Prognostic Performance of the Clinical Frailty Scale for Predicting 30-Day Mortality in Hospitalised Indonesian Older Adults

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ABSTRACT

Background*:** *Frailty is common among hospitalized elderly patients, with prevalence rates ranging from 27% to 80%. Frail individuals have a higher risk of mortality than non-frail individuals do. The Clinical Frailty Scale (CFS), developed by the Canadian Study of Health and Aging (CSHA), is a widely used tool for assessing frailty and clinical outcomes in older adults. This study aimed to evaluate the prognostic performance of the CFS in predicting 30-day mortality among elderly inpatients.* ***Methods*: This prospective cohort study included patients aged ≥ 60 years admitted to the Haji Adam Malik Central General Hospital in Medan, Indonesia. Discrimination and calibration of the CFS were evaluated using the ROC curve and Hosmer-Lemeshow tests, while logistic regression identified factors independently associated with mortality. Discrimination and calibration of the CFS were evaluated using the ROC curve and Hosmer-Lemeshow tests, while logistic regression identified factors independently associated with mortality.* ***Results****: Among 120 patients, the 30-day mortality rate was 43.3%. The Hosmer–Lemeshow test indicated good calibration (p = 0.661), and ROC curve analysis showed good discrimination (AUC = 83.2%, 95% CI 76%–90.4%). Multivariate analysis identified the C-reactive protein level, CFS score, and nutritional status as independent predictors of 30-day mortality.* ***Conclusion****: Clinical Frailty Scale (CFS) demonstrates good prognostic performance for predicting 30-day mortality among elderly inpatients, with elevated CRP, higher CFS scores, and malnutrition serving as independent predictors of death.*

Keywords*: Frailty, Clinical Frailty Scale, 30-day mortality.*

INTRODUCTION

Frailty is a clinical syndrome in elderly individuals characterized by reduced strength, endurance, and physiological function, resulting in increased vulnerability and dependence on others.[1-3] It is more common in women and increases with age, affecting 10–14% of individuals aged 65 years and older and up to 26% of those aged 85 years and above.[3] Globally, the prevalence of frailty ranges from 12 to 24%.4 In Asia, the prevalence is reported to be 14.6%, while in Indonesia, where the elderly population is growing rapidly, it is 25.2%.[5,6] Frailty is a strong predictor of poor outcomes in elderly patients, including higher mortality rates, compared to non-frail individuals. [1,3,7]

The Clinical Frailty Scale (CFS), an assessment tool developed by the Canadian Study of Health and Aging (CSHA), integrates comorbidities, physical function, and cognition to provide an overall measure of frailty in older adults.[1,8-10] It is a validated scale and an easy-to-

use tool for assessing frailty and fitness across clinical settings. It was initially published in 2005 as a 7-point scale but was modified in 2007 to a 9-point scale to better distinguish between varying degrees of frailty and severe illness. In 2020, CFS version 2.0 introduced more precise descriptions and updated terminology, such as changing 'well' to 'fit' and 'vulnerable' to 'living with very mild frailty.' The CFS classifies individuals on a 9-point visual chart ranging from 1 ('Very Fit') to 9 ('Terminally Ill'), based on their physical activity, function, and dependence in daily living. [11,12]

A retrospective study in England found that CFS was independently associated with 30-day mortality among hospitalized elderly patients.[13] Another study showed that CFS was the most effective tool for predicting 30-day readmission.[14] Comparative studies have also demonstrated that both the FRAIL and CFS scales identify high-risk elderly patients, with the FRAIL scale performing slightly better in mortality prediction.[15] Furthermore, CFS can predict short-term mortality in the acute care settings, considering disease severity and comorbidities.[16]

A systematic review and meta-analysis by Rottler et al. confirmed that CFS is a valuable tool for assessing frailty and predicting clinical outcomes, including mortality and hospitalization.[17] Similar findings have been reported in Korea, supporting its role in screening high-risk elderly patients and assisting discharge planning.[18] CFS has also been validated for use in emergency departments and translated into multiple languages.[19-24]

A systematic review and meta-analysis by Rottler et al. (2022) revealed that CFS is a valuable tool for diagnosing frailty. Frailty is strongly associated with an increased risk of mortality and hospitalization. Similar findings have been reported in Korea, supporting its role in screening high-risk elderly patients and assisting discharge planning.[17] CFS has also been validated for use in emergency departments and translated into multiple languages. [18-24] Therefore, this study aimed to evaluate the prognostic performance of CFS in predicting 30-day mortality among elderly inpatients at a tertiary hospital in Medan, Indonesia.

METHODS

This prospective cohort study was conducted at the Haji Adam Malik Central General Hospital, Medan, to evaluate the Clinical Frailty Scale (CFS) as a predictor of 30-day mortality in elderly patients. The study was conducted from November to December 2023, following ethical clearance from the Health Research Ethics Commission of the Universitas Sumatera Utara (No. 1098/KEPK/USU/2023).

The study population consisted of elderly patients aged ≥ 60 years admitted to the Haji Adam Malik Central General Hospital. The target population consisted of all elderly inpatients at the hospital, whereas the accessible population comprised those admitted during the study period (November–December 2023). A minimum sample size of 120 participants was required for this study.

The inclusion criteria were patients aged ≥60 years admitted to the emergency department or transferred to inpatient wards following outpatient clinic assessment. Exclusion criteria were patients who refused to participate or withdrew consent during data collection.

After obtaining informed consent, participants were consecutively enrolled according to the inclusion and exclusion criteria. Each participant underwent a Clinical Frailty Scale (CFS) assessment upon admission. The collected data included demographic characteristics (age and sex), comorbidities (Charlson Comorbidity Index/CCI), Activities of Daily Living (ADL) scores, nutritional status (Mini Nutritional Assessment/MNA), serum albumin and CRP levels, caregiver information, and medication history.

The participants were followed up for 30 days after discharge from the hospital. Those who were discharged within 30 days were monitored via telephone follow-up with the patient or caregiver. Patients who could not be contacted during the follow-up period were categorized as being lost to follow-up.

Data were analyzed using IBM SPSS Statistics for Windows (version 25.0; IBM Corp., Armonk, NY, USA) under an institutional

license. Descriptive statistics were used to assess demographic and clinical characteristics. The discrimination performance of the Clinical Frailty Scale was evaluated using the Area Under the Curve (AUC) from receiver operating characteristic (ROC) analysis, and calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test. Multivariate analysis was performed using multiple logistic regression to identify independent predictors of 30-day mortality.

RESULTS

Subject Characteristics

A total of 120 elderly patients were enrolled at our institution. Patients aged ≥ 60 years who consented to participate were included, while those who declined or withdrew consent were excluded (**Figure 1**).

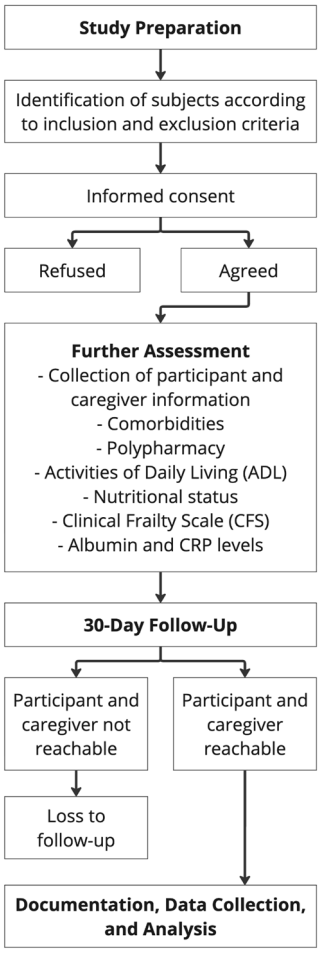

Figure 1. Study flowchart

The baseline characteristics are presented in **Table 1**. The study included 67 males (55.8%) and 53 females (44.2%), with a median age of 67 years (range, 60–98 years). The most common comorbidities were hypertension (n = 52; 43.3%) and diabetes mellitus (n = 39; 32.5%). Polypharmacy was reported by 56 participants (46.7%). Thirty-day mortality occurred in 52 (43.3%) patients. Hypertension was the most common comorbidity, affecting 52 people (46.7%), followed by diabetes (39, 32.5%), chronic kidney failure (24, 20%), malignancy (20, 16.7%), and other conditions (30, 25%). Of these, 30 patients had additional comorbidities . **Table 2** summarizes the CFS scores of the study population.

Table 1.Baseline characteristics

Characteristics (n = 120)	n (%)
Gender, n (%)	
Male	67 (55.8)
Female	53 (44.2)
Age, year	
Median (Min – Max)	67 (60 – 98)
60 – 69 years	76 (63.3)
≥ 70 years	44 (36.7)
Comorbidities, n (%)	
Hypertension	52 (43.3)
Diabetes mellitus	39 (32.5)
Congestive heart failure	15 (12.5)
Chronic kidney failure	24 (20)
COPD	13 (10.8)
Cerebrovascular disease	13 (10.8)
Trauma/fracture	1 (0.8)
Malignancy	20 (16.7)
Liver cirrhosis	12 (10)
Autoimmune disease	2 (1.7)
Others	30 (25)
Polypharmacy, n (%)	
Yes	56 (46.7)
No	64 (53.3)
30-day mortality, n (%)	
Yes	52 (43.3)
No	68 (56.7)
ADL	
Median (Min – Max)	9 (0 – 20)
Total dependence	22 (18.3)
Heavy dependence	36 (30)
Moderate dependence	46 (38.3)
Light dependence	15 (12.5)
Independent	1 (0.8)
Nutritional status	
Median (Min – Max)	8 (3 – 14)
Malnutrition	120 (100)

CCI score, n (%)	
1-2	14 (11.7)
3-4	43 (35.8)
≥5	63 (52.5)
Albumin, g/dL	
Mean (SD)	2.92 (0.65)
Low	97 (80.8)
Normal	23 (19.2)
CRP, mg/dL	
Median (Min – Max)	0.7 (0.7 – 32.5)
≥ 1mg/dL	45 (37.5)
< 1 mg/dL	75 (62.5)

ADL, activities of daily living; CCI, Charlson comorbidity index; COPD, Chronic obstructive pulmonary disease; CRP, C-reactive protein; SD, Standard deviation

Table 2. Distribution of CFS scores

Characteristics (n = 120)	n (%)
Median (Min – Max)	6 (3 – 9)
1-3	2 (1.7)
4-5	48 (40)
6	16 (13.3)
7-8	45 (37.5)
9	9 (7.5)

CFS = Clinical Frailty Scale

Discriminative Ability of CFS for 30-Day Mortality

The Clinical Frailty Scale demonstrated good discriminative ability in predicting 30-day mortality, with an AUC of 0.832 (95% CI: 0.76–0.904, $p < 0.001$) (**Figure 2**). An AUC >0.8 indicates strong discrimination between patients who died within 30 days and those who survived.

A cut-off value of 7 was selected based on the optimal balance between sensitivity and specificity (as determined by the Youden Index). Using this threshold, the CFS predicted 30-day mortality with a sensitivity of 75% and specificity of 77.9%, corresponding to a positive predictive value of 72.2% and a negative predictive value of 80.3%. The overall predictive accuracy at this cut-off was 76.7% (**Table 3**).

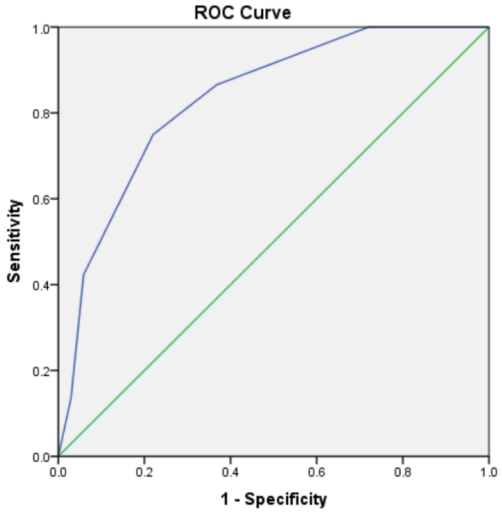

Figure 2. ROC curve of CFS for 30-day mortality

Bivariate Analysis of Factors Associated with 30-Day Mortality

Bivariate analysis of demographic and clinical variables is presented in **Table 4**. Age ≥70 years was significantly associated with increased 30-day mortality ($p < 0.05$), whereas sex was not. Functional dependence, assessed using ADL scores, was associated with higher mortality, with patients exhibiting greater dependence being more likely to die within 30 days ($p < 0.05$).

Nutritional status, measured using MNA scores, was significantly associated with mortality; patients who died had lower median MNA scores than survivors ($p < 0.05$). Among the comorbidities, only cerebrovascular disease was significantly associated with mortality. The Charlson Comorbidity Index scores and serum albumin levels were not significantly associated with 30-day mortality. Elevated CRP levels and higher CFS scores were significantly associated with increased mortality ($p < 0.05$).

Table 3. Sensitivity, specificity, PPV, NPV, and accuracy of CFS cut-off = 7

Parameter	30-day mortality		Sens	Spec	PPV	NPV	Accuracy
	Yes	No					
CFS							
≥7	39	15	75%	77.9%	72.2%	80.3%	76.7%
<7	13	53					

NPV, negative predictive value; PPV, Positive predictive value; Sens, Sensitivity; Spec = Specificity

Table 4. Bivariate analysis of factors associated with 30-day mortality

Characteristics	30-day mortality		P-value
	Yes	No	
Gender, n (%)			
Male	31 (46.3)	36 (53.7)	0.466*
Female	21 (39.6)	32 (60.4)	
Age, year			
≥ 70 years	26 (59.1)	18 (40.9)	0.008*
60 – 69 years	26 (34.2)	50 (65.8)	
ADL, n (%)			
Total dependence	16 (72.7)	6 (27.3)	<0.001*
Heavy dependence	26 (72.2)	10 (27.8)	
Moderate dependence	9 (19.6)	37 (80.4)	
Mild dependence	1 (6.7)	14 (93.3)	
Independent	0	1 (100)	
Nutritional status			
Mean (SD)	6.92 (1.88)	9.34 (2.13)	<0.001†
Median (Min – Max)	7 (3 – 11)	10 (5 – 14)	
Comorbidities			
Hypertension, n (%)			
Yes	24 (46.2)	28 (53.8)	0.586*
No	28 (41.2)	40 (58.8)	
DM, n (%)			
Yes	17 (43.6)	22 (56.4)	0.969*
No	35 (43.2)	46 (56.8)	
Congestive heart failure, n (%)			
Yes	7 (46.7)	8 (53.3)	0.781*
No	45 (42.9)	60 (57.1)	
Chronic kidney failure, n (%)			
Yes	10 (41.7)	14 (58.3)	0.854*
No	42 (43.8)	54 (56.2)	
COPD, n (%)			
Yes	8 (61.5)	5 (38.5)	0.161*
No	44 (41.1)	63 (58.9)	
Cerebrovascular disease, n (%)			
Yes	10 (76.9)	3 (23.1)	0.010*
No	42 (39.3)	65 (60.7)	
Fracture trauma, n (%)			
Yes	0	1 (100)	1.000‡
No	52 (43.7)	67 (56.3)	
Malignancy, n (%)			
Yes	11 (55)	9 (45)	0.324‡
No	41 (41)	59 (59)	
Liver cirrhosis, n (%)			
Yes	4 (33.3)	8 (66.7)	0.461*
No	48 (44.4)	60 (55.6)	
Autoimmune diseases, n (%)			
Yes	0	2 (100)	0.505‡
No	52 (44.1)	66 (55.9)	
Others, n (%)			
Yes	12 (40)	18 (60)	0.671*
No	40 (44.4)	50 (55.6)	
CCI score, n (%)			
1-2	8 (57.1)	6 (42.9)	0.323*
3-4	15 (34.9)	28 (65.1)	
≥5	24 (38.1)	39 (61.9)	
Polypharmacy, n (%)			
Yes	27 (48.2)	29 (51.8)	0.313*
No	25 (39.1)	39 (60.9)	
Albumin, n (%)			
Low	44 (45.4)	53 (54.6)	0.357*
Normal	8 (34.8)	15 (65.2)	
CRP, n (%)			
≥ 1mg/dL	29 (64.4)	16 (35.6)	<0.001*
< 1 mg/dL	23 (30.7)	52 (69.3)	
CFS			
≥ 7	39 (72.2)	15 (27.8)	<0.001*
< 7	13 (19.7)	53 (80.3)	

ADL, activities of daily living; CCI, Charlson Comorbidity Index; CFS, Clinical Frailty Scale; COPD, Chronic obstructive pulmonary disease; CRP, C-reactive protein; SD, Standard deviation
*Chi-square, †Mann Whitney, ‡Fischer exact

Multivariate Analysis of Independent Predictors of 30-Day Mortality

Multivariate logistic regression was performed to identify independent predictors of 30-day mortality. Variables included in the model were age, ADL, nutritional status, COPD, cerebrovascular disease, CRP, and CFS, which were selected based on bivariate analysis result ($p < 0.25$) (**Table 5**).

Table 5. Multivariate analysis of factors influencing 30-day mortality

Variable	OR	95% CI	P-value
Nutritional status	0.668	0.51 – 0.88	0.003
CRP	4.262	1.61 – 11.30	0.004
CFS	4.052	1.43 – 11.50	0.009

CFS = Clinical Frailty Scale; CRP = C-reactive protein

The results showed that three independent variables significantly affected 30-day mortality: nutritional status, CRP levels, and CFS values (**Table 5**). Variables with p-values >0.05 were systematically removed using the enter method.

Three variables remained significant predictors:

- **CRP ≥1 mg/dL:** OR 4.262 (95% CI: 1.61–11.30), indicating that patients with elevated CRP were over four times more likely to experience 30-day mortality.
- **CFS ≥7:** OR 4.052 (95% CI: 1.43–11.50), indicating that higher frailty increased the risk of 30-day mortality by fourfold.
- **Nutritional status (MNA):** Higher scores were associated with a protective effect, whereas lower scores were associated with an increased mortality risk.

The logistic regression model explained 47.9% of the variance in 30-day mortality (Nagelkerke R^2) and correctly predicted outcomes in 79.2% of the cases. The Hosmer–Lemeshow test confirmed good model calibration ($p > 0.05$).

Combined Predictive Model: Nutritional Status, CRP, and CFS

ROC analysis of the combined predictive model, including nutritional status, CRP, and CFS, demonstrated strong predictive performance, with an AUC of 0.857 (95% CI: 0.788–0.926, $p < 0.001$) (Figure 3), indicating robust discrimination of 30-day mortality in elderly patients at our institution.

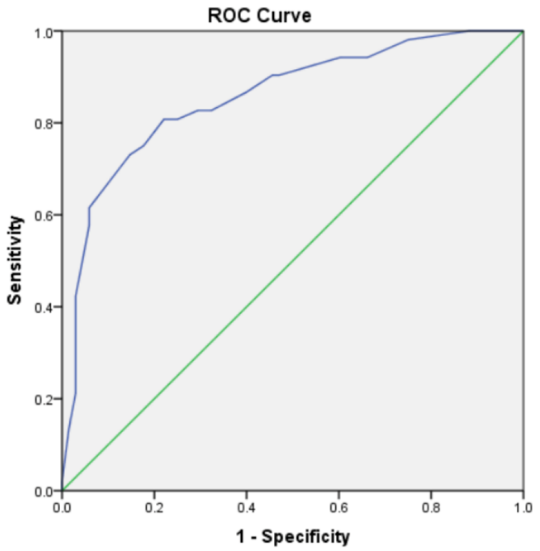

Figure 3. ROC curve of the combined predictive model (nutritional status, CRP, CFS)

DISCUSSION

Main Findings

This study included 120 hospitalized elderly patients, of whom 55.8% were male, with a mean age of 68.4 years; the majority fell within the 60–69 age category. A total of 52 patients (43.3%) died within 30 days of hospital admission, indicating a higher short-term mortality rate compared to previous studies, which reported rates of 5.3%–17.1% [13,14,18]. The leading independent predictors of 30-day mortality identified in our study were elevated CRP levels (≥1 mg/dL), a CFS score of ≥ 7, and poor nutritional status, as measured by the MNA. Specifically, CRP ≥1 mg/dL increased the risk of mortality 4.262-fold (95% CI: 1.61–11.30), CFS ≥7 increased the risk 4.052-fold (95% CI: 1.43–11.50), and lower MNA scores were associated with higher mortality. An AUC of 0.832 indicates good discriminative ability of CFS, defined as AUC 0.8–0.9 (Hosmer & Lemeshow classification).[13,18]

Internal Validity

This study employed a prospective cohort design with consecutive sampling and strict inclusion/exclusion criteria to enhance internal validity. Standardized assessments were used for frailty (CFS), nutritional status (MNA), and functional dependence (ADL). Comprehensive data collection included demographic characteristics, comorbidities (CCI), polypharmacy, serum albumin, and CRP levels. Participants were followed up for 30 days post-admission, with discharged patients monitored via telephone to minimize loss to follow-up. Multivariate logistic regression was

performed to adjust for potential confounders and ensure that the identified predictors were independently associated with mortality.[7,13]

External Validity

Our findings are consistent with those of previous studies reporting CFS as a reliable predictor of mortality in hospitalized elderly patients. Romero-Ortuno et al. found that CFS scores 6–8 were significant independent predictors of mortality.[13] Other studies have reported slightly lower 30-day mortality rates (5.3%–17.1%) [13,14,18], which may be attributed to differences in patient populations, comorbidity burden, or healthcare settings. These findings suggest that the results may be generalizable to similar tertiary care hospital populations, although caution is warranted when applying these findings to community-dwelling elderly individuals.

Biological Plausibility

The observed associations are biologically plausible. Frailty reflects decreased physiological reserves and multisystem vulnerability, which predisposes patients to adverse outcomes.[7,25] Elevated CRP levels indicate systemic inflammation, which contributes to frailty by triggering cellular and multi-organ changes, thereby increasing the risk.[7,26,27] Malnutrition further exacerbates vulnerability by promoting protein catabolism, reducing muscle mass and strength, decreasing bone mineral density, impairing cellular immunity, and increasing the risk of infection.[28,29] The combination of frailty, inflammation, and malnutrition creates a biologically coherent pathway that explains the increased 30-day mortality observed in this study.

Clinical Implications

These findings highlight the importance of early screening of frailty, nutritional deficits, and systemic inflammation in hospitalized elderly patients. Identifying high-risk individuals using CFS, MNA, and CRP can inform targeted interventions to improve outcomes, such as nutritional support, physiotherapy to maintain functional status, and monitoring/managing inflammatory conditions. Proactive management of these risk factors may reduce the short-term mortality, functional decline, and long-term adverse outcomes in this population.[7,13,31]

Limitations and Suggestions for Further Research

This study had several limitations. First, this study was conducted at a single center, which may limit the generalizability of the findings to other hospital settings or populations. Second, information regarding the clinical condition of the patients at the time of hospital admission—such as the severity of acute illness or emergency status—was not systematically recorded or analyzed. Therefore, the influence of these initial conditions on the 30-day mortality remains unclear. Third, this study did not investigate the impact of hospital length of stay on mortality outcomes.

Future research should address these limitations and further evaluate interventions aimed at reducing frailty, correcting malnutrition, and controlling systemic inflammation to improve the survival of hospitalized elderly patients. Multicenter studies with larger and more diverse populations are needed to validate these findings. Longitudinal studies examining dynamic changes in frailty, CRP, and nutritional status over time could clarify causal relationships and help refine the predictive models for mortality. Additionally, studies assessing the effect of patients' clinical condition upon admission and hospital length of stay on mortality could provide valuable insights to guide clinical decision-making.[13,30]

CONCLUSION

The CFS is a practical tool for assessing frailty and can serve as a predictor of 30-day mortality in hospitalized elderly patients. CFS is versatile, easy to use in various clinical settings, and capable of evaluating a wide range of outcomes in the care of older adults, demonstrating good calibration and discriminative ability. Among the factors studied, three variables were found to most strongly influence 30-day mortality: CRP levels greater than 1 mg/dL, CFS scores of 7 or higher, and malnutrition.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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