

Modification of a Validated Risk Stratification Tool to Characterize Geriatric Hip Fracture Outcomes and Optimize Care in a Post-COVID-19 World

Sanjit R. Konda, MD,^{a,b} Rachel A. Ranson, MS,^a Sara J. Solasz, BA,^a Nicket Dedhia, BA,^a Ariana Lott, MD,^a Mackenzie L. Bird, BA,^a Emma K. Landes, BA,^{a,b} Vinay K. Aggarwal, MD,^{a,c} Joseph A. Bosco III, MD,^a David L. Furgiuele, MD,^d Jason Gould, MD,^d Thomas R. Lyon, MD,^e Toni M. McLaurin, MD,^{a,c} Nirmal C. Tejwani, MD,^{a,c} Joseph D. Zuckerman, MD,^a Philipp Leucht, MD, PhD,^{a,c} Abhishek Ganta, MD,^{a,b} and Kenneth A. Egol, MD,^{a,b} for the NYU COVID Hip Fracture Research Group

Objectives: (1) To demonstrate how a risk assessment tool modified to account for the COVID-19 virus during the current global pandemic is able to provide risk assessment for low-energy geriatric hip fracture patients. (2) To provide a treatment algorithm for care of COVID-19 positive/suspected hip fractures patients that accounts for their increased risk of morbidity and mortality.

Setting: One academic medical center including 4 Level 1 trauma centers, 1 university-based tertiary care referral hospital, and 1 orthopaedic specialty hospital.

Patients/Participants: One thousand two hundred seventy-eight patients treated for hip fractures between October 2014 and April 2020, including 136 patients treated during the COVID-19 pandemic between February 1, 2020 and April 15, 2020.

Intervention: The Score for Trauma Triage in the Geriatric and Middle-Aged ORIGINAL (STTGMA_{ORIGINAL}) score was modified by adding COVID-19 virus as a risk factor for mortality to create the STTGMA_{COVID} score. Patients were stratified into quartiles to demonstrate differences in risk distribution between the scores.

Main Outcome Measurements: Inpatient and 30-day mortality, major, and minor complications.

Results: Both STTGMA score and COVID-19 positive/suspected status are independent predictors of inpatient mortality, confirming their use in risk assessment models for geriatric hip fracture patients. Compared with STTGMA_{ORIGINAL}, where COVID-19 patients are haphazardly distributed among the risk groups and COVID-19 inpatient and 30 days mortalities comprise 50% deaths in the minimal-risk and low-risk cohorts, the STTGMA_{COVID} tool is able to triage 100% of COVID-19 patients and 100% of COVID-19 inpatient and 30 days mortalities into the highest risk quartile, where it was demonstrated that these patients have a 55% rate of pneumonia, a 35% rate of acute respiratory distress syndrome, a 22% rate of inpatient mortality, and a 35% rate of 30 days mortality. COVID-19 patients who are symptomatic on presentation to the emergency department and undergo surgical fixation have a 30% inpatient mortality rate compared with 12.5% for patients who are initially asymptomatic but later develop symptoms.

Conclusion: The STTGMA tool can be modified for specific disease processes, in this case to account for the COVID-19 virus and provide a robust risk stratification tool that accounts for a heretofore unknown risk factor. COVID-19 positive/suspected status portends a poor outcome in this susceptible trauma population and should be included in risk assessment models. These patients should be considered a high risk for perioperative morbidity and mortality. Patients with COVID-19 symptoms on presentation should have surgery deferred until symptoms improve or resolve and should be reassessed for surgical treatment versus definitive nonoperative treatment with palliative care and/or hospice care.

Key Words: hip fracture, COVID-19, coronavirus, risk stratification

Level of Evidence: Prognostic Level III. See Instructions for Authors for a complete description of Levels of Evidence.

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INTRODUCTION

In late 2019, the development of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2 or

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From the ^aDivision of Orthopaedic Trauma Surgery, Department of Orthopaedic Surgery, NYU Langone Health, NYU Langone Orthopaedic Hospital, New York, NY; ^bDepartment of Orthopaedic Surgery, Jamaica Hospital Medical Center, Queens, NY; ^cDepartment of Orthopaedic Surgery, Bellevue Hospital, New York, NY; ^dDepartment of Orthopaedic Surgery, NYU Winthrop Hospital, Mineola, NY; and ^eDepartment of Orthopaedic Surgery, NYU Langone Hospital-Brooklyn, Brooklyn, NY.

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Reprints: Sanjit R. Konda, MD, Department of Orthopaedic Surgery, NYU Langone Orthopaedic Hospital, 301 East 17th St, New York, NY 10003 (e-mail: Sanjit.Konda@nyulangone.org).

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COVID-19) began in Wuhan, China, and has continued to spread globally. As of May 24, 2020, the worldwide case burden is 5,204,508 cases with a death toll of 337,687 patients. In the United States, 1,568,448 cases have resulted in 94,011 deaths within the same period. Of these US cases and deaths, 195,452 (12.5%) and 16,469 (17.5%) are from the 5 boroughs of New York City.^{1,2}

Because most states enforced some form of social distancing during this period, there was a significant reduction in trauma-related injuries; however, geriatric low-energy falls resulting in hip fractures still occurred with frequency during this period. In this vulnerable population, a significant number of patients were at a risk for COVID-19 and many presented with signs and symptoms of this predominantly respiratory disease, which, more recently, has been found to affect multiple organ systems.^{3–5} Traumatic fracture in patients that is best treated with operative fixation have been considered essential surgery to optimize their functional outcome. However, there are little pre-existing data regarding their perioperative risk for increased morbidity or mortality in patients in need of essential surgery who are infected with this novel virus. Two recent studies have identified COVID-19 positive/suspected status an independent predictor of inpatient mortality in geriatric low-energy hip fracture patients.^{6,7}

The Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA) tool is a risk stratification tool that was created to predict inpatient mortality in a subset of trauma patients. To date, this tool has been demonstrated to predict mortality and hospital quality measures in a variety of trauma patients, including those with hip fractures.^{8–17} The purpose of this study is 2-fold as follows: (1) To demonstrate that modifying the STTGMA tool to account for the COVID-19 virus, a risk factor for inpatient mortality, improves the tool's ability to risk stratify low-energy hip fracture patients during a period where there is a novel and lethal virus without a vaccine and herd immunity has not been reached. (2) To develop a decision-making algorithm for operative versus nonoperative treatment of COVID-19 positive/suspected hip fracture patients based on STTGMA risk stratification, COVID-19 positive/suspected status, COVID-19 symptomatology on presentation, and complication risk profile as outlined by this study.

MATERIALS AND METHODS

Patient Characteristics

An Institutional Review Board approved geriatric trauma database was queried for any patient aged 55 and older who sustained a hip fracture through a low-energy mechanism of injury (defined as a fall from standing or from less than 2 stairs). Additional inclusion criteria for study analysis was presence of an intertrochanteric, femoral neck, or subtrochanteric hip fractures [OTA/AO fracture classification of 31A, 31B, and 32(A-C)]. Between October 2014 and January 2020, all patients were recruited from 1 of 4 hospitals within a single academic medical center. During the COVID-19 pandemic, patients were recruited from 2 additional hospitals within the same academic medical center. The time

frame for the pandemic was defined as February 1, 2020, onward. Although the first reported COVID-19 case in New York City was on March 1, there is growing evidence that the virus was prevalent in this community, and nationally, much earlier.^{18–22} Within the health system, which covers 3 of the 5 boroughs of New York City (Manhattan, Queens, and Brooklyn) and the neighboring region of Nassau County, Long Island, there are 4 American College of Surgeons-verified level one trauma centers, one tertiary care referral center, and one orthopaedic specialty hospital.

Patients were identified as COVID-19 positive if they had a positive COVID-19 RT-PCR test before, during, or within one week after hospitalization for their hip fracture. Patients were identified as COVID-19 suspected if they had signs and symptoms consistent with this virus but had a negative COVID-19 test or they presented before routine COVID-19 testing for symptomatic patients in our health system (March 15th). COVID-19 symptoms were recorded, including fever ($>100.5^{\circ}\text{F}$), cough, shortness of breath, nausea, vomiting, abdominal pain, diarrhea, headache, stroke, or seizure. Information regarding baseline demographics, injury status at presentation, and index hospitalization was retrospectively reviewed through electronic medical records. All patients that met inclusion criteria were included in the final study analysis. Demographic variables collected included patient age, race, preinjury ambulatory and functional status, and comorbidities as measured by the Charlson Comorbidity Index. Injury status comprised the Glasgow Coma Scale and Abbreviated Injury Severity (AIS) scores for the head and neck (AIS-HN), chest (AIS-C), and pelvis and extremity (AIS-EXT). Aside from race and AIS-EXT, these variables comprise the low-energy STTGMA_{ORIGINAL} score, which provides a percentage risk of inpatient mortality.

Hospital quality measures such as length of stay (LOS), need for intensive care unit (ICU) and stepdown unit level care, and discharge location were reviewed. Complications related to index hospitalization included acute renal failure, surgical site infection, decubitus ulcer, urinary tract infection, acute anemia, sepsis, pneumonia, acute respiratory failure, acute myocardial infarction, deep vein thrombus, pulmonary embolism, cardiac arrest, stroke, and inpatient mortality. All patients treated during the pandemic were followed for 30 days after discharge, and all other patients were followed for up to 1 year after discharge.

Statistical Analysis

A modified STTGMA-COVID inpatient mortality risk score (STTGMA_{COVID}) was created through a logistic regression analysis with inpatient mortality as the dependent variable and STTGMA_{ORIGINAL} score and COVID status (either positive/suspected or negative) as the independent variables. The score was created using all 1278 hip fracture patients those included the 136 patients that presented during the COVID-19 pandemic. The area under the receiver operating characteristic curve (AUROC) was calculated for STTGMA_{COVID}. Patients were stratified into quartiles (Q1 = minimal risk, Q2 = low risk, Q3 = moderate risk, and Q4 = high risk) based on their STTGMA_{COVID} score ranging from 0% to 100%. Comparative analyses were performed between

the COVID positive/suspected and COVID negative cohorts for demographic and injury characteristics using χ^2 , Fisher exact, and independent samples t tests where indicated. Descriptive analysis was used to compare the ability of STTGMA_{ORIGINAL} and STTGMA_{COVID} with risk stratify inpatient and 30 days mortality in the total patient cohort and in the COVID positive/suspected cohort. Statistical analyses were performed using SPSS software, version 25.

RESULTS

Between October 2014 and January 2020, 1142 patients ages 55 and older who sustained hip fractures [OTA/AO 31A, 31B, and 32(A-C)] through low-energy mechanisms were enrolled in a prospective orthopaedic trauma database (historical cohort). During the COVID-19 global pandemic period from February 1, 2020 to April 15, 2020, an additional 136 consecutive patients who met inclusion criteria were identified and enrolled in the database (pandemic cohort). A total of 1278 hip fractures were included in the study analysis. Of the 136 patients treated for hip fractures during the pandemic, 17 tested positive for COVID-19 and 14 were suspected to have contracted COVID-19 (total 31 COVID-19 positive/suspected). Note that this is the same cohort of patients on whom this group has previously reported.⁶ All demographic characteristics were similar between the pandemic and historical cohorts (Table 1). COVID positive patients were more likely to present with decreased ambulatory capacity ($P = 0.012$) compared with the historical control group. Head/neck, chest, and hip injury patterns, as well as surgical treatment did not differ between cohorts.

In the pandemic cohort, there were 5 (5/31, 16.1%) COVID-19 positive/suspected patients who were deemed too ill for immediate surgical intervention and were treated non-operatively. Four of the 5 (80%) patients had symptoms on presentation. Of these 5 patients, 2 (40%) expired during their inpatient hospitalization and both were symptomatic on presentation. Three patients (60%) were able to recover from their COVID-19 complications; one patient underwent an uneventful hemiarthroplasty at 2 weeks after admission, and 2 patients were treated definitively with nonoperative management. In comparison, 18 (18/1247, 1.4%) patients who were COVID negative were deemed too sick for operative intervention. Of these 18 patients, 1 (5.6%) patients expired during their index hospitalization, and 0 additional patients expired within 30 days of discharge of their index hospitalization.

The AUROC of the STTGMA_{COVID} logistic regression equation was found to be 0.809 (confidence interval: 0.733–0.885). Both STTGMA_{ORIGINAL} and COVID-19 positive/suspected status were identified as independent predictors of inpatient mortality ($P < 0.001$). Fig. 1 shows detailed characteristics of the independent variables, including the STTGMA_{COVID} logistic regression equation that predicts inpatient mortality.

STTGMA_{COVID} cutoff scores for quartiles were Q1: 0%–1.34%, Q2: 1.35%–1.46%, Q3: 1.47%–1.81%, and Q4: 1.82%–100%. Significant differences among risk groups were demonstrated for several complications (Table 2). Notably between Q1 and Q4, there was a 5.6× increased risk of sepsis/septic shock, 5.3× increased risk of pneumonia, 3.5× increased risk of acute renal failure/acute kidney injury, 1.8× increased risk of urinary tract infection, 3.6× increased risk of acute respiratory failure, 4.1× increased risk of cardiac arrest

TABLE 1. Population Characteristics

	COVID+/Suspected (N = 31)	COVID- (N = 1247)	P
Age	81.6 ± 9.6	81.6 ± 10.4	0.976
GCS	14.9 ± 0.3	14.9 ± 0.7	0.764
CCI	1.9 ± 1.7	1.45 ± 1.7	0.142
AIS-H	0.0 ± 0.0	0.04 ± 0.3	0.441
AIS-C	0.03 ± 0.2	0.02 ± 0.2	0.725
Ambulatory status*	1.58 ± 0.7	1.33 ± 0.5	0.012
Fracture pattern			0.046
Femoral neck	19 (61.3%)	511 (41%)	
Intertrochanteric	12 (38.7%)	653 (52.3%)	
Subtrochanteric	0 (0%)	83 (6.7%)	
Implant type			<0.001
Nonoperative	4† (12.9%)	18 (1.4%)	
Short IMN	8 (25.8%)	508 (40.7%)	
Long IMN	2 (6.5%)	170 (13.6%)	
Sliding hip screw	0 (0%)	89 (7.1%)	
Hemiarthroplasty	12 (38.7%)	286 (22.9%)	
Total hip arthroplasty	0 (0%)	79 (6.3%)	
CRPP	5 (16.1%)	97 (7.8%)	

Bold indicates significant differences between cohorts.

*Ambulatory status is categorized into 3 discrete levels. Community ambulators, household ambulators, and nonambulators are assigned to groups 1, 2, and 3, respectively.

†1 patient initially treated nonoperatively was subsequently treated with a hemiarthroplasty. This patient is reported in the hemiarthroplasty group.

CCI, Charlson Comorbidity Index; CRPP, closed reduction and percutaneous pinning; GCS, Glasgow Coma Scale; IMN, Intramedullary Nail.

STTGMA _{COVID} Variables	B-Coefficients	P-Values
STTGMA _{ORIGINAL} Score	15.301	<0.001
COVID-19 Status	2.645	<0.001
Constant	-4.459	<0.001

Risk of inpatient mortality = $1/(1+\text{EXP}(-(-4.459+15.301*[\text{STTGMA-ORIGINAL Score}] + 2.645*[\text{COVID-19 Status}])))$

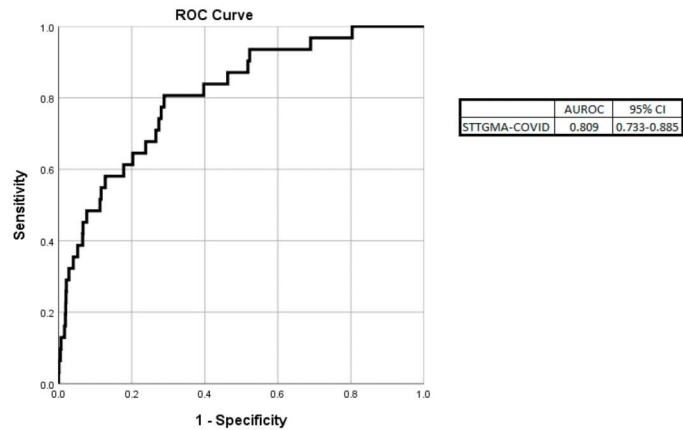


FIGURE 1. STTGMA_{COVID} score variables including B-coefficient and P values. Logistic regression equation is provided. The dependent variable is a risk of inpatient mortality and the independent variables are STTGMA_{ORIGINAL} score and COVID-19 status.

(Q2 vs. Q4), and a 22× increased risk of inpatient mortality. Significant differences among risk groups were demonstrated for all 3 hospital quality measures (Table 3). Notably between

Q1 and Q4, there was a 1.3× longer increased LOS, 4.3× increased need for ICU admission, and a 3.0× decrease in home discharge.

TABLE 2. Distribution of Inpatient Complications and Hospital Quality Measures Across Risk Stratified Quartiles for STTGMA_{COVID}

	Q1 (N = 320) Pandemic: N = 22 (C+/S = 0) STTGMA: 0–1.34%	Q2 (N = 319) Pandemic: N = 28 (C+/S = 0) STTGMA: 1.35–1.46%	Q3 (N = 320) Pandemic: N = 31 (C+/S = 0) STTGMA: 1.47–1.81%	Q4 (N = 319) Pandemic: N = 55 (C+/S = 31) STTGMA: 1.82–100%	P
Complications					
Sepsis or septic shock	3 (0.9%)	5 (1.6%)	6 (1.9%)	16 (5.0%)	0.003
Pneumonia	7 (2.2%)	8 (2.5%)	12 (3.8%)	37 (11.6%)	<0.001
Deep vein thrombus/ pulmonary embolism	3 (0.9%)	5 (1.6%)	9 (2.8%)	8 (2.5%)	0.294
Myocardial infarction	2 (0.6%)	5 (1.6%)	8 (2.5%)	9 (2.8%)	0.164
Acute renal failure/acute kidney injury	10 (3.1%)	21 (6.6%)	31 (9.7%)	35 (11%)	0.001
Stroke	0	0	3 (0.9%)	3 (0.9%)	0.110
Surgical site infection	0	0	0	1 (0.3%)	0.390
Decubitus ulcer	3 (0.9%)	8 (2.5%)	5 (1.6%)	5 (1.6%)	0.478
Urinary tract infection	24 (7.5%)	25 (7.8%)	32 (10%)	43 (13.5%)	0.041
Acute respiratory failure	8 (2.5%)	13 (4.1%)	16 (5%)	29 (9.1%)	0.001
Anemia	98 (30.6%)	110 (34.5%)	102 (31.9%)	106 (33.2%)	0.749
Cardiac arrest	0	3 (0.9%)	4 (1.3%)	13 (4.1%)	<0.001
Inpatient mortality	1 (0.3%)	3 (0.9%)	6 (1.9%)	21 (6.6%)	<0.001
Hospital quality measures					
LOS (d)	6.0 ± 4.0	6.4 ± 4.1	6.8 ± 3.8	8.0 ± 5.0	<0.001
Need for ICU	12 (3.8%)	33 (10.3%)	40 (12.5%)	52 (16.3%)	<0.001
ICU LOS (d)	4.5 ± 4.1	2.0 ± 1.0	2.3 ± 1.4	6.7 ± 6.6	0.298
Discharge home*	136 (42.6%)	53 (16.8%)	42 (13.4%)	43 (14.4%)	<0.001

*Excludes patients who died during their index hospitalization.

Subgroup analysis of the high-risk Q4 cohort comparing COVID-19 positive/suspected with COVID-19 negative patients (historical and pandemic cohorts) demonstrated that COVID positive/suspected patients had a 3.1× increased risk of septic shock, 7.9× increased risk of pneumonia, 5.6× increased risk of acute respiratory failure, 4.6× increased risk of inpatient mortality, and a 4.3× increased risk of 30 days mortality (Table 4).

The overall inpatient mortality and 30 days mortality rate for the entire 1278 hip fracture patients was 2.4% (31/1278) and 3.9% (50/1278), respectively. During the pandemic, the inpatient and 30 days mortality rates were 5.8% (8/136) and 12.5% (17/136), respectively. The COVID-19 negative inpatient and 30 days mortality rate during the pandemic was 0.7% (1/105) and 6.7% (6/105), respectively. The inpatient and 30 days mortality rate of the COVID-19 positive/suspected patients during the pandemic was 22.6% (7/31) and 35.5% (11/31), respectively. Thus, there was a 32× increased risk of inpatient mortality and 5.2× increased risk of 30 days mortality during the pandemic in COVID positive/suspected patients compared with COVID negative patients (Table 3). Of the 31 COVID-19 positive/suspected patients, 15 patients were symptomatic on presentation, and 5 (5/15, 33%) expired during their inpatient hospitalization. Ten symptomatic patients underwent operative fixation, and 3 (3/10, 30%) expired during their inpatient hospitalization. There were 16 asymptomatic COVID-19 positive/suspected patients all of which underwent operative fixation, and 2 (2/16, 12.5%) expired during their inpatient hospitalization.

COVID-19 positive/suspected status and COVID-19 mortalities were distributed haphazardly among risk quartiles when using the STTGMA_{ORIGINAL} score; however, when

using the STTGMA_{COVID} score all 31 (100%) of COVID-19 positive/suspected patients were triaged into the high-risk Q4. In addition, all COVID-19 positive/suspected mortalities, both inpatient and 30 days, were triaged to the high-risk Q4 (Table 3). Based on these results, we were able to confirm an algorithmic approach for COVID positive/suspected hip fracture patients (Fig. 2).

DISCUSSION

In this study, we modified a validated middle-aged and geriatric trauma mortality risk tool to account for a novel and deadly risk factor for mortality, the COVID-19 virus, in an elderly population of low-energy geriatric hip fractures. Results during the pandemic time frame covered by this study revealed that COVID positive/suspected patients have a 32× increased risk of inpatient mortality and 5.2× increased risk of 30 days mortality compared with COVID negative patients. The STTGMA_{COVID} tool is able to triage 100% of COVID-19 patients to the high-risk quartile in our limited patient sample. This allows for an opportunity to initiate early clinical pathways to optimize decision making in the perioperative period surrounding hip fracture treatment. In orthopaedics, diagnosis of COVID-19 infection has altered treatment practices and has necessitated alterations in clinical management.^{4,5,23,24} Our group has developed a high-risk Q4 COVID-19 positive/suspected hip fracture decision-making pathway based on the results of this study. Ultimately, COVID-19 positive/suspected patients are an extremely high-risk group of patients and surgical treatment of their fracture should be deferred until COVID-19 symptoms have started to improve or patients are asymptomatic.

TABLE 3. Distribution of Inpatient and 30 d Mortality Into Risk Quartiles Using STTGMA_{ORIGINAL} and STTGMA_{COVID} Scoring Tools

	Q1 (N = 320) Pandemic: N = 25 (C+/S = 4) STTGMA: 0–1.05%	Q2 (N = 319) Pandemic: N = 36 (C+/S = 7) STTGMA: 1.06–1.59%	Q3 (N = 320) Pandemic: N = 43 (C+/S = 12) STTGMA: 1.60–2.92%	Q4 (N = 319) Pandemic: N = 32 (C+/S = 8) STTGMA: 2.93–100%	P
Complications					
Mortality using STTGMA _{ORIGINAL}					
Inpatient mortality	2 (0.6%)	6 (1.9%)	6 (1.9%)	17 (5.3%)	0.001
Inpatient mortality due to COVID-19	1 (4.0%)	3 (8.3%)	0	3 (9.4%)	0.229
30-Day mortality	3 (0.9%)	7 (2.2%)	12 (3.8%)	28 (8.8%)	<0.001
30-Day mortality due to COVID-19	1 (4.0%)	4 (11.1%)	3 (7.0%)	3 (9.4%)	0.766
Complications					
Mortality using STTGMA _{COVID}					
Inpatient mortality	1 (0.3%)	3 (0.9%)	6 (1.9%)	21 (6.6%)	<0.001
Inpatient mortality due to COVID-19	0	0	0	7 (12.7%)	0.012
30-Day mortality	2 (0.6%)	3 (0.9%)	10 (3.1%)	35 (11%)	<0.001
30-Day mortality due to COVID-19	0	0	0	11 (20%)	0.001

TABLE 4. Subgroup Analysis of Complication and Hospital Quality Measure Profile for COVID-19 Positive/Suspected Versus COVID-19 Negative Patients in the High-Risk Q4 Cohort for Patients

Complication	COVID+/S, N = 31	COVID-, N = 288	P
Sepsis/Septic shock	4 (12.9%)	12 (4.2%)	0.058
Pneumonia	17 (54.8%)	20 (6.9%)	<0.001
Deep vein thrombosis/pulmonary embolism	2 (6.5%)	6 (2.1%)	0.177
Myocardial infarction	2 (6.5%)	7 (2.4%)	0.214
Acute kidney injury/acute renal failure	4 (12.9%)	31 (10.8%)	0.761
Stroke	0 (0%)	3 (1%)	1.000
Surgical site infection	0 (0%)	1 (0.3%)	1.000
Decubitus ulcer	0 (0%)	5 (1.7%)	1.000
Urinary tract infection	2 (6.5%)	41 (14.2%)	0.403
Acute respiratory failure	11 (35.5%)	18 (6.3%)	<0.001
Anemia	10 (32.3%)	96 (33.3%)	1.000
Cardiac arrest	2 (6.5%)	11 (3.8%)	0.366
Inpatient mortality	7 (22.6%)	14 (4.9%)	0.002
30-Day mortality	11 (35.5%)	24 (8.3%)	<0.001
Hospital quality measures			
LOS (d)	8.9 ± 6.8	7.9 ± 4.8	0.022
Need for ICU	6 (19.4%)	46 (16.0%)	0.628
ICU LOS (d)	9.6 ± 7.3	2.6 ± 1.5	0.065
Discharge home*	3 (12.5%)	40 (14.5%)	0.784

Bold denotes significant values.

*Discharge home excludes mortalities therefore the N value for COVID+/S is 24 and COVID- is 275.

+, positive; S = suspected; -, negative.

Patients with higher STTGMA_{COVID} scores experienced longer LOS, need for ICU-level care, and longer ICU LOS. These results are congruent with previous reports of various cohorts of patients with COVID-19 infection.²⁵ Our highest risk quartile, Q4, when compared with other populations of COVID+ patients recently published, experienced similar complication rates, including those related to cardiac and pulmonary function.^{26,27} Specifically, Zhou et al²⁸ demonstrated that sepsis, respiratory failure, and pneumonia were the most commonly occurring complications in a cohort of patients that did not survive COVID-19 infection. In our cohort of 11 COVID-19 positive/suspected patients who died within 30 days, the most common complications were pneumonia (7, 63.6%), acute respiratory failure (7, 63.6%), and sepsis/septic shock (4, 36.4%) (see **Table, Supplemental Digital Content 1**, <http://links.lww.com/JOT/B155> that describes complications occurring in the COVID-19 positive/suspected cohort that died within 30 days). These results indicate that the COVID-19 virus can lead to a cascade of decompensation that affects multiple organ systems. Pathways designed to target the most common complications observed in COVID-19 positive/suspected patients may improve short-term survival rates in this population.

We observed a higher than usual rate of nonoperative treatment of COVID positive/suspected hip fractures during the pandemic time frame (5/31, 16.1%) compared with nonoperative treatment of COVID-19 negative patients during the entire 5.5 years data collection period (18/1247, 1.4%). The increase in nonoperative treatment was a direct result of the patient's symptomatology on admission. Of the 5 patients

treated nonoperatively, 4 were symptomatic on presentation and had respiratory symptoms that continued to worsen. Two of these patients (STTGMA_{COVID} inpatient mortality risk scores of 15.6% and 15.8%) continued to deteriorate and expired during the index hospitalization. Of the 2 patients whose symptoms resolved (effectively COVID-19 negative), 1 patient whose initial STTGMA_{COVID} inpatient mortality risk score was 15.5% was downgraded to a STTGMA_{COVID} score of 1.3% placing them into the low-risk quartile (Q2). This patient underwent hemiarthroplasty at 2 weeks after admission and continued to improve up to the 30 days follow-up period. The other patient whose symptoms resolved had a STTGMA_{COVID} inpatient mortality risk score that was downgraded from 39.7% to 4.5%. However, this patient remained in the high-risk quartile (Q4), and the decision was made to continue definitive nonoperative treatment.

This study is limited by the relatively small sample size of COVID-19 positive/suspected patients (31). However, because COVID-19 positive/suspected status correlates highly with short-term mortality, the numbers accrued in this study are adequate to put forth a risk prediction tool including COVID-19 status as an independent variable. To compensate for this uncommon outcome, our study included multiple large urban centers that were located in the epicenter of the global pandemic. Therefore, we were able to accrue a larger cohort of elderly low-energy geriatric hip fracture patients than has been previously reported. It is not clear yet if the results of this study can be extrapolated to other orthopaedic injuries. Future studies will need to be performed evaluating

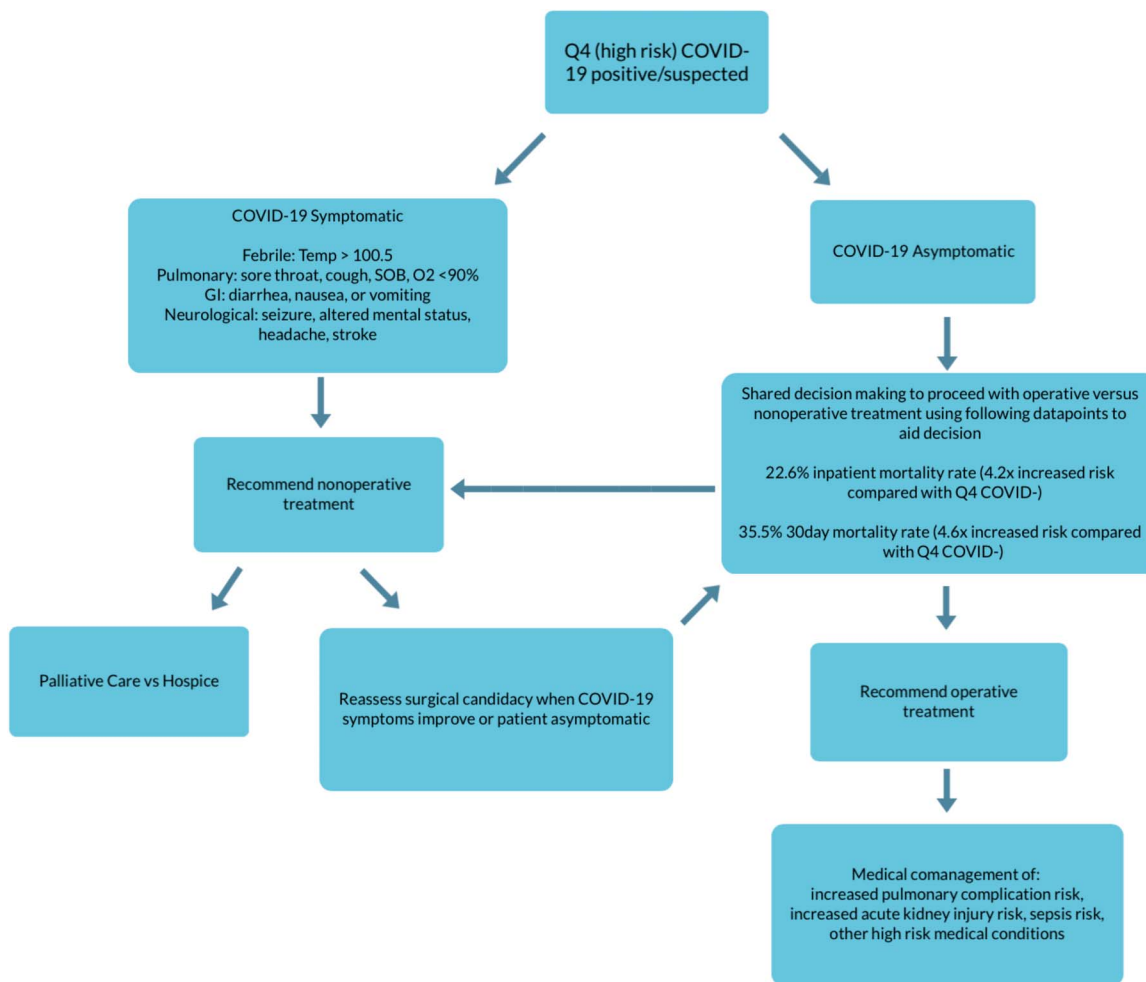


FIGURE 2. Hip fracture decision making algorithm stratified by STTGMA_{COVID} risk quartiles with a focus on the high-risk Q4 COVID-19 positive/suspected cohort. GI, gastrointestinal; Q, quartile; SOB, shortness of breath.

the utility of the STTGMA_{COVID} tool in other orthopaedic injuries seen during the pandemic.

Given the rapid evolution of this pandemic and the predicted second surge that some have suggested may be worse than this initial pandemic, our team has made our risk prediction tool publicly available and free to access at the following web site: www.sttgma.com along with the high-risk Q4 decision making algorithm currently used at our institution and the associated complication profile associated with each risk quartile. The tool will undergo regularly scheduled updates to account for advances in treatment of the COVID-19 virus that will hopefully decrease the lethality of this risk factor. Use of this tool may provide surgeons, physicians, and other providers with useful clinical information that can augment their clinical decision making and/or patient–physician interactions by discussing expected outcomes in a frail and susceptible elderly population.

CONCLUSIONS

This article serves as a roadmap to risk assess, stratify, and treat hip fracture patients during the current COVID-19

pandemic and as long as COVID-19 remains an endemic virus with significant lethality. This tool adequately accounts for the COVID-19 virus as one of the most lethal risk factors seen in our lifetime in this cohort of susceptible patients.

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