

1 Detecting acute deterioration in older adults living in residential aged care: a scoping review.

2 **Abstract**

3 **Objectives**

4 To explore models, processes or tools implemented in residential aged care (RAC) to support
5 Registered Nurses (RNs) to identify and respond to the acute deterioration of people living in
6 RAC (residents).

7 **Design**

8 Scoping literature review of English Language articles published in peer reviewed journals

9 **Settings and participants**

10 Interventions include in this review were conducted in RAC facilities providing long term 24
11 hour medical, nursing and social care for people aged 65 or older with age related disability

12 **Methods**

13 We completed a MESH term and key word search of MEDLINE, Embase, CINAHL, PubMed
14 and Google Scholar. Included studies had (a) part of the intervention based in RAC (b) directly
15 impacted on RAC RN day to day practice and (c) contained or provided access to the intervention
16 to identify and / or respond to acute resident deterioration. Data charting included author, date,
17 country, study design and the components, development and efficacy of the models, processes
18 or tools to identify and respond to acute deterioration.

19 **Results**

20 We found 46 studies: 12 model of care evaluations, 17 studies detailing the clinical pattern of
21 acute resident deterioration and 17 deterioration detection tool studies. Model of care studies
22 did not evaluate individual model components. There was a consistent clinical pattern (signs &
23 symptoms) of illness presentation among residents experiencing acute deterioration.
24 Deterioration detection tools were either based on vital signs or health domains. There was some
25 evidence that supported the use of health domains tools. Tools were not aimed at RNs.

26 **Conclusion and implications**

27 We found no early warning systems (EWS) (to identify and response to acute resident
28 deterioration) designed for RN use in RAC. This is an important practice gap. It implies there
29 is a need to develop an EWS to support RNs with the distinct needs of the RAC population.

30

31 **Introduction**

32 Detecting acute deterioration in people living in Residential Aged Care (RAC) is an
33 important clinical skill; it enables nurses to access the right treatment, at the right time, in the
34 right place, for this frail and vulnerable population.¹⁻³ People living in RAC (residents) are
35 aged 65 or older and they have an age related disability that requires 24 hour medical, personal
36 and social care. As a cohort they have multiple morbidity, functional limitation and an
37 estimated 62% dementia.⁴ As a result moderate to severe frailty⁵ is common in this
38 population.^{6,7}

39 Frailty is a *clinically recognisable state of increased vulnerability*⁸ during which
40 individuals have difficulty maintaining homeostasis and relatively small stressors can result in
41 disproportionate clinical deterioration.⁹ The recognition of acute deterioration in residents can
42 be difficult as presentation of illness is often, subtle or atypical. Atypical presentations
43 include, non-specific symptoms, unusual symptoms of the underlying disease or an absence of
44 symptoms.^{10,11} Atypical presentations and frailty conspire to make people living in RAC care
45 one of the most clinically complex and vulnerable patient cohorts.¹²

46 Terminology and configuration of RAC varies across jurisdictions, however, generally
47 Registered Nurses (RNs) are the lead health professionals for the most frail and complex
48 residents. In the United States of America (USA) RNs lead skilled nursing facilities, in the
49 United Kingdom (UK) nursing homes are RN led while care homes are not and in Australia
50 (AU) all RAC is overseen by RNs.

51 In RAC (unlike acute care) there is no standard method of detecting acute deterioration.
52 Evidence suggests that RNs use a combination of clinical judgement,¹³ resident specific
53 knowledge,^{14,15} family request^{15,16} and organisational processes¹⁷ to support their decision
54 making when resident appear unwell. Interest is growing in the transferability of hospital

55 ‘Early Warning Scores’ (acute deterioration detection tools) to community settings, however
56 there are few examples of these in RAC.¹³

57 This review explored the literature related to the support of RAC RNs in their
58 endeavours to identify and respond to the acute deterioration of residents. Scoping reviews
59 support the exploration of literature because they maintain a systematic approach while being
60 inclusive of all research methods. A review protocol was developed and uploaded to the Open
61 Science Framework in March 2020 and updated 09/24/2021.¹⁸ No other completed reviews
62 examining the detection of deterioration in residents were found, however a similar review
63 protocol has been published.¹⁹ This review asked what models, systems, processes or tools
64 have been tested or implemented in RAC to support RNs to identify and respond to the acute
65 deterioration of residents. We also considered how they were developed, their components
66 and evidence of efficacy.

67

68 **Methods**

69 **Search strategy**

70 We searched MEDLINE Ovid (1946-present) Embase (1980-present), CINAHL Plus
71 (1937 to present), PubMed (1945-present) Google Scholar and hand searched the
72 bibliographies of selected articles and systematic reviews. A health sciences librarian was
73 consulted on search design. This resulted in a Medical Subject Headings (MeSH) search
74 supplemented by key word searching. The MEDLINE search strategy combined the RAC
75 population with three board areas, nursing assessment, admission avoidance and early warning
76 literature. Specifically MeSH terms (“skilled nursing facilities” “nursing homes” “homes for
77 the aged”) AND (“nursing assessment”, “quality improvement” “decision support systems,
78 clinical”, “clinical deterioration”, “health status indicators”, “monitoring physiologic”, “vital
79 signs”, “delirium”, “sepsis”, “emergency service hospital”, “emergency medical services”

80 “patient transfer”) and key words (“track and trigger”, “patient deteriorat*”, early warn* adj1
81 chart or scor* or scale or system or tool*). No date limits were specified. Studies were limited
82 to English language only. The most recent search was completed on 30th September 2021.

83

84 **Eligibility criteria**

85 Only primary research literature published in peer review journals was included. The
86 following definition of acute deterioration was used; “*a sudden, clinically important rapid*
87 *deviation from a patients’ baseline cognitive, behavioural, functional or physical domains*”
88 *where, clinically important, means a deviation that without intervention may result in*
89 *complications or death.”*²⁰ This definition was considered to include undifferentiated
90 disease, delirium, infection and sepsis. Single disease studies were excluded as older adults in
91 RAC often have multiple morbidity and the application of multiple single disease pathways
92 without consideration to frailty is likely to be harmful to the resident.²¹ It was assumed that
93 unplanned hospitalisations were the consequence of acute resident deterioration. Studies that
94 (a) had part of the intervention based in RAC with a (b) direct impact on RAC RN day to day
95 practice and (c) contained or provided access to the detail of the intervention used to identify
96 and / or respond to acute deterioration were eligible for inclusion. Methodological appraisal
97 was not applied as the aim was to explore rather than to assess the quality of available
98 literature.

99

100 **Study selection**

101 The primary author completed title and abstract screening against study criteria. These
102 were checked by the second reviewer to ensure consistency. Discrepancies were resolved by
103 discussion and consensus. The primary author completed retrieval of full text articles, these

104 were imported into 'Sciwheel' reference manager and graded for inclusion/exclusion the
105 second reviewer checked the assumptions and rationale.

106

107 **Data Extraction**

108 A data extraction tool was constructed and independently tested. The final data
109 extraction tool included author, date and country of publication detail, study design and
110 purpose, relevance to this review along with intervention development, key components and
111 available efficacy data. Data was extraction was independently checked (see Table 1).

112

113 **Data synthesis**

114 An iterative process was used to map the evidence into three research categories; (1)
115 models of care that aimed at a reducing the acute hospitalisation of residents, (2) descriptive
116 studies that presented the clinical pattern of acute resident deterioration (3) deterioration
117 detection tools designed to support clinical decision making.

118

119 **Results**

120 Due to the broad nature of the search 3776 studies were identified. Title and abstract
121 screening reduced this to 136 studies that were retrieved for full review, of which 46 met
122 eligibility criteria (see figure 1 PRISMA flow diagram). More than half of the studies (n=24)
123 were conducted in the USA, the remainder were from AU (n=8) the UK (n=6) Canada (n=6)
124 and Sweden (n=2). Eighty-five percent (n=39) of studies were published in the last 10 years.
125 Study methodologies included, observational (n=24), quality improvement (n=11) tool
126 development and validation (n=6) case controlled (n=2) and one each of a survey, focus group
127 study and randomised controlled trial (see table 1). Categorised by primary research focus, 12
128 studies evaluated models of care, 17 described typical clinical patterns of acute deterioration

129 and 17 focused on deterioration detection tools. Although studies were sorted into categories
130 there was some crossover, e.g., models of care often included tools and descriptions of resident
131 deterioration.

132

133 **Models of care**

134 Three models of care were found in the literature; Interventions to Reduce Act Care
135 Transfers (INTERACT),^{22–26} Early Detection of Deterioration in the Elderly (EDDIE)^{27,28} and
136 the Aged Care Emergency (ACE).^{29–32} All models were implemented in RAC facilities with a
137 RN workforce and were aimed at reducing hospitalisation by improving the identification and
138 response to the acute deterioration of residents. INTERACT^{22–26} was the most widely
139 researched model, developed in 2009, it has been implemented in hundreds of RAC facilities
140 ^{33,34} in the USA, it was also adapted for use in AU³⁵ and the UK.³⁶ ACE ^{29–32} was piloted 4
141 facilities in 2015 and then rolled out to include a further 81 RAC facilities. While EDDIE^{27,28}
142 is the most recent with a published pilot study only.²⁷

143 A panel of gerontology experts lead by Dr Joseph Ouslander (Geriatric Medicine)
144 developed the INTERACT model³³. EDDIE was also developed in collaboration with RAC.
145 Both models focused on the management of geriatric conditions. ACE^{29–32} was developed by
146 acute care clinicians and focused on conditions that precipitate Emergency Department
147 presentation.

148 Clinical condition guidelines and tools, education and additional staff^{fr22,25,26,29–32,35} were
149 the main components of the models (see table 1). All models attended to communication
150 pathways supporting RAC RNs to access care for unwell residents. INTERACT was the only
151 model with a tool prompting support workers (SWs) to report resident changes to the RN.

152 Model efficacy was measured by hospitalisation rate in all cases. Quality
153 improvement implementation studies produced large reductions in hospitalisation rate (50%²³,

154 30%³⁷, 20%³² 19%²⁷,16%³⁰,11%²⁶) while experimental research designs showed no impact on
155 resident hospitalisation rates.^{22,31,35,36}

156

157 **Typical clinical patterns of acute resident deterioration**

158 Sixteen studies³⁸⁻⁵⁴ described the clinical signs, symptoms and conditions observed in
159 residents during episodes of acute deterioration that resulted in hospitalisation. Due to the use
160 of the same data collection in a sub-set of six studies^{45,46,48,52-54} over 16,000 episodes of acute
161 deterioration were directly comparable (see table 2). Acute deterioration was associated with
162 two or more clinical signs in approximately two thirds (62%⁴⁶ & 69%⁴⁵) of residents while
163 40% of residents experienced three or more clinical changes.^{45,46} The most frequently reported
164 changes were altered mental status^{38,42,45,46,48,52-54} abnormal vital signs^{45,46,48} (blood pressure
165 (BP) or respiratory rate (RR)) functional decline,^{45,46} uncontrolled pain,^{46-48,52,54} breathing
166 difficulty,^{45,46,48,54} behavioural change,^{45,46,48,54} and a decreased food or fluid intake.^{45,46} One
167 further study⁴⁶ observed clinical changes in residents who were not hospitalised. This cohort
168 had a similar clinical pattern of deterioration albeit with a larger proportion of residents with
169 functional changes and a smaller proportion with abnormal vital signs compared to the
170 hospitalised group. Table X compares the clinical pattern of acute deterioration identified in
171 the research with the components of the general deterioration detection tools found in the
172 literature.

173

174 **Deterioration detection tools**

175 Of the 19 deterioration detection tools found, nine focused on general deterioration,^{28,29,34,35,55-}
176 ⁵⁹ three identified delirium,⁶⁰⁻⁶³ six sepsis^{64,65} and two infection.⁶⁶⁻⁶⁸ Four tools(EI Bestawi
177 and Kohm 2018; Barker et al. 2019; Huckfeldt et al. 2018; Ouslander 2019) included a
178 response to resident deterioration, of those three (Stop and Watch (S&W),²³ Practical Routine

179 Elder Variants Indicate Early Warning of Emergency Department (REVIEW-ED)⁵⁸ & National
180 Early Warning Score (NEWS)^{55,56,69}) prompted the SW to escalate care and the other (Change
181 in Condition File Card(CIC))²³ was aimed at RNs. Tool design relied either on vital signs or
182 changes in resident health domains to identify deterioration. The exception to that was CIC²³
183 that contained both vital signs and an A to Z of presenting signs and symptoms to identify
184 deterioration.

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Vital sign deterioration detection tools

188 Of the vital sign tools; five^{23,27,28,35,55,56,69,29} identified general deterioration, six
189 sepsis,^{64,65} and one fever.⁶⁶ Most of the general deterioration tools were implemented and
190 evaluated as a component of the a model of care (ACE,²⁹ EDDIE,²⁸ CIC from INTERACT²³ &
191 a CIC adaptation³⁵) NEWS was the only tool implemented as a single intervention.^{55,56,69} Most
192 (ACE,²⁹ EDDIE,²⁸ & NEWS^{55,56,69}) were adapted from hospital early warning scores and had
193 an urgency scales associated with vital sign ranges. Whereas CIC^{23,35} was either ‘triggered’ or
194 ‘not triggered.’

195 General deterioration tools measured RR,^{23,27–32,35,55,56,64,66,69} oxygen saturation
196 (SaO₂),^{23,27–32,55,56,64,66,69} systolic BP,^{23,27–32,35,55,56,64,66,69} heart rate,^{23,27–32,35,55,56,64,66,69} and
197 temperature.^{23,27–32,35,55,56,64,66,69} There was considerable variation between tool parameter
198 trigger points for example hypoxia triggered at SaO₂ <90%²³ and <95%,^{28,70} tachypnea at
199 >20^{55,56,69} and >29²³ breaths per minute (bpm) and tachycardia at >90⁵⁵ and >120^{29,30} beats
200 per minute (see figure 2 might be supplementary). A population study⁶⁹ provided evidence that
201 tachypnea >22 bpm and SaO₂ <92% were the most closely matched to resident mortality.

202 There was no individual efficacy data for EDDIE, ACE, or CIC due to being a
203 component of a model of care. One large study([Barker et al. 2019](#)) evaluated the use of digital
204 technology to implement NEWS in care homes in the UK. They found little correlation

205 between NEWS measurements and SWs sense of concern for resident welfare. When SWs
206 were concerned for residents 62% of scores were low risk (score 1-2) and 18% were high or
207 critical risk (score ≥ 5). However interviews(Stocker et al. 2021) revealed staff appreciated the
208 impact of NEWS on communication with acute care. A further NEWS(Hodgson et al. 2022)
209 study measured vital signs in response to a clinical trigger (e.g. a resident fall) and statistically
210 a link was found between hospitalisation and NEWS. In this study SWs relied on their
211 knowledge of the resident to identify deterioration and used NEWS to aid communication;
212 researchers concluded NEWS alone could not diagnose deterioration.

213 Standard acute care sepsis tools, analysed in a single retrospective study⁶⁴ lacked
214 efficacy in the RAC population, the most effective ('100-100-100') had a sensitivity of 28%,
215 13-72 hours before acute hospitalisation. Similarly three months of prospective screening in
216 RAC with the 'Systemic Inflammatory Response Syndrome'⁶⁵ tool found four cases of sepsis
217 (0.2%) from 2038 completed screens.

218

219 **Health domain deterioration detection tools**

220 Seven tools (4 general deterioration, 3 delirium & 1 infection) observed cognitive, behavioural
221 and functional changes in residents to identify deterioration. The general deterioration tools,
222 (Illness Warning Instrument⁵⁷ (IWI), Stop and Watch (S&W),²³ PREVIEW-ED⁵⁸ &
223 Significant Seven (S7)⁵⁹) were aimed at SWs. All of these tools were developed in RAC and
224 some efficacy evidence was reported

225 The IWI⁵⁷ tested in a small study (n=74) had a sensitivity of 53% and a positive
226 predictive value (PPV) of 17% for developing acute illness in the next seven days. A follow
227 up study⁴¹ found resident markers of disorientation (PPV 37%), reduced appetite (PPV 46%),
228 lethargy (PPV 51%) and weakness (PPV 50%) were most correlated with acute deterioration.

229 The pilot implementation of PREVIEW-ED⁵⁸ was associated with a 57% reduction in resident

230 hospitalisation in a limited number of targeted conditions. A secondary analysis³⁴ of
231 INTERACT data linked S&W use with a reduction in resident hospitalisation.

232 Only one of the three delirium tools, Recognising Acute Delirium As part of your
233 Routine (RADAR)⁶³ included geriatric expertise in its development, validity testing reported
234 sensitivity of 100% (CI 3-100%), specificity 44% (CI 0-22%) and application time of seven
235 seconds. This exceeded the reported ability of the Confusion Assessment Method⁶¹ to detected
236 the prodrome of delirium in RAC (10%) and was more efficient than the Delirium Observation
237 Screening Scale⁶⁰ that was estimated to require 3 hours of staff time each day in a 40 bedded
238 unit. ? infection

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240

241 **Discussion**

242 Models of care^{22-32,35,36} found were complex multimodal interventions whose efficacy
243 was measured with a single outcome, hospitalisation rate. It was not possible to determine
244 which model component had the greatest impact on RN decision making. Descriptive
245 studies^{45,46,48} highlighted the clinical pattern of acute resident deterioration and recognition of
246 this pattern has the potential to help RNs identify deterioration. A variety of vital sign and
247 health domain deterioration detection tools were found. The CIC reporting guideline was the
248 only tool to use vital signs and health domains to support RNs to identify and report resident
249 deterioration. When tools were compared with the clinical pattern of acute deterioration
250 observed in practice there was limited correlation (see table X). Overall, specific evidence of
251 tool efficacy with the RAC population was sparse and is an area for further study.

252 However, research efficacy data doesn't necessarily drive practice change. Models of
253 care identified in this study continue to be rolled out(Carter et al. 2021; Hullick et al. 2022)
254 implying there is an appetite for pragmatic approaches to supporting RN practice.

255 Pragmatically, the consistency of the clinical pattern of acute resident deterioration^{45,46,48}
256 provides evidence to argue for a frailty cohort approach. It is time to stop regarding frail older
257 adults as ‘atypical’^{10,11,71} members of the general population and start defining deterioration
258 that is “typical for frailty”.

259 A common understanding of acute deterioration in the frail older adult could provide
260 the foundation of a deterioration detection tool to support RNs in RAC, not only to identify
261 resident deterioration, but also, to initiate a response to that deterioration with a language that
262 is understood across clinical boundaries. The evidence from NEWS suggests that it is the
263 support with clinical communication rather than the aid to diagnoses that makes it most useful.

264 The key challenge with vital sign early warning tool (such as NEWS) is they rely on
265 regular monitoring. While this may be acceptable (or even the gold standard) in the hospital
266 setting it usually does not occur (nor is necessary) when the patient goes home. People living
267 in RAC are at home and while Baker et al⁵⁵ demonstrate regular vital sign measurement can be
268 done in RAC, there is no evidence that it should be done⁷². Questions such as the acceptability
269 of this practice to residents⁷³, the cost-benefit (from a staff resource perspective)⁷³ the impact
270 on resident outcomes⁷³ and even the specifics of normal/abnormal physiological ranges in frail
271 older adults are all areas for further study.

272 Health domain tools on the other hand place the work of regular monitoring onto staff
273 and maintain the home-like experience of the resident. The health domain tools found in this
274 study were aimed at SWs who spend the most time directly interacting with residents and
275 would be most likely to detect changes.

276 This leaves and an important clinical gap. Once concern about a deteriorating resident
277 is escalated to the RN there is no clear, quick, systematic, model, processes or tool that
278 supports the RN to; identify deterioration, determine the associated clinical risk and respond in
279 an manner relative to that risk. It is perhaps recognition of this gap that is driving interest in

280 the utility of tools such as NEWS in RAC. However research may be better focused on
281 developing a tool that is sensitive to the unique physiological state of frailty.

282

283 **Strength and Limitations**

284 This review excluded grey literature and non-English language publications so may have
285 missed some studies. As a scoping review, critical appraisal of research methodology was not
286 undertaken, however a broad collection of research has been included, which would not have
287 been achieved within a systematic review methodology. We were able to categorise
288 approaches to supporting RNs to identify the acute deterioration of residents and analyse the
289 available deterioration detection tools. Furthermore, it was possible to observe across articles
290 typical clinical patterns of acute deterioration in residents.

291

292 **Conclusion and implications**

293 This review found no well evidenced straight forward “go-to” model, system, process
294 or tool to support RNs in RAC to identify and respond to the acute deterioration of residents.
295 This is an important practice gap. The clinical pattern of the acute deterioration of residents is
296 well described and provides evidence for a cohort conceptualization of acute deterioration that
297 is ‘typical for frailty’. Furthermore this pattern could be the foundation for the development of
298 a tool to support RNs to identify and respond to acute resident deterioration.

299

300 **Conflicts of interest**

301 There are no known conflicts of interest

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Table 1: Research literature table: grouped by review category

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
Models of care:							
Arendts et al ³⁵ 2018 Australia	Cluster controlled evaluation	Evaluate Nurse Practitioner (NP) support in 6 RACFs over 12 months.	1. Model of care includes tools based on INTERACT to identify acute deterioration 2. Model includes deterioration detection tool to identify acute deterioration	Clinical guideline common geriatric presentations Communication pathways Acute deterioration trigger points - Respiratory rate >28 or <10 - Pulse >110 or <50 - SBP >210 or <90 or >20 mmHg reduction - Temperature (oral) >38.50C	RAC development Modified INTERACT See Ouslander 2009	Model: non-significant effect on resident hospitalisation rate Tool: no specific efficacy data	Underpowered study. Intervention and control group not matched
Carter et al ²⁷ 2020 Australia	Prospective pre-post cohort study	Implement a model of care: Early Detection of Deterioration in Elderly (EDDIE) to avoid resident hospitalisation in 1 RACF over 12 months	1. Model of care includes systems, process and tools to identify acute deterioration	See O'Neill et al 2017 (below)	Model: RAC development	Model: 19% decrease in annual hospitalisations	Single facility study
Conway et al ³⁰ 2015 Australia	Pre-post intervention study	To evaluate ACE model 4 pilot RACFs over 9 months	1. Model of care includes systems, process and tools to identify acute deterioration	Clinical guideline common emergency presentations and dedicated ED staff responding to RAC nurses (Age Care Emergency Manual) includes a deterioration detection tool Dedicated nurses in ED to receive calls and residents from RACF nurses Collaboration: meetings between teams caring for residents	Model: AC development	Model: 16% reduction Emergency Department (ED) presentations	No analysis of individual elements of model
Hullick et al ³¹ 2016 Australia	Pre-post intervention compared to control group	Evaluate ACE model of care in 4 RACFs over 9 months.	1. Model as Conway et al 2015 (above) 2. Clinical conditions responsible for acute deterioration (triage diagnosis)	Falls (20%) Respiratory illness (12%) Abdominal issue (12%) Cardiac problem (9%) Pain (7%)	Model: AC development	Model: no overall reduction in ED presentations	Assessed via hospital data no identifier in this system for living in RACF, potential missing data
Hullick et al ³² 2021 Australia	Step wedge cluster intervention trial	Evaluate model of care (ACE) in 81 RACFs over 39 months	1. Model as Conway et al 2015 (above) 2. Clinical conditions responsible for acute	Fall (24%) n=4348 Respiratory (10%) n=1905 Injury (6%) n=1099	Model: AC development	Model: residents were 20% less likely to be transferred to ED	Clusters not randomly allocated, initially targeted RACF

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
		(n=18,837 ED presentations)	deterioration (triage diagnosis)	Chest pain (4%) n= 773 Confusion / disorientation (4%) n=675 Fever (4%) n=676 Abdominal pain (4%) n=647 Collapse / syncope (3%) n=491			with high rates of ED transfer
Kane et al ²² 2017 USA	Randomised implementation study	Evaluate Interventions to Reduce Acute Care Transfers (INTERACT) model of care in 85 RACF over 12 months	1. Model of care includes systems, process and tools to identify acute deterioration	See Ouslander et al 2009 (below)	Model: RAC development	Model: non statistically significant reduction in hospitalisation	RACFs reported using INTERACT tools before study began
O'Neill et al ²⁸ 2017 Australia	Qualitative evaluation of pilot model of care implementation	Nursing view of subacute pilot model of care 15 months after implementation in 1 RACF	1. Model of care became known as EDDIE	Clinical guidelines and skills training on urinary tract infections, chest pain, falls, delirium, dehydration, dyspnoea, constipation, palliative care Communication tool Situation Background Recommendation and Response (SBAR) Medical equipment supply Policy and procedure to embed model	Model: RAC development	Nurse appreciated decision support tools and equipment. Positive reports on use of SBARR Collaboration with experts help staff feel supported	Single site study purposive sample
			2. Model includes deterioration detection tool to identify acute deterioration	Emergency trigger points - Respiratory rate >30 or <4 - Oxygen saturation <89% - Pulse >140 or <50 - SBP >200 mmHg or <80 mmHg - Temperature <35.0C >39.0C - Conscious to pain or no response	Modified AC tool: developed from "Between the Flags" New South Wales early warning tool	Tools: no specific efficacy data	
Ouslander et al ²³ 2009 USA	Quality improvement study	Pilot implementation of model of care: Interventions to Reduce Acute Care Transfer (INTERACT) in 3 RACFs over 6 months.	Model of care includes 1. Tool: Stop and Watch to identify acute deterioration	Seems different to usual Talks or communicates less Overall needs more help Participates less in activities Ate less, difficulty swallowing medication No bowel motion > 3 days or diarrhoea Drank less Weight change Agitated or more nervous than usual Tired, weak, confused, or drowsy Change in skin colour or conditions more Help walking, transferring, toileting	RAC development: designed by an expert panel process Focuses on identify and responding to acute deterioration avoid the need for acute transfer (original tools have developed to version 4.5)	Model: 50% reduction in hospitalisation following introduction of model. Tools: no specific efficacy data	Convenience sample of RACF selected for inclusion in pilot study Preliminary study no control or comparison group
			2. Tool: "Change in Condition" file care when to report to	Trigger points - Systolic BP >200 mmHg or < 90 mmHg - Diastolic BP > 115 mmHg			

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
			physician includes vital signs and clinical condition triggers to identify acute deterioration	<ul style="list-style-type: none"> – Resting pulse > 100 or < 50 – Respiration >28 or < 10 – Oral temperature > 101.5°F (38.6°C) – Oxygen saturation < 90% 			
			3. Care paths: clinical guidelines for key conditions	Acute change in mental status, Change in behaviour, Dehydration, Fever, Gastrointestinal symptoms, Shortness of breath, Congestive heart failure, Lower respiratory track illness, Urinary tract infection, Fall			
			4. Quality improvement tool: Review of Acute Care Transfer	Tool to analyse hospital transfers, includes collecting clinical data			
			5. SBAR (Situation Background Assessment Recommendation) communication tool and progress note	Pre-formatted tool supports assessment of residents and clinical communication for escalation of care by nurses to physician/nurse practitioner			
			6. Advance care planning tools	Communication tools, comfort care plan, Resuscitation guidance, Guidance on sepsis and infection			
Ouslander et al ²⁴ 2011 USA	Quality improvement study	Implement INTERACT II in 25 RACFs over 6 months	1. Model of care includes systems, process and tools to identify acute deterioration	See Ouslander et al 2009 (above)	Model: RAC development	Model: 17% reduction in hospitalisation Tools: no specific efficacy data	Hospitalisation rates based on self reports Participating RACF had higher than average admission rate before intervention
Rantz et al ²⁵ 2017 USA	Quality improvement study	Implement and evaluate model of care INTERACT in 16 RACFs over 4 years	1. Model of care includes systems, process and tools to identify acute deterioration	See Ouslander et al 2009 (above)	Model: RAC development	Model: 30% reduction hospitalisation Tools: no specific efficacy data	Targeted RACF willing to participate had base line high admission rates No comparison group
Sampson et al ³⁶ 2020	Cluster randomised	Implement Better health in residents of care	1. Model of care includes systems, process and	Modified INTERACT: See Ouslander et al 2009 (above)	See Ouslander et al 2009 (above)	Model: none of the 14 RACFs implemented the model.	Limited data collected due to

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
UK	implementation study	homes with nursing model in 14 RACFs over 10 months	tools to identify acute deterioration			And modification process RAC based interviews and co-design workshops	lack of implementation
Tena-Nelson et al ²⁶ 2012 USA	Quality improvement study	Implement INTERACT model of care in 30 RACFs over 12 months	1. Model of care includes systems, process and tools to identify acute deterioration	See Ouslander et al 2009 (above)	Model: RAC development	Model: 11% reduction in hospitalisation. Tools: no specific efficacy data	No comparison groups Self-reported hospitalization data Missing data 12 of 30 RACF were excluded from evaluation
Descriptive studies: clinical patterns of the acute deterioration of residents							
Alessi and Harker ³⁸ 1998 USA	Prospective cohort	Describe 184 episodes of acute resident deterioration in 1 RACF over 3 years (n=140)	1. Clinical sign of acute deterioration 2. Clinical conditions responsible for acute deterioration 3. Risk factors of acute deterioration 4. Predictors of acute deterioration.	Fever $\geq 100^{\circ}\text{F}$ (26%) Urinary or faecal change (15%) Mental status change (11%) Respiratory status change (11%) Skin breakdown (10%) Infection (68%) - Pneumonia (n=37) - Complicated urinary tract infection (n=30) - Wound infection(n=9) - Other infection (n=1) Acute cardiac illness (6%) Gastrointestinal bleeding (6%) Drug toxicity (4%) Exacerbation chronic lung disease (3%) Skin ulcers OR 4.9 (95% CI 1.3-18.4) Mobility dependence OR 2.3 (95% CI 1.2-4.7) Anaemia OR 6.0 (95% CI 1.6-22.1) Faecal incontinence OR 4.9 (95% CI 1.3-18.4) Anaemia OR 6.1 (95% CI 1.5-21.4) Mobility dependence OR 2.6 (95% CI 1.2-5.7)	RAC study: acute illness defined as “ <i>a change in the individuals health associated with specific signs and symptoms of recent onset</i> ”	Not applicable	98% of participants were male, not reflective of usual RACF population
Ashcraft and Owen ³⁹ 2014 USA	Survey	Identify signs and symptoms of deterioration indicating need for hospital transfer (n=109)	1. Clinical signs of acute deterioration with importance ranked by RNs	1. Change in level of consciousness 2. Chest pressure or tightness 3. Shortness of breath 4. Decreased oxygenation 5. Muscle or bone pain	AC developed study: close question survey	Not applicable	Survey contained only physical signs of deterioration

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations	
Boockvar and Lachs ⁴⁰ 2002 USA	Prospective observational study	Describe acute deterioration in 65 subjects 1 RACF over 5 months (n=204)	1.	Clinical conditions responsible for acute deterioration and hospitalisation	Lower respiratory infection (26%) n=20 Urinary tract infection (21%) n=16 Congestive heart failure (14%) n=11 Dehydration (10%) n=8 Gastroenteritis (8%) n=6 Cardiac ischaemia (3%) n=2 Upper respiratory infection (3%) n=2	RAC study: data collected during routine clinical rounds	Not applicable	Conducted in 1 RACF with onsite doctor and NP able to provide intravenous antibiotics – reducing likelihood of hospitalisation
Boockvar and Lachs ⁴¹ 2003 USA	Prospective observational study	Examine the relationship between clinical signs and acute deterioration in 1 RACF over 9 months (n=202)	1.	Predictive value of clinical signs for acute deterioration	¹ Lethargy PPV 51% ¹ Weakness PPV 50% ¹ Appetite decreased PPV 46% ¹ Agitation and PPV 37% ¹ Disorientation PPV 31% ¹ Dizziness PPV 27% ¹ Falls PPV 23% Delusions PPV 21% Depressed mood PPV 17% Weight loss PPV 17% Aggression PPV 13% Any of the above PPV 24% ¹ statistical association with acute deterioration in multivariate logistic regression analysis	RAC study: signs of deterioration predetermined, and evidence of symptoms obtained from nursing records	Overall PPV of any clinical sign listed 24% Overall NPV any non-specific symptom 91%	Relied on nursing notes for observation of signs of deterioration
Boockvar et al ⁴² 2013 USA	Prospective observational study	Describe incidence, risk factors and relationship of acute illness and delirium during 232 episodes of acute deterioration in 3 RACF over 12 months (n=136)	1. 2. 3.	Clinical signs of acute deterioration Clinical conditions responsible for acute deterioration Correlation delirium with acute deterioration	Activities of daily living decline (32.6%) Cognitive decline (28.6%) Falling (8.6%) Urinary tract infection (20%) Cellulitis (15%) Lower respiratory tract infection (9%) Congestive heart failure (3%) Chronic Obstructive Pulmonary Disease (3%) Dehydration (2%) Sepsis (2%) Delirium occurred in 18% (n=41) of acute events Median time from onset of acute illness to delirium was 3 days Falls (27%) n=171	Secondary analysis of data from parent study. Clinical pattern observation	Not applicable	Selected participants receiving regular opioid antidepressants or antipsychotics 65% of participants were male, not reflective of usual RACF population
Cummings et al ⁴³ 2020 Canada	Prospective descriptive study	Describe resident transfers from 25 RACFs to hospital over 12 months (n=637)	1.	Clinical signs of acute deterioration.	Sudden change in condition (24%) n=150 Shortness of breath (20%) n=126 Nausea/vomiting/diarrhoea (7%) n=45 General malaise or weakness (6%) n=35	AC developed data collection tool: Transition Tracking Tool (TTT)	Not applicable	Missing data about transitions First time TTT has been used

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
				Cough with congestion (5%) n=32 Constipation/abdominal pain (5%) n=30			
Kuehn and Sendelweck ⁴⁴ 1995 USA	Retrospective data analysis study	Corelate falls and acute illness by medical record review in 1 RACF over 12 months (n=121)	1. Support for falling as a clinical sign of acute deterioration	Significant correlation between falls and acute deterioration. 19% residents with concurrent illness had a fall compared to 7% of those without concurrent illness	RAC developed study: data collection tool developed by authors	Not applicable	Single RACF study. 30 day time frame for occurrence fall and acute deterioration fall days
Ouslander et al ⁷⁴ 2016 USA	Root cause analysis study	Analyse resident hospitalisations from 64 RACFs over 12 months (n=5011)*	1. Risk factors for acute deterioration resulting in hospitalisation (long stay residents)	Multiple comorbidities (51%) n=1173 Polypharmacy (21%) n=1000 CHF (19%) n=410 COPD (15%) n=348 Dementia (8%) n=251 Fracture (7%) n=149 End stage renal disease (4%) n=81 Cancer (3%) n=78 Surgical complications (3%) n=79	RAC developed study: episodes reviewed using Review of Acute Care Transfers tool	Not applicable	
Ouslander et al ⁴⁵ 2016 USA	Root cause analysis study	Analyse resident hospitalisations from 64 RACFs over 12 months (n=4856)*.	1. Clinical signs of acute deterioration	Abnormal vital signs (33%) n=1622 Altered mental status (28%) n=1356 Short of breath (23%) n=1132 Uncontrolled pain (19%) n=901 Low pulse oximetry (16%) n=792 Functional decline (16%) n=759 Behavioural symptoms (15%) n=733 Fever (12%) n=587 Decreased food and fluid intake (12%) n=567 Unresponsive (10%) n=498 Skin wound or ulcer (8%) n=407 Fall (8%) n=392 Bleeding (8%) n=380 Nausea/vomiting (7%) n=345 Urinary incontinence (3%) n=164	RAC developed study: episodes reviewed using Review of Acute Care Transfers tool	Not applicable	RACF volunteered to participate more likely to be motivated to participate
Ouslander et al ⁴⁶ 2018 USA	Root cause analysis study	Describe episodes of acute deterioration managed in 133 RACFs over 12	1. Clinical signs of acute deterioration in RACF	Functional decline (28%) n=2154 Altered mental status (27%) n=2094 Pain new or uncontrolled (24%) n=1844 Behaviour change (21%) n=1599 Decreased food or fluid (15%) n=1164 Abnormal BP or RR (14%) n=1086	RAC developed study: episodes reviewed with Change in condition (CIC) without Transfer tool. Note: tool collects same data as	OR for transfer to acute care -Change in mental status 2.1 (CI 1.4-2.5) -Unresponsive 3.8 (CI 2.7-5.4)	Convenience sample of RACF motivate to participate

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
		months (n=7689)*		Cough n=1057 (14%) Shortness of breath (13%) n=986 Skin or wound change (12%) n=886 Urinary symptoms (9%) n=708 Fever (9%) n=702 Nausea/vomiting (7%) n=565 Falls (6%) n=471 Low pulse oximetry (6%) n=423 Bleeding (3%) n=201 Diarrhoea n=235 (3%) Hyperglycaemia (1%) n=111	Review of Acute Care Transfer	-Shortness of breath 2.2 (CI 1.9-2.7) -Abnormal vital signs 2.2 (CI 1.9-2.6) -Bleeding 2.1 (CI 1.5-3.0) -New or worse confusion 2.0 (CI 1.6-2.4)	Not a random sample of change in condition tools
Popejoy et al ⁴⁸ 2019 USA	Descriptive study	Analyse resident hospitalisations from 16 RACFs over 32.5 months (n=3946)	1. Clinical signs of acute deterioration 2. Risk factors associated with deterioration	Functional change and new confusion Abnormal BP or RR and functional changes Behaviour changes and new confusion New SOB and functional change Abnormal vital signs (26%) n=1041 (26%) Pain (19%) n=745 Breathing difficulty (19%) n=747 Confusion worsening cognition (19%) n= 741 Falls (13%) n=532 Behaviour symptoms (13%) n=492 Fever (10%) n=378 Bleeding (9%) n=342 Nausea/vomiting (8%) n=325 Cough (5%) n= 206 Urinary symptoms/incontinence (4%) n=149 Polypharmacy (76%) n=2992 Multiple morbidity (61%) n=2395 Dementia (40%) n=1592 CHF (28%) n=1113 COPD (22%) n=852 Fracture (5%) n=194	RAC developed study: episodes reviewed using Review of Acute Care Transfers tool	Not applicable	Full time advanced practice nurses in RACF limits generalisability
Reid et al ⁴⁹ 2013 Canada	Pilot tool to collect descriptive data	Develop and pilot Older Persons Transition in Care (OPTIC) Transition Tracking tool in 2 RACFs and 2 EDs over 3 months (n=54)	1. Clinical signs of acute deterioration	Falls (31%) n=21 Change in physical condition (15%) n=10 Nausea/vomiting/diarrhoea (12%) n=8 Change in mental status (7%) n=5 SOB (4%) n=3 Chest pain (4%) n= 3	AC developed: Transition Tracking tool electronic data collection tool works across services	Not applicable	Small sample size

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
Sluggett et al ⁵⁰ 2020 Australia	Root cause analysis	Describe 49 incidents of infection related hospitalisations from 6 RACFs over 12 months (n=41)	1. Clinical signs of acute deterioration related to infection 2. Type of infection resulting in transfer to hospital	New or worsening pain (35%) n=17 Feeling unwell (31%) n=15 Malaise, lethargy, drowsiness, or refusal to get out of bed (27%) n=13 Nausea or vomiting (27%) n=13 Decreased oral intake (20%) n=10 Functional decline (18%) n=9 New or increased abdominal pain or diarrhoea (17%) n=8 Altered mental status or behaviour change (14%) n=7 Fall (14%) n=7 Fever, chills, rigour (14%) n=7 Respiratory (59%) n=29 Urinary (59%) n=29 Pneumonia (25%) n=12 Exacerbation COPD (10%) n=5 Skin (6%) n=8	RAC developed: tool informed by Review of acute care transfers	Not applicable	Retrospective data from small sample limits generalisability
Unroe et al ⁵¹ 2015 USA	Descriptive study	Describe resident hospitalisations from 19 RACFs over 12 months n=910	1. Risk factors associated with hospitalisation	Hospitalised in last 6 months (45%) n=412 CHF (29%) n=267 Dementia and behaviour issue (29%) n=261 COPD (26%) n=234 New medication or dose change in last 48 hours (14%) n=126	RAC developed modified Review of Acute Care Transfers	Not applicable	
Unroe et al ⁵² 2018 USA	Descriptive study	Describe resident hospitalisations using from 19 RACFs over 20 months (n=1174)	1. Risk factors associated with hospitalisation 2. Clinical conditions resulting in hospitalisation	Dementia (54%) n=1035 Diabetes Mellitus (28%) n=535 Falls (27%) n=518 COPD or asthma (26%) n=510 Dementia related behaviours (25%) n=490 CHF (24%) n=457 Hospitalised in the last 30 days (23%) n=434 History of recurring UTI (16%) n=304 Cognitive, behavioural, psychiatric (31%) n=600 Fall, trauma, fracture, (17%) n=349 Cardiovascular (17%) n=320 Respiratory (16%) n=312 Pain (11%) n=218 Infection (10%) n=199 (10%) Gastrointestinal (9%) n=168	RAC developed modified Review of Acute Care Transfers	Not applicable	Diagnoses are based on RN review of discharge summaries Data loss for residents who died in hospital
Unroe et al ⁵³ 2020 USA	Descriptive study	Review of 867 hospitalisations using from 19 RACFs to	1. Clinical conditions resulting in hospitalisation	Cognitive/behavioural/psychiatric (22%) n=190 Fall/fracture/trauma (19%) n=162 Respiratory (11%) n=91 Cardiovascular (10%) n=82	RAC developed: modified Review of Acute Care Transfers	Not applicable	Sample from RACF actively engaged in improvement

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
		hospital over 17 months (n=867)		Pneumonia (10%) n=65			process may not be generalisable
Vogelsmeier et al ⁵⁴ 2019 USA	Descriptive study	Described hospitalisations using from 16 RACFs over 20 months (n=650)	1. Clinical signs of acute deterioration 2. Clinical conditions resulting in hospitalisation	Acute change in mental status (24%) n=156 Fall (18%) n=115 Pain (14%) n=95 High/low body temperature (12%) n=80 Cellulitis or wound (4%) n=24 Urinary tract infection (3%) n= 22 Respiratory infection (3%) n=20	RAC developed Review of Acute Care Transfers	Not applicable	
Deterioration detection tools; also see Arendts et al 2018, O'Neill et al 2017, Ouslander et al 2009 (above)							
Barker et al ⁵⁵ 2019 UK	Descriptive analysis of tool use	Review the use of the National Early Warning Score (NEWS) by HCAs in 46 RACF over 30 months (n=2424). Use repeated 19,604	1. Tool: vital signs to identify acute deterioration 2. Correlation of NEWS urgency scores with HCA concern (n=2256) and without HCA concern (n=6277) for resident welfare	Critical risk trigger points (graduated scale) - Respiration rate ≥ 25 or ≤ 8 - Oxygen saturation $\leq 91\%$ - Pulse ≥ 131 or ≤ 40 - SBP ≥ 220 or ≤ 90 mmHg - Temperature $\geq 39.1^{\circ}\text{C}$ or $\leq 35^{\circ}\text{C}$ - Any change in level of consciousness or confusion	Modified AC tool: developed from UK National Early Warning Score (NEWS)	HCA concerned for resident 62% low NEWS (0-2) 21% intermediate NEWS (3-4) 11% high NEWS (5-6) 6% critical NEWS (9-13) HCA not concerned for resident 75% low NEWS (0-2) 18% intermediate NEWS (3-4) 5% high NEWS (5-6) 2% critical NEWS (9-13)	Missing data 11071 measurements not categorised No resident outcome data No firm conclusion could be drawn on whether NEWS triggered the most appropriate response
Boockvar et al ⁵⁷ 2000 USA	Tool development and validation study	Develop and validate the: Illness Warning Instrument in 1 RACF over 4 weeks (n=74)	1. Tool: Clinical signs to identify acute deterioration.	Resident weak Said hello or smiled at you as usual Nervous or agitated Self-reported complaint Reduced the amount of eating	RAC developed; focus groups identified signs of deterioration, 12 items, tested for 28 days and reduced to a 5-item tool.	Sensitivity 53% Specificity 93% PPV 17% NPV 96%.	Based on 19 acute events.
Conway et al ²⁹ 2015 Australia	Case study description	Implement Aged Care Emergency (ACE) model of care to identify and respond to	1. Model of care includes vital signs tool to identify acute deterioration	Danger trigger points (graduated scale) - Respiratory rate >30 and <5 - Oxygen saturation $<90\%$ despite oxygen - Respiratory effort obvious distress and cyanosis - Pulse >140 or <40	Modified AC tool: developed from "Between the Flags" New South Wales early warning tool	Not applicable case study only	Case study only

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
		acute deterioration.		<ul style="list-style-type: none"> - SBP >200 or <90 mmHg - Temperature >38.50C - Conscious to pain or no response or sudden change to mental status - Pain obviously distressed - Blood glucose less than 4 mmol/L and unresponsive to oral glucose or > 28 mmol/L 			
Elbestawi and Kohm ⁵⁸ 2018 Canada	Design and pilot test a tool to identify acute deterioration	To develop and pilot Practical Routine Elder Variants Indicate Early Warning of Emergency Department (PREVIEW-ED) tool in 5 RACFs over 13 weeks.	1.	Tool: Clinical signs to identify and respond to acute deterioration.	Mental status Food and fluid intake Family/resident concern Mobility Level of consciousness Respiratory problem Change in Activities of Daily Living Urinary system problem Skin breakdown	RAC developed; chart review and focus group identified signs of deterioration. Signs weighted to trigger escalation to RN Reduced hospitalisation reported in 2 pilot sites by 57% and 71% respectively Tool use takes 10 to 15 seconds per resident	Pilot study short duration. No comparison group. Measured reduction in target conditions only (pneumonia, UTI, dehydration, CHF)
Hodgson et al(Hodgson et al. 2022) 2022 UK	Mixed methods analyse of NEWS in care	Evaluate NEWS in 4 RACFs over 8 months with 276 residents	1.	Efficacy of NEWS	See Barker et al (2019)	Modified AC tool: developed from UK National Early Warning Score (NEWS)	Link between NEWS and hospital admission (p=0.000). Could not be used alone as a diagnostic tool
Huckfeldt et al ³⁴ 2018 USA	Secondary analysis of Randomised Controlled Trial	Understand the relationship between model of care implementation and acute hospitalisation rate in 264 RACFs over 12 months	3.	Indication of effectiveness of two INTERACT tools (Stop and Watch & SBAR communication tool)	Reviewed tool use in groups: Group 1: Low to moderate tool use Group 2: Increased tool use Group 3: Consistent moderate to high tool use	See Ouslander 2019	High tool use was associated with greater reduction in all-cause hospitalisations and potentially avoidable hospitalisations Missing data due to RACF dropping out of study Self-reported tool implementation rates
Little et al ⁵⁹ 2019 UK	Quality improvement study	Implement an author developed tool "Significant 7" to identify deterioration in 1 RACF over 4 months (n=22)	1.	Tool: Clinical signs to identify acute deterioration.	Confusion Mood Pain Hydration Skin Breathing Toilet or bowel habits	Not described	No effectiveness data related to tool Tested in on unit of 22 residents No acute deterioration data available
Porter et al ⁶⁵ 2021 USA	Quality improvement study	Implement daily sepsis screening for all residents in 1 RACF for 3	1.	Use of tool: Systemic inflammatory response syndrome (SIRS) to	SIRS 2 or more of Temperature >380C or < 360C Heart rate >90 Respiratory rate >20	RAC implementation of AC developed tool:	2038 screening episodes occurred identifying 4 cases of sepsis Volume of screening to identify cases high resource

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
		months, 2038 screens	identify sepsis in RACF	PaCO ₂ <32 mmHg WBC >2,000 or <4000 cells / microlitre			demand or limited outcome
Sloane et al ⁶⁶ 2014 USA	Retrospective data analysis study	Establish temperature norms for RACF population, data from 12 RACFs over 3 months (n=1007)	1. Temperature range norms for RACF population 2. Fever definition for individual resident	Non-illness' 97.2 ⁰ F to 98.2 ⁰ F (36.2 ⁰ C to 36.7 ⁰ C) Fever at 2 standard deviations from mean >98.7 ⁰ F (37.1 ⁰ C) Fever at 3 standard deviations above mean >99.2 ⁰ F (37.3 ⁰ C) >1.0 ⁰ F above usual temperature fever likely >1.5 ⁰ F above usual temperature fever very likely	RAC study of temperature	Not applicable	Method temperature measurement not recorded Sample limited to those treated with antibiotic Single measurement in one day
Sloane et al ⁶⁴ 2018 USA	Retrospective data analysis study	Analyse the efficacy of standard sepsis tools in the RACF population via review of medical records from 31 RACFs over 18 months n=236	1. The relevance of standard sepsis tools in the RACF population	SIRS – see porter et al (above) Quick Sepsis related Organ Failure Assessment (qSOFA) infection and 2 or more of – Respiratory rate >22 – Altered level of consciousness – Systolic BP < 100 mmHg 100-100-100: 2 or more of – Temperature > 1000F – Heart rate >100 bpm – Systolic BP < 100 mmHg Measured temperature ≥99 ⁰ F (37.2 ⁰ C) Measured temperature ≥100.2 ⁰ F (37.9 ⁰ C)	Study of AC developed tools using RAC data	SIRS sensitivity 13-72 hours before hospitalisation 10% and 36% ≤ 12 hours before. qSOFA sensitivity 13-72 hours before hospitalisation 7% and 27% ≤ 12 hours before 100-100-100 sensitivity 13-72 hours before hospitalisation 28% and 79% ≤ 12 hours before. ≥99.0 ⁰ F sensitivity at 13-72 hours before hospitalisation 22% and at ≤ 12 hours before 51% ≥100.2 ⁰ F sensitivity at 13-72 hours before hospitalisation 9% and at 12 hours before 40%	Data assessed was discharge summaries in RACF, so data gaps, 20% residents not returned to RACF so no data, missing parameters to measure qSOFA
Stocker et al ⁵⁶ 2021 UK	Semi structured interviews	Interviews 10 RACF staff & senior national health service staff (n=17)	1. Explore experience of using NEWS in RACF during the COVID -19 pandemic	See Barker et al 2019 (above)	RAC acceptability of AC developed tool	Shared clinical language of NEWS was valued and resulted in better response from acute care. RACF staff felt empowered	Under representation of non-senior HCAs Unable to interview general practitioner

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations	
Stow et al ⁶⁹ 2021 UK	Ecological time series data study	Correlate scores from the NEWS with death in 460 RACFs over 3 months (n=6464)	1.	Correlation between vital signs and death in RACF population	See Barker et al 2019 (above)	AC developed tool	High respiratory rates (≥ 22) and low oxygen saturation ($\leq 92\%$) most closely follow pattern of population all-cause mortality in RACF Two-week time lag between change in temperature ($\geq 36.9^{\circ}\text{C}$), respiratory rate (≥ 22) oxygenation ($\leq 92\%$) and death	Method means data correlation could be erroneous
Teale et al ⁶⁰ UK 2018	Prospective observational study	Test a delirium screening tool: Delirium Observation Screening Scale (DOSS) in 9 RACFs over 16 months, produced, 30,201 screening events (n=216)	1.	Tool: Delirium Observation Screening Scale (DOSS) to identify delirium: 25 questions in 8 categories	<ol style="list-style-type: none"> 1. Consciousness 2. Attention/concentration 3. Thinking 4. Memory/orientation 5. Psychomotor activity 6. Sleep/wake cycle 7. Mood 8. Perception 	AC development	71 episodes of delirium Sensitivity 61% (CI 39-80%) Specificity 7% (CI 70-73%) PPV 1.6%, NPV 99.5%. Resource implication would take 3 hours of staff time per day in a 40 bed RACF	Expected 58,900 completed screens (got 51%) and 36% of screening tools were fully completed
Tingström et al ⁶⁸ 2010 Sweden	Focus group study	Explore HCA observation of signs and symptoms of acute deterioration related due to infection (n=21)	2.	Clinical signs of acute deterioration related to infection	<p>Category; "not usual self"</p> <ul style="list-style-type: none"> - Discomfort - Unrestrained behaviour - Aggressive - Restless - Confused - Tired and feeble - Decreased eating <p>Category: "seems to be ill":</p> <ul style="list-style-type: none"> - General signs of illness - Pain - Specific signs and symptoms of infection 	RAC development	Not applicable	Translation from Swedish to English may have lost meaning
Tingström et al ⁶⁷ 2015 Sweden	Prospective tool testing study	Valid tool: Early Detection Infection Scale (EDIS) in 6 RACFs over 12 months (n=204)	1.	Tool: EDIS identify acute deterioration related to infection. Designed for HCA use (binary scale)	<p>Confusion</p> <p>Aggression</p> <p>Infirmity /apathy</p> <p>Unrestrained behaviour</p> <p>Changed appetite</p> <p>Pain</p> <p>Expression of illness in the eyes</p> <p>General signs and symptom of illness</p> <p>Urinary tract symptoms</p> <p>Respiratory symptoms</p>	RAC development: used research above Tingström et al 2010 to develop tool	Signs with a strong correlation with infection were <ul style="list-style-type: none"> - General signs and symptoms of illness - Respiratory symptoms - Temperature $37.8^{\circ}\text{C} \pm 0.9^{\circ}\text{C}$ 	No gold standard to measure infection presence Missing data 44% of EDIS form completed when HCA suspected infection

Primary author	Study design	Research purpose	Evidence provided	Key components (of interest to this study)	Development	Efficacy	Limitations
				Symptoms of wound infection Elevated temperature			
Voyer et al ⁶¹ 2012 Canada	Case control tool testing	Prospective weekly delirium assessments of residents in 7 RACFs over 6 months (n=279)	1. The usefulness of tool: Confusion Assessment Method (CAM) in identifying prodrome of delirium (weekly screening).	CAM positive 1 and 2 plus 3 or 4 1. Acute onset and fluctuating confusion 2. Inattention 3. Disorganised thinking 4. Altered level of consciousness	Acute care screening tool tested in RAC	Those with 3 symptoms (8% of residents) OR of delirium 2.52 (CI 1.08-5.87) 90% of time residents with perceptual symptoms did not develop delirium	No immediate clinical implications Screen occurred only once a week
Voyer et al ⁶² 2012 Canada	Prospective observational study	Determine accuracy of RNs identification of delirium during routine care in 7 RACFs over 6 months (n=202)	1. Nurses can identify delirium during routine daily care	Assessed against CAM criteria	Acute care screening tool ed in RAC	Routine observation sensitivity 51%, specificity 89%, PPV 35% NPV 95%	May have missed cases of delirium due to fluctuation of symptoms
Voyer et al ⁶³ 2015 Canada	Tool validation study	Test tool: Recognising Acute Delirium As part of your Routine (RADAR) in 3 hospital and 5 RACFs units over 12 months (total residents n=51)	1. Tool: identify <i>delirium</i>	RADAR positive if yes to 1 of following questions: when you gave the resident his/her medication: 1. Was the resident drowsy? 2. Did the resident have trouble following instructions? 3. Were the resident's movements slowed down?	AC and RAC developed tool: focus group and refinement process	Repeated tool use (3-4 times) per resident Sensitivity 100% (CI 3-100), Specificity 44% (28-60), PPV 4 % (CI 0-22%) NPV 100% (CI 81-100%) Takes 7 seconds to use	Small number residents in study Only applied when resident taking medication

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* dataset from Kane et al²² 2017. CI= 95% confidence interval. PPV: positive predictive value. NPV: negative predictive value. OR odds ratio. LR likelihood ratio. RACF residential aged care facility. HCA health care assistant. RN Registered Nurse. NP Nurse Practitioner. AC: Acute Care. RAC: Residential Aged Care

545 Table 2: Typical patterns of acute deterioration in residents

Study	Ouslander et al ⁴⁶	Ouslander et al ⁴⁵	†Popejoy et al ⁴⁸	Vogelsmeier et al ⁵⁴	Unroe et al ⁵²	Unroe et al ⁵³
Root Cause Analysis Tool*	Change in Condition Without Transfer	Review of Acute Care Transfer	Review of Acute Care Transfer	Review of Acute Care Transfer	Review of Acute Care Transfer	Review of Acute Care Transfer
Total episodes†	7689 (%)	4856 (%)	3964 (%)	650 (%)	1174 (%)	867 (%)
Signs of acute deterioration						
Altered mental status	2094 (27)	1356 (28)	741 (19)	156 (24)	600 (31)	190 (22)
Functional decline	2154 (28)	759 (16)				
Reduced food and/or fluid intake	1164 (15)	567 (12)				
Behaviour symptoms or change	1599 (21)	733 (15)	492 (13)			
New or uncontrolled pain	1844 (24)	901 (19)	745 (19)	95 (15)	218 (11)	
Breathing difficulty	986 (13)	1132 (23)	747 (19)		312 (16)	91 (11)
Cough	1057 (14)					
Skin or wound changes	886 (12)					
New urinary	708 (9)	164 (3)	(3) (4)	22 (3)		
Nausea or vomiting	565 (7)	345 (7)	325 (8)			
Fall	471 (6)	392 (8)	532 (14)	115 (18)	314 (17)	162 (19)
Unresponsive		498 (10)	300 (8)			
Abnormal BP or respiratory rate	1086 (14)	1622 (33)	1041 (26)			
Pulse oximetry low	423 (5)	792 (16)	837 (21)			
Fever	702 (9)	587 (12)	378 (10)			

* Acute Change in Condition and Review of Acute Care Transfer tools collect same data points. †Each episode may have more than one sign of deterioration