The Journal of Frailty & Aging 15 (2026) 100128

Contents lists available at ScienceDirect

The Journal of Frailty & Aging

journal homepage: www.elsevier.com/locate/tjfa

Brief Report

Assessing frailty with clinical and laboratory measures in hospitalized older adults: A comparison of all-cause mortality across two geriatric departments

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ARTICLE INFO

Keywords:
Frailty
Acute care
Mortality
Hospital
Geriatrics

ABSTRACT

By 2030, one in six people globally will be over 60, potentially increasing the burden of frailty, a condition characterized by reduced physiological resilience and poor clinical outcomes. Although frailty affects up to 49 % of hospitalized patients, it is frequently under-recognized. Tools like the Clinical Frailty Scale (CFS) and the FI-Lab aim to assess frailty, though each has limitations. This retrospective cohort study evaluated the predictive value of CFS and FI-Lab, separately and in combination, for in-hospital and three-month post-discharge mortality in older adults. The study included 410 hospitalized patients (median age 87) admitted to two geriatric units between 2023 and 2025. Frailty was assessed using the CFS and a 22-item FI-Lab derived from blood tests within 48 h of admission. In-hospital and post-discharge mortality rates were 12.6 % and 24.7 %, respectively. Both FI-Lab and CFS were independently associated with increased mortality risk. A weak correlation between the two tools ($r = 0.19$, $p < 0.001$) suggests they capture distinct but complementary aspects of frailty. These findings support the combined use of FI-Lab and CFS for more accurate risk stratification in acutely ill older adults. FI-Lab may reflect acute physiological stress not captured by clinical measures alone, aiding early identification of vulnerable patients. Despite limitations, including modest sample size and lack of adjustment for multimorbidity, this study highlights the potential utility of integrating lab-based frailty assessments into routine hospital care for personalized geriatric management.

1. Introduction

The World Health Organization (WHO) estimates that by 2030 one out of six people worldwide will be aged 60 years and as the global aging of the population increases, a notable rise in the global prevalence of frailty is also predicted [1–3]. Frailty is characterized by a reduced physiological reserve to environmental stressors with unfavorable clinical outcomes, including mortality, disability, and reduced quality of life [4,5]. In this realm, the paradigm of aging and frailty poses critical health care concerns, as frailty is associated with higher healthcare utilization, especially in older adults that are more likely to experience frequent hospital use [6].

Although a median prevalence of frailty of up to 49 % is documented and a series of instruments to measure frailty in the hospital setting have been developed, frailty remains an underrecognized geriatric syndrome upon admission, augmenting the burden of care and driving negative clinical outcomes both during in-hospital stay and hereafter discharge [7,8].

The Clinical Frailty Scale (CFS) is among the frailty measurement tools that have proven prognostic accuracy in hospitalized older adults, although it requires geriatric training and competence, making it susceptible to physician judgment biases, especially in non-geriatric hospital wards [9,10].

To counterbalance a physician's subjectivity, the FI-Lab is a frailty tool based on laboratory values and clinical parametric data that may complement the multidimensional nature of frailty in the hospital

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https://doi.org/10.1016/j.tjfa.2025.100128
Received 3 October 2025; Accepted 17 December 2025
Available online 29 January 2026

setting, potentially detecting some burdening hospital-related effect on the individual clinical trajectory [11]. In line with that, two cohort studies investigating the association of FI-LAB upon admission and in-hospital mortality in older adults yielded mixed data [12,13]. Namely, Ysea-Hill et al. have demonstrated that a moderate to high FI-Lab score was associated with worsened outcomes in hospitalized older adults, outlining that FI-Lab may be considered a valuable tool for the early identification of higher-risk frail older patients eligible for mitigating strategies to constrain unfavorable clinical outcomes [12].

Similarly, Nakashima et al. evaluated both the CFS and FI-Lab to determine the appropriateness of the combined use of these frailty measurements in predicting overall mortality [13]. The authors underscored that each scale reflected some aspects of frailty in acutely hospitalized older adults, and the combined use fit better in terms of assessment of the risk of mortality and prolonged hospital stay [13].

Given this background, the aim of this study was to assess the predictive accuracy of both the FI-Lab tool and CFS for all-cause in-hospital and three-month post-discharge mortality in a cohort of predominantly oldest-old hospitalized patients (≥85 years).

2. Methods

This is a retrospective cohort study of hospitalized patients at the Geriatric Clinic of IRCCS Polyclinic San Martino, Genoa, Italy (from January to December 2023) and at the Geriatric Unit of Azienda Ospedaliero-Universitaria di Alessandria, Alessandria, Italy. Data were consequently collected in two waves: from June 2024 to November 2024 and from March 2025 to June 2026. This study was approved by the IRB (CERA N 24–54) of the University of Genoa, Italy.

Demographic data, including age, sex, number of medications, and accommodation status before hospitalization, were collected at hospital admission. Each patient received a geriatric assessment from an expert geriatrician, including Basic Activity of Daily Living (BADL) [14] to assess functional status, the Clinical Frailty Scale (CFS) [15] to screen for frailty status, and the number of medications prior to hospital admission.

CFS on admission estimated the patient's frailty status at baseline (2 weeks prior to admission). The score ranged from 1 (very fit) to 9 (terminally ill).

For each patient, an FI-Lab was calculated using 22 laboratory parameters from blood tests [16] (see YTable S1 in the Supplementary Material), such as hematology, electrolytes, liver, renal function, inflammation, coagulation, and blood pressure. Each parameter of FI-Lab was coded as "0″ or "1," where "0″ indicates values within the normal range and "1" values outside the normal range. The measured ratio of the laboratory tests was defined by the number of measured tests for each patient over the 22 available laboratory tests. The FI-lab was calculated by dividing the FI-lab by the measured ratio. When unavailable, they were excluded from the calculation. FI-Lab was calculated only when more than 70 % of laboratory test results were available. Blood sampling was performed during the first day of hospitalization or within the first 48 h from hospital admission.

At discharge, length of hospital stay was collected. Three-month post-discharge mortality was obtained from the patient's electronic chart.

The inclusion criteria were age over 65 years old and the presence of 70 % of laboratory test results included in the FI-Lab.

The exclusion criteria were age below 65 years old, inability to provide informed consent, life expectancy reduced to 6 months at the time of admission and/or eligibility for palliative care, critically ill patients, absence of CFS assessment.

2.1. Statistical analysis

Continuous variables were presented as mean and standard deviation (SD) or with median and interquantile range (IQR) when appropriate, while categorical variables were reported as percentages, with absolute numbers provided in the tables. The correlation between CFS and FI-Lab was performed with Spearman's rank correlation coefficient.

To identify predictors of in-hospital and post-discharge mortality, univariable logistic regression analyses were performed, including the following variables: age, sex, FI-Lab, CFS, and number of daily medications and accommodation status before hospitalization. Variables that were significant at the univariable analysis, along with age and sex, entered the multivariable logistic regression models. Results from both univariable and multivariable analyses are reported as odds ratios (ORs) and 95 % confidence intervals (CIs).

The discriminatory ability of FI-Lab, CFS, and their combination was assessed for each reported outcome using Receiver Operating Characteristic (ROC) curves. The Area Under the Curve (AUC) with 95 % CIs was calculated, and ROC curves were compared using DeLong's test.

A two-sided p-value <0.05 was considered statistically significant. Data analyses were performed using GraphPad Prism (version 10), Jamovi (version 2.3.28.0) and RStudio (version 2023.06.00).

3. Results

A total of 410 patients were included in the study. The median patient's age was 87 years (IQR 9). The majority of them were oldest-old (62.8 %), with 57.3 % female.

The patient's clinical phenotype was characterized by moderate frailty with a median CFS value of 6 (IQR 2) and functional decline with a median BADL of 3 (IQR 4). The median FI-Lab value was 0.35 (IQR 0.16) (see Table S2 in the Supplementary Material). All-cause in-hospital mortality was 12.6 % and three-month post-discharge mortality was 24.7 %.

The results showed a weak correlation between CFS and FI-lab (r = 0.19, p-value < 0.001) (see Figure S1 supplementary materials).

Multiple logistic regression analyses showed that all-cause in-hospital mortality was associated with both FI-Lab (OR 1.04 for each 10-point increase, p-value <0.05) and CFS (1.71, p-value <0.01).

Three-month post-discharge mortality was associated with both FI-Lab (OR 1.05 for each 10-point increase, p-value <0.001) and CFS (1.69, p-value <0.001).(Table 1)

Table 1
Logistic regression model with in hospital and three-months post discharge mortality.

In-hospital mortality	*Univariable Logistic Regression*		*Multivariable Logistic Regression*	
Variable	*OR (95 % CI)*	*p-value*	*OR (95 % CI)*	*p-value*
Age (years)	1.05 (1.00 – 1.10)	<0.05	1.06 (0.99 – 1.12)	0.091
Sex (male)	1.76 (0.97 – 3.18)	0.060	1.80 (0.85 – 3.80)	0.126
CFS	1.97 (1.40 – 2.78)	<0.001	1.71 (1.20 – 2.43)	<0.01
FI-Lab (+ 0.01 points)	1.05 (1.03 – 1.08)	<0.001	1.04 (1.01 – 1.06)	<0.05
Post-discharge mortality	*Univariable Logistic Regression*		*Multivariable Logistic Regression*	
Variable	*OR (95 % CI)*	*p-value*	*OR (95 % CI)*	*p-value*
Age (years)	1.04 (1.00 – 1.08)	<0.05	1.02 (0.97 – 1.07)	0.503
Sex (male)	1.69 (1.04 – 2.75)	<0.05	1.35 (0.72 – 2.54)	0.351
CFS	1.84 (1.40 – 2.41)	<0.001	1.69 (1.28 – 2.423)	<0.001
FI-Lab (+ 0.01 points)	1.05 (1.03 – 1.07)	<0.001	1.05 (1.02 – 1.07)	<0.001

Abbreviations: CI, Confidence Interval; CFS, Clinical Frailty Scale; OR, Odds Ratio.

The ROC curve for FI-Lab showed moderate predictive accuracy for all-cause in-hospital mortality (AUC 0.67 [95 % CI 0.59–0.74]) and for three-month post-discharge mortality (AUC 0.68 [95 % CI 0.61–0.74]).

The ROC curve for CSF showed moderate predictive accuracy for all-cause in-hospital mortality (AUC 0.70 [95 % CI 0.63–0.78]) and for three-month post-discharge mortality (AUC 0.69 [95 % CI 0.62–0.77]).

Notably, the ROC curve model using the combined tools (CFS and FI-Lab) showed an AUC of 0.77 (95 % CI 0.69–0.84) for all-cause in-hospital mortality and 0.75 (95 % CI 0.68–0.82) for three-month post-discharge mortality (Fig. 1).

A statistical significant difference was observed when comparing the CFS ROC curve and the combination ROC curve both for in-hospital mortality ($p < 0.05$) and post-discharge mortality ($p < 0.05$).

4. Discussion

This is among the few studies to investigate the combined use of CFS and FI-Lab tools in the prediction of in-hospital mortality and three-month post-discharge mortality in a convenient cohort of real-world hospitalized, mainly oldest-old patients, underscoring that the combined use could be better than the single use in terms of assessing the risk of the outcomes.

It is noteworthy that a weak correlation between FI-lab and CFS was observed in line with the findings of Ellis et al. [17] and Nakashima et al. [13], suggesting that these two frailty measurements may complement individual frailty, reflecting a distinct frailty profile, especially in the face of decompensating acute illness.

It is generally accepted that hospitalization poses a high environmental stressor for frail older adults, favoring increased risk for mortality, complications, or long-term adverse events, and that frailty assessments are usually mutated from community dwellings aimed at quantifying the accumulation of clinical deficits to provide a frailty-based individual risk. However, it is currently unclear to which extent these frailty measurements may be translated into an acute setting where acute illnesses superimpose cumulated chronic clinical conditions [17].

This uncertainty further complicates the appropriate identification of higher-risk frail patients that may require targeted interventions.

The present findings supported the fact that FI-lab is an acute information in addition to those conferred from CSF and chronological age that may encompass both predisposing features of frailty-related organ dysfunction or precipitating features for acute illness, driving unfavorable outcomes. Moreover, the combined predictive accuracy of laboratory-based frailty and clinical frailty measurements may indicate that laboratory features may intercept acute allostatic overload provided from an acute illness to existing accumulated multiple clinical deficits, allowing for an early identification of complex frail patients, potentially adding valuable information in relation to increased burdening of frailty during in-hospital stay.

Notably, a FI-Lab 10-point increase was associated with higher all-cause in-hospital and three-month post-discharge mortality, suggesting that changes in the FI-Lab might add prognostic information during the course of in-hospital stay in frail oldest old.

This study adds to the scant body of evidence about the FI-Lab in the hospital acute setting and may serve as a preliminary platform for motivating additional research in this field.

Strengths of the study are the convenient sample and that the study was conducted in two different acute geriatric units of northern Italy. The data censoring allows for the accuracy of the mortality analysis.

Limitations of this study include the relatively small sample size, the lack of evaluation of specific causes of death, and the absence of adjustment for specific multimorbidity patterns. Furthermore, given the study design, some missing data were present, as reported in the supplementary material, which may have introduced potential bias in the analysis. Finally, we believe that assessing the temporal trend of FI-Lab during hospital stay, alongside other frailty models, could have further strengthened the analysis and improved its comprehensiveness.

Eventually, the assessment of the multidimensional nature of frailty in the hospital setting remains a challenge. The FI-lab may help in the early identification of complex and acutely ill older adults who have preexisting cumulated clinical deficits that may reduce resilience to precipitant in hospital factors, burdening frailty trajectory and increasing the overall risk of adverse outcomes.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Giulia Venturelli: Data curation, Investigation, Writing – original draft. **Francesco Canepa:** Data curation, Investigation, Writing – original draft. **Luca Tagliafico:** Data curation, Formal analysis, Writing – review & editing. **Silvia Ottaviani:** Data curation, Formal analysis, Writing – review & editing. **Stefania Peruzzo:** Writing – review & editing. **Alessio Nencioni:** Supervision, Writing – review & editing. **Aldo Bellora:** Supervision, Writing – review & editing. **Fiammetta Monacelli:** Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

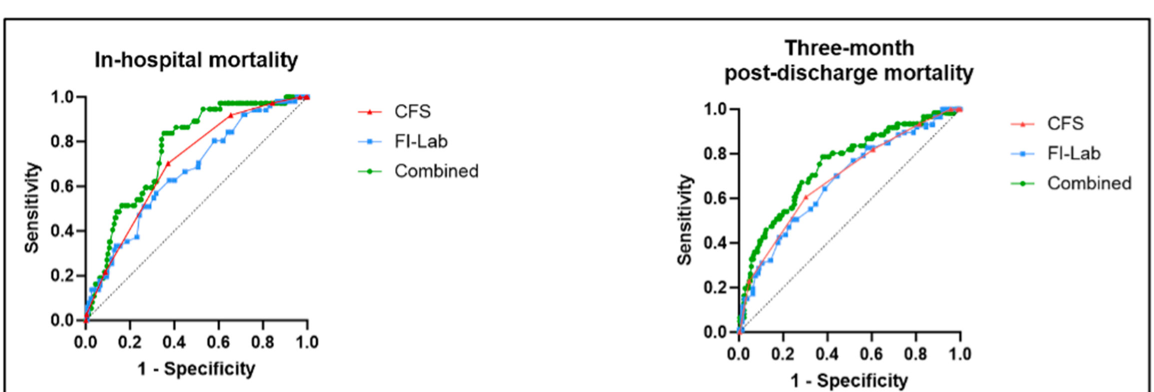

Fig. 1. The figure illustrates the ROC curves for FI-Lab and CFS and their combination in predicting all-cause in-hospital mortality and three-month post-discharge mortality.

the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2025.100128.

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