



Which frailty scale for patients admitted via Emergency Department? A cohort study

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ABSTRACT

Objectives: To determine the prevalence of frailty in Emergency Departments (EDs); examine the ability of frailty to predict poor outcomes post-discharge; and identify the most appropriate instrument for routine ED use.

Methods: In this prospective study we simultaneously assessed adults 65 + yrs admitted and/or spent one night in the ED using Fried, the Clinical Frailty Scale (CFS), and SUHB (Stable, Unstable, Help to walk, Bedbound) scales in four Australian EDs for rapid recognition of frailty between June 2015 and March 2016.

Results: 899 adults with complete follow-up data (mean (SD) age 80.0 (8.3) years; female 51.4%) were screened for frailty. Although different scales yielded vastly different frailty prevalence (SUHB 9.7%, Fried 30.4%, CFS 43.7%), predictive discrimination of poor discharge outcomes (death, poor self-reported health/quality of life, need for community services post-discharge, or reattendance to ED after the index hospitalization) for all identical final models was equivalent across all scales (AUROC 0.735 for Fried, 0.730 for CFS and 0.720 for SUHB).

Conclusion: This study confirms that screening for frailty in older ED patients can inform prognosis and target discharge planning including community services required. The CFS was as accurate as the Fried and SUHB in predicting poor outcomes, but more practical for use in busy clinical environments with lower level of disrup-

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tion. Given the limitations of objectively measuring frailty parameters, self-report and clinical judgment can reliably substitute the assessment in EDs. We propose that in a busy ED environment, frailty scores could be used as a red flag for poor follow-up outcome.

1. Introduction

Between 2015 and 2050 the world's older population is projected to triple (Wan, Goodkind, & Kowal, 2016) and there will be more older adults living longer with chronic conditions (Beard et al., 2016). These individuals will substantially increase the demand on healthcare systems worldwide, most of which are already under significant human resource shortages and financial pressure (Perera et al., 2014). In this growing population of patients, frailty is a key feature, yet there remains no agreement on an operational definition (Rodriguez-Manas et al., 2013). Frailty can be viewed as a person's biological age rather than a chronological age (Mitnitski et al., 2002), which increases

vulnerability to external stressors (Clegg et al., 2013; Fried et al., 2001). Frailty is often associated with poor health outcomes such as early readmission to hospital (Dent & Hoogendijk, 2014; Kahlon et al., 2015), and functional dependency after an acute hospital admission (Bagshaw et al., 2014) and in-hospital death (Khandelwal et al., 2012). As many symptoms of frailty are slowly progressive, frailty may be overlooked in clinical settings, or considered to be just 'normal aging' (Lee, Heckman, & Molnar, 2015). Fortunately frailty identification is now routinely performed in geriatric medicine, and has recently become commonly used in medical specialties for outcome prediction in surgical (Lin et al., 2016) and oncology patients (Wildiers et al., 2014). Numerous scales have been developed to measure risk and level of frailty (de Vries

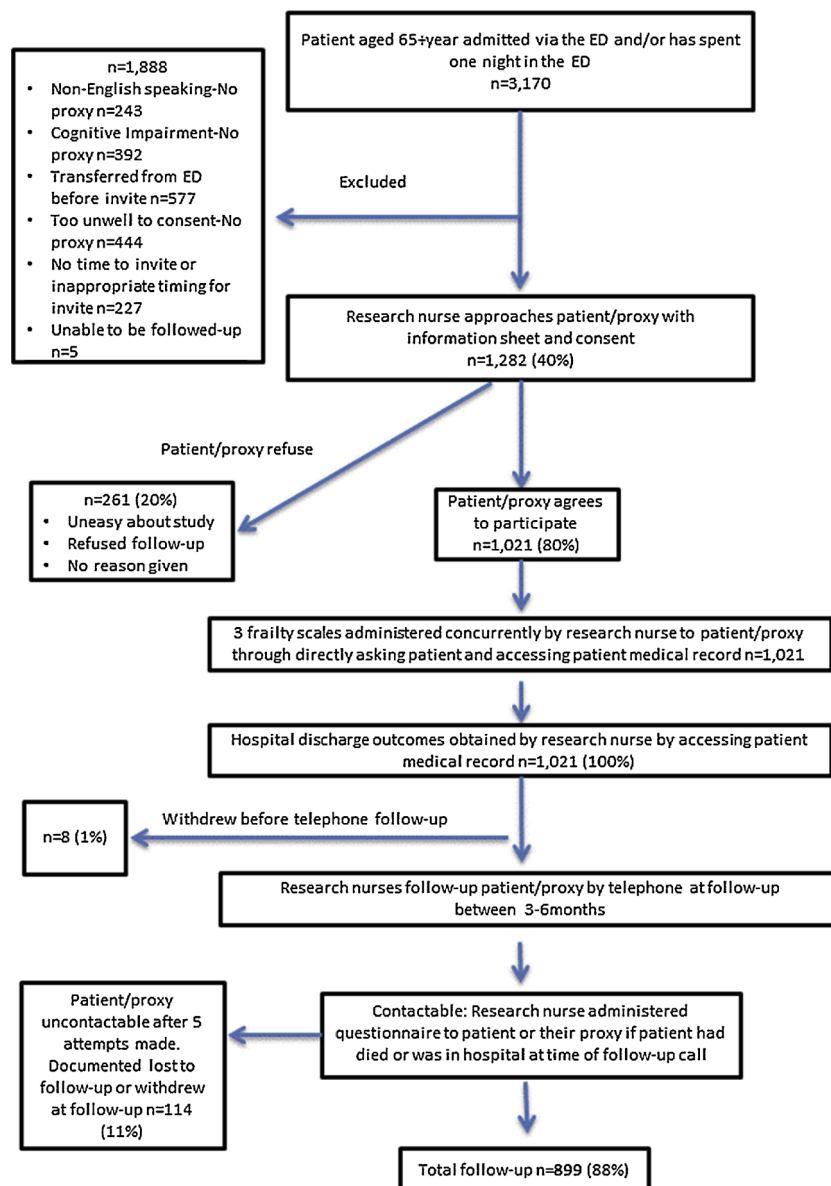


Fig. 1. Recruitment and follow-up process of older adults (65+ years) screened for frailty from four Australian Emergency Departments and followed-up via telephone post discharge.

et al., 2011; Dent & Perez-Zepeda, 2015). However there has been no formal consensus on the best definition and tool for use in the emergency department (ED) to identify the presence of frailty (Van Kan et al., 2008), risk stratification and feasibility in regards to the use of frailty scales in the ED (Elliott, Hull, & Conroy, 2017) and its prognostic value.

Recognizing the frail patient on the dying journey may prevent inappropriate management such as potentially harmful treatments and non-beneficial invasive tests (Clegg et al., 2013; Dent et al., 2016). Without a standardized approach to measuring frailty in the ED, clinicians will visually assess or 'eyeball' for frailty. However clinicians judgement when compared to objectively measuring for frailty does not always marry up (Ahmed et al., 2016). The Comprehensive Geriatric Assessment (CGA) has been referred to as the 'gold standard' for frailty identification (British Geriatrics Society, 2014). However, in EDs, due to system and patient pressures, time constraints, and reliance on specialist skills (Ellis, Marshall, & Ritchie, 2014) performing CGAs routinely is not often feasible. Therefore it has been suggested that using briefer validated scales to identify these high-risk patients who may still benefit from less comprehensive geriatric assessments (Graf et al., 2011).

A screening tool for safe use amongst clinicians in the ED should be easily applied, have the ability to score without relying on comprehensive patient documentation or equipment, be replicable and sensitive to change over time.

A limited number of frailty tools have been used in the ED setting, including the Identification of Seniors at Risk (Salvi et al., 2012) and the Triage Risk Screening Tool (Meldon et al., 2003), with the majority of frailty scales well known for community use; however few studies report the predictive accuracy for many of these scales. Fried's 'Phenotypic frailty' scale, based on data from the Cardiovascular Health Study (Fried et al., 2001), defines frailty as the presence of three of the following five variables: unexplained weight loss, low grip strength, slow walking, self-reported exhaustion and low physical activity. The Canadian Study of Health and Aging Clinical Frailty Scale (CFS) employs a set of icons to aid the identification and classification of frail patients (Rockwood et al., 2005) based on their capacity to undertake activities of daily living. This approach has been simplified further by another scale that use gait to determine the severity of illness of acutely ill medical patients: one is a four point scale (Kellelt et al., 2014) according to whether the patient has a Stable gait, Unstable gait, needed Help to walk or was Bedridden (i.e. SUHB scale).

In this study we used these three frailty scales in four Australian hospitals for rapid recognition of frailty for routine use in the ED. Our ultimate goal was to investigate associations with a poor composite outcome both objective and subjective parameters as *death is not the only healthcare outcome important to patients* (Kellelt, 2016).

1.1. Objectives

- 1) To determine the prevalence of frailty in older patients (aged ≥ 65 years) seeking admission via EDs
- 2) To determine the strength of association between frailty in the week before ED presentation and poor outcomes three months post-discharge
- 3) To determine the most accurate scale in predicting poor outcomes and the most practical of the three frailty scales for routine use in the ED

2. Methods

2.1. Patient recruitment

A nested cohort study of participating older adults was conducted in

four large public Australian teaching hospitals between June 2015 and March 2016. The aggregated ED presentations for the year 2015–16 was 266,583 for the study hospitals (Australian Institute of Health & Welfare, 2017). Registered nurses with backgrounds in Emergency Care, Intensive Care or Aged Care recruited patients between business hours (8am–6pm) Monday to Friday in the ED. Eligibility criteria were age 65 years and older (hereon termed 'older'), admitted to hospital via ED or has spent at least one night in the ED; and ability to consent, or availability of a proxy for consent, to answering questions at admission, at telephone follow-up and for access to patient records. Exclusion criteria were the patient's inability to communicate in English; too unwell to participate; cognitive impairment unless there was a consenting proxy available, or patient transferred out of the ED before invite by the research nurse. (Fig. 1 illustrates the recruitment and follow-up process). Due to Australia's four-hour rule (Sullivan et al., 2016), a target which aims to discharge or transfer patients from the ED within four hours, the decision was made to only include patients who had spent at least one night in the ED to give staff the possibility of consenting, recruiting and applying the frailty scales.

We used the CriSTAL tool (Cardona-Morrell & Hillman, 2015) (Appendix 1) to screen for levels of risk, and we used the rule of ten to make recruitment during business hours viable and to avoid overfitting in the final model (Subramanian & Simon, 2013). That is, we expected a minimum of ten events per variable on the 29-item checklist, that is, at least 290 poor outcome events. Hence we agreed on a minimum recruitment of 300 consecutive patients per site, to cater for and anticipated 10% loss to follow-up.

2.2. Baseline measurements

We used three frailty scales to compare performance. The Fried scale (Fried et al., 2001) was chosen as this study was part of a larger multi-centre study validating the CriSTAL tool (Cardona et al., 2018; Cardona-Morrell & Hillman, 2015) which includes the Fried phenotypic scale. After consultation with clinicians, the two other frailty scales – CFS (Rockwood et al., 2005) and SUHB (Kellelt et al., 2014) were selected due to their rapid applicability in routine care and were not reliant on complex calculations or laboratory tests. All three scales classified frailty into frail, pre-frail and robust (See Appendix 2a & 2b for description of scales and cut-off points).

To improve the feasibility of implementation of the frailty scales self-reported frailty, as measured by others (Op het Veld et al., 2018; Papachristou et al., 2017), was chosen and assessed in relation to the patient status in the week prior to ED presentation. Our pilot test during the first two weeks confirmed that it was not feasible to measure many objective items due to participant's acute illness, cardiac monitoring, intravenous medications, and inability to get a physiotherapist to assist with mobility.

2.3. Baseline and discharge data collection

To ensure inter-rater reliability, all ED research nurses were trained in the collection of data and observed by two of the most experienced research nurses in delivering the three frailty scales for their first few participants enrolled. Patient clinical, health and socio-demographic variables were extracted on admission via clinical notes either electronically or paper notes within 24 h of the patient presenting to the ED. Multi-morbidity was the sum of chronic diseases from the CriSTAL tool (Cardona-Morrell & Hillman, 2015) and it was defined as having two or more of the chronic conditions present (Appendix 1). No additional information was systematically available at time of recruitment on activities of daily living or past frailty status. Discharge date and outcome ascertainment was documented by the research nurse from the hospital's electronic database (Fig. 1). Additional variables verbally obtained

by the patient or their surrogate were admissions to other hospitals or ICU in the past year and the participant's self-rated health (Idler & Benyamini, 1997).

2.4. Follow-up data collection

Post-discharge outcomes were ascertained between 3–6 months via telephone call to the patient or their proxy. A standard questionnaire including frailty measurements; self-rated health; the participant's quality of life using the single global question (World Health Organization, 2004), health services used; and survival status was ascertained by purpose-trained registered research nurses who were not part of the treating team and were blinded to the participant's clinical status on presentation to the ED. A maximum of five telephone attempts was made to contact participants, with efforts made at different times of the day on different week days 3–6 months after initial assessment (Fig. 1).

2.5. Primary outcomes of interest and data sources

2.5.1. Prevalence of frailty

Prevalence of frailty as measured by each different scale. The distribution of stratified frailty levels (frail, pre-frail, robust).

2.5.2. Poor follow-up outcome

Poor outcome at follow-up was defined as a composite measure similar to other studies (Bagshaw et al., 2014; Dent et al., 2014; Hastings et al., 2008; Wou et al., 2013) of at least one of the following: death at any time, poor or fair self-reported quality of life at follow-up, need for community services following discharge, poor or fair self-reported health at follow-up, or reattendance to ED after the index hospital admission as reported at the time of the follow-up call.

2.5.3. Impact of frailty on poor outcome

Using the same operational definition of poor outcome we examined the associations between aggregated frailty as stated in the baseline measurements (objective 2).

2.6. Secondary outcome

2.6.1. The most appropriate tool for use in ED

For the purpose of this study we selected nine criteria to determine which frailty scale is the most appropriate to administer in ED: best predicts poor outcomes (as defined by the Area Under the Receiver Operating Characteristic curve); ease of use; rapid administration; comprehensive assessment with readily available data items; objective parameters; replicability; not reliant on complex equipment/assessment; easily understood; and usable to identify change over time.

2.7. Ethics

This study was conducted according to the Declaration of Helsinki guidelines, including written consent by patients or surrogates, and ability to withdraw at any time. The protocol for the multicentre study was endorsed by the South Eastern Sydney Local Health District Human Research Ethics Committee (15/026, HREC 15/POWH/55).

2.8. Statistical analysis

Analysis was conducted on the 899 participants who had complete follow-up data available (88% of the initial sample, Fig. 1). Univariate comparisons of proportions used chi-squared test. All variables with

frequencies > 10 and with $p < 0.20$ were included in the logistic regression model and backwards elimination was used to sequentially remove non-significant items from the model until all remaining variables have a likelihood ratio p -value < 0.05, except for age and sex, which always remained in the model to assess associations between frailty and poor follow-up outcomes. We used dichotomized frailty classifications for all three frailty scales by combining pre-frail and robust for investigation of objective 2 as previously conducted by others (Dent et al., 2014). This was done on clinical grounds as our intention was the early detection of frailty in ED.

All base models included adjustment for age group, sex, multi-morbidity (defined as the sum of target chronic illnesses), triage category (urgency), and length of stay as clinically plausible contributors to poor outcome. Additional variables controlled for were country of birth and cause of consultation as potential confounders. Sensitivity analysis was undertaken for time to follow-up call and poor composite discharge outcomes as time to follow-up call varied between participants. Duration of follow-up time had no impact on the outcome after adjusting for confounders (data not shown). Therefore our analysis includes the entire sample regardless of follow-up duration. All final models retained age and sex regardless of statistical significance as it is known that females tend to be more frail (Collard et al., 2012) and males tend to have poorer outcomes (Wang et al., 2012). To assess the discriminant ability of each scale, probabilities of the regression analyses were used to generate area under receiver operator characteristic (AUROC) curves, and estimated sensitivity and specificity (Fawcett, 2006) and Youden Index (YI) [sensitivity + specificity -1]. Higher YI values indicated better diagnostic performance for the frailty scales. An AUROC was considered to be of adequate predictive accuracy when ≥ 0.70 (Sutton, Grimmer-Somers, & Jeffries, 2008). Descriptive statistics for distributions of the various frailty scores were conducted using SPSS (IBM v 22). All multivariable analyses were conducted using SAS v9.4 (Cary NC, USA). Results are presented following the STROBE guidelines.

3. Results

The 899 eligible patients (Fig. 1) with complete data from baseline to follow-up (51.4% female) had a mean age was 80.0 years (SD 8.3) years with 75% of participants being admitted and 258 (25.3%) spending at least one night in the ED without admission to hospital. The mean LOS was 6.1 days (SD 9.3) and mean time to follow-up call was 137.2 days (SD 41.0) with 9.5% mortality by the end of follow-up ($n = 85$). Delays in contacting participants for follow-up meant that some outcomes were ascertained beyond 3 months. We hereby refer to the poor short-term outcome of 3–6 months. The median follow-up time overall was 124 days (IQR 105–168). There was no significant difference in demographic characteristics between the participants and those who were lost to follow-up. Participant demographic and clinical characteristics are described in Table 1.

3.1. Frailty prevalence at baseline

The prevalence of frailty varied greatly depending on the scale used on admission with SUHB scale classifying participants more being robust (45.3%) and pre-frail (45.1%) whereas Fried most people as pre-frail (55.4%) and CFS scale classified most patients as frail (43.7%) (Fig. 2). Comparison across the three scales revealed agreement in frailty classification in only 228 (25.4%) of participants; whereas for 598 (66.5%) frailty scores spanned across two adjacent frailty categories when measured by different scales; and 73 (8.1%) were classified at both ends of scale i.e. robust and frail by two different instruments.

Table 1
Demographic and clinical characteristics at baseline.

Variable	n = 899
Demographics	
Age, Mean (SD)	80 (8.3)
65–74 years n (%)	255 (28.4)
75–84 years n (%)	348 (38.7)
85 + years n (%)	296 (32.9)
Female Gender n (%)	462 (51.4)
Most disadvantaged SES n (%) ^a	168 (18.7)
Least disadvantaged SES n (%) ^a	198 (22.0)
Born outside of Australia n (%)	389 (43.3)
Residential Aged Care Facility n (%)	57 (6.3)
Clinical characteristics	
Cognitive Impairment n (%) ^b	92 (10.2)
Renal Abnormality n (%) ^c	113 (12.6)
Cardiac Abnormality n (%) ^d	460 (51.2)
Advanced Malignancy n (%)	46 (5.1)
COPD n (%)	142 (15.8)
Multi-morbidity n (%) ^e	137 (15.2)
Hospital admission in past year n (%)	526 (58.5)
ICU admission in past year n (%)	69 (7.7)
Not for Resuscitation n (%)	41 (4.6)
LOS (days) Mean (SD)	6.1 (9.3)
Time to follow-up (days) Mean (SD)	137.2 (41.0)
Died (anytime) n (%)	85 (9.5)
Top 3 categories: Reason for consult	
Respiratory n (%)	140 (15.6)
Trauma/Injuries n (%)	123 (13.7)
Chest pain n (%)	90 (10.0)
Top 3 categories: Treating team	
Emergency n (%)	223 (24.8)
Geriatrics n (%)	144 (16.0)
Cardiology n (%)	119 (13.2)

COPD = chronic obstructive pulmonary disease.

SES = socio-economic status.

ICU = intensive care unit.

LOS = length of stay.

^a 2033.0.55.001 - Socio-economic Indexes for Areas (SEIFA), Data Cube only, 2011. <http://www.abs.gov.au/ausstats/abs@.nsf/DetailsPage/2033.0.55.0012011?OpenDocument>.

^b Cognitive Impairment includes: dementia, long term mental illness, behavioural alterations and disability from stroke.

^c Renal Abnormality includes: oliguria and chronic kidney disease.

^d Cardiac Abnormality includes: myocardial infarction, chronic heart failure and abnormal electrocardiogram.

^e Multi-morbidity = presence of two or more chronic conditions.

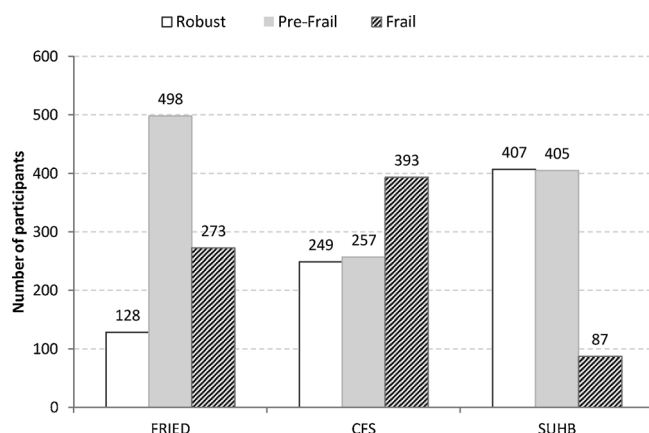


Fig. 2. Classification of frailty on admission using three frailty scales.

Table 2
Unadjusted associations of baseline of frailty and poor follow-up outcomes for the three frailty scales (N = 899).

Scales	Good Outcome ^b n (%)	Poor outcome ^{b,a} n (%)	Chi square, P value
Fried Scale			55.523, < .001
Not Frail	247 (39.5)	379 (60.5)	
Frail	39 (14.3)	234 (85.7)	
CFS Scale			65.416, < 0.001
Not Frail	217 (42.9)	289 (57.1)	
Frail	69 (17.6)	324 (82.4)	
SUHB scale			20.465, < 0.001
Not Frail	277 (34.1)	535 (65.9)	
Frail	9 (10.3)	78 (89.7)	

Index: CFS = Clinical Frailty Scale; SUHB = scale for Stable gait/unstable gait, needing Help or being bedridden.

^a Poor outcome at follow-up includes at least one of: death, poor or fair self-reported health at follow-up, poor or fair quality of life at follow-up or new presentation to an emergency department or need for community services.

^b Raw percentage.

3.2. Association between frailty and poor follow-up outcomes

There was a significant positive association between frailty with poor follow-up outcomes (Table 2). Likewise there was a severity response relationship, where increasing levels of frailty, were coupled with increasing proportions of participants' experiencing poor outcomes (Fig. 3).

3.3. Predictors of poor follow-up outcome

Across all three frailty scales and after adjusting for potential confounders, frailty remained a strong predictor of poor follow-up outcomes, carrying a four-fold risk (Table 3). Patients with two or more chronic conditions had three times the odds of a poor outcome. Oldest participants (85 + years) and participants reporting poor baseline health had twice the odds of a poor outcome at follow-up. All scales showed good predictive discrimination expressed as AUROC (Sutton et al., 2008). Similarly, the YI values of the three scales were similar (0.214, 0.229 and 0.197 for the CFS, Fried and the SUHB respectively).

For low probabilities of death (38% and above), the sensitivity of all three frailty scales to predict poor [composite] discharge outcome was excellent (99%) whereas specificity was higher (> 81%) at probability levels of 75% and above (Appendix 3)

3.4. Individual contributions to poor outcomes

Of the 68.2% (613/899) of participants with poor composite follow-up outcome, the contributions of individual risk factors in descending order were: fair/poor SRH (63.3%), CFS frailty (52.9%), poor/fair self-rated quality of life (50.7%), re-presentations to the ED (50.4%), Fried frailty (38.2%), use of community services while at home (36.1%), death (13.9%) and SUHB frailty (12.7%). All patients (100%) who reported the presence of risk factors other than frailty had a poor outcome.

3.5. Appropriate tool for use in the ED

Based on our findings of speed and ease of administration, ability to understand the scores, comprehensiveness, non-reliance on equipment or extensive documentation, and accuracy (Appendix 4) we conclude that the CFS was the most appropriate tool to measure frailty in the ED

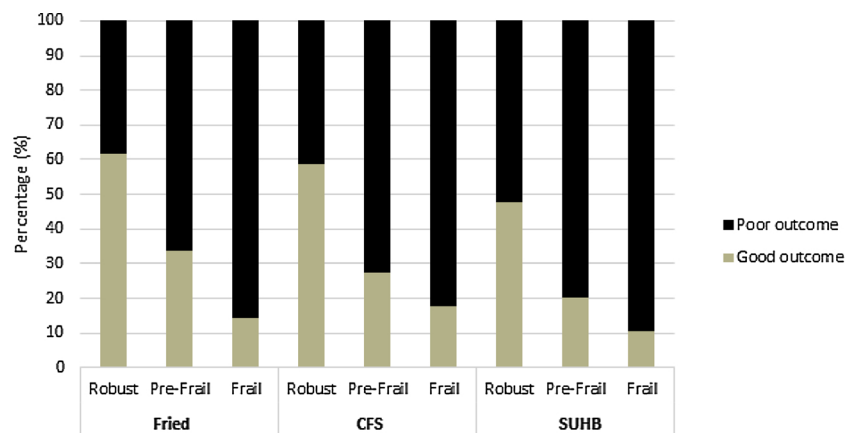


Fig. 3. Poor follow-up outcomes by frailty scales and baseline frailty classification (N = 899).

environment despite some subjectivity involved in the clinical assessment and marginally lower AUROC (0.730) compared to the Fried scale (0.735). We did not measure replicability or the ability to estimate change over time but it is clear that the broad range of scores of CFS frailty (5–9) renders it less useful to monitor changes over time, whereas the other two scales have clear-cut thresholds to monitor changes from frailty to pre-frailty or robust status.

4. Discussion

To our knowledge this is the largest prospective study of frailty in emergency departments published to date. This study using three different ways to assess frailty has shown that objectively measuring frailty in busy emergency departments is impractical but self-reported frailty or observed frailty are still a useful approach to screening. However assessed, frailty status in the week before the acute admission (the acute frailty state was not investigated), was significantly associated with a composite poor outcome for older patients including at least one of the following: death in hospital or post-discharge, poor or fair self-reported quality of life at follow-up, need for community services following discharge, poor or fair self-reported health at follow-up, or reattendance to ED after the index hospital admission. Frailty remained a significant predictor of poor short-term outcome after adjusting for age, sex, length of stay, and number of co-morbidities. Worthy of notice, 57.8% of those not accessing community services by three months also had a poor outcome. In the urban Australian health

system, this is likely to be due to lack of knowledge of service entitlements, lack of support to access them (Lewis, Samperi, & Boyd-Skinner, 2017) or long waiting lists (Department of Health, 2017).

This study also highlights that self-reported frailty can act as a substitute for objective measures in busy EDs, where patients are unable to mobilize and staff are pressured by time constraints. The lack of feasibility in this non-research environment was clear, just as in another recent study where self-reported frailty has been used including variation in the definitions of the Fried parameters (Delgado et al., 2015). Objective performance-based measures may not be appropriate in the ED when patients are acutely unwell and in pain and may exacerbate these symptoms with others reporting that measuring objective parameters in hospitalised older patients is time consuming, resource-intensive and can become exhausting for older patients (Joosten et al., 2014).

It is acknowledged that older ED patients often overestimate their abilities to function (Nielsen et al., 2016) whereas their surrogates may underestimate the older person's functional ability (Magaziner et al., 1997) particularly for people with cognitive impairment (Loewenstein et al., 2001). It is somewhat reassuring that a recent study in older adults observed acceptable (70%) agreement between the performance based measures of the Fried scale and self-report (Op het Veld et al., 2018). Given our results and the limited resources of health systems to enable dedicated specialized staff routinely screening for frailty status in older patients presenting to the ED, using self-report appears to be reliable and practical approach.

Table 3

Unadjusted and adjusted associations between baseline frailty and poor outcome at follow-up. Outcome of final logistic regression models for 3 frailty scales.

Predictors Of Poor Follow-Up Outcome	Fried (binary) OR (95% CI)	p-value	CFS (binary) OR (95% CI)	p-value	SUHB (binary) OR (95% CI)	p-value
Unadjusted Frailty	3.91 (2.69–5.69)	< 0.001	3.53 (2.58–4.83)	< 0.001	4.49 (2.21–9.08)	< 0.001
Unadjusted AUROC	0.623		0.644		0.548	
Adjusted Frailty ^a	2.58 (1.72–3.86)	< 0.001	2.20 (1.55–3.12)	< 0.001	2.46 (1.16–5.05)	0.019
Multi-morbidity ^b	3.18 (1.85–5.48)	< 0.001	3.07 (1.78–5.29)	< 0.001	3.26 (1.90–5.58)	< 0.001
Length of stay	1.05 (1.02–1.08)	0.002	1.05 (1.02–1.08)	0.003	1.05 (1.02–1.08)	0.002
Poor BL-SR health ^c	2.17 (1.37–3.45)	0.001	2.25 (1.42–3.57)	0.006	2.67 (1.70–4.19)	< 0.001
Male	0.74 (0.55–1.01)	0.058	0.77 (0.56–1.05)	0.093	0.70 (0.52–0.95)	0.021
Age 75–84	1.45 (1.02–2.08)	0.041	1.32 (0.92–1.89)	0.133	1.46 (1.03–2.09)	0.036
Age 85+	1.90 (1.28–2.82)	0.002	1.68 (1.12–2.53)	0.012	2.10 (1.42–3.11)	0.002
Adjusted AUROC	0.735		0.730		0.720	

Index: CFS = Clinical Frailty Scale; SUHB = scale for Stable gait/unstable gait, needing Help or being bedridden.

AUROC = Area Under the Receiver Operating Characteristic curve.

^a Adjusted model controls for age, sex, multi-morbidity, triage category, hospital length of stay, reason for consultation and country of birth.

^b Multi-morbidity = presence of two or more chronic conditions.

^c BL-SR = Baseline self-rated (health).

The large proportion of ‘not-frail’ people experiencing poor outcomes can be explained largely by the inclusion of pre frailty in the non-frail category. Further, the broad scope of poor outcome in our study could have meant larger probability of experiencing any of the parameters. Another important finding of this study was the discrepancy of classification of frailty across the three scales used which strongly suggests they are measuring different constructs. Our study used several frailty scales concurrently as we were in search for the most suitable tool to be used in the ED setting. We found that the CFS scale was the most user-friendly, least demanding and most comprehensive to use. The CFS was associated with similar accuracy (AUROC) as the two others frailty scales, so it was more appropriate for routine use in busy EDs.

We propose that in a busy ED environment, frailty scores could be used as a red flag for poor outcome. Early recognition of frailty on presentation to hospital can inform early discharge planning from the ED and given that the discharge planning should ideally start at the beginning of the hospital journey (Mennuni et al., 2017; Preston et al., 2018) our results suggest and we recommend that frailty screening be undertaken at the start of hospitalization. However, recognising and measuring frailty and its severity in the emergency department is of little use unless there is an associated clinical, health system and social response for the patient and their family (Beard et al., 2016; Dent et al., 2016). It has been suggested that older adults who are identified at being of higher risk of complications may benefit from further in-depth geriatric screening (Samaras et al., 2010). Quite apart from predicting outcomes such as hospital and nursing home admissions, lengthy hospital stay and death (Jorgensen & Brabrand, 2017), there are other good reasons to assess frailty in emergency departments, such as reducing the risk of falls and bedsores, and determining the need to provide assistance with the activities of daily living during hospital stay and at time of discharge planning. More importantly, severely frail individuals diagnosed late would not be able to benefit from timely honest end-of-life communication that incorporates their values and goals of care for shared decision-making (van de Pol et al., 2016). It is important to note that identification of frailty in the ED is aimed to prevent harm to the older person with frailty which may occur through unnecessary tests or treatments. Likewise older adults who present to the ED as robust and pre-frail, will also benefit from tailored care such as referral to balance and muscle stabilising programs (Cardona-Morrell et al., 2017) to restore some functionality and slow-down progression to severe frailty, therefore diagnosis as early as possible is likely to be beneficial (Dent et al., 2017).

Among the strengths of this study, the study population was heterogeneous in clinical profile and ethnic background, included admissions through the four seasons, hence incorporating variations in patient profiles visiting the ED, and concurrent frailty assessment via emergency department research nurses was possible using three different approaches. We predicted a composite outcome after a short-term from discharge, and estimated accuracy of the outcome prediction adjusting for multiple confounders and examined the individual contributions of the objective and subjective risk factors on the outcome. Despite the many strengths of our study, there were some limitations. For instance, although varied in size and patient case mix and cultural backgrounds, the target hospitals were located in a single country. Frailty was observed and self-reported rather than measured, but previous research shows the accuracy is equivalent (Op het Veld et al.,

2018). Patients who were discharged from the ED on the same day were not included in this study, but this population is presumably less frail given their earlier discharge from the ED. Hence these results cannot be generalizable to older people with ambulatory care sensitive conditions who do not require hospital stay. The follow-up time varied due to practicalities of post-discharge contact with older people. This cohort was assembled from a real-life setting from consecutive patients – as practically possible during business hours. Patients who were unable to consent due to cognitive impairment or communication barriers were excluded, therefore results may not be generalizable to all patient types.

4.1. Implications for practice

These findings suggest that for busy environments where there is no geriatrician, rapid observational assessment and self-report can substitute the comprehensive geriatric assessment (CGA), to flag pre and post-discharge support. For settings where there is, frailty scales can be used for triaging to CGA's on the ward. As instruments classify patients in different ways, care must be exercised in administering the scales and use of a consistent instrument over time is recommended for monitoring progress and prevent misclassification. Future research could compare the effectiveness of rapid frailty screening versus comprehensive geriatric assessment.

5. Conclusions

This prospective study revealed that despite the variation in classification of frailty by different scales, there is merit in using self-reported frailty in emergency departments to identify people at risk of poor short-term outcomes including ED re-attendances and death, recognise those in need for community support, and those whose prognosis indicates the need for discussions about transition onto appropriate end-of-life care pathways. Our recommendation is to screen for frailty in older ED patients, and use the same scale for consistency at follow-up. The CFS appeared to be as accurate as Fried and SUHB in predicting these outcomes, but more practical for use in busy clinical environment with lower level of disruption.

Conflicts of interest

None.

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Appendix 1 CriSTAL Tool

☐	Age ≥ 65 AND Being admitted via emergency Department
	Reason for consultation
	Admitting team
☐	Meets ≥ 2 MET selected calling criteria below
☐	1-Decreased LOC: Glasgow Coma Score change >2 or AVPU =P or U
☐	2-Systolic blood pressure <90 mmHg
☐	3-Respiratory rate <5 or >30
☐	4-Pulse rate <40 or >140
☐	5-Need for oxygen therapy or known oxygen saturation $<90\%$
☐	6-Hypoglycaemia: BGL 1.0 - 4.0 mmol/L
☐	7-Repeat or prolonged seizures: 1 of ≥ 5 minutes duration or >1 per day of any duration
☐	8-Low urinary output (<15 ml/hour or <0.5 ml/kg/hour)
AND	OTHER RISK FACTORS /PREDICTORS (Tick as many as relevant)
☐	Personal history of active disease: ☐ 1-Advanced malignancy ☐ 2-chronic kidney disease ☐ 3-chronic heart failure ☐ 4-chronic obstructive pulmonary disease ☐ 5-new cerebrovascular disease ☐ 6-myocardial infarction ☐ 7-moderate/severe liver disease
☐	Evidence of cognitive impairment (e.g. long term mental disorders, dementia, behavioural alterations or disability from stroke) ☐ Long term mental disorder ☐ Dementia ☐ Behavioural Alterations ☐ Disability from stroke
☐	Nursing home resident /in supported accommodation
☐	Proteinuria on a spot urine sample: ++ or >30 mg albumin/g creatinine ☐ Yes, several occasions ☐ Yes, single result ☐ No ☐ Don't know

	Abnormal ECG (atrial fibrillation, ventricular tachycardia, other abnormal rhythm or >5 ectopics/min, changes to Q or ST waves) ☐ Acute abnormality ☐ Chronic abnormality ☐ Both chronic and acute this assessment Type of abnormality (optional):..... ☐ No abnormality ☐ Don't know
	Patient Demographics: Sex 1. ☐ Male 2. ☐ Female Date of birth ____/____/_____ Country of birth: 1. ☐ Australia 2. ☐ Out of Australia (English speaking) 3. ☐ Out of Australia (NESB) ☐ Country of birth:..... ☐ Aboriginal or Torres Strait Islander ☐ Neither Postcode of residence: _____
☐	Previous hospitalisation for at least one night in past year ☐ Yes ☐ No ☐ Can't remember Total number of hospitalisations in the past year _____
☐	Repeat ICU admission at previous hospitalisation ☐ Yes repeat ICU admission Total number in past year _____ ☐ Yes, single ICU admission only ☐ No ICU admission at all ☐ Unknown
☐	ASK PATIENT:: Compared with people of the same age would you say your health is: ☐ Poor ☐ Fair ☐ Good ☐ Very good ☐ Excellent ☐ Person unable to answer/no proxy ☐ Person refuses to answer
AND	Evidence of frailty (ASK PATIENT IF NO INFORMATION ON RECORD) Tick as many as relevant:
☐	1. Unintentional or unexplained weight loss (4.5 Kg in past year)
☐	2. Self-reported exhaustion (felt that everything was an effort or felt could not get going at least 3 days in the past week)
☐	3. Weakness (low grip strength for writing or handling small objects, difficulty or inability to lift heavy objects >=4.5Kg)
☐	4. Slow walking speed (walks 4.5 metres in ≥7 seconds)
☐	5. Inability for physical activity or new inability to stand
	☐ Person unable to answer/no proxy ☐ Person refuses to answer

Appendix 2a Frailty scales description

The Fried scale measures five variables: unexplained weight loss, low grip strength, slow walking, self-reported exhaustion and low physical activity. We defined frailty as present if three or more of these conditions have been satisfied, pre-frail if one or two conditions is satisfied and robust if none of the conditions was satisfied.

The Clinical Frailty Scale (CFS) developed by Rockwood and colleagues has a 7 point scale which is highly correlated with the Frailty Index and our study used the now modified 9-point scale, used for educational and research purposes (http://geriatricresearch.medicine.dal.ca/clinical_frailty_scale.htm). The CFS relies on clinical judgement and is used to assign the patient to a category of frailty by using short descriptors and pictographs. People were classified as frail if they scored a number five or greater; A score of four was classified as pre-frail and less than four were classified as robust.

The SUHB Scale Is a four-point scale based on a person's walking gait. It consists of four items: Steady/stable gait; Unsteady/unstable gait; Help required with walking or Bedbound/Bedridden. Participants were classified as Frail if they required help with walking or were bedbound, Pre-frail was assigned if the person had an unsteady gait and those with a steady gait were classified as robust.

Appendix 2b Cut off points for pre-frailty and frailty for each scale

	CFS	SUHB	Fried
Robust	1-3	S	0
Pre-frail	4	U	1-2
Frail	5-9	H-B	3-5
Not frail	1-4	S-U	0-2
Frail	5-9	H-B	3-5

Index: CFS = Clinical Frailty Scale;

SUHB = scale for Stable gait/unstable gait, needing Help or being bedridden

Appendix 3 Accuracy of binary frailty predictions for poor composite outcome: sample cut-off probabilities for final models

Predictive probability cut-off	CFS Sensitivity (%)	CFS Specificity (%)	Fried Sensitivity (%)	Fried Specificity (%)	SUHB Sensitivity (%)	SUHB Specificity (%)
0.38 [‡]	99.0	4.2	99.0	4.2	100	4.2
0.50	89.6	31.8	89.7	33.2	91.0	28.7
0.75	48.1	82.7	48.1	81.1	45.0	83.6

Index: CFS = Clinical Frailty Scale;

SUHB = scale for Stable gait/unstable gait, needing Help or being bedridden

‡ Lowest available probability

Appendix 4 Ideal criteria for selecting the most appropriate frailty scale for use in the emergency department

Frailty Scale	Ease of use	Rapid administration	†Readily available data items	‡Objective parameters	Replicability	Not reliant on complex equipment or assessment	Easily understood	Highest AUROC	Identify change over time
Fried	X	X	X	X	–	X	✓	✓	✓
CFS	✓	✓	✓	X	–	✓	✓	X	X
SUHB	✓	✓	✓	X	–	✓	X	X	✓

Index: CFS = Clinical Frailty Scale; SUHB = scale for Stable gait/unstable gait, needing Help or being bedridden

†Either recorded in medical notes or reported by the participant/proxy

‡In theory these parameter are objective, however in practice in the emergency department these were self-reported

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