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MORe PREcISE: Longitudinal patient reported outcome measures in stroke at 3 and 6 months.

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ABSTRACT

Background and Purpose: Post-stroke morbidity is common, but little is known about the burden on patients' lives from their own perspective. Understanding morbidity from the point of view of the patient may support targeted intervention in post-stroke recovery. This study used a stroke specific Patient Reported Outcome Measure (PROM) containing Mental health (MH) and Physical Health (PH) domains and 5 stroke specific questions. We aimed to consider trends over a 6-month period and further assess the association between the MH and PH measures and common clinical measures.

Methods: A multicenter prospective cohort study was conducted at 19 hospital sites across England and Wales. Patients were enrolled from August 2018 to September 2019. Clinical measures and PROMs were assessed at three timepoints: acutely following the index stroke, at 3 and 6-months post-stroke. Clinical measures and PROMs were assessed in each of these points.

Results: Physical health PROM domains show significant gradual improvement across the study period (χ^2 42.6312, p<0.0001), whereas cognitive function domains (χ^2 3.7849, p<0.875) did not echo this trend. All clinical measures (GAD-7, PHQ9, MoCA, MRS) were associated with poorer PROM MH outcomes, (aMD -4.4, CI -0.59, -0.29, $p \leq 0.001$, aMD -0.45, CI -0.59, -0.32, $p = < 0.001$, aMD 0.75, CI 0.56, 0.95, aMD -1.91, CI -2.41, -1.47, $p \leq 0.001$). Clinical measures of disability, as per the MRS, are associated with poor PROM PH scores (aMD -0.57, 95% CI -0.94, -0.20, $p = 0.003$).

Conclusions: This research indicates there is unmet cognitive burden in stroke survivors. PROMs may be able to measure unmet more discretely than common clinical tools that are used post-stroke. Further research and guidance on how to integrate PROMs into current clinical frameworks is essential.

Introduction

Persistent morbidity is frequently observed following a stroke, affecting approximately 50% of survivors with prolonged disability.[1-3] The repercussions manifest in a combination of physical and psychological symptoms. The identification and attribution of these symptoms often emanate from the healthcare team and the broader system, sidelining the crucial perspective of the stroke survivor. This oversight can lead to an incomplete understanding of how the survivor perceives the profound impact of the stroke on their life.

To address this disparity, there has been a growing integration of patient-reported outcome measures (PROMs) in stroke care.[4-7] PROMs are designed to evaluate health status from the vantage point of the patient, prioritizing the subjective patient experience over that of the clinician or systematic perceptions. While widely used generic health rating scales like the Short Form 36 and EQ-5D offer convenience, they fall short in capturing the specific challenges confronted by stroke survivors. In response, stroke-specific rating scales, such as the Stroke Impact Scale, have been introduced to address this limitation.[4]

In a concerted effort to enhance the efficacy of PROMs in stroke care, a collaborative working group, comprising stroke survivors, the

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Abbreviations and Acronyms

CI	Confidence interval
CRF	Case Report Form
GAD-7	Generalized anxiety disorder 7
ICHOM	International Consortium Health Outcomes Measurement
mRS	Modified Rankin Score
PHQ9	Patient Health Questionnaire 9
PROM	Patient Reported Outcome Measure
PROMIS-10	Patient-Reported Outcomes Measurement Information System Global Health Short Form-10
QoL	Quality of Life
SF-MoCA	Short-Form Montreal Cognitive Assessment

International Consortium for Health Outcomes Measurement (ICHOM), and a diverse team of healthcare professionals, formulated a standardized set of 15 questions in 2016.[7] This set amalgamates 10 questions from the PROMIS-10, a patient reported outcome measure which allows components of both physical and mental health to be accessed from the patient perspective, with an additional five tailored specifically for stroke-related needs.

Following a stroke, comorbidities such as cognitive impairment, anxiety, and depression, are commonly seen.[3] These coexisting conditions significantly influence an individual's perception and assessment of the stroke's impact on their life. Moreover, many survivors contend with varying degrees of compromised physical function, which can be very severe. Addressing these multifaceted aspects is integral to comprehensive stroke care and consideration of long-term quality of life post-stroke.

To better understand the patient-reported morbidity experienced by stroke survivors and the influence of cognition, anxiety, depression, and physical function on these self-reported symptoms, the Morbidity Prevalence Estimate in Stroke (MORe PREcISE) study was conducted.[5,6] The study aimed to consider the longitudinal outcomes of patient reported outcome measures across a 6-month follow up period and consider the association to known predictors of stroke and validated clinical measures. In this vein, how PROMs dynamically change over time, and further how they interact with known measures, may support further understanding and thus integration of PROMs into clinical care.

Aims

The primary aim of this study was to assess the longitudinal trends across patient reported outcome measures, measured at 3 time points: baseline (within 14 days of index stroke), at 3 months and at 6 months after the event.

Further we aim to assess the association between the MH and PH patient reported measures following a stroke and pre-existing health conditions and commonly used clinical measures at 3- and 6-months post-stroke.

Methods

Study design

The full study protocol has previously been published.[5,6] In brief, this is a prospective cohort study enrolling stroke survivors between August 2018 and October 2019. Patients were recruited from 19 hospital sites with acute and hyper-acute facilities in England and Wales. Morbidity-related information was systematically collected at three distinct time intervals: baseline (within 14 day of index stroke event), 3 months post-stroke, and 6 months post-stroke. To ensure flexibility in data collection, a window of 14 days from the occurrence of the event was designated for the data-gathering process.

Inclusion criteria:

Participants eligible to be recruited for this study include those aged 18 years or over with a clinical diagnosis of stroke, within the previous 14 days; cerebral infarct (ICD I63); intracerebral hemorrhage (ICD I61); or stroke not specified as hemorrhagic or infarction (ICD I64) . Exclusion criteria include a diagnosis of transient ischemic attack (ICD G45), subarachnoid hemorrhage (ICD I60), or any condition defined under ICD G93 (eg, anoxic brain damage) . Patients receiving palliative care or are eligible for palliative care are also excluded from this study.

Ethical approval

Ethical approval was granted by the South Wales, NHS Research Ethics Committee (REC) [18/WA/0299]

Measures

Demographic, lifestyle, and clinical measures

In the initial baseline assessment, information including age, sex, stroke type (ischemic or hemorrhagic), pre-stroke smoking, alcohol consumption, and the level of care were collected. Clinical characteristics were also considered, encompassing past medical history such as hypertension, diabetes, transient ischemic attacks, and prior stroke. At the subsequent 3 and 6-month follow-up points, both lifestyle and clinical variables were re-collected.

Patient-Reported outcome measures

This study employed a Stroke-Specific Patient-Reported Outcome Measure administered at each time point (baseline, 3 months, and 6 months).[7,8] The instrument comprises 10 questions derived from the Patient-Reported Outcomes Measurement Information System Global Health Short Form-10 (PROMIS-10), encompassing two domains: physical health (PH) and mental health (MH). Scores from the Global Physical Health Score and the Global Mental Health score can be then standardized to the general population, using the "T-Score". Domain specific cut offs (normed against the US population) can be reported as poor, fair, good, very good and excellent in each domain; Global Mental as <29, 30-40, 41-48, 49-56, and >56 and Global Physical as <35, 36-42,43-50, 51-58 and >58 respectively.[4-8] Additionally, Salinas et al incorporated an additional 5 stroke-specific questions, relating to walking, feeding, toileting, feeding and communication, which are also reported here.

Montreal cognitive assessment (MoCA)

The Short Form Montreal Cognitive Assessment[9] (SF-MoCA) was administered at baseline. The SF-MoCA, a condensed 10-point version derived from the original 30-item Montreal Cognitive Assessment, encompasses three sections: clock drawing, abstraction, and 5-word recall. This tool serves as a potential indicator of post-stroke cognitive impairment, employing a threshold score of 7.

The Telephone Montreal Cognitive Assessment Short[9] (T-MoCA) was conducted at the 3 and 6-month intervals. Like the SF-MoCA, the T-MoCA acts as an indicator of post-stroke cognitive impairment, utilizing a cut off of 8 or below as an indicator for cognitive impairment.

Patient health questionnaire-9 (PHQ-9)

The PHQ-9, a patient health questionnaire assessing symptoms of depression was employed at all time points.[10] Its previous endorsement in stroke contexts stems from its brevity and robust psychometric properties.[11] The instrument is used in primary care as a screening tool for symptoms of depression, we utilised a cut of 10 or above as an indicator of moderate clinical depression.

Generalised anxiety disorder-7 (GAD-7)

The GAD-7 assessed symptoms of generalised anxiety and was administered at all time points.[12] The tool has been widely used within primary care as a screening tool for anxiety, we utilised a cut of 10 or above as an indicator of moderate clinical anxiety.

Modified rankin scale (mRS)

The mRS (Modified Rankin Scale) serves as a pivotal scoring tool for evaluating functional disability in stroke, systematically administered across all time points.[13] This scale is intricately designed using the Rankin Focussed Assessment (RFA), a questionnaire that facilitates a comprehensive evaluation of disability on a global scale following a stroke. Scores on the Modified Rankin scale range from 0 to 6, where 0 signifies the lowest level of disability (none) and 5 indicates the highest (6 being dead).[14,15]

Data analysis

All data analysis were undertaken in Stata version 18.0. Data were cleaned centrally to ensure reliability and completeness. The measures were scored using the validated methods. Missingness was considered as previously described.[6] In short, Item missingness (e.g. no more than >30%) within each measure (or domain) were pro-rata mean imputed. Participants with over 30% of missing items were defined as missing. Baseline demographic and clinical measures were presented to describe the included patient population.

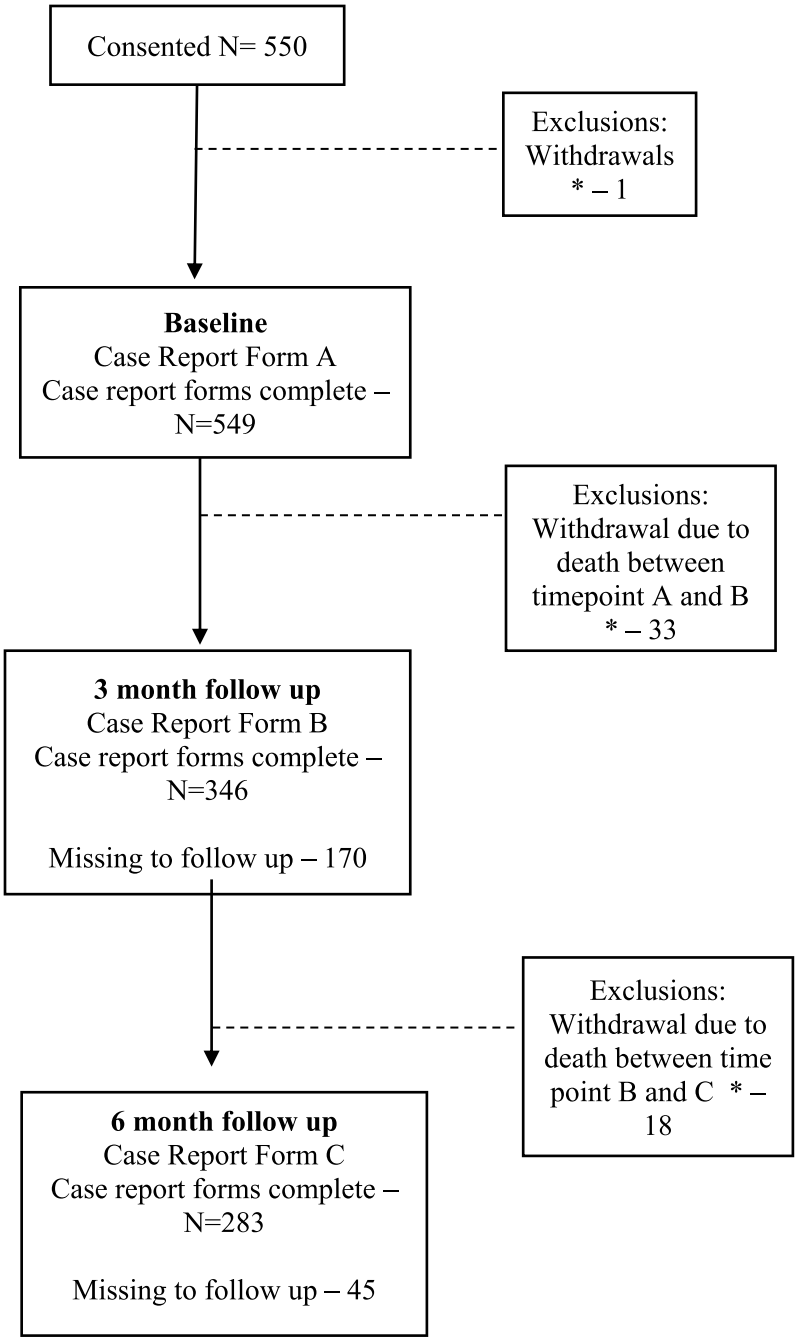

Diagram 1. Consort diagram demonstrating number of participants approached and consented (N=550), number of subjects that completed baseline collection (N=549), 3-month collection (N=346) and 6-month collection (N=283). Exclusions are defined as voluntary withdrawal or withdrawal due to death. Missing to follow up was defined as those who were not a known exclusion and failed to complete the subsequent case report form.

Outcomes

The co-primary outcomes were the Mental and Physical health domains. Secondary outcomes included the GAD-7; PHQ-9; mRS, SF-MoCA and the additional 5 stroke specific questions (walking, toileting, dressing, tube feeding and communication).

Covariates. The following were fitted to assess any association with the outcomes: pre-stroke hypertension, previous TIA, previous stroke, pre-stroke diabetes, pre-stroke atrial fibrillation, female sex, age, current living alone.

Statistical analysis

The association between exposures and outcomes were fitted using a crude and multivariable multilevel linear model, where participant was fitted as a random effect. This utilized PH and MH domain T-scores. The multivariable model was adjusted for: age and sex. Residuals were used to visually inspect the distributional assumptions from each linear model. The analysis presented the mean difference (MD) and adjusted mean difference (aMD) reported with associated 95% CI and p-values.

Results

Study population

From 19 hospitals 550 participants consented between August 2018 to September 2019, and one subject withdrew prior to completing the baseline visit assessments, leaving 549 (Diagram 1). Further withdrawals, primarily due to death, and loss to follow up left 346 at 3 months and 283 participants at 6 months. Follow up ended in March 2020 and was impacted by the COVID-19 pandemic, where several participants were lost to follow up. Demographic variables were evenly distributed across all three timepoints are described in Table 1.

Table 1
Demographic distribution of study participants reporting responses across baseline, 3 month and 6-month collection.

Demographic distribution of study participants						
	Baseline		3-month		6-month	
	N=549		**N=346**		**N=279**	
Gender						
Female	232	(42.3%)	146	(42.4%)	114	(40.9%)
Male	317	(57.7%)	198	(57.6%)	165	(59.1%)
Education level						
Primary school level	19	(3.5%)	8	(2.3%)	5	(1.8%)
Secondary school level	311	(56.7%)	199	(57.9%)	156	(55.9%)
College level or above	216	(39.3%)	136	(39.5%)	118	(42.3%)
Age						
< 75	269	(49.0%)	157	(45.5%)	128	(45.8%)
75 – 85	199	(36.3%)	133	(38.6%)	108	(38.7%)
> 85	81	(14.8%)	55	(15.9%)	43	(15.4%)
Stroke type						
Hemorrhage	58	(10.6%)	40	(11.6%)	40	(14.3%)
Infarct	489	(89.1 %)	304	(87.9%)	239	(85.7%)
Undefined[*]	2	(0.4%)	2	(0.6%)		
Alcohol consumption						
Non-drinker	182	(33.2%)	163	(47.7%)	84	(30.1%)
1 and 14 units per week	295	(53.7%)	160	(46.8 %)	158	(56.6%)
Over 14 units per week	71	(12.9%)	19	(5.6%)	37	(13.3%)
Smoking status						
Non-smoker	243	(44.3%)	172	(49.4%)	134	(48%)
Ex-smoker	232	(42.3%)	152	(43.9%)	127	(45.5%)
Smoker	73	(13.3%)	22	(6.6%)	18	(6.5%)
Level of home care						
No care	527	(95.9%)	271	(84.2%)	234	(83.9%)
Receives home care	14	(2.6%)	41	(11.9%)	34	(12.3%)
Residential/ Nursing Home	5	(0.9%)	10	(2.9%)	9	(3.2%)

[*] Undefined stroke type can be considered as a clinically diagnosed stroke which was not specified as haemorrhagic or infarction (ICD I64) as per the inclusion criteria.

Patient reported outcome measure – PROMIS 10

PROMIS-10 MH was scored as 'poor' at baseline for 20 (4.4%) of participants, and 12 (3.46%) and 6 (2.34%) in the 3-month and 6-month follow up, respectively (χ^2 3.7849, p<0.875 (Table 2). In the PROMIS-10 PH, physical health was reported as 'poor' for 202 (44.2%) of participants at baseline, compared to 108 (31.40%) and 68 (26.88%) in the 3-month and 6-month follow-up (χ^2 42.6312, p<0.0001) (Table 2).

Patient reported functional independence questions

There was a trend across the five functional questions encompassing feeding, walking, communication, dressing and toileting (Appendix 1). At baseline, 97 (18.8%) participants reported being unable to walk, 156 (30.2%) being able to walk with help and 236 (50.97%) being able to walk without help. This was seen to be 17 (6.3%), 22 (8.1%) and 233 (85.7%) respectively at 6 months (χ^2 101.20, p<0.0001). At baseline, 302 (58.5%) were independent of toileting, improving to 250 (91.9%) at 6 months (χ^2 150.45, p<0.0001). At baseline, 296 (57.4%) were independent of dressing, improving to 228(83.8%) at 6 months (χ^2 99.25, p<0.0001). Further, at baseline 30 (5.8%) participants required support with feeding via nasogastric tube, reducing to 7 (2.6%) at 6 months (χ^2 16.52, p<0.0001). At baseline, 91 (17.7%) reported communication problems, which remained much unchanged, with 45 (16.5%) at 6 months (χ^2 1.96, p<0.374) (Table 3).

Mental Health Domain

Multivariable analysis for MH was negatively associated with pre-existing diabetes (aMD-1.85, CI -3.51, -0.20, p=0.028) and negatively associated with previous stroke (aMD -2.55, CI -4.57, -0.52, p=0.013) and living alone (aMD -1.77, CI -3.18, -0.37, p=0.013). Multivariable analysis was associated with all clinical measures of morbidity. Worse mental health scores were associated with higher levels of anxiety, as measured by GAD-7 (aMD -0.44, CI -0.59, -0.29, $p\leq$0.001), higher levels depression as measured by PHQ-9 (aMD -0.45, CI -0.59, -0.32, p=<0.001), higher levels of cognitive impairment as measured by MoCA (aMD 0.75, CI 0.56, 0.95) and high levels of disability, as measured by Modified Rankin Scale (aMD -1.91, CI -2.41, -1.47, $p\leq$0.001). PROMs with worse outcomes were associated with measures such as poor walking (aMD -3.86, CI -5.34, -2.38, $p\leq$0.001), needing help to go to the toilet, (aMD -3.77, CI -5.15, -2.40, $p\leq$0.001) and needing help to dress (aMD -4.75, CI -3.40, -6.10, $p\leq$0.001).

In summary, worse mental health scores were associated with pre-stroke diabetes, previous stroke and living alone. Worse mental health scores were associated with all clinical health measures of morbidity and patient reported outcomes within the five functional independence questions.

Physical health domain

Multivariable analysis for PH were negatively associated with pre-existing atrial fibrillation (aMD -1.49, 95% CI -2.84, -0.13, p=0.03). Multivariable analysis was associated with clinical measures of disability measured with the Modified Rankin Scale, high levels of disability were associated with worse patient reported physical health scores (aMD -0.57, 95% CI -0.94, -0.20, p=0.003). Multivariate analysis was associated with worse patient reported outcomes associated to poor walking (aMD -2.80, 95% CI -3.94, -1.66, $p\leq$0.001), needing help to go to the toilet (aMD -1.09, 95% CI -2.20, -0.06, p=0.05) and needing help to dress (aMD -2.56, 95% CI -3.59, -1.52, $p\leq$0.001).

In summary, there were greater symptoms of poorer physical health associated with pre-existing atrial fibrillation, clinical measures of disability, the modified Rankin score and patient reported outcomes within the five additional functional questions.

Table 2
Trends across Mental and physical health domains of PROMIS 10 reporting responses across baseline, 3 month and 6-month collection.

Trends across Mental and physical health domains of PROMIS 10							
Mental health domain	*BaselineN=451*	*3 monthN=347*	*6monthsN=256*	***Physical health domain***	*Baseline N=456*	*3 monthN=344*	*6 monthN=253*
Poor	20 (4.4%)	12 (3.5%)	6 (2.3%)	***Poor***	202 (44.2%)	108 (31.4%)	68 (26.8%)
Fair	101 (22.4%)	72 (20.7%)	49 (19.1%)	***Fair***	122 (24.6%)	136 (39.5%)	87 (34.4%)
Good	141 (31.2%)	104 (29.9%)	82 (32.1%)	***Good***	120 (26.3%)	87 (25.3 %)	83 (32.8%)
Very good	149 (33.1%)	102 (29.4%)	70 (27.3%)	***Very good***	41 (8.9%)	12 (3.5%)	13 (5.1%)
Excellent	97 (21.5%)	57 (16.4%)	49 (19.1%)	***Excellent***	9 (1.9%)	1 (0.3%)	2 (0.8%)
X^2	3.78	P value	>0.874	X^2	43.63	P value	P<0.01

Table 3
Reported associations between PROMIS 10 outcomes, demographic measures, existing conditions and clinical outcome measures

	Mental health mean difference (or β for continuous predictors)				Physical health mean difference (or β for continuous predictors)			
Covariate	N	aMD	95% CI	P-value	N	aMD	95% CI	P-value
Gender (Female)	N=498	-0.62	-1.99, 0.82	0.41	N=502	-0.73	-1.68, 1.27	0.16
Alcohol (Over 14 units per week)	N=510	-1.36	-1.16, 1.46	0.22	N=514	0.75	-1.19, 0.77	0.67
Previously diagnosed AF	N=492	-1.71	-3.36, 0.21	0.81	N=497	-1.49	-2.84, -0.13	**0.03**
Previously diagnosed Diabetes	N=492	-1.85	-3.51, -0.20	**0.028**	N=497	-0.2	- 1.43, 0.86	0.62
Previously diagnosed stroke	N=497	-2.55	- 4.57, -0.52	**0.013**	N=501	-0.38	-1.82, 1.03	0.60
Previously diagnosed hypertension	N=495	0.19	-1.20, 1.58	0.78	N= 500	0.07	- 0.89, 1.03	0.85
Currently lives alone	N=507	-1.77	-3.18, -0.37	**0.013**	N=512	-0.18	-1.21, 0.83	0.71
Needs help to walk	N=472	-3.86	-5.34, -2.38	**<0.001**	N=470	-2.80	-3.94 -1.66	**<0.001**
Needs help to toilet	N=509	-3.77	-5.15, -2.40	**<0.001**	N=513	-1.09	-2.20, -0.06	**0.05**
Needs help to dress	N=513	-4.75	-3.40, -6.10	**<0.001**	N=513	-2.56	-3.59,-1.52	**<0.001**
Age	N=494	0.00	-0.05, 0.05	0.95	N=497	-0.02	-0.06, 0.02	0.26
MRS	N=493	-1.91	- 2.41, -1.47	**<0.001**	N=491	-0.57	-0.94, -0.20	**0.003**
GAD-7	N=294	-0.44	-0.59, -0.29	**<0.001**	N=485	-0.04	-0.16, 0.08	0.49
PHQ-9	N=284	-0.45	-0.59, -0.32	**<0.001**	N=307	-0.08	-0.19, 0.03	0.18
MoCA	N=501	0.75	0.56, 0.95	**<0.001**	N=507	0.11	-0.44, 0.26	0.12

Discussion

This is a multicenter prospective cohort study using patient reported outcomes measures of morbidity across six months. Broadly, these results demonstrate that the physical health domain improved over the six-month period, although self-reported mental health showed far less improvement.

We demonstrate associations between mental health outcomes and pre-existing conditions, such as diabetes and a history of stroke. Living alone emerged as a contributing factor to poorer mental health scores. Clinical measures of anxiety, depression, cognitive impairment, and disability significantly contributed to worse mental health scores. Pre-existing atrial fibrillation and clinical measures of disability were associated with poorer physical health outcomes.

The trends demonstrated are in keeping with current literature. Previous work in PROMs demonstrated unfavorable outcomes at 3-months post stroke[16] despite clinical improvement in clinical measures of depression and anxiety (such as the HADS depression and anxiety). Further, we suggest the observed changes in PROMIS-10 scores over time demonstrate the dynamic recovery process of stroke disease. While this would be expected in the short term time-span post-stroke, we suggest that PROMs may potentially serves as a predictor of morbidity based on its impact on the patient's quality of life rather than relying solely on external descriptors and variables.

It is interesting to consider the trends of both improvement and non-change across a 6-month time frame. There is an expected improvement in the physical health domain, likely to be explained by the natural recovery period post-stroke as stated. This is mirrored across most stroke specific questions, where there is improvement across walking, toileting, and dressing. Yet, the improvement seen in the cognitive domain is not statistically significant, giving rise to the question of whether there are ongoing unmet mental health needs in the stroke population. This is not entirely surprising. Mental health sequelae post-stroke, partially higher prevalence of depression and anxiety, are well documented,[17,18] yet there is notable improvement in the clinical scores, such as GAD-7 and PHQ-9 (Appendix 2) alone, indicating that clinical measures may not be sufficient to measure the mental morbidity burden post-stroke. While the drivers of mental health morbidity in the population is likely multi-factorial, we suggest that a disparity across the clinical measures and morbidity reported within the PROMs may be due to the ability to discern elements of morbidity that are not clinically accessed or deemed clinically significant. Prior work using PROMs in post-stroke supports the suggestion that they can add value compared just to clinical instruments alone.[19] Katzan et demonstrated that PROM tools such as the SIS-16 may have a better ability to identify change than mRS in health status of relevance to the patient, across a cohort of 3283 ischemic stroke patients.[20]

Moreover, our data showed little improvement in speech over the 6-month follow-up period. We suggest that poor communication may contribute to or drive poorer mental health outcomes. While this may be a symptom that is linked to stroke location or stroke severity and thus have a confounding effect, this suggestion is supported by recent research.[21] A recent rapid evidence review by Kristo et al.[22] suggests a high prevalence of aphasic stroke survivors experiencing depression, underpinning unsupported communication as a potential driver of poor mental health outcome. While it is difficult to delineate if this is due to communication alone, or confounded with stroke severity in general, targeting communication therapies early in stroke may indirectly support mental health outcome improvement in these patients. Given this it may allow insight into an area of unmet need, where it may be difficult to ascertain the true impact of ongoing disability on everyday life.

When considering associations to known risk factors to stroke, we demonstrate that some key risk factors are associated with potentially worse reported outcomes. The correlation between worse PROMs and pre-existing conditions like diabetes may be due to a poor functional baseline and the inability to cope with further disease burden.[23] While we are not able to comment on the impact of glucose control, diabetic management or known diabetic complications, we suggest this may be driven by worse baseline comorbidity placing patients at risk of more severe stroke, as well as likely poorer pre-stroke function. More so,

patient reported outcomes are associated with expected clinical measures: poor clinical mental health and physical burden logically correlate to worsened PROMs. While this trend is expected, it consolidates the usefulness of PROMs in reflecting the clinical picture and severity of disease burden. We suggest that the PROMS are not only likely to reflect clinical measures but also to add additional benefit by being able to capture components of unmet clinical needs that clinical measures alone are unable to discern. When looking at the information offered by both components, one can begin to understand the challenges faced by stroke survivors in addressing their mental and physical health and functional needs. Previous associations between clinical risk factors and PROMs have been poorly outlined, but this study supports the need to devise a risk stratification for those patients at risk of poor outcomes.

As a large multicenter study, our research offers a chronological assessment of post-stroke quality of life from the patient's perspective, using a standardized questionnaire that considers both physical and mental health in its overall score. The longitudinal design, spanning a 6-month follow-up period, enables a nuanced understanding of the evolving nature of mental and physical health post-stroke. Further, the PROMIS-10, employed in our study as a tool for gathering information on patients' self-reported mental and physical health, has demonstrated its feasibility as an instrument in stroke survivors. This instrument offers a straightforward means of capturing parameters that hold significance for patients and correlates with clinically important measures of morbidity.[24] This is supported by recent work where systematic reviews of interpretability of PROMIS measures in stroke patients suggests sufficient structural and construct validity and internal consistency in stroke patients.[25] More so, concerns regarding the ability to respond if there are communication or deficits have been addressed. Reimer et al investigated reliability of proxy reports on patient reported outcomes measures in stroke across a systematic review, highlighting proxy respondents are reliable sources for PROM reports on physical domains in ADLs, PROMs and QoL scales.[26] Beyond this, Gadea et al demonstrate a PROM mobile-app-based communication system is a reliable and valid strategy to assess the outcome in stroke, opening an avenue for this tool to be integrated in current care frame works in an easy and affordable way.[27] Thus, its simplicity and patient-centric approach make it a valuable and feasible tool for assessing the impact of stroke on individuals' lives.[20,28,29]

We acknowledge our study's limitations. Importantly, we recognize that a significant portion of patients were reported as missing from follow-up at the 3 and 6-month timepoints, coinciding with the onset of the COVID-19 pandemic. This external factor likely impacted the study's completion rates to a large extent due to decreased patient access, redirected resources and primary investigators s being redeployed. Other factors that may have influenced the completion rate have been considered such as questionnaire design, accessibility of follow up and patient screening. Given that the stroke population is often elder, frailer, and increasingly co-morbid consideration to appropriate use of virtual follow up was considered. It may be argued that those with more significant morbidity may be more difficult to capture as within follow up, thus the rates and impact of morbidity in this cohort may be underestimated.

In terms of stroke population, we attempted to utilize a population that was reflective of the current UK stroke population. However, we recognize some limitations of this. Previous strokes were considered as part of the past medical history via medical notes or a care team and then confirmed by the participant or participant's family or friends. 82 (14.99%) of participants, at study entry, were reported to have a previous stroke. Yet granular details of pre-stroke, including type, severity and time to next stroke event were not included . Premorbid status was considered. This was captured within lifestyle factors (such as pre-stroke level of care and function). However, it is a limitation that premorbid cognitive impairment can not be able be defined with granular detail as previous clinical measures of cognitive impairment or scales would have not been available for most cases and retrospective analysis of records were not conducted. More so, the rate of hemorrhagic stroke we reported is at the lower end of estimated prevalence, estimated in the UK at 10-20%. We reported 58 (10.6%) hemorrhagic strokes at study entry. We note that hemorrhagic strokes, and their severity, may influence degree of cognitive involvement. Two strokes were classified as 'undefined'. This refers to cases where the stroke was clinically diagnosed but not specified as either hemorrhagic or ischemic (ICD I64), in accordance with the inclusion criteria. Follow-up investigations or imaging to further characterize stroke type and severity were not included in the analysis. We believe this may have led to an underestimation of the effect, as individuals with more severe strokes and impairments might have been less likely to provide consent for the study, resulting in a lower-than-expected incidence in the population. It is important to note that we did not consider stroke location and the influence on morbidity. While we focused on overall patient reported morbidity in the stroke population, we acknowledge that stroke location has significant impact on the presentation, symptoms, and morbidity within stroke. Despite this, global consideration of the entire population of stroke survivors and consideration of PROMS that can be utilised across the entire population is needed.

In terms of design, our study outlines the immediate impact in the recovery phase of stroke up to 6 months, longer follow up may also add value allowing associations and trends in long term recovery to be elucidated. Further, as there were limited interventions carried out based on patient reported outcome measures, further consideration of appropriate strategies in clinical management should be considered. Significantly, we have not contemplated the magnitude of burden across mental health and physical health domains, but rather considered general trends and changes across a 6-month period. A way to further this line of thought would be to consider the significance of the stroke impact on the quality of day to day life and formulate appropriate stroke specific interventions to aid in this respect.

Nonetheless, the implications of our results for clinical practice are substantial. Identifying associations between mental and physical health outcomes and pre-existing conditions allows healthcare professionals to tailor interventions based on individual patient profiles. The integration of patient perspectives through stroke-specific PROMs enriches the understanding of the unique challenges faced by survivors, enabling more personalized and effective care. Integration of PROMs in stroke care is possible and feasible.[30–35] PROMS have been shown to be feasible within the stroke survivor population, so integration into current care structures is highly desirable, with additional consideration for the use of PROMs in those with a high morbidity burden. Also, PROMs can be used as a tool to facilitate shared decision-making between healthcare providers and stroke patients. By involving patients in the assessment of their own health outcomes, PROMs can empower patients to actively participate in treatment decisions and set realistic goals for rehabilitation.[36–39]

In future research, exploring the effectiveness of targeted interventions addressing specific pre-existing conditions and understanding the interplay between mental and physical health in influencing stroke recovery will be crucial for advancing stroke care and rehabilitation strategies

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Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

Ethical approval

Ethical approval was granted by the South Wales, NHS Research Ethics Committee (REC) [18/WA/0299].

Guarantor

JH.

Contributorship

JH conceived the study and received funding for the study. AP, AS, BC, and JH designed the study. AP was the study coordinator supported by AS. AC and BC developed the statistical analysis plan. Data analysis and interpretation was carried out by AC and BC. The first draft of the manuscript was done by AC, MAGV, BC and JH. All authors have drafted the final manuscript.

CRediT authorship contribution statement

Amber E Corrigan: Writing – review & editing, Writing – original draft, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Marie AG Verstraete:** Writing – review & editing. **Ben Carter:** Writing – review & editing, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Alexander Smith:** Writing – review & editing, Funding acquisition, Data curation. **Anna Pennington:** Methodology, Investigation, Data curation, Conceptualization. **Jonathan Hewitt:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

No conflicts of interest.

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2. Morriston Hospital
3. Princess of Wales NHS Trust
4. Prince Charles NHS Trust
5. University Hospital Wales
6. Bronglais NHS Trust
7. Glangwili NHS Trust
8. Withybush NHS Trust
9. Ysbyty Glan Clwyd
10. Southmead Hospital
11. Somerset Research Collaboration
12. Yeovil District Hospital
13. Gloucestershire Royal Hospital
14. Lewisham Hospital
15. Oxford NHS Trust
16. West Middlesex University Hospital
17. Kingston Hospital
18. Wolverhampton NHS Trust
19. North West Anglia NHS Trust

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jstrokecerebrovasdis.2024.108023.

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