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Original Article

Association of Clinical Frailty Scale with Readmission and Mortality Rate in Hospitalized Older Adults

Yun-Ju Cheng [a,d #], Hsiang-Kuang Tseng [a,b,c *#], Yih-Jin Hu [d *]

[a] *Division of Geriatric Medicine, Department of Internal Medicine, MacKay Memorial Hospital, Taipei, Taiwan,* [b] *Department of Medicine, MacKay Medical College, New Taipei City, Taiwan,* [c] *Institute of Long-term Care, MacKay Medical College, New Taipei City, Taiwan,* [d] *Department of Health Promotion and Health Education, National Taiwan Normal University, Taipei, Taiwan*

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SUMMARY

Background: In this study, we examined the correlation between frailty levels and mortality/readmission rates in older (65+ years) inpatients.
Methods: A total of 1,156 individuals aged ≥ 65 years who had been admitted to the emergency department of a tertiary hospital were assessed for frailty using the Clinical Frailty Scale (CFS). With the patients categorized as CFS 1–3, 4–6, or 7–9, multinomial logistic and Cox regression analyses were used to evaluate the associations between frailty and short-term readmission and mortality.
Results: Patients who were CFS 4–6 had a 5.63% higher risk of short-term readmission (odds ratio [OR], 1.516; 95% confidence interval [CI], 0.947–2.427) and a 9.98% higher risk of mortality (hazard ratio [HR], 1.463; 95% CI, 0.992–2.157) than those categorized as CFS 1–3. Those who were CFS 7–9 had an 8.96% higher risk of short-term readmission (OR, 2.144; 95% CI, 1.284–2.427) and a 23.37% higher risk of mortality (HR, 2.036; 95% CI, 1.349–3.072) than those who were CFS 1–3.
Conclusion: CFS can be used to predict short-term readmission to the emergency department in older patients and survival time in a graded manner.

1. Introduction

The increasing worldwide demographic shift towards an aged society, with a predicted upsurge of population aged 65 and older from 8.5% in 2000 to nearly 25% by 2050,[1] signals an urgent need for healthcare and social support system innovations. Various methods and tools are available for measuring frailty in older adults. The two most common methods are Fried's phenotype and the Frailty Index developed by Rockwood and Mitnitski.[2] However, the choice for the most suitable frailty measurement for clinical and research applications is controversial. Common findings were observed in two systematic review articles on the Clinical Frailty Scale (CFS), when reviewing 526 relevant articles published between 2015 and 2017, as well as 756 articles from 2011 to 2020. The CFS was found to be predictive of mortality, complications, disability, length of hospital stay, readmissions, in-hospital treatments, cognitive function, and falls.[3,4] The CFS is primarily based on the theory of cumulative deficits associated with aging, considering the distribution of the frailty index and life trajectory.[5,6] This assessment tool categorizes the degree of frailty of older adults into nine levels through visual representations and brief text-based descriptions,[7,8] with a high level of agreement between different evaluators (weighted kappa = 0.61–0.86).[9–11] From CFS 9 (end-of-life illness) to CFS 1 (very fit), this tool assesses activity, energy, physical activity, and function in the two weeks preceding admission, as a baseline measurement.[12] It has been widely used in both research and clinical practice.[3,4] The CFS has been acknowledged worldwide for its role in comprehensively determining varying frailty levels and for its intrinsic value in clinical risk stratification.[3,7] It also has a proven aptitude for accurately predicting in-hospital mortality.[8,13,14] However, despite its broad global applications, the exploration of CFS remains notably sparse in the older demographic of Taiwanese patients.

The prevalence of approximately 8–9 years of unhealthy life expectancy in Taiwan reflects a disparity between lifespan and health span. It accentuates a sad undertone to the nation's super-aged status. This dichotomy provokes crucial questions for the clinical and societal systems of the country, such as the following. Can strategies be identified to curtail this period of unhealthy life expectancy, thereby enhancing the quality of years lived? Can a viable clinical tool, such as the CFS, be efficiently operationalized to predict and navigate the complexities of health and morbidity in an aging population? We aimed to address these questions, explore relevant associations, and determine the clinical applicability of CFS for predicting and potentially ameliorating the trajectories of morbidity and mortality among older adults in Taiwan.

The study population consisted of individuals aged 65 years and older who underwent CFS assessments at a medical center in Taiwan

* Corresponding author. Division of Geriatric Medicine, MacKay Memorial Hospital, No. 45, Minsheng Rd., Tamsui Dist., New Taipei City 25160, Taiwan.
E-mail address: eric120008@mmc.edu.tw (H.-K. Tseng)
Department of Health Promotion and Health Education, National Taiwan Normal University, No. 162, Sec. 1, Heping East Rd., Taipei 10610, Taiwan.
E-mail address: t09016@ntnu.edu.tw (Y.-J. Hu)
* Co-correspondence, equal contribution.
# Co-first author, equal contribution.

between January 1, 2021 and December 31, 2022. This emphasis on CFS assessments over the two-year period was primarily driven by participation in the National Health Administration's Acute Care for Elderly (ACE) program. Follow-up data until June 30, 2023 was available. The CFS data in this study could be retrospectively obtained from the patients' medical records or our comprehensive geriatric assessment (CGA) database. Our literature review revealed that the CFS can be categorized in various ways depending on the research design and requirements. In this study, we included patients undergoing their initial CFS assessments.[16,17] Based on the experience of clinical experts, the resultant CFS scores were divided into three groups: 1–3 (healthy), 4–6 (frail), and 7–9 (profound frailty). Of these, 1,043 (90.2%) cases were assessed by physicians and 113 (9.8%) by nurses. All assessors had completed an 8-hour course on geriatric frailty and had been trained in the use of the CFS.

2. Materials and methods

2.1. Study design and participants

This study was approved by the MacKay Memorial Hospital Institutional Review Board under review number 23MMHIS184e. Our medical center obtained authorization from Dalhousie University in 2021 to use the CFS to assess patients aged 65 and older. We retrospectively reviewed medical records and databases, extracting relevant data from inpatients at a medical center in Taiwan. The patients were admitted between January 1, 2021 and December 31, 2022, and had CFS data recorded in their electronic medical records. Data were tracked until June 30, 2023. Patients without CFS data were not included.

2.2. Clinical measurements and definitions

We reviewed the medical records and relevant information of all of the eligible patients, extracting data such as sex, age, admission and discharge dates, disease diagnoses, clinical laboratory reports, death dates, and instances of short-term readmission. Short-term readmission referred to rehospitalization occurring within 14 days following an earlier discharge from hospital. Four categories of disease diagnoses were considered based on the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) diagnostic codes, as follows: 1) Heart diseases: 142, 143, and 150; 2) Pulmonary diseases: 127, J40–J47, J60–J68, and J70; 3) Kidney diseases: N03, N05, N18, N19, and Z49; 4) Diabetes: E10–E14. This information was obtained from medical records and the collected registry database.

Data extraction was conducted using Brio Query version 8.3, a software initially developed by Brio Technology, based in the San Francisco Bay area, California, USA, which later became a part of Oracle Corporation. The extracted data was subsequently organized and compiled using Microsoft Excel 2013. Participant data were subjected to scrutiny and cleaning, followed by encoding and de-identification. Subsequent data analysis was carried out using SPSS for Windows version 24.0. Laboratory test reports closest to the admission date were selected, and missing values were imputed using mean imputation.

2.3. Statistical analysis

We described categorical variables as absolute numbers and corresponding percentages, and continuous variables as means with associated standard deviations (SDs) or medians with associated interquartile ranges (IQRs) for non-parametric data.

To analyze the association between frailty status and short-term admission and mortality, we stratified the CFS scores into 1–3, 4–6, and 7–9 ranges. We analyzed the relationships between baseline variables and clinical laboratory data using these CFS categories, via one-way analysis of variance or the Kruskal-Wallis test for continuous variables and the Chi-squared test for categorical variables. We used multivariate logistic regression to assess the associations between CFS and short-term readmission. The Kaplan-Meier product-limit method was used to plot survival curves stratified by CFS. We used Cox proportional hazards models to assess the associations between CFS and all-cause mortality, by adjusting for potential confounding variables. We specified three models to estimate the relative risk of short-term readmission and mortality in the CFS 4–6 and 7–9 groups, compared to that of the 1–3 group.

Model 1 was the initial crude model. Model 2 was adjusted for demographic data (age, sex), as well as comorbidities (heart diseases, pulmonary diseases, renal diseases, and diabetes). It was further adjusted to include biochemical parameters (hemoglobin, hematocrit, white blood cell count, blood glucose, creatinine, glutamic oxaloacetic transaminase and glutamic pyruvic transaminase, albumin level, C-reactive protein, potassium, and sodium) in Model 3.

3. Results

3.1. Patient characteristics

Figure 1 illustrates the screening of 7,565 candidate individuals, from whom 1,156 inpatients were eventually recruited. Of them, 1,060 (91.7%) were assessed in the emergency department, while 96 (8.3%) received evaluations in the inpatient wards. The cohort included 596 females, representing 51.6% of the total. The average age of the participants was 81.9 years, with an SD of 9.1 years. The mean duration of hospital stay was 12.7 days, with an SD of 13.9

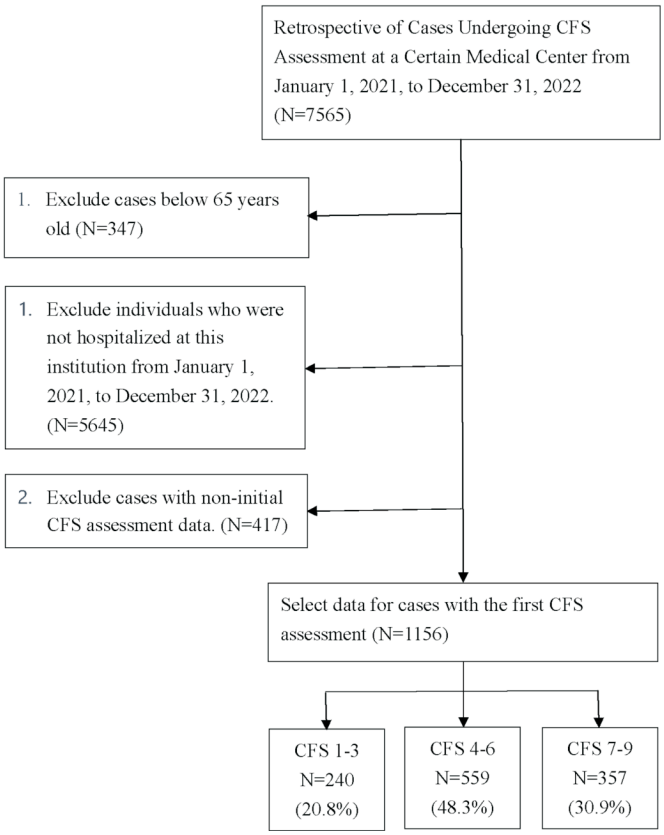

Figure 1. Process for screening and enrolling research cases.

days. Table 1 details the demographic and clinical test data of the participants, categorized according to their CFS groups.

3.2. Survival analysis among different CFS groups

This study highlighted substantial variations in median survival times across different CFS categories. For those categorized as CFS 1–3, representing a healthier group, the median survival time was 562 days, with an SD of 156.2 days and a 95% confidence interval (CI) ranging 499.6–539.4 days. By contrast, those classified as CFS 4–6, indicative of a frail state, showed a median survival of 548 days, with an SD of 206.7 days and a 95% CI ranging 451.7–486.1 days. For the group with profound frailty, that is, CFS 7–9, the median survival was 534 days, with an SD of 248.7 days and a 95% CI of 371.7–423.5 days. As shown in Figure 2, Kaplan-Meier survival curves further revealed a significant relationship between CFS and survival time ($p < 0.001$), suggesting that lower levels of frailty as assessed by CFS were linked to longer survival durations.

3.3. Factors influencing all-cause mortality in hospitalized adults aged 65 and above

During the tracking period of 2.5 years, 26.2% (n = 303) of the participants died for various reasons. As shown in Table 2, CFS grouping was confirmed as a significant risk factor for mortality ($p < 0.001$) without adjusting for laboratory test variables. Specifically, as the CFS grouping was based on ascending frailty, the hazard ratio (HR) for all-cause mortality increased with increased CFS measure (p for trend < 0.001, both; Table 2). In comparison to the CFS 1–3 group, the CFS 4–6 (frail) group had an HR for mortality of 1.463 (95% CI, 0.992–2.157), and the CFS 7–9 (profound frailty) group had an HR for mortality of 2.036 (95% CI, 1.349–3.072). These findings demonstrate the significant impact of CFS levels on mortality risk in hospitalized adults aged ≥ 65, with higher frailty levels associated with increased mortality risk.

3.4. Factors influencing short-term readmission in old adults aged 65 and older

In the context of predicting short-term rehospitalization using the CFS, 203 cases (17.6%) were readmitted within 14 days for various reasons. Table 3 shows that the three-tiered CFS grouping data could be used to significantly predict 14-day rehospitalization among older adults, (p for trend < 0.05, both). Specifically, participants of the CFS 4–6 (frail) group had an HR of 1.516 (95% CI, 0.947–2.427) compared to those in the healthier CFS 1–3 group. Similarly, participants with CFS scores in the 7–9 range (profound frailty) had an HR of 2.144 (95% CI, 1.284–3.578) compared to those with CFS scores of 1–3.

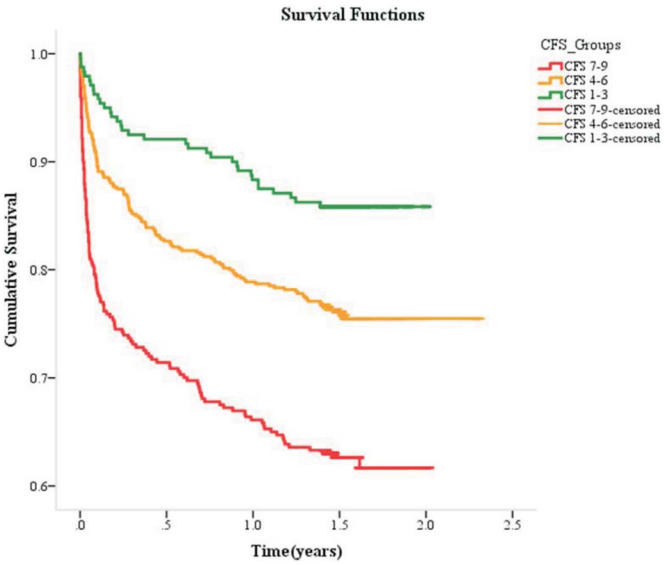

Figure 2. Kaplan-Meier survival curves with all-cause mortality as the outcome by CFS groups (N = 1156).

Table 1
Demographic data and clinical laboratory value by CFS group.

Characteristics	CFS group			p-value
	CFS 1–3	CFS 4–6	CFS 7–9	
Numbers	240	559	357	
Continuous variables, mean (SD)				
Age (y)	76.3 ± 8.1	81.9 ± 8.8	85.5 ± 8.6	< 0.001***
Hospital days	9.6 ± 11.2	12.8 ± 14.4	14.7 ± 14.5	< 0.001***
Categorical variables, n (%)				
Sex (women)	122 (50.8)	283 (50.6)	191 (53.5)	0.675
Chronic disease				
Heart disease	32 (13.3)	136 (24.3)	96 (26.9)	< 0.001***
Pulmonary disease	19 (7.9)	77 (13.8)	48 (13.4)	0.057
Diabetes	78 (32.5)	215 (38.5)	135 (37.8)	0.260
Renal disease	56 (23.3)	215 (38.5)	127 (35.6)	< 0.001***
Lab data				
Hb < 8.0 g/dL	8 (3.3)	46 (8.2)	32 (9.0)	0.023*
WBC > 12000/mm^3	52 (21.7)	135 (24.2)	133 (37.3)	< 0.001***
BS > 200 mg/dL	21 (8.8)	81 (14.5)	58 (16.2)	0.028*
Cr > 2.0 mg/dl	40 (16.7)	152 (27.2)	94 (26.3)	0.005*
GOT > 100 U/L	14 (5.8)	18 (3.2)	6 (1.7)	0.020*
GPT > 100 U/L	12 (5.0)	19 (3.4)	8 (2.2)	0.187
Alb > 3.0 mg/L	14 (5.8)	49 (8.8)	65 (18.2)	< 0.001***
CRP > 10 mg/dl	38 (15.8)	75 (13.4)	66 (18.5)	0.116
K^+ < 3.5 mEq/L	43 (17.9)	96 (17.2)	60 (16.8)	0.939
K^+ > 5.3 mEq/L	22 (9.2)	32 (5.7)	30 (8.4)	0.139

Abbreviations: CFS: Clinical Frailty Scale; SD: standard deviation; Hb: hemoglobin; WBC: white blood cell count; BS: blood sugar; Cr: creatinine; GOT: glutamate oxaloacetate transaminase; GPT: glutamic pyruvic transaminase; Alb: albumin; CRP: C-reactive protein; K^+: potassium.
* $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$.

Table 2
Incidence rate and relative risks (95% CI) of mortality by CFS group.

Mortality	CFS group			*p*-value
	CFS 1–3	CFS 4–6	CFS 7–9	
All-cause mortality				
No. of events	34	135	134	
Incidence rate (/100 PYS)	14.1	24.1	37.5	
Model 1	1	1.821 (1.250–2.653)	3.207 (2.201–4.673)	< 0.001***
Model 2	1	1.422 (0.967–2.089)	2.306 (1.551–3.430)	< 0.001***
Model 3	1	1.463 (0.992–2.157)	2.036 (1.349–3.072)	0.001**

Note. Model 1: Crude model. Model 2: Adjusted for age, gender, heart diseases, pulmonary diseases, renal diseases, and diabetes. Model 3: Adjusted for age, gender, heart diseases, pulmonary diseases, renal diseases, diabetes, Hb, WBC, BS, Cr, GOT, GPT, albumin, C-reactive protein, potassium, and sodium.
Abbreviation: PYS, person-years.
* $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$.

Table 3
Incidence rate and relative risks (95% CI) of short-term readmission by the CFS group.

Short term readmission	CFS group			*p*-value
	CFS 1–3	CFS 4–6	CFS 7–9	
All-cause short-term readmission				
No. of events	28	98	77	
Incidence rate (/100 PYS)	11.7	17.5	21.6	
Model 1	1	1.610 (1.026–2.525)	2.083 (1.304–3.324)	0.009*
Model 2	1	1.519 (0.953–2.421)	2.075 (1.259–3.419)	0.014*
Model 3	1	1.516 (0.947–2.427)	2.144 (1.284–3.578)	0.011*

Note. Model 1: Crude model. Model 2: Adjusted for age, gender, heart diseases, pulmonary diseases, renal diseases, and diabetes. Model 3: Adjusted for age, gender, heart diseases, pulmonary diseases, renal diseases, diabetes, Hb, WBC, BS, Cr, GOT, GPT, Albumin, CRP, potassium, and sodium.
Abbreviation: PYS, person-years.
* $p < 0.05$; ** $p < 0.005$; *** $p < 0.001$.

4. Discussion

Post-hospitalization mortality rate and factors associated with short-term readmission are clinical issues of concern. The CFS has been validated to predict adverse outcomes in older adults in several studies.[14,18] Our results show that, in hospitalized patients over the age of 65, the level of frailty was significantly positively correlated with all-cause mortality and readmission within 14 days. Thus, the CFS is an effective and reliable tool for identifying frailty in an emergency room setting, providing valuable information that can aid emergency room physicians with decision-making regarding care and treatment.[11] Our study findings also support previous research on the effectiveness of CFS in predicting adverse outcomes in older hospitalized patients.

In this study, we used CFS to classify individuals into three categories (CFS 1–3, 4–6, and 7–9) and used a three-tiered strategy to analyze outcomes in patients or their families, thereby enhancing the comprehensibility of our results. Furthermore, this classification facilitates the simplification and straightforward implementation of future interventions. For example, CFS 7–9 is associated with profound frailty, often indicating individuals who require palliative and end-of-life care. In this category, the primary goal is to provide compassionate and supportive care that focuses on comfort and dignity during the final stages of life. CFS 4–6 identifies individuals who are experiencing different levels of frailty and may have multiple chronic conditions. The primary focus in this group shifts toward chronic disease management with an emphasis on assessing frailty status.[19] CFS 1–3 represents relatively robust and independent individuals capable of independently performing daily activities. In this group, the primary focus is on health literacy promotion,[20] encouraging active frailty screening,[21] and ensuring the safe use of vaccines.[22]

Despite the advantages mentioned above, this retrospective study may have suffered from some degree of systemic bias. It was confined to only one medical center and mainly included emergency cases. Therefore, its inferential scope is limited and may not represent other medical institutions or different types of cases. The CFS evaluation results used in this study were also based on a single assessment by a single rater, which could have resulted in a bias. It should be noted that, in alignment with the Acute Care for Elderly (ACE) project, the assessors who performed the CFS evaluations in this study underwent an 8-hour course on geriatric frailty and training related to the CFS. However, an analysis of inter-rater consistency was not conducted, which could also be considered a key limitation of the study. Moreover, the prognostic ability of the CFS require longer-term follow-up studies to confirm their accuracy. We did not compare the CFS-based evaluation with other predictive tools owing to uncertainty about its advantages or disadvantages in terms of prediction.

In summary, the CFS is a valuable tool for healthcare professionals to categorize patients based on their frailty, allowing for tailored intervention strategies. Whether patients' primary needs are enhancing health literacy, managing chronic conditions, or providing end-of-life care to satisfy the unmet need for palliative care, the CFS can help guide healthcare teams to provide appropriate and personalized care for individuals in varying stages of frailty.

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Declaration

The authors declare no potential conflicts of interest to this article's research, authorship, and publication.

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