	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Glyncoch	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Graig	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Hawthorn	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Hirwaun	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Llanharan	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llanharry	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llantrisant Town	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llantwit Fardre	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llwyn-y-pia	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Maerdy	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Mountain Ash East	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Mountain Ash West	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cardiff	Cardiff	Cardiff	Cardiff
Penrhiwceiber	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cardiff	Cardiff	Cardiff	Cardiff
Pentre	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pen-y-graig	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pen-y-waun	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Pont-y-clun	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Pontypridd Town	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Porth	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Rhigos	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Rhondda	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Rhydfelen Central/Ilan	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Rhydfelen Lower	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Taffs Well	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Talbot Green	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Ton-teg	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Tonypandy	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Tonyrefail East	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Tonyrefail West	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Trallwng	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Trealaw	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Treforest	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Treherbert	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Treorchy	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Tylorstown	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Tyn-y-nant	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Ynyshir	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cardiff	Cardiff	Cardiff	Cardiff
Ynysybwl	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cardiff	Cardiff	Cardiff	Cardiff
Ystrad	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Swansea						
Bishopston	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Bonymaen	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Castle	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Clydach	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Cockett	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Cwmbwrla	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Dulais East	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Dunvant	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Fairwood	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gorseinon Central	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gorseinon East	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gower	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gowerton East	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Gowerton West	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Graigfelen	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Killay North	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Killay South	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Kingsbridge	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Landore	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llangyfelach	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Llansamlet	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Lower Loughor	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Mawr	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Mayals	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Morriston	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Mynyddbach	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Newton	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Oystermouth	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Penclawdd	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Penderry	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Penllergaer	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Pennard	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Penyrheol	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Pontardulais	Llandeillo	Llandeillo	Swansea	Swansea	Swansea	Swansea
Sketty	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
St. Thomas	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Tal-y-bont	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Townhill	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Uplands	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Upper Loughor	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
Vardre	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
West Cross	Mumbles Head	Llandeillo	Swansea	Swansea	Swansea	Swansea
The Vale of Glamorgan						
Alexandra	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Baruc	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Buttrills	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Cadoc	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Castleland	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Cornerswell	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Court	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Cowbridge	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Dinas Powys	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Dyfan	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Gibbonsdown	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Illtyd	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Llandough	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Llandow/Ewenny	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Llantwit Major	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Peterston-super-Ely	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Rhoose	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
St. Athan	St Athan	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
St. Bride's Major	St Athan	Cardiff Bute Park	Port Talbot	Port Talbot	Port Talbot	Port Talbot
Stanwell	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Sully	Cardiff Weather Centre	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Wenvoe	Cardiff Bute Park	Cardiff Bute Park	Cardiff	Cardiff	Cardiff	Cardiff
Torfaen						
Abersychan	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Blaenavon	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Brynwern	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Coed Eva	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Croesyceiliog North	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Croesyceiliog South	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Cwmyniscoy	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Fairwater	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Greenmeadow	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llantarnam	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanyrafon North	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Llanyrafon South	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
New Inn Lower	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
New Inn Upper	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Panteg	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Pontnewydd	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Pontnewynydd	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Pontypool	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Snatchwood	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Cadocs and Penygarn	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
St. Dials	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Trevethin	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Two Locks	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Upper Cwmbran	Penhow	Penhow	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Wainfelin	Tredegar Bryn Bach Park No 2	Tredegar Bryn Bach Park No 2	Cwmbran	Cwmbran	Cwmbran	Cwmbran
Wrexham						
Acton	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Borras Park	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Bronington	Shawbury	Shawbury	Wrexham	Aston Hill	Wrexham	Wrexham
Brymbo	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Bryn Cefn	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Caia Park	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Cefn	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Ceiriog Ganol Ceiriog Ucha	Lake Vyrnwy	Alwen	Wrexham	Aston Hill	Wrexham	Wrexham
Chirk North	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Chirk South	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Coedpoeth	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Esclusham	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Garden Village	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Gresford East and West	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Grosvenor	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Gwenfro	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Gwersyllt East and South	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Gwersyllt North	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Gwersyllt West	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Holt	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Johnstown	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Little Acton	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Llangollen Rural	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Llay	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Maesydre	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Marchwiel	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Marford and Hoseley	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham

Ward name	Weather station-temperature	Weather station-snow	NO2 station	O3 station	PM10 station	SO2 station
Minera	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
New Broughton	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Offa East	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Offa West	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Overton	Shawbury	Shawbury	Wrexham	Aston Hill	Wrexham	Wrexham
Pant	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Penycae	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Plas Madoc	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Ponciau	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Queensway	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Rhosnesni	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Rossett	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Ruabon	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Stansty	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham
Whitegate	Hawarden Bridge	Hawarden Bridge	Wrexham	Aston Hill	Wrexham	Wrexham

Appendix 15: Summary of residuals by ward (observed – expected triage call rates) (b)

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Isle of Anglesey	Aberffraw	NAMA	35.02	0.104	0.043	0.060
Isle of Anglesey	Amlwch Port	NAMB	40.46	0.164	0.064	0.100
Isle of Anglesey	Amlwch Rural	NAMC	25.47	0.078	0.042	0.037
Isle of Anglesey	Beaumaris	NAMD	20.45	0.078	0.049	0.029
Isle of Anglesey	Bodffordd	NAME	17.95	0.096	0.050	0.046
Isle of Anglesey	Bodorgan	NAMF	23.74	0.090	0.046	0.044
Isle of Anglesey	Braint	NAMG	8.66	0.047	0.096	-0.049
Isle of Anglesey	Bryngwran	NAMH	30.55	0.155	0.061	0.094
Isle of Anglesey	Brynteg	NAMJ	15.99	0.090	0.052	0.038
Isle of Anglesey	Cadnant	NAMK	11.48	0.103	0.060	0.043
Isle of Anglesey	Cefni	NAML	9.73	0.104	0.049	0.056
Isle of Anglesey	Cwm Cadnant	NAMM	5.38	0.078	0.051	0.027
Isle of Anglesey	Cyngar	NAMN	21.24	0.095	0.051	0.044
Isle of Anglesey	Gwyngyll	NAMP	5.74	0.055	0.067	-0.012
Isle of Anglesey	Holyhead Town	NAMQ	46.84	0.137	0.061	0.075
Isle of Anglesey	Kingsland	NAMR	33.56	0.169	0.051	0.118
Isle of Anglesey	Llanbadrig	NAMS	29.91	0.069	0.037	0.032
Isle of Anglesey	Llanbedrgoch	NAMT	16.74	0.076	0.055	0.020
Isle of Anglesey	Llanddyfnan	NAMU	12.48	0.058	0.063	-0.005
Isle of Anglesey	Llaneilian	NAMW	23.48	0.087	0.049	0.038
Isle of Anglesey	Llanfaethlu	NAMX	23.76	0.110	0.054	0.056
Isle of Anglesey	Llanfair-yn-Neubwll	NAMY	17.56	0.143	0.054	0.089
Isle of Anglesey	Llanfihangel Ysgeifiog	NAMZ	15.31	0.096	0.055	0.041
Isle of Anglesey	Llangoed	NANA	17.16	0.082	0.048	0.034
Isle of Anglesey	Llanidan	NANB	21.79	0.080	0.051	0.029
Isle of Anglesey	Llannerch-y-medd	NANC	36.89	0.115	0.046	0.068
Isle of Anglesey	London Road	NAND	31.71	0.162	0.069	0.093
Isle of Anglesey	Maeshyfryd	NANE	42.01	0.157	0.065	0.092
Isle of Anglesey	Mechell	NANF	28.42	0.078	0.034	0.044
Isle of Anglesey	Moelfre	NANG	29.49	0.114	0.041	0.073
Isle of Anglesey	Morawelon	NANH	52.08	0.149	0.071	0.078
Isle of Anglesey	Parc a'r Mynydd	NANJ	22.75	0.138	0.039	0.099
Isle of Anglesey	Pentraeth	NANK	18.11	0.133	0.059	0.074
Isle of Anglesey	Porthyfelin	NANL	39.60	0.142	0.083	0.059
Isle of Anglesey	Rhosneigr	NANM	33.67	0.106	0.055	0.050
Isle of Anglesey	Rhosyr	NANN	22.95	0.095	0.049	0.046
Isle of Anglesey	Trearddur	NANP	12.91	0.164	0.052	0.112
Isle of Anglesey	Tudur	NANQ	45.25	0.097	0.072	0.026
Isle of Anglesey	Tysilio	NANR	13.24	0.090	0.061	0.029

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Isle of Anglesey	Valley	NANS	17.40	0.154	0.056	0.098
Gwynedd	Aberdaron	NCMA	28.39	0.030	0.014	0.017
Gwynedd	Aberdovey	NCMB	14.42	0.074	0.061	0.013
Gwynedd	Abererch	NCMC	16.19	0.041	0.031	0.010
Gwynedd	Abersoch	NCMD	21.74	0.087	0.022	0.065
Gwynedd	Arthog	NCME	28.17	0.076	0.020	0.056
Gwynedd	Bala	NCMF	19.59	0.061	0.017	0.044
Gwynedd	Barmouth	NCMG	42.71	0.049	0.014	0.035
Gwynedd	Bethel	NCMH	13.00	0.093	0.062	0.032
Gwynedd	Bontnewydd	NCMJ	13.22	0.073	0.066	0.007
Gwynedd	Botwnnog	NCMK	24.08	0.038	-0.006	0.044
Gwynedd	Bowydd and Rhiw	NCML	44.92	0.062	0.015	0.046
Gwynedd	Cadnant	NCMM	35.51	0.114	0.051	0.063
Gwynedd	Clynnog	NCMN	24.76	0.106	0.050	0.056
Gwynedd	Conglywal and Maenofferen	NCMP	30.85	0.049	0.019	0.030
Gwynedd	Corris/Mawddwy	NCMQ	28.47	0.067	0.011	0.056
Gwynedd	Criccieth	NCMR	18.03	0.048	0.020	0.028
Gwynedd	Cynfal and Teigl	NCMS	25.28	0.040	0.024	0.016
Gwynedd	Deiniol	NCMT	23.93	0.149	0.053	0.096
Gwynedd	Deiniolen	NCMU	31.86	0.131	0.039	0.091
Gwynedd	Dewi	NCMW	18.51	0.131	0.083	0.048
Gwynedd	Dolbenmaen/Beddgelert	NCMX	18.23	0.043	0.033	0.009
Gwynedd	Dolgellau/Llanelltyd/Brithdir and Llanfachreth	NCMY	17.05	0.043	0.010	0.033
Gwynedd	Dyffryn Ardudwy	NCMZ	16.73	0.052	0.034	0.018
Gwynedd	Efail-newydd/Buan	NCNA	20.96	0.034	0.014	0.019
Gwynedd	Garth	NCNB	6.39	0.073	0.028	0.045
Gwynedd	Gerlan	NCNC	26.79	0.081	0.057	0.023
Gwynedd	Glyder	NCND	9.27	0.152	0.072	0.080
Gwynedd	Harlech	NCNE	17.11	0.053	0.022	0.031
Gwynedd	Hendre	NCNF	25.44	0.117	0.058	0.060
Gwynedd	Hirael	NCNG	27.00	0.123	0.088	0.035
Gwynedd	Llanaelhaearn/Pistyll	NCNH	30.40	0.045	0.025	0.020
Gwynedd	Llanarmon/Llanystumdwy	NCNJ	16.94	0.068	0.031	0.037
Gwynedd	Llanbedr	NCNK	20.91	0.058	0.018	0.039
Gwynedd	Llanbedrog	NCNL	21.94	0.031	0.035	-0.003
Gwynedd	Llanberis	NCNM	22.09	0.083	0.036	0.048
Gwynedd	Llandderfel	NCNN	19.88	0.049	0.053	-0.004
Gwynedd	Llandwrog	NCNP	18.85	0.063	0.043	0.021
Gwynedd	Llandygai	NCNQ	15.48	0.101	0.057	0.044
Gwynedd	Llanengan	NCNR	17.21	0.035	-0.003	0.038
Gwynedd	Llangelynin/Bryn-crug	NCNS	19.07	0.062	0.034	0.028
Gwynedd	Llanllechid/Aber	NCNT	10.91	0.102	0.049	0.053

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Gwynedd	Llanllyfni	NCNU	27.58	0.112	0.035	0.077
Gwynedd	Llanrug	NCNW	21.75	0.081	0.062	0.019
Gwynedd	Llanuwchllyn	NCNX	18.28	0.042	0.000	0.042
Gwynedd	Llanwnda	NCNY	17.34	0.091	0.045	0.046
Gwynedd	Marchog	NCNZ	62.35	0.149	0.077	0.072
Gwynedd	Menai (Bangor)	NCPA	7.91	0.133	0.052	0.081
Gwynedd	Menai (Caernarfon)	NCPB	13.05	0.066	0.057	0.009
Gwynedd	Nefyn	NCPC	21.10	0.039	0.035	0.004
Gwynedd	Ogwen	NCPD	32.01	0.075	0.066	0.008
Gwynedd	Peblig	NCPE	67.93	0.118	0.068	0.050
Gwynedd	Penisarwaun	NCPF	22.21	0.085	0.030	0.055
Gwynedd	Penrhyndeudraeth	NCPG	18.16	0.041	0.033	0.008
Gwynedd	Pentir	NCPH	11.06	0.102	0.060	0.042
Gwynedd	Penygroes	NCPJ	31.16	0.071	0.033	0.039
Gwynedd	Porthmadog East	NCPK	17.31	0.038	0.029	0.009
Gwynedd	Porthmadog-Gest	NCPL	7.22	0.056	0.049	0.007
Gwynedd	Porthmadog-Tremadog	NCPM	20.02	0.030	0.016	0.013
Gwynedd	Porthmadog West	NCPN	14.90	0.059	0.022	0.037
Gwynedd	Pwllheli North	NCPP	28.53	0.056	0.018	0.038
Gwynedd	Pwllheli South	NCPQ	39.28	0.061	0.030	0.031
Gwynedd	Rachub	NCPR	38.42	0.094	0.054	0.040
Gwynedd	Seiont	NCPS	27.87	0.102	0.049	0.053
Gwynedd	Talysarn	NCPT	46.61	0.089	0.056	0.033
Gwynedd	Trawsfynydd	NCPU	23.70	0.049	0.014	0.035
Gwynedd	Tudweiliog	NCPW	24.62	0.038	-0.008	0.047
Gwynedd	Tywyn	NCPX	20.29	0.045	0.030	0.014
Gwynedd	Waunfawr	NCPY	15.25	0.068	0.036	0.032
Gwynedd	Y Felinheli	NCPZ	16.23	0.088	0.055	0.033
Conwy	Betws yn Rhos	NEMA	11.82	0.042	0.062	-0.019
Conwy	Bro Machno/Betws-y-Coed	NEMB	15.16	0.064	0.025	0.038
Conwy	Bryn	NEMC	29.91	0.081	0.051	0.030
Conwy	Bryn Rhys	NEMD	9.66	0.102	0.046	0.056
Conwy	Caerhun	NEME	14.20	0.086	0.053	0.033
Conwy	Capelulo	NEMF	17.93	0.081	0.046	0.036
Conwy	Colwyn	NEMG	18.89	0.073	0.072	0.000
Conwy	Conwy	NEMH	11.93	0.086	0.044	0.042
Conwy	Craig-y-Don	NEMJ	12.57	0.088	0.038	0.050
Conwy	Crwst	NEMK	15.28	0.063	0.053	0.010
Conwy	Deganwy	NEML	8.94	0.097	0.054	0.042
Conwy	Dinarth	NEMM	5.07	0.085	0.056	0.029
Conwy	Eglwysbach	NEMN	12.42	0.055	0.039	0.016
Conwy	Eirias	NEMP	12.39	0.065	0.060	0.006
Conwy	Fforddlas	NEMQ	8.03	0.053	0.025	0.028

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Conwy	Gele	NEMR	7.38	0.068	0.051	0.018
Conwy	Glyn	NEMS	29.26	0.117	0.037	0.080
Conwy	Gogarth	NEMT	22.92	0.120	0.027	0.093
Conwy	Gower	NEMU	20.21	0.064	0.060	0.004
Conwy	Kinmel Bay	NEMW	26.90	0.077	0.069	0.008
Conwy	Llanddulas	NEMX	10.04	0.090	0.066	0.024
Conwy	Llanfair Talhaiarn	NEMY	12.97	0.043	0.049	-0.006
Conwy	Llangernyw	NEMZ	15.19	0.045	0.051	-0.005
Conwy	Llansannan	NENA	12.14	0.029	0.038	-0.010
Conwy	Llysfaen	NENB	24.20	0.081	0.058	0.023
Conwy	Marl	NENC	9.59	0.081	0.053	0.028
Conwy	Mochdre	NEND	20.88	0.082	0.045	0.037
Conwy	Mostyn	NENE	22.44	0.126	0.062	0.064
Conwy	Pandy/Lafan	NENF	13.03	0.118	0.022	0.096
Conwy	Pant-yr-afon/Penmaenan	NENG	31.17	0.122	0.037	0.085
Conwy	Penrhyn	NENH	4.12	0.089	0.047	0.042
Conwy	Pensarn	NENJ	16.53	0.094	0.046	0.047
Conwy	Pentre Mawr	NENK	24.58	0.088	0.057	0.031
Conwy	Rhiw	NENL	13.29	0.074	0.055	0.019
Conwy	Rhos	NENM	14.25	0.083	0.054	0.029
Conwy	Towyn	NENN	28.54	0.075	0.059	0.016
Conwy	Trefriw	NENP	17.36	0.064	0.046	0.017
Conwy	Tudno	NENQ	31.09	0.108	0.069	0.039
Conwy	Uwchaled	NENR	17.18	0.046	0.023	0.023
Conwy	Uwch Conwy	NENS	15.26	0.066	0.020	0.045
Denbighshire	Bodelwyddan	NGMA	24.72	0.070	0.056	0.014
Denbighshire	Corwen	NGMB	20.43	0.051	0.041	0.009
Denbighshire	Denbigh Central	NGMC	22.64	0.035	0.041	-0.007
Denbighshire	Denbigh Lower	NGMD	4.48	0.030	0.053	-0.023
Denbighshire	Denbigh Upper/Henllan	NGME	28.90	0.028	0.032	-0.004
Denbighshire	Dyserth	NGMF	14.88	0.081	0.067	0.014
Denbighshire	Efenechtyd	NGMG	9.41	0.062	0.048	0.014
Denbighshire	Llanarmon-yn-Ial/Llandegla	NGMH	10.53	0.097	0.052	0.045
Denbighshire	Llanbedr Dyffryn Clwyd	NGMJ	5.22	0.071	0.048	0.022
Denbighshire	Llandrillo	NGMK	13.01	0.043	0.025	0.018
Denbighshire	Llandyrnog	NGML	19.75	0.040	0.027	0.013
Denbighshire	Llanfair Dyffryn Clwyd Gwyddelwern	NGMM	10.48	0.069	0.047	0.021
Denbighshire	Llangollen	NGMN	13.29	0.071	0.044	0.026
Denbighshire	Llanrhaeadr-yng-Nghinmeirch	NGMQ	7.94	0.041	0.056	-0.015
Denbighshire	Llanynys	NGMR	10.41	0.066	0.022	0.043
Denbighshire	Meliden	NGMS	30.22	0.058	0.068	-0.011
Denbighshire	Prestatyn Central	NGMT	15.89	0.056	0.081	-0.025

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Denbighshire	Prestatyn East	NGMU	12.79	0.108	0.036	0.072
Denbighshire	Prestatyn North	NGMW	21.56	0.074	0.077	-0.003
Denbighshire	Prestatyn South West	NGMX	18.53	0.069	0.077	-0.008
Denbighshire	Rhuddlan	NGMY	12.98	0.065	0.058	0.007
Denbighshire	Rhyl East	NGMZ	27.91	0.074	0.071	0.003
Denbighshire	Rhyl South	NGNA	19.03	0.072	0.098	-0.025
Denbighshire	Rhyl South East	NGNB	18.58	0.073	0.095	-0.022
Denbighshire	Rhyl South West	NGNC	49.88	0.091	0.084	0.007
Denbighshire	Rhyl West	NGND	74.87	0.138	0.071	0.067
Denbighshire	Ruthin	NGNE	6.74	0.076	0.042	0.034
Denbighshire	St. Asaph East	NGNF	6.41	0.049	0.053	-0.004
Denbighshire	St. Asaph West	NGNG	14.94	0.047	0.034	0.013
Denbighshire	Trefnant	NGNH	13.02	0.038	0.058	-0.021
Denbighshire	Tremeirchion	NGNJ	10.18	0.037	0.043	-0.006
Wrexham	Acton	NLMA	21.76	0.096	0.100	-0.004
Wrexham	Borras Park	NLMB	4.67	0.086	0.116	-0.030
Wrexham	Bronington	NLMC	9.79	0.014	0.049	-0.035
Wrexham	Brymbo	NLMD	31.34	0.078	0.068	0.010
Wrexham	Bryn Cefn	NLME	19.00	0.073	0.080	-0.007
Wrexham	Caia Park	NLMF	53.93	0.094	0.101	-0.007
Wrexham	Cefn	NLMG	30.52	0.063	0.069	-0.006
Wrexham	Ceiriog Ganol Ceiriog Ucha	NLMH	15.73	0.066	0.046	0.020
Wrexham	Chirk North	NLMJ	16.64	0.046	0.049	-0.003
Wrexham	Chirk South	NLMK	9.38	0.056	0.042	0.014
Wrexham	Coedpoeth	NLML	15.62	0.073	0.087	-0.014
Wrexham	Esclusham	NLMM	15.87	0.078	0.071	0.006
Wrexham	Garden Village	NLMN	4.79	0.082	0.099	-0.017
Wrexham	Gresford East and West	NLMP	6.63	0.080	0.076	0.004
Wrexham	Grosvenor	NLMQ	19.53	0.100	0.068	0.032
Wrexham	Gwenfro	NLMR	42.09	0.077	0.091	-0.014
Wrexham	Gwersyllt East and South	NLMS	10.49	0.094	0.081	0.013
Wrexham	Gwersyllt North	NLMT	27.19	0.089	0.081	0.008
Wrexham	Gwersyllt West	NLMU	17.74	0.081	0.088	-0.007
Wrexham	Holt	NLMW	9.41	0.089	0.069	0.020
Wrexham	Johnstown	NLMX	20.75	0.096	0.100	-0.004
Wrexham	Little Acton	NLMY	6.06	0.083	0.122	-0.039
Wrexham	Llay	NLMZ	18.76	0.097	0.077	0.020
Wrexham	Maesydre	NLNA	22.12	0.065	0.110	-0.045
Wrexham	Marchwiel	NLNB	8.06	0.076	0.063	0.013
Wrexham	Marford and Hoseley	NLNC	3.76	0.090	0.062	0.028
Wrexham	Minera	NLND	9.53	0.081	0.072	0.009
Wrexham	New Broughton	NLNE	19.57	0.090	0.078	0.012
Wrexham	Offa East	NLNF	20.75	0.081	0.096	-0.015

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Wrexham	Offa West	NLNG	20.22	0.097	0.077	0.020
Wrexham	Overton	NLNH	10.88	0.024	0.041	-0.017
Wrexham	Pant	NLNJ	32.40	0.075	0.101	-0.026
Wrexham	Penycae	NLNK	31.99	0.091	0.067	0.024
Wrexham	Plas Madoc	NLNL	72.33	0.076	0.113	-0.036
Wrexham	Ponciau	NLNM	21.95	0.076	0.063	0.013
Wrexham	Queensway	NLNN	54.69	0.098	0.107	-0.009
Wrexham	Rhosnesni	NLNP	4.91	0.084	0.119	-0.035
Wrexham	Ruabon	NLNR	23.48	0.081	0.071	0.011
Wrexham	Stansty	NLNS	12.19	0.079	0.099	-0.020
Wrexham	Whitegate	NLNT	25.66	0.098	0.108	-0.010
Wrexham	Llangollen Rural	NLNU	14.98	0.071	0.061	0.010
Powys	Aber-craf	NNMA	32.93	0.120	0.056	0.064
Powys	Banwy	NNMB	19.27	0.040	-0.005	0.044
Powys	Berriew	NNMC	14.02	0.056	0.039	0.017
Powys	Builth	NNMD	9.06	0.095	0.027	0.069
Powys	Bwlch	NNME	9.35	0.044	0.079	-0.035
Powys	Caersws/Carno	NNMF	15.83	0.053	-0.008	0.061
Powys	Churchstoke	NNMG	13.89	0.048	0.040	0.008
Powys	Clyro/Painscastle	NNMH	9.05	0.068	0.047	0.021
Powys	Crickhowell/Vale of Grwyney	NNMJ	9.70	0.061	0.055	0.006
Powys	Cwm-twrch	NNMK	29.36	0.160	0.067	0.093
Powys	Disserth and Trecoed	NNML	13.96	0.063	-0.012	0.074
Powys	Dolforwyn	NNMM	9.06	0.085	0.036	0.049
Powys	Felin-fach	NNMN	8.98	0.033	0.017	0.016
Powys	Forden	NNMP	9.62	0.096	0.035	0.061
Powys	Glantwymyn/Cadfarch	NNMQ	18.11	0.038	0.014	0.025
Powys	Glasbury	NNMR	10.77	0.054	0.040	0.015
Powys	Glascwm/Llanelwedd	NNMS	10.67	0.115	0.025	0.090
Powys	Guilsfield Within	NNMT	6.67	0.031	0.036	-0.005
Powys	Guilsfield Without	NNMU	8.56	0.038	0.018	0.020
Powys	Gwernyfed	NNMW	13.91	0.076	0.046	0.030
Powys	Hay	NNMX	13.50	0.104	0.058	0.046
Powys	Kerry	NNMY	8.39	0.073	0.014	0.059
Powys	Knighton	NNMZ	10.76	0.054	0.015	0.038
Powys	Llanafanfawr/Erwood	NNNA	15.35	0.073	0.030	0.043
Powys	Llanbadarn Fawr	NNNB	12.01	0.045	-0.012	0.057
Powys	Llanbister/Beguildy	NNNC	16.40	0.061	-0.006	0.067
Powys	Llanbrynmair	NNND	21.23	0.037	0.012	0.024
Powys	Llandinam	NNNE	13.97	0.048	0.019	0.028
Powys	Llandrindod East Llandrindod West	NNNF	18.06	0.065	-0.009	0.074
Powys	Llandrindod North	NNNG	17.67	0.068	-0.005	0.073

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Powys	Llandrindod South	NNNH	15.42	0.059	-0.012	0.071
Powys	Llandrinio	NNNJ	11.67	0.058	0.060	-0.002
Powys	Llandysilio	NNNK	16.99	0.081	0.050	0.030
Powys	Llanfair Caereinion	NNNL	14.38	0.043	0.026	0.017
Powys	Llanfihangel	NNNM	19.66	0.036	0.039	-0.003
Powys	Llanfihangel Rhydithon Llangunllo	NNNN	12.68	0.057	0.020	0.037
Powys	Llanfrynach/Talybont-on-Usk	NNNP	10.83	0.061	0.045	0.016
Powys	Llanfyllin	NNNQ	16.32	0.056	0.014	0.042
Powys	Llangamarch/Llanwrtyd Wells	NNNR	17.39	0.109	0.014	0.096
Powys	Llangattock	NNNS	16.01	0.062	0.052	0.010
Powys	Llangors	NNNT	7.51	0.044	0.038	0.006
Powys	Llangynidr	NNNU	7.27	0.061	0.069	-0.008
Powys	Llanidloes	NNNW	8.29	0.027	-0.009	0.036
Powys	Llanrhaeadr-ym-Mochnant Llansilin	NNNX	12.72	0.060	0.020	0.040
Powys	Llansantffraid	NNNY	18.74	0.042	0.048	-0.006
Powys	Llanwddyn	NNNZ	17.59	0.042	0.012	0.030
Powys	Llanyre	NNPA	9.42	0.067	0.004	0.063
Powys	Machynlleth	NNPB	19.27	0.048	0.011	0.037
Powys	Maescar/Llywel	NNPC	12.74	0.043	0.022	0.021
Powys	Meifod	NNPD	18.21	0.051	0.046	0.005
Powys	Mochdre	NNPE	10.98	0.077	-0.001	0.078
Powys	Montgomery	NNPF	13.92	0.080	0.020	0.060
Powys	Newtown Central	NNPG	29.27	0.145	0.048	0.097
Powys	Newtown East	NNPH	17.59	0.126	0.006	0.120
Powys	Newtown Llanllwchaiarn North	NNPJ	5.37	0.101	0.027	0.075
Powys	Newtown Llanllwchaiarn West	NNPK	7.90	0.092	0.020	0.072
Powys	Newtown South	NNPL	30.50	0.158	0.014	0.143
Powys	Old Radnor New Radnor Gladestry	NNPM	15.42	0.046	0.007	0.039
Powys	Presteigne	NNPN	11.05	0.046	0.026	0.020
Powys	Rhayader Town/Llansantffraed-Cwmdeuddwr	NNPP	14.30	0.043	-0.003	0.046
Powys	Rhiewcynon	NNPQ	15.46	0.080	0.003	0.076
Powys	St. David Within	NNPR	13.41	0.044	0.007	0.038
Powys	St. Harmon/Nantmel	NNPS	16.69	0.053	-0.007	0.060
Powys	St. John	NNPT	13.85	0.044	0.019	0.025
Powys	St. Mary	NNPU	5.84	0.052	0.022	0.030
Powys	Talgarth/Bronllys	NNPW	11.96	0.058	0.046	0.011
Powys	Tawe-Uchaf/Ystradfellte	NNPX	37.00	0.109	0.055	0.053
Powys	Trefeglwys/Llangurig	NNPY	14.91	0.041	0.007	0.034
Powys	Trewern	NNPZ	14.68	0.072	0.054	0.018

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Powys	Welshpool Castle	NNQA	23.95	0.205	-0.012	0.217
Powys	Welshpool Gungrog	NNQB	14.96	0.049	0.030	0.019
Powys	Welshpool Llanerchyddol	NNQC	12.49	0.045	0.034	0.010
Powys	Ynyscedwyn	NNQD	24.38	0.132	0.079	0.053
Powys	Yscir	NNQE	10.44	0.047	0.035	0.012
Powys	Ystradgynlais	NNQF	39.61	0.164	0.070	0.094
Ceredigion	Aberaeron	NQMA	13.43	0.065	0.000	0.065
Ceredigion	Aberporth	NQMB	21.40	0.072	0.020	0.052
Ceredigion	Aberystwyth East	NQMC	4.67	0.084	0.050	0.033
Ceredigion	Aberystwyth North	NQMD	7.85	0.095	0.029	0.065
Ceredigion	Aberystwyth South	NQME	29.96	0.064	0.055	0.009
Ceredigion	Aberystwyth West	NQMF	11.38	0.089	0.063	0.026
Ceredigion	Beulah	NQMG	19.59	0.061	0.011	0.050
Ceredigion	Borth	NQMH	18.26	0.062	0.025	0.038
Ceredigion	Capel Dewi	NQMJ	23.35	0.068	0.013	0.056
Ceredigion	Cardigan	NQMK	26.11	0.071	-0.005	0.076
Ceredigion	Ceulanamaesmawr	NQML	11.30	0.053	0.016	0.037
Ceredigion	Ciliau Aeron	NQMM	21.45	0.050	0.002	0.047
Ceredigion	Faenor	NQMN	6.38	0.069	0.036	0.033
Ceredigion	Lampeter	NQMP	7.75	0.074	0.003	0.070
Ceredigion	Llanarth	NQMQ	24.65	0.059	0.007	0.052
Ceredigion	Llanbadarn Fawr	NQMR	6.16	0.075	0.047	0.028
Ceredigion	Llandyfriog	NQMS	25.82	0.062	0.013	0.048
Ceredigion	Llandysiliogogo	NQMT	18.56	0.051	-0.004	0.055
Ceredigion	Llandysul Town	NQMU	25.05	0.050	0.010	0.040
Ceredigion	Llanfarian	NQMW	12.27	0.085	0.036	0.049
Ceredigion	Llanfihangel Ystrad	NQMX	22.58	0.073	0.019	0.054
Ceredigion	Llangeitho	NQMY	29.13	0.054	0.003	0.051
Ceredigion	Llangybi	NQMZ	24.29	0.073	0.002	0.071
Ceredigion	Llanrhystud	NQNA	16.13	0.062	0.021	0.042
Ceredigion	Llansantffraid	NQNB	18.14	0.059	0.016	0.043
Ceredigion	Llanwenog	NQNC	16.66	0.057	0.007	0.050
Ceredigion	Lledrod	NQND	24.62	0.075	0.028	0.047
Ceredigion	Melindwr	NQNE	10.80	0.069	0.031	0.038
Ceredigion	New Quay	NQNF	21.97	0.083	-0.003	0.087
Ceredigion	Penbryn	NQNG	23.69	0.074	0.019	0.055
Ceredigion	Penparc	NQNH	15.91	0.084	0.006	0.078
Ceredigion	Tirymynach	NQNJ	11.08	0.060	0.046	0.014
Ceredigion	Trefeurig	NQNK	8.27	0.050	0.035	0.015
Ceredigion	Tregaron	NQNL	21.97	0.064	0.007	0.057
Ceredigion	Troedyraur	NQNM	24.39	0.081	-0.003	0.084
Ceredigion	Ystwyth	NQNN	8.87	0.045	0.033	0.012
Pembrokeshire	Amroth	NSMA	18.52	0.072	0.041	0.032

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Pembrokeshire	Begelly	NSMB	16.20	0.077	0.041	0.036
Pembrokeshire	Brawdy	NSMC	14.42	0.090	0.040	0.050
Pembrokeshire	Burton	NSMD	8.48	0.068	0.053	0.014
Pembrokeshire	Camrose	NSME	11.17	0.078	0.041	0.037
Pembrokeshire	Carew	NSMF	12.84	0.043	0.049	-0.006
Pembrokeshire	Castle	NSMG	25.03	0.094	0.044	0.050
Pembrokeshire	Cilgerran	NSMH	17.22	0.075	0.002	0.074
Pembrokeshire	Clydau	NSMJ	20.96	0.059	0.022	0.037
Pembrokeshire	Crymych	NSMK	17.27	0.070	0.032	0.039
Pembrokeshire	Dinas Cross	NSML	15.46	0.071	0.032	0.039
Pembrokeshire	East Williamston	NSMM	18.73	0.056	0.029	0.027
Pembrokeshire	Fishguard	NSMN	17.82	0.090	0.033	0.057
Pembrokeshire	Garth	NSMP	29.31	0.091	0.071	0.021
Pembrokeshire	Goodwick	NSMQ	26.28	0.085	0.039	0.046
Pembrokeshire	Hakin	NSMR	27.42	0.059	0.051	0.008
Pembrokeshire	Hundleton/Stackpole	NSMS	13.17	0.049	0.038	0.011
Pembrokeshire	Johnston	NSMT	21.09	0.073	0.046	0.027
Pembrokeshire	Lampeter Velfrey	NSMU	15.22	0.054	0.039	0.015
Pembrokeshire	Lamphey	NSMW	15.45	0.052	0.075	-0.022
Pembrokeshire	Letterston	NSMX	17.05	0.075	0.049	0.025
Pembrokeshire	Llangwm	NSMY	13.36	0.060	0.053	0.006
Pembrokeshire	Maenclochog	NSMZ	22.44	0.036	0.038	-0.002
Pembrokeshire	Manorbier	NSNA	18.58	0.076	0.025	0.051
Pembrokeshire	Martletwy	NSNB	20.15	0.048	0.037	0.011
Pembrokeshire	Merlin's Bridge	NSNC	22.87	0.076	0.031	0.044
Pembrokeshire	Milford Central and East	NSND	23.92	0.064	0.056	0.008
Pembrokeshire	Milford North and West	NSNE	28.64	0.074	0.060	0.014
Pembrokeshire	Narberth Rural	NSNF	11.62	0.053	0.016	0.037
Pembrokeshire	Narberth Urban	NSNG	21.03	0.054	0.020	0.034
Pembrokeshire	Newport	NSNH	15.40	0.059	0.037	0.022
Pembrokeshire	Neyland East	NSNJ	25.48	0.047	0.075	-0.028
Pembrokeshire	Neyland West	NSNK	32.02	0.045	0.056	-0.010
Pembrokeshire	Pembroke Dock: Central	NSNL	34.46	0.059	0.069	-0.010
Pembrokeshire	Pembroke Dock: Llanion	NSNM	43.20	0.053	0.043	0.010
Pembrokeshire	Pembroke Dock:Market	NSNN	27.91	0.054	0.057	-0.004
Pembrokeshire	Pembroke Dock: Pennar	NSNP	27.13	0.037	0.060	-0.024
Pembrokeshire	Pembroke: Monkton	NSNQ	64.14	0.046	0.034	0.012
Pembrokeshire	Pembroke: St. Mary	NSNR	33.65	0.034	0.055	-0.021
Pembrokeshire	Pembroke: St. Michael	NSNS	12.13	0.039	0.038	0.001
Pembrokeshire	Penally	NSNT	11.74	0.057	0.027	0.029
Pembrokeshire	Prendergast	NSNU	14.48	0.058	0.045	0.013
Pembrokeshire	Priory	NSNW	9.28	0.075	0.049	0.026
Pembrokeshire	Rudbaxton	NSNX	5.29	0.078	0.043	0.035

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Pembrokeshire	St. David's	NSNY	17.45	0.051	0.015	0.035
Pembrokeshire	St. Dogmaels	NSNZ	21.90	0.069	0.000	0.069
Pembrokeshire	St. Ishmael's	NSPA	17.81	0.090	0.047	0.044
Pembrokeshire	Saundersfoot	NSPB	12.45	0.063	0.020	0.044
Pembrokeshire	Scleddau	NSPC	18.37	0.099	0.041	0.057
Pembrokeshire	Solva	NSPD	17.24	0.082	0.034	0.048
Pembrokeshire	Tenby	NSPE	18.10	0.060	0.027	0.033
Pembrokeshire	The Havens	NSPF	15.21	0.098	0.050	0.048
Pembrokeshire	Wiston	NSPG	14.25	0.054	0.028	0.026
Carmarthenshire	Abergwili	NUMA	8.84	0.059	0.046	0.013
Carmarthenshire	Ammanford	NUMB	29.02	0.101	0.083	0.018
Carmarthenshire	Betws	NUMC	23.90	0.109	0.067	0.042
Carmarthenshire	Bigyn	NUMD	37.07	0.084	0.069	0.015
Carmarthenshire	Burry Port	NUME	33.74	0.053	0.055	-0.002
Carmarthenshire	Bynea	NUMF	35.96	0.069	0.057	0.012
Carmarthenshire	Carmarthen Town North	NUMG	13.52	0.080	0.055	0.025
Carmarthenshire	Carmarthen Town South	NUMH	15.07	0.094	0.035	0.058
Carmarthenshire	Carmarthen Town West	NUMJ	8.38	0.089	0.035	0.054
Carmarthenshire	Cenarth	NUMK	14.55	0.069	0.005	0.064
Carmarthenshire	Clynderwen	NUML	14.69	0.050	0.012	0.038
Carmarthenshire	Cross Hands	NUMM	27.09	0.097	0.047	0.050
Carmarthenshire	Cynwyl Elfed	NUMN	17.31	0.072	0.045	0.027
Carmarthenshire	Cynwyl Gaeo and Llanwrda Talley	NUMP	17.89	0.070	0.028	0.042
Carmarthenshire	Dafen	NUMQ	31.44	0.080	0.058	0.022
Carmarthenshire	Elli	NUMR	29.19	0.064	0.069	-0.005
Carmarthenshire	Felinfoel	NUMS	46.65	0.090	0.057	0.033
Carmarthenshire	Garnant	NUMT	35.68	0.084	0.047	0.037
Carmarthenshire	Glanamman	NUMU	37.31	0.070	0.064	0.006
Carmarthenshire	Glanymor	NUMW	65.06	0.094	0.056	0.038
Carmarthenshire	Glyn	NUMX	23.27	0.060	0.060	0.000
Carmarthenshire	Gorslas	NUMY	16.65	0.078	0.052	0.026
Carmarthenshire	Hendy	NUMZ	13.97	0.139	0.070	0.069
Carmarthenshire	Hengoed	NUNA	25.87	0.065	0.050	0.016
Carmarthenshire	Kidwelly	NUNB	34.49	0.065	0.048	0.017
Carmarthenshire	Laugharne Township	NUNC	19.65	0.052	0.028	0.024
Carmarthenshire	Llanboidy	NUND	13.71	0.067	0.032	0.035
Carmarthenshire	Llanddarog	NUNE	9.24	0.072	0.050	0.022
Carmarthenshire	Llanddowror	NUNF	17.52	0.075	0.040	0.035
Carmarthenshire	Llandeilo-Tywi and Castle	NUNG	17.22	0.061	0.031	0.030
Carmarthenshire	Llandovery Town/Cilycwm and Llanfair-ar-y-bryn	NUNH	18.74	0.037	0.007	0.030
Carmarthenshire	Llandybie and Heolddu	NUNJ	22.02	0.082	0.058	0.023
Carmarthenshire	Llandyfaelog	NUNK	14.55	0.042	0.041	0.001

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residals
Carmarthenshire	Llanegwad and Llanfynydd	NUNL	20.15	0.049	0.031	0.019
Carmarthenshire	Llanfihangel Aberbythych and Llangathen	NUNM	13.99	0.086	0.051	0.035
Carmarthenshire	Llanfihangel-ar-Arth	NUNN	19.30	0.068	0.028	0.039
Carmarthenshire	Llangeler	NUNP	22.98	0.065	0.028	0.037
Carmarthenshire	Llangennech	NUNQ	21.91	0.082	0.057	0.024
Carmarthenshire	Llangunnor	NUNR	8.73	0.055	0.035	0.020
Carmarthenshire	Llangyndeyrn	NUNS	28.35	0.078	0.047	0.031
Carmarthenshire	Llansadwrn and Llangadog Myddfai and Llanddeusant	NUNT	19.02	0.051	0.029	0.022
Carmarthenshire	Llansteffan	NUNU	10.66	0.070	0.036	0.034
Carmarthenshire	Llanybydder/Llanllwni	NUNW	18.31	0.071	0.023	0.048
Carmarthenshire	Lliedi	NUNX	25.90	0.081	0.084	-0.003
Carmarthenshire	Llwynhendy	NUNY	51.84	0.074	0.061	0.012
Carmarthenshire	Manordeilo and Salem Ffairfach	NUNZ	14.24	0.049	0.049	0.001
Carmarthenshire	Myddynfych	NUPA	26.47	0.078	0.070	0.007
Carmarthenshire	Newchurch	NUPB	8.53	0.057	0.053	0.004
Carmarthenshire	Pantyffynnon	NUPC	42.90	0.102	0.071	0.030
Carmarthenshire	Pembrey	NUPD	30.83	0.068	0.052	0.016
Carmarthenshire	Pencarreg	NUPE	16.84	0.061	0.017	0.044
Carmarthenshire	Penygroes	NUPF	23.29	0.075	0.058	0.017
Carmarthenshire	Pontamman	NUPG	12.57	0.077	0.067	0.010
Carmarthenshire	Pontyberem	NUPH	25.86	0.072	0.049	0.022
Carmarthenshire	Quarter Bach Llynfell Brynamman	NUPJ	30.54	0.105	0.064	0.041
Carmarthenshire	St. Clears	NUPK	12.62	0.045	0.031	0.014
Carmarthenshire	St. Ishmael	NUPL	19.58	0.094	0.057	0.037
Carmarthenshire	Saron	NUPM	27.51	0.104	0.067	0.037
Carmarthenshire	Swiss Valley	NUPN	10.24	0.054	0.046	0.008
Carmarthenshire	Trelech	NUPP	15.91	0.064	0.035	0.029
Carmarthenshire	Trimsaran	NUPQ	32.47	0.071	0.049	0.022
Carmarthenshire	Tumble	NUPR	28.11	0.075	0.053	0.022
Carmarthenshire	Tycroes	NUPS	17.63	0.095	0.079	0.015
Carmarthenshire	Tyisha	NUPT	45.79	0.087	0.101	-0.014
Carmarthenshire	Whitland	NUPU	18.79	0.048	0.018	0.030
Swansea	Bishopston	NXMA	5.10	0.136	0.083	0.053
Swansea	Bonymaen	NXMB	39.13	0.162	0.076	0.086
Swansea	Castle	NXMC	39.30	0.188	0.081	0.106
Swansea	Clydach	NXMD	16.86	0.197	0.084	0.113
Swansea	Cockett	NXME	24.08	0.204	0.086	0.118
Swansea	Cwmbwrla	NXMF	18.42	0.178	0.133	0.045
Swansea	Dulais East	NXMG	29.99	0.166	0.077	0.089
Swansea	Dunvant	NXMH	5.59	0.142	0.093	0.049
Swansea	Fairwood	NXMJ	9.30	0.103	0.075	0.028

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Swansea	Gorseinon Central	NXMK	21.17	0.142	0.068	0.075
Swansea	Gorseinon East	NXML	32.31	0.260	0.092	0.169
Swansea	Gower	NXMM	8.61	0.120	0.065	0.056
Swansea	Gowerton East	NXMN	7.29	0.121	0.085	0.036
Swansea	Gowerton West	NXMP	9.28	0.223	0.086	0.137
Swansea	Graigfelen	NXMQ	40.08	0.222	0.080	0.142
Swansea	Killay North	NXMR	2.68	0.120	0.082	0.038
Swansea	Killay South	NXMS	4.96	0.106	0.086	0.020
Swansea	Kingsbridge	NXMT	9.00	0.189	0.088	0.101
Swansea	Landore	NXMU	33.91	0.174	0.096	0.078
Swansea	Llangyfelach	NXMW	7.71	0.221	0.079	0.142
Swansea	Llansamlet	NXMX	17.56	0.246	0.080	0.166
Swansea	Lower Loughor	NXMY	22.87	0.208	0.090	0.118
Swansea	Mawr	NXMZ	13.16	0.157	0.080	0.077
Swansea	Mayals	NXNA	2.83	0.181	0.048	0.133
Swansea	Morriston	NXNB	16.90	0.185	0.094	0.092
Swansea	Mynyddbach	NXNC	23.82	0.191	0.092	0.099
Swansea	Newton	NXND	2.64	0.138	0.079	0.059
Swansea	Oystermouth	NXNE	6.44	0.133	0.092	0.041
Swansea	Penclawdd	NXNF	12.66	0.132	0.081	0.051
Swansea	Penderry	NXNG	64.18	0.190	0.095	0.095
Swansea	Penllergaer	NXNH	24.04	0.157	0.076	0.081
Swansea	Pennard	NXNJ	7.38	0.130	0.068	0.061
Swansea	Penyrheol	NXNK	19.24	0.189	0.075	0.114
Swansea	Pontardulais	NXNL	18.78	0.165	0.078	0.087
Swansea	St. Thomas	NXNM	31.38	0.150	0.082	0.068
Swansea	Sketty	NXNN	5.43	0.142	0.085	0.056
Swansea	Tal-y-bont	NXNP	15.97	0.130	0.076	0.054
Swansea	Townhill	NXNQ	66.79	0.166	0.113	0.053
Swansea	Uplands	NXNR	7.83	0.163	0.114	0.048
Swansea	Upper Loughor	NXNS	14.82	0.179	0.091	0.088
Swansea	Vardre	NXNT	21.05	0.256	0.088	0.168
Swansea	West Cross	NXNU	13.27	0.172	0.099	0.073
NPT	Aberavon	NZMA	34.22	0.124	0.088	0.036
NPT	Aberdulais	NZMB	35.04	0.150	0.062	0.088
NPT	Allt-wen	NZMC	14.39	0.223	0.080	0.143
NPT	Baglan	NZMD	14.31	0.130	0.076	0.053
NPT	Blaengwrach	NZME	31.38	0.059	0.043	0.016
NPT	Briton Ferry East	NZMF	22.54	0.127	0.069	0.058
NPT	Briton Ferry West	NZMG	49.10	0.099	0.075	0.024
NPT	Bryn and Cwmavon	NZMH	30.80	0.080	0.075	0.005
NPT	Bryn-coch North	NZMJ	7.10	0.110	0.080	0.030
NPT	Bryn-coch South	NZMK	15.55	0.152	0.094	0.058

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
NPT	Cadoxton	NZML	8.69	0.131	0.082	0.049
NPT	Cimla	NZMM	11.64	0.109	0.084	0.025
NPT	Coedffranc Central	NZMN	24.16	0.154	0.097	0.056
NPT	Coedffranc North	NZMP	15.89	0.156	0.090	0.066
NPT	Coedffranc West	NZMQ	16.34	0.153	0.064	0.088
NPT	Crynant	NZMR	28.23	0.107	0.066	0.041
NPT	Cwmllynfell	NZMS	32.59	0.223	0.077	0.145
NPT	Cymmer	NZMT	66.57	0.168	0.079	0.089
NPT	Dyffryn	NZMU	29.18	0.156	0.068	0.088
NPT	Glyncorrwg	NZMW	57.96	0.162	0.070	0.092
NPT	Glynneath	NZMX	29.69	0.068	0.050	0.018
NPT	Godre'r graig	NZMY	37.78	0.207	0.078	0.129
NPT	Gwaun-Cae-Gurwen	NZMZ	37.78	0.093	0.075	0.018
NPT	Gwynfi	NZNA	64.18	0.184	0.076	0.108
NPT	Lower Brynamman	NZNB	40.37	0.100	0.062	0.038
NPT	Margam	NZNC	25.15	0.139	0.068	0.071
NPT	Neath East	NZND	45.98	0.128	0.076	0.052
NPT	Neath North	NZNE	25.90	0.111	0.084	0.026
NPT	Neath South	NZNF	33.96	0.125	0.104	0.022
NPT	Onllwyn	NZNG	53.69	0.107	0.026	0.081
NPT	Pelenna	NZNH	39.60	0.060	0.059	0.001
NPT	Pontardawe	NZNJ	24.26	0.218	0.075	0.143
NPT	Port Talbot	NZNK	23.75	0.111	0.081	0.030
NPT	Resolven	NZNL	25.20	0.071	0.054	0.017
NPT	Rhos	NZNM	9.75	0.162	0.070	0.093
NPT	Sandfields East	NZNN	50.96	0.122	0.099	0.024
NPT	Sandfields West	NZNP	60.97	0.104	0.102	0.002
NPT	Seven Sisters	NZNQ	39.52	0.065	0.071	-0.007
NPT	Taibach	NZNR	26.34	0.115	0.071	0.044
NPT	Tonna	NZNS	19.32	0.110	0.071	0.039
NPT	Trebanos	NZNT	26.39	0.211	0.082	0.128
NPT	Ystalyfera	NZNU	50.12	0.167	0.080	0.087
Bridgend	Bettws	PBMA	59.87	0.087	0.090	-0.004
Bridgend	Blackmill	PBMB	47.11	0.076	0.081	-0.005
Bridgend	Blaengarw	PBMC	34.90	0.073	0.078	-0.006
Bridgend	Brackla	PBMD	8.23	0.140	0.111	0.028
Bridgend	Caerau	PBME	62.80	0.067	0.071	-0.004
Bridgend	Cefn Cribwr	PBMF	22.33	0.056	0.075	-0.019
Bridgend	Coity Higher	PBMG	6.00	0.097	0.079	0.018
Bridgend	Cornelly	PBMH	33.39	0.063	0.075	-0.012
Bridgend	Coychurch Lower	PBMJ	6.30	0.113	0.050	0.062
Bridgend	Laleston/Merthyr Mawr	PBMK	14.91	0.168	0.069	0.099
Bridgend	Llangeinor	PBML	41.85	0.139	0.068	0.071

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Bridgend	Llangynwyd	PBMM	20.44	0.105	0.078	0.027
Bridgend	Maesteg East	PBMN	25.74	0.084	0.076	0.008
Bridgend	Maesteg West	PBMP	33.30	0.090	0.078	0.011
Bridgend	Morfa	PBMQ	31.92	0.160	0.100	0.060
Bridgend	Nantyffyllon	PBMR	31.59	0.084	0.076	0.008
Bridgend	Nant-y-moel	PBMS	29.84	0.094	0.064	0.030
Bridgend	Newcastle	PBMT	14.07	0.118	0.097	0.022
Bridgend	Newcastle Higher	PBMU	10.20	0.085	0.069	0.017
Bridgend	Ogmore Vale	PBMW	22.79	0.068	0.070	-0.002
Bridgend	Oldcastle	PBMX	8.33	0.126	0.077	0.050
Bridgend	Pencoed	PBMY	9.72	0.087	0.067	0.020
Bridgend	Pontycymmer	PBMZ	30.59	0.100	0.075	0.024
Bridgend	Porthcawl East	PBNA	16.28	0.159	0.085	0.074
Bridgend	Porthcawl West	PBNB	8.93	0.152	0.081	0.071
Bridgend	Pyle	PBNC	27.03	0.060	0.092	-0.032
Bridgend	St. Bride's Minor	PBND	31.15	0.069	0.072	-0.003
Bridgend	Ynysawdre	PBNE	20.16	0.088	0.083	0.004
The Vale of Glamorgan	Alexandra	PDMA	7.99	0.078	0.072	0.006
The Vale of Glamorgan	Baruc	PDMB	9.02	0.053	0.062	-0.009
The Vale of Glamorgan	Buttrills	PDMC	23.05	0.058	0.110	-0.052
The Vale of Glamorgan	Cadoc	PDMD	26.05	0.080	0.082	-0.003
The Vale of Glamorgan	Castleland	PDME	34.72	0.062	0.061	0.001
The Vale of Glamorgan	Cornerswell	PDMF	7.03	0.072	0.106	-0.034
The Vale of Glamorgan	Court	PDMG	31.10	0.050	0.109	-0.059
The Vale of Glamorgan	Cowbridge	PDMH	3.58	0.058	0.048	0.011
The Vale of Glamorgan	Dinas Powys	PDMJ	3.74	0.104	0.078	0.026
The Vale of Glamorgan	Dyfan	PDMK	13.14	0.040	0.065	-0.025
The Vale of Glamorgan	Gibbonsdown	PDML	34.32	0.049	0.084	-0.036
The Vale of Glamorgan	Illtyd	PDMM	8.36	0.053	0.083	-0.031
The Vale of Glamorgan	Llandough	PDMN	4.24	0.097	0.073	0.024
The Vale of Glamorgan	Llandow/Ewenny	PDMP	4.55	0.085	0.067	0.017
The Vale of Glamorgan	Llantwit Major	PDMQ	5.66	0.072	0.069	0.002
The Vale of Glamorgan	Peterston-super-Ely	PDMR	12.89	0.067	0.062	0.005
The Vale of Glamorgan	Rhoose	PDMS	7.43	0.078	0.055	0.023

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
The Vale of Glamorgan	St. Athan	PDMT	8.58	0.094	0.065	0.029
The Vale of Glamorgan	St. Bride's Major	PDMU	5.25	0.091	0.063	0.028
The Vale of Glamorgan	Stanwell	PDMW	10.44	0.078	0.108	-0.030
The Vale of Glamorgan	Sully	PDMX	4.12	0.085	0.073	0.013
The Vale of Glamorgan	Wenvoe	PDMY	3.30	0.081	0.064	0.017
RCT	Aberaman North	PFMA	33.62	0.084	0.079	0.005
RCT	Aberaman South	PFMB	46.95	0.076	0.068	0.007
RCT	Abercynon	PFMC	34.52	0.047	0.076	-0.029
RCT	Aberdare East	PFMD	25.41	0.068	0.077	-0.009
RCT	Aberdare West/Llwydcoed	PFME	21.60	0.064	0.081	-0.016
RCT	Beddau	PFMF	14.04	0.063	0.070	-0.006
RCT	Brynna	PFMG	10.76	0.062	0.074	-0.012
RCT	Church Village	PFMH	12.65	0.076	0.083	-0.007
RCT	Cilfynydd	PFMJ	26.09	0.052	0.057	-0.005
RCT	Cwmbach	PFMK	37.02	0.049	0.081	-0.033
RCT	Cwm Clydach	PFML	53.56	0.105	0.081	0.024
RCT	Cymmer	PFMM	47.33	0.120	0.088	0.032
RCT	Ferndale	PFMN	36.49	0.065	0.067	-0.002
RCT	Gilfach Goch	PFMP	52.46	0.082	0.082	0.000
RCT	Glyncoch	PFMQ	57.71	0.038	0.082	-0.044
RCT	Graig	PFMR	22.71	0.045	0.065	-0.020
RCT	Hawthorn	PFMS	19.11	0.032	0.035	-0.003
RCT	Hirwaun	PFMT	32.61	0.068	0.073	-0.005
RCT	Llanharan	PFMU	19.15	0.047	0.065	-0.018
RCT	Llanharry	PFMW	29.40	0.064	0.064	0.000
RCT	Llantrisant Town	PFMX	5.05	0.057	0.064	-0.007
RCT	Llantwit Fardre	PFMY	4.17	0.063	0.070	-0.006
RCT	Llwyn-y-pia	PFMZ	55.30	0.133	0.089	0.044
RCT	Maerdy	PFNA	68.43	0.059	0.068	-0.009
RCT	Mountain Ash East	PFNB	28.08	0.092	0.079	0.013
RCT	Mountain Ash West	PFNC	51.67	0.171	0.055	0.116
RCT	Penrhiwceiber	PFND	54.01	0.072	0.102	-0.030
RCT	Pentre	PFNE	31.86	0.078	0.075	0.003
RCT	Pen-y-graig	PFNF	45.57	0.087	0.090	-0.003
RCT	Pen-y-waun	PFNG	73.34	0.100	0.029	0.071
RCT	Pont-y-clun	PFNH	7.61	0.061	0.071	-0.010
RCT	Pontypridd Town	PFNJ	5.83	0.049	0.056	-0.007
RCT	Porth	PFNK	30.14	0.131	0.093	0.038
RCT	Rhigos	PFNL	31.60	0.064	0.047	0.017
RCT	Rhondda	PFNM	22.03	0.059	0.062	-0.003

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RCT	Rhydfelen Central/Ilan	PFNN	52.94	0.046	0.059	-0.013
RCT	Rhydfelen Lower	PFNP	30.78	0.048	0.068	-0.020
RCT	Taffs Well	PFNQ	9.04	0.082	0.063	0.018
RCT	Talbot Green	PFNR	17.75	0.052	0.059	-0.007
RCT	Ton-teg	PFNS	4.50	0.049	0.073	-0.024
RCT	Tonypandy	PFNT	35.15	0.127	0.090	0.037
RCT	Tonyrefail East	PFNU	33.98	0.056	0.075	-0.020
RCT	Tonyrefail West	PFNW	46.22	0.079	0.080	-0.002
RCT	Trallwng	PFNX	13.04	0.047	0.087	-0.040
RCT	Trealaw	PFNY	46.99	0.122	0.090	0.033
RCT	Treforest	PFNZ	11.31	0.067	0.048	0.019
RCT	Treherbert	PFPA	53.84	0.127	0.074	0.054
RCT	Treorchy	PFPB	29.30	0.072	0.066	0.006
RCT	Tylorstown	PFPC	64.66	0.063	0.078	-0.015
RCT	Tyn-y-nant	PFPD	22.17	0.040	0.112	-0.072
RCT	Ynyshir	PFPE	47.05	0.103	0.083	0.020
RCT	Ynysybwl	PFPF	22.54	0.058	0.046	0.012
RCT	Ystrad	PFPG	37.23	0.070	0.080	-0.011
Merthyr Tydfil	Bedlinog	PHMA	46.39	0.099	0.079	0.020
Merthyr Tydfil	Cyfarthfa	PHMB	43.00	0.144	0.095	0.048
Merthyr Tydfil	Dowlais	PHMC	50.72	0.126	0.091	0.035
Merthyr Tydfil	Gurnos	PHMD	71.24	0.126	0.127	-0.001
Merthyr Tydfil	Merthyr Vale	PHME	47.88	0.083	0.080	0.003
Merthyr Tydfil	Park	PHMF	27.50	0.152	0.096	0.056
Merthyr Tydfil	Penydarren	PHMG	50.76	0.136	0.142	-0.006
Merthyr Tydfil	Plymouth	PHMH	35.75	0.125	0.080	0.045
Merthyr Tydfil	Town	PHMJ	34.18	0.149	0.088	0.061
Merthyr Tydfil	Treharris	PHMK	27.02	0.079	0.075	0.005
Merthyr Tydfil	Vaynor	PHML	36.07	0.127	0.099	0.028
Caerphilly	Aberbargoed	PKMA	63.50	0.090	0.072	0.018
Caerphilly	Abercarn	PKMB	22.74	0.147	0.076	0.071
Caerphilly	Abertysswg	PKMC	40.21	0.083	0.086	-0.003
Caerphilly	Aber Valley	PKMD	41.11	0.101	0.087	0.014
Caerphilly	Argoed	PKME	45.48	0.128	0.065	0.063
Caerphilly	Bargoed	PKMF	49.27	0.112	0.087	0.025
Caerphilly	Bedwas and Trethomas	PKMG	28.71	0.101	0.088	0.013
Caerphilly	Blackwood	PKMH	19.24	0.144	0.091	0.053
Caerphilly	Cefn Fforest	PKMJ	36.88	0.136	0.123	0.013
Caerphilly	Crosskeys	PKMK	21.95	0.157	0.075	0.083
Caerphilly	Crumlin	PKML	28.09	0.149	0.080	0.069
Caerphilly	Darran Valley	PKMM	60.81	0.082	0.080	0.002
Caerphilly	Gilfach	PKMN	40.85	0.100	0.094	0.005
Caerphilly	Hengoed	PKMP	42.35	0.113	0.092	0.021

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Caerphilly	Llanbradach	PKMQ	19.16	0.102	0.076	0.026
Caerphilly	Machen	PKMR	33.65	0.124	0.083	0.041
Caerphilly	Maesycwmmer	PKMS	18.11	0.142	0.069	0.072
Caerphilly	Morgan Jones	PKMT	20.10	0.122	0.102	0.019
Caerphilly	Moriah	PKMU	49.17	0.091	0.087	0.004
Caerphilly	Nelson	PKMW	22.35	0.082	0.073	0.009
Caerphilly	Newbridge	PKMX	24.52	0.203	0.076	0.127
Caerphilly	New Tredegar	PKMY	65.50	0.087	0.069	0.018
Caerphilly	Pengam	PKMZ	27.32	0.121	0.087	0.034
Caerphilly	Penmaen	PKNA	17.24	0.135	0.085	0.050
Caerphilly	Penyrheol	PKNB	24.25	0.112	0.104	0.008
Caerphilly	Pontllanfraith	PKNC	23.75	0.136	0.090	0.045
Caerphilly	Pontlottyn	PKND	53.68	0.078	0.072	0.006
Caerphilly	Risca East	PKNE	18.50	0.173	0.098	0.075
Caerphilly	Risca West	PKNF	20.88	0.167	0.080	0.088
Caerphilly	St. Cattwg	PKNG	36.90	0.105	0.083	0.022
Caerphilly	St. James	PKNH	34.40	0.100	0.075	0.025
Caerphilly	St. Martins	PKNJ	8.30	0.124	0.086	0.037
Caerphilly	Tir-Phil	PKNK	55.44	0.088	0.085	0.002
Caerphilly	Twyn Carno	PKNL	60.37	0.100	0.074	0.025
Caerphilly	Ynysddu	PKNM	24.55	0.158	0.082	0.076
Caerphilly	Ystrad Mynach	PKNN	15.86	0.134	0.072	0.062
Blaenau Gwent	Abertillery	PLMA	32.08	0.117	0.089	0.028
Blaenau Gwent	Badminton	PLMB	23.45	0.087	0.084	0.003
Blaenau Gwent	Beaufort	PLMC	30.26	0.072	0.074	-0.002
Blaenau Gwent	Blaina	PLMD	39.44	0.099	0.082	0.017
Blaenau Gwent	Brynmawr	PLME	34.22	0.084	0.082	0.002
Blaenau Gwent	Cwm	PLMF	38.35	0.093	0.084	0.009
Blaenau Gwent	Cwmtillery	PLMG	40.78	0.107	0.079	0.028
Blaenau Gwent	Ebbw Vale North	PLMH	37.37	0.087	0.095	-0.008
Blaenau Gwent	Ebbw Vale South	PLMJ	38.30	0.100	0.078	0.022
Blaenau Gwent	Georgetown	PLMK	23.58	0.067	0.072	-0.005
Blaenau Gwent	Llanhilleth	PLML	50.40	0.103	0.072	0.031
Blaenau Gwent	Nantyglo	PLMM	57.82	0.083	0.083	0.000
Blaenau Gwent	Rassau	PLMN	41.11	0.076	0.079	-0.003
Blaenau Gwent	Sirhowy	PLMP	49.44	0.069	0.063	0.006
Blaenau Gwent	Six Bells	PLMQ	32.64	0.097	0.070	0.027
Blaenau Gwent	Tredegar Central and West	PLMR	51.04	0.055	0.072	-0.017
Torfaen	Abersychan	PMMA	32.95	0.136	0.076	0.060
Torfaen	Blaenavon	PMMB	25.93	0.073	0.069	0.003
Torfaen	Brynwern	PMMC	31.50	0.156	0.119	0.037
Torfaen	Coed Eva	PMMD	13.02	0.177	0.118	0.059
Torfaen	Croesyceiliog North	PMME	12.50	0.164	0.107	0.056

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Torfaen	Croesyceiliog South	PMMF	8.30	0.158	0.092	0.066
Torfaen	Cwmyniscoy	PMMG	35.32	0.198	0.071	0.127
Torfaen	Fairwater	PMMH	13.33	0.176	0.104	0.072
Torfaen	Greenmeadow	PMMJ	26.04	0.208	0.091	0.117
Torfaen	Llantarnam	PMMK	19.13	0.186	0.081	0.106
Torfaen	Llanyrafon North	PMML	8.55	0.209	0.074	0.135
Torfaen	Llanyrafon South	PMMM	6.12	0.111	0.076	0.036
Torfaen	New Inn Lower	PMMN	7.52	0.194	0.084	0.110
Torfaen	New Inn Upper	PMMP	5.64	0.157	0.072	0.085
Torfaen	Panteg	PMMQ	11.53	0.155	0.085	0.070
Torfaen	Pontnewydd	PMMR	20.65	0.180	0.099	0.081
Torfaen	Pontnewynydd	PMMS	21.63	0.223	0.089	0.134
Torfaen	Pontypool	PMMT	17.70	0.215	0.080	0.135
Torfaen	St. Cadocs and Penygarn	PMMU	47.12	0.187	0.083	0.104
Torfaen	St. Dials	PMMW	31.49	0.221	0.089	0.132
Torfaen	Snatchwood	PMMX	29.14	0.190	0.093	0.097
Torfaen	Trevethin	PMMY	55.62	0.190	0.078	0.113
Torfaen	Two Locks	PMMZ	18.70	0.195	0.076	0.118
Torfaen	Upper Cwmbran	PMNA	32.30	0.209	0.086	0.123
Torfaen	Wainfelin	PMNB	16.23	0.173	0.071	0.102
Monmouthshire	Caerwent	PPMA	5.21	0.095	0.070	0.026
Monmouthshire	Caldicot Castle	PPMB	3.90	0.091	0.086	0.005
Monmouthshire	Cantref	PPMC	13.88	0.103	0.072	0.031
Monmouthshire	Castle and Grofield	PPMD	10.02	0.127	0.080	0.047
Monmouthshire	Croesonen	PPME	17.67	0.105	0.113	-0.008
Monmouthshire	Crucorney	PPMF	10.37	0.105	0.074	0.031
Monmouthshire	Dewstow	PPMG	16.23	0.102	0.137	-0.035
Monmouthshire	Goetre Fawr	PPMH	6.65	0.092	0.065	0.026
Monmouthshire	Lansdown	PPMJ	24.27	0.087	0.118	-0.032
Monmouthshire	Larkfield	PPMK	3.90	0.053	0.064	-0.011
Monmouthshire	Llanbadoc	PPML	10.76	0.061	0.073	-0.012
Monmouthshire	Llanelly Hill	PPMM	13.92	0.066	0.071	-0.005
Monmouthshire	Llanfoist Fawr	PPMN	6.60	0.106	0.062	0.044
Monmouthshire	Llangybi Fawr	PPMP	5.97	0.075	0.063	0.012
Monmouthshire	Llanover	PPMQ	13.06	0.120	0.058	0.062
Monmouthshire	Llantilio Crossenny	PPMR	11.98	0.113	0.066	0.047
Monmouthshire	Llanwenarth Ultra	PPMS	10.60	0.089	0.070	0.019
Monmouthshire	Magor with Undy	PPMT	4.16	0.128	0.080	0.048
Monmouthshire	Mardy	PPMU	21.48	0.096	0.071	0.026
Monmouthshire	Mitchel Troy	PPMW	7.97	0.145	0.062	0.083
Monmouthshire	Overmonnow	PPMX	12.46	0.134	0.060	0.074
Monmouthshire	Portskewett	PPMY	5.77	0.083	0.067	0.015
Monmouthshire	Priory	PPMZ	10.40	0.131	0.085	0.047

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Monmouthshire	Raglan	PPNA	5.22	0.100	0.054	0.047
Monmouthshire	Rogiet	PPNB	6.70	0.140	0.075	0.064
Monmouthshire	St. Arvans	PPNC	5.77	0.056	0.048	0.008
Monmouthshire	St. Christopher's	PPND	6.98	0.053	0.085	-0.032
Monmouthshire	St. Kingsmark	PPNE	2.09	0.108	0.071	0.037
Monmouthshire	St. Mary's	PPNF	8.17	0.093	0.062	0.031
Monmouthshire	Severn	PPNG	6.45	0.100	0.077	0.023
Monmouthshire	Shirenewton	PPNH	7.53	0.071	0.052	0.019
Monmouthshire	Thornwell	PPNJ	14.31	0.087	0.067	0.020
Monmouthshire	Trellech United	PPNK	6.41	0.072	0.047	0.025
Monmouthshire	Usk	PPNL	1.79	0.038	0.066	-0.029
Monmouthshire	Vauxhall	PPNM	5.60	0.121	0.058	0.063
Monmouthshire	West End	PPNN	9.88	0.122	0.118	0.004
Monmouthshire	Wyesham	PPNP	14.55	0.121	0.058	0.063
Newport	Allt-yr-yn	PRMA	8.55	0.147	0.086	0.061
Newport	Alway	PRMB	31.19	0.171	0.127	0.043
Newport	Beechwood	PRMC	14.65	0.152	0.127	0.025
Newport	Bettws	PRMD	49.31	0.140	0.090	0.050
Newport	Caerleon	PRME	3.29	0.115	0.068	0.046
Newport	Gaer	PRMF	25.67	0.155	0.105	0.050
Newport	Graig	PRMG	3.34	0.173	0.084	0.089
Newport	Langstone	PRMH	4.58	0.166	0.067	0.099
Newport	Liswerry	PRMJ	20.64	0.171	0.081	0.091
Newport	Llanwern	PRMK	13.92	0.160	0.077	0.083
Newport	Malpas	PRML	8.48	0.083	0.117	-0.034
Newport	Marshfield	PRMM	7.21	0.155	0.070	0.085
Newport	Pillgwenlly	PRMN	63.71	0.124	0.084	0.039
Newport	Ringland	PRMP	42.06	0.147	0.108	0.039
Newport	Rogerstone	PRMQ	5.86	0.159	0.093	0.066
Newport	St Julians	PRMR	12.51	0.163	0.121	0.042
Newport	Shaftesbury	PRMS	22.47	0.129	0.102	0.027
Newport	Stow Hill	PRMT	27.10	0.183	0.091	0.092
Newport	Tredegar Park	PRMU	58.79	0.183	0.099	0.084
Newport	Victoria	PRMW	29.13	0.155	0.144	0.011
Cardiff	Adamsdown	PTMA	38.41	0.139	0.112	0.027
Cardiff	Butetown	PTMB	53.40	0.154	0.038	0.117
Cardiff	Caerau	PTMC	45.61	0.059	0.091	-0.032
Cardiff	Canton	PTMD	11.50	0.102	0.095	0.007
Cardiff	Cathays	PTME	8.20	0.139	0.070	0.069
Cardiff	Creigiau	PTMF	2.26	0.061	0.071	-0.010
Cardiff	Cyncoed	PTMG	1.13	0.072	0.085	-0.013
Cardiff	Ely	PTMH	46.72	0.074	0.112	-0.038
Cardiff	Fairwater	PTMJ	22.06	0.083	0.098	-0.015

UA	Wardname	edivcode	WIMD	triage call rate	predicted call rate	residuals
Cardiff	Gabalfa	PTMK	8.54	0.086	0.100	-0.013
Cardiff	Grangetown	PTML	32.44	0.095	0.081	0.014
Cardiff	Heath	PTMM	1.93	0.074	0.104	-0.030
Cardiff	Lisvane and St. Mellons	PTMN	2.60	0.108	0.073	0.035
Cardiff	Llandaff	PTMP	1.22	0.087	0.091	-0.004
Cardiff	Llandaff North	PTMQ	24.97	0.082	0.107	-0.025
Cardiff	Llanishen	PTMR	4.79	0.091	0.097	-0.007
Cardiff	Llanrumney	PTMS	35.10	0.080	0.105	-0.025
Cardiff	Pentwyn	PTMT	14.82	0.118	0.113	0.005
Cardiff	Pentyrch	PTMU	2.84	0.074	0.068	0.006
Cardiff	Plasnewydd	PTMW	10.53	0.123	0.135	-0.012
Cardiff	Radyr and St. Fagans	PTMX	1.72	0.104	0.071	0.032
Cardiff	Rhiwbina	PTMY	1.65	0.076	0.076	0.000
Cardiff	Riverside	PTMZ	21.70	0.119	0.093	0.026
Cardiff	Roath	PTNA	2.17	0.106	0.096	0.010
Cardiff	Rumney	PTNB	21.54	0.101	0.093	0.008
Cardiff	Splott	PTNC	41.41	0.121	0.088	0.033
Cardiff	Trowbridge	PTND	34.87	0.163	0.086	0.076
Cardiff	Whitchurch and Tongwynlais	PTNE	6.49	0.079	0.073	0.006

Appendix 16: Real Nursing? The Development of Telenursing by Snooks et al. 2008

JAN ORIGINAL RESEARCH

Real nursing? The development of telenursing

Helen A. Snooks, Anne M. Williams, Lesley J. Griffiths, Julie Peconi, Jaynie Rance, Sharon Snelgrove, Srikant Sarangi, Paul Wainwright & Wai-Yee Cheung

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Abstract

Title. Real nursing? The development of telenursing

Aim. This paper is a report of a study to understand the impact of telenursing from the perspective of nurses involved in its provision, and in more traditional roles.

Background. Nurse-led telephone helplines have recently been introduced across the United Kingdom, a major step in the development of nursing practice.

Method. A structured questionnaire was sent to all nurses working in the NHS Direct (National Health Service Direct) Wales telephone service ($n = 111$). Ninety-two completed questionnaires were returned (response rate 83 per cent). Two focus groups were conducted: one with telephone service nurses ($n = 8$) and one with other nurses ($n = 5$). The data were collected in 2002.

Findings. Respondents represented a highly educated workforce from a range of healthcare specialties. They reported that they joined the telephone service for improved salary and flexible working. Two-thirds reported improved job satisfaction. All focus group participants reported that the development of nursing skills was affected by the use of decision support software and the remote nature of the consultation. Participants reported opportunities for skill development, although the role could be stressful. All agreed that the service was popular with callers, but the nurses from outside raised concerns about whether telenursing was 'real' nursing and about the evidence base for the service and access by disadvantaged groups.

Conclusion. Differences between the groups reflect policy tensions between the need to develop new nursing skills, including the use of technology, to improve efficiency and recognition of the worth of hands-on nursing. These tensions must be addressed for the telephone service to function as part of an integrated healthcare system.

Keywords: focus groups, nurse roles, policy, questionnaires, telenursing, technology

Introduction

The NHS 24-hour nurse-led telephone-based health advice and information helpline, commonly known as NHSD, was launched in England in 1998 (Department of Health 1997), and in Wales in 2000 (Gregory & Kennedy 1999). Evidence shows

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that educational interventions which enhance people's sense of self-efficacy can reduce the demand for medical intervention leading to cost savings (Coulter 2003), seen as integral to the modernization of the NHS (Wanless 2002). Modernization involves the reconfiguration of professional roles, particularly at the boundary between medicine and nursing. At this boundary, as previous work has shown, substitution of nurses for doctors and the creation of new roles form part of a workforce reconfiguration strategy. This strategy has been used in the united kingdom (UK) and internationally to meet changing patient expectations, rising costs and skills shortages (Sibbald *et al.* 2004, Hyde *et al.* 2005). From this perspective NHSD, insofar as it may redirect patients from doctors to nurses, can be seen as part of a wider effort to control access to care (Charles-Jones *et al.* 2003a) and as having consequences for patients, doctors and nurses.

Background

A telephone advice service represents a break with traditional forms of delivering nursing care, and is increasingly being used in a range of developed countries (Lattimer & George 1996), from Australia (Turner *et al.* 2002) and New Zealand (St George & Cullen 2001), through Denmark (Christensen & Olsen 1998), Sweden (Marklund & Bengtsson 1989) and the UK (Department of Health 1997), to Canada (Lafrance & Leduc 2002) and the United States of America (Barber *et al.* 2000). Telenursing has been explored in a preliminary way in general practice (Charles-Jones *et al.* 2003b) and community nursing (Wilson & Williams 2000). However, there is still much work to be performed to understand telephone-based clinical decision-making processes and nursing practice issues. Pettinari and Jessop (2001) explored the impact of NHSD on nursing, and looked at how the absence of visibility is managed through the development of assessment skills based on professional knowledge and experience, compensating for not being able to see patients. They identified three broad areas in which nurses anticipate and manage absence of co-presence: (1) gathering information, (2) delivering information, advice and reassurance (3) building trust and rapport. Central to the reasoning process is 'picture building', in which both the person and the pathology are visualized (Edwards 1998). To do this, nurses elicit the presence of physical signs and symptoms by asking specific questions about, for example, the presence of a rash or a level of pain, but they also try to build a picture of the client as a person and their environment. The nurse is dependent on the quality and accuracy of the information provided, which requires that the caller gives the information in a way that allows the nurse to understand and visualize the caller's situation.

Outcomes of assessments made over the telephone by nurses vary (O'Cathain *et al.* 2003, 2004), and nurses feel ambivalent about telephone work, with some expressing enhanced levels of satisfaction and others concerned about the lack of what they perceive to be 'hands-on nursing' and the 'monotony' of working in a call centre (Knowles *et al.* 2002). The impact of the recruitment of nurses by NHSD on other services has been assessed (Morrell *et al.* 2002). However, the views of nurses in the wider NHS workforce about the impact of NHSD have not been researched in any systematic manner. The study reported here was the first opportunity to compare the views of two groups of nurses, working within and outside of the service, about the impact of NHSD Wales (NHSDW).

The study

Aim

The aim of the study was to understand the impact of telenursing from the point of view of nurses involved in its provision, and those in more traditional roles.

Design

The work was conducted in two phases. Phase 1, a survey of nurses working within NHSDW, focused on recruitment, reasons for joining the service and job satisfaction. The focus groups undertaken in Phase 2 concentrated on issues arising from the survey related to the development of nursing practice and clinical decision-making.

Participants

All NHSDW nurse advisors were invited to participate in the study by responding to the questionnaire survey and by joining a focus group discussion. In addition, a purposive sample of nurses working outside NHSD was invited to participate through a second focus group. Full details of respondents are given below.

Data collection

Phase 1 NHSDW nurse survey
The questionnaire used to survey nurses working for NHSDW was closely based on that originally developed for use with NHSD nurses in England (Knowles *et al.* 2002). The three-page questionnaire, which included both structured items and open-ended questions, was distributed to every nurse advisor working in the three NHSDW sites in Wales via team managers and then through the internal mail system in October 2002. Completed questionnaires were returned in reply-paid envelopes direct to the research team via the general postal system. After 3 weeks the nurse advisors were reminded by the training and development manager to return their questionnaires if they had not already performed so. Assurances of confidentiality and anonymity were reinforced. Finally, follow up questionnaires were distributed 1 month after the first distribution of questionnaires. Completed questionnaires were identified by a randomly assigned number for analysis.

Phase 2 focus groups
Two focus groups were held, one with NHSDW nurses and one with non-NHSD nurses. Participants for the first group were recruited through advertisements across NHSDW sites. The second group was recruited purposively, through professional contacts, to include nurses in Wales from outside NHSD with a mix of backgrounds and levels of seniority. Groups were facilitated by senior researchers from the research team, with research team observers present to take notes. Topic guides for the focus groups were developed from the project brief, the literature about NHSD, and responses to the questionnaire survey. Because participant numbers were small, we undertook to ensure that the nurses could not be identified from the quotations reported. We have not therefore coded speakers, but have been careful to select quotations from a range of participants, and highlighted areas of consensus or disagreement.

Ethical considerations

The study was approved by the appropriate Research Ethics Committees. All participants were given information about the study and were assured that individual identities would be protected in all reported findings. Focus group participants were asked to sign consent forms at the outset of discussions.

Data analysis

The survey data were coded and analysed using an Access database and Statistical Package for the Social Sciences (SPSS) Version 11 for Windows (SPSS Inc., Chicago, IL, USA). Comparisons were made with national data using the chi-squared test for differences in proportions. Responses to the open-ended questions were thematically analysed. Focus group transcripts were analysed inductively to identify themes, which were then discussed, amended and agreed among team members to ensure that key themes or points had not been overlooked or misinterpreted.

Results

Nurse survey

A response rate of 83% was achieved (92/111), although not all respondents answered every question. The large majority of NHSDW nurse advisors were women, of British/Welsh nationality and aged between 28 and 43 years. The workforce was highly experienced, with a mean of 18 years' (range: 2–39 years) experience in a variety of NHS specialties (Table 1).

Comparison with published data on the demographic profile of the Welsh nursing workforce (Royal College of Nursing 2005) indicated that nurses working in NHSDW were educated to a higher level. Fifty-four per cent of NHSDW nurses had a Bachelor's or higher degree, compared to 17% for all nurses in Wales ($P < 0{\cdot}001$). There were no statistically significant differences in the percentage of male nurses (NHSDW: 9%; Wales: 7%, $P = 0{\cdot}65$) or in the percentage of minority ethnic nurses (NHSDW: 1%; Wales: 5%, $P = 0{\cdot}20$).

Most respondents cited opportunities for improved salary (81·9%, $n = 68$), flexible working (80·2%, $n = 65$) and promotion (65·0%, $n = 52$) as reasons for joining the service. Two-thirds reported improved job satisfaction since joining the service ($n = 61$, 68·5%) although a minority ($n = 15$, 16·8%) reported that this had worsened.

Responses to a concluding open-ended question (see Table 2) generally indicated high levels of job satisfaction, with the challenges and the development of new skills cited as rewarding. However, the degree of surveillance and audit was found to be stressful. Working hours were found to be less flexible than expected, respondents reported missing 'hands-on' nursing and monotony was reported by some to be a problem. Several respondents offered positive free-text comments about the management style of the new service. Overall, these findings were similar to those previously reported (Knowles *et al.* 2002), although they seem to

Table 1 Characteristics of respondents to nurse survey

	n (%)
Gender (n = 89)	
Female	81 (91·0)
Male	8 (9·0)
Nationality (n = 83)	
British/Welsh	82 (99·0)
Indian	1 (1·0)
Age (n = 65)	
21–27 years	6 (9·2)
28–43 years	54 (83·1)
44+ years	5 (7·7)
Worked for National Health Service (NHS) prior to working in NHS Direct Wales (n = 91)	87 (95·6)
Professional qualifications (n = 91)	
Registered General Nurse – Adult	74 (81·2)
State Registered Nurse*	12 (13·2)
State Enrolled Nurse*	9 (9·9)
Registered Mental Health Nurse	4 (4·4)
Registered Nurse	4 (4·4)
Registered Nurse – child	9 (9·8)
Midwife	16 (17·5)
Education (n = 92)	
Diploma level qualification	26 (28·3)
Bachelor's degree	25 (27·2)
Master's degree	5 (5·4)
Specialty prior to working for NHS Direct Wales (n = 86)	
Accident and emergency/walk-in Centre	11 (12·8)
Community/general practitioner	10 (11·6)
Midwifery	10 (11·6)
Paediatrics	9 (10·5)
Intensive therapy unit/critical care	9 (10·5)
Surgery	6 (7·0)
Medicine	6 (7·0)
Gynaecology	3 (3·5)
Plastics	3 (3·5)
Miscellaneous (health visiting; theatre; nursing home; oncology; mental health; ophthalmic; elder care; other)	19 (22·1)

*The term State Registered/Enrolled Nurse was an earlier term for Registered/Enrolled Nurse.

indicate a more positive relationship between front-line advisors and managers in Wales.

Focus groups

The first group, of nurses working in NHSDW as nurse advisors, was held at one NHSDW call centre, with video links to the other two study sites. Four nurses from one centre, three from the second and one from the third participated in the discussion. The second, non-NHSD, group included a district nurse, a health visitor, an accident and emergency service nurse manager, a nurse practitioner (acute medical admissions) and a midwife. This focus group was held at a university site.

In addressing the study aim, discussions fell into two broad areas: challenges and stresses and development of nursing practice. The findings are presented according to these broad areas, and by theme within each area.

Challenges and stresses

Nurses in both groups discussed areas of challenge as well as important benefits related to working within NHSDW.

Theme 1: not being with the patient.

Although the remote nature of the consultation was seen to offer an opportunity to develop new skills, it was also seen as being a source of stress, in part because of the lack of visibility, and also because of the lack of opportunity to follow up callers:

Non-NHSD nurse: '...although we find as nurses it's easier to do face-to-face [nursing], it's actually much more difficult to do at a distance'.

NHSDW nurse: '...hands on and also the closure...that you don't get and that a lot of nurses miss, certainly initially, till they get used to it...you don't know whether the caller is going to take your advice or not'.

NHSDW nurses raised the issue of stress related to their work from several different aspects. Calls made by people with mental health problems were consistently brought up as being of concern, as exemplified by the following quotation:

NHSDW nurse: 'I think a lot of mental health calls particularly, you know, ...you're frightened of saying too much in case you're gonna kind of open [something] you can't deal with'.

Calls for children were also cited as causing anxiety:

NHSDW nurse: 'Children definitely generate a worry...because you've got to rely solely on what the carer is telling you'.

NHSDW nurse: '...disclosure and consent and all those issues around child protection can be very stressful'.

Calls identified as needing an emergency response were also stressful:

NHSDW nurse: '...persuading some callers that they do need an ambulance because...the system and your clinical skills have told you that it's an urgent call and they're saying...no I don't want one, ...so that's generating stress in you 'cos you know there's not much time really and you try to use your skills to persuade them why, without panicking them'.

Table 2 Examples of answers given in response to request: 'Please make any other comments about working for National Health Service (NHS) Direct Wales'

Theme	Respondent	Quotation
Job satisfaction	W9	I feel totally different since working here; more relaxed definitely, more valued and supported
	W2	Since joining NHS Direct it is not what I expected...working for NHS Direct is very rewarding and a tremendous learning curve
	W29	There are tremendous opportunities within this expanding service to expand your knowledge base
Surveillance/audit	W55	Not keen on the controlling aspect...was assured that the service was run with a 'no blame' culture – this is definitely not the case
	W85	I have found the environment intense and claustrophobic. Feel an undue pressure from management, media, callers and politics...I have found this job to have worn me out, close to burn out
Flexibility of hours	W64	I find the reality of working for NHS Direct Wales does not meet the pre-interview promises. Family working is not as flexible as I had hoped
Hands-on nursing	W64	...there is little, if any opportunity to maintain clinical skills in working hours
	W14	One can become clinically deskilled because of long periods away from clinical placements
Monotony	W16	Working 37·5 hours per week at a pod does not give complete job satisfaction. Nurses need to have input into other areas...to relieve monotony
Relationship between nurses and managers	W81	An enthusiastic service with lots of support from managers
	W9	The atmosphere is very good and the managers very approachable

Theme 2: contact with patients at individual level.

One-to-one contact with callers was described at various times during the NHSDW nurse focus group, as stressful:

NHSDW nurse: '...and whilst you're working, it's just you and the caller...it can be quite isolating I think. You can spend your whole shift just talking to callers and the calls are quite intense, one after the other, you end up quite strained mentally'.

However, they could also be satisfying:

NHSDW nurse: '...being able to have a one-to-one, so often in a ward situation you might have eight or ten young children...and you could rarely have a one-to-one with any of them, 'cos there was always someone wanting something else...being able to totally give that caller the time that they need'.

NHSDW nurses reported that they gained satisfaction from the relationship they built up with callers, particularly when they received feedback from them. Some nurses managed to reconstruct the experience of call centre nursing to provide them with 'closure' or continuity, where thanks from patients might be seen as a proxy for the ongoing relationship with patients:

NHSDW nurse: 'Most people will say thanks, and they find it helpful at the end of calls which is probably a greater satisfaction rate than you have on a day-to-day basis in other aspects of nursing'.

Theme 3: generic setting.

The challenge of answering difficult questions and working with nurses from a range of backgrounds was welcomed:

NHSDW nurse: 'Working with colleagues that are coming in new all the time from different disciplines also gives you the chance to find out what's current and also gives you a lot of satisfaction...'.

The variety of the role was commented on positively by several participants:

NHSDW nurse: 'I feel in the last 2 years that I have been here it's certainly helped my personal development because of the job being varied...and very challenging'.

Theme 4: reduced physical demands.

The benefits of a less physically-demanding role were recognized by nurses in both groups:

Non-NHSD nurse: 'The workload is at a different pace, and you can only race up and down the wards, can't you, for so many days in a year without getting physically exhausted'.

NHSDW nurse: 'Your feet don't ache any more!'

Development of nursing practice

Theme 1: development of new communication skills.

A central feature of telephone nursing is the lack of visibility, because of the remote nature of the consultation. This has an impact on the skills required to assess and give advice. However, it also brings opportunities; in particular the opportunity to develop new communication skills was recognized by nurses working within NHSDW and those outside:

NHSDW nurse: 'You ask the (mother) questions and she's interpreting it in her own way...and what she's asking the child is completely different to what you've asked her...it's constantly rewording it and acutely listening perhaps what they are passing on to the child and what the child is saying back to then and the different way they'll say the response back to you'.

Non-NHSD nurse: 'I think I would welcome somebody coming back in with...customer care skills that maybe people were never taught...'.

NHSDW nurses emphasized the centrality of communication skills and relationship- building in telephone-based encounters. Encouraging interaction and empathy were described as important, demonstrating coherence with professional ideology:

NHSDW nurse: 'I think it's important to build up relationship with them quite quickly and build up the trust, you know, and empathy so that you can get the best for that caller'.

Theme 2: risks of telenursing.

Potential pitfalls of remote nursing were also described:

NHSDW nurse: 'It's very much about picture building, which, you know, ...can send us to wrong conclusions'.

Non-NHSD nurse: 'It dehumanizes the way we are living and I would much rather, it's much more than talking to somebody when you can see them, it's the body language, it's the reaction, it's something other than just hearing the words'.

Another nurse in the non-NHSD group felt that the remote nature of the call necessarily limited the consultation:

Non-NHSD nurse: 'Although I think NHSD staff would say that they use their personal skills and experience, I think away from the face-to-face consultation it is easy to be...even more task-oriented'.

The reference to task orientation carries within it a powerful coded criticism which claims a more positive value for face-to-face contact within the professional ideology of nursing, and equates remote nursing with technologized or depersonalized care.

Theme 3: real nursing?

The contrast between the face-to-face provision of care in a traditional manner and care by telephone raises a dilemma, perhaps best encapsulated by the ways in which non-NHSD nurses questioned whether NHSD nursing is real nursing. They went on to suggest that nurses might lose their all round skills whilst working at NHSD:

Non-NHSD nurse: 'There is a place in NHS[D] for nurses who perhaps, there are nurses who don't really want to nurse people'.

However, NHSDW nurses were clear that they depended on their nursing experience and knowledge to carry out their new role:

NHSDW nurse: 'I worked in intensive care before and when somebody is described as being grey, cold, clammy, you know, straightway you know that they're probably quite poorly...you've got this picture from past experience which you can build on and ask the relevant questions'.

These nurses clearly felt ownership and responsibility for decisions made, despite the use of decision support software:

Facilitator: 'So, at the end of the consultation, who has made the decision, is it a nursing decision or is it a computer decision?'

(All NHSDW nurses): 'Nursing decision'.

NHSDW nurse: 'Yeah, because if you'd have any doubt of the disposition, you would change it...you could discuss, but it's still your call if you've taken it and you're the one who decides'.

Theme 4: changing role of nurses.

Perceptions of the public as well as those within the profession were discussed when questioning the identity of NHSD nurses as 'real' nurses by the non-NHSD nurses:

Non-NHSD nurse: 'I just wonder what the public's perception is, do they realise that there is a nurse at the end of the phone or do they think it's just a call-person?'

The role of telenursing was discussed by non-NHSD nurses in the context of wider changes in the role and identity of nurses:

Non-NHSD nurse: 'I suppose historically you think of nurses as people by the bedside, doing the hands-on, but...there are so many that aren't [doing] that sort of thing'.

Related to this was the increasing role of nurses as gatekeepers to care:

Non-NHSD nurse: 'Nurse practitioners in the primary care setting are doing more...referring patients to hospital and is that going to happen to NHSD? Are they going to be seen more as the gatekeepers to acute sectors of the health service?'

Theme 5: value of the service.

Nurses within NHSDW were clear that the service was successful in empowering patients for the future:

NHSDW nurse: 'I think it's needed because the public needs to some degree learn self-empowerment and how to take their health in their own hands when it's appropriate and we're there to guide them'.

Non-NHSD nurses agreed to some extent that the service might play a role in empowerment but conditioned this evaluation by emphasising the limits of the service:

Non-NHSD nurse: 'There are very positive sides...information is power for the patient and relative, it enables them to go to other sites of the health service to gain what they want'.

Non-NHD nurse: 'It does arm patients with information, but...that is going to be limited to a group of patients'.

Although not specifically asked about issues of access, non-NHSD nurses repeatedly raised concerns about the appropriateness of a telephone-based service to the needs of people in some disadvantaged groups:

Non-NHSD nurse: 'My experience of the impact of NHSD...was that with people like from ethnic groups it actually widened...inequalities in health because people did not have access to a telephone and they didn't have the skills for a long consultation...it was the value of the nurse in a face-to-face consultation that was guiding that patient through the healthcare system'.

Non-NHSD nurse: 'To ask people who've been through a very traumatic life to go on to a telephone conversation is asking too much of people who are homeless'.

Non-NHSD nurse: 'Is it more accessible to middle class type England than it is to...the ordinary working class...'.

Non-NHSD nurse: 'I'm not sure what this expensive service is actually doing for the major users of healthcare, older people...

In contrast, none of the NHSDW nurses acknowledged any concern about the applicability of the service to different groups. The only comment about access was made with the converse point:

NHSDW nurse: '...wants a chat, it's quite satisfying to know that we are there for them and accessible. It's the main thing to be accessible'.

Non-NHSD nurses raised other concerns related to the value of the service. They specifically questioned the evidence on which its introduction and development had been based:

Non-NHSD nurse: '...whether [NHSD is] going to expand by stealth as opposed to extend from evidence of effectiveness and...'.

Several times they raised the issues of opportunity cost, for example:

Non-NHSD nurse: '...and if that money had been put into the wards you could have upgraded, given them an F grade on the ward for their experience, how much better that would have been'.

Theme 6: operating as part of a system.

Finally, both groups expressed concerns about the impact of NHSD on the healthcare system, and its integration with other parts of the system:

Non-NHSD nurse: 'The people that NHSD send to us.... I don't know whether they would have come anyway, and I don't know the number who haven't come – but there are people who come, who are sent by ambulance...and there are people who just walk in'.

NHSDW nurse: 'I don't see...much joining up of the whole healthcare system'.

Discussion

Study limitations

Findings from two focus groups can only give a glimpse of the views of nurses working inside and outside NHSD; nevertheless, the discussions provided some initial insight into the views and concerns of nurses about NHSD in Wales. We do not have information about the experience of nurses in the non-NHSD group of giving telephone advice, although this might have influenced their views. It would be useful to repeat the focus groups in Wales and in other NHSD services in the UK to confirm (or otherwise) our findings and to explore further areas of difference and their implications.

Interpretation of findings

A striking aspect of these findings is the way in which both groups of nurses drew on a shared ideology of professional nursing to justify quite different positions in relation to a technological development, telenursing. In part this is due to the dilemmas generated by policy pressures, which emphasize and place positive value on conflicting positions. Nurses are expected to adapt, expand roles and acquire new technological expertise to deal with increasing numbers of patients more efficiently. At the same time they are exhorted to put the patient at the centre of everything they do and to work alongside patients to deliver individually tailored care based on a holistic relationship (Latimer 2000). Both groups of nurses in our study were at pains to claim for themselves the identity of 'real' nurses. The differences between remote nursing and face-to-face nursing reflect the dilemma of making standardized care available to greater numbers of patients whilst increasing the patient-centredness of individual consultations and care. Whilst the RCN definition of nursing (Royal College of Nursing 2003) is broad enough to include care that is delivered remotely, it is clear from our focus groups that this conflict has not yet been comfortably resolved, at least for these participants.

What is already known about this topic

- National Health Service Direct is a popular service with callers, although nurses in the service describe their work in both positive and negative terms.
- Nursing by telephone requires the development of different skills from face to face nursing.
- Assessment and communication skills are particularly important in telenursing.

What this paper adds

- Nurses working within and outside the telephone-based helpline agreed that telenursing offers opportunities for skill development and job satisfaction.
- Nurses from outside the service questioned whether nursing by telephone constitutes 'real' nursing, the effectiveness of the service and the evidence base for its implementation.
- Differences between groups reflect wider tensions in nursing that need to be addressed in order for the service to function as part of an integrated system for unscheduled health care.

Thus, NHSDW was described on the one hand in positive terms - as having provided opportunities for promotion and skill acquisition and development, with attractions cited as the role being physically easier than hands on nursing and its innovative character. The remote nature of the consultation was discussed as being an opportunity yet also stressful. On the other hand, the remote nature of the consultation and use of decision support software were acknowledged to affect the provision of the service and the development of nursing skills, both positively and negatively. In particular, views differed between NHSDW nurses and those from outside the service in terms of whether telenursing is 'real' nursing. These more negative aspects of remote nursing were countered by nurses working within the service, who described high levels of job satisfaction and cited relationships built with callers, the availability of expertise from a range of colleagues, and the variety they of the work.

All agreed that communication skills needed to be highly developed in the telephone-based encounter. However, there was a difference between NHSDW and non-NHSD nurses with regard to the value of the service. Whilst all agreed that it was popular with callers, nurses from outside NHSD questioned the evidence-base for the implementation of the service and whether the money was best spent in this way.

Access issues were raised by the non-NHSD nurses in relation to minority ethnic groups, lower socioeconomic groups, homeless and older people. These concerns have been raised many times [George (2002), National Audit Office, NHS Direct in England (2002)] and in several recent reports of empirical studies (Burt *et al.* 2003, Cooper *et al.* 2005, Knowles *et al.* 2006).

NHSDW nurses were generally very positive about their working environment and the satisfactions they derived from their work. They talked about the satisfaction they got from their one-to-one consultations, and were unanimous in reporting that they relied on their nursing skills to carry out the role. They also were in agreement that the service was worthwhile, although they were only able to back this up by describing caller satisfaction and empowerment in very broad terms. In common with telephone nurse advisors working in Sweden, they reported stresses related to lack of visual contact with patients and maintaining clinical skills (Wahlberg *et al.* 2003). By contrast, although the non-NHSD participants acknowledged the opportunities that nurses were offered within NHSD, there was consistent scepticism about the value of the service and the political context for its introduction.

Policy concerns identified by our participants – inequalities in health, equality of access to services, and evidence based practice – were used by non-NHSD nurses to strengthen an argument against 'remote' nursing. The double criticism highlighted by comments made by this group was that not only is NHSD failing to provide 'real' nursing but that it also fails to tackle many important current policy concerns.

Conclusion

Our findings reflect difficulties currently faced by the nursing profession. Conflicting policy demands and expectations, both from the public and within the profession, mean that nurses are expected to acquire and work with traditional nursing values (Wimpenny 2002); however, at the same time, the pressures of increased demand which NHSD attempts to tackle have led to a tight management style and standardized computer decision software that can be seen to contribute to a loss of traditional nursing skills. At one level, then, it is no surprise to find nurses supporting competing versions of what 'real' nursing might be in practice. Our findings suggest there may be a rift between nurses working within and outside the service. If NHSD, as policy direction indicates (Department of Health 2001), is to truly form an integrated part of the healthcare system, these gaps between those inside and those outside the service in perception of the role and its worth will need to be addressed. Issues of access and concerns about cost-effectiveness need to be addressed through research, practice and service development. More split roles, for instance working part of the time for NHSD as a nurse advisor and part of the time giving care in a face-to-face context, and joint working across services might increase understanding and appreciation of the attractions, stresses and value of the delivery of nursing through this remote route.

Author contributions

HAS, AMW, SSa, PW and WYC were responsible for the study conception and design and HAS and LJG were responsible for the drafting of the manuscript. AMW, JP, JR, SSn and PW performed the data collection and HAS, AMW, LJG, JP, SSn, PW and WYC performed the data analysis. HAS, PW and AMW obtained funding and JP, JR and SSn provided administrative support. HAS, AMW, LJG, JP, JR, SSn, SSa, PW and WYC made critical revisions to the paper. HAS, AMW and PW supervised the study.

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Appendix 17: Telenursing in the UK: A brief profile of National Health Service Direct by Peconi et al. 2009

Telenursing in the UK: A Brief Profile of National Health Service Direct

13

Julie Peconi, Helen Snooks, and Alison Porter

Abbreviations

CCDS	Computerized clinical decision support
GP	General practitioner
NHS	National Health Service
NHS 24	National Health Service 24
NHSD	National Health Service Direct
NHSDW	National Health Service Direct Wales
UK	United Kingdom

13.1 Introduction

The responsibility for health and well-being in the United Kingdom (UK) falls to the National Health Service (NHS). The NHS was established in 1948 to promote "the establishment of a comprehensive health service designed to secure improvement in the physical and mental health of the people of England and Wales and the prevention, diagnosis and treatment of illness" (NHS Act, 1946). The service varies from health-care provision in other Western countries, in that responsibility falls to the government in power.[17] As a result of changes in political administration and alongside changes in health, an aging population and advances in technology, over the past 60 years the NHS has experienced many adaptations, not only in the manner of delivery of health-care services, but also in the structure and organization of these services.

The NHS has recently undergone a series of changes in an attempt to bring the service up to date with economic, technological, medical, and social conditions. The explicit aim

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is to modernize the NHS to meet public expectations.[8] This includes an increased emphasis on the provision of care in the community, self-care, and prevention, with a parallel shift in the role of the general practitioner (GP). In the emergency care context, modernization is also taking place with the 2001 Reforming Emergency Care policy document complimenting the wider NHS modernization agenda.[27]

One important element of modernization which makes full use of technological advances in communication is telenursing, the provision of nursing services through means other than face-to-face contact. This chapter focuses on one aspect of telenursing in the UK, through the medium of 24-h nurse-led telephone helplines: NHS Direct (NHSD) in England, NHS Direct Wales (NHSDW), and NHS 24 in Scotland. The services provide health information and advice, often in emergency situations, and signpost callers to onward services if needed, for the cost of a local phone call. The aim of this chapter is to provide a brief history of these services, a picture of current use, and the role of nursing in NHSD, while highlighting issues of access and implications for the future.

13.2 Introducing NHSD, NHSDW, and NHS 24

In September 1997, the Chief Medical Officer for England's "Developing Emergency Services in the Community" recommended improving access to the NHS by the provision of emergency help and advice through a telephone helpline.[2] Shortly afterward, the British Government published a white paper, "The New NHS: Modern, Dependable", in which a 24-h nurse-led telephone health-care advice and information line – NHSD – was introduced in England. The service was followed quickly by similar services in Wales and Scotland. The aim of NHSD was to provide "easier and faster advice and information to people about health, illness, and the NHS, so that they are better able to care for themselves and their families."[7] The service was to empower patients while acting as a 24-h signpost to the multilayered NHS, directing callers to the most appropriate level of care. The specific objectives for the new service, set out by the Department of Health, the government department responsible for public health issues, included[23]:

- To offer the public a confidential, reliable, and consistent source of professional advice on health care, 24 h a day, so that they can manage many of their problems at home or know where to turn to for appropriate care.
- To provide simple and speedy access to a comprehensive and up-to-date range of health and related information.
- To help improve quality, increase cost-effectiveness, and reduce unnecessary demands on other NHS services by providing a more appropriate response to the needs of the public.
- To allow professionals to develop their role in enabling patients to be partners in self-care, and help them to focus on those patients for whom their skills are most needed.

NHSD was launched in 1998 with three pilot sites. The service rapidly expanded, and the scheme became nationwide in November 2000, with 22 call centers established across the country. The service is believed to be the world's first national nurse telephone clinical assessment service.[36] In December 1999, NHSD Online was introduced, a website where information about clinical conditions and health-care guidance can be accessed free of charge.[37] Information kiosks and digital television have also been added.

In Wales, several policy documents[13,42] gave a commitment to await research findings from the pilot sites in England before implementing a national health helpline, although in practice comprehensive evidence about costs, impact and evidence was not produced before the service was expanded to cover both the whole of England and Wales.[16] In 1999, the Secretary of State announced the introduction of NHSDW. The service was to be commissioned by the Specialised Health Services Commission for Wales based in Swansea NHS Trust. It was operational in April 2000 in two areas, with the rest of Wales receiving service by December of the same year. The aims of NHSDW are similar to NHSD: "to help callers by providing the right advice, information and reassurance they require to look after themselves, if appropriate." It was also designed to ensure that callers who need further care are directed to the right service at the right time.[12]

In Scotland, the service is named NHS 24 and introduction followed a similar pattern. In March 1999, an initial announcement was made by the Secretary of State for the country that an investment was to be made in primary care to pilot the expansion of existing GP "out-of-hours" services to include 24-h access to nurse-led health advice. In December 2000, the service was officially named NHS 24 and was rolled out in pilot areas during 2001. However, while the new service in Scotland was to be similar to NHSD in England, in that nurse triage was to play a key role, there was a stronger focus on integration with existing services, including GP out-of-hours, ambulance, and pharmacists.[3]

Although these services are separately run in practice, in this chapter, for simplicity, the term "NHSD" is used to refer to all three (unless otherwise specified as relating to England), as they are so similar in objectives and organization.

13.3 How NHSD Works in Practice

At the time of writing, NHSD in England has 36 call centers across the country with over 3,000 employees – 1,200 of whom are nurses. All services operate similarly to call centers, in which employees work independently answering continuous calls from the public. There is an option for nurses to discuss calls with colleagues from other specialties although all calls are timed and recorded. As calls may be stressful, staff are given the opportunity to debrief following a shift.

13.3.1 The Call Handler

Although NHSD is referred to as a "nurse-led" service, calls to the service are first answered by a call handler who gathers basic information. The call handler will then direct the call to the most appropriate person – a nurse or health information advisor, depending on the nature of the query. If the condition of the caller or patient is not urgent, the call may then be put in a queue and the caller called back when the next appropriate person is available. By contrast, if the call handler deems the situation to be an emergency, he/she can call an ambulance immediately.

13.3.2 Health Information Referral

Health information advisors deal with enquiries about local services and requests for information about conditions, treatments, and procedures. In NHSD, approximately 13% of calls are handled by health information advisors who may or may not be medically qualified (many come from the social-care environment). Health information advisors also offer information on the prevention of ill health, such as referrals to local smoking cessation schemes. Information is supplied to the caller by phone, by post, or via the Internet.

13.3.3 The Nurse Advisor

NHSD nurse advisors come from a variety of backgrounds including midwifery, health visiting, pediatrics, accident and emergency, and community nursing. Nurse advisors do not make diagnoses but triage callers or patients, using computerized clinical decision support (CCDS) software called the Clinical Advice System. At the start of the telephone conversation, from the caller's responses to initial questions, the nurse decides which algorithm, or branch of the system, to follow, leading the caller through a series of questions resulting in advice concerning further health-care required, where to go for that care and when. This call outcome is termed the "disposition." At any stage in the conversation the nurse can override the system's recommended course of action but should document his/her reasons for doing so.

13.4 Research Evidence Concerning NHSD

Each of the three services (NHSD, NHSDW, and NHS 24) has undergone independent evaluations, with some consistent results across services.[3,22,23,41] Although these evaluations have shown that the services are generally well liked by the public, each also indicates that the speed of expansion has left many issues still to be explored. For example, in Scotland, an independent evaluation concluded the service's actual role had changed significantly compared with its intended role and many processes and procedures had not withstood the pressures of operation.[3] Key areas highlighted by the research evidence include the role of nursing in NHSD, call volume and patterns, impact on the demand for other services, clinical and cost-effectiveness, user satisfaction, and issues of access.

13.5
The Role of Nursing in NHSD

The introduction of NHSD was seen by some as a new career option for nurses and the service has provided employment for those with disabilities who otherwise may have had to leave the profession.[19] On the whole, NHSD nurses have been found to be generally satisfied with working for the service and have gained opportunities for skill development and promotion since joining, although a minority also have reported the work to be monotonous[14] and stressful.[40]

Although NHSD nurses use their professional clinical judgment to assess a caller's health and are only supported by the CCDS, there has been some debate about whether working in NHSD as a nurse advisor constitutes "real nursing," with nurses outside the service in particular expressing doubts.[40] This is understandable, given that telenursing differs from the traditional hands-on delivery of nursing care and there is still much work to be done to understand telephone-based clinical decision making and nursing practice issues. NHSD, as one of the "pioneers" for telephone-based delivery of public health care,[4] has been the setting for much of this research. Pettinari and Jessop[34] explored how professional knowledge and experience were used to build skills to manage the absence of visibility. They identified three broad areas in which nurses have adapted to manage the lack of copresence: (1) gathering information, (2) delivering information, and (3) building trust and rapport. In this way the nurse is able to build a picture of the client and his/her environment, a process seen as central to the reasoning process.[11] Despite this, stresses related to the lack of face-to-face contact with patients were found to be present with telephone nurse advisors both in NHSD in the UK[40] and in Sweden.[44]

Research has also focused on how nurses maintain their professional values within the restriction of the call center environment with its close monitoring. Evidence suggests that nurses use their professional clinical skills, as outcomes of assessments over the telephone by nurses vary,[29,38] indicating an interaction with the CCDS. Mueller et al. found that NHSD nurses display professionalism in four ways: safety of advice, negotiating conflicting expectations, monitoring and simulation, and the role of emotional labor and empathy. Overall, the researchers found evidence that in NHSD, empathy and caring are seen as a component of professional identify and are not due to managerial coercion.[20]

13.6
Service Use

The volume of calls to NHSD has increased steadily since its inception with almost five million calls taken in England on the direct number in 2007/2008.[36] Evaluations of NHSD and NHSDW found that the callers make contact with appropriate services following their call to NHSD in a large majority of cases. Furthermore, serious adverse events resulting from NHSD contract were likely to be rare.[22] However, evidence in Wales deemed the service to be expensive (average marginal cost per call £29 compared to £23 for a consultation with a GP).[41]

Callers appear to be extremely satisfied with their contacts with NHSD.[28] Of the callers who followed the advice given, 95% were satisfied[35] while in a separate study, 95% rated the advice and/or information given as excellent, very good, or good.[26] The website has also grown in popularity with almost 31 million hits in 2007/2008 (a tenfold increase over 5 years).[26]

Published results indicate that self-care advice accounts for the largest proportion of call outcomes,[26,33] with almost 50% of calls resulting in advice to self-care.[26] As one of the objectives of NHSD was to ease pressure on emergency and unscheduled care providers,[2] these data sound promising. However, although methodologically difficult to measure, evidence suggests that in its first year in England, NHSD did not reduce the demand for other immediate care service providers (accident and emergency, ambulance, and GP services) although it may have restrained increasing demand on GPs' out-of-hours services.[21] Using a similar methodology, no evidence of any substitution of demand for other service providers was found in Wales.[41]

13.7 Issues of Access

Equity of access has always been one of the fundamental aims of the NHS. Indeed, in the same white paper which announced the introduction of NHSD, fair access was cited as an important dimension of the new NHS framework: "The NHS contribution must begin by offering fair access to health services in relation to people's needs, irrespective of geography, class, ethnicity, age, or sex."[7] Despite this, concerns have been raised by evaluators,[12] policy makers,[25] and nurses[40] that NHSD is not reaching all of the population, with those who may be particularly vulnerable – older people, those living in areas of deprivation, and those from ethnic minority backgrounds – generally making much less use of the service than other groups such as young parents (who are particularly heavy users), the relatively well educated and affluent.

Published studies have looked at who uses NHSD by exploring access across many different patient groups. These studies looked at whether older people,[6] patients in general practice waiting rooms,[36,43] those from varying levels of deprivation,[1,5] and those who arrived at a hospital by ambulance[17] were aware of and had used the service. Two studies looked at a random sample of the general population[15,39] when attempting to explore access.

In two ecological studies (an investigation that involves a group, typically a geographically defined area, as the unit of analysis),[18] NHSD call rates rose with increasing deprivation but dropped off in the most deprived areas.[1,5] When figures were further broken down, Cooper et al.[5] found that the effect of extreme deprivation seemed to raise rates of calls about adults but reduce rates about children. At an individual level, results are similar, with questionnaires used to gather information on socioeconomic characteristics regarding the use of NHSD. Material deprivation significantly reduced the likelihood of using NHSD as well as non-UK birth of the head of the family.[39] Respondents were less likely to use NHSD if they were aged 65 or more, lacked access to a car or telephone, did not own their homes, had language or hearing difficulties, or had left full-time education at a young age.[15] There were conflicting results with respect to the relationship between use of the service and health status.[36,39]

Several studies compared levels of awareness of NHSD across different populations. Both David[6] and McInerney et al.[17] found that awareness of NHSD declined with age although there are mixed conclusions as to whether this lack of awareness impacted use by the elderly. David found that contacts with NHSD declined with age in line with levels of awareness, suggesting that older people were no less likely than younger ones to use the service if they were aware of it. In contrast, in a questionnaire survey of those in a general practice waiting room, Ullah et al.[43] found that even when aware of NHSD, older people were less like to use it with the most cited reasons for people over 50 not using it being that they preferred to see their GP.

Ambulatory patients from less affluent postcodes and those from ethnic minorities were also found to be less aware of the service,[17] although there were no differences in use or awareness of NHSD in ethnic group or social class.[43] It is, however, important to keep in mind that many of these studies took place shortly after the introduction of NHSD and levels of awareness today may have changed.

13.8 Discussion: Implications for Policy, Research, and Practice

In its first 10 years of existence, NHSD has grown in size, scope (expanding to include the website, digital television and information kiosks), and popularity with high levels of caller satisfaction. The service now handles calls to out-of-hours GP services in some parts of the country, as well as various other clinical assessment services, "choose and book" appointments. Work with local providers of urgent care is also underway to strengthen the integration of service provision.[10] Priorities for the future include building on the core service it provides and moving to a contract that would fit the new NHS environment, providing more enhanced services for customers; working more closely with other NHS organizations and integrated services, and being at the forefront to the application of new technologies to health care.[26]

Research evidence indicates that nurses are generally satisfied with working in NHSD and have adapted views on traditional "hands-on" nursing to fit the call center environment. However, it has been argued that NHSD has been introduced without a solid evidence base[16] and the speed of expansion has often made evaluation difficult, leaving many issues needing further exploration. In particular, the service has not been found to reduce the demand for other immediate care service providers and, in this way, has failed to meet one of its original intended objectives. Although it has been suggested that NHSD is offering an alternative route into the NHS for those concerned with being considered "time wasters" by other busy services,[31] the full reasons why this substitution of demand has not occurred are not yet understood.

In addition, levels of access from vulnerable groups (those who are economically deprived, of ethnic minority background or older than 65 years) are lower than the general population. These groups of the population are already disadvantaged in terms of their health status and access to services and are groups that could potentially stand to benefit the most from a confidential service within their own homes. Further research is needed to understand the reasons why these groups are not using the service fully and what can be done to improve equity of access.

Despite a lack of robust evidence concerning the achievement of NHSD's objectives, in practical terms the service is safe and well liked and would be politically difficult to decommission. Indeed, policy direction indicates that NHSD is to continue to form an integrated part of the health-care system.[9,24] However, in the resource-limited NHS environment, concerns about clinical and cost-effectiveness, and access by disadvantaged groups, need to be further explored in order to understand what value is added by the service, and how the service can be developed in such a way that its effectiveness and reach across the population are maximized.

13.9 Summary

- NHSD, NHSDW, and NHS 24 are 24-h nurse-led confidential health advice and information telephone services.
- The services' aims include the provision of "easier and faster advice and information to people about health, illness and the NHS, so that they are better able to care for themselves and their families."
- NHSD nurses are generally satisfied in working for the service and have adapted their role to fit the telenursing environment, although a small minority report the work to be monotonous and stressful.
- The services are well liked by the public with satisfaction rates as high as 95%.
- Advice to self-care accounts for the largest proportion of call outcomes, although the service has not shown to lessen the demand for other immediate care service providers.
- Despite call volumes increasing steadily, the service is underused by vulnerable groups (those who are economically deprived, of ethnic minority background or older than 65 years).
- NHSD continues to grow in size, scope, and popularity with policy direction indicating that it is to continue to form an integrated part of the UK health-care system.
- More research is needed to understand how the service can maximize its effectiveness and reach across the population.

Glossary

Computerized clinical decision support software – An electronic program that can aid in decision making and triage.

National Health Service – The organization responsible for health and well-being in the UK, which is the responsibility of the government in charge.

NHS Direct – A 24-h nurse-led confidential telephone helpline providing health-care advice and information to callers.

White paper – In the context of UK government policy, a white paper is a first draft of proposed legislation which will be subject to debate before becoming a law.

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Appendix 18: Does deprivation affect the demand for NHS Direct in Wales? Study of routine data. Peconi et al. 2014

Does deprivation affect the demand for NHS Direct in Wales? Study of routine data

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Key words: telemedicine, hotlines, health services needs and demand, poverty areas, socioeconomic factors, vulnerable populations

What is already known on this topic

NHS Direct and NHS Direct Wales are 24-hour nurse-led telephone lines for advice and information about healthcare.

Evidence on socioeconomic variation in demand for these services is equivocal, but most research suggests underuse by more deprived patients, notably those living in areas of deprivation.

There has been little analysis of differences between call rates for advice and those for information only; or of other variables which may affect the relationship between deprivation and demand.

What this study adds

Analysis of over 400 000 calls to NHS Direct Wales showed no evidence of any intrinsic effect of patient deprivation on demand measured by calls per population.

There were differences in the patterns of calls for advice and those for information only.

Other previously unexplored factors that help to predict call rates include ethnicity, day of the week and whether patients made the calls themselves.

Abstract (298 words)

Objective To estimate the effect of deprivation on the demand for calls to NHS Direct Wales (NHSDW) controlling for confounding factors.

Design Study of routine data on over 400 000 calls to NHSDW using multiple regression to analyse the logarithms of ward-specific call rates across Wales by characteristics of call, patient and ward, notably the Welsh Index of Multiple Deprivation.

Setting 810 electoral wards with average population of 3300, defined by 1998 administrative boundaries.

Population All calls to NHSDW between January 2002 and June 2004.

Main outcome measures We used ward populations as denominators to calculate the rates of three categories of calls: calls seeking advice; calls seeking information only; and all calls combined.

Results Confounding variables explained 33.0% of variation in advice call rates, and 27.5% of variation in information call rates, but only 15.4% of variation in combined call rates (all significant at 0.1% level). However deprivation was not a statistically significant predictor of any of these rates (significance levels 0.158, 0.244 and 0.331 respectively). The proportion of the ward population categorised as 'white' was a highly significant predictor of all three call rates. For advice calls and combined calls, rates decreased highly significantly with the proportion of those who called the service for themselves. Information call rates were higher on weekdays and highest on Mondays, while advice call rates were highest on Sundays.

Conclusions Deprivation had no detectable effect on demand for calls. While our data may have underestimated the 'need' of deprived patients, they yield no evidence that policy makers should seek to improve demand from those patients. However we found differences in the way callers use advice and information calls. Previously unexplored variables that help to predict ward-specific call rates include ethnicity, day of the week and whether patients made the calls themselves.

INTRODUCTION

Healthcare is free of charge in the UK and equal access for all is one of the guiding principles of the National Health Service (NHS). The founders of the NHS believed that inequalities in access would fade away. Yet in reality those most disadvantaged often make less use of services[1] and those living in deprived areas generally have worse health status.[2-4] So improving access to health services for those who are disadvantaged is seen as a prerequisite for improving the health of the population. The provision of healthcare over the telephone eliminates issues of location – of patient and provider – and enables policy makers to improve access. In England, NHS Direct (NHSD), a 24-hour nurse-led health information telephone line, was introduced to provide 'easier and faster advice and information to people about health, illness and the NHS so that they are better able to care for themselves and their families'.[5] Callers can use the service to seek advice (e.g. on which healthcare service to use) or for information only (e.g. location of nearest pharmacy). Similar services exist both in Scotland (NHS 24) and in Wales (NHS Direct Wales). In England the NHS has recently added a new number 111 to the emergency number 999 and NHSD to facilitate access to the many services.[6]

Early concerns from evaluators[7], policy makers[8] and nurses[9] suggested that NHSD and its counterparts were not reaching all the population equally. There is research evidence that NHSD is generally used by those who are less disadvantaged: individual socioeconomic indicators showed patients were less likely to use the service if: they did not own a car or lived in rented or social housing;[10-12] had left education at a young age or with fewer qualifications;[11] or had lower household incomes or manual jobs.[12] Evidence at area level about calls to NHSD in England is mixed. Across all calls there appears to be a general increase in call rates with deprivation although this drops off in the most deprived areas.[13,14] When age and gender were also considered, however, call rates about children were lower in the most deprived areas;[14,15] while call rates for males and older people were higher in the most deprived areas. [15] In Wales there was no clear relationship.[16]

This evidence indicates that use of healthcare is complex and all contributing factors must be fully recognised if access is to be correctly understood.[17] Confounding variables are those whose relationship with both dependent and independent variables can obscure true associations.[18,19] This is shown in the changing relationship between call rates and deprivation when age and gender were considered. This is also apparent in studies exploring access to telephone advice across general practitioner out-of-hours (GP OOH) services which suggest an interaction between use and distance[20-22] and between use and the rurality of an area.[21] However, the existing literature on NHSD often correlates patient deprivation and demand in isolation and rarely considers other confounding variables. Furthermore all researchers have combined calls for advice with those only for information before analysis. However there is no evidence that these types of calls are homogeneous. By augmenting and analysing over 400,000 anonymous calls to NHS Direct in Wales, we aimed to estimate the intrinsic effects of deprivation on the demand for advice calls and information calls after controlling for potentially confounding factors.

METHODS

This study analysed routinely collected data on calls to NHSDW. We complemented these with data on the associated wards, notably from the 2001 Census. We received a favourable opinion from the South East Wales Local Ethics Committee in September 2004. We describe our methods in full elsewhere.[23]

Time and place

In 2003 Wales comprised 22 unitary authorities or 865 electoral wards with an average population of 3300. We acquired anonymous data on all calls to NHSDW originating from Wales between January 2002 and June 2004 (n=615 739). To protect patient confidentiality, an NHSDW data analyst removed all patient identifying information, replacing this information with unitary authority, ward and the Welsh Index of Multiple Deprivation (WIMD) as an indicator of deprivation. Though this was necessary for ethical approval, we lost the ability to link calls and identify repeat callers. We excluded duplicate records of known calls, and calls which had been transferred from an Emergency Department (ED) or GP OOH services. We also excluded 59 253 patients without information on postcode since we could not assign a WIMD score or other ward-specific data. Initial exploration of the data suggested that NHSD in England had received the majority of calls from Flintshire and one adjacent ward in Wrexham. NHSD confirmed that these wards had English dialling codes, which routed calls automatically to England. We therefore excluded all calls from these areas.[23] The final number of calls available for analysis was 409 611 across 810 wards (Figure 1).

We separated calls seeking advice on symptoms from those seeking only information. To address potential sources of bias, we included variables reported in the literature as affecting demand. We considered two categories of such variables – relating to the call or to the ward (Table 1).

Data

Individual NHSDW call variables

For all calls NHSDW provided data on date and type (advice or information), age, gender, ethnicity and presenting symptom of the patient, the relationship of caller to patient, and the advice given by the NHSDW nurse advisor. The accompanying paper (Peconi et al. Advice given by NHS Direct in Wales: do deprived patients get more urgent decisions? Study of Routine Data) analyses the resulting data on individual calls to study the effect of deprivation and other variables on advice given.

In contrast this paper analyses the effect of deprivation and other variables on call rates by ward, the natural unit of analysis. So we converted individual variables to proportions by ward, for example the proportion of self callers per ward. Before doing so, we coded symptoms according to the International Classification of Primary Care-2 (ICPC-2);[24] and relationship of caller to patient as self or surrogate. From the date of the call, we calculated the day of the week.

Ward-specific variables

Our main explanatory variable was the Welsh Index of Multiple Deprivation (WIMD), the deprivation index used in Wales during data collection and since. Although used mainly as a single score, the WIMD comprises six domains of deprivation: (1) Income (with a weight of 25%) (2) Employment (25%) (3) Health and disability (15%) (4) Education, skills and training (15%) (5) Housing (10%) (6) Geographical (10%).[25] The least deprived ward in Wales at data collection was Cyncoed in Cardiff, a ward including a small village with some of the highest property prices and most popular schools and a WIMD score of 1.13. The most deprived ward was Rhyl West in a seaside town with many inhabitants receiving governmental financial assistance, with a WIMD score of 74.87. To each call with a defined postcode (each of which covered an average of 18 residents), the NHSDW data analyst assigned the WIMD score for the corresponding ward.

We mapped the location of each of the 23 hospitals in Wales or on the English-Welsh border with an ED at the time of data collection. As data on individual distances to ED were not available, we used the geographical centroid of each ward (the geometric centre of the ward's shape) to calculate the straight-line distance for patients in that ward to the nearest ED. This is a widely accepted measure for estimating distances to health services.[26,27] As an indicator of the concentration of people in a ward, we derived population density from the 2001 Census and the 2003 ward boundaries using Geoconvert.[28] Though NHSDW had provided the age, gender and ethnicity of individual patients, we derived the corresponding ward-specific proportions from the more accurate 2001 Census (Table 1).

Outcome measures and statistical methods

As calls for advice differ in purpose and practice from calls only for information we used three dependent variables for wards – call rates for advice, for information and in total. We calculated these by dividing the number of each type of call in each ward by the 2001 Census population of that ward from the Office of National Statistics (ONS). As early analysis showed that the distribution of residuals was not normal, we transformed call rates by taking square roots and logarithms. As the logarithmic transformation brought the distribution of residuals much closer to normality, we adopted that throughout. We used SPSS version 16.0 to create three multiple linear regression models for each of our three outcome measures. First we entered all variables except day of the week and deprivation; then we added weekday; and finally we added 'deprivation' as a continuous variable. By adding deprivation to the statistical model at the final step we were able to estimate its true contribution after accounting for known potential confounding variables.

Most NHSDW variables were missing fewer than 1% of their data. Not surprisingly very few (3.1%) of those calling for information only had a symptom recorded. Hence, when we analysed information call rates, we did not include symptom as a potential confounding variable. Though NHSDW collected ethnicity data only for the final year, we were able to derive appropriate proportions by ward (Table 2). As we could not identify repeat callers, we could not estimate the effect of different advice given on future calls, and therefore did not include advice as a potential confounding variable. Instead the accompanying paper reports on the effect of deprivation on advice given.

RESULTS

Table 2 summarises the patients and their calls to NHS Direct Wales. Most calls (69%) were for advice; more than half (58%) were on the caller's behalf. Most patients (62%) were female; the mean age of callers was 33.4 years, well below the average age in Wales. Sunday was the most popular day for calls (16%). More symptomatic calls concerned digestive symptoms (16%) than any other group. Table 3 aggregates data across wards. Call rates varied widely across the country with little discernible pattern (Figure 2). Bronington in Wrexham, a rural ward close to the Welsh-English border had the lowest call rate at 0.029 per inhabitant over 30 months; Gorseinon East, a ward near Swansea, the second city in Wales, with a history of coal mining, tinplate factories and woollen mills, had the highest at 0.337. Distances to hospital EDs ranged from 0.2 km to 56 km; and population density from 0.04 to

100 people per hectare. Ward populations were predominantly 'white' (98.6%) with an average age of 40.4 years; 51.5% were female.
The correlation between advice call rates and information call rates was low ($r=0.097$, $p=0.006$). Correlations between deprivation scores and call rates were positive for advice calls ($r=0.166$, $p<0.001$) and negative for information ($r=-0.123$, $p<0.001$). At first sight this suggests that the more deprived are more likely to phone NHS Direct for advice calls then information. Table 4 shows variation in the correlations between deprivation scores and the proportion of calls by day of the week, suggesting that the more deprived are more likely to phone NHS Direct at weekends. These findings confirmed our plan to separate advice and information calls, then to model the effect of known confounding variables, next to add the effect of day of the week, and only finally to test whether deprivation improves the resulting models.

Deprivation and demand for NHSDW
We developed three multiple regression models to explore the relationship between deprivation and demand in the form of logarithms of call rates – for advice, only for information and for advice or information. Tables 5, 6 and 7 summarise the change in each model with the addition of each 'block' of explanatory variables. The known confounding variables ('Block 1') achieved the highest adjusted R^2 of 0.307 for advice call rates, compared with 0.141 for both information call rates and 0.144 for combined call rates (all significant at 0.1% level). In other words these variables explain 33.0% of variability in advice call rates, but only 14 % of variability in information or combined call rates. Adding the proportions of calls on each day of the week ('Block 2') explained a further 2.2% of variability in advice call rates, 13.3% of that in information call rates and 1.0% of that in combined call rates. However adding deprivation ('Block 3') could not increase the adjusted R^2 by more than 0.1% in any of the three models. Thus the final models explained 33% of the variability in advice call rates, and 27.5% of that in information call rates, but only 15.4% of that in combined call rates.

Generally the same variables appeared in all three models with little change in the direction and size of the standardised coefficients. However deprivation could not significantly improve the prediction of any call rate: the significance levels were 0.158 for advice calls, 0.244 for information calls and 0.331 for combined calls. But the proportion of the ward population categorised as 'white' was a significant negative predictor of all three call rates with standardised coefficient of -0.135 ($p<0.001$) for advice calls, -0.105 ($p=0.002$) for information calls and -0.182 ($p<0.001$) for combined calls; the more people with a 'white' ethnicity in a ward, the fewer calls. The proportion of callers who called NHSDW for themselves was a strong negative predictor of call rates both for advice (standardised coefficient = -0.256, $p<0.001$) and combined (standardised coefficient = -0.281, $p<0.001$): the more self-callers in a ward, the fewer calls. The coefficient for distance to ED was also negative for both advice and combined call rates; as distance to the nearest ED increased, call rates decreased. However neither self-call rates nor distance significantly predicted information call rates.

For advice calls, the significantly negative standardised coefficients show that calls on one day replace calls on other days. For information calls the trend was reversed with positive standardised coefficients nearly all significant, showing that calls on one day encourage calls on other days.

DISCUSSION

Main findings

Call rates to NHS Direct (NHSD), deprivation scores, distance to hospital emergency departments (EDs) and population density all varied greatly across wards in this small but heterogeneous country. Included in our linear regression models these variables explained much of the variability in call rates across wards. The low correlation (r=0.097) between advice call rates and information call rates justified the need to look at these separately. However deprivation did not contribute significantly to explaining variation in any call rate, yielding no evidence of any intrinsic relationship between call rates and deprivation. While the proportion of 'white' residents in a ward predicted all call rates, patterns of use also varied by the proportions of self callers and day of the week.

Strengths and limitations of the study

This is the first large national study exploring demand for telephone based healthcare – with data on over 400 000 calls over 30 months. To understand the influence of deprivation on demand we included 14 potential independent variables, informed by the existing literature on deprivation and healthcare. We sought transparency in recoding variables using recognised systems[24-27] and used accepted methods to overcome lack of individual distances to ED.[26,27] We explored advice and information calls both separately and combined, and rigorously tested the relationships between deprivation and demand in sequence. Throughout these detailed explorations findings remained consistent: in this population there is no evidence that deprivation affects demand. However our study has limitations as well as strengths. In particular we could not trace callers through the dataset, or distinguish between many unique calls or the same caller phoning several times. Although this study used the recognised ICPC-2 system to code patients' symptoms, this does not measure severity of complaint. Hence we cannot tell whether those calling from deprived areas had worse health and how this affected demand. Another limitation is the 'ecological fallacy' – the danger of inferring individual trends from grouped data. [29] Finally, we could not include those 60 000 calls (12%) without a deprivation score; they could be genuine emergencies where it was not possible to collect all information or uncooperative callers who refused to give their address.

Findings in Context

Other studies have found that call rates to NHSD rose with increasing deprivation but tailed off in the most deprived areas. Our findings suggest no evidence of any relationship between call rates and deprivation, we judge because the inclusion of confounding variables like population density, distance to ED and day of the week isolate the intrinsic role of deprivation. Our findings suggest that demand for NHSD is not as simple as presented in many previous studies conducted at ward level. For example no study had distinguished between advice and information calls or included day of the week as a potential confounding variable. However our study can identify only socioeconomic influences that operate at ward level and could obscure evidence that suggests that NHSD is being used by those who are better off.[10- 12]

Implications

Nevertheless this study suggests that NHSDW is one of the least discriminatory health services, and that similar previous studies have overestimated the effect of deprivation on demand. However the role of patient symptoms in predicting demand needs further exploration, particularly severity of complaint. In future, fortunately, the Secure Anonymised

Information Linkage (SAIL) databank[30] could overcome the other two major limitations of the present dataset – inability to identify repeat callers to NHSD, and lack of data on individual patient circumstances, especially socioeconomic. By combining datasets through anonymous linkage, SAIL can trace patients who contact any service during the period studied, yielding a more accurate picture of service use. We therefore recommend anonymous data linkage as an important early step in pursuing these issues. Finally the finding that calls varied by day of week has implications for staffing.

Conclusions

This study has identified previously unexplored differences in the rates of calls to NHS Direct for advice and for information. We have characterised many factors that influence demand for NHSD. Nevertheless much variation in call rates remains unexplained. In particular individual socioeconomic indicators that we did not have may yet help to predict call rates. While our data may have underestimated the 'need' of deprived patients for healthcare, they yield no evidence that policy makers should seek to improve access to NHSD for those patients. Although these patients may go elsewhere for healthcare, we have shown that NHSD Wales provides equitable access in response to ward-specific deprivation.

No competing interests

"All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work."

Contributors: JP and HS designed the study. JP cleaned, managed and analysed the data, and drafted and revised the paper. She is guarantor. SM provided expertise in informatics, SR expertise in medical geography, IR and AW expertise in statistics, and HS expertise in emergency care. All authors revised the draft paper.

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Table 1: Study variables

Variable	Definition of categories	Equivalent ward variable
NHSDW call variables		
Type of call	For advice; only for information	Proportion of advice calls from ward
Patient's age	Age in completed years	Mean age of ward population. from 2001 Census
Patient's gender	Male; female	Proportion of females in ward from 2001 Census
Patient's main symptom	International Classification of Primary Care 2 [25]	Proportion of patients with digestive symptoms (most common) in ward
Patient's ethnicity	White; other specified ethnicity; not specified	Proportion of 'white' residents in ward from 2001 Census
Relationship of patient to caller	Self caller; surrogate caller	Proportion of self callers in ward
Day of week when call occurred	Sunday; Monday; Tuesday; Wednesday; Thursday; Friday; Saturday	Proportion of calls from ward on each day
Advice given	Advice given by NHSDW	Not applicable (analysed in accompanying paper)
Ward variables		
Call rate (dependent variable)	Not applicable	Number of calls from ward divided by 2001 Census population
Deprivation score (main explanatory variable)	Not applicable	Measured by Welsh Index of Multiple Deprivation (WIMD)[26]
Distance to ED	Not applicable	Measured by straight line from geographical centroid of ward to nearest Emergency Department (ED)
Population density	Not applicable	Number of people per hectare in ward from 2001 Census

Table 2: Characteristics of patients and their calls (N = 409,611)

NHSDW call variable		n	%
Call type	For advice	281 223	68.7
	For information only	128 388	31.3
Day on which call occurred	Sunday	66 297	16.2
	Monday	61 502	15.0
	Tuesday	56 341	13.8
	Wednesday	55 863	13.6
	Thursday	55 488	13.5
	Friday	52 836	12.9
	Saturday	61 284	15.0
Relationship of caller to patient	Self	237 356	58.0
	Surrogate	172 064	42.0
	Not recorded	191	<0.1
Gender	Male	155 279	38.0
	Female	253 843	62.0
	Not recorded	489	0.12
Ethnicity	White background	3 929	1.0
	Any other background	180 308	44.0
	Not recorded (mainly before July 2003)	225 374	55.0
Symptom (from ICPC-2)	Digestive	67 190	16.4
	General and unspecified	32 262	7.9
	Skin	30 304	7.4
	Musculoskeletal	27 982	6.8
	Respiratory	27 325	6.7
	Neurological	21 260	5.2
	Female genital	6 929	1.7
	Eye	6 390	1.6
	Ear	6 410	1.6
	Psychological	6 106	1.5
	Urological	5 964	1.5
	Pregnancy and childbearing	4 266	1.0
	Cardiovascular	2 620	0.6
	Male genital	2 387	0.6
	Not recorded (mainly information calls)	162 216	39.6
Advice given	999 or ambulance	12 791	3.1
	ED or other hospital	29 865	7.3
	Emergency GP or dentist	89 902	21.9
	Other GP or dentist	82 149	20.1
	Other	27 131	6.6
	Self-care	154 584	37.7
	Not assessed	13 189	3.2
Deprivation (from WIMD)	Least deprived fifth	83 071	20.3
	2nd least deprived fifth	64 652	15.8
	3rd least deprived fifth	74 167	18.1
	4th least deprived fifth	85 024	20.8
	Most deprived	102 697	25.1

Table 3: Characteristics of wards (n=810)

Variables	**Minimum**	**Maximum**	**Mean**	**s.d.**
Total call rates	0.029	0.337	0.144	0.051
Advice call rates	0.014	0.260	0.093	0.043
Information call rates	0.015	0.147	0.051	0.024
Deprivation (from WIMD)	1.13 (least)	74.87 (most)	22.22	14.18
Distance to ED (in km)	0.200	55.98	13.82	11.36
Population density (people/hectares)	0.043	100.24	9.70	13.19
Individual level variables (proportions/ward)				
Self callers	0.357	0.900	0.609	0.107
Digestive symptoms	0.109	0.663	0.315	0.105
Mean age of residents (years)	28.8	52.2	40.4	3.3
Female residents	0.456	0.571	0.515	0.014
'White ethnicity' residents	0.676	1.000	0.986	0.024
Calls on a Sunday	0.036	0.273	0.148	0.046
Calls on a Monday	0.065	0.289	0.159	0.033
Calls on a Tuesday	0.056	0.237	0.144	0.028
Calls on a Wednesday	0.060	0.267	0.141	0.027
Calls on a Thursday	0.034	0.243	0.137	0.024
Calls on a Friday	0.053	0.245	0.133	0.026
Calls on a Saturday	0.036	0.280	0.139	0.041

Table 4: Pearson correlation coefficients between deprivation and the ward level proportion of calls by day of week for advice, information and total calls

Correlations between deprivation (WIMD) and proportion of advice calls by day of week								
	WIMD	Sunday calls	Monday calls	Tuesday calls	Wednesday calls	Thursday calls	Friday calls	Saturday calls
WIMD	1	0.048	-0.082	-0.076	-0.055	0.161	-0.105	0.082
p value		0.171	0.019	0.03	0.118	0.000	0.003	0.02
Correlations between deprivation (WIMD) and proportion of information calls by day of week								
	WIMD	Sunday calls	Monday calls	Tuesday calls	Wednesday calls	Thursday calls	Friday calls	Saturday calls
WIMD	1	0.167	-0.151	-0.034	-0.102	-0.017	-0.042	0.145
p value		0.000	0.000	0.339	0.004	0.634	0.236	0.000
Correlations between deprivation (WIMD) and proportion of total calls by day of week								
	WIMD	Sunday calls	Monday calls	Tuesday calls	Wednesday calls	Thursday calls	Friday calls	Saturday calls
WIMD	1	0.154	-0.166	-0.117	-0.127	0.078	-0.130	0.162
p value		0.000	0.000	0.001	0.000	0.026	0.000	0.000

Table 5: Factors affecting (logarithm of) call rates to NHS Direct Wales for advice: multiple regression

	Block 1[a]			Block 2[b]			Block 3[c]		
Adjusted R squared			0.307			0.329			0.330
Independent variables	Unstandardised coefficients		Standardised coefficients	Unstandardised coefficients		Standardised coefficients	Unstandardised coefficients		Standardised coefficients
	β	Std error	β	β	Std error	β	β	Std error	β
Distance	-0.006	0.001	-0.157	-0.006	0.001	-0.165	-0.007	0.001	-0.169
Population density	0.004	0.001	0.105	0.003	0.001	0.092	0.003	0.001	0.089
Mean age	-0.011	0.005	-0.076	-0.011	0.005	-0.080	-0.009	0.005	-0.064
Proportion female	2.408	1.017	0.077	2.225	1.005	0.071	2.009	1.016	0.064
Proportion 'white'	-0.023	0.006	-0.121	-0.025	0.006	-0.133	-0.025	0.006	-0.135
Proportion digestive symptoms	-0.391	0.162	-0.090	-0.041	0.179	-0.010	-0.047	0.179	-0.011
Proportion self callers	-1.656	0.174	-0.345	<0.001	0.192	-0.265	-1.228	0.194	-0.256
Proportion on Monday			Not entered	-1.814	0.560	-0.136	-1.847	0.560	-0.139
Proportion on Tuesday			Not entered	-2.477	0.583	-0.162	-2.490	0.583	-0.163
Proportion Wednesday			Not entered	-1.584	0.547	-0.106	-1.617	0.547	-0.108
Proportion on Thursday			Not entered	-1.509	0.560	-0.096	-1.610	0.564	-0.102
Proportion on Friday			Not entered	-2.832	0.565	-0.185	-2.837	0.564	-0.185
Proportion on Saturday			Not entered	-1.595	0.542	-0.138	-1.630	0.542	-0.141
WIMD			Not entered			Not entered	0.001	0.001	0.045

a $F(7, 802) = 52.21$, $p<0.001$; b $F(13, 796) = 31.54$, $p<0.001$; c $F(14, 795) = 29.47$, $p<0.001$

Table 6: Factors affecting (logarithm of) call rates to NHS Direct Wales for information: multiple regression

	Block 1[a]			Block 2[b]			Block 3[c]		
Adjusted R squared			0.141			0.274			0.275
Independent variables	Unstandardised coefficients		Standardised coefficients	Unstandardised coefficients		Standardised coefficients	Unstandardised coefficients		Standardised coefficients
	β	Std error	β	β	Std error	β	β	Std error	β
Distance	0.004	0.001	0.096	<0.001	0.001	-0.003	<0.001	0.001	0.002
Population density	-0.003	0.001	-0.091	-0.001	0.001	-0.037	-0.001	0.001	-0.036
Mean age	0.008	0.005	0.060	0.009	0.005	0.064	0.007	0.005	0.050
Proportion female	2.664	1.103	0.086	1.978	1.016	0.064	2.149	1.027	0.070
Proportion 'white'	-0.018	0.007	-0.097	-0.020	0.006	-0.108	-0.019	0.006	-0.105
Proportion self callers	2.245	0.267	0.295	0.368	0.293	0.048	0.298	0.299	0.039
Proportion on Monday			Not entered	2.916	0.423	0.309	2.899	0.423	0.307
Proportion on Tuesday			Not entered	2.521	0.458	0.232	2.550	0.459	0.235
Proportion on Wednesday			Not entered	2.805	0.474	0.256	2.792	0.474	0.255
Proportion on Thursday			Not entered	2.654	0.474	0.224	2.665	0.473	0.225
Proportion on Friday			Not entered	1.568	0.476	0.132	1.575	0.476	0.133
Proportion on Saturday			Not entered	0.188	0.578	0.019	0.187	0.578	0.019
WIMD score			Not entered			Not entered	-0.001	0.001	-0.039

a $F(6, 803) = 23.12$, $p<0.001$; b $F(12, 797) = 26.47$, $p<0.001$; c $F(13, 796) = 24.55$, $p<0.001$

Table 7: Factors affecting (logarithm of) call rates to NHS Direct Wales for advice or information: multiple regression

	Block 1[a]			Block 2[b]			Block 3[c]		
Adjusted R^2			0.144			0.154			0.154
Independent variables	Unstandardised coefficients		Standardised coefficients	Unstandardised coefficients		Standardised coefficients	Unstandardised coefficients		Standardised coefficients
	β	Std error	β	β	Std error	β	β	Std error	β
Distance	-0.004	0.001	-0.116	-0.004	0.001	-0.114	-0.003	0.001	-0.109
Pop density	0.001	0.001	0.047	0.001	0.001	0.043	0.001	0.001	0.044
Mean age	0.005	0.004	0.048	0.006	0.004	0.053	0.005	0.005	0.042
Proportion female	0.716	0.918	0.048	0.573	0.915	0.023	0.694	0.923	0.027
Proportion 'white'	-0.027	0.006	-0.181	-0.028	0.006	-0.183	-0.028	0.006	-0.182
Proportion digestive symptoms	1.537	0.193	0.446	1.578	0.200	0.457	1.600	0.201	0.464
Proportion self callers	-1.120	0.238	-0.332	-1.094	0.223	-0.325	-0.947	0.259	-0.281
Proportion advice calls	0.461	0.249	0.162	0.390	0.270	0.137	0.414	0.271	0.146
Proportion on Monday	Not entered			-0.961	0.661	-0.089	-0.928	0.662	-0.086
Proportion on Tuesday	Not entered			-1.096	0.686	-0.085	-1.032	0.689	-0.080
Proportion Wednesday	Not entered			-0.654	0.672	-0.050	-0.612	0.673	-0.046
Proportion on Thursday	Not entered			-0.133	0.655	-0.009	-0.040	0.662	-0.003
Proportion on Friday	Not entered			-2.235	0.667	-0.158	-2.199	0.668	-0.155
Proportion Saturday	Not entered			-1.248	0.670	-0.141	-1.209	0.671	-0.137
WIMD	Not entered			Not entered			-0.001	0.001	-0.036

a $F(8, 801) = 17.99, p<0.001$; b $F(14, 795) = 11.52, p<0.001$; c $F(15, 794) = 10.81, p<0.001$

Figure 1: Flowchart showing selection of calls for analysis

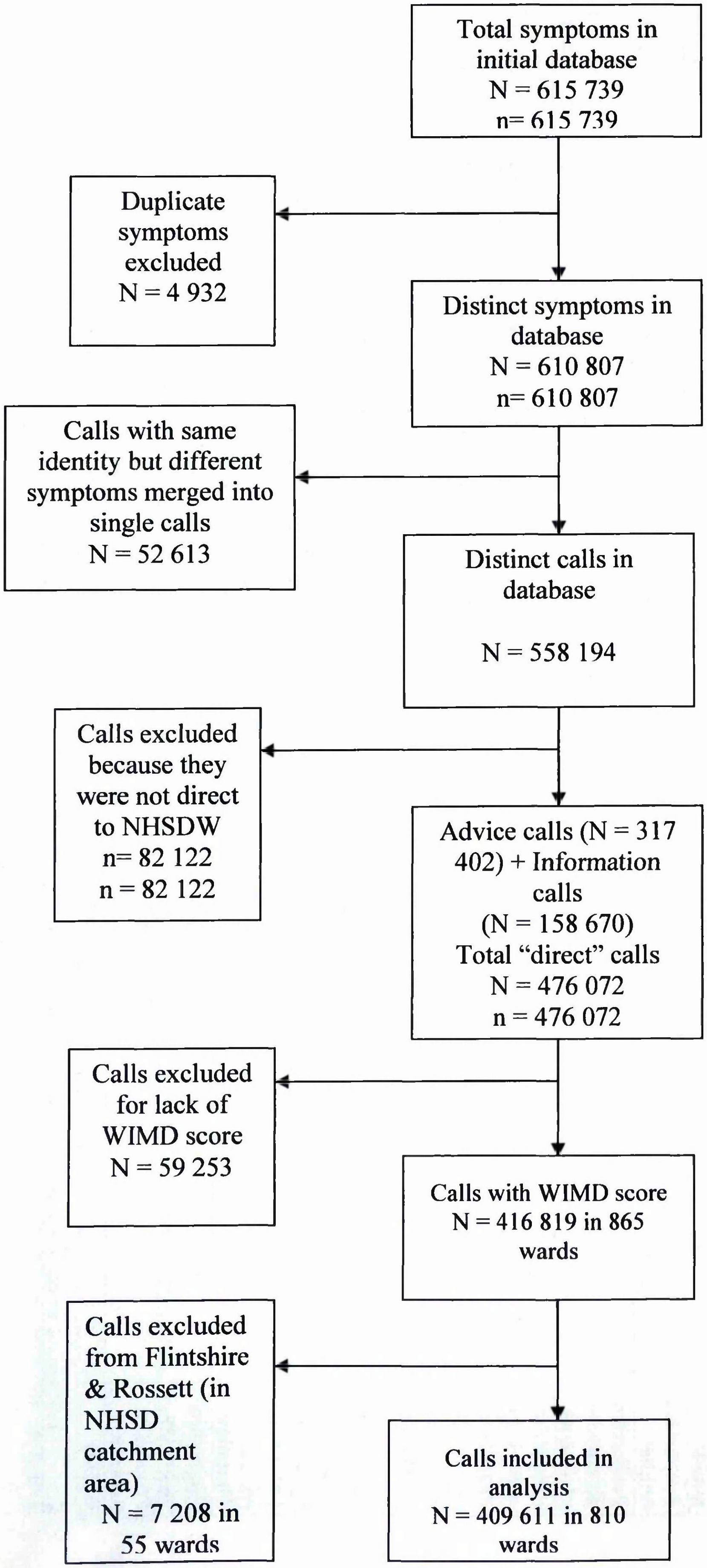
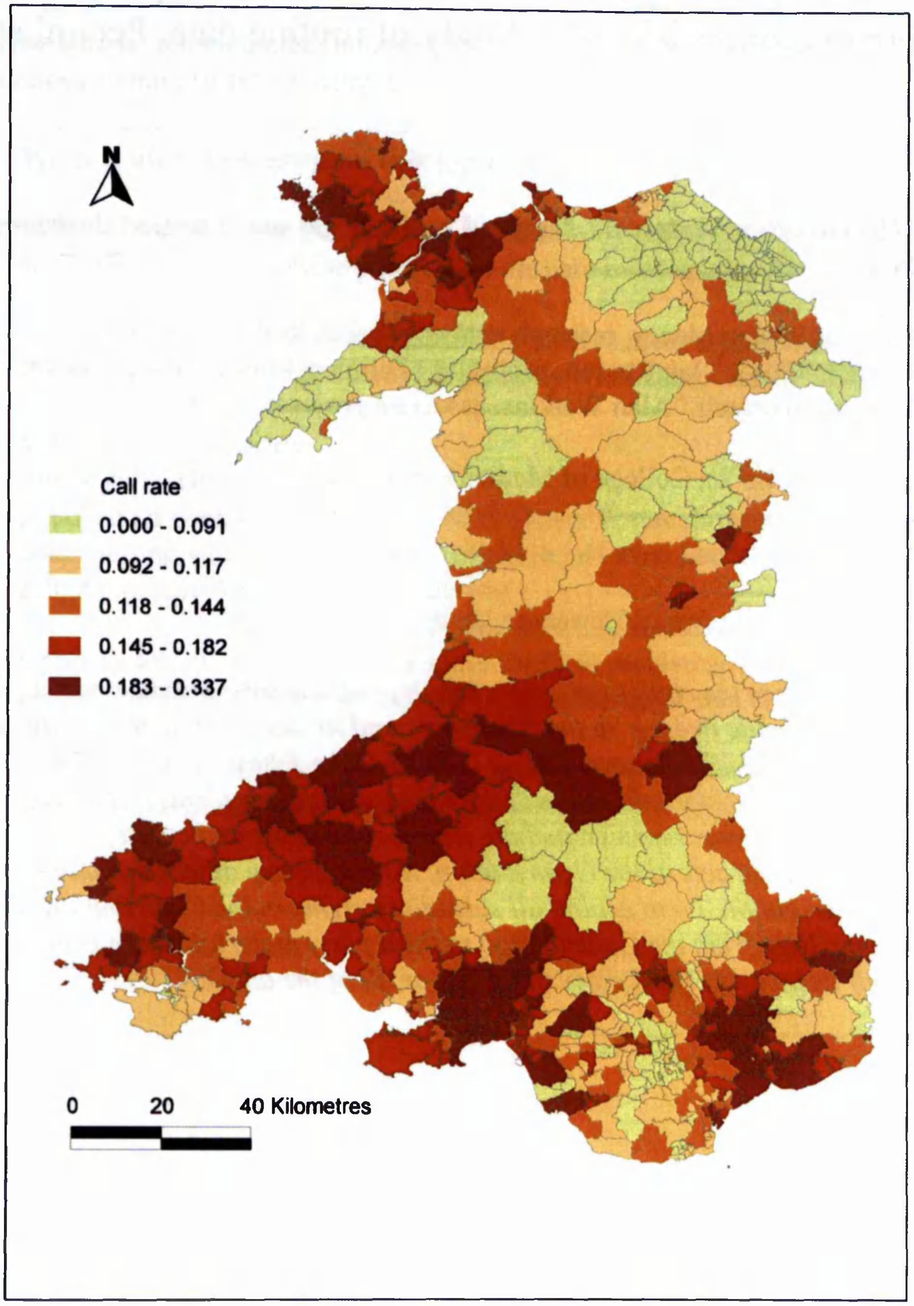


Figure 2: Variation in call rates across Welsh wards



Appendix 19: Advice given by NHS Direct in Wales: do deprived patients get more urgent decisions? A Study of routine data. Peconi et al. 2014

Advice given by NHS Direct in Wales: do deprived patients get more urgent decisions? Study of routine data

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WORD count: 2960 (excluding abstract and tables)

Key words: telemedicine, hotlines, health services needs and demand, poverty areas, socioeconomic factors, vulnerable populations

What is already known on this topic

NHS Direct and other providers of healthcare by telephone use computerised decision support software to advise patients on the care most appropriate to their needs.

Those living in deprived areas generally receive more urgent healthcare out of hours but the effect of deprivation on advice given by NHS Direct is not known.

What this study adds

Analysis of over 400 000 calls to NHS Direct Wales showed that after adjustment for confounding variables, increased patient deprivation had a small to moderate positive effect on receiving more urgent advice.

Other factors that make patients more likely to receive advice to take urgent action included calls made on their behalf, calls on Sundays, and calls about white patients.

While this study suggests that advice given by NHS Direct Wales is more equitable than feared, it advocates more research into the influence of patient and call characteristics.

Abstract (294 words)

Objective To estimate the effect of deprivation on advice given by nurses in NHS Direct Wales (NHSDW) controlling for confounding variables.

Design Study of routine data on over 400 000 calls to NHSDW. We used logistic regression to adjust for covariates and model the effect of deprivation on advice given by nurses in response to calls seeking advice or information.

Setting Wales, United Kingdom.

Population All calls to NHSDW between January 2002 and June 2004.

Main outcome measures Receiving advice to phone 999 rather than seek other care; receiving advice to seek care face to face rather than self-care.

Results After adjustment for covariates, an increase in deprivation from one fifth to the next fifth increased by 13% the probability that those calling for advice rather than information were told to phone 999 [Odds ratio (OR) 1.127; 95% confidence interval (CI) from 1.113 to 1.143]. Deprivation also increased the corresponding probability of being advised to seek care face to face rather than self-care by 5% (OR 1.049; 95% CI from 1.041 to 1.058) and within calls for information by 3% (OR 1.034; 95% CI from 1.022 to 1.047). Those who called NHSDW for themselves had less chance of receiving urgent advice (either to phone 999 or to seek care face to face); ORs ranged from 0.420 to 0.864. For advice but not information calls, the probability of receiving advice to seek care face to face increased on Sundays; but decreased if the patient was non-white (OR 0.818; 95% CI from 0.729 to 0.918).

Conclusions For advice calls, increased deprivation increased the chance of receiving more urgent advice, particularly advice to call 999. While our dataset may underestimate the 'need' of deprived patients, it yields no evidence of major inequity in advice for these patients.

INTRODUCTION

One of the founding principles of the National Health Service (NHS) in the UK was equality of access to, and provision of, healthcare. [1,2] Yet, in the UK and internationally, inequalities in health persist with people living in economically deprived areas known to have poorer health, including higher levels of depression [3] and poorer physical function. [4] People living in deprived areas are also less likely to have access to good quality medical care than those in more affluent areas, and consultations with General Practitioners (GPs) and other health practitioners may be less clinically effective. [5] Evidence from providers of healthcare out of hours suggests that those from more deprived backgrounds receive more urgent care. [6-8] National, nurse-led telephone advice and information lines such as NHS Direct (NHSD), NHS Direct Wales (NHSDW) and NHS 24 in Scotland are in theory well placed to help those at socio-economic disadvantage. For the cost of a local phone call, they aim to provide accessible, standardised advice and information. NHS England has recently introduced '111' as a new number to simplify entry into the complex emergency care system. [9] Nurse advisors generally use computerised decision support software (CDSS) to advise callers on the most appropriate form of healthcare or how to treat their symptoms themselves. Nurses work through a series of questions and answers to a decision. Although they can override this decision, the aim of this software is to give consistent advice in similar circumstances independent of patient or nurse characteristics.

However there is evidence about variable provision in NHSD: nurses with over 20 years experience were more likely to advise callers to care for themselves; [10] and Registered Sick Childrens Nurses were more likely to refer children with fever or rash to routine GP appointments. [11] However both studies lacked evidence about the influence of patient characteristics on outcomes. Patient deprivation has differentially affected the use of GP services that provide telephone advice out of hours: odds ratios (ORs) have ranged from 0.81 [95% confidence interval (CI) 0.74 to 0.88] [12] through 0.88 (95% CI 0.81 to 0.95) [13] to 1.01 (95% CI 1.01 to 1.02). [14] However, once advised to see a GP, those in deprived areas were more likely to receive home visits. [12-14] However we know of no study of the effect of patient deprivation on advice given by NHSD nurses. This paper therefore aims to describe how deprivation affects advice given by NHSDW controlling for other variables that affect this advice.

METHODS

Time and place

The South East Wales Local Research Ethics Committee approved this study in September 2004. We describe our methods in full elsewhere [15] and in detail in the accompanying paper (Peconi et al. Does deprivation affect the demand for NHS Direct in Wales? Study of routine data). In summary we collected anonymous data on all 615 739 calls to NHSDW originating from Wales between January 2002 and June 2004. We excluded duplicate calls, calls transferred from Emergency Departments (EDs) or GP Out-of-hour (OOH) services, and calls without patient postcodes and therefore deprivation scores. As exploration revealed that most calls from Flintshire and Rossett in Wrexham go to NHSD in England, we excluded all calls from this area. This left 409 611 calls for analysis.

Data

NHSDW provided data on: date and thus day of call and its type – whether for advice or information; patient's age, gender, ethnicity, symptom, and relationship to caller; and the advice of the NHSDW nurse advisor (Table 1). We coded patient symptoms according to the International Classification of Primary Care-2 (ICPC-2).[16] We supplemented these data with variables available only at ward level, notably deprivation score, distance to nearest ED and population density.

Table 2 shows how we defined our variables for logistic regression analysis. As preliminary analysis showed digestive symptoms were most frequent, we grouped the rest to simplify analysis. Similarly we coded the relationship of caller to the patient as self, or surrogate for calls on behalf of someone else. As data on patient ethnicity were available for only the final year, we created two dummy variables consistent with categories in the 2001 Census: 'white or unknown ethnicity' versus 'any other ethnicity'; and 'known' (white or other) versus 'unknown'.

The original dataset used 244 different types of advice. Using NHSDW's algorithm we reduced these to 30 (Appendix 1). We then recoded them into the six ordered categories used to evaluate NHSD in England[17] and in Wales.[18] These rank advice by urgency from 999 call through ED or other self-referral to hospital, GP or dentist within four hours (labelled as "emergency"), GP or dentist less urgently, other healthcare and self-care (the least expensive). We labelled as 'not assessed' calls with no specific advice, including calls in which the nurse could not contact the caller again after several attempts. More than 50,000 early calls used an older version of the NHSDW system that recorded up to four different categories of advice per call. To include these calls in analysis, one of us (JP) assigned each to its highest level of advice; for example, a call yielding advice to 'contact GP' and undertake 'self-care' in the meantime received a final classification of 'contact GP'.

Outcome variables

As advice could thus take one of six forms, we summarised it by two binary variables: first whether the patient received advice to phone 999 versus any other care (contact hospital, GP, dentist or other healthcare, or care for oneself); and (2) whether the advice was to contact any healthcare professional (care face to face) versus self-care. Thus calls that received advice to phone 999 were always in the more urgent category. Following a previous study,[10] we chose these variables to represent the riskiest decisions for the nurse. We treated calls which had been coded as 'not assessed' as self-care as they had not received any other advice from NHSDW.

Ward level variables

Our main explanatory variable was the summary score of the Welsh Index of Multiple Deprivation (WIMD), the deprivation index used in Wales during data collection and since.[19] To each call with a defined postcode (each of which covered an average of 18 residents), the NHSDW data analyst assigned the WIMD score for the corresponding electoral ward (with an average population of 3300). We assigned each ward to its 'deprivation fifth' within the full range of deprivation scores. We estimated the distance from each ward centroid to the nearest ED[20,21] and estimated population density from the 2001 Census information for the 2003 administrative boundaries, which we converted to 1998 wards by Geoconvert.[22]

As climatic variables like temperature[23,24] and pollutants[25] affect patient health, we added the average of the maximum and minimum monthly temperatures and air quality measures including the pollutants Ozone, Particulate Matter 10, Sulphur Dioxide and Nitrogen Dioxide for each ward. Unfortunately the paucity of weather stations (n=24) and air quality measuring stations (n=7) in Wales and on the border reduced the value of these data in initial analysis; so we excluded them from final analysis.

Statistical methods and sensitivity analyses

As calls for advice differ in purpose and practice from calls only for information, we analysed these types of call separately. Both yielded two separate models: for the likelihood of receiving advice to call 999 over any other advice; and for receiving face to face care (including emergency care) over self-care. We undertook three logistic regressions for each combination of call type and care model: first we entered all variables except day of the week and deprivation; then we added weekday; and finally we entered 'deprivation fifth' as an ordinal variable since that is simpler but little less discriminatory than as a continuous variable. By adding deprivation to the statistical model at the final step we were able to estimate its true contribution after accounting for known potential confounding variables.

For the majority of NHSDW variables missing data were fewer than 1% with some exceptions. NHSDW collected data on race only for the final year. As expected, the majority (96.9%) of those calling for information (for example, how to give up smoking or the location of the nearest open pharmacy) did not have a symptom recorded. Thus when analysing calls for information we did not include symptom as a potential confounding variable. We conducted all analyses in SPSS version 16.0.

RESULTS

Table 3 describes the characteristics of the individual data. Most calls (69%) were for advice; more than half were on the caller's behalf. Most patients (62%) were female; 55% had no ethnicity recorded; and the mean age of patients was 33.4 years. Sunday was the most popular day for calls (16.2%). More symptomatic calls concerned digestive symptoms (16.4%) than any other group. Over 40% of callers were advised to contact GP or dentist. When WIMD scores were analysed in fifths, 25.1% of calls came from the most deprived fifth. Distances to ED ranged from 0.2 km (from Aberystwyth East in Ceredigion to Bronglais General Hospital) to 56.0 km (from Aberdaron in Gwynedd to Gwynedd Hospital in Bangor). Population density ranged from 0.04 people/hectare in Llanuwchllyn in Gwynedd to 100 in Plasnewydd in Cardiff (Table 4).

Initial exploration showed statistically significant differences between mean WIMD scores by advice given. Calls for advice gave patients living in deprived areas more chance of being told to phone 999: the mean WIMD score of those so advised was 26.4; while that of those advised to care for themselves was 22.7 (Table 5). For information calls the corresponding mean WIMD scores were 24.4 and 22.0. When we classified deprivation scores in fifths, these differences became clearer, both for advice and for information (Table 6). Only 3.6% of callers for advice from the least deprived areas received advice to call 999, compared with 5.6% from the most deprived areas. Advice to contact an emergency GP or dentist was also more frequent in the most deprived areas (33.4% versus 29.8%). Similarly the frequency of advice to care for themselves was 17.4% in the least deprived areas but 15.0% in the most deprived. For information calls, differences were similar but less marked.

These initial findings continued when we included other explanatory variables within logistic regression analyses. This was particularly true for advice calls (Tables 7 and 8): an increase in deprivation from one fifth to the next increased by 13% the probability of receiving advice to call 999 (OR 1.127; 95% CI 1.113 to 1.143). Moving from one deprivation fifth to the next also increased the probability in advice calls of receiving advice to seek care face to face but by less (OR 1.049; 95% CI 1.041 to 1.058). For information calls (Tables 9 and 10), the impact of deprivation on the advice to call 999 was not significant (OR=1.024; 95% CI 0.912 to 1.149) although there was a slight increase in the probability of receiving advice to seek face to face care with deprivation fifth (OR=1.034, 95% CI 1.022 to 1.047).

For variables which appeared in most models, the direction of effect was mainly consistent with the exception of day of the week. For advice calls, the probability of receiving advice to seek face to face care increased on Sunday while the probability of receiving advice to seek emergency care increased on Mondays and Thursdays. In all models, those who called NHSDW for themselves always had less probability of receiving more urgent advice; ORs ranged from 0.420 to 0.888 (Tables 7 to 10). In both advice and information calls, those whose ethnic status was recorded as non-white had less chance of receiving advice to seek face to face care (advice calls: OR 0.818; 95% CI 0.729 to 0.918; information calls: OR: 0.815; 95% CI 0.672 to 0.988). Most other variables had ORs close to 1, showing little change in the probability of receiving more urgent advice (Tables 7 to 10).

DISCUSSION

Main findings

Simple analysis showed that those in more deprived areas generally received more urgent decisions. This trend was consistent across both advice and information. However, this trend was generally weaker in the more comprehensive regression models. Indeed, within information calls deprivation did not affect the probability of receiving advice to seek emergency care. Although other findings were all highly significant statistically, most practical differences were quite small: for example the odds of being advised to seek care face to face by 5% for each transition from one 'deprivation fifth' to the next highest. There was one exception to this: for advice calls, moving from one deprivation fifth to the next increased the probability of receiving advice to call 999 by 13%. Generally the same explanatory variables appeared consistently across models with no change in direction and little change in effect size. For example callers who rang NHSDW for themselves consistently had less chance of receiving more urgent advice than callers of behalf of the patient.

Strengths and limitations of the study

This is the first large study of relationships between patient deprivation and the consequences of telephone-based healthcare, with data on 400 000 calls over 30 months. To explore the influence of deprivation on advice given we included known confounding variables from previous studies of deprivation and healthcare.[12-14] We used accepted methods to overcome methodological issues like ranking advice by urgency and inferring distances to hospitals. We modelled the relationships between deprivation and advice by separating calls for advice from those for information only. The main limitation was the lack of any measure of symptom severity. Although we used the ICPC-2 coding system to summarise patient symptoms, this does not address severity. Thus this dataset cannot tell whether two different callers with 'digestive' symptoms had similar levels of dysfunction. Similarly we do not know whether those calling from deprived areas had worse health and how this affected the advice given. Another limitation was the absence of personal addresses from our dataset, with the result that inferences about individual characteristics stemmed from ward-level data.[26] Although we have used proxies like the geometric centre of a ward to calculate distance to ED, this method does not discriminate between types of journey, for example mountainous or motorway.

Finally we could not include those 59,523 calls (12%) without recorded wards; these may represent a distinctive group of callers, for example genuine emergencies without time to collect all information or uncooperative callers who refused to give their address. Despite these limitations, our findings have remained consistent: in this national dataset, there is a small to moderate effect of deprivation on the advice given.

Findings in context

One of the difficulties in analysing advice given using routine data from NHSD is the focus on one simplified outcome. Many aspects of calls, for example time or psychological state of the caller, could have influenced the final advice. Although we have analysed the most urgent advice given, any other advice given within the phone call disappears unless specifically recorded. We do not know who made the final decision – the CDSS or the nurse advisor by overriding that system. Furthermore, as we cannot identify repeat callers, we cannot infer how the advice affected future contacts. Fortunately our findings are generally consistent with literature suggesting that those more deprived receive more urgent outcomes, both from other emergency healthcare services [6-8] and from telephone-based healthcare. [27] In particular our findings resemble those of O'Reilly and colleagues [14] who reported that the probability of seeing a GP out of hours is only slightly increased by deprivation. In short, by specifying a fuller range of independent variables, our models better estimate the true effect of deprivation.

Implications

The tendency for those living in more deprived areas to receive more urgent outcomes has important consequences for policy, practice and research. Although all differences were small, they were highly significant statistically. Whether these differences result from inequalities in health or in healthcare-seeking behaviour needs further exploration: is this tendency a true consequence of poorer health, or an artefact of the pattern of communication between nurse advisor and caller? Are callers from more affluent areas more likely to define their concerns more clearly, thus avoiding the need for care face to face? There is also a need to characterise and quantify these types of results in terms of financial effects on the NHS and individual patients. Though we compared advice to call 999 with all other forms, and care face to face with self care, we recommend future researchers model the full range of advice and thus continue to build fully specified regression models of advice given in telephone healthcare out of hours. Qualitative interviews with callers and nurse advisors and analysis of call transcripts should explore reasons for contact with NHSD, explanations for variations in advice given across groups, and the relationship between nurse advisors and patients.

Conclusions

This study has shown that deprivation, although statistically significant in a large dataset, has a small to moderate effect on advice. While it is possible that our dataset underestimated the 'need' of deprived patients, it yields no evidence of great inequity in outcome for those living in deprived areas. Our models also showed that calls on a Sunday, calls made on behalf of the patient, and calls about white patients were all more likely to receive a more urgent decision. The introduction of '111' calls (less urgent than '999') in the UK and the resulting change in the role of NHSD makes the future of telephone healthcare out of hours uncertain. Nevertheless telephone advice will continue to play a large part in the delivery of emergency care. Hence there is need for further research on the effects of patient and call characteristics on advice given. In the meantime this study shows that NHSD is not disadvantaging those living in deprived areas.

No competing interests

"All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; and no other relationships or activities that could appear to have influenced the submitted work."

Contributors: JP and HS designed the study. JP cleaned, managed and analysed the data, and drafted and revised the paper. She is guarantor. SM provided expertise in informatics, SR expertise in medical geography, IR and AW expertise in statistics, and HS expertise in emergency care. All authors revised the draft paper.

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Table 1: Study variables

Variable	Original categories
NHSDW call variable	**Definition of categories**
Advice (dependent variable)	999 call or ambulance; care face to face; self care
Day of week when call occurred	Sunday; Monday; Tuesday; Wednesday; Thursday; Friday; Saturday
Type of call	For advice; only for information
Patient's age	Age in completed years
Patient's gender	Male; female
Patient's ethnicity	White; other specified ethnicity; not specified
Patient's main symptom	International Classification of Primary Care 2 [16]
Relationship of patient to caller	Self caller; surrogate caller
Ward variable	**Method of measurement**
Deprivation score	Measured by Welsh Index of Multiple Deprivation (WIMD) [19]
Distance to ED	Measured by straight line from geographical centroid of ward to nearest Emergency Department (ED)
Population density	Number of people per hectare in ward

Table 2: Codes used in logistic regression analysis

Study variable	Zero	One
Advice to seek emergency care	all other care	999 call or emergency care
Advice to seek care face to face	self-care	care face to face (including emergency care)
Gender	male	female
Main symptom (from ICPC-2)	not digestive	digestive
Relationship of patient to caller	surrogate caller	self
Other ethnic background	white or unknown	other
Ethnicity known	unknown	known (white or other)
Call occurred on Sunday	all other days	Sunday
Call occurred on Monday	all other days	Monday
Call occurred on Tuesday	all other days	Tuesday
Call occurred on Wednesday	all other days	Wednesday
Call occurred on Thursday	all other days	Thursday
Call occurred on Friday	all other days	Friday
Call occurred on Saturday	all other days	Saturday
Resident in least deprived 5th of wards	least deprived	2nd least deprived (2 = 3rd most deprived; 3 = 2nd most deprived; 4 = most deprived)

Table 3: Characteristics of patients and their calls (N = 409,611)

NHSDW call variable		n	%
Call type	For advice	281 223	68.7
	For information only	128 388	31.3
Day on which call occurred	Sunday	66 297	16.2
	Monday	61 502	15.0
	Tuesday	56 341	13.8
	Wednesday	55 863	13.6
	Thursday	55 488	13.5
	Friday	52 836	12.9
	Saturday	61 284	15.0
Relationship of caller to patient	Self	237 356	58.0
	Surrogate	172 064	42.0
	Not recorded	191	<0.1
Gender	Male	155 279	38.0
	Female	253 843	62.0
	Not recorded	489	0.12
Ethnicity	White background	3 929	1.0
	Any other background	180 308	44.0
	Not recorded (mainly before July 2003)	225 374	55.0
Symptom (from ICPC-2)	Digestive	67190	16.4
	General and unspecified	32262	7.9
	Skin	30304	7.4
	Musculoskeletal	27982	6.8
	Respiratory	27325	6.7
	Neurological	21260	5.2
	Female genital	6929	1.7
	Eye	6390	1.6
	Ear	6410	1.6
	Psychological	6106	1.5
	Urological	5964	1.5
	Pregnancy and childbearing	4266	1.0
	Cardiovascular	2620	0.6
	Male genital	2387	0.6
	Not recorded (mainly information calls)	162216	39.6
Advice given	999 or ambulance	12 791	3.1
	ED or other hospital	29 865	7.3
	Emergency GP or dentist	89 902	21.9
	Other GP or dentist	82 149	20.1
	Other	27 131	6.6
	Self-care	154 584	37.7
	Not assessed	13 189	3.2
Deprivation (from WIMD)	Least deprived fifth	83071	20.3
	2nd least deprived fifth	64652	15.8
	3rd least deprived fifth	74167	18.1
	4th least deprived fifth	85024	20.8
	Most deprived	102697	25.1

Table 4: Characteristics of wards (N = 810)

Variable	Minimum	Maximum	Mean	s.d.
Call rate	0.029	0.337	0.144	0.051
Deprivation (from WIMD)	1.13 (least)	74.87 (most)	22.22	14.18
Distance to ED	0.200	55.98	13.82	11.36
Population density	0.043	100.24	9.70	13.19

Table 5: WIMD deprivation scores by advice given

Advice given	n	Mean	Standard deviation	95% confidence interval for mean	
				Lower	Upper
Calls for advice [a]					
999 or ambulance	12646	26.41	16.35	26.13	26.70
ED or other hospital	29549	23.33	15.34	23.15	23.51
Emergency GP or dentist	87975	24.32	15.76	24.22	24.42
Other GP or dentist	79444	23.12	15.35	23.02	23.23
Contact other professional	17127	23.50	15.55	23.27	23.73
Self-care	46706	22.74	15.08	22.60	22.87
Not assessed	7776	23.97	15.75	23.62	24.32
Total	281223	23.65	15.53	23.59	23.71
Calls for information only [b]					
999 or ambulance	145	24.38	16.44	21.68	27.08
ED or hospital	316	22.11	13.94	20.57	23.65
Emergency GP or dentist	1927	24.44	15.81	23.73	25.15
Other GP or dentist	2705	22.29	14.90	21.73	22.86
Contact other professional	10004	23.17	15.14	22.87	23.47
Self-care	107878	22.05	14.15	21.96	22.13
Not assessed	5413	22.25	14.38	21.87	22.63
Total	128388	22.19	14.29	22.11	22.27

a F (df = 6, N = 281 216) =139.47; p<0.001

b F (df = 6, N = 128 381) = 18.21; p<0.001

Table 6: Advice given by WIMD deprivation fifths

Advice given	1 (least deprived)	2	3	4	5 (most deprived)
Calls for advice [a]	n (%)	n (%)	n (%)	n (%)	n (%)
999 or ambulance	2086 (3.6)	1540 (3.7)	2114 (4.3)	2671 (4.7)	4235 (5.6)
ED or hospital	6309 (10.9)	4339 (10.5)	5077 (10.4)	6048 (10.6)	7776 (10.3)
Emergency GP or dentist	17330 (29.8)	12335 (29.7)	15164 (31.0)	17907 (31.3)	25239 (33.4)
Other GP or dentist	17057 (29.4)	12203 (29.4)	13915 (28.5)	15881 (27.8)	20388 (27.0)
Other professional	3664 (6.3)	2531 (6.1)	2906 (5.9)	3481 (6.1)	4545 (6.0)
Self care	10118 (17.4)	7356 (17.7)	8278 (16.9)	9569 (16.7)	11385 (15.0)
Not assessed	1494 (2.6)	1207 (2.9)	1393 (2.9)	1601 (2.8)	2081 (2.8)
Total	58058 (100)	41511 (100)	48847 (100)	57158 (100)	75649 (100)
Calls for information only [b]	n (%)	n (%)	n (%)	n (%)	n (%)
999 or ambulance	31 (0.1)	24 (0.1)	20 (0.1)	32 (0.1)	38 (0.1)
ED or hospital	71 (0.3)	48 (0.2)	56 (0.2)	67 (0.2)	74 (0.3)
Emergency GP or dentist	355 (1.4)	281 (1.2)	339 (1.3)	424 (1.5)	528 (2.0)
Other GP or dentist	577 (2.3)	442 (1.9)	511 (2.0)	581 (2.1)	594 (2.2)
Other professional	2032 (8.1)	1627 (7.0)	1746 (6.9)	2116 (7.6)	2483 (9.2)
Self care	20905 (83.6)	19727 (85.2)	21560 (85.2)	23504 (84.3)	22182 (82.0)
Not assessed	1042 (4.20)	992 (4.3)	1088 (4.3)	1142 (4.1)	1149 (4.2)
Total	25013 (100)	23141 (100)	25320 (100)	27866 (100)	27048 (100)

a Chi squared (df = 24) = 847; p<0.001
b Chi squared (df = 24) = 214; p<0.001

Table7: Likelihood of advice calls advising 999 call rather than any other care

Variable	Block 1 Odds Ratio (95% confidence interval)***	Block 2 Odds Ratio (95% confidence interval)***	Block 3 Odds Ratio (95% confidence interval)***
Distance to ED (per mile)	1.006 (1.004 – 1.009)	1.006 (1.004 – 1.009)	1.006 (1.003 - 1.008)
Population density (people per hectare)	1.002 (1.001 – 1.004)	1.002 (1.001 - 1.004)	1.002 (1.001 - 1.003)**
Patient age (per year)	1.026 (1.026 – 1.027)	1.027 (1.026 - 1.027)	1.027 (1.026 - 1.027)
Gender			
Male	1.00	1.00	1.00
Female	0.873 (0.839 -0.908)	0.874 (0.840 - 0.909)	0.871 (0.837 - 0.906)
Relationship			
Surrogate caller	1.00	1.00	1.00
Self caller	0.418 (0.401-0.436)	0.414 (0.397 - 0.432)	0.420 (0.403 - 0.438)
Non-white race			
White or unknown	1.00	1.00	1.00
Non-white	1.123 (0.923 - 1.366)*	1.122 (0.922 - 1.364)*	1.13 (0.929 - 1.375)*
Known race			
Unknown	1.00	1.00	1.00
Known (white or other)	1.212 (1.166 - 1.260)	1.213 (1.166 - 1.260)	1.211 (1.165 - 1.259)
Symptom			
All other symptoms	1.00	1.00	1.00
Digestive symptom	0.307 (0.289 - 0.326)	0.305 (0.287 - 0.325)	0.305 (0.287 - 0.324)
Day of call			
Sunday	Not entered	1.00	1.00
Monday	Not entered	1.075 (1.004 - 1.150)**	1.076 (1.005 - 1.151)**
Tuesday	Not entered	1.058 (0.986 - 1.135)*	1.058 (0.986 - 1.135)*
Wednesday	Not entered	1.062 (0.991 - 1.138)*	1.063 (0.991- 1.139)*
Thursday	Not entered	1.136 (1.061 - 1.215)	1.126 (1.053 - 1.205)**
Friday	Not entered	1.054 (0.983 - 1.131)*	1.056 (0.984 - 1.133)*
Saturday	Not entered	0.903 (0.848 -0.962)**	0.902 (0.847 - 0.961)**
Deprivation fifth (ordinal)	Not entered	Not entered	1.127 (1.113 - 1.143)

*** $p<0.001$ unless otherwise indicated; ** $p < 0.05$, * $p>0.05$ (therefore non-significant)

Odds ratios are the odds of receiving advice to call 999 or otherwise seek emergency care relative to baseline in the logistic regression model comprising the variables: distance to ED, population density, patient age, female caller of unknown race about her own non-digestive symptoms on a Sunday, and deprivation fifth.

Table 8: Likelihood of advice calls advising care face to face rather than self-care

	Block 1	Block 2	Block 3
Variable	**Odds Ratio (95% confidence interval)*** **	**Odds Ratio (95% confidence interval)*** **	**Odds Ratio (95% confidence interval)*** **
Distance to ED (per mile)	0.990 (0.988 - 0.991)	0.990 (0.988 - 0.991)	0.990 (0.988 - 0.991)
Population density (people per hectare)	1.001 (1.001 - 1.002)**	1.001 (1.001 - 1.002)**	1.001 (1.001 - 1.002)**
Patient age (per year)	1.010 (1.010 – 1.011)	1.010 (1.009 - 1.011)	1.010 (1.009 – 1.011)
Gender			
Male	1.00	1.00	1.00
Female	1.128 (1.100 - 1.156)	1.126 (1.099 - 1.154)	1.125 (1.098 - 1.153)
Relationship			
Surrogate caller	1.00	1.00	1.00
Self caller	0.845 (0.821 - 0.869)	0.860 (0.836 - 0.885)	0.864 (0.840 - 0.890)
Non-white race			
White or unknown	1.00	1.00	1.00
Non-white	0.806 (0.718 - 0.905)	0.813 (0.725 - 0.913)	0.818 (0.729 - 0.918)
Known race			
Unknown	1.00	1.00	1.00
Known (white or other)	1.169 (1.141 - 1.198)	1.170 (1.142 - 1.199)	1.169 (1.140 - 1.197)
Symptom			
All other symptoms	1.00	1.00	1.00
Digestive symptom	0.627 (0.612 - 0.643)	0.632 (0.616 - 0.648)	0.631 (0.616 – 0.648)
Day of call			
Sunday	Not entered	1.00	1.00
Monday	Not entered	0.778 (0.745 - 0.812)	0.779 (0.746 - 0.813)
Tuesday	Not entered	0.779 (0.745 - 0.814)	0.778 (0.745 - 0.813)
Wednesday	Not entered	0.774 (0.740 - 0.809)	0.774 (0.740 - 0.809)
Thursday	Not entered	0.832 (0.796 - 0.870)	0.830 (0.794 - 0.867)
Friday	Not entered	0.740 (0.708 - 0.773)	0.740 (0.708 - 0.773)
Saturday	Not entered	0.844 (0.810 - 0.880)	0.844 (0.810 - 0.879)
Deprivation fifth (ordinal)	Not entered	Not entered	1.049 (1.041 - 1.058)

*** p<0.001 unless other wise indicated; ** p < 0.01.

Odds ratios are the odds of receiving advice to call 999 or otherwise seek emergency care relative to baseline in the logistic regression model comprising the variables: distance to ED, population density, patient age, female caller of unknown race about her own non-digestive symptoms on a Sunday, and deprivation fifth.

Table 9: Likelihood of information calls advising 999 call rather than any other care

	Block 1	Block 2	Block 3
Variable	**Odds Ratio (95% confidence interval)*** **	**Odds Ratio (95% confidence interval)*** **	**Odds Ratio (95% confidence interval)*** **
Distance to ED (per mile)	0.989 (0.970 - 1.009)*	0.991 (0.972 -1.010)*	0.991 (0.971 - 1.01)*
Population density (people per hectare)	1.003 (0.993 - 1.014)*	1.003 (0.992 - 1.014)*	1.003 (0.992 - 1.014)*
Patient age (per year)	1.013 (1.005 - 1.021)**	1.013 (1.005 - 1.021)**	1.013 (1.005 - 1.021)**
Gender			
Male	1.00	1.00	1.00
Female	1.036 (0.726 - 1.479)*	1.03 (0.721 - 1.470)*	1.029 (0.721 - 1.470)*
Relationship			
Surrogate caller	1.00	1.00	1.00
Self caller	0.431 (0.296 - 0.627)	0.458 (0.314 - 0.669)	0.460 (0.315 - 0.672)
Non-white race			
White or unknown	1.00	1.00	1.00
Non-white	0.888 (0.122 - 6.449)*	0.904 (0.124 - 6.566)*	0.906 (0.125 - 6.585)*
Known race			
Unknown	1.00	1.00	1.00
Known (white or other)	0.762 (0.542 - 1.070)*	0.766 (0.546 - 1.076)*	0.766 (0.545 - 1.076)*
Symptom			
All other symptoms	Not entered	Not entered	Not entered
Digestive symptom	Not entered	Not entered	Not entered
Day of call			
Sunday	Not entered	1.00	1.00
Monday	Not entered	0.734 (0.388 - 1.389)*	0.735 (0.388 - 1.390)*
Tuesday	Not entered	0.622 (0.316 - 1.224)*	0.623 (0.317 - 1.225)*
Wednesday	Not entered	0.912 (0.487 - 1.705)*	0.912 (0.488 - 1.706)*
Thursday	Not entered	0.591 (0.294 - 1.187)*	0.591 (0.294 - 1.188)*
Friday	Not entered	0.889 (0.470- 1.680)*	0.889 (0.470 -1.681)*
Saturday	Not entered	1.349 (0.724 - 2.513)*	1.349 (0.724 - 2.513)*
Deprivation fifth (ordinal)	Not entered	Not entered	1.024 (0.912- 1.149)*

*** p<0.001 unless other wise indicated; ** p < 0.05, * p>0.05 (therefore non-significant)

Odds ratios are the odds of receiving advice to call 999 or otherwise seek emergency care relative to baseline in the logistic regression model comprising the variables: distance to ED, population density, patient age, female caller of unknown race about her own non-digestive symptoms on a Sunday, and deprivation fifth.

Table 10: Likelihood of information calls advising care face to face rather than self-care

	Block 1	Block 2	Block 3
Variable	**Odds Ratio (95% confidence interval)*** **	**Odds Ratio (95% confidence interval)*** **	**Odds Ratio (95% confidence interval)*** **
Distance to ED (per mile)	0.986 (0.984 – 0.988)	0.988 (0.986 – 0.990)	0.988 (0.986 - 0.990)
Population density (people per hectare)	1.003 (1.002 – 1.005)	1.003 (1.002 – 1.004)	1.003 (1.002 – 1.004)
Patient age (per year)	1.001 (1.000 -1.002)**	1.001 (1.000 – 1.002)**	1.001 (0.973 - 1.049)**
Gender			
Male	1.00	1.00	1.00
Female	1.018 (0.980 – 1.057)*	1.011 (0.973 – 1.050)*	1.010 (0.973 – 1.049)*
Relationship			
Surrogate caller	1.00	1.00	1.00
Self caller	0.673 (0.644 – 0.704)	0.713 (0.682 – 0.746)	0.716 (0.685 - 0.749)
Non-white race			
White or unknown	1.00	1.00	1.00
Non-white	0.794 (0.655 – 0.963)**	0.811 (0.669 -0.983)**	0.815 (0.672 – 0.988)**
Known race			
Unknown	1.00	1.00	1.00
Known (white or other)	0.950 (0.917 – 0.983)**	0.955 (0.922 - 0.989)**	0.954 (0.921 – 0.988)**
Symptom			
All other symptoms	Not entered	Not entered	Not entered
Digestive symptom	Not entered	Not entered	Not entered
Day of call			
Sunday	Not entered	1.00	1.00
Monday	Not entered	0.598 (0.560 - 0.639)	0.599 (0.561 – 0.639)
Tuesday	Not entered	0.590 (0.551 - 0.630)	0.590 (0.552 – 0.631)
Wednesday	Not entered	0.625 (0.585 - 0.668)	0.625 (0.585 – 0.669)
Thursday	Not entered	0.669 (0.626 - 0.715)	0.670 (0.627 – 0.716)
Friday	Not entered	0.626 (0.585 - 0.670)	0.627 (0.585 – 0.670)
Saturday	Not entered	1.007 (0.941 - 1.078)*	1.007 (0.941 – 1.078)*
Deprivation fifth (ordinal)	Not entered	Not entered	1.034 (1.022 – 1.047)

*** p<0.001 unless other wise indicated; ** $p < 0.05$, * p>0.05 (therefore non-significant)

Odds ratios are the odds of receiving advice to call 999 or otherwise seek emergency care relative to baseline in the logistic regression model comprising the variables: distance to ED, population density, patient age, female caller of unknown race about her own non-digestive symptoms on a Sunday, and deprivation fifth.

Appendix 1: Summary of advice recodings

Original code included:	Recoded according to NHSDW algorithm	Recoded as hierarchy of care
"999"	999/ambulance	999/ambulance
"accident and emergency", "casualty"	ED	ED hospital
"administration only"	Administration only	Not assessed
"non-assessed", "not assessed", "triage refused"	Call unassessed as per policy	Not assessed
"caller not wishing to proceed"	Caller not wishing to proceed	Not assessed
"contact dentist ..routine appointment"	Contact dentist for routine appt	Dentist
"contact dentist..24 hours"	Contact dentist next working day	Dentist
"contact dentist ..12 hours"	contact dentist within 12 hours	Dentist
"contact dentist..urgently or within 1 hour"	Contact dentist within 1 hour	Emergency Dentist
"Contact dentist within 4 hours"	Contact dentist within 4 hours	Emergency Dentist
"Contact GP service within 36 hours"	Contact GP service within 36 hours	GP
"contact GP practice within 4hours"	Contact GP practice within 2 hours	Emergency GP
"contact GP practice within 12 hours"	Contact GP within 6 hours	GP
"practice nurse", "toxbase or local poisons centre", "community crisis line", "district nurses", "family planning clinic", "genitor-urinary medicine clinic", "health visitor", "community mental healthcare team", "midwife", "optician", "orthodontist", "emergency contraception"	Contact other healthcare professional	Other
"social worker"	Contact other professional	Other
"pharmacist"	Contact pharmacist	Other
"police"	Contact police now	Other
"walk in centre"	Contact walk in centre	Other
"direct admission"	Direct transmission to hospital	ED/hospital
"GP to ring"	GP to ring	Emergency GP
"dentist info given", "follow-up" "measles health scare info", "health alert-MMR", "help line numbers given", "info provided or given"	Health information provided	Self-care
"Home care"	Home care	Self-care
"advice nurse will call back notifications in X days/hours/minutes", "follow up cancelled", "go to specific algorithm", "health information referral", "left message notification in X hours/minutes, " line busy", "maximum 3 attempts", "message handling only", "no answer", "send to ..queue"	Not assessed	Not assessed
"appt with hospital", "home visit required", "no action required", "nurse to call poisons centre",	Other	Other

Original code included:	**Recoded according to NHSDW algorithm**	**Recoded as hierarchy of care**
"other", "PCC visit", "public health emergency"		
"contact GP in 48 hrs", "contact GP practice on Monday", "Routine appt with GP"	Routine appointment with GP	GP
"speak to doctor next working day or within 12 hours"	Speak to GP next working day	GP
"speak to doctor within 4 hours"	Speak to GP within 2 hours	Emergency GP
"speak to doctor within 1 hour (as soon as possible)"	Speak to GP within 1 hour	Emergency GP

Glossary

Term	Description
Algorithm	A decision tree that presents different options or prompts depending on answers to previous questions
Author	Julie Peconi, PhD student and writer of this thesis
Caller	The person who rings NHSDW. This may or may not be also the patient
Centriod	The geographical centre of a ward
Clinical decision support software (CDSS)	A software package that supports the user in assessing and advising patients
Demand	The willingness and/or ability to seek, use, and, in some settings pay for services, also known as *'expressed demand'*
Disposition	The final advice that the Nurse Advisor gives to the caller following a telephone assessment. In this study, the disposition is the outcome of the call
NHS Direct, NHS Direct Wales and NHS 24	The UK's national telephone health advice and information lines
NHS CAS	The computer decision support system (CDSS) used in NHS Direct
Outcome	The final advice given to the caller by the Nurse Advisor, also known here as the 'Disposition'
Patient	The person for whom the call to NHSDW concerns, may or may not be the same as the caller
Symptom	The complaint, issue or question that is recorded as a patient's reason for contact with NHSDW
Thiessen polygon	Polygons whose boundaries define the area that is closest to each point relative to all other points (as from http://www.ian-ko.com/ET_GeoWizards/UserGuide/thiessenPolygons.htm)
Unscheduled care	Any episode of care provided for the patient which is unplanned and may require prompt action in response to an acute, minor or major injury or illness

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