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The Frail Fail: Increased Mortality and Post-Operative Complications in Orthopaedic Trauma Patients

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ABSTRACT

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Importance: The burgeoning elderly population calls for a robust tool to identify patients with increased risk of mortality and morbidity. The modified frailty index (MFI) is an important comprehensive assessment of postoperative complications in orthopaedic trauma patients.

Objective: To determine the effectiveness of the MFI as a predictor of morbidity and mortality in orthopaedic trauma patients.

Design: Retrospective review of database records

Setting: Participating hospitals in National Surgical Quality Improvement Project (NSQIP)

Participants: The NSQIP database was queried to identify patients age 60 and above who underwent surgery for pelvis and lower extremity fractures between 2005-2014.

Main Outcomes and Measures: For each patient, an MFI score was calculated using NSQIP variables. The relationship between the MFI score and 30-day mortality and morbidity was determined using chi-square analysis. MFI was compared to age, American Society of Anesthesiologists physical status classification, and wound classifications in multiple logistic regression.

Results: Study sample consisted of 36,424 patients with 27.8% male and 80.5% white with an average age of 79.5 years (SD 9.3). MFI ranged from 0 to 0.82 with a mean MFI of 0.12 (SD 0.09). As MFI score increased, mortality increased from 2.7% to 13.2% and readmission increased from 5.5% to 18.8%. The rate of any complication increased from 30.1% to 38.6%. Frail patients also had higher odds of adverse hospital discharge (MFI of 0.45+ OR: 8.6, 95% CI: 4.0-18.4). Length of hospital stay increased from 5.3 days (±5.5 days) to 9.1 days (±7.2 days) between MFI score 0 and 0.45+. There was a stronger association between MFI and 30-day mortality (adjusted OR for MFI 0.45+: 2.6, 95% CI: 1.7-3.9) compared to age (aOR for age: 1.1, 95% CI: 1.1-1.1) and ASA (aOR 2.5, 95% CI: 2.3-2.7).

Conclusions and Relevance: MFI was significantly associated with morbidity and mortality in orthopaedic trauma patients. Future direction will be to conduct a study to validate the index and compare to other morbidity scales. The use of MFI can provide an individualized risk assessment tool that can be used by an interdisciplinary team for perioperative counseling and to improve outcomes.

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INTRODUCTION

The population of older adults is growing at a rapid rate. In 2050, the estimated population in the United States of adults aged 65 and older is projected to be 83.7 million, almost double the estimated 43.1 million in 2012 (1). In a large population-based study of over 400,000 trauma hospital admissions, 27% of patients were over the age of 65, with fall mechanisms alone costing approximately $34 billion dollars annually in the United States (2-3).

Orthopaedic trauma in the individual geriatric patient is closely linked to morbidity and mortality. Fractures of the pelvis and lower extremities are particularly disabling due to weight-bearing restrictions, which necessitate the use of assistive devices (walker, wheelchair, crutches). Within lower extremity orthopaedic trauma, substantial research effort has been focused on geriatric patients with hip fractures, and one-year mortality after a hip fracture is estimated between 18% and 33% (4). Presence of co-morbidities has been associated with increased in-hospital, greater than 6-month and 1-year mortality (5-6). Similar high rates of morbidity and mortality have been demonstrated in other geriatric lower extremity injuries including distal femur fractures and periprosthetic fractures (7-11).

Numerous strategies for pre-operative risk stratification and patient physiology optimization have been proposed, and inter-disciplinary management teams have been shown to improve survival and decrease morbidity when the total geriatric patient is treated in the perioperative period (12-17). Expeditious medical optimization and clearance, timely surgery, early post-operative mobilization, standardized venothromboembolism prophylaxis and delirium prevention protocols improve patient care when coordinated between primary care and orthopaedic providers.

Additionally, patients with multiple co-morbidities can be considered "physiologically-old", with similar high risk of morbidity and mortality after lower extremity trauma; however, they may not be treated with appropriate interdisciplinary care in the peri-injury and peri-operative time period due to their young chronological age. In recent years, "frailty" or a multidimensional state of weakness, vulnerability, and decreased physiologic reserve has been introduced as a diagnosis of “unsuccessful aging”. In frail patients, multiple organ systems have a lower threshold of decline and are more susceptible to external stressors of trauma. Though frailty has a well-defined correlation with age, age alone is not necessarily synonymous with frailty. Frailty has been associated with increased post-operative complications, including increased mortality and need for long-term care. The association between frailty indices and postoperative outcomes has been shown to be important in a variety of medical and surgical specialties (18). Within orthopaedics, very little research has been performed on frailty in association with morbidity and mortality, and the available studies are limited to the hip fracture population (19-24). The purpose of this study is to perform a critical evaluation of frailty and its relationship with mortality and postoperative complications in orthopaedic trauma patients.

METHODS

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) is a national database of surgical data collected from participating hospitals. The database contains 136 variables that include demographic information, preoperative risk factors and postoperative outcomes (25). This data is collected and verified by a certified clinical nurse at each participating site. NSQIP participant use file from 2005-2014 were queried to identify patients age 60 and above undergoing surgery for pelvic, acetabular, and lower extremity orthopaedic trauma based on Current Procedural Terminology (CPT) codes.

From the original Canadian Study of Health and Aging Frailty Index (CSHA-FI), 11 variables were matched to 16 variables available in the NSQIP database (Figure 1) (26). The 11 variables evaluated were history of diabetes mellitus, congestive heart failure, hypertension requiring medications, myocardial infarction, percutaneous coronary intervention and/or stenting or angina, transient ischemic attack and cerebrovascular accident, cerebrovascular accident with neurologic deficit, impaired sensorium, chronic obstructive pulmonary disease or pneumonia, peripheral vascular disease or rest pain, and functional status index. Functional status index assesses patient's ability to perform activities of daily living (ADLs) 30 days before surgery. ADLs include bathing, feeding, dressing, toileting, and mobility. 'Independent' status is defined as no assistance required from another person for any ADLs, 'partially dependent' requires some assistance from another person, and 'totally dependent' requires total assistance for all ADLs. All variables were dichotomous (present or absent) except for functional status index, which was recoded into independent and partially/totally dependent. The modified frailty index (MFI) score was calculated by summing the number of variables present for each patient and then dividing by the total number assessed (n/11, range 0.0 to 1.0). MFI score of 0 was used as the reference category.

From the NSQIP database, thirty-day mortality and postoperative complications were identified. Primary outcome of interest was thirty-day mortality. Secondary outcomes analyzed were thirty-day reoperation, readmission, and Clavien-Dindo grade IV complications which included cardiac arrest, myocardial infarction, septic shock, pulmonary embolism, renal failure, reintubation, and failure to wean. These variables were accessible in the NSQIP database and were consistent with the definition of grade IV classification as life-threatening complications with organ dysfunction. Complications were also analyzed by organ system and included thirty-day rates of infections (surgical site infection including superficial, deep, and organ space infection), wound occurrences (wound infection plus dehiscence), cardiac complications (myocardial infarction and cardiac arrest), pulmonary complications (pulmonary embolism and pneumonia), hematologic complications (deep vein thrombosis), renal complications(acute renal failure), and any occurrence (all adverse events documented in NSQIP except mortality). Adverse discharge was defined as any discharge to non-home location. Total length of hospital and intensive care unit stay was also examined in relation to MFI.

To determine MFI's effectiveness in predicting mortality and complications, we compared the effect of increasing MFI on outcomes with the American Society of Anesthesiologists physical classification system (ASA class), wound class, and age. These other variables have been demonstrated to be effective predictors of thirty-day mortality. ASA class 1 includes healthy patients, class 2 is patients with mild systemic disease, class 3 is patient with severe systemic disease, class 4 is patient with severe systemic disease that is a constant threat to life, and class 5 are moribund patients not expected to survive without operation. Wound classes included: class I (clean without infection nor inflammation), class II (clean-contaminated), class III (contaminated), and class IV (dirty-infected).

Analyses using simple logistic regression and chi square test were performed to compare rates of mortality, reoperation, readmission, complications, and length of stay across the MFI score. Multivariable logistic regressions were then used to assess predictors of thirty-day mortality, reoperation, readmission, and Clavien-Dindo IV complications. The first regression model included MFI and demographic variables (age, gender, race, and BMI) while the second model included MFI, demographics, and variables deemed significant from the univariate analysis. ASA, wound classifications, and MFI scores were analyzed as categorical variable with ASA class I, wound class I, and MFI score 0 designated as the reference groups. All analyses were done using SAS 9.4 (Cary, NC) and a $p<0.05$ was considered significant.

RESULTS

From the NSQIP database, 36,242 patients were identified from 2006-2014. In the cohort, 10,073 (27.8%) were male and the mean age was 79.5 years (±9.3 years) (Table 1). The majority of the patients were white (29,164, 80.5%) and had normal weight, BMI 18.5-24.9 (15,310 42.2%). The injuries sustained included hip (27,638, 76.3%), ankle (3,878, 10.7%), knee (2,454, 6.8%), femur (1,396, 3.9%), tibia (560, 1.5%), and pelvis and acetabulum (316, 0.9%). MFI scores ranged from 0 to 0.45+ with a mean MFI score of 0.12 (±0.09) (Figure 2). Most patients in the cohort had an MFI score of 0.09 (14,823, 40.9%).

As MFI increased from 0 (no frailty-associated variables) to 0.45 (5 of 11 variables) or higher, thirty-day mortality increased in a stepwise fashion from 2.7% to 13.2% ($p<0.001$) (Table 2). Readmission increased from 5.5% at MFI score of 0 to 18.8% at MFI of 0.45 ($p<0.001$). Similarly, reoperation rates increased from 2.0% at MFI of 0 to 3.3% at MFI of 0.45 with a peak reoperation rate at 3.6% at MFI of 0.27. Clavien-Dindo class IV complications increased with increasing MFI from 2.3% to 11.9% ($p<0.001$) while rate of any complication increased from 30.1% to 38.6% at MFI of 0 and 0.45 ($p<0.001$), respectively. In looking at complications by systems, there were higher rates of cardiac, pulmonary, and renal complications associated with increasing MFI. There was no association between increasing MFI and hematologic complications ($p=0.93$). Frailty was also associated with adverse hospital discharge as patients with MFI 0.45+ had an 8.6 OR of being discharged to location other than home compared to MFI of 0 (95% CI: 4.0-18.4, $p<0.001$).

Frailty was also associated with longer length of stay for overall hospitalization and intensive care units. Hospital length of stay increased from 5.3 days (±5.5 days) in an MFI of 0 to 9.1 days (±7.2 days; $p<0.001$) in an MFI of 0.45+. ICU stay increased from 4.0 days (±4.3 days) to 8.0 days (±5.2 days; $p<0.01$) between MFI score 0 and 0.45+ (Figure 3).

Multivariate analysis showed that MFI maintained a strong association with thirty-day mortality even after adjusting for demographic variables and length of stay, operative time, type of injury, and occurrence of complications (Table 3). Mortality had a higher odds ratio with MFI at 0.45+ (aOR 2.6, 95% CI: 1.7 -3.9, p<0.001) than with ASA (aOR 2.5, 95% CI: 2.3-2.7, p<0.001) and age (aOR: 1.1, 95% CI: 1.1-1.1, p<0.001). Analysis for thirty-day readmission further adjusted for discharge destination of patient and showed that MFI had higher odds ratios in thirty-day readmission compared to ASA and age as MFI 0.45+ had a 2.9 aOR (95% CI 1.7-4.8, p<0.001) while ASA and age had a 1.40 aOR (95% CI: 1.3-1.5, p<0.001) and 1.00 aOR (95% CI: 1.0-1.01, p=0.853), respectively (Table 4). Patients who were discharged to skilled facility had a 1.3 aOR (95% CI: 1.1-1.5, p=0.001) of readmission compared to those discharged home. Similarly, patients discharged to rehab compared to those discharged home had increased odds of being readmitted to the hospital (aOR 1.3, 95% CI: 1.1-1.5, p=0.004).

In considering significant predictors of clavien-dindo type IV complications, MFI of 0.45+ had an aOR of 2.9 (95% CI: 1.9-4.6, p<0.001) followed by ASA classification (aOR 1.5, 95% CI: 1.3-1.6) and age (aOR 1.02, 95% CI: 1.01-1.02, p<0.001) (Table 5).

DISCUSSION

With an increasing elderly and co-morbid trauma population in the United States, tools that can accurately predict postoperative complications and mortality are needed to counsel patients on risk, and help direct inter-disciplinary perioperative care. The results of this study demonstrate that the modified frailty index had strong association with mortality, post-operative complications, and hospital/ICU length of stay in patients age 60 and above with orthopaedic injuries of the pelvis and lower extremity.

Frailty has only been recently recognized in the surgical literature; the term frailty did not appear as a title word in a major surgical journal until a letter to the editor in 2006, and the first surgical publication was in 2009 (27-28). Frailty can be conceptualized as an age-related, multi-dimensional state of decreased physiologic reserve that results in diminished resiliency and increased vulnerability to stressors, and has been introduced as a diagnosis of "unsuccessful aging". The precise cause and physiology of frailty are not fully understood – it is unclear if it is a distinct pathophysiological process or if it is incumbent to the aging process.

Despite a generally agreed upon definition and conceptualization of frailty as a distinct diagnosis, some disagreement exists on which tool is best to assess frailty. Two of the most commonly cited tools for assessing frailty are the phenotypic definition and the accumulation of deficits definition (29-30). In the phenotypic definition, the presence of five factors is assessed: unintentional weight loss (> 4.5 kg in 1 year), weakness (maximal grip strength), slowness (walking speed assessment), self-reported exhaustion, and low physical activity. Scores of 0 indicate robustness, 1 or 2 indicate pre-frail, 3 or greater indicate frail. Utilizing a phenotypic definition is difficult in a trauma population, in which weakness and slowness cannot be accurately tested in a majority of injured states. In the accumulation of deficits definition, also known as the frailty index (FI), 30 to 70 dichotomized deficits are examined, including co-morbidities, level of function on activities of daily living, and signs from physical and neurological examination. The deficits present are recorded and scaled to the number of deficits screened. FI was found to be more predictive of mortality than age in community dwellers (31). Further studies have shown that a modified frailty index can be calculated with as few as ten variables assessing medical history and function (32-33).

There have been very few studies examining frailty in orthopaedic trauma patients, and the published studies are limited to the hip fracture population (34-39). Published studies in other surgical specialties have shown robust correlations between frailty and poor surgical outcomes, including serious complications, prolonged length of stay, need for discharge to a care facility, hospital readmission, 30-day mortality, and long-term mortality (40-44). Even though frailty is highly correlated with age, frailty in a younger age range (over age 50) has been shown to be associated with more adverse effects in an intensive care population, with higher rates of nosocomial infections and re-intubation, greater in-hospital and ICU length of stay, and increased in-hospital and one-year mortality (45).

Using a modified frailty index, our study found that 41% of the 36,242 patients in the NSQIP database with pelvic and acetabular injuries had an MFI around 0.09 (1 deficit out of 11 assessed). With increasing MFI scores, there was a stepwise increase in mortality risk, with multivariate analysis demonstrating an adjusted odds ratio for mortality of 2.6 when MFI is 0.45+, significantly increased when compared to age (aOR 1.1). Similarly, pulmonary and cardiac in-hospital complications increased 4-fold as MFI increased from 0 to 0.45. In addition, there was an increasing linear trend in both ICU and hospital length of stays with increasing MFI scores. Of all of the possible complications assessed, frailty was not associated with increasing rates of reoperation or hematologic complications. This could be explained by the fact that more frail patients may be less likely to be subjected to reoperations due to surgeon preference or other post-operative complications, thus introducing a selection bias in analysis.

Risk assessment tools in orthopedic surgical patients

The American Society of Anesthesiologist (ASA) physical status classification system has been commonly used to grade preoperative physical health of patients. This classification divides patients into categories based on severity of their diseases ranging from Class I which included normal healthy patient to class IV which had patients with severe systemic disease that is a constant threat (46). Correlation of ASA classifications with postoperative complications and mortality have been extensively studied in general surgery since implementation of the classification in 1963 (47-51). Specifically in orthopedic surgery, ASA scores have been shown to be significant predictors of postoperative delirium and death in geriatric total hip and total knee arthroplasty (52-53). However, application of this score has shown inconsistencies in interrater reliability due to vague definitions and broad categorizations that do not accurately reflect differential risk of patients (54-57).

In addition to ASA, the utility of comorbidity scales in predicting postoperative outcomes has been investigated in orthopedic literature. The Charlson Comorbidity Index is a commonly used scale that assesses 19 weighted comorbid conditions to quantitatively predict primarily survival and extended to predict functional outcome, length of stay, implant longevity, and resource use (58-62). While this index has been validated and shown high reliability, the measure is sensitive to life threatening conditions and does not account for functional outcomes (63-66). Other prognostic indexes such as the Orthopaedic Multidimensional Prognostic Index (Ortho-MPI) have been developed; however these indices may have limited application to a specific subset of patients such as the elderly with only hip or femur fractures (67).

Comparatively the frailty index presents a comprehensive assessment of risk outcome that takes into consideration both physical and functional characteristics that are independent of age. For this reason, the frailty index can be appropriately applied to the wide demographic of patients who suffer from orthopaedic trauma. The use of frailty index also provides an individualized risk assessment that can be quickly calculated based on routinely collected information by any care provider in the clinical setting. Although the comprehensive frailty index based on the original CSHA study included nearly 70 variables, a modified index has been proven to be as effective with as few as 11 variables, thus simplifying the assessment process and allowing for flexibility based on available data points (68). The continuous scale of the index also allows dynamic tracking of changes in patient outcome over time that is not inherently possible with other static risk assessment tools.

Strengths and weaknesses

With over 30,000 cases, our current study sample size provided sufficient power to determine statistical significance. This study utilizes the NSQIP database which has a standardized process of prospectively collecting data with trained nurses to ensure quality data collection. Our study is also one of the few studies that have applied the MFI and concept of frailty to orthopaedic trauma patients in association with postoperative outcomes as well as lengths of stay.

The retrospective cohort design characteristic of database studies presented certain limitations in our study. Although the NSQIP database has dedicated data collection teams, there is still unavoidable missing data and data input issues. Moreover, the database collects information from participating hospitals which may not fully represent national trends. Further studies can prospectively apply the MFI scores to predict patient outcomes and compare the relationship between the MFI index with other frailty indices.

Implications of study

With a burgeoning elderly population that is more likely to sustain orthopaedic trauma, there is an important need for a comprehensive and dynamic risk assessment tool to improve outcomes when these patients are admitted for care. While we have shown that the MFI is effective in determining postoperative complications, the individualized score can be used to guide perioperative care in an interdisciplinary team setting. As each component of the frailty index addresses a specific clinical or functional deficit, specialty teams can be involved as necessary to address these issues. Moreover, the scale design of the MFI allows for dynamic tracking of each patient's health which can be used for targeted counseling and risk stratification. Patients can be shown the variables within the index that can be adjusted to subsequently reduce their frailty score and thus correspondingly their risk of postoperative complications. The application of this proactive patient counseling not only reduces risk of postoperative complications but also targets interventions to decrease the associated high cost burden to the healthcare system. Additional research will be necessary to externally validate the MFI as a risk assessment tool and to directly compare it to other orthopaedic comorbidity scales.

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TABLES

TABLE 1. DEMOGRAPHICS	
Variable	**N (%)**
N	36,242
Gender	
Male	27.8
Female	72.2
Age (mean, SD), years	79.5 (9.3)
Race	
Caucasian	80.5
Black of African American	3.6
Asian, Native Hawaiian or Pacific Islander	2.7
American Indian or Alaska Native	0.5
Unknown	12.8
BMI (mean, SD), kg/m^2	25.9 (6.6)
Underweight (<18.5)	7.9
Normal weight (18.5-24.9)	42.2
Overweight (25.0-29.9)	29.2
Obese (30.0-34.9)	12.4
Severely obese (35.0-39.9)	4.9
Morbidly obese (≥40.0)	3.4
ASA Class	
1-Normal healthy	1.3
2-Mild systemic disease	21.5
3-Severe systemic disease	60.9
4-Severe systemic disease with threat to life	16.3
5-Critically ill	0.1
Wound classification	
I-Clean	98.0
II-Clean, contaminated	1.2
III-Contaminated	0.5
IV-Dirty	0.3
Region of injuries	
Hip	76.3
Ankle	10.7
Knee	6.8
Femur	3.9
Tibia	1.5
Pelvic and acetabular	0.9

TABLE 2. Rate of outcome with increasing MFI score

Outcome	Overall	MFI Score						P value
		0 (n=7087)	0.09 (n=14,823)	0.18 (n=9,857)	0.27 (n=3,270)	0.36 (n=886)	0.45+ (n=319)	
	%	%	%	%	%	%	%	
Mortality	4.8	2.7	3.8	5.7	8.8	10.1	13.2	<0.001
Readmission	8.5	5.5	7.6	10.1	14.3	14.2	18.8	<0.001
Reoperation	2.6	2.0	2.6	2.8	3.6	2.1	3.3	<0.001
Any complication	37.7	30.1	37.6	41.5	42.7	40.9	38.6	<0.001
Clavien-Dindo IV Complications	4.1	2.3	3.2	4.9	6.8	10.3	11.9	<0.001
Infection	1.3	1.1	1.2	1.4	2.0	1.8	1.9	0.006
Wound	0.5	0.3	0.5	0.5	1.1	0.5	0.9	<0.001
Cardiac	2.0	0.9	1.6	2.4	3.8	4.6	5.6	<0.001
Pulmonology	3.4	2.1	2.8	4.2	5.0	7.1	6.9	<0.001
Hematology	1.2	1.1	1.2	1.3	1.2	1.5	1.6	0.927
Renal	0.3	0.2	0.2	0.4	0.6	1.2	1.3	<0.001

TABLE 3. 30-day Mortality Association with MFI

	Crude OR	95% CI	Model 1	95% CI	Model 2	95% CI
MFI						
0	Ref	--	Ref	--	Ref	--
0.09	1.45	1.22-1.71	1.22	1.01-1.46	1.00	0.83-1.20
0.18	2.23	1.89-2.64	1.89	1.57-2.27	1.30	1.08-1.57
0.27	3.52	2.91-4.25	2.96	2.41-3.64	1.81	1.46-2.24
0.36	4.10	3.15-5.33	3.55	2.66-4.73	1.94	1.44-2.62
0.45+	5.56	3.90-7.94	5.02	3.38-7.43	2.56	1.71-3.85
Age			1.08	1.07-1.09	1.06	1.05-1.07
ASA					2.48	2.25-2.73

Model 1: adjusted for age, sex, race, BMI

Model 2: adjusted for age, sex, race, BMI, total length of stay, operative time, region of injury, any occurrence of complication

TABLE 4. 30-day Readmission Association with MFI

	Crude OR	95% CI	Model 1	95% CI	Model 2	95% CI
MFI						
0.00	Ref	--	Ref	--	Ref	--
0.09	1.40	1.24-1.59	1.25	1.10-1.43	1.11	0.97-1.27
0.18	1.92	1.69-2.19	1.75	1.53-2.01	1.41	1.23-1.63
0.27	2.85	2.43-3.34	2.56	2.16-3.03	1.96	1.64-2.33
0.36	2.82	2.11-3.78	2.57	1.89-3.50	1.81	1.31-2.49
0.45+	3.96	2.46-6.37	3.74	2.30-6.07	2.87	1.72-4.80
Age			1.02	1.01-1.02	1.00	1.00-1.01
ASA					1.40	1.30-1.51
Discharge destination						
Home					Ref	--
Skilled care					1.28	1.10-1.48
Rehab					1.27	1.08-1.50

Model 1: adjusted for age, sex, race, BMI

Model 2: adjusted for age, sex, race, BMI, total length of stay, operative time, region of injury, any occurrence of complication, discharge destination

TABLE 5. Clavien-Dindo Complications Association with MFI							
		Crude OR	95% CI	Model 1	95% CI	Model 2	95% CI
MFI							
	0.00	Ref	--	Ref	--	Ref	--
	0.09	1.43	1.19-1.71	1.39	1.13-1.69	1.23	1.01-1.51
	0.18	2.21	1.84-2.64	2.04	1.67-2.49	1.60	1.30-1.97
	0.27	3.10	2.52-3.81	2.88	2.29-3.61	1.98	1.56-2.52
	0.36	4.89	3.75-6.39	4.53	3.37-6.07	2.96	2.18-4.02
	0.45+	5.78	3.98-8.39	5.33	3.55-8.00	2.97	1.94-4.55
Age				1.02	1.02-1.03	1.02	1.01-1.02
ASA						1.45	1.31-1.61

Model 1: adjusted for age, sex, race, BMI

Model 2: adjusted for age, sex, race, BMI, total length of stay, operative time, region of injury

FIGURES

FIGURE 1. Canadian Study on Health and Aging Frailty Index mapped to NSQIP modified frailty index

CSHA-FI	NSQIP	MFI Variable
History of diabetes mellitus	Diabetes mellitus—non-insulin Diabetes mellitus—insulin Diabetes mellitus—oral	1
Congestive heart failure	Congestive heart failure within 30 days before surgery	2
Hypertension requiring medication	Hypertension requiring medication	3
Myocardial infarction	History of myocardial infarction within past 6 months before surgery	4
Cardiac problems	Previous percutaneous coronary intervention Previous cardiac surgery History of angina within 1 month before surgery	5
Cerebrovascular problems	History of transient ischemic attack Cerebrovascular accident with no neurologic deficit	6
History of stroke	Cerebrovascular accident or stroke with neurologic deficit	7
Clouding or delirium History relevant to cognitive impairment or loss Family history relevant to cognitive impairment	Impaired sensorium	8
Lung problems	History of COPD Pneumonia	9
Decreased peripheral pulses	History of revascularization or amputation for peripheral vascular disease Rest pain or gangrene	10
Changes in everyday activity Problems with getting dressed Problems with bathing Problems with carrying out personal grooming Problems with cooking Problems with going out alone	Functional health status before surgery-partially dependent Functional health status before surgery-totally dependent	11

FIGURE 2. MFI distribution in patients with pelvis and lower extremity injuries.

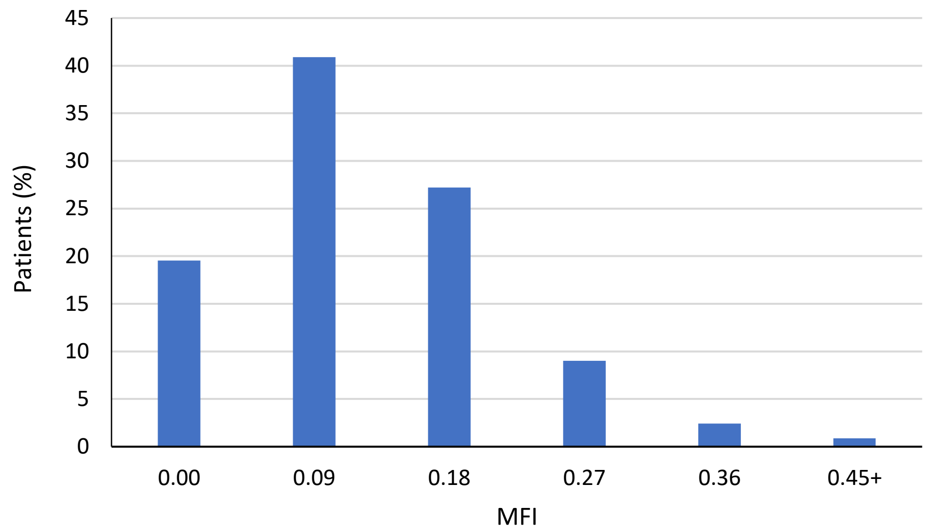

FIGURE 3. Length of stay by MFI score