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The pictorial fit-frail scale: a novel tool for frailty assessment in critically ill older adults

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Abstract

Background Frailty is a state of high vulnerability to adverse health outcomes. It is an important factor influencing the prognosis of older, critically ill patients. Several methods to assess frailty were evaluated in the critical care setting. The Pictorial Fit-Frail Scale (PFFS) is a validated quick and easy-to-use tool for frailty assessment. It takes < 5 min to fill by the patient or caregiver; it requires no clinical examination by medical staff. This study evaluated the use of the PFFS in an intensive care unit (ICU).

Methods A single-center retrospective study, performed in an 18-bed mixed medical-surgical ICU in a university-affiliated tertiary hospital. As of 1/9/2022, all older patients are routinely asked to fill out the PFFS. Patients were grouped based on their PFFS score. Baseline characteristics and admission outcomes were compared. Correlation between the PFFS and prognostic scores was examined. Mortality was analyzed using logistic and Cox regressions.

Results 168 patients were included. 56 (33.33%) patients were non-frail, 81 (48.21%) were mildly-moderately frail, and 31 (18.45%) were severely frail. There were no differences in baseline characteristics or prognostic scores between frailty groups. No correlation was found between PFFS, age, APACHE2, and SOFA24. Multivariate logistic regression demonstrated an association between frailty and 90d but not with ICU mortality. Cox regression demonstrated higher mortality in the mild-moderate frailty (HR 2.053, 95%CI 1.009, 4.179) and severe frailty (HR 4.353, (95% CI 1.934, 9.801)) groups compared to the non-frail group.

Conclusion Frailty assessment by the PFFS in the ICU is feasible. Frailty is a distinct characteristic of older, critically ill patients and is independently associated with 90d mortality.

Keywords Frailty, Pictorial fit-frail scale, Older critically ill patient, Prognostic scores, ICU admission outcomes

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Introduction

Frailty is a state of high vulnerability to adverse health outcomes, including disability, dependency, falls, need for long-term care, and mortality [1]. Several definitions exist, but most measure vulnerabilities and strengths to indirectly assess physiological reserve [2]. Frailty is not age-dependent [3], but it is related to age [4–6].

Frailty prevalence is estimated at 28–46% of acute ICU admissions. Frailty has increasingly been recognized as an important factor in the prognosis assessment of older critically ill patients, in terms of mortality (in-hospital and long-term), hospital length of stay (LOS), and discharge disposition [7–10]. It has also been shown that frailty is associated with a higher risk of persistent clinical illness (critical care dependency for survival) [11] and higher rates of delirium [12].

This emphasizes the importance of measuring vulnerabilities and resilience, both assessed by frailty measures, in critical care settings [6, 13]. Commonly used prognostic factors for ICU and hospital mortality, such as APACHE2 (Acute Physiology and Chronic Health Evaluation) and SOFA (Sequential Organ Failure Assessment), measure chronic diseases and pathophysiological changes of acute illness. Frailty assessment might serve as an additional tool for prognosis assessment [13] and treatment decision-making in the ICU.

The clinical frailty score (CFS) is an accepted and commonly used tool for frailty assessment in the critical care setting. Its association with ICU- and 30-day mortality is well described [7, 8, 10, 14–20]. However, as CFS is a judgment-based measure, an inter-rater variability exists, especially between experienced geriatricians and other caretakers. This might decrease the CFS prognostic accuracy [21–23].

In 2019 the Pictorial fit-frail scale (PFFS) was introduced as a quick and easy-to-use tool for frailty assessment [24]. It takes less than 5 min to fill by the patient or caregiver, it's not based on language or health literacy, and it requires no clinical examination by the medical staff (hence not subjected to any caretaker bias) [24, 25]. The PFFS was validated in several clinical settings, including a thoracic surgery clinic [26], a geriatric clinic [27], a memory clinic [28], and primary care clinics [29]. It has not been assessed in the critical care setting. Due to its simplicity, we incorporated the PFFS as a routine measure in older patients admitted to our ICU. This study aims to describe the PFFS scores of older patients admitted to the general ICU, its correlation with commonly used ICU prognostic scores, and its association with outcomes including ICU length of stay, length of ventilation (LOV), ICU mortality, and 90d mortality.

Methods

Participants, procedure, and setting

A single-center retrospective study. The study was approved by the Rabin medical center institutional review board (IRB) committee (RMC-0600-23) on September 13th, 2023. Patient confidentiality was maintained throughout data collection and analysis by replacing protected personally identifiable information with research identification codes (ID codes). Since data were evaluated retrospectively, pseudonymously and solely obtained for the study purposes, a requirement of informed consent was waived (naturally, due to the retrospective nature of the study, a patient's consent to participate is not applicable). All study procedures were in accordance with the Helsinki Declaration of 1975.

We included in the study all patients aged ≥ 70 years who were admitted to the ICU during the study period (September 1st, 2022, until August 31st, 2023). We excluded patients who were admitted for less than 24 h, and readmissions of patients during the study period (only the first admission was used). We extracted data from electronic medical records including age, sex, BMI, ICU admission and discharge dates, ICU admission reason (categorized as medical, surgical (whether planned or urgent), trauma, transplantation, or Obstetrics-Gynecology), APACHE2 admission score, SOFA24 score (First SOFA score calculated at 24 h of ICU admission), PFFS score (from which a frailty index score was calculated, termed $PFFS_{TRANS}$; see below) and admission outcomes including ICU length of stay (LOS), length of ventilation (LOV), and mortality (ICU and 90 day mortality).

Measures

PFFS This scale was validated for frailty assessment in several settings [26–29]. It uses visual images in 14 diverse health domains to assess and grade frailty levels (Fig. 1; the full PFFS is available at: https://www.dal.ca/sites/gmr/our-tools/pictorial-fit-frail-scale.html). The person fillin g the questionnaire (in this study either the patient or a caregiver) is asked to mark in each domain the image that best describes the patient's usual state. We transformed the PFFS to a frailty index ($PFFS_{trans}$)). The standard procedure to do this involves first summarizing the scores of all filled domains for a total score between 0 and 43. Then, this summative score is divided by the total number of levels with a response to generate the $PFFS_{trans}$ that ranges from 0 to 1. Patients missing responses in more than 3 domains (> 20% of total domains) were omitted from the analysis since stable $PFFS_{trans}$ could not be calculated [26, 28].

The PFFS has been routinely administered to all older patients (≥ 70 years old) admitted to the general ICU since September 2022. Alert and cooperative patients were asked to complete the PFFS independently as part

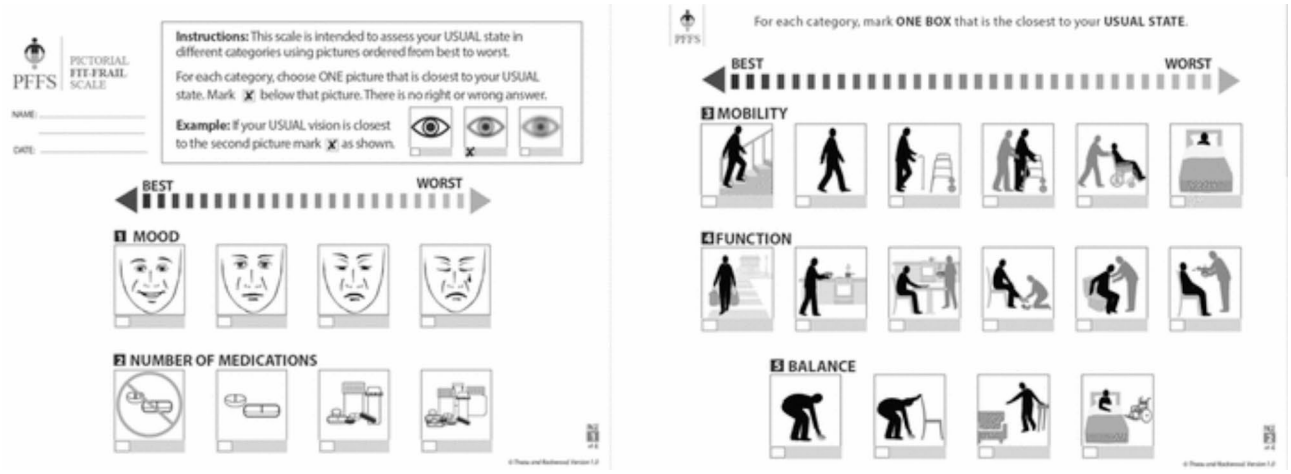

Fig. 1 The first five domains of the Pictorial Fit-Frailty Scale [24]

of their ICU admission. In case the patient was sedated, we asked a close family member who accompanied the patient, during the admission, to complete the PFFS instead. The person completing the PFFS was instructed to complete it according to the normal, usual state of the patient, (i.e. two weeks before the current severe illness). After completing the PFFS, its results were entered into the electronic medical record.

Patients were grouped into frailty categories by their $PFFS_{TRANS}$, based on accepted frailty index levels: no frailty $0 \le PFFS < 0.2$, mild-moderate frailty $0.2 \le PFFS < 0.45$, and severe frailty $PFFS \ge 0.45$ [30–32].

Statistical analysis

We compared baseline characteristics, by PFFS grade with the Fisher exact test for categorized variables, and the Kruskall-Wallace test for numerical variables.

To examine the degree of correlation between the different scores ($PFFS_{TRANS}$, APACHE2 and SOFA24) we used Spearman correlation. To avoid collinearity, for this analysis, we subtracted the age points from the APACHE2 score (APACHE2NA – APACHE2 no age; 5 points were subtracted from patients aged 70–74, and 6 points from patients older than 75).

We described LOS & LOV differences between frailty groups. We did not perform further analysis for these outcomes, as they are affected by several factors, including mortality, hospital structural considerations, and clinical decisions, making statistical models not suitable [33].

We performed univariate and multivariate logistic regression for ICU mortality and 90d mortality. $PFFS_{TRANS}$ was multiplied by 100 for the regression analysis, to reflect an odds ratio of 0.01-point increase. We also performed multivariate Cox PH regression for 90d mortality. Inclusion into the multivariate model was based on a priori selection due to clinical significance.

Statistical analysis was performed using SAS vs. 9.4 (SAS Institute, Cary North Carolina). All tests were two-tailed, and a *p*-value of 5% or less was considered statistically significant.

All datasets of this study are available from the corresponding author on reasonable request.

Results

There were overall 929 admissions to the ICU during the study period, of which 268 admissions were of patients aged 70 years and older. Of those, 11 patients were admitted twice, and their later admissions were excluded. In addition, 50 patients were admitted for less than 24 h and thus excluded. PFFS was filled for 168 of the remaining 207 patients (81.16%) who were included in the final analysis (Fig. 2). The majority (73%) of the patients were ventilated, thus their PFFS were filled by a healthcare proxy (caregiver, family member, etc.) but data regarding the identity of the person filling the PFFS was not recorded.

No significant differences were found between the frailty groups in most descriptive characteristics, including age, sex, BMI, APACHE2, and SOFA24. Even so, there was a higher proportion of trauma patients in the non-frail group and a higher proportion of surgical patients in the severe frailty group (Table 1). Of note, due to a shortage of ICU beds, none of the 42 admissions due to a surgical problem were planned; 6 surgical admissions were due to acute complications of elective procedures, and 36 were of emergent procedures. There was no correlation between $PFFS_{TRANS}$ and age ($r_{spearman}=0.075$, $p=0.333$), APACHE2NA ($r_{spearman}=0.068$, $p=0.379$), and SOFA24 ($r_{spearman}=0.105$, $p=0.175$) (Table 2).

Figure 3 describes patient outcomes according to their frailty level (non-frail, mild-moderate frailty, severe frailty). There was a significant difference between the groups in 90d mortality (non-frail 25%, mild-moderate

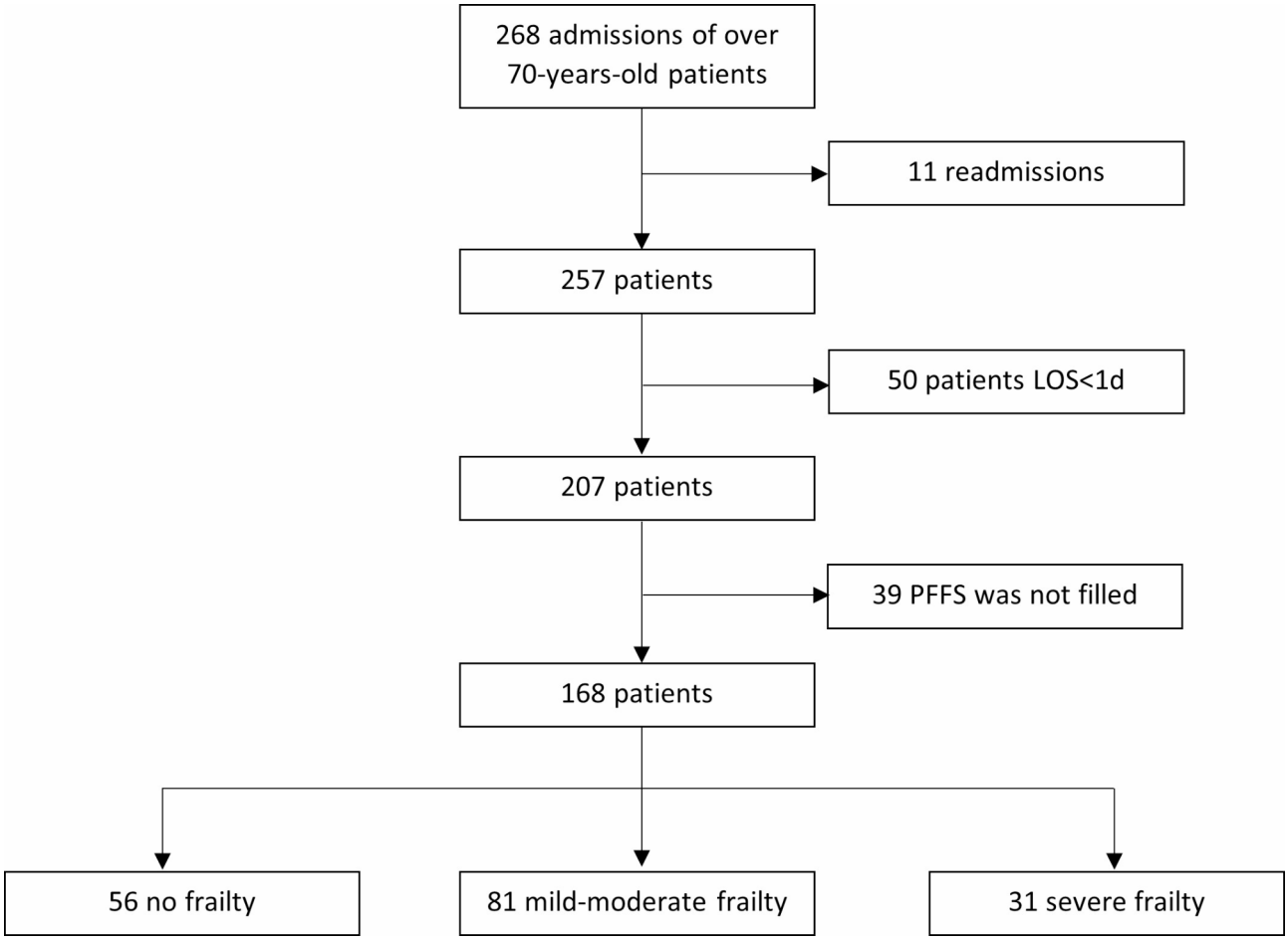

Fig. 2 Flowchart of study participants. LOS – Length of stay; PFFS – Pictorial Fit Frailty Scale

Table 1 Baseline characteristics by frailty level

	No frailty ($PFFS_{Trans}$<0.2)	**Mild-moderate frailty (0.2 ≤ $PFFS_{Trans}$ <0.45)**	**Severe frailty ($PFFS_{Trans}$≥0.45)**	***p* value**
n	56 (33.33)	81 (48.21)	31 (18.45)	
Age (years)	75.24 (71.93, 77.22)	75.72 (72.93, 79.32)	75.69 (72.76, 80.75)	0.333
Male sex	38 (67.86)	49 (60.49)	17 (54.84)	0.468
BMI (kg/m^2)	28.03 (24.47, 31.20)	27.34 (24.22,31.59)	26.70 (22.84, 30.49)	0.564
Admission category				
Medical	33 (58.93)	57 (70.37)	15 (47.49)	0.014
Surgical	12 (21.43)	16 (19.75)	14 (24.56)	
Trauma	9 (16.07)	6 (7.41)	2 (6.45)	
Transplantation	2 (3.57)	1 (1.23)	0	
Ob-Gyn	0	1 (1.23)	0	
APACHE2	22 (16.24,5)	24 (19, 27)	23 (18,28)	0.287
SOFA24	7 (4, 9.5)	8 (5, 10)	8 (4, 10)	0.498
$PFFS_{Trans}$	0.12 (0.07,0.16)	0.30 (0.24,0.40)	0.56 (0.49,0.65)	NA

Categorial variables are represented by (n, %); numerical variables by median (IQR). *p* value was calculated using Fisher exact test for categorical variables, and Kruskall-Wallace test for numerical variables to compare between the three frailty groups. BMI – Body Mass Index; APACHE2 – Acute Physiology And Chronic Health Evaluation 2 score; SOFA 24 – Sequential Organ Failure Assessment at 24 h from admission; $PFFS_{Trans}$ – indexed Pictorial Fit Frailty Score

Table 2 Spearman correlation coefficients between age, prognostic scores, and PFFS

	APACHE2	SOFA24	$PFFS_{TRANS}$
Age	-0.192*	-0.091	0.075
APACHE2		0.596**	0.068
SOFA24			0.105

* $p=0.007$; ** $p<0.0001$; all other p values were greater than 0.05. APACHE2 – Acute Physiology And Chronic Health Evaluation 2 score, without age component; SOFA 24 – Sequential Organ Failure Assessment at 24 h from admission; $PFFS_{TRANS}$ – Pictorial Fit Frailty index

frailty 44.4%, severe frailty 64.5%; $p=0.001$). There were no significant differences between the groups in LOS, LOV, and ICU mortality.

In a univariate analysis for ICU mortality, only APACHE2NA (OR 1.107 (95% CI 1.044, 1.173), $p=0.0007$), and SOFA24 (OR 1.304 (95% CI 1.147, 1.4862), $p=<0.0001$) were found as significant covariates, while frailty and other baseline characteristics were not. A univariate analysis for 90d mortality demonstrated that APACHE2NA (OR 1.113 (95% CI 1.059, 1.170), $p>0.0001$), SOFA24 (OR 1.263 (95%CI 1.146, 1.362), $p<0.0001$), and frailty whether $PFFS_{TRANS}$ (OR 1.027 (95% CI 1.008, 1.045), $p=0.004$) or frailty groups (mild-moderate OR 2.206 (95% CI 1.1067, 4.563), $p=0.0329$; severe OR 5.168 (95% CI 2.076, 12.866), $p=0.0004$) were significantly associated with mortality, whereas other baseline characteristics were not (supplement table S1). In a multivariate analysis for ICU mortality including baseline characteristics, prognostic scores, and frailty, the only significant covariate was SOFA24 (OR 1.191 (95% CI 1.009, 1.407), $p=0.039$); For 90d mortality the only covariates that were found significant were SOFA24 (OR 1.193 (95% CI 1.044, 1.363), $p=0.01$) and frailty, both mild-moderate (OR 2.277 (95% CI 1.017, 5.101), $p=0.046$) and severe (OR 5.848 (95% CI 2.051, 16.675), $p=0.001$) (Supplement table S2). Similar results were found when replacing the frailty groups with the continuous PFFS score (supplement table S3).

Multivariate survival analysis using Cox regression showed similar results: SOFA24 (HR 1.167, $p=0.004$) and frailty, both mild-moderate (HR 2.053, $p=0.047$) and severe (HR 4.353, $p=0.0004$) were the only covariates significantly associated with mortality (Table 3). Similar results were found when replacing the frailty groups with the continuous PFFS score (supplement table S4). Kaplan-Meyer survival curve demonstrated a significant difference between the groups, starting at approximately 20 days after ICU admission. This correlates with similar ICU mortality between the groups, but an overall higher mortality rate in the group with higher frailty levels (Fig. 4).

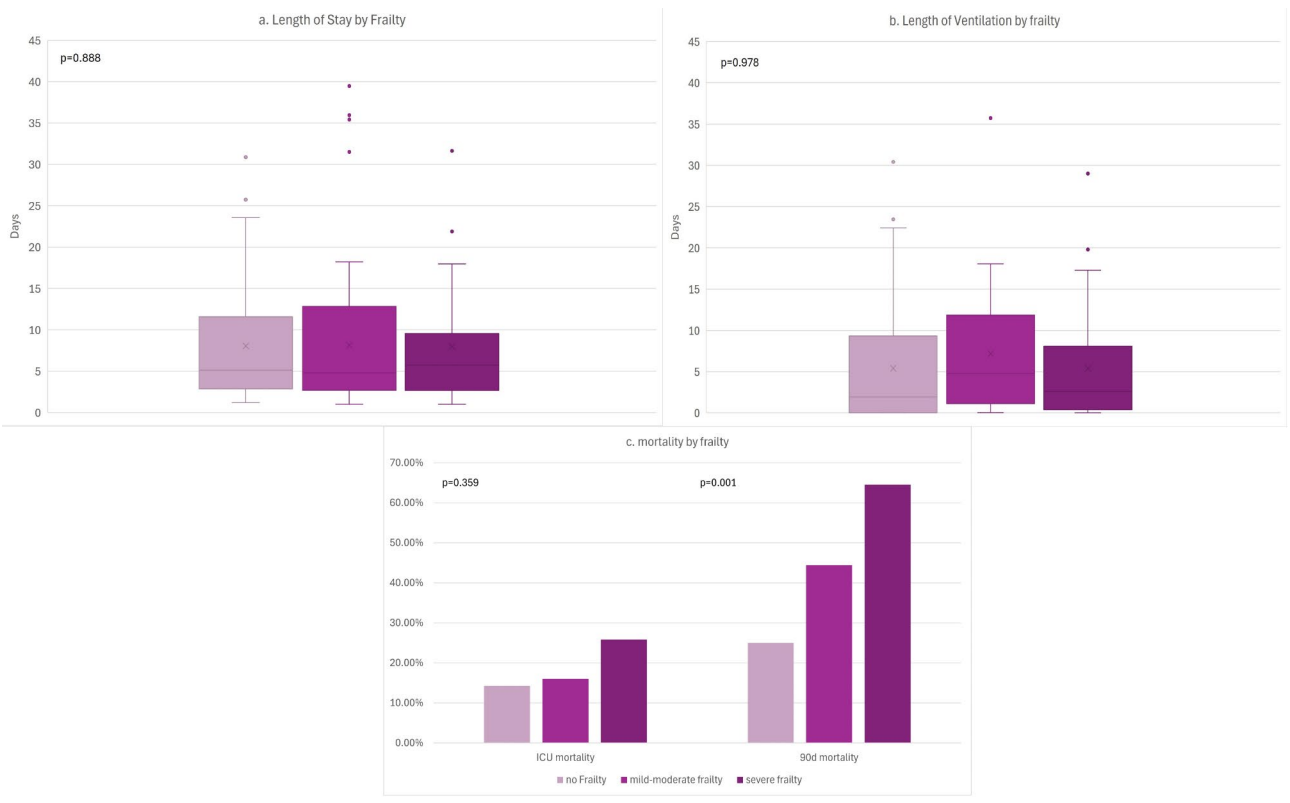

Fig. 3 Outcomes by frailty level. a & b. box plots of length of stay (**a**) & length of ventilation (**b**) by frailty groups; c. mortality by frailty groups

Table 3 Cox regression for 90-d mortality

			95% CI		
		Hazzard Ratio	Lower	Upper	*P* value
Age (years)		1.003	0.949	1.059	0.928
Sex (Ref: Male)		1.136	0.623	2.069	0.678
BMI (kg/m^2)		0.971	0.930	1.014	0.184
APACHE2		1.041	0.991	1.093	0.106
SOFA24		**1.167**	**1.049**	**1.297**	**0.004**
Frailty (Ref: Non-frail)	**Mild-moderate**	**2.053**	**1.009**	**4.179**	**0.047**
	Severe	**4.353**	**1.934**	**9.801**	**0.0004**

CI – Confidence Interval; BMI – Body mass index; APACHE2 – Acute Physiology And Chronic Health Evaluation 2 score, without age component; SOFA 24 – Sequential Organ Failure Assessment at 24 h from admission

Discussion

This study evaluated frailty, as measured by the PFFS, in older patients admitted to the critical care unit and its association with short and long-term outcomes. We demonstrated high PFFS completion rates. Baseline characteristics were similar between frail (whether mild-moderate or severe) and non-frail patients, except for a higher proportion of surgical patients in the severely frail group, and a higher proportion of trauma patients among the non-frail group. The higher proportion of surgical patients in the severely frail group might be explained by the high prevalence of older frail patients undergoing emergency surgery rather than elective procedures, as shown also in other studies [34, 35]. There was no correlation between PFFS and age, APACHE2NA, and SOFA24 scores. There was a significant increase in 90d mortality in frail patients, while there were no significant differences in ICU admission outcomes, including ICU mortality, between the groups.

There are several methods to assess frailty; the comprehensive geriatric assessment (CGA) is considered the gold standard. However, this method requires resources including time and healthcare providers who specialize in geriatrics. These are usually not available at the time of critical illness and admission to the ICU. Several validated methods for frailty assessment exist, including the Clinical Frailty Scale (CFS) [30], Frailty Index (FI), modified frailty index (MFI) [5, 36], Tilburg Frailty Indicator (TFI) [37], and others [3, 38–41]. These tools were validated in different settings and found to be associated with several outcomes [42]. However, differences exist between these tools; Some require clinical assessment (with or without patient cooperation) [5, 30, 37, 38], while others require only a review of healthcare records (EHR) [36, 39, 40, 43]. There are differences between these tools in sensitivity and specificity for frailty assessment [41]. The PFFS is

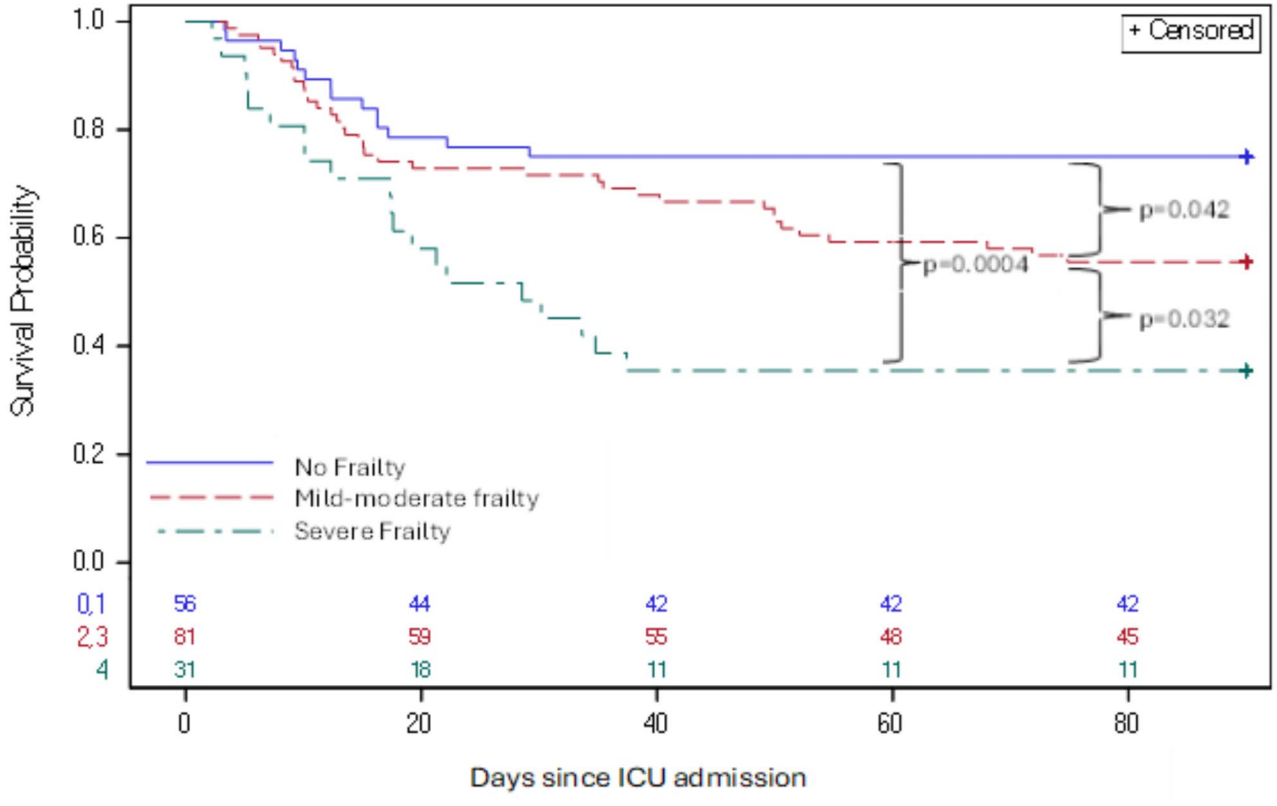

Fig. 4 Kaplan-Meyer survival curve for 90d survival by frailty level

a validated tool that overcomes many of these obstacles by assessing frailty in a quick, easy-to-use, and non-language or literacy-dependent way.

Many studies have shown an association between frailty (assessed by CFS or MFI) and short-term mortality, both ICU mortality and 30-day mortality [7, 8, 10, 14–20, 36, 44, 45], but other studies did not [46, 47]. The same conflicting results exist regarding ICU LOS, and LOV. Several studies have shown increased ICU LOS in frail patients [20, 44, 45], or trends suggesting it [7], while others have not [9, 18, 46]. LOV was only scarcely assessed; Zamipeiri et. al [36]. found an association between frailty and LOV, but other studies did not [18, 46]. We could not find a difference in these outcomes between frailty groups. However, similar to other studies, we demonstrated a significant and independent association of frailty, as measured by the PFFS, with 90d mortality [7, 10, 18, 44–46, 48–50].

Data regarding the correlation between age, ICU prognostic scores, and frailty are conflicting. Many studies demonstrated a correlation between age, high ICU prognostic scores, and frailty [10, 16, 17, 20, 44, 45, 51, 52], while others could not find a correlation between all these factors in older critically ill patients [30, 34–36, 51]. There is one study in which a slight positive correlation was demonstrated between CFS and APAHCE2 [10]; another study found positive correlations between FI and other prognostic factors [53]. However, FI includes chronic comorbidities, so this correlation is not surprising. Our study aligns with Maguet. et al., showing no difference in age or ICU prognostic scores between different frailty levels [18].

The absence of a significant correlation between PFFS and age, APACHE2NA, and SOFA24 in our study, and the lack of difference in short-term ICU outcomes (LOS, LOV, and mortality) between different PFFS-frailty levels suggests that frailty, assessed by PFFS, may be a unique and distinct patient characteristic in older adults, which is independent of age, other co-morbidities, or the critical illness presentation. Similar findings were described (although some of them were in a different setting) [18, 54]. These findings are not consistent, as other studies demonstrated associations between frailty and severity scores [8, 9]. Indeed, classic prognostic factors for short-term mortality (APACHE2 and SOFA24), were found predictive for ICU mortality, while PFFS was not. However, frailty measured by the PFFS was found to be an independent risk factor for 90d mortality. Moreover, adjusting mortality to baseline characteristics and prognostic scores showed that frailty level measured by the PFFS, was a stronger risk factor for 90d mortality compared to commonly and well-accepted ICU prognostic scores. Our results are somewhat different from previous studies (demonstrating an association between frailty (assessed by CFS) and ICU mortality); it might suggest that critical care treatment can support older patients to survive a critical illness crisis, regardless of frailty level. As frailty reflects vulnerability and limited physiological reserve, recovery and longer-term survival from critical illness are reduced in older patients with frailty.

It is possible, that different tools used to measure frailty, estimate it differently (as evidenced by a moderate correlation between them [26–29]). Most studies regarding frailty in critically ill older patients evaluated frailty using CFS [7–10, 14–18, 20, 45, 48, 49, 51, 52, 55–59], yet other tools are possible as well [18, 24–26, 28, 31, 36, 37, 46, 56]. Although CFS categorization might be performed by ICU staff without any training (using the CFS description, and additional information given by the patient or caregiver [9, 15]), a broader evaluation and experience might be needed, as CFS is partially affected by clinical judgment [23]. The PFFS is a validated, quick, and easy-to-use tool that might overcome this difficulty, as it is filled by the patient or caregiver, and does not require a comprehensive assessment by the ICU staff or previous training [24, 25]. To our knowledge, this is the first study using the PFFS to assess frailty in older adults admitted to the ICU.

Our study has several limitations. First, this is a retrospective single-center study, which might limit its generalizability. Second, critical illness is likely to affect frailty assessment. However, this cannot be avoided when the assessment is performed in the ICU (or even when considering ICU admission). Therefore, patients did not undergo a CGA, to confirm the frailty level calculated by the PFFS. Third, we did not measure frailty using other validated tools such as the CFS, hence differences between the different tools are only theoretical. However, PFFS was validated as a frailty measure in other settings and shown to correlate with CGA-based FI [26]. Fourth, the PFFS completion rate was 80%, which might suggest an underlying bias. Fifth, in patients that the PFFS was filled by a healthcare proxy, we did not further ask the patients to fill the PFFS when their condition allowed it. Thus, we were not able to assess differences in frailty assessment between the patient and a healthcare proxy [25]. This might have an impact on the results. Finally, we did not record how resource-consuming this process has been, how long it took to complete the PFFS. This data is importantfor generalization and implementation in other care settings. However, since it was easily accepted by the staff in our ICU as part of routine workflow, we believe it can be implemented in other settings as well.

Conclusion

Frailty assessed by the PFFS was found to be a distinct characteristic in older critically ill patients, not associated with other baseline characteristics, and different

from commonly used ICU prognostic scores. Higher frailty level, as measured by the PFFS, is associated with increased 90d mortality, even though short-term outcomes were similar. Further studies are needed to evaluate PFFS scores in older patients surviving critical illness with longer-term outcomes. Future intervention studies should examine whether incorporating the PFFS in ICU settings will improve clinical decision making and patient outcomes.

Abbreviations

BMI	Body mass index
APACHE2	Acute physiology and chronic health evaluation 2 score
SOFA24	Sequential organ failure assessment at 24 h from admission
PFFS	Pictorial fit frailty scale
LOS	Length of stay
LOV	Length of ventilation
CFS	Clinical frailty scale
CGA	Comprehensive geriatric assessment
MFI	Modified frailty index
TFI	Tilburg frailty indicator
FI	Frailty index

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-025-05773-4.

Supplementary Material 1

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Not applicable.

Author contributions
LS – Conceptualization, Investigation, Data curation, Writing – Original Draft, Writing – Review & Editing; OT – Conceptualization; Writing – Review & Editing; RM - Data curation; TS - Methodology, Software, Validation, Formal Analysis, Writing – Review & Editing; IK - Conceptualization, Investigation, Writing – Review & Editing, Supervision; LC - Conceptualization, Investigation, Writing – Original Draft, Writing – Review & Editing, Supervision.

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Data availability
The datasets generated and/or analyzed during the current study are not publicly available as Clalit Health Services (the biggest HMO service provider in Israel, which Rabin Medical Center is part of) policy does not allow sharing of patient's data. Datasets are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the ethics committee of Rabin Medical Centre (RMC-0600-23). Patient confidentiality was maintained throughout data collection and analysis by replacing protected personally identifiable information with research identification codes (ID codes). Since data were evaluated retrospectively, pseudonymously and solely obtained for the study purposes, a requirement of informed consent was waived. Due to the retrospective nature of the study, a patient's consent to participate is not applicable.

Consent for publication
Not applicable.

Competing interests
Olga Theou (with Kenneth Rockwood) has asserted copyright of the Pictorial Fit-Frail Scale, which is made freely available for education, research, and not-for-profit health care. Licenses for commercial use are facilitated through the Dalhousie Office of Commercialization and Industry Engagement. The other authors declare that they have no competing interests.

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