ORIGINAL ARTICLE

Impact of the Clinical Frailty Score on Outcomes of Critically Ill Patients in a Tertiary Care ICU

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Abstract

Background: Advanced age is a known marker of vulnerability, but frailty is an independent predictor of poor outcomes in critically ill patients. The clinical frailty score (CFS) facilitates rapid assessment, aiding prognostication, care improvement, and resource allocation, particularly in resource-limited intensive care units (ICUs).

Materials and methods: A prospective observational cohort study was conducted from April to September 2023 at a tertiary care ICU. The study included 166 patients aged ≥50 years with ICU stays longer than 48 hours, excluding those with contraindications for care escalation. Data were collected on demographics, Clinical parameters, and scoring systems including acute physiological and chronic health evaluation II (APACHE-II), sequential organ failure assessment (SOFA), Charlson comorbidity index (CCI), and CFS. Predictive analyses were performed using receiver operating curve (ROC) curves, cut-offs, and logistic regression.

Results: The median age of patients was 65 years, with an APACHE-II score of 18 and a CFS of 4. In-hospital mortality was 46.4%. The CFS outperformed other scoring systems in predicting both in-hospital mortality [Area under the receiver operating characteristic curve (AUC-ROC) 0.73] and net negative outcomes (AUC ROC 0.75). Frailty (CFS ≥6) was present in 39.75% of patients, with each unit increase in CFS associated with a 41.8% higher odds of mortality and a 50.7% higher odds of net negative outcomes. The optimal CFS cut-offs were 4 for 80% sensitivity and 6 for 80% specificity.

Conclusion: The CFS is a practical and reliable tool for predicting ICU outcomes, outperforming traditional scoring systems. It supports improved decision-making and resource allocation. Further multicenter studies are necessary to validate its broader use in critical care practice.

Keywords: Clinical frailty score, Critical illness, Frailty assessment in hospital mortality resource allocation, Patient outcome assessment.

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Highlight

Clinical frailty score (CFS) is a superior predictor of in-hospital mortality and net negative outcomes in intensive care unit (ICU) patients compared to traditional scoring systems. Each unit increase in CFS significantly raises mortality risk, emphasizing its utility in prognostication, resource allocation, and decision-making in critically ill patients.

Introduction

Advancing age of patients is traditionally considered as an indicator of increased vulnerability to physiological stress. Age is linked to multiple co-existing morbidities, advance medical complexity and reduced life expectancy.[1] However, it is not only the chronological age but frailty and decrease in functioning across multiple systems, is associated with poor net outcomes.[2–5] Frailty and advancing age are not synonymous. Frailty is now increasingly identified and demonstrated to have vulnerability independent of age.[6] The frailty is now an emerging global healthcare burden and have major public health and clinical practice implications.[7] A rapid and accurate assessment of clinical frailty can aid in early prognostications, rational utilization of valuable intensive care resources, especially in resource limited settings. Goals of care and special care bundles can be integrated with patient's decision once accurate assessment of frailty is done.[5,6]

Assessment of frailty can be done by using various tools, with the CFS being the most commonly used. Clinical frailty score is a straightforward, nine-point, subjective tool designed to identify frail patients in the ICU.[8–10] Clinical frailty score can be used, like other conventional tools of prognostic assessment in ICU [e.g. acute physiological and chronic health evaluation II (APACHE II), Charlson comorbidity index (CCI), sequential organ failure assessment (SOFA)]. However, only limited literature is available in our regional clinical settings.

Thus, we aimed to evaluate the predictive ability of the CFS in relation to in-hospital mortality among adult patients admitted to the intensive care unit of our tertiary care center.

Materials and Methods

We conducted this prospective observational cohort study, from April to September 2023 (6 months) at our institute in

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Conflict of interest: None

the Department of Critical Care Medicine after approval from Institutional Ethical Committee.

We included all the patients admitted to our Critical Care Medicine Department with age 50 years and stayed in ICU for more than 48 hours. We excluded other patients of age <49 years, ICU stay of <48 hours, patients with written "do not intubate" "do not escalate" and/or "diagnosed medical futility". We collected relevant demographic and clinical data of these patients. Investigating team assessed frailty by interviewing the patient's/surrogate decision makers on a scale of 1 (clinically non frail) to 9 (terminal illness) on CFS.[6]

Sample Size and Statistical Methods

We calculated sample size with G power software v 3.1.9.6 to have power of 0.95 and alpha error is 0.05, with effect size of 0.6012 sample size is calculated to total 145 participants equally distributed among both the groups.[5]

Qualitative variables were presented as frequencies and percentages, while quantitative variables were expressed as mean with standard deviation (SD) and median with interquartile range (IQR) as it was found appropriate. The Kolmogorov–Smirnov test was used to check for data normality, and nonparametric tests were applied when normality was not met. A comparison between various predictive scores and variable was done by receiver operating curve (ROC) curve. A cut-off value of scores was derived for the primary outcome, and 2 groups were made for comparison. Quantitative variables were analyzed between the frail and non-frail groups using either the unpaired *t*-test or the Mann–Whitney test, depending on data distribution. Qualitative variables were compared using the Chi-square test or Fisher's exact test, as found appropriate. Further, we did a regression analysis to know the effect of frailty on clinical outcomes.

A *p*-value of less than 0.05 was considered statistically significant. Data entry was performed using an MS Excel spreadsheet, and statistical analysis was conducted using IBM SPSS Statistics for Windows, Version 23.0 (Armonk, NY: IBM Corp.).

Results

A total of 1,861 patients admitted in ICU during the study period. According to pre-defined inclusion criteria, 234 patients were included in the study. Out of 234 patients, 68 patients had not given the consent and hence 166 patients were considered for the study. Among these, 95 (57.2%) patients had net negative outcome, either dead or had persistent organ dysfunction at the time of discharge (Fig. 1).

Baseline demographic and clinical parameters are depicted in Table 1. Out of 166 patients, 110 (66.3%) were males and 56 (33.7%) were females. The median age of the study population was 65 (IQR-16). Patients enrolled from medical ICU were 150 (95.8%). Comorbidities were present in total 150 (90.4%) patients. Diabetes and hypertension were the most common comorbidities. Diabetes was present in 72 (43.4%) patients and hypertension was in 97 (58.4%) patients. Our study population had median APACHE II score at 48 hours was 18 (IQR-9), median SOFA score at the time of admission was 5 (IQR-4), Charlson comorbidity score 4 (IQR-3), median CFS 4 (IQR-3).

Median number of days on oxygen support were 2 (IQR-1). Median number of days on noninvasive ventilation (NIV) support was 1 (IQR-2). The median number of days on mechanical ventilation (MV) support were 5 (IQR-7). Median weight of the patients was 67 (IQR-13). Median Height of the patients was 160 (IQR-9). The median

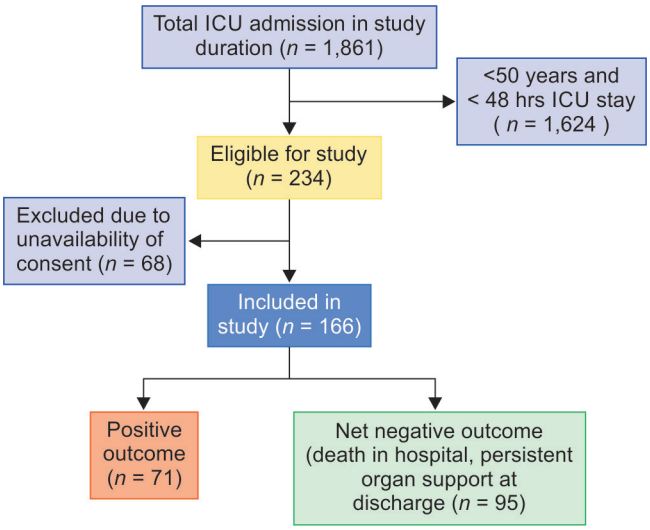


Fig 1: STROBE flow diagram of the study

Table 1: Baseline characteristics of patient population

Baseline characteristics	*Median*	*IQR*
Age	65	16.00
Number of days in hospital	12	10.00
Number of days in ICU	12	11.00
Height (cms)	160	9.00
Weight	67	13.00
Body mass index	25.72	3.95
APACHE II score at 48 HRS of admission	18	9.00
SOFA score on admission	5	4.00
Clinical frailty score	4	3.00
Charlson comorbidity score	4	3.00
Number of days of oxygen support in ICU	2	1.00
Number of days	1	2.00
Number of days on MV	5	7.00
	Count	*Table N %*
Sex		
Female (F)	56	33.7%
Male (M)	110	66.3%
Medical/surgical patient		
Medical	159	95.8%
Surgical	7	4.2%
Comorbidities		
Yes	150	90.4%
Diabetes		
Yes	72	43.4%
Hypertension		
Yes	97	58.4%
Hypothyroidism		
Yes	36	21.7%
Chronic obstructive pulmonary disease (COPD)		
Yes	49	29.5%
Asthma		
Yes	7	4.2%

(Contd...)

Table 1: *(Contd...)*

Baseline characteristics	*Count*	*Table N %*
Heart failure		
Yes	19	11.4%
Coronary artery disease		
Yes	23	13.9%
Chronic kidney disease (CKD)		
Yes	42	25.3%
Liver dysfunction		
Yes	11	6.6%
Malignancy		
Yes	14	8.4%
Immune compromised		
Yes	12	7.2%
Oxygen support in ICU		
Yes	135	81.3%
Mechanical ventilation support		
Yes	133	80.1%
Vasopressor support		
Yes	130	78.3%
Organ support		
Yes	123	74.1%
Dialysis		
Yes	27	16.3%
Tracheostomies		
Yes	40	24.1%
Discharged		
Yes	83	50.0%
30 days mortality		
Yes	76	45.8%
In hospital mortality		
Yes	77	46.4%
Organ support at the time of discharge from ICU		
Yes	21	12.7%
Net negative outcome persistent organ support/death		
Yes	95	57.2%

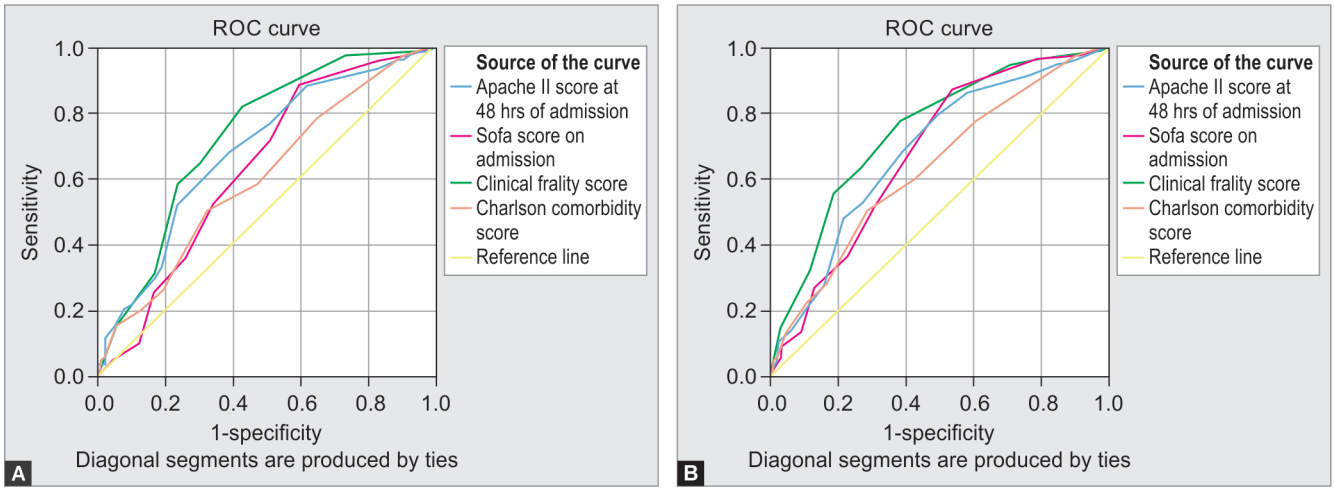
BMI, body mass index; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease

body mass index (BMI) of the patients was 25.72 (IQR-3.95). In our study, 135 (81.3%) patients received oxygen support and 133 (80.1%) patients received MV support. In total 130 (78.3%) patients required vasopressor support to maintain a mean arterial pressure (MAP) >65 mm Hg. Total 27 (16.3%) patients received dialysis and 40 (24.1%) patients underwent tracheostomy. Patients discharged were 83 (50%). Thirty-day mortality was seen in 76 (45.8%) and in-hospital mortality was seen in 77 (46.4%). Organ support at the time of discharge from ICU was present in 21 (12.7%) patients.

We did a comparative ROC analysis (Fig. 2) of APACHE II at 48 hours, SOFA score on admission, Charlson comorbidity score and CFS at the time of admission for prediction of in-hospital mortality (Fig. 2A). Receiver operating curve showed CFS performed best among all scores [area under the receiver operating characteristic curve (AUC-ROC) 0.73] ($p = 0.00$) compared with AUC ROC Charlson co-morbidity score 0.60 ($p = 0.0$), SOFA score on admission 0.64 ($p = 0.00$) and APACHE-II at 48 hours of admission 0.68 ($p = 0.00$). A similar analysis of ROC for prediction of net negative outcome (Fig. 2B) (death or persistent organ dysfunction) also suggested that CFS has a better predictive ability among all other scores AUC ROC 0.75 ($p = 0.00$) vs 0.69 ($p = 0.00$), 0.68 ($p = 0.00$), and 0.64 ($p = 0.00$) respectively for APACHE-II at 48 hours of admission, SOFA score on admission, and Charlson comorbidity score.

We found the cut off value for CFS for prediction of in-hospital mortality was four for 80% sensitivity and six for 80% specificity (Table 2). We created 2 groups for different CFS scores <6 vs ≥6, number of patients were 100 (60.24%) in CFS <6 group and in CFS ≥6 number of patient were 66 (39.75%) (Table 3). These groups had significant difference for APACHE II score at 48 hours of admission, SOFA score on admission, Charlson comorbidity score, oxygen support in ICU, use of MV support, use of Vasopressor support, use of other organ support, number of days on MV, net negative outcome (persistent organ support/death), patients discharged without organ dysfunction, 30 days mortality and in-hospital mortality.

To know the association of outcomes with the independent variables, we also did binomial logistic regression analysis for "In-hospital mortality" and "net negative outcome (persistent organ support/death)" (Table 4). Clinical frailty score was a better predictor of both the outcomes. While other scores did not perform comparatively. Each rise in CFS was leading to 41.8% rise in odds of "In-hospital mortality", and 50.7% rise in odds of "net negative outcome (Persistent Organ Support/Death)".



Figs 2A and B: Receiver operating characteristic analysis

Table 2: Receiver operating curve analysis (cut-off values of CFS)

Area under the curve				
			Cut-off points for curve	
Test result variable(s)	*Area*	*Asymptotic Sig.*[a]	*80% Sn*	*80% Sp*
2A: In hospital mortality				
APACHE II score at 48 hours of admission	0.68	0.00	15.00	20.00
SOFA score on admission	0.64	0.00	4.00	7.00
Clinical frailty score	0.73	0.00	4.00	6.00
Charlson comorbidity score	0.60	0.02	2.00	5.00
Area under the curve				
			Cut-off points for curve	
Test result variable(s)	*Area*	*Asymptotic Sig.*[b]	*80% Sn*	*80% Sp*
2B: Net negative outcome persistent organ support/death				
APACHE II score at 48 hours of admission	0.69	0.00	15.00	20.00
SOFA score on admission	0.68	0.00	4.00	7.00
Clinical frailty score	0.75	0.00	3.00	5.00
Charlson comorbidity score	0.64	0.00	2.00	5.00

The test result variable(s): APACHE II score at 48 HRS of admission, SOFA score on admission, clinical frailty score, Charlson comorbidity score has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased; (A) Under the nonparametric assumption; (B) Null hypothesis: True area = 0.5

Table 3: Comparative analysis frail and non-frail patients

Descriptive statistics					
	CFS effect				
	<6		*≥6*		
Continuous data	*Median*	*IQR*	*Median*	*IQR*	*p-value*
Age	64.00	16.00	69.00	15.00	0.06
Number of days in hospital	12.00	8.50	12.00	15.00	0.75
Number of days in ICU	12.00	8.50	12.00	15.00	0.76
Height (cms)	160.00	8.50	159.50	7.00	0.48
Weight	67.50	12.50	67.00	15.00	0.40
BMI	25.71	3.42	25.96	3.95	0.82
APACHE II score at 48 HRS of admission	16.00	7.00	20.00	6.00	0.00
SOFA score on admission	5.00	3.00	6.00	4.00	0.00
Clinical frailty score	3.00	2.00	7.00	2.00	0.00
Charlson comorbidity score	3.00	2.00	5.00	3.00	0.00
Number of days of oxygen support in ICU	2.00	1.00	2.00	3.00	0.25
Number of days on MV	5.00	6.00	6.50	6.00	0.03
	CFS effect				
	≥6		*≥6*		
Categorical data	*Count (n = 100)*	*%*	*Count (n = 66)*	*%*	*p-value*
Sex					
Female	31	31%	25	37.88%	0.36
Male	69	69%	41	62.12%	
Medical/surgical patient					
Medical	93	93%	66	100%	0.03
Surgical	7	7%	0	0.0%	
Comorbidities					
Yes	86	86%	64	96.97%	0.02
Diabetes					
Yes	41	41%	31	46.97%	0.45

(Contd...)

Table 3: *(Contd...)*

	CFS effect				
	≥6		*≥6*		
Categorical data	*Count (n = 100)*	*%*	*Count (n = 66)*	*%*	*p-value*
Hypertension					
Yes	53	53%	44	66.67%	0.08
Hypothyroidism					
Yes	15	15%	21	31.82%	0.01
COPD					
Yes	27	27%	22	33.33%	0.38
Asthma					
Yes	6	6%	1	1.51%	0.16
Heart failure					
Yes	11	11%	8	12.12%	0.82
Coronary artery disease					
Yes	13	13%	10	15.15%	0.69
CKD					
Yes	22	22%	20	30.3%	0.23
Liver dysfunction					
Yes	5	5%	6	9.09%	0.3
Malignancy					
Yes	9	9%	5	7.57%	0.75
Immune compromised					
Yes	7	7%	5	7.57%	0.89
Oxygen support in ICU					
Yes	87	87%	48	72.73%	0.02
Mechanical ventilation support					
Yes	74	74%	59	89.39%	0.015
Vasopressor support					
Yes	73	73%	57	86.36%	0.041
Organ support					
Yes	61	61%	62	93.94%	0
Dialysis					
Yes	19	19%	8	12.12%	0.24
Tracheostomies					
Yes	24	24%	16	24.24%	0.971
Discharged					
Yes	68	68%	21	31.81%	0
30 days mortality					
Yes	32	32%	45	68.18%	0
In-hospital mortality					
Yes	32	32%	45	68.18%	0
Organ support at the time of discharge from ICU					
Yes	11	11%	10	15.15%	0.43
Net negative outcome persistent organ support/death					
Yes	43	43%	55	83.33%	0

BMI, body mass index; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease

Table 4: Logistic regression analysis

		Variables in the equation					
		B	*S.E.*	*Wald*	*df*	*p-value*	*OR*
Regression analysis for in hospital mortality	Step 1[a]						
	APACHE II score at 48 hours of admission	0.109	0.043	6.389	1	0.011	1.115
	SOFA score on admission	–0.067	0.084	0.637	1	0.425	0.935
	Clinical frailty score	0.349	0.094	13.683	1	0.000	1.418
	Comorbidities	0.061	0.644	0.009	1	0.924	1.063
	Constant	–3.420	1.313	6.784	1	0.009	0.033
Regression analysis for net negative outcome (persistent organ dysfunction/ death in hospital)	Step 1[a]						
	APACHE II score at 48 hours of admission	0.064	0.044	2.140	1	0.144	1.066
	SOFA score on admission	0.080	0.089	0.801	1	0.371	1.083
	Clinical frailty score	0.410	0.101	16.455	1	0.000	1.507
	Comorbidities	0.034	0.630	0.003	1	0.957	1.035
	Constant	–3.134	1.272	6.066	1	0.014	0.044

Discussion

This study evaluated the epidemiological pattern of clinical frailty in >50-year-old patients admitted to our tertiary care hospital. We evaluated various characteristics of 166 admitted patients that match our inclusion criteria. In this population, we could find a prevalence of frailty (CFS ≥6) of about 39.75% (n = 66). The CFS performed the best for prediction of in-hospital mortality among the studied parameters, with AUC ROC 0.73 (p = 0.00). Further the binomial regression analysis proves that CFS has significant association with the in-hospital mortality (OR 1.42, p = 0.00) and net negative outcome (persistent organ dysfunction/death in hospital) (OR 1.51, p = 0.00).

In present study population prevalence of frailty (CFS ≥6) was 39.76%, with a median CFS score of 4 (IQR = 3). It is higher than a previously reported meta-analysis [Pooled prevalence of frailty 30% (95% CI: 29–32%).[2] This study has included various studies with different inclusion criteria. Another study which had regional and inclusion criteria similarity, report a prevalence of 38.6%.[5] The patients in present study have a median APACHE-II score at 48 hours was 18 (IQR-9)], it was similar to the previous related studies which report APACHE-II scores of 19.8 ± 6.7 and 21± 7, respectively.[10,11]

In the present study, frail patients (CFS ≥ 6) have more use of MV (74 vs 89.39%, p = 0.015), more median days on MV [5.00 (IQR: 6.00) vs 6.5 (IQR: 6.00), p = 0.03], vasopressor support (73 vs 86.36%, p = 0.04) and use of other organ support (61 vs 93.94%, p = 0.0). A previous study found no significant difference in MV use between frail and non-frail patients (80 vs 82%, respectively; RR 1.01; 95% CI: 0.93–1.10; p = 0.81; I^2 = 67%). However, these findings were derived from a pool of highly heterogeneous studies. In other prospective study similar results were observed 10 ± 14 12 ± 20 0.54.[2] The need for organ support in frail patients has shown variability across studies, possibly due to differences in frailty definitions and limitations in care for these patients.

Our study groups had similar days in hospital and ICU [12.00 (IQR: 8.5) vs 12.00 (IQR: 15.00), p = 0.75], and number of days on oxygen support [2.00 (IQR: 1.00) vs 2.00 (IQR 3.00), p = 0.25]. But significantly high (1.5 day) days on MV [median 5 days (IQR: 6.00) vs 6.5 days (IQR: 6.00), p = 0.03]. Multiple studies have examined the association between frailty and length of stay (LOS) in both the hospital and ICU. A pooled analysis indicated a longer stay for frail patients, with a mean difference of 3.39 days (95% CI: –0.33 to 7.10; p = 0.07; I^2 = 77%) for hospital LOS and 0.33 days (95% CI: –0.78 to 1.44; p = 0.56; I^2 = 73%) for ICU LOS, although the results were not statistically significant.[2,10,12–15]

In present study, 68% patients from non-frail group and 31.81% patients from frail group were discharged successfully without any organ support (p = 0.00). Whereas, 32% non-frail and 68.18% frail patients (p = 0.00) had in-hospital mortality. Another 11% patients and 10% patients (p = 0.43) required organ support at the time of discharge from ICU in non-frail vs frail groups respectively. Further analysis suggested significantly higher net negative outcomes (in-hospital mortality and persistent organ support) in frail group 83.33 vs 43% in non-frail group (p = 0.00). Another Indian study reported significantly higher 30 days mortality 49 (26%) vs 28.5 (24%) (p = 0.02) in frail (CFS ≥5) vs non-frail (<5) but ICU mortality were similar in both the groups.[5] A meta-analysis that combined studies using various frailty scores and criteria found an increased risk of mortality among frail patients. The analysis reported a higher risk in frail patients for ICU mortality (RR 1.51; 95% CI: 1.31–1.75; p = 0.00; I^2 = 8%), hospital mortality (RR 1.71; 95% CI: 1.43–2.05; p = 0.00; I^2 = 32%), and long-term mortality (RR 1.53; 95% CI: 1.40–1.68; p = 0.00; I^2 = 0%).[2]

Variation in reporting study populations, geographical regions, frailty scores and cut off values might have led to variations in outcomes in different studies. But a common theme of poor outcome remains static across the literature.[2,5,16]

We performed binomial logistic regression analysis to know the impact of CFS on "in-hospital mortality" and "net negative outcome (persistent organ support/death)". Clinical frailty score was a better predictor of both the outcomes, comparing other scores. Each rise in CFS was leading to 41.8% rise in odds of "In-hospital mortality", and 50.7% rise in odds of "net negative outcome (persistent organ support/death)". Though direct comparison with this data was not available, but other studies also reported a constantly increasing odds of mortality with increasing CFS.[2,16,17]

Strength and Limitations

Present study reported some crucial epidemiological data points and filled the data gaps for our region. It focused on ability of frailty and its comparison with conventional scoring systems to predict in-hospital mortality and net negative outcome (persistent organ

support/death), which makes it relevant for daily use applications. Final results showed that CFS outperformed the SOFA on admission/APACHE-II at 48 hours/Charlson comorbidity score, which highlights its importance in routine use. We did fine statistical comparison which provided specific cut off points (80% sensitivity and specificity cut off for individual outcomes) and provided actionable insight for practitioners. Out study did categorization based on CFS cut off value and provided deeper comparative analysis. Binomial logistic regression analysis demonstrated independent association of CFS with outcomes after adjusting for other variables. We were also able to quantify the incremental impact of frailty in present study, providing a broader perspective for patient care at bedside.

There were some limitations also to present study, such as single center involvement, limited sample size, consent limitation in 68 patients. We also did not capture progressive worsening or improvement in frailty during ICU stay. We captured only short term outcomes and functional outcomes were missed, which limits practical application. Despite multivariate adjustment, some unmeasured factors were not accounted and captured, like nutrition status, nutrition therapy, rehabilitation possibilities and efforts. This could have influence the association and outcomes.

Conclusion

The CFS is a reliable and practical tool to predict critical outcomes, in-hospital mortality and net negative outcome (persistent organ support or death). Compared to traditional scoring systems (APACHE-II at 48 hours, SOFA on admission and Charlson co-morbidity score), CFS has better predictive ability and has independent association with adverse outcomes. This study provided quantifiable incremental impact of CFS on outcomes, which emphasizes the importance of frailty assessment on admission and judicious resource allocation in high-risk groups.

These findings must be interpreted in proper context of inclusion criteria of the study and its limitations as mentioned above. A larger cohort study with multicenter involvement is now warranted to validate our data and explore further utility of CFS as a prognostic model in routine ICU practice.

Overall, our findings underscore the value of incorporating frailty assessment into critical care to enhance decision-making, improve patient outcomes and provide rational resource allocation.

Author Contributions

SS: Data curation, original draft; PG: Conceptualization, administration, supervision; PP: Data curation, supervision, original draft, final draft writing; AJ: Resources, validation, final draft writing; SJ, RJ, DG, MM and HA: Reviewing and editing the final draft; RJ: Conceptualization, methodology, data analysis, supervision, final draft writing.

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