Loss of Ambulatory Level and Activities of Daily Living at 1 Year Following Hip Fracture: Can We Identify Patients at Risk?

Sanjit R. Konda, MD[1,2] , **Nicket Dedhia, BA**[1],
Rachel A. Ranson, MS[1], **Yixuan Tong, BA**[1],
Abhishek Ganta, MD[1,2], and **Kenneth A. Egol, MD**[1,2]

Abstract

Introduction: Operative hip fractures are known to cause a loss in functional status in the elderly. While several studies exist demonstrating the association between age, pre-injury functioning, and comorbidities related to this loss of function, no studies have predicted this using a validated risk stratification tool. We attempt to use the Score for Trauma Triage for Geriatric and Middle-Aged (STTGMA) tool to predict loss of ambulatory function and need for assistive device use. **Materials and Methods:** Five hundred and fifty-six patients ≥55 years of age who underwent operative hip fracture fixation were enrolled in a trauma registry. Demographics, functional status, injury severity, and hospital course were used to determine a STTGMA score and patients were stratified into risk quartiles. At least 1 year after hospitalization, patients completed the EQ-5D questionnaire for functional outcomes. **Results:** Two hundred and sixty-eight (48.2%) patients or their family members responded to the questionnaire. Of the 184 patients alive, 65 (35.3%) reported a return to baseline function. Eighty-nine (48.4%) patients reported a loss in ambulatory status. Patients with higher STTGMA scores were older, had more comorbidities, reported greater need for help with daily activities, increased difficulty with self-care, and a reduction in return to activities of daily living (all p ≤ 0.001). Patients with lower STTGMA scores were more likely to never require an assistive device while those with higher scores were more likely to continue needing one (p = 0.004 and p < 0.001). Patients in the highest STTGMA risk groups were 1.5x more likely to have an impairment in ambulatory status (need for ambulatory assistive device or decreased ambulatory capacity) (p = 0.004). **Discussion:** Patients in higher STTGMA risk quartiles were more likely to experience impairment after hip fracture surgery. The STTGMA tool can predict loss of ambulatory independence following hip fracture. At-risk populations can be targeted for enhanced physiotherapy and rehabilitation services for optimal return to prior functioning.

Introduction

Hip fractures are among the most common fracture types with over 250,000 occurring annually in the United States accounting for 14% of all fractures nationally.[1] Nationally, the number of hip fractures is projected to increase to 840,000 by the year 2040.[2,3] The elderly are disproportionately affected by hip fractures and have a high rate of associated mortality following this injury.[4]

For those that survive their hip fracture and initial hospitalization, loss of function remains one of the greatest hurdles to overcome as they continue to maintain their activities of daily living (ADLs) and attempt to regain their previous functional status.[5] Older patients who sustain a hip fractures report

poorer physical and emotional health outcomes well after their injury and many report never reaching their baseline

[1] Division of Orthopedic Trauma Surgery, Department of Orthopedic Surgery, NYU Langone Health, NYU Langone Orthopedic Hospital, New York, NY, USA
[2] Department of Orthopaedic Surgery, Jamaica Hospital Medical Center, Queens, NY, USA

Corresponding Author:
Sanjit R. Konda, Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, 301 East 17th Street, New York, NY 10003, USA.
Email: sanjit.konda@nyulangone.org

functional status.[6-8] Use of an assistive device, in particular, is prevalent in the elderly; two-thirds of the 6.1 million adults in the United States that use assistive devices are over the age of 65 years old.[9]

The Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA) is a validated risk stratification tool that predicts the risk of inpatient mortality in those presenting to the emergency department based on demographic information, injury severity, and pre-injury functional status.[10-16] The STTGMA tool has demonstrated success in stratifying hospital quality outcomes measures (length of stay, complications, and discharge location), inpatient cost, and long-term functional outcomes.[13-15,17]

The loss of function middle-aged and elderly patients experience following hip fracture has been studied in relation to pre-injury functional status.[8] Previous studies have demonstrated that patients with decreased ambulatory capacity prior to an operatively-treated hip fracture recover their functional status less often than those that are independent.[5,18,19] The purpose of this study was to determine whether an established mortality risk tool, calculated at presentation to the emergency department, could predict loss of ambulatory ability, need for assistive devices, and increased requirement for assistance at least one year after operative fixation following a hip fracture.

Methods

In this retrospective cohort study using prospectively collected data, 556 patients 55 years of age and older with a femoral neck, intertrochanteric, or subtrochanteric hip fracture (AO/OTA classification 31A, 31B, and 32(A-C).1) who presented to one urban academic medical center (consisting of one tertiary care referral center, one level 1 trauma center, and one orthopedic specialty hospital) and were treated with either arthroplasty (total hip replacement, hemiarthroplasty) or internal fixation (closed reduction and percutaneous pinning, sliding hip screw, or cephalomedullary nail) between 2014 and 2019 were prospectively enrolled into a database for geriatric and middle-aged patients presenting with orthopedic trauma. Patient demographic information, injury type and severity, hospital quality metrics, major and minor complications, and one year functional outcomes including mortality were recorded. Inclusion criteria included patients 55 years of age or older that presented acutely for traumatic hip fracture and operative fixation. Patients were excluded if they were under the age of 55, experienced periprosthetic fracture, or experienced subacute traumatic injury.

Demographic information collected included age, sex, and comorbidities as measured by the Charlson comorbidity index (CCI), a weighted range of comorbidities between zero and 24 that progressively increases with additional chronic conditions. Mechanism of injury was recorded as low energy (ground level fall or fall < 2 stairs) or high energy (fall $\geq$ 2 stairs, pedestrian struck, motor vehicle or motorcycle accident). Hospital quality metrics included length of stay, occurrence of major and minor complications, 30-day readmission rate, and discharge

location. Major complications were defined as development of sepsis, pneumonia, DVT/PE, myocardial infarction, stroke, acute respiratory failure, or cardiac arrest. Minor complications were defined as development of acute renal failure, surgical site infection, decubitus ulcer, UTI, and acute blood loss anemia. Patients were followed prospectively for at least one year, after which contact was attempted by telephone at least five times within three weeks of the date of one-year follow-up to administer the EQ-5D questionnaire which measures functional outcomes including questions rating current mobility, self-care, usual activities, pain/discomfort, and anxiety/depression on a scale of 1 to 3. Additionally, patients reported if they felt they had returned to their baseline level of functioning, whether they required a new assistive device, whether they had a new need for help with their activities of daily living (ADLs), and whether they required a new home health aide after their operatively treated hip fracture. The need for an assistive device or the loss of ambulatory capacity were combined into one metric, encumbrance, related to overall ambulatory function. Patients were considered lost to follow-up if they did not answer any phone call or their phone number was out-of-service.

The STTGMA score was calculated based on a patient's injury severity (Glasgow Coma Scale, Abbreviated Injury Severity score, and mechanism of injury), current health status (CCI, use of anticoagulation medication, and albumin levels), and pre-injury functional status (ambulatory capacity and use of an assistive device) were recorded.[11] Ambulatory capacity was stratified in three groups: community ambulator, household ambulator, or non-ambulatory with inclusion criteria into each of these groups comprising any ability to ambulate in that specific capacity either independently or with assistance. Assistive device was recorded in binary fashion, with inclusion criteria into each of these groups comprising any use of an assistive device for ambulation including use of a cane, walker, or wheelchair. These variables were used to calculate the STTGMA score for each patient that predicts risk (0%-100%) of inpatient mortality during index hospitalization. Full description of the predictors utilized in the model can be found in a previous publication by this group.[11,12] Patients were then stratified into quartiles (Q) based on their STTGMA scores (Q1 minimal risk: $\leq$0.12%, Q2 low risk: 0.13%-0.20%, Q3 moderate risk:0.21-0.64%, and Q4 high risk: $\geq$0.65%).

Results

Two hundred and sixty-eight (48.2%) patients (or family members in the case of deceased patients) with operatively treated hip fractures were able to be reached by telephone at least one year after their index hospitalization. Eighty-four (31.3%) patients had died at an average of 366 days after discharge. Therefore, 184 patients were available for study analysis.

Ninety-five (51.6%) of patients sustained hip fractures of AO/OTA classification 31A, 77 (41.8%) of 31B, 10 (5.4%) of 32A, and two (1.1%) of classification 32C. Ninety (48.9%) patients were treated with intramedullary nails, 29 (15.8%) with sliding hip screw fixation, 38 (20.7%) with

Table 1. Demographics, Injury and Surgical Information, and Hospital Quality Measures Distributed by STTGMA Quartile.

	STTGMA Quartile					
	Q1 N = 46 0%-0.12%	Q2 N = 46 0.13%-0.20%	Q3 N = 46 0.21%-0.64%	Q4 N = 46 0.65%-100%	Total	p
Age (mean ± SD)	69.3 ± 8.5	80.1 ± 9.8	79.8 ± 9.3	83.9 ± 7.2	-	<0.001
Sex (% Female), n (%)	31 (67.4%)	36 (78.3%)	31 (67.4%)	31 (67.4%)	129 (70.1%)	0.584
CCI (mean ± SD)	0.2 ± 0.4	0.5 ± 0.6	1.3 ± 1.0	2.2 ± 1.5	-	<0.001
STTGMA Score (%) (mean ± SD)	0.1 ± 0.0	0.2 ± 0.0	0.4 ± 0.1	2.0 ± 2.2	-	<0.001
AO/OTA Classification						
31A	21 (45.7%)	20 (43.5%)	28 (60.9%)	26 (56.5%)	95 (51.6%)	0.273
31B	18 (39.1%)	24 (52.2%)	15 (32.6%)	20 (43.5%)	77 (41.8%)	0.282
32A	7 (15.2%)	2 (4.3%)	1 (2.2%)	0 (0%)	10 (5.4%)	0.007
32C	0 (0%)	0 (0%)	2 (4.3%)	0 (0%)	2 (1.1%)	0.108
Surgery Type						
IMN	23 (50.0%)	18 (39.1%)	26 (56.5%)	23 (50.0%)	90 (48.9%)	0.412
SHS	7 (15.2%)	6 (13.0%)	11 (23.9%)	5 (10.9%)	29 (15.8%)	0.334
HA	7 (15.2%)	13 (28.3%)	7 (15.2%)	11 (23.9%)	38 (20.7%)	0.310
THA	6 (13.0%)	4 (8.7%)	2 (4.3%)	1 (2.2%)	13 (7.1%)	0.181
CRPP	3 (6.5%)	5 (10.9%)	0 (0%)	6 (13.0%)	14 (7.6%)	0.090
Length of Stay (days), (mean ± SD)	5.8 ± 3.4	7.3 ± 4.6	7.8 ± 6.0	9.1 ± 5.4	-	0.017
Readmission (30 day), n (%)	2 (4.3%)	1 (2.2%)	3 (6.5%)	7 (15.2%)	13 (7.1%)	0.076
Need for ICU Care, n (%)	3 (6.5%)	5 (10.9%)	9 (19.6%)	6 (13.0%)	23 (12.5%)	0.293
Minor Complications, n (%)	18 (39.1%)	24 (52.2%)	22 (47.8%)	25 (54.3%)	89 (48.4%)	0.475
Major Complications, n (%)	1 (2.2%)	5 (10.9%)	10 (21.7%)	13 (28.3%)	29 (15.8%)	0.003
Discharge Home, n (%)	23 (50.0%)	12 (26.1%)	7 (15.2%)	5 (10.9%)	47 (25.5%)	<0.001

IMN – Intramedullary Nail; SHS – Sliding Hip Screw; HA – Hemiarthroplasty; THA – Total Hip Arthroplasty; CRPP – Closed Reduction and Percutaneous Pinning; CCI – Charlson Comorbidity Index; ICU – Intensive Care Unit.

hemiarthroplasty, 13 (7.1%) with total hip arthroplasty, and 14 (7.6%) with closed reduction and percutaneous pinning.

Compared to Q1, patients in the Q4 cohort were 14.6 years older (p < 0.001), had 11x higher CCI (0.2 ± 0.4 Q1 vs 2.2 ± 1.5 Q4) (p < 0.001), had 1.6x longer LOS (5.8 ± 3.4 Q1 vs 9.1 ± 5.4 Q4) (p = 0.001), experienced 13x more major complications (p = 0.003), and experienced a 4.6x decrease in home discharge after hospitalization (p < 0.001) (Table 1). They additionally had a 2x increased need for ICU-level care although this was not significantly different between groups (p = 0.485). These differences are congruous with previously published literature using the STTGMA score for risk stratification.[2,13-16]

Of the 184 patients alive at the time of phone follow-up, 65 (35.3%) patients reported a subjective return to baseline functioning. When stratified by risk group, those with higher STTGMA risk scores reported a 2.6x greater need for help with daily activities (p = 0.001). Patients with the highest-risk STTGMA scores in Q4 reported a 1.7x increase in difficulty with self-care and 1.4x decrease in return to usual activities of daily living (p < 0.001 and p = 0.001, respectively). Compared to Q1, Q4 patients had a 2x increased need for home health aide, although this was not significantly different between quartiles (p = 0.160). There was no difference between groups with regard to self-reported pain and discomfort levels or feelings of anxiety and depression (all p > 0.05).

One hundred and eleven (60.3%) patients required no ambulatory assistive device prior to index hospitalization. However, at least one year after hospitalization, 65 (35.3%) of these patients reported a new need for an ambulatory assistive device. Those in the lowest STTGMA risk quartile (Q1) were 3.2x more likely to never need an assistive device (either before hospitalization or one year afterward) compared to those in Q4 (p = 0.004). Additionally, patients in Q4 were 6.5x more likely to continue requiring an assistive device after operative hip fracture repair that they had needed prior to their injury when compared to patients in Q1 (p < 0.001) (Table 2).

Of those alive at the time of follow-up, 148 (80.4%) patients were identified as community ambulators while 35 (19.0%) were household ambulators prior to hip fracture; this distribution is similar in composition to previous reports.[20,21] Eighty-eight (47.8%) patients reported a loss in ambulatory capacity of one level (decrease from community ambulator to household ambulator or household ambulator to non-ambulatory) and 7 (3.8%) patients reported a loss of two levels (decrease from community ambulator to non-ambulatory). Seventy-four (40.2%) reported no change and 15 (8.2%) reported an improvement of one level (Figure 1). There was no difference

Table 2. Changes in Functional Status Metrics Distributed by STTGMA Quartile.

		STTGMA Quartile					
		Q1 N = 46 0%-0.12%	Q2 N = 46 0.13%-0.20%	Q3 N = 46 0.21%-0.64%	Q4 N = 46 0.65%-100%	Total	p
Change in AS							
	Improve 1 level	6 (13.0%)	0 (0%)	3 (6.5%)	6 (13.0%)	15 (8.2%)	0.066
	No change	20 (43.5%)	24 (52.2%)	19 (41.3%)	11 (23.9%)	74 (40.2%)	**0.045**
	Loss of 1 level	19 (41.3%)	19 (41.3%)	22 (47.8%)	28 (60.9%)	88 (47.8%)	0.195
	Loss of 2 levels	1 (2.2%)	3 (6.5%)	2 (4.3%)	1 (2.2%)	7 (3.8%)	0.652
Need for NAD							
	Never need	19 (41.3%)	14 (30.4%)	7 (15.2%)	6 (13.0%)	46 (25.0%)	**0.004**
	Continued use	4 (8.7%)	10 (21.7%)	16 (34.8%)	26 (56.5%)	56 (30.4%)	**<0.001**
	New need	16 (34.8%)	20 (43.5%)	20 (43.5%)	9 (19.6%)	65 (35.3%)	0.053
Loss of AS *or* NAD (encumbrance)		26 (56.5%)	33 (71.7%)	39 (84.8%)	39 (84.8%)	137 (74.5%)	**0.004**
Loss of AS *and* NAD		13 (28.3%)	17 (37.0%)	21 (45.7%)	25 (54.3%)	76 (41.3%)	0.067

AS – Ambulatory Status; NAD – New Assistive Device.

between STTGMA risk groups for those that lost ambulatory capacity and those that either experienced no change or improvement (95 vs 89 patients, p = 0.273).

The two metrics, assistive device use and ambulatory capacity, were then combined into one metric (encumbrance) to examine the lasting effects of hip fracture. This metric was created as a cumulative measure of loss of function differentiating patients that experienced full return to function from those that did not. At one year following surgery, patients in the highest-risk Q4 group were 1.5x more likely to be encumbered in ambulation compared to the Q1 cohort (Table 2); 39 (84.8%) patients in the Q4 highest-risk group experienced either a decrease in their pre-injury ambulatory capacity or need for an assistive device at time of follow-up compared to 39 (84.8%) in the Q3, 33 (71.7%) in the Q2, and 26 (56.5%) in the Q1 minimal-risk group (p = 0.004) (Figure 2). Although not quite reaching significance, there was a clear trend toward patients in higher STTGMA quartiles having a 1.9x increase in impairment in both need for assistive device and decreased ambulatory capacity (p = 0.067).

Discussion

Loss of function in elderly patients following operative hip fracture fixation is burdensome but it is difficult to determine which patients may be most affected when they present with an acute hip fracture. In this study, the STTGMA tool, when applied using only information available upon admission, was effective in determining the loss of ambulatory independence as measured by both change in ambulatory capacity and need for assistive devices. When stratified by STTGMA score, patients with higher risk scores experienced a greater decline in overall functioning; they were more likely to require assistance with daily activities, more likely to have increased difficulty with self-care, and more likely to report a reduction in ability to perform their usual activities. Additionally, patients

with higher STTGMA risk scores were more likely to continue requiring use of an assistive device. Finally, those with higher STTGMA scores were more likely to be encumbered in ambulation when compared to those with lower STTGMA scores. These results demonstrate the utility of the STTGMA risk stratification tool in determining which patients have more difficulty with ambulation after their hip fracture.

The disability associated with hip fractures limits patient ADLs at the expense of their caretakers and the institutions that provide care for them.[5,22,23] As evidenced in this study, patients with higher STTGMA scores required more assistance with self-care and an increased inability to perform their usual activities. This comes at great social cost as well, including a higher incidence of depression and social isolation in the elderly with mobility limitations after hip fracture.[24,25] With early implementation of the STTGMA score to predict ambulatory independence, physicians and allied health professionals may be able to identify which patients may require higher utilization of services such as increased training for mobility aids and physical and occupational therapy so they may direct resources accordingly. Additionally, counseling of patients and their caregivers can be given early in their care regarding expectations for ambulatory independence based on the risk stratification generated in this study.

The level of encumbrance (as described above) encountered by patients at one year following surgery for their hip fracture was stratified well by STTGMA quartile. This provides very useful prognostic information that can aide the physician-patient-family interaction during the index hospitalization and at subsequent follow-up encounters. The STTGMA stratification of patients allows for more patient-specific prognostic information to be provided instead of generalized data for all-comers that may not be as accurate.

Compliance with assistive device use is directly correlated with patient expectations of device use during their initial hospitalization.[26] Patients that receive training for assistive device use
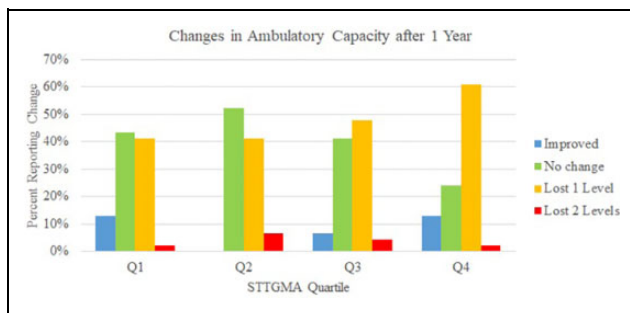
Figure 1. Distribution of patients experiencing loss or gain of ambulatory capacity one year after operative hip fracture (community ambulator, household ambulator, and non-ambulatory).
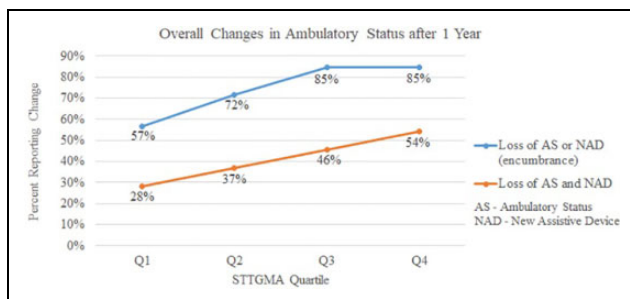

Figure 2. Overall changes in ambulatory status after 1 year.

report a greater ability to complete ADLs and report higher overall satisfaction.[27] By using the STTGMA tool to predict continued need for an assistive device, expectations can be set early during index hospitalization and subsequent follow-up visits so patients may have a more amenable outlook on assistive device use. Additionally, the duration of inpatient physical therapy has been demonstrated to predict functional improvement and functional status at discharge in patients with lower extremity orthopedic injury.[5] Early identification of patients predicted to have greater functional deficits, through use of the STTGMA score, could allow for concentrated inpatient and outpatient physiotherapy in an attempt to reduce loss of function in the long-term.

This study has several limitations including its retrospective nature, high loss to follow-up, and reliance on self-reported questionaries for outcomes. Another limitation of this study is the isolated timepoint of data collection approximately one year after surgery at which follow up data was collected. Previous studies have suggested that a majority of recovery after hip fracture occurs in the first six months and determining the change in function between 6 months and one year could provide further insight as to if an additional decline occurs.[5,7] Additionally, in this study there was no differentiation made between types of assistive device patients used at either initial or follow-up timepoints. While patients were queried regarding continued and new use of devices, it is possible that they may have progressed to a device that provides more assistance. While the data reported here is in terms of new and continued use of any assistive device, more specific conclusions cannot be generated based on assistive device type.

In conclusion, using the STTGMA tool to identify patients who may be most at risk for reductions in ambulatory ability following operative fixation of traumatic hip fracture may allow for strategies aimed at optimizing ambulation and return to ADLs in these patients. In addition, it gives the treating physician information to share with patients and families with regard to expectations for recovery of independence.

Author Notes

Declaration of Conflicting Interests

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ORCID iD

Sanjit R. Konda, MD https://orcid.org/0000-0001-8488-2677

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