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Frailty and functional decline indices predict poor outcomes in hospitalised older people

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Abstract

Background: admission to a Geriatric Evaluation and Management Unit (GEMU) can optimise a patient's chance of functional recovery.
Objective: to evaluate the ability of several commonly used frailty and functional decline indices to predict GEMU outcomes, both at discharge and at 6 months.
Design: prospective, observational study.

Setting and participants: consecutive GEMU patients aged ≥70 years.
Methods: patients were classified as 'frail' or 'at high risk of functional decline' using several frailty and functional decline instruments. Predictive ability was evaulated using logistic regression and area under receiver operator characteristic (ROC) curves ($_{au}$ROC).
Results: a total of 172 patients were included. Frailty prevalence varied from 24 to 94% depending on the instrument used. Several instruments predicted patients at risk of poor outcome, including the Frailty Index of Accumulative Deficits (FI-CD), Fried's Cardiovascular Health Study index, the Study of Osteoporotic Fractures index, an adapted Katz score of activities of daily living (ADL), Instrumental ADL, the Score Hospitalier d'Evaluation du Risque de Perte d'Autonomie (SHERPA) and grip strength [odds ratio (OR) range of 2.06–6.47]. Adequate discriminatory power for discharge outcome was achieved by the FI-CD ($_{au}$ROC = 0.735, $P < 0.001$) and an adapted Katz score ($_{au}$ROC = 0.704, $P = < 0.001$). The FI-CD also showed adequate discriminatory power for a poor 6-month outcome ($_{au}$ROC = 0.702, $P < 0.001$).
Conclusion: frailty and functional decline instruments can predict older patients at risk of poor outcome. However, only the FI-CD showed adequate discriminatory power for outcome prediction at both follow-up time-points.

Keywords: *frail elderly, geriatric assessment/methods, aged, 80 and over, prognosis, older people*

Introduction

Frailty is a major contributor to morbidity and mortality in older people [1]. It is estimated that individuals identified as frail are over twice as likely to encounter adverse health outcomes as their non-frail counterparts [2, 3]. Although there is currently no gold standard definition for frailty, it is generally considered to be a multi-factorial condition characterised by a heightened vulnerability to changes in health status [4]. Indices developed to identify frailty are generally of two types: phenotypic and multidimensional. Phenotypic indices measure the physical signs of frailty, and include the Cardiovascular Health Study (CHS) index [5] and the simpler Study of Osteoporotic Fractures (SOF) index [6]. Multi-dimensional indices incorporate both the physical and psycho-social components of frailty, and include the frailty index of accumulated deficits (FI-CD) [7] and the simper indices: the Multi-dimensional prognostic index (MPI) [8], the ten-domain frailty index based on Comprehensive Geriatric Assessment (FI-CGA-10) [9] and FRAIL (Fatigue, Resistance Ambulation, Illness, Loss of Weight) [1]. Indices used to measure functional decline can also be considered frailty indices [10]; examples include the Katz score of activities of daily living (ADL) [11], Lawton's Instrumental ADL (IADL) scale [12], the Score Hospitalier d'Evaluation du Risque de Perte d'Autonomie (SHERPA) [13] and the hospital admissions risk profile (HARP) [14].

Hospitalised older people are often frail. Accurate identification of which patients are likely to encounter poor health outcomes is important for care planning and risk assessment for intended surgical or medical treatments [4]. As yet, no consensus exists as to which frailty instrument most accurately identifies older hospitalised patients at risk of poor outcomes. The purpose of this study was to evaluate several common frailty and functional decline indices on their ability to predict poor Geriatric Evaluation and Management Unit (GEMU) outcomes, both at discharge and at 6 months.

Methods

Between 22 October 2010 and 23 December 2011, consecutive patients aged ≥70 years were recruited from the GEMU at the Queen Elizabeth Hospital (TQEH), South Australia. The GEMU is a specialised ward designed to optimise a patient's chance of recovery following acute admission [15]. GEMU patients are pre-selected for entry predominantly from TQEH's Acute Medical Unit using the clinical judgement of geriatricians.

All patients (or their authorised proxy) gave their informed consent, in accordance with ethical standards from the 2000 Declaration of Helsinki. The study was approved by the Human Research Ethics Committee (TQEH). Data were collected during the first 72 h of GEMU admission. Patient (or proxy) interview was used to obtain socio-demographic and health data, including nutritional status by the Mini Nutritional Assessment (MNA) [16]. Patient clinical records were used to obtain CGA items including medications, admission diagnosis, Geriatric Depression Scale-15 (GDS-15) [17], Mini-Mental State Examination (MMSE) [18] and Braden skin assessment [19].

Single markers

Single markers of frailty used were grip strength and walking speed. Grip strength was assessed as the maximum of three attempts of the dominant hand using a hand held dyanmometer: low grip strength <18 kg (women), <30 kg men [20]. Walking speed was meaured over 6 m, with or without the use of a walking aid. Slow walking speed was defined as unable to walk 6 m in 30 s [21].

Phenotypic frailty indices

CHS index

The CHS index defines frailty as three or more of: shrinking, weakness, exhaustion, slowness and low physical activity [5].

Shrinking (unintentional weight loss of ≥4.5 kg in the last year) and exhaustion (self-report) were defined as per original CHS criteria [5]. Weakness (low grip strength) and low physical activity were applied as per the Frailty Intervention Trial [20]. Slow walking speed was defined as above [21].

SOF index

The SOF index defines frailty as two or more of: weight loss (5% loss either intentional or unintentional over the last year), self-report of low energy and low mobility (unable to rise from a chair five times) [6].

FRAIL index

For our study, FRAIL [1] classified frailty as three or more of: fatigue (self-report), resistance (unable to rise from a chair five times), ambulation (slow walking speed); illnesses (≥5 illnesses on Charlson's co-morbidity index (CCI) [22]) and loss of weight of 5% or more in the past year.

Multi-dimensional indices

FI-CD

The FI-CD involves the accumulation of ≥30 co-morbidities, disabilities and health deficiencies [7, 23]. Deficits are then summed and divided by the total number of deficits [7, 23]. For example, if 10 deficits are present in a list of 50, the frailty index is 0.2 (10/50) [23]. The present study followed guidelines by Searle *et al.* [23] to select 50 multi-dimensional health deficits. Deficits were predominantly obtained from patient CGAs, thus the FI-CD in our study was akin to a CGA frailty index (FI-CGA) [24] (see Supplementary data available in *Age and Ageing* online, Appendix A).

The FI-CD is a continuous variable and any cut-off points to define frailty are arbitrary. A cut-off score of <0.45 was used to define frailty in this study [25], which can be considered to be a cut-off point to define severe frailty [26]. A previously used cut-off point to define frailty (<0.2) [27] was not used in this study for two reasons: (i) this cut-off point possibly distinguishes robust from pre-frail categories [23, 28] and (ii) the majority of patients (94%) in our study were classified as frail by this low cut-off point.

FI-CGA-10

The CGA was used to construct a ten-domain FI-CGA (termed FI-CGA-10 for this study), based on the FI-CGA definition operationalised by Jones *et al.* [9, 29] as applied by Pilotto *et al.* [30]. The FI-CGA-10 is distinct from the more comprehensive 52 component FI-CGA described by Rockwood *et al.* [24, 31]. FI-CGA-10 components were: cognition (MMSE), mood and motivation (GDS-15), hearing or sight problem, mobility (6 m walk time), balance (standing ability), bowel function, bladder function, function, ADLs, IADLs, nutritional status (MNA) and social resources [9]. Problems for each component were classified as: major (two points), minor (1 point) and none (0 point) [9]. Scores were summed and frailty defined as scores >13/20 [30].

MPI

MPI components include: ADL, IADL, MMSE, CCI, MNA, Braden skin assessment, medication number and living status [8]. Problems for each component were classified as: major (1 point), minor (0.5 point) and none (0 point) [8]. Scores were summed, divided by eight [8] and scores >0.66 graded as frailty [30].

SHERPA

Weighted SHERPA components are: falls in the previous year, MMSE (first 21 questions), bad self-perceived health, age and IADL [13]. Scores were summed and frailty defined as scores >6/11.5, corresponding with SHERPA's 'high risk of functional decline' [13].

HARP

HARP's weighted components are: age (scored 0–2 points), MMSE-21 (scored 0–1 points) and IADL (scored 0–2 points) [14]. Scores ≥4 were classified as frailty, equivalent to 'high risk of functional decline' on HARP [14].

Functional decline instruments

ADL

ADL evaluation instruments included Lawton's IADL scale and an adapted Katz index. For Lawton's scale, frailty was defined as dependency on others to perform ≥3 IADLs: telephoning, shopping, food preparation, housekeeping, laundry, transport, medication and finances [12]. For the adapted Katz score, frailty was defined as dependency for ≥1 of: feeding, washing, grooming, dressing, toileting, transferring from a bed or chair and walking [32].

CCI

CCI [22] was used to assess co-morbidity, with scores ≥5 chosen as the cut-point to evaluate its prediction of poor outcomes, based on FRAIL's Illness criteria [1].

Outcomes

A composite outcome measure of 'poor outcome' was defined as one or more of (i) death; (ii) admission to a residential care facility and (iii) move from low-level care to high-level care within residential care. Outcomes were considered both at discharge and at 6-month follow-up. Six-month outcome data were obtained both by telephone (patient or proxy) and accessing the South Australian Health Department Open Architecture Clinical Information System.

Statistical analyses

Normally distributed variables were expressed as mean (standard deviation) and non-normally distributed variables as median (range). Owing to the low prevalence of patients classified as robust by the majority of frailty instruments, frailty was categorised as either Frail or Not Frail (pre-frail or robust) for each instrument. Using these dichotomised frailty classifications, bivariate logistic regression models were used to assess associations between frailty instruments and poor outcome. Each instrument was modelled separately and all models included adjustment for age and gender. Thereafter, the resultant-predicted probabilities of the regression analyses were used to generate receiver operator characteristic (ROC) curves, with area under curve ($_{au}$ROC) computed to evaluate discriminative ability. An $_{au}$ROC of ≥0.7 was set as the threshold for adequate predictive accuracy [33]. Sensitivity, specificity, positive (PPV) and negative (NPV) predictive values and Youden Index (sensitivity + specificity – 1) were also calculated. All analyses were performed using SPSS for Windows 19.0 (SPSS, Inc., Chicago, IL, USA) with statistical significance set at $P < 0.05$.

Results

A total of 427 new patients aged ≥70 years were admitted to the GEMU during the study period. Study exclusion reasons were: dementia/unresolved delirium within 72 h of GEMU admission without proxy ($n = 77$), language barrier without proxy ($n = 67$), clinician advised against inclusion (elder-abuse, physically aggressive, medically unwell: $n = 33$), infectious ($n = 11$), missed by researcher ($n = 4$) and declined participation ($n = 63$). Table 1 shows admission characteristics of the 172 patients recruited. Frailty prevalence ranged from 24 to 94% depending on the instrument used.

Results from logistic regression analyses used to assess associations between frailty instruments and poor outcomes are shown in Table 2. For all instruments, strength of prediction was stronger at discharge than at 6-month follow-up. Grip strength, adapted Katz index, FI-CD and SOF were most predictive of poor discharge outcome. The FI-CD, SOF, adapted Katz index and grip strength were most predictive of poor outcome at 6 months. IADL, CHS and SHERPA were also predictive of outcomes both at discharge and at 6 months. Gait speed was predictive of poor outcome at 6 months but not at discharge. The simpler multidimensional indices (FRAIL, FI-CGA-10, MPI, HARP) and co-morbidity (CCI) were not predictive of any outcomes.

To assess predictive accuracy, $_{au}$ROC curves were computed (see Table 3 and Supplementary data available in *Age and Ageing* online, Appendix B). Overall, $_{au}$ROC values for all instruments were higher at discharge than at 6 months. FI-CD showed adequate discriminatory power for outcome prediction at both time-points (both $_{au}$ROCs >0.7). The adapted Katz index showed adequate discriminatory power for outcome prediction at discharge, but not at 6 months. All other instruments lacked discriminatory power in outcome prediction. Age lacked discriminatory power for outcome

Table 1. Admission characteristics of patients ($n = 172$)

Variable	Overall, *n* (%)
Age	
70–79 years	31 (18)
80–89 years	100 (58)
90–101 years	41 (24)
Gender (women)	129 (72)
Private health insurance	62 (36)
Residing in residential care	8 (5)
Education	
Primary school or less	73 (42)
Junior high school	83 (48)
Senior high school	10 (6)
Tertiary education	5 (3)
Birthplace	
Australia	118 (69)
UK/Europe	53 (31)
Other	1 (1)
English as primary language	139 (81)
Medical history	
Polypharmacy (≥6 medications)	131 (76)
Hearing impairment	98 (57)
Lives alone	97 (56)
Use of dentures	84 (49)
Cognitive impairment (MMSE <24)	74 (43)
Depressive risk (GDS-15 >5)	61 (40)
Malnutrition (MNA <17)	53 (31)
Falls in the previous year (self-reported)	111 (65)
Hospitalised (any reason) in the last 3 months	50 (29)
Hospital for falls in the previous year	36 (22)
Activities of daily living (ADL)	
Dependence feeding	55 (32)
Dependence washing	123 (72)
Dependence grooming	75 (44)
Dependence dressing	100 (58)
Dependence toileting	84 (49)
Dependence transferring	90 (52)
Dependence walking	67 (39)
Dependence in any ADL (≅Katz score for frailty)[a]	129 (75)
Dependence in >3 ADL	90 (52)
Dependence in all ADL	29 (17)
Medical condition	
Chronic heart failure	74 (43)
Diabetes	52 (30)
Renal impairment	37 (22)
Tumour	33 (19)
Previous myocardial infarction	31 (18)
Previous stroke	28 (16)
Pressure sore or skin ulcer	27 (16)
Peripheral vascular disease	21 (12)
CCI (≥5 illnesses)	38 (28)
Frailty and pre-frailty prevalence	
FI-CD	
Frail (index >0.45)	65 (38)
Pre-frail (index 0.2 to 0.45)	96 (56)
Robust (index <0.2)	11 (6)
CHS	
Frail (≥3 components)	96 (56)
Pre-frail (1–2 components)	64 (7)
Robust	12 (64)
SOF	
Frail (≥2 components)	120 (70)
Pre-frail (1 components)	44 (26)
Robust	6 (4)

Continued

Table 1. Continued

Variable	Overall, *n* (%)
FRAIL	
Frail (≥3 components)	107 (62)
Pre-frail (1–2 components)	62 (36)
Robust	3 (2)
FI-CGA-10	
Frail (Scores >13)	45 (26)
Pre-frail (1–2 components)	109 (63)
Robust	18 (11)
SHERPA	
High risk (score >6)[a]	87 (51)
Moderate risk (scores 5–6)	41 (24)
Low or mild risk (scores 0–4.5)	43 (25)
MPI	
Severe mortality risk (index >0.66)[a]	42 (24)
Moderate risk (index 0.34–0.66)	125 (73)
Low risk (index ≤0.33)	5 (3)
HARP	
High ADL decline risk (score ≥4)[a]	43 (25)
Moderate ADL decline risk (scores 2 or 3)	91 (53)
Low ADL decline risk (scores 0 or 1)	38 (22)
Lawton IADL	
Frail (≥3 dependencies in IADL)	98 (57)
Low grip strength (<18 kg F; <30 kg M)	128 (74)
Slow walking speed (>30 s/6 m)	46 (27)
Outcomes	
Length of GEMU stay (days); median (range)	12 (1–91)
Poor discharge outcome	35 (20)
In-hospital mortality	7 (5)
New discharge to a residential care facility	26 (15)
New discharge to high to low-level care	2 (1)
Poor 6-month outcome	78 (45)
Mortality (including in-hospital)	28 (16)
Residential care admission (including in-hospital)	50 (29)

[a]Equivalent to frailty for the purposes of our study.

FI-CD, frailty index of cumulative deficits; CHS, Cardiovascular Health Study index (Fried); SOF, Study of Osteoporotic Fractures index; FRAIL, Fatigue, Resistance, Ambulation, Illness, Loss of Weight index; FI-CGA-10, Frailty Index based on Ten Domain Comprehensive Geriatric Assessment; Katz, adapted Katz index of 7 activities of daily living (ADL); SHERPA, Score Hospitalier d'Evaluation du Risque de Perte d'Autonomie index; MPI, multi-dimensional index; HARP, hospital admissions risk profile; CCI, Charlson's co-morbidity index; GEMU, Geriatric Evaluation and Management Unit; MNA, Mini Nutritional Assessment; MMSE, Mini-Mental State Examination Score; GDS-15, Geriatric Depression Scale (15 Item).

prediction: $_{au}$ROC (discharge) = 0.571, $P = 0.195$; $_{au}$ROC (6 months) = 0.540, $P = 0.363$.

For all instruments, NPV was high for discharge and moderate-high for 6-month outcomes; PPV was low for discharge and low-moderate for 6-month outcomes. The FI-CD showed the highest Youden Index value.

Discussion

This study evaluated frailty and functional decline indices as predictors of poor outcomes in hospitalised older people. It was found that several instruments were able to identify those patients at an increased risk of poor outcomes, both at discharge and 6 months. Predictive of poor outcome at both time-points were: grip strength, FI-CD, the adapted Katz score, SOF, CHS, SHERPA and Lawton's IADL index. Gait speed was predictive of poor outcome at 6 months but not at discharge. Some indices (FRAIL, FI-CGA-10, MPI and HARP) were not predictive of any study outcomes, perhaps because our study included many severely frail patients. Age and co-morbidity did not predict poor outcomes, which confirm findings from a recent study of older rehabilitation patients [2]. As such, age and illnesses per se should not be barriers for rehabilitation access.

The FI-CD was the only instrument to show adequate discriminatory power for outcome prediction at both discharge ($_{au}$ROC = 0.735) and 6 months ($_{au}$ROC = 0.702). This good discriminatory ability agrees with a previous epidemiological study looking at mortality prediction [27] and is likely to result from the multi-dimensional nature of the FI-CD [23]. FI-CD is also advantageous because it can identify early frailty risk [23, 25].

The adapted Katz index also showed adequate discriminatory power for prediction of poor discharge outcome ($_{au}$ROC = 0.704). Katz is advantageous in a clinical setting due to its fast and simple application and it can be applied in more general hospital wards where CGAs are not routine. However, the Katz index does not identify early frailty risk or encompass frailty's multi-dimensional nature.

The phenotypic frailty indices (CHS and SOF), even though predictive of poor outcomes at both time-points, lacked sufficient discriminatory power in their predictions, which agrees with some studies of hospitalised people [3, 30, 34], but not others [3]. Our study also found that the MPI showed a low predictive ability, perhaps unexpectedly, as a recent study of hospitalised older persons found MPI outperformed other frailty instruments [30].

Overall predictive ability of frailty instruments in our study was higher at discharge than at 6 months, which was also found in a recent study of hospitalised older persons [30]. NPV was generally high for all instruments in predicting outcomes, which indicates that almost all frail patients were identified. PPV on the other hand was generally only low-moderate, indicating a high number of false positives tests occurred.

Study results should be interpreted with caution as the cut-point for frailty classification by the FI-CD (>0.45) may have identified more severely frail patients than other instruments. There was also the potential for over-estimation of performance-based frailty components. For example, patients unable to walk due to injury/illness were deemed as having low mobility. An additional limitation was the low number of patients classified as robust, which precluded a comparison of all three frailty categories (frail, pre-frail and robust). Study results may also lack generalisation to other wards, as GEMU patients are highly selected prior to their admission. Study strengths included the wide range of indices evaluated, the prospective design and the comprehensive admission data set.

Future research should focus on the clinical application of frailty instruments in a larger group of patients across multiple ward areas—particularly with regard to practicality [35],

Table 2. Results of binary logistic regression analyses indicating the contribution of frailty instruments to study outcomes[a], controlling for age and gender ($n = 172$[b])

Index	Frailty prevalence, *n* (%)	Poor discharge outcome (*n* = 35)			Poor 6-month outcome (*n* = 98)		
		OR	95% CI	*P*-value	OR	95% CI	*P*-value
Grip	128 (75)	6.47	1.46–28.60	**0.014**	2.65	1.23–5.69	**0.013**
Katz	129 (75)	5.55	1.56–11.73	**0.008**	3.17	1.45–6.91	**0.004**
FI-CD	65 (38)	5.09	2.23–11.62	**<0.001**	4.25	2.18–8.31	**<0.001**
SOF	120 (70)	3.44	1.21–9.78	**0.020**	3.26	1.55–6.87	**0.002**
Lawton	98 (57)	3.06	1.28–7.29	**0.012**	2.21	1.18–4.16	**0.014**
CHS	96 (56)	2.98	1.28–6.97	**0.012**	2.17	1.15–4.09	**0.017**
SHERPA	87 (51)	2.54	1.06–6.07	**0.037**	2.54	1.06–6.07	**0.037**
Gait speed	46 (27)	2.18	0.94–5.06	0.068	2.06	1.01–4.20	**0.046**
HARP	43 (25)	2.04	0.89–4.68	0.091	1.91	0.93–3.92	0.079
FRAIL	107 (62)	1.81	0.78–4.19	0.166	1.68	0.87–3.22	0.120
CCI	38 (28)	1.10	0.44–2.73	0.847	1.48	0.71–3.10	0.295
FI-CGA-10	45 (26)	1.01	0.42–2.43	0.976	1.59	0.79–3.19	0.195
MPI	42 (24)	0.94	0.38–2.33	0.901	1.68	0.83–3.42	0.152

[a]Poor outcome = mortality, admission to a residential care facility, or move from low-level care to high-level care within a residential care facility.
[b]Frailty was categorised as frail/not frail, with not frail = pre-frail or robust.
$n = 172$ for all outcomes, except at hospital discharge, where two patients were excluded as they were already residing in high-level care at baseline.
OR, odds ratio; CI, confidence interval; FI-CD, frailty index of cumulative deficits; CHS, Cardiovascular Health Study index (Fried); SOF, Study of Osteoporotic Fractures index; FRAIL, Fatigue, Resistance, Ambulation, Illness, Loss of Weight index; FI-CGA-10, Frailty Index based on Ten Domain Comprehensive Geriatric Assessment; Katz, adapted Katz index of 7 activities of daily living; SHERPA, Score Hospitalier d'Evaluation du Risque de Perte d'Autonomie index; MPI, multi-dimensional index; HARP, hospital admissions risk profile; CCI, Charlson's co-morbidity index.
Bold indicates significance.

Table 3. Diagnostic values for frailty, functional decline and co-morbidity indices for the prediction of poor outcomes at both discharge and at 6-month follow-up[a]

	Poor discharge outcome (*n* = 35)								Poor 6-month outcome (*n* = 98)							
Index	$_{au}$ROC	*P*-value	95% CI	Se	Sp	PPV	NPV	YI	$_{au}$ROC	*P*-value	95% CI	Se	Sp	PPV	NPV	YI
FI-CD	**0.735**	<0.001	0.64–0.83	65.7	70.4	36.5	88.8	36.1	**0.702**	<0.001	0.62–0.78	55.1	76.6	66.2	67.3	31.7
Katz	**0.704**	<0.001	0.60–0.81	91.4	29.6	25.2	93.0	21.1	0.646	0.001	0.56–0.73	84.6	33.0	51.2	72.1	17.6
SHERPA	0.697	<0.001	0.59–0.80	74.3	56.3	30.6	89.4	30.6	0.657	<0.001	0.58–0.74	65.4	61.7	58.6	68.2	27.1
Lawton	0.694	<0.001	0.59–0.80	77.1	48.9	28.1	89.2	26.0	0.635	0.002	0.55–0.72	67.9	52.1	54.1	66.2	20.1
Grip	0.690	0.001	0.59–0.79	94.3	31.1	26.2	95.5	25.4	0.627	0.004	0.54–0.71	84.6	34.0	51.6	72.7	18.7
SOF	0.679	0.001	0.58–0.78	85.7	33.6	25.2	90.0	19.3	0.657	<0.001	0.58–0.74	85.7	33.6	25.2	90.0	19.3
CHS	0.675	0.001	0.57–0.78	74.3	49.6	27.7	88.2	23.9	0.627	0.004	0.54–0.71	65.4	52.1	53.1	64.5	17.5
Gait	0.643	0.009	0.53–0.75	37.1	76.3	28.9	82.4	13.4	0.613	0.011	0.53–0.70	33.3	78.7	56.5	58.7	12.1
HARP	0.639	0.011	0.53–0.75	37.1	79.3	31.7	82.9	16.4	0.600	0.024	0.52–0.69	32.1	80.9	58.1	58.9	12.9
FRAIL	0.638	0.012	0.53–0.74	71.4	40.7	23.8	84.6	12.2	0.608	0.015	0.52–0.69	67.9	42.6	49.5	61.5	10.5
MPI	0.617	0.033	0.50–0.73	22.9	76.3	20.0	79.2	−0.8	0.599	0.025	0.51–0.68	29.5	79.8	54.8	57.7	9.3
FI-CGA-10	0.617	0.033	0.50–0.73	25.7	74.8	20.9	79.5	0.50	0.588	0.047	0.50–0.67	30.8	77.7	53.3	57.5	8.4
CCI	0.579	0.074	0.49–0.67	25.6	80.9	52.6	56.7	6.50	0.592	0.039	0.51–0.68	80.9	52.6	56.7	45.3	<0.1

[a]Poor outcome = mortality, admission to a residential care facility, or move from low-level care to high-level care within the residential facility.
$n = 172$ for all outcomes, except hospital discharge, where two patients were excluded as they were already residing in high-level care at baseline.
$_{au}$ROC, area under receiver operator characteristic curve (adjusted for age and gender); CI, confidence interval; Se, sensitivity; Sp, Specificity; PPV, positive predictive value; NPV, negative predictive value; YI, Youden index; FI-CD, frailty index of cumulative deficits; CHS, Cardiovascular Health Study index (Fried); SOF, Study of Osteoporotic Fractures index; FRAIL, Fatigue, Resistance, Ambulation, Illness, Loss of Weight index; FI-CGA-10, Frailty Index based on Ten Domain Comprehensive Geriatric Assessment; Katz, adapted Katz index of 7 activities of daily living; SHERPA, Score Hospitalier d'Evaluation du Risque de Perte d'Autonomie index; MPI, multi-dimensional index; HARP, hospital admissions risk profile; CCI, Charlson's co-morbidity index.
Bold indicates adequate discriminatory power ($_{au}$ROC >0.7).

detection of frailty change [23] and ability to distinguish pre-frailty from frailty [35].

Conclusion

Frailty and functional decline instruments can be used to identify older hospitalised patients at risk of poor outcomes post-hospitalisation. However, only the FI-CD and the adapted Katz index achieved adequate discriminatory power for outcome prediction at discharge; and only the FI-CD achieved adequate discriminatory power in predicting poor 6 month outcome. Further research in a larger group of hospitalised older patients is warranted.

Key points

- Frailty is common in hospitalised older people.
- Frailty and functional decline instruments can be used to identify older patients at risk of poor outcomes.
- The FI-CD showed the highest discriminatory power in predicting poor outcomes at both time-points.

Authors' contributions

E.D., R.V. and I.C. conceived the study and participated in its design. E.D. conducted all data collection and established the database. S.H. and E.D. contributed to the statistical analysis of data. S.H., E.D., R.V. and I.C. contributed to the interpretation of the data. E.D. completed the first draft of the manuscript. All authors read and approved the final manuscript.

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Conflicts of interest

R.V. is on the Malnutrition in the Elderly Advisory Board, Nestle Australia. She has been part of the PROT-AGE initiative and the MNA initiative which was supported by educational grants from Nestle, Inc.

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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Falls prevention in hospitals and mental health units: an extended evaluation of the FallSafe quality improvement project

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Abstract

Background: inpatient falls are a major patient safety issue causing distress, injury and death. Systematic review suggests multifactorial assessment and intervention can reduce falls by 20–30%, but large-scale studies of implementation are few. This paper describes an extended evaluation of the FallSafe quality improvement project, which presented key components of multifactorial assessment and intervention as a care bundle.
Methods: data on delivery of falls prevention processes were collected at baseline and for 18 months from nine FallSafe units and nine control units. Data on falls were collected from local risk management systems for 24 months, and data on underreporting through staff surveys.
Results: in FallSafe units, delivery of seven care bundle components significantly improved; most improvements were sustained after active project support was withdrawn. Twelve-month moving average of reported fall rates showed a consistent downward trend in FallSafe units but not controls. Significant reductions in reported fall rate were found in FallSafe units (adjusted rate ratio (ARR) 0.75, 95% confidence interval (CI) 0.68–0.84 $P < 0.001$) in the 12 months following full implementation but not in control units (ARR 0.91, 95% CI 0.81–1.03 $P = 0.13$). No significant changes in injurious fall rate were found in FallSafe units (ARR 0.86, 95% CI 0.71–1.03 $P = 0.11$), or controls (ARR 0.88, 95% CI 0.72–1.08 $P = 0.13$). In FallSafe units, staff certain falls had been reported increased from 60 to 77%.