# Validation of the Clinical Frailty Scale for Prediction of Thirty-Day Mortality in the Emergency Department

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**Study objective:** We validate the Clinical Frailty Scale by examining its independent predictive validity for 30-day mortality, ICU admission, and hospitalization and by determining its reliability. We also determine frailty prevalence in our emergency department (ED) as measured with the Clinical Frailty Scale.

**Methods:** This was a prospective observational study including consecutive ED patients aged 65 years or older, from a single tertiary care center during a 9-week period. To examine predictive validity, association with mortality was investigated through a Cox proportional hazards regression; hospitalization and ICU transfer were investigated through multivariable logistic regression. We assessed reliability by calculating Cohen's weighted κ for agreement of experts who independently assigned Clinical Frailty Scale levels, compared with trained study assistants. Frailty was defined as a Clinical Frailty Scale score of 5 and higher.

**Results:** A total of 2,393 patients were analyzed in this study, of whom 128 died. Higher frailty levels were associated with higher hazards for death independent of age, sex, and condition (medical versus surgical). The area under the curve for 30-day mortality prediction was 0.81 (95% confidence interval [CI] 0.77 to 0.85), for hospitalization 0.72 (95% CI 0.70 to 0.74), and for ICU admission 0.69 (95% CI 0.66 to 0.73). Interrater reliability between the reference standard and the study team was good (weighted Cohen's κ was 0.74; 95% CI 0.64 to 0.85). Frailty prevalence was 36.8% (n=880).

**Conclusion:** The Clinical Frailty Scale appears to be a valid and reliable instrument to identify frailty in the ED. It might provide ED clinicians with useful information for decisionmaking in regard to triage, disposition, and treatment. [Ann Emerg Med. 2020;76:291-300.]

Please see page 292 for the Editor's Capsule Summary of this article.

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## INTRODUCTION

Frailty is a state of increased vulnerability to poor resolution of homeostasis after a stressor event.[1,2] Frail older patients are at increased risk of emergency department (ED) visits, hospitalization, disability, and death.[3-6] Screening for frailty could potentially inform complex decisionmaking processes in regard to diagnostic approaches, treatment strategies, and involvement of geriatric specialist services.[7] Although the term "frailty" was not used, the concept of pragmatic risk stratification of older ED adults' vulnerability for less optimal outcomes was identified as a high-priority geriatric emergency medicine focus 15 years ago.[8]

Self-reported weakness and slowness, however, were shown to be poor predictors of objectively measured frailty.[9] Multiple instruments for frailty identification, such as the Canadian Study on Health and Aging Frailty Index,[10] Tilburg Frailty Indicator,[11] Fatigue, Resistance, Ambulation, Illnesses and Loss of Weight Scale (FRAIL),[12] and the seven question tool of the Program on Research for Integrating Services of the Maintenance of Autonomy (PRISMA-7),[13] have been studied, including some in ED settings,[14,15] but few meet the requirements of brevity and simplicity needed in an urgent care setting.[16] In addition, frailty transcends episodes of emergency care, so objective measures of frailty require transdisciplinary acceptance and applicability to facilitate between-specialty communication of age-related vulnerability in clinical and research settings.[17]

The Clinical Frailty Scale is an easy-to-use, 9-point scale developed within the Canadian Study of Health and Aging. The initial validation included 2,305 subjects living in institutional facilities, at home, or elsewhere in the community. The scale allows clinicians to stratify older

**Editor's Capsule Summary**

*What is already known on this topic*

In the inpatient setting, frailty has been shown to predict hospital length of stay and mortality. No measure of frailty has been validated in the acute care setting.

*What question this study addressed*

This prospective observational study of emergency department (ED) patients aged 65 years and older assessed the validity and reliability of the Clinical Frailty Scale.

*What this study adds to our knowledge*

Among 2,393 patients, the Clinical Frailty Scale was an accurate independent predictor of hospitalization, ICU admission, and 30-day mortality, and demonstrated good interrater reliability.

*How this is relevant to clinical practice*

Frailty as a concept, and the Clinical Frailty Scale in particular, may be a useful complement to other information in predicting health outcomes for older ED patients.

patients by degrees of vulnerability.[18] A pictograph and a clinical description (Appendix E1, available online at http://www.annemergmed.com, German translation) help to assign scores in the Clinical Frailty Scale, ranging from very fit (score 1) to terminally ill (score 9). The scale might be usable and feasible in an emergency setting, according to emergency staff interviews discussing case vignettes.[16] Some interviewees stated that they did not use frailty tools because they use their clinical judgment instead. However, this clinical judgment is not a reliable process and not always accurate compared with formal scales.[16] Furthermore, clinical judgment might be subject to variation in regard to frailty assessment.[16]

Frailty status as measured by the Clinical Frailty Scale is an independent predictor for inhospital mortality and length of stay for hospitalized patients.[19,20] However, to date, only 2 studies have investigated the predictive value of the scale in the acute care setting. One retrospective study examined the scale in regard to 30-day inpatient mortality in a nonconsecutive sampling of hospitalized patients.[21] Another study assessed its accuracy for 90-day mortality in acutely admitted surgical inpatients.[22] To date, the scale has not been validated in the ED setting in a consecutive sample, to our knowledge.

Therefore, the primary objective of this prospective study of consecutive patients aged 65 years and older was to validate predictive accuracy of the Clinical Frailty Scale in the ED for 30-day mortality. Secondary outcomes were predictive accuracy of the scale for ICU admission and hospitalization, and its reliability in a consecutive patient sample. In addition, we aimed to quantify the ED prevalence of frailty as measured by the scale. Furthermore, we compared the performance of the scale with the well-established Emergency Severity Index, which also has prognostic properties, as well as the Identification of Seniors at Risk score.[23-25] The Identification of Seniors at Risk is a quick and simple screening tool that, according to the American College of Emergency Physicians (ACEP) geriatric ED guidelines, should be completed as part of the initial evaluation of older ED patients.[8,26] Last, we examined the distribution of frailty categories across different triage levels.

## MATERIALS AND METHODS

### Study Design and Setting

This was a prospective observational study with consecutive sampling. All patients aged 65 years and older who presented to the ED of the University Hospital Basel between March 18 and May 20, 2019, were assessed for inclusion 24 hours a day, 7 days a week. The University Hospital Basel is a tertiary care center with an annual ED attendance of approximately 52,000 patients aged 16 years and older, of whom 16,700 (32%) are aged 65 years or older. The overall admission rate in 2019 was 33%. For patients aged 65 years and older, admission rate was 61% in 2019. Obstetric, pediatric, and ophthalmologic patients are treated in separate facilities nearby. There are 3 geriatric hospitals, 2 hospices for palliative care, and 39 nursing homes with almost 2,900 nursing beds in the Basel area.[27]

### Selection of Participants

The study protocol was approved by the local ethics board. Every patient presenting to the ED of the University Hospital Basel during the study period was screened for inclusion. Patients who were unable to provide informed consent (eg, treatment in the resuscitation bay, immediate transfer to the ICU) were not screened for inclusion. We included all patients aged 65 years or older after oral consent. Patients denying consent were not included. Patients with mild cognitive impairment were not excluded, which is in accordance to previous recommendations.[28]

### Methods of Measurement

Because the study site is located in a German-speaking area of Switzerland, we performed an authorized translation of the Clinical Frailty Scale clinical descriptions into German, following the recommended guidelines by the International Society for Pharmacoeconomics and Outcome Research Task Force for Translation and Cultural Adaptation, as described previously.[23,29] The 10-step translation process includes forward and backward translation, harmonization, and a cognitive debriefing. Each translation step was performed by 2 native-German-speaking and native-English-speaking emergency clinicians (forward and backward translation, respectively). The original Clinical Frailty Scale pictographs were used.[30] A dedicated study team consisting of medical students in their fourth to sixth year (of 6 years) of medical school training performed data collection. Study personnel were unaware of the hypothesis of this study and were not involved in patient care. For the assessment of frailty with the Clinical Frailty Scale, each member of the study team received a 30-minute teaching session, including an introduction to the basic concept of frailty, visualized by a short explanatory video, and our translation of the scale (Appendix E1, available online at http://www.annemergmed.com; English version available at https://www.dal.ca/sites/gmr/our-tools/clinical-frailty-scale.html). In addition, we used 4 case vignettes to practice Clinical Frailty Scale score assignment. Results were compared and discussed in focus groups.

Each eligible patient was assigned a frailty level according to the Clinical Frailty Scale as soon as he or she arrived in a treatment bay. Patients assigned a score of 5 or higher were considered frail.[18]

To test for reliability, a reference standard (an advanced practice nurse and an emergency physician) assigned Clinical Frailty Scale scores to a random subsample of patients during ED care. The calculated sample size to detect a $\kappa$ of 0.60 with 80% power was 94 patients.[31] Both assessors were blinded to the scoring of each other, as well as the study teams' scores.

Demographics (age and sex), condition (medical versus surgical), and the Emergency Severity Index level[23] were collected from the electronic health record. The index level is obtained routinely for every ED patient on arrival.

We used the validated German version of the Identification of Seniors at Risk[32] and defined seniors at risk as patients with an Identification of Seniors at Risk score greater than or equal to 2.[33,34] Concomitantly to the Clinical Frailty Scale assessment, study personnel scored the Identification of Seniors at Risk as soon as the patient arrived in the treatment bay.

### Outcome Measures

The primary outcome was 30-day all-cause mortality, which was death within 30 days of ED presentation. We retrieved the date of death with the electronic health record, official registries, and insurance data. Secondary endpoints were ICU admission rate and hospitalization. We defined hospitalization as a hospital stay longer than 24 hours. We aimed to include 2,100 patients to have sufficient power for our analysis,[35,36] including 5% for missing data, which, if any, was omitted listwise.

### Primary Data Analysis

We provide descriptive statistics as median and interquartile range for continuous variables and as number and percentage for categoric variables. Characteristics of patients with complete Clinical Frailty Scale data and those with missing data, as well as those who were lost to follow-up, were compared. Differences were tested with Kruskal-Wallis or Wilcoxon-Mann-Whitney or Pearson's $\chi^2$ tests as appropriate to the size and level of measurement of groups being compared.

To determine whether the Clinical Frailty Scale is an independent predictor of mortality, we computed a Cox proportional hazards regression model adjusted for age (continuous), sex (binary), and condition (binary: medical versus surgical), assuming that frailty level remained constant over time. The analyzed interval was 30 days. We decided to compute the Clinical Frailty Scale as a categoric variable with 4 groups, as suggested previously.[21] Groups were as follows: up to vulnerable (score 1 to 4), describing a non- to prefrail population as a reference; mildly frail (score 5); moderately frail (score 6); and severely or very severely frail (score 7 to 8). A priori, score 9 (terminally ill) was excluded to avoid confounding. Hazard ratios with 95% confidence intervals (CIs) were calculated for the predictors; the effect of the full-factor Clinical Frailty Scale was evaluated with a likelihood ratio test. To check the proportional hazards assumption for the covariates, we performed Schoenfeld's test[37] and plotted and inspected each variable in a log-log curve. We calculated survival curves to visualize time to 30-day all-cause mortality across collapsed Clinical Frailty Scale groups. To test robustness of our Cox proportional hazards model for 30-day mortality and to determine the predictive validity for ICU admission and hospitalization, we used multivariable logistic regression, including age, sex, condition, and either the Clinical Frailty Scale or the Emergency Severity Index; computed receiver operating characteristic (ROC) curves; and calculated their areas under the curve with 95% CIs.

Level of agreement for Clinical Frailty Scale scores was calculated between the experts and the study team with weighted Cohen's κ statistic. CIs were calculated with bootstrapping. We interpreted agreement according to κ values as follows[38]: 0.01 to 0.20 poor, 0.21 to 0.40 slight, 0.41 to 0.60 fair, 0.61 to 0.80 good, 0.81 to 0.92 very good, and 0.93 to 1.00 excellent.

To evaluate the predictive performance, the calculated multivariable logistic regression models were used to compare the area under the curve of the ROC for the Clinical Frailty Scale with the Emergency Severity Index and the Identification of Seniors at Risk in regard to the outcomes (30-day mortality, ICU admission, and hospitalization) and analyzed differences with the DeLong test.[39]

To assess calibration, we compared the average predicted probabilities and average observed frequencies of the outcome at each level of risk across a population graphically and tested agreement with the Hosmer-Lemeshow test.[40]

To tabulate Clinical Frailty Scale scores across Emergency Severity Index levels, we collapsed the index levels into 2 groups: cannot wait (levels 1 to 2) and can wait (levels 3 to 5). All statistical analyses were performed with R (version 3.5.2; R Foundation for Statistical Computing, Vienna, Austria) and RStudio (RStudio, Inc, Boston, MA). This study is presented in adherence with Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis reporting standards.[41]

## RESULTS

### Characteristics of Study Subjects

Of 2,459 included patients aged 65 years and older, 43 (1.7%) had missing Clinical Frailty Scale scores and 23 (0.9%) were lost to 30-day follow-up. The final study population consisted of 2,393 patients aged 65 years and older (Figure 1).

The median age was 78 years (interquartile range 72 to 86 years) and 1,218 (51%) were women. Most patients were assigned a medium urgency triage level of Emergency Severity Index score 3 (n=1,143, 47.8%). There was no significant difference between the population of patients with missing Clinical Frailty Scale data or between the population of patients lost to follow-up compared with patients analyzed in regard to age, sex, triage level, and condition (medical versus surgical) (Table 1).

### Main Results

The overall mortality rate was 5.3% (128 deaths), ICU admission rate was 8.9% (n=214), and hospitalization rate was 62.9% (n=1,506). Distribution of frailty levels and outcomes are shown in Table 2.

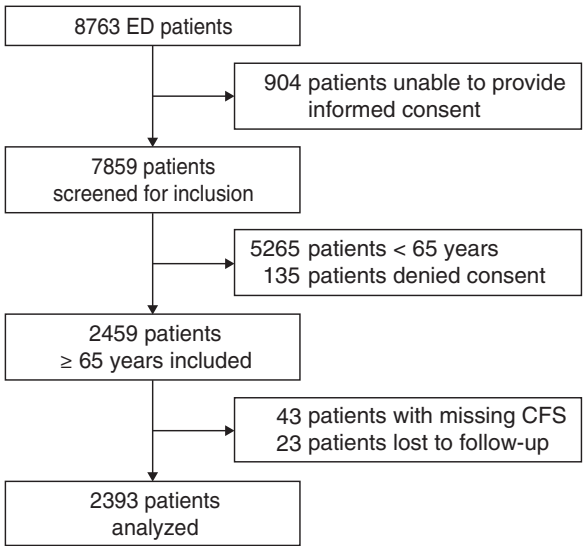


**Figure 1.** Inclusion procedure. Recruitment and follow-up process of the all-comer ED population. *CFS*, Clinical Frailty Scale.

The Cox regression showed an effect of the factor Clinical Frailty Scale on the hazard ($\chi^2$=117.56; $P\leq$.001). Inspection of the individual hazard ratios in Table 3 shows that higher frailty levels are associated with higher hazards. Calculated survival curves are shown in Figure 2.

Interrater reliability between experts and the study team was good. The calculated weighted Cohen's κ was 0.74 (95% CI 0.64 to 0.85) for the Clinical Frailty Scale scores of 94 patients.

The prevalence of frail patients (Clinical Frailty Scale score ≥5) in our ED population was 36.8% (n=880 of 2,393 patients). Most patients were assigned a score of 3 (managing well).

The performance of the Clinical Frailty Scale compared with that of the Emergency Severity Index in regard to prediction of 30-day mortality, ICU admission, and hospitalization is shown in Figure 3. The ROC area under the curve for 30-day mortality was 0.81 (95% CI 0.77 to 0.85) for the Clinical Frailty Scale adjusted for age, sex, and condition (medical versus surgical), and 0.74 (95% CI 0.69 to 0.78) for the Emergency Severity Index adjusted for age, sex, and condition (Table E1, available online at http://www.annemergmed.com). The DeLong test for the Clinical Frailty Scale model adjusted for age, sex, and condition compared with the Emergency Severity Index model adjusted for age, sex, and condition yielded a significant difference ($z$=4.26; $P$<.001), in which the Clinical Frailty Scale model outperformed the Emergency Severity Index model in prediction of 30-day mortality. The grouped observed occurrence compared with the grouped predicted probability of the 3 outcomes is shown

**Table 1.** Patient characteristics.

| | All | Missing CFS | Lost to Follow-up | Analyzed |
|---|---|---|---|---|
| Patients, No. | 2,459 | 43 | 23 | 2,393 |
| Age, median (IQR), y | 78 (72–86) | 75 (72–84) | 77 (71–81) | 78 (72–86) |
| Female sex, No. (%) | 1,247 (51) | 19 (44) | 10 (43) | 1,218 (51) |
| Medical patients, No. (%) | 1,439 (58.5) | 24 (55.8) | 16 (69.6) | 1,399 (58.5) |
| **ESI level, No. (%)** | | | | |
| 1 | 100 (4.1) | 4 (9.3) | 0 | 96 (4.0) |
| 2 | 893 (36.3) | 16 (37.2) | 11 (47.8) | 866 (36.2) |
| 3 | 1,172 (47.7) | 19 (44.2) | 10 (43.5) | 1,143 (47.8) |
| 4 | 272 (11.1) | 3 (7.0) | 2 (8.7) | 267 (11.2) |
| 5 | 22 (0.9) | 1 (2.3) | 0 | 21 (0.9) |

*IQR*, interquartile range; *ESI*, Emergency Severity Index.
The table comprises demographic and acuity level of all included patients (2,459). Differences between analyzed and excluded groups were tested with Kruskal-Wallis or Wilcoxon-Mann-Whitney or Pearson's $\chi^2$ tests as appropriate to the size and level of measurement. No significant difference between the 3 groups (analyzed, missing CFS, and lost to follow-up) was found. Data are shown as median and IQR for continuous variables and as number and percentage for categoric variables.

in Figure E1 (available online at http://www.annemergmed.com). The Hosmer-Lemeshow test was nonsignificant, indicating a good agreement between predicted probability and observed frequency for the measured outcomes 30-day mortality and ICU admission. For the outcome hospitalization, the Hosmer-Lemeshow test yielded a significant result, indicating poor predictions. Graphically, we can determine an overestimation.

We analyzed a cohort of 2,081 patients for the assessment of the Identification of Seniors at Risk; 312 had missing data. For baseline characteristics, see Table E2, available online at http://www.annemergmed.com. We identified 1,698 patients (81.6%) at risk in our study population. The performance of the Clinical Frailty Scale compared with that of the Identification of Seniors at Risk in regard to prediction of 30-day mortality, ICU admission, and hospitalization is shown in Figure E2, available online at http://www.annemergmed.com. We found a higher predictive performance of the Clinical Frailty Scale model compared with the Identification of Seniors at Risk model in regard to ICU admission and 30-day mortality prediction (Table E3, available online at http://www.annemergmed.com).

By tabulating Emergency Severity Index levels (cannot wait versus can wait) to Clinical Frailty Scale groups (up to vulnerable, mildly frail, moderately frail, and severely or very severely frail), we identified 462 frail patients (19.4%) who were deemed able to wait (Table 4).

## LIMITATIONS

This was a single-center study of a mainly white population during a 9-week period from March to May in an academic tertiary care center in Northwestern Switzerland. The results therefore may not be generalizable to other settings or seasons. We had a relatively small number of patients with missing Clinical Frailty Scale levels or missing follow-up. However, these patients were not different concerning baseline demographics and triage levels (Table 1). We included only the covariables age, sex, and condition (medical versus surgical) for our regression models because these parameters were routinely available at the ED. Other predictors such as polypharmacy, dementia, social isolation, limited health literacy, malnutrition, poverty, or depression might affect the predictive value of the Clinical Frailty Scale. Furthermore, we did not include comorbidity and disability as covariates in our model because these syndromes can affect individuals independent of their frailty level.[7] Moreover, we did not compare our findings with the Charlson comorbidity index, derived in 1987 for 1-year mortality, because its selection of comorbidities as well as the associated weights of comorbidity categories should be updated, as recently suggested.[42] We analyzed all patients aged 65 years or older and did not differentiate any preadmission status such as care facility residence. In previous studies on a vulnerable older ED population, the percentage of nursing home patients was approximately 7% in our setting.[43] Our secondary outcomes ICU and hospital admission are process measures and possibly not comparable to those of other settings. In addition, there is a strong primary care system in Northwestern Switzerland. Many patients are evaluated by a primary care physician before being sent to the ED, which may partially explain the higher admission rates of older patients in our setting compared with the United States.[44] We hypothesize that the relatively high

**Table 2.** Outcomes of older ED patients, stratified by Clinical Frailty Scale scores.

| | | CSF Score | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **All (n=2,393)** | **1 (n=36)** | **2 (n=348)** | **3 (n=680)** | **4 (n=449)** | **5 (n=299)** | **6 (n=250)** | **7 (n=187)** | **8 (n=128)** | **9 (n=16)** |
| Age, median (IQR), *y* | 78 (72–86) | 74 (70–78) | 72 (68–77) | 76 (70–82) | 81 (74–86) | 84 (77–88) | 84 (76–90) | 82 (75–89) | 82 (76–87) | 78 (73–82) |
| Female sex, No. (%) | 1,218 (51) | 14 (39) | 148 (43) | 343 (50) | 227 (51) | 177 (59) | 149 (60) | 97 (52) | 55 (43) | 8 (50) |
| Hospitalization, No. (%) | 1,506 (62.9) | 9 (25.0) | 125 (35.9) | 368 (54.1) | 307 (68.4) | 227 (75.9) | 194 (77.6) | 146 (78.1) | 117 (91.4) | 13 (81.2) |
| ICU admission, No. (%) | 214 (8.9) | 0 | 12 (3.4) | 56 (8.2) | 32 (7.1) | 19 (6.4) | 33 (13.2) | 19 (10.2) | 40 (31.2) | 3 (18.8) |
| 30-day mortality, No. (%) | 128 (5.3) | 0 | 1 (0.3) | 13 (1.9) | 8 (1.8) | 19 (6.4) | 24 (9.6) | 21 (11.2) | 39 (30.5) | 3 (18.8) |

The table comprises demographics and outcomes of analyzed population (2,393), stratified by CFS scores. Data are shown as median and IQR for continuous variables and as number and percentage for categoric variables.

number of admissions also might be the reason why the calibration for the outcome hospitalization yields an overestimating model. However, this hypothesis requires further testing in different populations and settings.

We tested for reliability only in a subset of patients, which might bias the results. Furthermore, we assumed that frailty assessed with the Clinical Frailty Scale is static between or during episodes of ED care, but may fluctuate during periods of relative wellness. Previous research has not delineated the dynamics of short-term change in frailty of inpatients, nor the short-term changes in frailty status of patients during ED treatment and after discharge from the ED. We estimate decline in frailty caused by primary illness or adverse effects of procedures and drugs to be a relatively slow process of days rather than a drastic event occurring within hours, but this belief is merely speculative and probably requires further study. In accordance with current understanding, we do not expect a change in frailty level as measured by Clinical Frailty Scale during a patient's stay in the ED.

The study team might not have been ideal frailty assessors because they lack long-standing clinical experience. However, they received formal training, and it is unclear which health care professionals are the ideal assessors compared with a criterion standard. Both ED nurses and emergency physicians, when interviewed, were willing to use the Clinical Frailty Scale in 75% of cases in one mixed-methods study.[16] Because the Clinical Frailty Scale contains certain subjective components, perfect agreement appears unlikely. We demonstrated good but not excellent agreement in our study. In addition, another study in a similar setting demonstrated good interrater agreement (0.72) between scores of nurses and physicians or advanced practitioners.[45] Physician-reported Clinical Frailty Scale score compared with patient self-assessment is preferable,[46] but the minimal qualifications or level of medical expertise of the health care provider frailty assessor is still unknown. We did not examine outcomes such as hospital length of stay, institutionalization, or readmission, usually considered relevant for the frail population. Because older patients are frequently admitted to one of the geriatric hospitals nearby, determination of total length of stay was impossible for this study.

Finally, the Emergency Severity Index was designed for determination of urgency and the allocation of ED resources. Although we compared the Clinical Frailty Scale with the Emergency Severity Index in terms of prognostic performance, we acknowledge that the latter is not explicitly designed for prognostic purposes. However, our data provide the building blocks of discriminatory and calibration validity required to justify the next stages of

**Table 3.** Hazard and odds ratios for respective outcomes.

| | Mortality | | 30-Day Mortality | | ICU Admission | | Hospitalization | |
|---|---|---|---|---|---|---|---|---|
| | HR | CI | OR | CI | OR | CI | OR | CI |
| Age, y | 1.03 | 1.01–1.05 | 1.03 | 1.01–1.06 | 0.97 | 0.95–0.98 | 1.03 | 1.02–1.04 |
| Female sex | 0.61 | 0.42–0.87 | 0.58 | 0.39–0.86 | 0.55 | 0.40–0.74 | 0.82 | 0.68–0.98 |
| Medical condition | 1.72 | 1.15–2.56 | 1.72 | 1.14–2.66 | 1.88 | 1.37–2.62 | 3.02 | 2.53–3.63 |
| **CFS score** | | | | | | | | |
| 1–4 (reference) | — | — | — | — | — | — | — | — |
| 5 | 4.04 | 2.17–7.55 | 4.12 | 2.15–7.82 | 1.22 | 0.71–2.01 | 2.59 | 1.92–3.51 |
| 6 | 5.99 | 3.32–10.82 | 6.24 | 3.38–11.57 | 2.72 | 1.74–4.19 | 2.61 | 1.89–3.66 |
| 7–8 | 12.3 | 7.46–20.27 | 13.4 | 8.07–22.85 | 3.73 | 2.57–5.37 | 3.75 | 2.73–5.25 |

*HR*, Hazard ratio; *OR*, odds ratio.
The table comprises hazard ratios for mortality and odds ratios for 30-day mortality, ICU admission, and hospitalization. The models were calculated with the CFS groups up to vulnerable (score 1 to 4), mildly frail (score 5), moderately frail (score 6), and severely and very severely frail (score 8), and with covariables age, sex, and condition (medical versus surgical). Patients assigned CFS score 9 (terminally ill) were excluded listwise. The CFS group up to vulnerable (score 1 to 4) was the reference category.

research evaluating influence and unintended consequences of accelerating or altering ED processes as a result of the Clinical Frailty Scale with or without Emergency Severity Index screening.

## DISCUSSION

To our knowledge, this is the first study prospectively investigating predictive validity of the Clinical Frailty Scale in a consecutive sample of older ED patients. We performed a culturally adapted translation of the scale into German according to recommended guidelines[29] and identified it as an accurate and independent predictor for all-cause 30-day mortality, as well as for hospitalization and ICU admission, independent of age, sex, and condition (medical versus surgical). We also found good Clinical Frailty Scale score agreement between reference standard and study personnel. The prevalence of patients identified as frail in our ED was 37%. In regard to mortality prediction, the Clinical Frailty Scale outperformed the Emergency Severity Index.

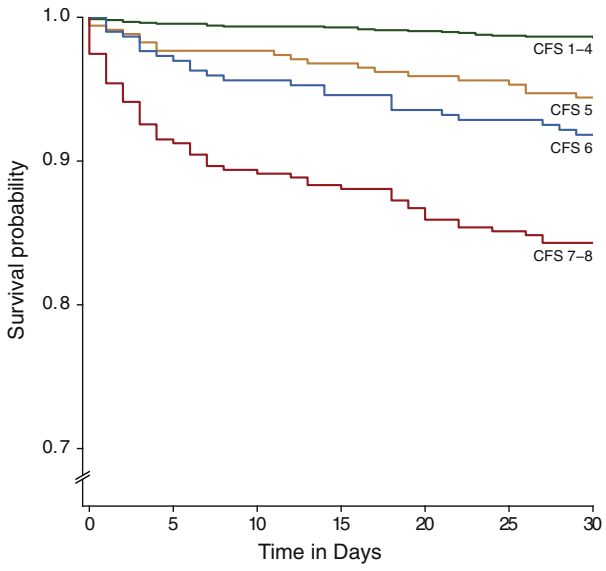


**Figure 2.** Survival curve for Clinical Frailty Scale groups. The curve for the 4 collapsed CFS groups was as follows: up to vulnerable (CFS score 1 to 4), mildly frail (CFS score 5), moderately frail (CFS score 6), and severely and very severely frail (CFS score 7 to 8). CFS score 9 (terminally ill) was excluded. To improve readability, the graph was cropped to 0.7 on the *y* axis.

We identified graded risk of 30-day mortality in older ED patients according to different Clinical Frailty Scale scores. The predictive value of the scale in regard to mortality in our ED was higher compared with that for nonelective hospitalized older patients,[21] but lower compared with that for the inpatient setting reported in other studies.[20,47-50] The lower performance of the scale in regard to the prediction of ICU transfer compared with the Emergency Severity Index might be explained by the fact that informal assessment of frailty or prognostication already occurs. This is in line with a recent prospective multicenter study demonstrating that the Clinical Frailty Scale was an independent prognostic factor for 1-month survival after ICU admission.[51]

Several studies determined the reliability of the Clinical Frailty Scale for different populations.[18,24,49] Our findings are comparable to the agreement between nurses and physicians in other studies reporting good agreement as well.[45,52]

According to the Clinical Frailty Scale, the prevalence of frailty in our setting seems to be in line with that of other

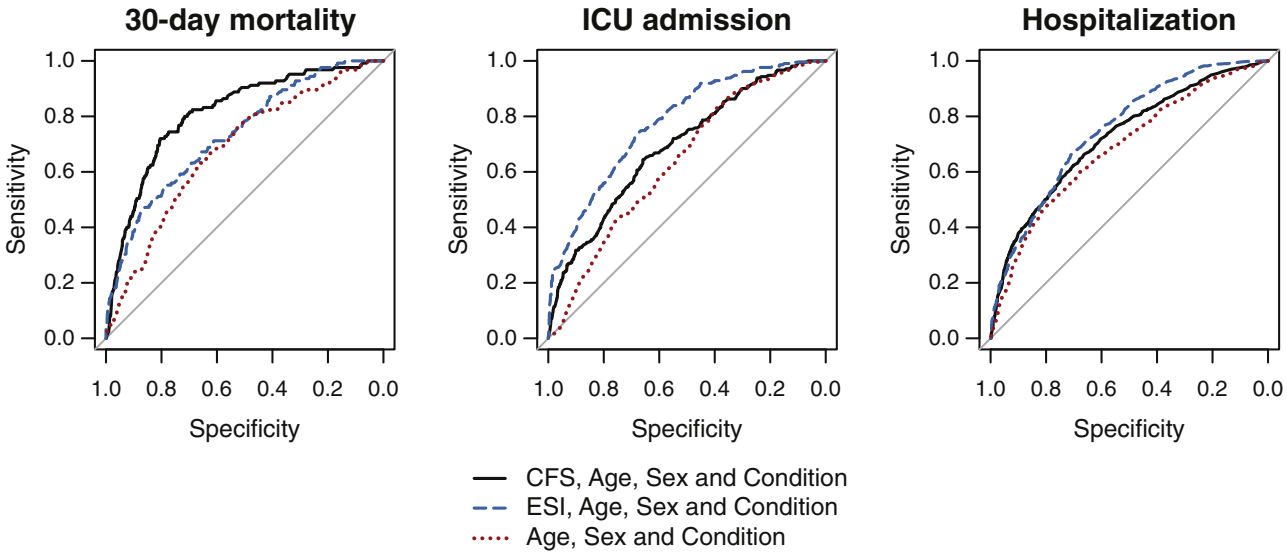


**Figure 3.** ROCs for respective outcomes are shown, as is comparison of 3 logistic regression models for the outcomes. The area under the curve for 30-day mortality prediction with the CFS was 0.81 (95% CI 0.77 to 0.85), for hospitalization 0.72 (95% CI 0.70 to 0.74), and for ICU admission 0.69 (95% CI 0.66 to 0.73).

studies (32.7% to 39.6%).[21,48] ED frailty prevalence measured with tools other than the scale, however, appears to vary widely.[53] The reason underlying this variation is unknown.

Older patients frequently have unique care needs that are often not addressed in typical EDs. They do not present with single-organ issues but rather with nonspecific complaints such as weakness.[54] A wide spectrum of underlying conditions ranging from acute life-threatening disease to social issues is found.[43] Frailty and urgency measures appeared to complement each other in our study. One fifth of our population was assigned a triage level "can wait" but was frail. Because a longer waiting time is a notable risk factor for adverse outcomes for frail patients, we believe that they should not wait, regardless of their Emergency Severity Index score. Both the Emergency Severity Index and Clinical Frailty Scale can be readily assessed as early as at triage, with similar effort. Early frailty screening is potentially useful for case finding (eg, by identifying older adults more likely to benefit from more comprehensive geriatric care, prognostication, and [resuscitative] decisionmaking).

Future studies should examine, ideally in different settings and locations, whether the Clinical Frailty Scale is correctly and reliably used by ED clinicians in nonresearch settings, and whether it retains prognostic accuracy after actual ED implementation. Because the evidence for frailty screening in the ED still is scarce,[55] further studies should investigate whether frailty identification in the ED is associated with improved outcomes. For example, Clinical Frailty Scale assessments could inform shared decisionmaking about the scope of diagnostic evaluation, level of interventional aggressiveness, end-of-life discussions, or all three.[56-59] Transdisciplinary clinical researchers also require a measure of "frailty" to compare older ED populations with medical and surgical study patients.[17] As a well-accepted construct and descriptor of frailty, the Clinical Frailty Scale provides that measure.

In summary, the Clinical Frailty Scale appears to be a reliable and valid instrument to identify frailty in the ED.

**Table 4.** Cross tabulation of frailty and acuity.

| | All | Up to Vulnerable | Mildly Frail | Moderately Frail | Severely and Very Severely Frail |
|---|---|---|---|---|---|
| Patients, No. | 2,377 | 1,513 | 299 | 250 | 315 |
| Cannot wait (ESI score 1–2), No. (%) | 954 (40.1) | 552 (23.2) | 112 (4.7) | 112 (4.7) | 178 (7.5) |
| Can wait (ESI score 3–5), No. (%) | 1,423 (59.9) | 961 (40.4) | 187 (7.9) | 138 (5.8) | 137 (5.8) |

The table comprises the distribution of the analyzed population (2,377) in regard to acuity and frailty. CFS groups were up to vulnerable (score 1 to 4), mildly frail (score 5), moderately frail (score 6), and severely and very severely frail (score 8). Patients assigned CFS score 9 (terminally ill) were excluded listwise.

Independent of potential confounders, the scale predicts 30-day mortality of ED patients aged 65 years and older. If subsequently validated in additional populations for accuracy, reliability, acceptability, and beneficial effect that outweighs harms, the scale could provide ED clinicians a new geriatric tool to guide decisionmaking for triage, disposition, and treatment.

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*Author contributions:* CHN conceived of the study. RB and CHN designed the trial and supervised the conduct of the trial and data collection. TK and TD-H undertook recruitment of patients. TK and MR analyzed the data. TK, MR, MB, SK-N, CRC, and CHN interpreted the data, including quality control. TK, MB, SK-N, CRC, and CHN drafted the article, and all authors contributed substantially to its revision. CHN takes responsibility for the paper as a whole.

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