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The frailty tipping point: Determining which patients are targets for intervention in a burn population

Kathleen Romanowski [a,*], Eleanor Curtis [b], Alura Barsun [a], Tina Palmieri [a], David Greenhalgh [a], Soman Sen [a]

[a] University of California, Davis, Department of Surgery, Division of Burn Surgery, United States
[b] University of California, Davis, Department of Surgery, United States

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ABSTRACT

Objective: Elderly burn patients vary in physiologic age and frailty. While previous evidence suggests that frailty on admission is associated with poor outcomes, changes in frailty during hospitalization for a burn injury have not been reported.

Methods: We performed a two-year retrospective review of all elderly (≥65 years) burn-patients admitted to our burn center. Patients who died during admission were excluded. Data collected include: demographics, injury characteristics, outcomes, and discharge disposition. Canadian Study on Health and Aging Clinical Frailty Scores (CFS) were calculated on admission and at discharge. Change in frailty was calculated for each patient. Mean values are represented as mean ± standard deviation, median values are represented as median (IQR).

Results: Seventy-nine patients, mean age of 75 ± 8 years, with a mean admission CFS was 4.3 ± 1.2 and discharge CFS was 5.1 ± 1.2 were included in the study. The mean change in CFS was −0.55 ± 0.93. Forty-six patients (59%) had no change or an improvement in frailty during hospitalization while 32 (41%) had worsened CFS at discharge. Patients whose CFS was worse at discharge had larger burns (12.8 ± 10.7% vs. 6.28 ± 5.7%), lower admission CFS (3.88 ± 1.5 vs. 4.93 ± 1.0), and longer ICU stays (15.6 ± 18.9 vs. 7.64 ± 10.6 days) than patients without change in CFS. On multivariate regression analysis TBSA (OR 1.2 (1.07–1.3)) and admission CFS of 1–4 (OR 7.9 (2.2–28)) were significant predictors of worsened CFS at discharge.

Conclusions: In our study population, patients with low admission frailty scores are at greatest risk for worsened frailty at discharge and should be targeted for the development of future frailty prevention programs.

1. Introduction

The elderly (consisting of ages 65 and older), exceeds 40.3 million people, representing around 12% of the population of the United States. This number is expected to exceed 20% of the population by 2040 [1]. As patients age, comorbidities tend to increase as does the complexity and challenges these patients present when admitted to burn centers. Elderly burn patients are known to have longer hospital admissions than

* *Corresponding author at*: University of California, Davis and Shriners Hospitals for Children Northern California, 2425 Stockton Blvd., Suite 718, Sacramento, CA, 95817, United States.
E-mail address: ksromanowski@ucdavis.edu (K. Romanowski).

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their younger counterparts with similar injuries [2]. Those patients that are discharged to skilled nursing facilities (SNF) are noted to die more often and have poor long-term function [3]. Older models to estimate burn outcomes looked at age and total body surface area (%TBSA) burns while newer models included presence of full thickness burns, inhalation injury and gender [4]. More recent models have also begun including pre-injury frailty [5].

Frailty has been defined as a state of vulnerability or poor resolution of homoeostasis after a stressor event and is a consequence of cumulative decline in many physiological systems during a lifetime [6]. This physiologic deterioration impacts a patient's ability to fully recover for a burn or injury. Frailty is known to be associated with increased mortality, increased falls in the elderly and poor discharge disposition (SNF and death vs. home) [7].

The Canadian Study on Health and Aging Clinical Frailty Scale (CFS) is a 7-point scale that is subjective and based on a holistic view of the patient's functional status. It focuses on their overall health, potential comorbidities and their ability to perform activities of daily living (ADLs) [8]. Previous evidence shows that high frailty scores on admission are associated with poor outcomes in elderly burn patients [9]. However, changes in frailty during admission for a burn injury have not previously been reported. We hypothesize that frailty scores worsen during admission in elderly burn patients increasing the need for SNF discharge in our patient population. Additionally, we hypothesize that change in CFS over the course of a hospitalization at our institution may be able to predict which patients would benefit from programs developed to prevent frailty.

2. Methods

After approval from the local institutional review board, we performed a two-year retrospective review of all elderly (≥65 years) burn-patients admitted to our burn center from June 2011 to May 2013. We excluded all patients who died during admission. Patients were identified by the local Trauma Registry modified for the American College of Surgery database (TRACS). We collected data about the patient's demographics age, sex, TBSA, days on the ventilator, ICU days, and discharge disposition. Frailty scores prior to injury and at discharge from physical therapy were assessed by the first author using the Canadian Study of Health and Aging Clinical Frailty Scale (CFS) (Table 1) [8]. Admission History and Physicals, social work notes, discharge planning notes, and physical therapy notes were evaluated by the first author until enough information on medical comorbidities and ability to perform ADLs was gathered to determine pre-injury and discharge frailty. Change in frailty was assessed by comparing the discharge CFS to the admission CFS. Admitted patients were eligible for inclusion if they were admitted to a burn service for a thermal injury and were age 65 and older. Exclusion criteria included: not enough information to score frailty, a non-survivable injury on admission, death during their hospital course, transfer to another acute level facility, left against medical advice or transfer to hospice.

R statistical package was used to analyze the data (www.r-project.org). Wilks–Shapiro test for normality was performed on all continuous data. Student's t-test was used to determine differences between groups for all normally distributed continuous data. Wilcox rank sum test was used to determine differences between groups for all non-parametric continuous data. Chi-square testing was used to determine significant differences in proportions and categorical data. Univariate analysis was done on all variables in relation to discharge disposition. The proportion of patients discharged to SNF was calculated for all admission and discharge frailty scores. Multivariate regression analysis was performed to assess factors leading to worsened frailty. All mean values are represented as mean±standard deviation, and all median values are represented as median (Inter Quartile Range). Multivariate analysis was performed for discharge to SNF adjusted for age and TBSA burn and looked at CFS on admission, CFS at discharge and change in FS.

3. Results

During the study period, 95 patients aged 65 and older were admitted to the Acute Burn Service. A total of 79 patients were included in the study (See Fig. 1 for exclusions from the study population). Descriptive analysis of the entire population including age, sex, TBSA, days on the ventilator, ICU days, hospital days, and discharge disposition (home vs SNF) as well as CFS at admission and discharge are shown in Table 2. The mean Admission CFS was 4.3±1.2 and increased to 5.1±1.2 at

Table 1 – Canadian study on health and aging clinical frailty score.

1 — Very fit	Robust, active, energetic, well-motivated and fit
2 — Well	Without active disease, but less fit than people in category 1
3 — Well with treated comorbid disease	Disease symptoms are well controlled compared with those in category 4
4 — Apparently vulnerable	Although not frankly dependent, these people commonly complain of being "slowed up" or have disease symptoms
5 — Mildly frail	With limited dependence on others for instrumental activities of daily living
6 — Moderately frail	Help is needed with both instrumental and non-instrumental activities of daily living
7 — Severely frail	Completely dependent on others for the activities of daily living, or terminally ill

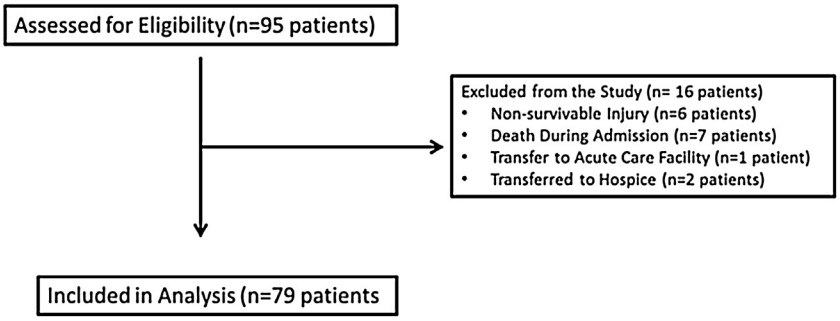

Fig. 1 – Patients included in study analysis.

discharge. The mean change in CFS from admission to discharge was −0.55±0.93.

Thirty-five percent of the patients were discharged to a SNF and 65% were discharged home. Discharge destination by admission and discharge frailty score is presented in Table 3. When comparing populations discharged to SNF vs. home, patients discharged to a SNF were older (77±9 vs. 73±7 years), suffered a larger burn injury (11 (6–17) % vs. 4 (2–10) % TBSA), and had longer hospital stays (8 (1–14.5) vs. 18(11–28) days) (Table 4). Additionally, both admission CFS (3.9±1.1 vs. 5.2±1) and discharge CFS (4.6±1 vs. 6±0.83) were significantly higher in patients discharged to a SNF though the change in CFS was similar between those discharged to home and SNF. Controlling for the effect of age and TBSA, both admission CFS (OR 3.4 (CI 1.7–6.3)) and discharge CFS (OR 3.4 (CI 1.7–6.7)) were independently associated with discharge to SNF. However, the change in CFS was not significant between the groups (OR 0.73 (0.4–1.4)). Due to the fact that factors such as insurance coverage can lead to patients not going to a SNF even when placement is recommended by the multidisciplinary medical team, we examined the 50 patients who were discharged home. Only 4 patients (8%) who ultimately went home had a recommendation for SNF placement. The reason for not going to a SNF was refusal by the patient or family in 3 cases and patient clearing physical therapy while waiting for insurance approval in 1 case.

On admission only 37% of the patients had a CFS≥5, however at discharge 66% of the patients had a CFS≥5. Despite the increase in the percentage of patients who had a CFS≥5, only 32 (41%) patients had a discharge CFS that was worse than their admission CFS. Patients whose frailty worsened during hospitalization were significantly different than those whose frailty was unchanged or improved with regards to Admission CFS (3.88±1.5 vs. 4.93±1.0, $p<0.001$), TBSA (12.8±10.7% vs. 6.28±5.7%, $p<0.01$), and ICU stay (15.6±18.9 vs. 7.64±10.6 days, $p<0.05$) (Table 5). Looking specifically at admission frailty as a predictor of worsened frailty, 22 (69%) of the 32 patients who had worsened frailty had admission CFS of 1–4

Table 2 – Descriptive analysis of burn patients aged 65 and older.

	N=79
Age (years)	74.8(7.7)
Males (n (%))	56 (70.1%)
TBSA (%)	6.5 (2.7–12.5)
Hospital days (days)	12(2.5–18)
ICU days (days)	8(1–15.5)
Discharged to home (n (%))	51 (64.6%)
Discharged to SNF/ECF (n (%))	28 (35.4%)
Admission CFS	4.3(1.2)
Discharge CFS	5.1(1.2)
Change in CFS	−0.55(0.93)

Table 3 – Summary of the proportion of patients being discharged to skilled nursing facilities in relation to their admission frailty score and discharge frailty score.

Frailty score at admission	Home	SNF	Proportion
2	4	2	33%
3	20	3	13%
4	15	6	29%
5	8	3	27%
6	1	14	93%
7	2	1	33%
Frailty score at discharge	**Home**	**SNF**	**Proportion**
3	7	0	0%
4	18	1	5%
5	17	6	26%
6	7	12	63%
7	1	9	90%

Table 4 – Summary of differences in discharge disposition in relation to age, gender, total body surface area (TBSA) burn, hospital days, admission frailty score (fs), discharge frailty score, and change in frailty score.

	Home	SNF/ECF	p-Value
Age	73.4(6.6)	77.4(8.9)	0.02
Male	38	18	NS
Female	13	10	NS
TBSA	4(2-10)	11(6.4-17.4)	0.0005
Hospital days	8 (1-14.5)	18(11–28)	<0.00001
Admission CFS	3.9(1.1)	5.2(1)	<0.00001
Discharge CFS	4.6(1)	6(0.83)	<0.00001
Change in CFS	0.5(0-1)	1(0-1.13)	NS

Table 5 – Comparison of patients who had no change or improved frailty with those whose frailty worsened during their hospitalization.

	Improved or no change (n=46)	Worsened frailty (n=31)	p-Value
Age (years)	75.4 (8.0)	75.9 (7.3)	NS
Admission CFS	4.98 (1.0)	3.88 (1.5)	<0.001
Discharge CFS	4.89 (1.0)	5.34 (1.3)	NS
TBSA	6.07 (5.5)	12.77 (10.7)	<0.01
LOS (days)	11.15 (11.9)	19 (20.5)	NS
LOS/TBSA	2.11 (1.8)	1.50 (1.1)	NS
Ventilator days (days)	2.24 (8.3)	2.09 (5.9)	NS
ICU days (days)	7.80 (10.5)	15.59 (18.9)	<0.05
OR trips	0.43 (0.62)	0.66 (0.7)	NS

Table 6 – Change in frailty during hospital stay based on admission CFS.

	CFS group 1–4	CFS group 5–7	p-Value
Discharge frailty no change or improved	15	31	
Discharge frailty worsened	22	10	0.003

(Table 6). In comparing the low admission CFS group to the high admission frailty group, the only significant differences were related to CFS and age (Table 7). Multivariate regression analysis demonstrated that TBSA (OR 1.2 (1.07–1.3)) and an admission CFS of 1–4 (OR 7.9 (2.2–28)) were significant predictors of worsened CFS at discharge (Table 8). Inhalation injury was not found to be a significant predictor of worsened frailty.

Table 7 – Comparison of patients by CFS grouping.

	CFS group 1–4	CFS group 5–7	p-Value
Age (years)	72.5(6)	76.9(8)	0.01
TBSA (%)	6 (3–11)	7 (2.3–14.5)	NS
LOS (days)	10(2–16)	12(3–21)	NS
Admission FS	3.4(0.8)	5.6(0.6)	<0.001
Delta FS	1 (0–2)	0 (0–0)	<0.001
Discharge FS	4.3(0.9)	5.8(0.9)	<0.001
Inhalation	0.14	0.03	NS

4. Discussion

Measures of frailty have been shown to help predict outcomes in elderly patients with a multitude of acute medical conditions. Many different scales have been used; however, the CFS, which is a simple seven-point scale described by Rockwood et al. in 2005 provided a way of measuring frailty as a holistic clinical judgment and therefore can be used retrospectively [8]. The scale was validated against a rules based assessment and performed as well or better than other standard measures, such as age, when predicting death or entry into a skilled nursing facility. Other frailty scoring systems have shown that increasing frailty has been associated with an increase in postsurgical complications and risk of discharge to assisted living facilities as well [10,11]. These previous studies showed that increasing frailty score increases risk of death and entrance into SNF. Our data is consistent with others, including our own previous studies, in that increasing admission CFS significantly increased the likelihood of SNF discharge [5,9]. In our current study, 62% of patients with a CFS $\geq$5 on admission were discharged to a SNF which is higher than the 33.8% we saw in our previous study [5]. Discharge CFS in this study population was also predictive of discharge to a SNF with 51.9% of patients with a discharge CFS $\geq$5 going to a SNF. The predictive ability of the discharge CFS has not been previously examined for the CFS and our current study demonstrates its potential utility in our patient population.

Despite focusing on discharge disposition as an outcome, there have been few studies that have focused on discharge frailty scores or change in frailty score. One of the few that did measure change in frailty is a study by Volpato et al. that examined the Multidimensional Prognostic Index Score (MPI) on both admission and discharge in a geriatric internal medicine population [12]. This study did not focus on outcomes following hospitalization, instead focusing on the change in MPI from admission to discharge and the relationship between length of

Table 8 – Multivariate regression analysis for worsening frailty.

	OR (Worsening frailty)	CI	p-Value
Age	0.99	0.92–1.08	NS
TBSA	1.2	1.07–1.3	0.0008
Inhalation injury	0.19	0.014–2.6	NS
Admission CFS group 1–4	7.9	2.2–28	0.0014

stay and worsening frailty in patients. They found that almost 60% of the patients had a change in MPI score from admission to discharge, however there was no statistically significant difference in MPI. This is likely due to some scores improving while others worsened. We found similar results in our study when looking specifically at the change in CFS from admission to discharge. The mean change in frailty score between admission and discharge for the entire population was 0.5 and 58.2% of patients had no change or an improvement in frailty during their hospitalization. This study also examined which patients had worsened MPI at discharge and found that patients with lower MPI on admission (less frail) had the largest increase in MPI (delta-MPI 0.041, $p < 0.001$). They also found that 38.1% of the low group had a worse MPI score at discharge, similar to our results, in which, patients with an admission CFS of 1-4 had a larger mean delta CFS than patients who had a higher admission frailty, $p < 0.001$. In fact, 59.4% of patients with CFS 1-4 had worsened frailty at the time of discharge (22 of 37 patients) compared with only 32.3% (10 of 31 patients) in the CFS 5-7 group, $p = 0.003$.

Our study has several limitations. First, due to the retrospective nature of this study, the data collected were not explicitly designed to assess for admission or discharge frailty and therefore may not fully be able to assess a patient's true functional status. Additionally, the data on which the admission and discharge frailty scores were assessed was taken from the reports of multiple authors in the patient's chart, and therefore, reflect the opinions of multiple individuals and which may not always agree with regards to admission or discharge CFS. The source of data used to determine the admission CFS included the admission history, admission laboratory data, and physical therapy notes primarily. When needed, discharge planner notes, and social worker notes were used to more fully understand a patient's admission functional status. Discharge CFS determination was made using discharge summaries, final physical therapy and occupational therapy assessments, and discharge planning notes. None of these data sources directly assessed frailty and were mostly subjective; however, they were meant to assess functional status which is in many ways closely related to frailty. Another limitation of this study given its retrospective nature is whether we are truly measuring changes in frailty or simply measuring deconditioning related to hospitalization. It is possible that the changes we see in functional status could be transient and more appropriately defined as deconditioning, or they could be more permanent and a sign of worsened frailty following burn injury. Only through following patients prospectively will we be able to determine the chronicity of the changes that we observed in this patient population. Finally, the same investigator determined both the admission CFS and the discharge CFS which introduces the possibility of bias into the determination of the frailty score.

Despite these limitations, our study is important as it is the first to look at the effects of injury and hospitalization on frailty in an elderly burn population through examining the difference between admission and discharge CFS. Future studies will initially focus on prospectively validating the CFS in a burn population as well as confirming propensity for those with lower admission CFS to have worsened frailty at discharge. In examining change in frailty only TBSA and lower admission CFS were found to be independent predictors or worsening frailty on multivariate regression analysis of our study population. As TBSA is not an easily modifiable risk factor, efforts aimed at the prevention of frailty in hospitalized patients should be aimed at patients who have low admission CFSs. These low admission CFS patients are a population of patients who are at risk for worsened frailty and therefore should be the target of interventions developed to treat or prevent frailty. As efforts move forward to create interventions targeted at ameliorating the worsening of frailty during hospitalization it will be critical to know which patients are at risk.

5. Conclusion

Frailty increases during hospitalization and is an independent factor for discharge to a SNF in elderly burn patients in our study population. Additionally, our patients with low admission frailty scores are at the tipping point for frailty and therefore are at the greatest risk for worsened frailty at discharge. Further study should focus on developing interventions that prevent worsening frailty during hospitalization and patients with low admission frailty scores should be the targets of these interventions.

Author contributions

Kathleen Romanowski – Study design, data collection, data analysis, manuscript writing.

Eleanor Curtis – Data collection, data analysis, manuscript writing.

Alura Barsun – Data collection, manuscript editing.

Tina Palmieri – Manuscript editing, contribution to discussion.

David Greenhalgh – Manuscript editing, contribution to discussion.

Soman Sen – Study design, data collection, data analysis, manuscript editing.

All of the above listed authors have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted. The manuscript, including related data, figures and tables has not been previously published and that the manuscript is not under consideration elsewhere.

Declaration of conflict

There are no conflicts to declare for the any of the authors.

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