Is the Clinical Frailty Scale at emergency department triage associated with adverse outcomes for older people?

Abstract

Study hypothesis

Is the Clinical Frailty Scale (CFS) applied at Emergency Department (ED) triage associated with important service and patient related outcomes?

Methods

We undertook a single centre, retrospective cohort study examining hospital-related outcomes and their associations with frailty scores assessed at ED triage. Participants were aged 65 or older, registered on their first ED presentation during the study period at a single, centralised ED in the UK. Baseline data included age, gender, CFS, National Early Warning Score-2 and the Charlson Comorbidity Index; outcomes included length of stay, readmissions (any future admissions), and mortality (in or out of hospital) up to two years following ED presentation. Survival analysis methods (standard and competing risks) were applied to assess associations between ED triage frailty scores and outcomes. Unadjusted incidence curves and adjusted hazard ratios are presented.

Results

52,562 individuals representing 138,328 ED attendances were included; participants' mean age was 78.0 years, 55% were female. Initial admission rates generally increased with frailty. Mean length of stay after 30 or 180 days follow up was relatively low; all CFS categories included patients that experienced zero days length of stay (i.e. ambulatory care) and patients with relatively high numbers of days in hospital.

Overall 46% of study participants were readmitted by the two year follow-up. Readmissions increased with CFS score up until CFS 6, then attenuated. Mortality rates increased with increasing frailty, the adjusted hazard ratio was 3.6 for CFS 7-8 compared to CFS 1-3.

Conclusions

Frailty assessed at ED triage (using the Clinical Frailty Scale) is associated with adverse outcomes in older people. Its use in ED triage might helpfully aid immediate clinical decision making and service configuration.

Introduction

Background

Older people with frailty admitted to hospital are at increased risk of a range of adverse outcomes, both in hospital and in the period following discharge[1]. A number of studies have confirmed that the Clinical Frailty Scale (CFS) is able to identify cohorts of hospitalised older people at risk of adverse outcomes, such as increased length of stay, functional decline, institutionalisation, and mortality[2-8].

Importance

Despite its feasibility of use in the Emergency Department (ED) setting[9], there is uncertainty about the predictive accuracy of the CFS when applied in the ED as a triage tool[10]. If frailty assessment is to be useful in the ED, intended users need to have confidence in its accuracy, especially if they are to use it to identify individuals who may benefit from frailty attuned interventions (e.g. Comprehensive Geriatric Assessment[11], person centred care[11], early discharge planning[1213] and advance care planning[13]). To our knowledge only one previous study has looked at the predictive properties of the CFS when applied at ED triage[14]. However, the previous study focused on short-term (30 day) outcomes and did not assess the predictive performance of the CFS for important quality indicators, such as length of stay and readmission.

Goal

The aim of this study was to assess the associations of the CFS when applied at emergency department triage with important patient and service outcomes.

Methods

Study design and setting

We undertook a single centre, retrospective cohort study examining service outcomes and mortality captured on routine datasets.

The Leicester Royal Infirmary (LRI) is one of the largest single-site Emergency Departments in the UK. The catchment population is approximately 1.1 million people, of whom around 165,000 are 65 years or older. The ED has over 230,000 attendances a year, including around 48,000 older people.

The LRI ED has been implementing screening for frailty since 2016, initially determining which tool was most useful[9], and then implementing CFS scoring using a structured programme including:

1. *Internal validation of CFS use* – clinical records were reviewed for evidence of frailty documentation, and accuracy (inter-rater reliability kappa>0.8[15 16]).

2. *Interventions* – education and training of all staff groups, individualised feedback, embedding the CFS into the Electronic Health Record (EHR - Nervecentre).
3. *Continuous measurement* - run charts were used to assess CFS use and notes were reviewed for evidence that frailty identification was linking to elements of Comprehensive Geriatric Assessment.

Selection of participants

This study examined care and outcomes for older people (65+), registered following their index ED presentation during the study period (01/10/17 to 30/09/2019).

Sample size

Given the exploratory nature of this study, no prior sample size calculation was undertaken. It was known that there would be tens of thousands of eligible patients attending each year, with high readmission and mortality rates are expected in this older population, ensuring a sufficient number of events would be observed during the study follow-up.

Measurements

The CFS is a 9-point scale representing different levels of frailty[17]. Starting at 1 (very fit), the scale progresses through increasing levels of frailty to 8 (very severely frail), and 9 (terminally ill). For the purposes of this study, we assigned the different categories into five groups:

- CFS 1-3: fit-managing well
- CFS 4-5: vulnerable/mild frailty
- CFS 6: moderate frailty
- CFS 7-8: severely to very severely frail
- CFS 9: terminally ill; life expectancy <6 months, but not otherwise evidently frail

The CFS was recorded on the Electronic Health Record (EHR) by the initial assessing clinician, typically a triage-trained staff nurse or emergency physician. We linked EHR CFS scores to Patient Administration Systems (PAS) using the hospital number (unique identifier); this allowed hospital metrics and outcomes, such as mortality, to be captured at the individual patient level.

Outcomes

The baseline and outcome data related to the index ED presentation only (the individual's first emergency presentation during the two year period). Baseline data included age, gender, CFS, acuity (National Early Warning Score-2, NEWS-2[18]), and the Charlson Comorbidity Index (CCI)[19]. PAS data contain a list of International Classification

of Disease version 10 (ICD-10) codes (used in this context for reimbursement), which were used to calculate the CCI for those admitted at their index ED presentation.

We tracked subsequent hospital use and outcomes for up to two years post index ED presentation; as participants entered the cohort at different time points, the follow-up period was variable. Outcomes were limited to service use, such as initial disposition, length of stay, readmission, and mortality (in or out of hospital). All participants were followed up until the study end, so no outcome data was lost.

Analyses

Baseline characteristics are reported using descriptive statistics; frequency and percent are reported for categorical variables and mean (SD), range, and median (IQR) are reported for continuous variables. The proportion and relative risk of admission are reported by CFS categories. Length of stay was calculated as the number of days between attendance and discharge, as recorded on the hospital systems. Length of stay is known to increase with frailty severity, except for individuals who have a CFS of 9, who have better access to community palliative care service (hence shorter stays)[4 20]. Instead, we estimated the cumulative time spent in hospital post initial ED attendance at 30 or 180 days, in those with at least that amount of follow-up.

Time to readmission was analysed using competing risks methods, with death as a competing event. Non-parametric cumulative incidence curves are presented to compare the unadjusted probability of readmission between CFS categories. The Fine and Gray subdistribution model[21] was applied to compare subdistribution hazard ratios of readmission between CFS categories, adjusted for age, gender, CCI, and NEWS-2. Mortality was analysed using standard survival analysis methods. Kaplan Meier survival plots, censored around five weeks following the end of the two-year period for recording attendances, are presented for unadjusted probability of death over time by CFS categories. Time to death was compared between CFS categories using Cox proportional hazards modelling[22], adjusted for age, gender, CCI and EWS. Both the proportional hazards and proportional subdistribution hazards assumptions were tested visually using Schoenfeld residuals plotted against time and found to be satisfactory. All analyses were performed in Stata version 16.

Ethics and governance

The study was undertaken as a service evaluation, under the auspices of the University Hospitals of Leicester frailty strategy – so no ethical approval was required. Governance approvals were granted by the hospital's Clinical Audit and Service Evaluation department. All data were fully anonymised prior to transfer from the NHS to the University for analysis. No funding was received for undertaking this work.

Results

Characteristics of study subjects

We obtained data on 52,562 individuals representing 138,328 ED attendances within the study period, following the removal of 366 attendances in the data cleaning process (due to duplicate Attendance ID (193 cases), near-duplicate time of Arrival at ED (15 cases), no recorded time of Disposition (1 case), no recorded time of discharge (44 cases), or period of time in ED overlaps with that of another spell (211 cases). Baseline data at first ED presentation are summarised in Table 1. Of the patients with an ED attendance during the study period, the mean age was 78.0 (SD 8.5, range 65-107) and 55.1% (28,981) were female. Overall, 50.3% (26,454) had CFS scores recorded; the CFS category distribution was:

- CFS 1-3: 32.1% (8,479)
- CFS 4-5: 37.0% (9,783)
- CFS 6: 17.9% (4,737)
- CFS 7-8: 12.3% (3,265)
- CFS 9: 0.7% (190)

Table 1 Baseline characteristics of patients stratified by CFS categories

Variable	**Study Sample (n=52,562)**	**CFS recorded (n=26,454, 50.3%)**	**No CFS recorded (n=26,108, 49.7%)**	**CFS 1–3 (n=8,479, 32.1%)**	**CFS 4-5 (n=9,783, 37.0%)**	**CFS 6 (n=4,737, 17.9%)**	**CFS 7-8 (n=3,265, 12.3%)**	**CFS 9 (n=190, 0.7%)**
Age, years (missing for 234 patients)								
Mean (SD)	78.0 (8.5)	80.1 (8.4)	75.9 (8.0)	75.4 (7.2)	81.0 (7.7)	84.0 (7.9)	84.3 (8.3)	80.2 (8.5)
Min, Max	65, 107	65, 107	65, 106	65, 101	65, 106	65, 107	65, 105	65, 101
Median (IQR)	78 (71, 85)	80 (73, 87)	75 (69, 82)	74 (70, 81)	81 (75, 87)	85 (79, 90)	85 (79, 91)	80 (73, 86)
Female gender	28981, 55.1%	14990, 56.7%	13991, 53.6%	4370, 51.5%	5545, 56.7%	2926, 61.8%	2056, 63.0%	93, 48.9%
CCI category (calculated only when there is a hospital admission)								
Not admitted	26,121	9,789	16,332	4,514	3,140	1,183	896	56
0	8866, 33.5%	5294, 31.8%	3572, 36.5%	1917, 48.3%	2105, 31.7%	823, 23.2%	440, 18.6%	9, 6.7%
1 to 2	11959, 45.2%	7766, 46.6%	4193, 42.9%	1551, 39.1%	3155, 47.5%	1782, 50.1%	1247, 52.6%	31, 23.1%
3 to 5	4299, 16.3%	2750, 16.5%	1549, 15.8%	326, 8.2%	1053, 15.9%	787, 22.1%	570, 24.1%	14, 10.4%
6 or more	1317, 5.0%	855, 5.1%	462, 4.7%	171, 4.3%	330, 5.0%	162, 4.6%	112, 4.7%	80, 59.7%
Early Warning Score								
% Recorded	77.3%	87.7%	66.8%	78.7%	90.3%	93.2%	94.8%	91.6%
Mean (SD)	1.74 (2.45)	1.88 (2.49)	1.56 (2.39)	1.29 (1.95)	1.78 (2.31)	2.17 (2.61)	2.89 (3.18)	4.52 (4.26)
Min, Max	0, 22	0, 20	0, 22	0, 14	0, 17	0, 17	0, 20	0, 18
Median (IQR)	1 (0, 3)	1 (0, 3)	1 (0, 2)	1 (0, 2)	1 (0, 3)	1 (0, 3)	2 (0, 5)	3 (1, 7)

Main results

Average follow-up from ED attendance to either death or the end of the study recording period was a median of 380 days (IQR: 175 to 585); overall 19,479 people were readmitted at least once and 9,215 died during the two year follow-up. The proportion of participants admitted following the index ED presentation was:

- CFS 1-3: 46.8%
- CFS 4-5: 67.9%
- CFS 6: 75.0%
- CFS 7-8: 72.6%
- CFS 9: 70.5%
- CFS not recorded: 37.4%

The relative risk of admission (CFS 1-3 being the reference category) was:

- CFS 4-5: 1.45 (95% CI 1.41-1.49)
- CFS 6: 1.60 (95% CI 1.56-1.65)
- CFS 7-8: 1.55 (95% CI 1.50-1.60)
- CFS 9: 1.51 (95% CI 1.37-1.66)
- CFS not recorded: 0.80 (95% CI 0.78-0.82)

Table 2 shows the cumulative number of days spent in hospital by CFS category, assessed at 30 or 180 days post index ED attendance in those who were ever admitted with at least this amount of follow-up. As expected, increasing frailty was associated with increased number of days in hospital at 30 and 180 days for those who were ever admitted although, when considering all patients, this dropped off slightly for the CFS 7-9 categories. Some patients across all CFS categories experienced very short admissions (less than 24 hours, i.e. observational medicine). The mean or median bed days at either 30 or 180 days follow up was reassuringly low, but equally all CFS categories exhibited some extremely high numbers of days in hospital (either at 30 or 180 day censor points), although the maximum days in hospital for the CFS 7-8 was 110/180 days, and 36/180 for those with CFS 9.

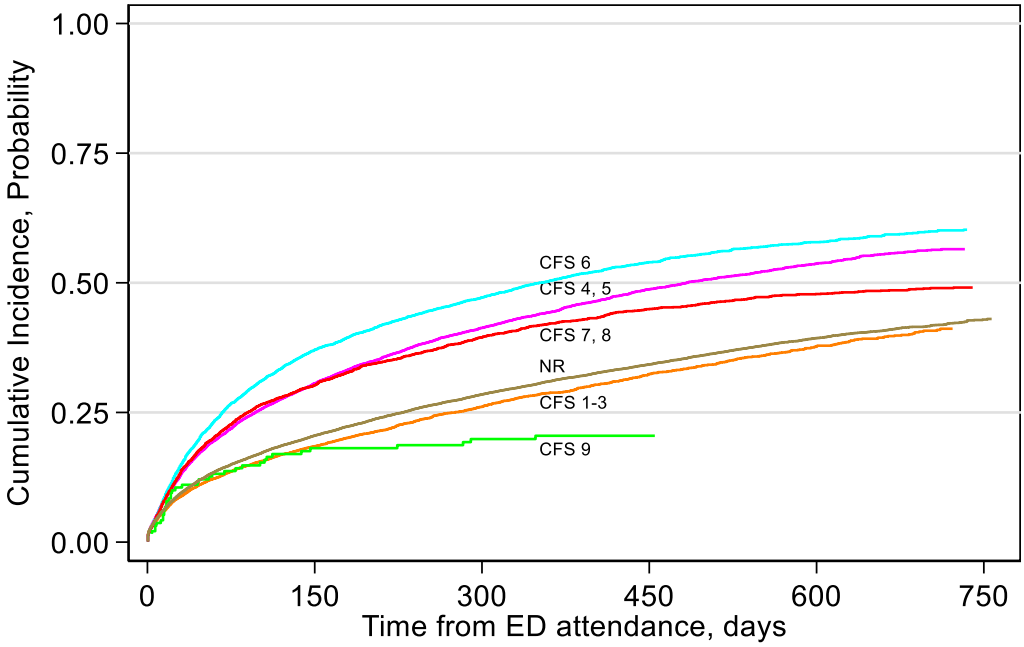
Table 2 Cumulative length of stay stratified by CFS categories

Variable	Study Sample (n=52,562)	CFS recorded (n=26,454, 50.3%)	No CFS recorded (n=26,108, 49.7%)	CFS 1–3 (n=8,479, 32.1%)	CFS 4-5 (n=9,783, 37.0%)	CFS 6 (n=4,737, 17.9%)	CFS 7-8 (n=3,265, 12.3%)	CFS 9 (n=190, 0.7%)
Proportion of patients with zero time spent in hospital, within 30 days* following ED attendance								
	58.3%	48.0%	68.8%	60.5%	41.7%	38.5%	46.6%	73.2%
Total days spent in hospital, within 30 days* following ED attendance								
Mean (SD)	8.1 (8.0)	8.4 (8.0)	7.6 (7.9)	6.3 (6.9)	8.3 (7.9)	9.9 (8.5)	10.3 (8.7)	10.4 (8.2)
Min, Max$	0.0, 30.0	0.1, 30.0	0.0, 30.0	0.1, 30.0	0.1, 30.0	0.1, 30.0	0.1, 30.0	1.0, 30.0
Median (IQR)	5.4 (2.0, 11.4)	5.7 (2.2, 12.0)	5.0 (2.0, 10.5)	4.0 (1.5, 8.0)	5.7 (2.2, 11.7)	7.4 (3.2, 14.0)	7.8 (3.0, 15.3)	9.0 (3.3, 12.5)
Proportion of patients with zero time spent in hospital, within 180 days following ED attendance**								
	53.9%	43.9%	64.1%	57.2%	36.8%	34.1%	43.0%	71.6%
Total days spent in hospital, within 180 days following ED attendance, for those who spent any time during that period**								
Mean (SD)	12.2 (15.1)	12.7 (15.1)	11.4 (14.9)	9.1 (14.0)	12.6 (14.6)	15.2 (16.6)	14.8 (15.1)	11.6 (9.3)
Min, Max$	0.1, 180	0.1, 180	0.1, 179.9	0.1, 180.0	0.1, 172.0	0.1, 175.5	0.1, 109.7	1.0, 36.4
Median (IQR)	7.0 (2.6, 16.0)	7.5 (3.0, 17.0)	6.2 (2.0, 14.4)	4.6 (2.0, 10.5)	7.8 (3.0, 17.0)	10.0 (4.3, 21.0)	10.0 (4.0, 20.5)	10.6 (4.0, 14.0)

*All patients in this analysis were followed up for at least 30 days
**These results exclude the 8759 patients followed up for less than 180 days

The probability of readmission by two years was 46%; the rates increased with increasing frailty (Figure 1 and Table 3). Readmission rates increased with increasing frailty up to CFS 6 (moderate frailty), but then decreased, with the lowest rate of all being for CFS 9.

*Figure 1 Plot of the cumulative incidence for **readmission**, without adjustment, with death as a competing risk (NR=not recorded)*



Number at risk

CFS 6	4737	2626	1753	1129	661	59
CFS 4, 5	9783	5767	3576	2069	1058	99
CFS 7, 8	3265	2088	1496	1058	689	97
NR	26108	18839	14337	9904	5114	552
CFS 1-3	8479	5408	3194	1691	836	87
CFS 9	190	134	112	86	54	12

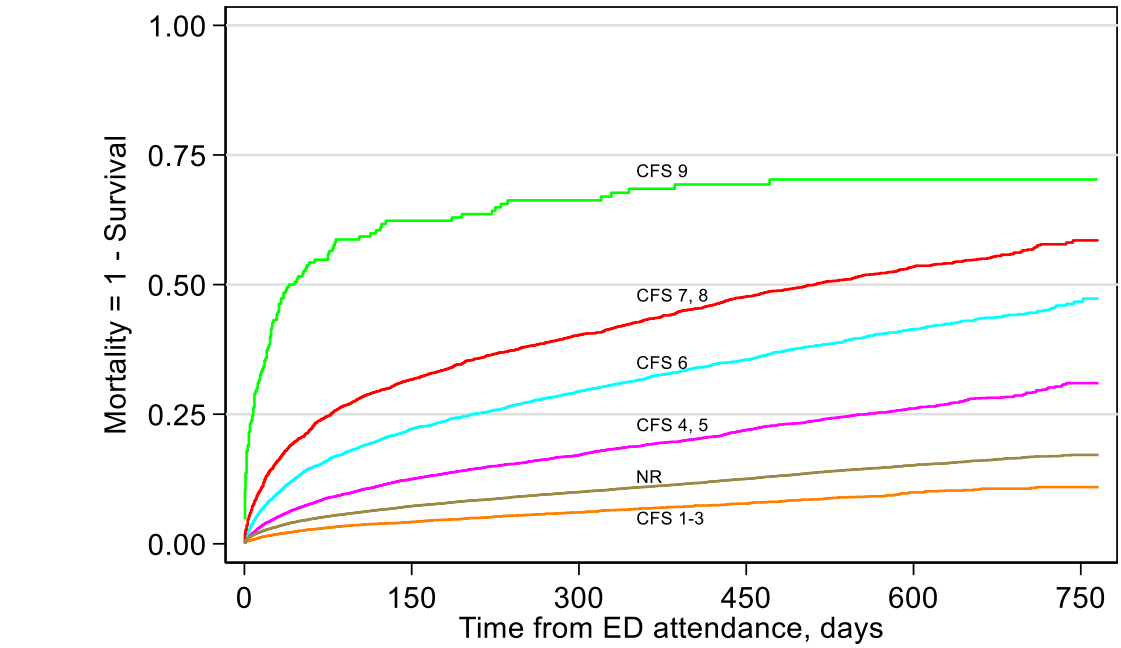
Overall mortality was 24% at two years, but mortality increased through the CFS categories (Figure 2). Interestingly, the mortality for those with missing CFS scores was similar to those with CFS 1-3 scores.

*Table 3 Fine and Gray regression comparison of time from arrival at ED to **readmission**, with death as a competing risk, by CFS category, adjusted for age, gender, CCI category, and NEWS-2.*

Variable		**n**	**sHR***	**95% CI**
CFS category	1 to 3	8479	Ref	- - - - - - - -
	4 or 5	9783	1.43	1.35 to 1.50
	6	4737	1.56	1.47 to 1.66
	7 or 8	3265	1.20	1.12 to 1.29
	9	190	0.50	0.36 to 0.70
	Not recorded	26108	1.21	1.16 to 1.27
Age, per 10 years			1.13	1.11 to 1.15
Gender	Male	23581	Ref	- - - - - - - -
	Female	28981	0.85	0.83 to 0.88
CCI category	0	8866	Ref	- - - - - - - -
	1 or 2	11959	1.13	1.08 to 1.18
	3 to 5	4299	1.12	1.06 to 1.18
	6 or more	1317	0.96	0.87 to 1.06
	Not admitted	26121	0.72	0.69 to0.75
EWS	<= 4	36893	Ref	- - - - - - - -
	>5	3735	0.81	0.77 to 0.86
	Not recorded	11934	0.69	0.63 to 0.72

*sHR=Subdistribution hazard ratio

Figure 2 Plot for mortality, as 1 – KM survival, by CFS category, without adjustment (NR=not recorded)



Number at risk

CFS 9	190	63	48	36	21	3
CFS 7, 8	3265	2055	1481	1028	641	73
CFS 6	4737	3270	2413	1671	1006	104
CFS 4, 5	9783	7319	5153	3293	1815	176
NR	26108	22006	18175	13412	7406	809
CFS 1-3	8479	6392	4164	2458	1344	176

Table 4 Cox proportional hazards regression comparison of time from arrival at ED to death, by CFS category, adjusted for age, gender, CCI and EWS.

Variable		**n**	**HR**	**95% CI**
CFS category	1 to 3	8479	Ref	- - - - - - - -
	4 or 5	9783	1.71	1.55 to 1.88
	6	4737	2.44	2.21 to 2.69
	7 or 8	3265	3.65	3.30 to 4.03
	9	190	5.60	4.59 to 6.82
	Not recorded	26108	1.77	1.62 to 1.94
Age, per 10 years			1.66	1.62 to 1.71
Gender	Male	23581	Ref	- - - - - - - -
	Female	28981	0.72	0.69 to 0.75
CCI category	0	8866	Ref	- - - - - - - -
	1 or 2	11959	1.85	1.73 to 1.97
	3 to 5	4299	2.87	2.67 to 3.08
	6 or more	1317	9.19	8.44 to 10.029
	Not admitted	26121	0.46	0.42 to 0.49
EWS	<= 4	36893	Ref	- - - - - - - -
	>5	3735	1.80	1.71 to 1.90
	Not recorded	11934	0.81	0.75 to 0.88

Limitations

The strengths of this description of outcomes for older people in emergency care settings include the large sample size, the inclusion of proximal and more distal patient harms, as well as service outcomes. We only captured acute hospital length of stay which does not reflect the entire patient journey, which could have included time in rehabilitation or other similar facilities. Our hospital records do not reliably capture new institutionalisation. We cannot exclude selection bias as an explanation for the changes observed; it is plausible that community service developments may have changed the nature of ED attendances over time. A disadvantage of routinely collected data is that it is dependent upon routine clinical practice[23]; in this case, not all patients were assessed for frailty using the CFS (despite several years of implementation). CFS completion was

not mandatory; many people for whom CFS was not recorded would have had short ED attendances in the 'minor injuries' area where the triage process is often condensed. Whilst there were high amounts of missing CFS scores, it is noteworthy that outcomes for this cohort were similar to those with lowest frailty levels; whether this reflects the assessors' assumptions about robustness vs. frailty is unclear. Charlson scores were only available for those patients who were admitted to hospital; we cannot be sure, but suspect that individuals discharged were at lower risk of adverse outcomes. Perhaps the main weakness of this work is that it has not captured direct patient outcomes such as function, satisfaction or quality of life; we are not aware of robust measures that are in place in routine data to enable such data to be collected out with a research trial.

Discussion

To our knowledge, this is the largest study of the Clinical Frailty Scale applied in emergency department triage, to identify the risk of adverse outcomes in older people. The CFS applied at a single point in time, even when adjusted for prognostically important covariates, was a strongly associated with the risk of increased hospital use and death. Cumulative days in hospital following the index ED attendance (over 30 or 180 days) generally increased with increasing CFS scores, whether this reflect service configuration, such as community support, is not possible to tell from this analysis.

Readmission rates increased with increasing frailty up to CFS 6 (moderate frailty), but then declined for higher CFS scores. This relationship was also observed for CCI category and EWS. It is important to note that those with higher frailty and comorbidity scores are much more at risk of mortality (as shown in table 4) and thus the observed relationship is likely to be due to these participants dying before having the chance to be readmitted. Competing risks analyses allow us to disentangle these relationships, and are essential for evaluating outcomes other than death in frail, older populations.

Our findings are consistent with the widely reported literature on frailty being associated with adverse outcomes in older people[2-8], as well as UK hospitalisation rates[24 25]. Importantly, the harms seen in this study are remarkably similar to those reported by Wallis *et al*[4]. Nevertheless, given different system configurations across the world, it would be important for sites to ascertain the outcomes from emergency triage CFS in their own settings.

Emergency clinicians might find the CFS scores in triage useful, helping gauge what the likely post-ED outcomes might be for cohorts of people with different levels of frailty. It might prompt consideration of more aggressive intervention in the very old but robust (assuming such intervention is valued by the patients themselves) or more palliative approaches in those with severe frailty, noting that no tool in isolation should be used to

direct clinical decision making. Frailty is an important predictor for geriatric syndromes such as delirium[26], so increased frailty might prompt emergency clinicians to more actively seek out cognitive impairment in frail older people, and initiate evidence based interventions[27]. Knowing frailty status prior to the acute illness or recent decline also helps to guide realistic goal setting and shared decision-making. When the decision is to admit, higher levels of frailty ('measured complexity') can help channel the admission to inpatient areas where frailty attuned care is available (such as Comprehensive Geriatric Assessment (CGA)[11]). Inpatient CGA makes older patients more likely to be alive and in their own homes at follow-up[11], and may also lead to higher levels of patient satisfaction[28].

Frailty and acute illness severity have been shown to be important and synergistic predictors of mortality when combined[3], but further testing of this concept is important if it is to influence policy decisions about which early warning systems should be in place. This is important given the concerns about the utility of physiological scores in older people[29 30]. Further work could examine the link between frailty at presentation, ED processes and hospital acquired harms, with a view to early activation of preventative strategies for those at the highest risk. Comparing and contrasting outcomes obtained with manual scores (with up to 50% of patients being missed) and more systematised tools such as the Hospital Frailty Risk Score[31] might be informative.

Finally, this was a single centre, hypothesis generating study, so validation in other settings would be useful.

In summary, frailty assessed at emergency department triage (using the Clinical Frailty Scale) is a potentially important predictor of adverse outcomes. A free to use CFS app is now available (https://apps.apple.com/gb/app/clinical-frailty-scale-cfs/id1508556286). Its use in ED triage might usefully influence immediate clinical decision making and service configuration.

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