

Original Article

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Comparison of two frailty screening tools for acutely admitted elderly patients

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ABSTRACT

INTRODUCTION. Frailty is a clinical syndrome that arises due to age-related decline, diseases, malnutrition and lifestyle. Two major perspectives on frailty exist: frailty as a phenotype and frailty as an accumulation of deficits. The two types are measured by Fried's Phenotype (FP) and the Clinical Frailty Scale (CFS), respectively. The aim of this study was to investigate which model best predicts 90-day mortality in elderly patients acutely admitted to an emergency department in Denmark.

METHODS. This study comprised a prospective cohort with the following inclusion criteria: age >65 years, acute admission and admission >24 h. Bispebjerg Hospital, Odense University Hospital and Hospital of Southwest Jutland participated in the study. The FP and the CFS were measured in all patients. Descriptive statistics, relative risk (RR), odds ratio (OR), risk difference and receiver-operating characteristics (ROC) analysis were performed. The outcome was 90-day mortality.

RESULTS. A total of 1,030 patients participated (mean age: 78.2 years, 54% female). Among these, 221 were frail by the FP (score > 3) and 555 participants were frail by the CFS (score > 5). Within 90 days, 128 died. The analyses revealed significant associations between frailty and 90-day mortality. For the FP, the RR was 2.67 (95% confidence interval (CI): 1.93-3.69), $p < 0.001$; and for the CFS, the RR was 4.12 (95% CI: 2.65-6.42), $p < 0.001$. The adjusted OR for the CFS was 4.38 (95% CI: 2.68-7.13); for the FP, 3.88 (95% CI: 2.51-6.01).

CONCLUSION. A significant association existed between frailty and 90-day mortality in the Danish cohort. However, the CFS is a better predictor of 90-day mortality than the FP. Even so, the CFS still has a lack of sensitivity and specificity.

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Frailty is a common clinical syndrome in older adults that carries an increased risk of poor health outcomes including falls, hospitalisation and mortality [1-5]. Frailty entails an age-related decline in organ function, multimorbidity, malnutrition and inactivity [5], causing reduced physiological reserves and ability to resist stressors [5-7]. Frail elderly people have increased vulnerability to sudden and even minor changes in health status [6]. Elucidating the aetiology and natural history of frailty is therefore critical for identifying high-risk subsets and new arenas for prevention and treatment.

Even so, no international or consensus exists about how to define and identify frailty [1]. It is estimated that 25-50% of people over 85 years are frail [4]. Evidence shows an association between frailty and mortality [2, 3] and systematic monitoring of frailty is recommended [4]. Despite this recommendation, an early screening for frailty in elderly patients in emergency departments (ED) had not yet been implemented [6]. Likewise, in Denmark, we have no common agreement on how to define and identify frailty, and screening for frailty has yet to be implemented.

Over the past 20 years, many different definitions of frailty have been developed most of which are targeted at specific clinical specialties [2, 3]. However, two major overall perspectives on frailty exist; frailty as an objectively measured clinical syndrome and frailty as an accumulation of deficits [4, 5]. "Fried's Phenotype" (FP) is a five-step clinical observation completed at the bedside for each patient who was validated by Fried et al. [7]. They defined frailty as a distinct clinical syndrome.

Frailty as an accumulation of deficits is measured by the Clinical Frailty Scale (CFS). The CFS is frailty screening model developed by Rockwood et al. that defines frailty as a multifactorial clinical syndrome [8].

This study investigated which model – FP or CFS – that best predicted 90-day mortality in elderly patients acutely admitted to an ED in Denmark.

METHODS

Study design and population

The study population was drawn from the Criteria for Screening and Triaging to Appropriate Alternative care (CriSTAL) study, an international multicentre, prospective cohort study [9, 10].

The criteria for being included in the cohort were age > 65 years, acute contact at the ED with subsequent admission exceeding 24 h. The exclusion criteria were hospital stay < 24 h, inability to communicate in Danish or English, dementia, cognitive impairments or a decreased level of consciousness [11].

All data were collected during the first 48 h of admission by designated study nurses. After securing a signed informed consent form for study participation, data were collected through face-to-face assessment with patients and healthcare chart review. Follow-up data were collected by study nurses through a telephone interview with the patient or his/her relative(s) and by collecting medical record data.

For this study, a sub-sample including 1,030 Danish patients were enrolled between January and June 2016 during business hours from EDs at Bispebjerg and Frederiksberg Hospital, Odense University Hospital, and from the Hospital of Southwest Jutland, Denmark.

The CriSTAL study was approved in Australia by the South Eastern Sydney Local Health District Ethics Committee [/026 HREC/15/POW/55]. Data were stored in the UNSW secure server [10]. In Denmark, the study was deemed exempt from approval by the Regional Health Research Ethics Committee of Southern Denmark as the study was considered a quality improvement initiative without an intervention. All patients in the study completed a written informed consent form.

Measurements

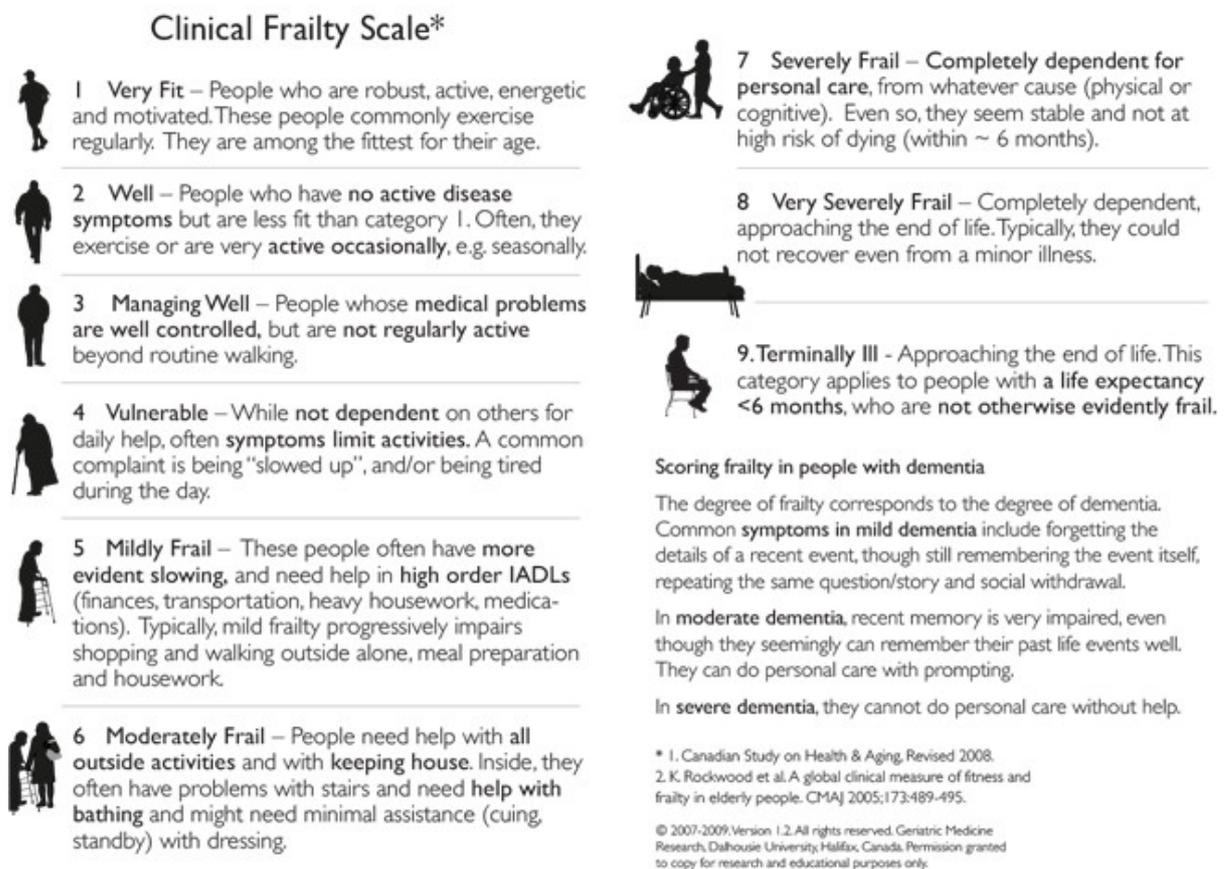
The degree of frailty for each patient was evaluated by the FP [7] and the CFS [8]. The order of data collection regarding the CFS and FP was unsystematic and data were measured in the same session as described in the protocol for the CriSTAL study [9, 10].

The FP model includes five criteria, and patients were categorised as frail if they met ≥ 3 criteria [7]. The criteria

were: 1) unintentional weight loss, 2) self-reported poor endurance/exhaustion during daily activities, 3) muscle weakness, 4) slowness and 5) low physical activity level [7]. Fried et al. validated the FP model using the Cardiovascular Health Study Cohort (n = 5,317) and found that FP was a strong predictor for mortality [7].

CFS (**Figure 1**) is a validated model developed by Rockwood et al. [8] who define frailty as a multifactorial clinical syndrome. The CFS is a clinically easily usable edition of the more comprehensive Frailty Index derived from The Canadian Study on Health and Aging. The CFS uses clinical descriptors and pictographs to stratify older adults according to level of vulnerability and number of deficits. Participants are scored from 1 (very fit) to 9 (terminally frail) and categorised as frail when scoring ≥ 5 [8, 12].

FIGURE 1 Illustration of the levels of frailty according to Clinical Frailty Scale.



The outcome measure was death within 90 days after discharge.

Statistics

The descriptive statistics of mean, standard deviation, range, proportions and counts were applied on the data set to describe variations and distributions of exposure, outcome and covariates.

Primarily, logistic regression analysis was used to determine the strength of the association between each frailty screening tool and 90-day mortality, adjusting for age, sex and index hospital. The odds ratio (OR) was calculated for continuous variables of both screening tools and compared. The relative risk (RR) of 90-day mortality was calculated with 95% confidence interval (CI) for frailty assessed by a dichotomous variable of FP and CFS. The risk difference (RD) between the frail and non-frail was calculated with 95% CI for both FP and CFS.

Secondly, the applicability of the predefined cut-off values for both frailty screening tools [7, 8] were tested on the Danish cohort. Sensitivity tests (± 1) were applied, illustrated by a receiver-operating characteristic (ROC) curve. In addition, the areas under the ROC curves (AUROC) were calculated as a measure of the accuracy of the screening tools.

All analyses were performed using SPSS software (Vers: 25); a $p < 0.05$ was considered statistically significant.

Trial registration: not relevant.

RESULTS

A total of 1,030 patients were recruited with equal distribution from each hospital. **Table 1** shows the baseline characteristics of the cohort. In total, 54% were females and the mean age was 78 years (65-100 years). A similar distribution is seen for frail/not frail by both tools, but the participants who died had a slightly higher mean age (81 years) and were more likely to be male (59%). The median length of stay was six days (interquartile range: 2-8), and the discharge destination percentage was: 34% – discharged home, 26% – discharged home with community service, 22% – discharge to a location other than the patient's residence (e.g., rehabilitation stay), 7% – transferred to a nursing home, 6% – died in hospital and 5% – transferred to other hospitals (incl. psychiatric hospitals).

TABLE 1 Basic characteristics of included participants.

	Total cohort (N = 1,030)	Time of death < 90 days (n = 128)	Frail on FP scale (n = 221)	Frail on CFS (n = 555)
Age, mean \pm SD (range), yrs	78.2 \pm 8.1 (65-100)	81.2 \pm 8.9 (65-99)	79.2 \pm 8.3 (65-99)	79.7 \pm 8.1 (65-100)
<i>Sex, n (%)</i>				
Male	478 (46.4)	75 (58.6)	102 (46.2)	256 (46.1)
Female	552 (53.6)	53 (41.4)	199 (53.8)	299 (53.9)
<i>Hospital, n (%)</i>				
<i>Bispebjerg and</i>				
Frederiksberg Hospital	350 (34.0)	49 (38.3)	26 (11.8)	217 (39.1)
Odense University Hospital	328 (31.8)	41 (32.0)	121 (54.8)	149 (26.8)
Hospital of Southwest Jutland	352 (34.2)	38 (29.7)	74 (33.5)	189 (34.1)
<i>Frailty</i>				
FP score, mean \pm SD (range)	1.5 \pm 1.3 (0-5)	2.1 \pm 1.5 (0-5)	3.4 \pm 0.6 (3-5)	1.79 \pm 1.3 (0-5)
CFS score, mean \pm SD (range)	4.8 \pm 1.8 (1-9)	6.2 \pm 1.7 (2-9)	5.4 \pm 1.7 (1-9)	6.2 \pm 0.9 (5-9)
<i>FP scale, n (%):</i>				
Frail	221 (21.5)	54 (42.2)	-	151 (27.2)
Not frail	809 (78.5)	74 (57.8)	-	404 (72.8)
<i>CFS, n (%):</i>				
Frail	555 (53.9)	106 (82.8)	151 (68.3)	-
Not frail	475 (46.1)	22 (17.2)	70 (31.7)	-
<i>FP scale + CFS, n (%):</i>				
Frail	151 (14.7)	47 (36.8)	151 (68.3)	151 (27.2)

CFS = Clinical Frailty Scale (scale: 1-9); FP = Fried's Phenotype (scale: 0-5); SD = standard deviation.

Among the 1,030 participants, 221 (21.5%) were considered frail using the FP with a score ≥ 3 and 555 (53.9%) were considered frail using the CFS with a score ≥ 5 . In total, 115 (14.7%) participants were frail by both FP and CFS.

In the entire cohort, 128 (12.4%) died within 90 days, of whom 54 (42.2%) were defined as frail by FP and 106 (82.8%) by CFS. The risk of dying in the 90 days following discharge was 24.4% for patients defined as frail by the FP and 19.1% for patients defined as frail by the CFS (**Table 2**). Patients meeting any of the frailty definitions had an approximately 15% increased risk of dying compared with non-frail patients (**Table 2**). Patients who were frail

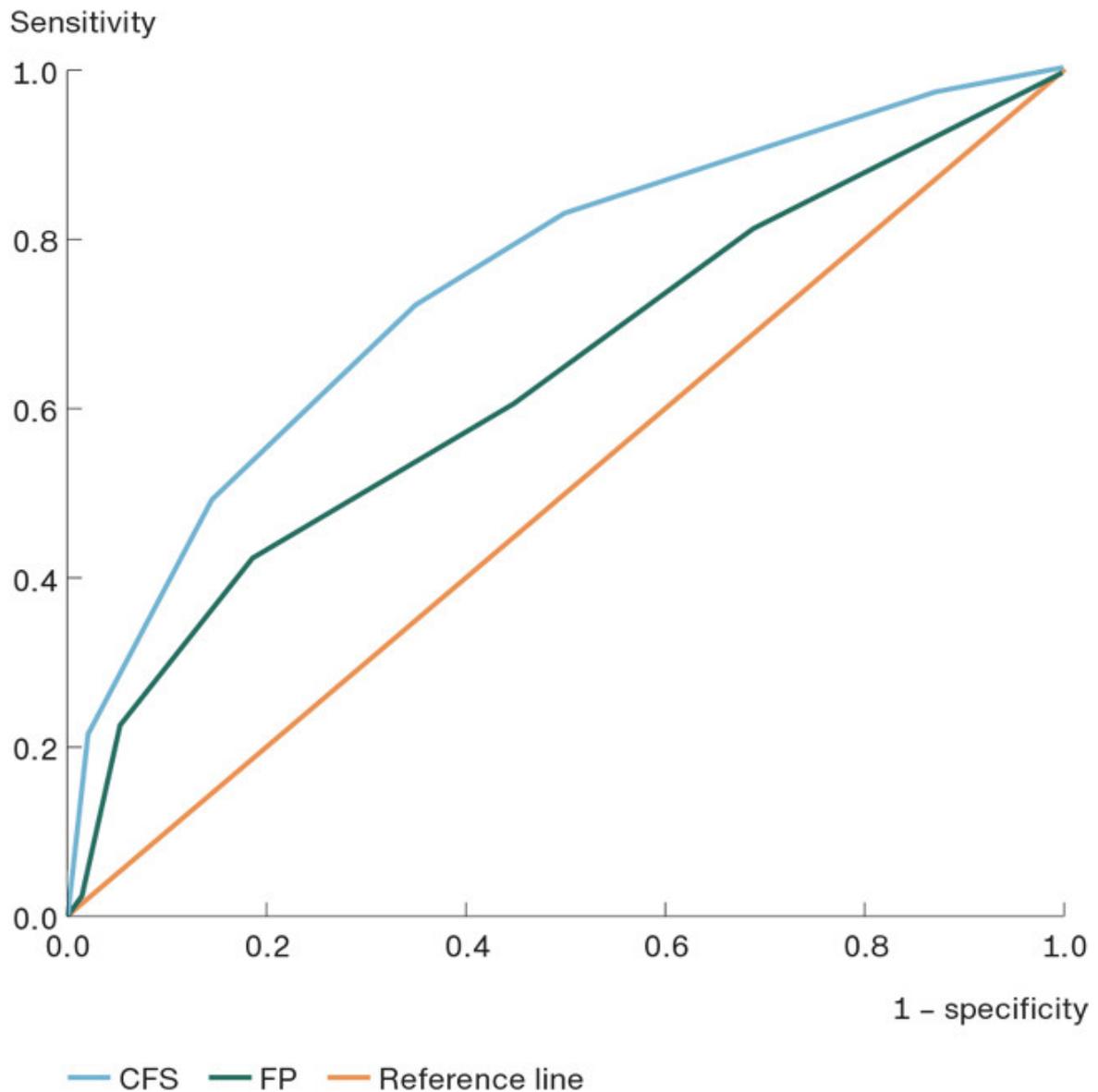
according to both the FP and the CFS frailty definitions had a 22% higher mortality risk than not-frail patients (Table 2). The crude and adjusted associations between FP, CFS and 90-day mortality are presented in Table 2. The adjusted ORs for the association between FP, CFS and 90-day mortality were 3.88 (95% CI: 2.51-6.01), $p = 0.0001$ and 4.38 (95% CI: 2.68-7.13), $p = 0.0001$, respectively. The ROC curves are illustrated in Figure 2. The lowest difference between 1 – sensitivity and 1 – specificity for FP on the Danish Cohort was calculated to 0.328, corresponding to FP values between 2.5 and 3.5, which corresponds to the predefined frailty by FP criteria of at least three out five positive signs [7]. The lowest difference between 1 – sensitivity and 1 – specificity for CFS on the Danish cohort was 0.398, corresponding to CFS values between 4.5 and 5.5, which corresponds to the predefined frailty by CFS criteria of a score of at least five [8]. The AUROC for FP was 0.64 (95% CI: 0.58-0.69, $p < 0.001$) and for CFS 0.75 (95% CI: 0.70-0.80, $p < 0.001$), suggesting poor to moderate discrimination.

TABLE 2 Relative risk, odds ratio and risk difference for both the Clinical Frailty Scale and Fried's Phenotype scale.

	Subtotal, N (% of total)	Time of death ≤ 90 days, n (% of N)	Risk difference		Relative risk		Crude odds ratio		Adjusted* odds ratio	
			calculated difference (95% CI)	p-value	calculated risk (95% CI)	p-value	calculated ratio (95% CI)	p-value	calculated ratio (95% CI)	p-value
<i>FP scale</i>										
Frail	221 (21.5)	54 (24.4)	0.15 (0.10-0.20)	< 0.0001	2.67 (1.93-3.69)	< 0.0001	3.21 (2.18-4.74)	< 0.0001	3.88 (2.51-6.01)	< 0.0001
Not frail	809 (78.5)	74 (9.1)								
<i>CFS</i>										
Frail	555 (53.9)	106 (19.1)	0.14 (0.10-0.19)	< 0.0001	4.12 (2.65-6.42)	< 0.0001	4.86 (3.02-7.84)	< 0.0001	4.38 (2.68-7.13)	< 0.0001
Not frail	475 (46.1)	22 (4.6)								
<i>FP scale + CFS</i>										
Frail	151 (14.7)	47 (31.1)	0.22 (0.16-0.28)		3.38 (2.48-4.66)	< 0.0001	4.45 (2.94-6.73)			
Not frail	879 (85.3)	81 (9.2)								

CFS = Clinical Frailty Scale; CI = confidence interval; FP = Fried's Phenotype.
a) Adjusted for age, gender and hospital.

FIGURE 2 Receiver-operating characteristic (ROC) curve for Clinical Frailty Scale (CFS) and Fried's Phenotype (FP) in the Danish cohort.



DISCUSSION

In summary, we found a surprisingly large difference in the percentage of individuals identified as frail depending on the screening tool used. Specifically, 22%, 54% and 15% of the patients were identified as frail by the FP, the CFS or by both screenings, respectively.

When evaluating the association between frailty and 90-day mortality, the tools were tested both as dichotomised and continuous variables. Studying frailty as a dichotomized variable, we found associations with 90-day mortality for both the FP and the CFS. When exploring frailty as a continuous variable, an association with 90-

day mortality was also identified. These findings are supported by several publications evaluating screening tools for frailty in different populations. Turusheva et al. [2] found an association between frailty by the FP and mortality in a community-dwelling population after being hospitalised. Romero-Ortuno et al. [13] found an association between frailty by the CFS and mortality for acutely admitted patients; similarly, Belga et al. [14] found an association between mortality and frailty assessed by the CFS in a cohort of hospitalised patients, but no significant association when measured by the FP.

In our study, we found that the CFS seems a slightly better for predicting mortality in the frail group than in the FP group when presented in the ROC (Figure 2). However, even though the CFS presented as the least inaccurate of the two, we observed a lack of 27% sensitivity and 40% specificity, which indicates lack of precision when the CFS is used to identify frailty in elderly Danish elderly patients who are acutely admitted. Combining the CFS with other clinical or paraclinical assessments may improve its predictive precision.

The low predictive ability of the CFS has been discussed by Belga et al. [14] who found a C statistic of 0.60 for CFS predicting 30-day mortality or re-admission. They problematised the fact that literature on comparison of different frailty screening tools is limited and noted that all tested measures have shown the same moderate ability in identifying frail patients. Our study adds to this finding by showing the same moderate accuracy in a Danish cohort.

Because the two tools identified different groups as frail, an ancillary analysis was performed. We calculated the RR for 90-day mortality of those patients in the Danish cohort who were defined as frail with both the FP and the CFS. A total of 151 patients were frail by both screening tools. This was significantly less than the number of frail patients identified by either of the tools alone; and for this group, the RD for 90-day mortality after discharge was 0.22 (0.16-0.28), which is higher than those for the FP and the CFS alone. Hence, combining the CFS and the FP may add to the strength of the predictive ability, but this will approach will also include patients who present with both phenotypical and clinical frailty, i.e. probably the frailest patients. At this point, the CFS seems to be the best measure in a clinical setting to assess frailty in a general clinical population, but a need exists for further development.

Strengths and limitations

It is a strength of this study that it was designed as a prospective cohort with assessment of frailty in the beginning of the acute admission without knowledge and distinction of the outcome 90 days after discharge. Likewise, it is a strength that the data were collected from three different hospitals located in different areas in Denmark and therefore representing the demographics broadly.

The study also has limitations. First, it is possible that not all potential confounders were measured in the dataset. These confounders include information about specific pathologies, existing comorbidities, polypharmacy, education and socio-economic status.

Second, some challenges are associated with measuring frailty in the acute setting because the measurement must reflect the final period leading up to the admission. A potential exacerbation of chronic illness, poor recall and stress from the emergency environment could lead to inconsistencies in the classification of the level of frailty [15]. This may result in identification of a higher than true frailty level, and lead to underestimation of the association between frailty and 90-day mortality. Our findings of only 15% in the cohort defined as frail with both CFS and FP supports this.

CONCLUSION

Frailty is predictive of 90-day mortality in acutely admitted patients. We compared two different screening tools

for clinical evaluation of frailty – both well-validated and representing two different perspectives on frailty. This study supports the use of the CFS in a clinical setting in the ED. However, further research is presently in progress [16] exploring the potential development of new and more accurate models for frailty screening to be used as early identification and guidelines of targeted, multifactorial clinical assessment.

The accuracy of the screening tool is only one part of the evaluation process. Often greater test accuracy comes at the cost of increased time for conducting the screening [17]. This perspective must be taken into consideration for future research and needs to be given high priority in the process of development, validation and testing to ensure clinical usability.

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Conflicts of interest Potential conflicts of interest have been declared. Disclosure forms provided by the authors are available with the article at ugeskriftet.dk/dmj

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