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

Introduction

Detecting acute deterioration in people living in Residential Aged Care (RAC) is an important clinical skill; it enables nurses to access the right treatment, at the right time, in the right place, for this frail and vulnerable population.[1–3] People living in RAC (residents) are aged 65 or older and they have an age related disability that requires 24 hour medical, personal and social care. As a cohort they have multiple morbidity, functional limitation and an estimated 62% dementia.[4]. As a result moderate to severe frailty[5] is common in this population.[6,7]

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

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

In RAC (unlike acute care) there is no standard method of detecting acute deterioration. Evidence suggests that RNs use a combination of clinical judgement,[13] resident specific knowledge,[14,15] family request[15,16] and organisational processes[17] to support their decision 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 AU[35] 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 model[33]. 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[22,25,26,29–32,35] 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 studies<mark>[38–54]</mark> 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 study[46] 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(ElBestawi

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 CIC[23]

183 that contained both vital signs and an A to Z of presenting signs and symptoms to identify

184 deterioration.

185
186
187 **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 INTERACT[23] &

191 a CIC adaptation[35]) NEWS was the only tool implemented as a single intervetion.[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 'tiggered' or

194 'not triggered.'

195   General deterioration tools measured RR,[23,27–32,35,55,56,64,66,69] oxygen saturation

196 (SaO$_2$),[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 SaO$_2$ <90%[23] and <95%,[28,70] tachypnea at

199 >20[55,56,69] and >29[23] breaths per minute (bpm) and tachycardia at >90[55] and >120[29,30] beats

200 per minute (see figure 2 might be supplmentary). A population study [69] provided evidence that

201 tachypnea >22 bpm and SaO$_2$ <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 study[64] 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 Instrument[57] (IWI), Stop and Watch (S&W),[23] PREVIEW-ED[58] &

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 IWI[57] 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 study[41] 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-ED[58] was associated with a 57% reduction in resident

230   hospitalisation in a limited number of targeted conditions. A secondary analysis[34] 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 Method[61] to detected

236   the prodrome of delirium in RAC (10%) and was more efficient that the Delirium Observation

237   Screening Scale[60] that was estimated to require 3 hours of staff time each day in a 40 bedded

238   unit. ? infection

239

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 sparce 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 al[55] demonstrate regular vital sign measurement can be

268 done in RAC, there is no evidence that it should be done[72]. Questions such as the acceptability

269 of this practice to residents[73], the cost-benefit (from a staff resource perspective)[73] the impact

270 on resident outcomes[73] 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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305   References

306

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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:

Primary author	Study design	Research purpose	Evidence provided		Key components (of interest to this study)	Development	Efficacy	Limitations
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	Clinical guideline common geriatric presentations Communication pathways	RAC development Modified INTERACT See Ouslander 2009	Model: non-significant effect on resident hospitalisation rate	Underpowered study. Intervention and control group not matched
			2.	Model includes deterioration detection tool to identify acute deterioration	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		Tool: no specific efficacy data	
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 0'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)		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
			2.	Clinical conditions responsible for acute deterioration (triage diagnosis)	Falls (20%) Respiratory illness (12%) Abdominal issue (12%) Cardiac problem (9%) Pain (7%)			
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)		Model: AC development	Model: residents were 20% less likely to be transferred to ED	Clusters not randomly allocated, initially targeted RACF
			2.	Clinical conditions responsible for acute	Fall (24%) n=4348 Respiratory (10%) n=1905 Injury (6%) n=1099			

				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 <350C >390C - 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 physician includes vital signs and clinical condition triggers to	Trigger points – Systolic BP >200 mmHg or < 90 mmHg – Diastolic BP > 115 mmHg – Resting pulse > 100 or < 50 – Respiration >28 or < 10 – Oral temperature > 101.5°F (38.6°C)			

Study	Study type	Intervention	#	Component	Description	Model/Process		Results	Limitations
				identify acute deterioration	– 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 UK	Cluster randomised implementation study	Implement Better health in residents of care homes with nursing model in 14 RACFs over 10 months	1.	Model of care includes systems, process and tools to identify acute deterioration	Modified INTERACT: See Ouslander et al 2009 (above)	See Ouslander et al 2009 (above) And modification process RAC based interviews and co-design workshops		Model: none of the 14 RACFs implemented the model. Tools: no specific efficacy data	Limited data collected due to 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	Fever ≥100^{0}F (26%) Urinary or faecal change (15%) Mental status change (11%) Respiratory status change (11%) Skin breakdown (10%)	RAC study: acute illness defined as "*a change in the individuals health associated with specific signs and symptoms of recent onset*"	Not applicable	98% of participants were male, not reflective of usual RACF population
			2.	Clinical conditions responsible for acute deterioration	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%)			
			3.	Risk factors of acute deterioration	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)			
			4.	Predictors of acute deterioration.	Anaemia OR 6.1 (95% CI 1.5-21.4) Mobility dependence OR 2.6 (95% CI 1.2-5.7)			
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
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% 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. Clinical signs of acute deterioration 2. Clinical conditions responsible for acute deterioration 3. 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	Secondary analysis of data from parent study. Clinical pattern observation	Not appliable	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.	Falls (27%) n=171 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 Cough with congestion (5%) n=32 Constipation/abdominal pain (5%) n=30	AC developed data collection tool: Transition Tracking Tool (TTT)	Not applicable	Missing data about transitions First time TTT has been used
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

Study	Design	Aim		Objective	Results	Method	Statistics	Limitations
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 appliable	
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 appliable	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 months (n=7689)*	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 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	RAC developed study: episodes reviewed with Change in condition (CIC) without Transfer tool. Note: tool collects same data as Review of Acute Care Transfer	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) –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)	Convenience sample of RACF motivate to participate Not a random sample of change in condition tools
			2.	Clinical signs of acute deterioration most commonly occurring together	Functional change and new confusion Abnormal BP or RR and functional changes Behaviour changes and new confusion New SOB and functional change			

Study	Study type	Aim	#	Objective	Findings	Tool developed		Limitations
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	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	RAC developed study: episodes reviewed using Review of Acute Care Transfers tool	Not applicable	Full time advanced practice nurses in RACF limits generalisability
			2.	Risk factors associated with deterioration	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			
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
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	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	RAC developed: tool informed by Review of acute care transfers	Not applicable	Retrospective data from small sample limits generalisability
			2.	Type of infection resulting in transfer to hospital	Respiratory (59%) n=29 Urinary (59%) n=29 Pneumonia (25%) n=12 Exacerbation COPD (10%) n=5 Skin (6%) n=8			

Study	Design	Aim/Sample	#	Focus	Findings	Tool	Validation	Limitations
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	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	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
			2.	Clinical conditions resulting in hospitalisation	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			
Unroe et al[53] 2020 USA	Descriptive study	Review of 867 hospitalisations using from 19 RACFs to hospital over 17 months (n=867)	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 Pneumonia (10%) n=65	RAC developed: modified Review of Acute Care Transfers	Not applicable	Sample from RACF actively engaged in improvement 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. 2.	Clinical signs of acute deterioration 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 te 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).	1.	Tool: vital signs to identify acute deterioration	Critical risk trigger points (graduated scale) - Respiration rate $\geq$25 or $\leq$ 8 - Oxygen saturation $\leq$ 91% - Pulse $\geq$131 or $\leq$40 - SBP $\geq$220 or $\leq$90 mmHg - Temperature $\geq$39.1^{0}C or $\leq$35^{0}C - Any change in level of consciousness or confusion	Modified AC tool: developed from UK National Early Warning Score (NEWS)		Missing data 11071 measurements not categorised No resident outcome data No firm conclusion could

							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)	be drawn on whether NEWS triggered the most appropriate response
		Use repeated 19,604	2.	Correlation of NEWS urgency scores with HCA concern (n=2256) and without HCA concern (n=6277) for resident welfare				
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 acute deterioration.	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 - 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	Modified AC tool: developed from "Between the Flags" New South Wales early warning tool	Not applicable case study only	Case study only
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	

Study	Design	Aim	#	Focus	Tool/Criteria	Comparison	Effectiveness	Limitations
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 months, 2038 screens	1.	Use of tool: Systemic inflammatory response syndrome (SIRS) to identify sepsis in RACF	SIRS 2 or more of Temperature >380C or < 360C Heart rate >90 Respiratory rate >20 PaCO2 <32 mmHg WBC >2,000 or <4000 cells / microlitre	RAC implementation of AC developed tool:	2038 screening episodes occurred identifying 4 cases of sepsis	Volume of screening to identify cases high resource 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. 2.	Temperature range norms for RACF population Fever definition for individual resident	Non-illness' 97.2^0F to 98.2^0F (36.2^0C to 36.7^0C) Fever at 2 standard deviations from mean >98.7^0F (37.1^0C) Fever at 3 standard deviations above mean >99.2^0F (37.3^0C) >1.0^0F above usual temperature fever likely >1.5^0F 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	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	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	Data assessed was discharge summaries in RACF, so data gaps, 20% residents not returned to RACF so no data, missing

		over 18 months n=236		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)			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%	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
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 (≤92%) most closely follow pattern of population all-cause mortality in RACF Two-week time lag between change in temperature (≥36.9^{0}C), respiratory rate (≥22) oxygenation (≤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	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% (CI70-73%) 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 deteriorate	2.	Clinical signs of acute deterioration related to infection	Category; "not usual self" – Discomfort – Unrestrained behaviour – Aggressive – Restless	RAC development	Not applicable	Translation from Swedish to English may have lost meaning

Author/Year/Country	Study type	Tool description		Aim	Criteria/Symptoms	Development	Results	Limitations
					– Confused – Tired and feeble – Decreased eating Category: "seems to be ill": – General signs of illness – Pain – Specific signs and symptoms of infection			
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)	Confusion Aggression Infirmity /apathy Unrestrained behaviour Changed appetite Pain Expression of illness in the eyes General signs and symptom of illness Urinary tract symptoms Respiratory symptoms Symptoms of wound infection Elevated temperature	RAC development: used research above Tingström et al 2010 to develop tool	Signs with a strong corelation with infection were – General signs and symptoms of illness – Respiratory symptoms – Temperature 37.8^{0}C +/- 0.9^{0}C	No gold standard to measure infection presence Missing data 44% of EDIS form completed when HCA suspected infection
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 *delirium*	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 al[22] 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

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