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Frailty and Short-Term Outcomes in Patients With Hip Fracture

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Abstract

Objectives: To assess the prevalence of frailty and its ability to predict short-term outcomes in older patients with hip fracture. **Design:** Prospective cohort study. **Setting:** University-affiliated community hospital. **Participants:** Thirty-five patients aged $\geq$65 treated with hip fracture. **Measurements:** Frailty was assessed using the 5 criteria of the Fried Frailty Index, modified for a post-fracture population. Cognitive impairment was assessed with the Montreal Cognitive Assessment (MoCA). The primary outcome was overall hospital complication rate. Secondary outcomes were length of stay (LOS) and specific complications. Differences between the frail and the non-frail were identified using chi-square analysis and analysis of variance (ANOVA) for categorical and continuous variables, respectively. **Results:** Eighteen (51%) participants were frail. Seventeen (49%) had $\geq$1 hospital complication. Twelve (67%) frail patients versus 5 (29%) non-frail patients had a complication ($P = .028$). Mean LOS was longer in patients with frailty (7.3 $\pm$ 5.9 vs 4.1 $\pm$ 1.2 days, $P = .038$). Most were frail for the weakness criterion (94%), and few were frail for the physical activity criterion (9%). Excluding these criteria, we developed a 3-criteria frailty index (shrinking, exhaustion, and slowness) that identified an increased risk of complications (64.7% vs 33.3%, $P = .061$) and LOS (7.4 $\pm$ 6.1 vs 4.2 $\pm$ 1.3 days, $P = .040$) in participants with frailty. Among non-frail participants with a high MoCA score of $\geq$20 (n = 12), 2 (17%) had complications compared to 10 (71%) frail participants with a low MoCA score (n = 14). **Conclusion:** Frailty is common in older patients with hip fracture and associated with increased LOS and postoperative complications. A low MoCA score, a hypothesized marker of more advanced cognitive frailty, may further increase risk. Frailty assessment has a role in prognostic discussion and care planning. The 3-criteria frailty index is an easily used tool with potential application in clinical practice.

Keywords
hip fracture, frailty, prognosis

Introduction

Hip fracture is a common and consequential event in the life of an older adult. In the United States in 2010, there were 258 000 hospital admissions for hip fracture among people aged 65 years and older.[1] Patients with hip fracture have a 25% reduction in life expectancy compared to their uninjured peers.[2] Over half will have persistent disability a year after fracture.[3] Understanding the factors that influence hip fracture outcome has the potential to guide multiple aspects of care including prognostic discussion and targeted intervention. Both age and pre-fracture functional status have been identified as useful prognosticators.[4] This pilot study examines the utility of frailty in predicting short-term hip fracture outcomes.

Frailty has been defined as a vulnerability to adverse outcomes. Although there is an overlap between frailty, disability, and comorbidity, these are distinct entities.[5] One widely used measure of frailty is the Fried Frailty Index,[6] which has been shown to be predictive of hospitalization, disability, and death. Frailty has been evaluated in general surgery patients and is predictive of adverse outcomes including wound infection, discharge to a skilled nursing facility, and mortality.[7-8] Recent research using an alternative frailty index showed frailty to be predictive of mortality, length of stay (LOS), and residence 30 days after hip fracture.[9] The prevalence and role of frailty in patients with hip fracture as measured by the Fried Frailty

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Index is less well known but is hypothesized to be common and a predictor of adverse outcomes.

There is an ongoing discussion on the definition of frailty,[10] including the consideration of whether cognitive impairment is a criterion of frailty.[11] For the purposes of this study, we considered the contribution of cognitive impairment separately. We conceptualized frailty as measured by the Fried Frailty Index as "physical frailty" and considered cognitive impairment as an indicator of "cognitive frailty." Cognitive impairment in patients with hip fracture is associated with increased mortality and nursing home admission.[12] The additive effects of physical frailty and cognitive frailty are less well known in a population with hip fracture. This pilot study examines the prevalence of these potential risk factors and their ability to predict short-term outcomes, namely, time to surgery, LOS, and complications with hip fracture.

Methods

Study Design and Participants

This prospective, observational cohort study was conducted in patients with hip fracture aged 65 years and older who underwent surgical fracture repair at a university-affiliated community hospital with Level III trauma center. All patients with hip fracture were admitted to the Geriatric Fracture Center (GFC), a model of co-management by orthopaedics and geriatrics.[13] The study spanned a 12-week period (June 2, 2013-August 30, 2013).

All patients admitted to the hospital with a hip fracture within the study time frame were considered for inclusion. Exclusion criteria included persons less than 65 years old, nonsurgical intervention, periprosthetic fracture, and pathological fracture. Informed consent was obtained through a process approved by the university's Institutional Review Board. In the case of patients who could not sign their surgical consent form, those with documented dementia or those with demonstrated delirium on study introduction, proxy consent was obtained in addition to patient assent.

This study merged data collected in interviews by the research team and data from the GFC registry. Basic information is collected on all patients with hip fracture who are admitted to the GFC as part of quality management and is entered into the registry. Variables obtained from the registry included demographics (age, gender, race, ethnicity, and primary residence prior to admission), comorbidities as included in the Charlson index,[14] Charlson comorbidity score, and activities of daily living (ADL) score on admission.[15] Variables assessed in interviews by the research team included frailty status, cognitive impairment status, and the presence or absence of delirium. Interviews were conducted after enrollment between the first post-operative day and hospital discharge.

Assessment of Frailty

Frailty was measured using the Fried Frailty Index, modified to meet the limitations of a recent post-fracture repair population. The index identifies the following 5 criteria of frailty: shrinking, exhaustion, slowness, weakness, and physical activity.[6] Each criterion is assigned a value of 0 or 1, with 1 indicating a person is frail for that criterion. Participants with a total score of 3 or higher are considered frail.

Modified Fried Frailty Index Criteria

1. *Shrinking* was defined as self-reported, unintentional weight loss of 10 pounds or more in the past year. If the participant answered yes to this weight loss criterion, he or she was frail for shrinking.
2. *Exhaustion* was measured by patient responses to questions regarding effort and energy. Patients were read 2 statements: (a) I felt that everything I did was an effort and (b) I could not get going. After each statement, participants were asked "How often in the week prior to your hip fracture did you feel this way?" If a participant answered 3 days or more to one or both of the questions, he or she was considered frail for exhaustion.
3. *Slowness* was defined as self-reported difficulty with walking 100 meters and up a flight of stairs prior to hip fracture. If the participant reported difficulty with one or both of the activities, he or she was considered frail for slowness.
4. *Weakness* was measured by grip strength. Determination of frail grip strength is dependent on gender and body mass index. A participant was considered frail for weakness if his or her average grip strength based on 2 trials was below the established threshold.[6] Participants who were unable to follow instructions and therefore unable to perform the grip strength test were considered frail for weakness. Four participants were considered frail for weakness due to inability to perform this test.
5. *Physical activity* was determined using participant responses to a leisure time questionnaire. Energy expenditure was calculated using a standardized algorithm. Men who expended <383 kcal/week and women who expended <270 kcal/week were considered frail for physical activity.

The criterion for exhaustion used in the context of this study deviated from the original index, which measured a 15-foot walk time. Because post-operative walk time is unlikely to accurately approximate baseline mobility, a validated, self-reported method was utilized.[16] All of the questions were asked in the context prior to hip fracture in an effort to obtain a frailty score that reflected pre-fracture status. If the participants consented themselves, questions were posed directly to the participants. If a family member provided consent for the participant due to capacity-limiting dementia or delirium, questions were posed to the family member alone or to the family member and participant simultaneously.

Assessment of Cognitive Function

Cognitive assessment was completed using the Montreal Cognitive Assessment (MoCA), a series of activities and questions

that assess several aspects of cognitive functioning.[17] The MoCA has been validated for detection of mild cognitive impairment. In this 30-point test, a score of 25 or lower is at least suggestive of mild cognitive impairment. In an effort to obtain a score reflective of pre-fracture cognition, this assessment was administered on the day prior to discharge or as close to discharge as possible. Delirium was measured using the Confusion Assessment Method (CAM)[18] either as informed by a mini-cog assessment[19] or the MoCA. An effort was made to measure the MoCA score in the absence of delirium based on a negative CAM.

Definition of Outcomes

Outcomes were obtained from the GFC registry. The primary outcome was overall complication rate during hospital admission; participants were determined to have had a complication if they had any of the specific complications listed subsequently. The secondary outcomes include time from admission until surgery, length of hospital stay (LOS), and specific complications, namely, pneumonia, cardiac complications, surgical site infection, deep vein thrombosis and/or pulmonary embolism, bleeding, renal insufficiency or failure, and delirium as determined by chart review by the GFC staff.[20] Cardiac complications included myocardial infarction, new congestive heart failure, new arrhythmia, and heart block.

Statistical Analysis

Statistical analysis was done using StatView 5 software for Windows (SAS Institute, Inc, Cary, North Carolina). Descriptive statistics including mean and standard deviation were calculated by standard formulas. Frailty status and categorical variables were compared using chi-square (χ^2) analysis. Analysis of variance was used to compare frailty and continuous variables.

Results

Sixty-three patients were admitted with hip fracture during the study time frame. Five patients were excluded due to age <65 years old, 3 for absence of surgical intervention, and 8 for periprosthetic fracture. Most patients admitted to our program undergo surgical repair of their hip fracture in order to preserve function and mobility; the 3 patients with hip fracture who did not have surgery were unfit for surgery and at the end of life. Forty-seven patients were eligible for study participation, and 36 (77%) consented to enroll. Seven patients declined participation, 4 patients were missed due to contact barriers, and 1 patient withdrew after enrollment. The final sample size was 35 participants.

Among the 35 participants, 18 (51%) were frail based on a modified Fried Frailty Index. The majority of participants were female, white, and lived in the community prior to hip fracture (Table 1). Disability, defined as any ADL dependency, was present in 12 (34%) participants. High comorbidity, defined as a Charlson Comorbidity score greater than the median score of 2, was present in 13 (37%) participants. There was a significant association between frailty and disability (χ^2 P value = .006). Frailty and high comorbidity failed to show association (χ^2 P value = .358).

Table 1. Clinical Characteristics of Study Participants.

Characteristic	All participants (n = 35)
Age, mean ± SD	86 ± 4
Female, n (%)	29 (83)
White, n (%)	35 (100)
BMI, mean ± SD	25 ± 4
Prior residence, n (%)	
Home	17 (48.5)
Home with services	9 (26.0)
Assisted living facility	3 (8.5)
Skilled nursing facility	6 (17.0)
Charlson comorbidity score, mean ± SD	2.2 ± 1.8
High comorbidity[a], n (%)	13 (37)
ADL score, mean ± SD	4.8 ± 2.0
Disability[b], n (%)	12 (34)
MoCA score, mean ± SD	14.9 ± 9.0
Low MoCA score[c], n (%)	19 (54)
Frail[d], n (%)	18 (51)
Shrinking	10 (29)
Exhaustion	11 (31)
Slowness	25 (71)
Weakness	33 (94)
Physical activity	3 (8.6)

Abbreviations: SD, standard deviation; ADL, activities of daily living; MoCA, Montreal Cognitive Assessment.
[a]High comorbidity defined as a Charlson comorbidity score ≥3.
[b]Disability defined as any ADL dependency or ADL score ≤5.
[c]Low MoCA score defined as score ≤19.
[d]Frailty defined as presence of ≥3 criteria of modified Fried Frailty Index.

Within the study population, 17 (49%) participants had one or more complications during hospitalization. Complications occurred in 12 (67%) frail participants versus 5 (29%) non-frail participants (χ^2 P value = .028). Of the 7 individual complications, delirium was the most common among all participants and among frail participants. Delirium demonstrated the closest association with frailty (χ^2 P value = .053) of all the individual complications. The average LOS among the frail patients and non-frail patients was 7.3 ± 5.9 days and 4.1 ±1.2 days, respectively (P value = .038). Mean time from admission to surgery among the frail patients and non-frail patients was 0.66 ± 0.23 days and 0.66 ± 0.29 days, respectively (P value = .935; Table 2).

Among all study participants, 33 (94%) were frail for weakness and 3 (9%) were frail for physical activity. Noting that weakness and physical activity were the least robust variables among the study participants, a 3-criteria frailty index was analyzed to assess for short-term outcomes based on this alternative definition of frailty. This abbreviated frailty index included assessment of shrinking, exhaustion, and slowness. The threshold for frailty was a score of ≥2, and outcomes were analyzed. Among the patients with frailty, 11 (65%) had

Table 2. Primary and Secondary Outcomes by Frailty Status.

	Frail (n = 18)	Non-frail (n = 17)	*P* Value
Any complication, n (%)	12 (67)	5 (29)	.038
Pneumonia	2 (11)	0 (0)	.157
Cardiac[a]	5 (28)	1 (6)	.086
PE/DVT	0 (0)	0 (0)	–
Bleeding	0 (0)	0 (0)	–
Surgical site infection	0 (0)	0 (0)	–
Renal insufficiency or failure	1 (6)	1 (6)	.967
Delirium	10 (56)	4 (24)	.053
LOS, days, mean ±SD	7.3 ± 5.9	4.1 ± 1.2	.038
Time to surgery, days, mean ±SD	0.66 ± 0.23	0.66 ± 0.29	.935

Abbreviations: PE/DVT, pulmonary embolism/deep vein thrombosis; LOS, length of stay; SD, standard deviation.
[a]Cardiac complications included myocardial infarction, new onset congestive heart failure, new arrhythmia and heart block.

complications compared to 6 (34%) of those who were non-frail (chi-square P value = .063). Patients with frailty had a mean LOS of 7.4 ± 6.1 days compared to 4.2 ± 1.3 days among the non-frail (P value = .040) patients.

Cognitive impairment was identified using the MoCA. The standard cutoff score for mild cognitive impairment is a MoCA score <26 out of 30 points. Using this threshold, 31 (89%) participants had some degree of cognitive impairment. Median MoCA score for the study population was 19 points. Based on this median score, participants were divided into "high MoCA" (>19) versus "low MoCA" (≤19) categories. Nineteen patients had a low MoCA score (54%). Fourteen participants were frail with a low MoCA, and the prevalence of overall complications was highest in this group with 10 (71%) participants experiencing complications. Twelve participants were non-frail with a high MoCA, and the prevalence of complications was lowest in this group with 2 (17%) participants having complications. In all, 2 of 4 patients who were frail with a high MoCA (50%) and 3 of 5 patients who were non-frail with a low MoCA (60%) had a complication. Among those with a low MoCA, 13 (68%) became delirious, whereas only 1 participant with a high MoCA had delirium. A low MoCA score was significantly associated with the complication of delirium (χ^2 P value = <.001).

Discussion

This study demonstrates that frailty is a common condition among older adults with hip fracture and represents a useful predictor of short-term outcomes in the context of hip fracture. Within the study population, the modified Fried Frailty Index identified half of participants as physically frail. Frailty was significantly associated with overall complications and increased LOS. A low MoCA score, hypothesized to be a marker of more advanced cognitive frailty, may have additive effects with physical frailty as measured by the modified Fried Frailty Index, further increasing the risk of complications and increased LOS. While this additive effect did not reach significance in this pilot study, it does suggest that physical and cognitive frailty may have utility when identified as separate risk factors.

The results of this study are consistent with the small body of literature on frailty and hip fracture outcomes in older adults. Alternative frailty indices have shown a significant association between frailty and outcomes after hip fracture including increased LOS[9] and mortality at 1 and 2 years post-fracture.[21] Both of these recent studies defined frailty using variations of a Frailty Index developed by Rockwell et al that assesses frailty and risk status by the proportion of accumulated deficits.[22] In this deficit accumulation model of frailty, the number of variables assessed is flexible and comorbidity, disability, and cognitive impairment are not separate entities. This is a notable departure from the model of frailty defined by the Fried Frailty Index. The practical advantage of the deficit accumulation model is the flexibility it allows when analyzing a preexisting database and creating a frailty index. A disadvantage of this index is the potentially cumbersome clinical application of a frailty assessment tool with a larger number of variables.

There is ongoing interest in a frailty measurement that is conceptually satisfying and clinically usable.[10] Specifically, there is an effort within the field of orthopaedics to identify a brief questionnaire to stratify risk among older adults with hip fracture.[23]

The original Fried Frailty Index, while straightforward in its premise and scoring, is time consuming and can be demanding of the patient and the provider. The Frailty Index conceptualized by Rockwell et al, while flexible in design and scope, is also time consuming and requires assessment of more variables. With the modified Fried Frailty Index used in this study, the variables of weakness and physical activity did not help distinguish risk groups, since most participants were frail for weakness and not frail for physical activity. Prospective research with community-dwelling, initially nondisabled older adults suggests certain frailty criteria are more robust than others. While low physical activity has been independently associated with chronic disability, long-term nursing home stay and death, weakness as measured by grip strength, may not be a strong frailty criterion.[11] With the goal of generating a clinically useful frailty index, we developed the 3-criteria frailty index. This index is an assessment tool to evaluate shrinking, exhaustion, and slowness. While analysis of data using the 3-criteria frailty index showed a trend toward association with complications, it nevertheless has potential for application in clinical practice (Figure 1). Further study with a larger sample size would help to confirm these findings.

There are limitations to this study. The small sample size limits the power of the study. All participants were recruited from the same academic community hospital. The GFC program has proportionately more patients from skilled nursing facilities, and therefore assessment of this population may overestimate frailty prevalence. Thus, results may not be generalizable. Additionally, all data were collected prospectively, and post-fracture data were used as a proxy for pre-fracture status. This point may be both a weakness and a strength.

A	In the last year, have you lost more than 10 pounds unintentionally (ie. not due to dieting or exercise)?	**Yes** ☐	**No** ☐	*If YES, frail for criterion A.* ___ / 1
B		**< 3 days**	**≥ 3 days**	*If ≥ 3 days to either, frail for criterion B.* ___ / 1
	I felt that everything I did was an effort. *How often in the week prior to hip fracture did you feel this way?*	☐	☐	
	I could not get going. *How often in the week prior to hip fracture did you feel this way?*	☐	☐	
C	Because of a health problem, do you have difficulty walking 100 meters?	**Yes** ☐	**No** ☐	*If YES to either, frail for criterion C* ___ / 1
	Because of a health problem, do you have difficulty climbing one flight of stairs without resting?	**Yes** ☐	**No** ☐	
A score ≥ 2 / 3 indicates frailty.				___ / 3

Figure 1. Geriatric Hip Fracture Frailty Assessment Tool. This assessment tool is based on the 3-criteria frailty index derived from the modified Fried Frailty Index. Criterion A measures shrinking, criterion B exhaustion, and criterion C slowness.

Participants may not accurately recall their status prior to the fracture, and this would affect the results of the modified Fried Frailty Index. Assessment of cognitive function in the postsurgical hospital setting may not represent a person's baseline cognitive function. There are many factors that could alter cognitive function in the hospital including anesthesia, pain medication, and delirium. Such variables were not formally controlled for in this study design. There was an effort to administer the MoCA in the absence of delirium as indicated by a negative CAM, and among all research participants, only 1 participant completed a MoCA with a positive CAM. However, the results analyze data gathered during hip fracture hospitalization, and clinical application of a frailty assessment tool would occur in the same clinical setting. This approach therefore has practical applicability.

Suffering from hip fracture as an older adult is both common and consequential. This pilot study has identified frailty as a potentially powerful predictor of hip fracture outcomes in older adults. A clinically usable frailty assessment tool may have important implications in the prognostic counseling and care planning among older adults with hip fracture.

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Declaration of Conflicting Interests

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