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Understanding hospital length of stay in trauma laparotomy patients: a National Trauma Database Study

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ABSTRACT

Introduction The diverse procedures and varying patient conditions in trauma laparotomy cases lead to significant variability in hospital length of stay (HLOS), posing challenges for effective patient care. Strategies to reduce HLOS are varied, with multiple factors potentially modifiable through targeted interventions. These interventions are most effective when target populations and their associated factors are clearly defined. This study aimed to stratify trauma laparotomy patients by their HLOS and identify factors associated with HLOS to enhance patient care.

Methods A retrospective analysis was conducted using the National Trauma Data Bank from January 2017 to December 2019. Adult trauma patients who underwent trauma laparotomy following blunt or penetrating abdominal injuries were identified using International Classification of Diseases, 10th Revision codes and Abbreviated Injury Scales. HLOS was stratified into three groups based on the IQR of the study population: short (< 5 days), medium (5–11 days) and long (> 11 days).

Results A total of 27 434 trauma laparotomy patients were identified. The overall median HLOS was 7.0 (5.0, 11.0) days. Penetrating mechanisms, particularly stab wounds, were strongly associated with a short HLOS. Additionally, isolated abdominal trauma, splenic injuries or spleen-related procedure were more likely to result in a short HLOS. Patients with a long HLOS experienced higher rates of in-hospital complications and were more frequently discharged to home with home health services or to extended care facilities. Most comorbidities were associated with a long HLOS, and patients with Medicaid or Medicare had a higher likelihood of a long HLOS.

Conclusion Despite the relatively homogenous trauma population, HLOS distribution varied significantly. Stratification based on HLOS revealed distinct factors associated with short and long HLOS categories, indicating that targeted interventions for each category could potentially reduce HLOS and enhance patient outcomes in the current era of constrained healthcare resources.

Level of evidence, study type Level IV, therapeutic/care management.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Prolonged hospital stays are associated with various negative consequences. Factors contributing to prolonged hospital stays have been studied in the broader trauma population.

WHAT THIS STUDY ADDS

⇒ This study specifically focuses on patients who underwent trauma laparotomy, a relatively homogenous subgroup within the trauma population. It highlights differences in patient characteristics and associated factors among groups stratified by hospital length of stay.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings suggest potential benefits from targeted interventions based on hospital length of stay.

INTRODUCTION

Healthcare systems worldwide face challenges stemming from resource constraints such as staff shortages, limited bed availability, and financial limitations. These issues are evident in the field of trauma surgery, as in many other medical disciplines.[1] Initiatives to eliminate waste in healthcare by reducing overuse or misuse are essential, and streamlining patient care effectively is crucial to achieving this goal.[2]

A trauma laparotomy is a common procedure in trauma surgery for both blunt and penetrating abdominal injuries. It encompasses a range of interventions, including the control of life-threatening hemorrhage, management of contamination, and exploratory diagnostic procedures.[3 4] Additionally, various factors beyond the injuries themselves contribute to the diversity of this patient population, including the urgency of the emergency situations, the resource-intensive nature of management, patients' intricate medical and social backgrounds, and institutional system limitations.[5 6] These diversities pose challenges when implementing initiatives or conducting research in this population. There is a necessity to stratify this patient population to gain a deeper understanding and to implement interventions that ensure effective patient care.

Hospital length of stay (HLOS) has been utilized as a meaningful outcome measure and a potential target for quality improvement activities.[7–9] Prolonged HLOS can lead to harm, such as an increased risk of nosocomial infections, physical deconditioning and diminished quality of life, and it is also a major driver of healthcare costs.[10 11] Therefore, it is closely monitored by hospitals and healthcare systems.[12] In contrast to elective surgery, the HLOS for trauma laparotomy patients is influenced by numerous clinical and non-clinical factors, as mentioned earlier. This complexity complicates the use of HLOS as a measure for quality improvement initiatives.[13] Nevertheless, for the practical aim of enhancing patient care, utilizing HLOS can be justified, as it reflects not only the severity of injuries and procedures performed but also various individual factors affecting their in-hospital clinical progress. Various strategies can reduce HLOS, and many factors influencing HLOS can potentially be modified through targeted interventions.[14]

Building on these contexts, we hypothesized that, despite the relatively homogenous nature of trauma laparotomy patients, variability within this population exists. Stratifying patients based on HLOS would reveal distinct factors contributing their length of stay (LOS), which could inform the development of targeted interventions. Therefore, this study aimed to stratify trauma laparotomy patients into short, medium and long LOS groups and to identify the clinical and non-clinical factors associated with HLOS to ultimately achieve effective patient care.

METHODS

Data source

A retrospective analysis was performed using the National Trauma Data Bank (NTDB) from January 2017 to December 2019. The NTDB, managed by the American College of Surgeons (ACS), is the largest aggregation of trauma registry data in the USA, with participation from over 900 hospitals. It adheres to the National Trauma Data Standard, which defines the reporting of specific data elements and includes patient demographics, injury-related information and patient outcomes.[15–17]

Study population

Adult trauma patients (18 years and older) who underwent a laparotomy following blunt or penetrating abdominal injuries were included in this study. These patients were identified using the International Classification of Diseases, 10th Revision, Procedure Coding System (ICD-10-PCS). ICD-10-PCS is a set of medical classification codes used for procedural coding in the healthcare industry, covering all procedural data in inpatient settings, including surgeries, diagnostic procedures and other medical interventions. Each ICD-10-PCS code consists of seven alphanumeric characters without decimal points (eg, 0FT10ZZ: resection of the right lobe of the liver using an open approach).[18] Coding details are explained in online supplemental material 1. In this study, we used the following logic: character 1 (section)=0 (surgical), character 2 (body system)=1, 4, 6, 7, D, F, G, T, U, W, character 3 (operation)=ANY, character 4 (body part)=alphanumeric characters applicable when combined with character 2, character 5 (approach)=0 (open approach), character 6 (device)=ANY, character 7 (qualifier)=ANY. Based on this logic, we identified 109 codes, all listed in online supplemental material 2).

We excluded patients under 18 years old, those who underwent laparoscopic procedures, and those with missing HLOS data. Missing HLOS data were all due to administrative reasons. Patients who died during hospitalization were also excluded because severe injuries leading to early death could result in a short HLOS, skewing the results. Additionally, we excluded patients with severe trauma in regions other than the abdomen, as our objective was to focus on abdominal trauma patients who underwent laparotomy. Using the Abbreviated Injury Scale (AIS), we identified patients with polytraumas, and then excluded those with an AIS severity greater than 3 in other body regions. Among those with isolated abdominal injuries, injuries of all severities were included (online supplemental material 3).

Data collection, definitions and outcomes of interest

Variables collected included patient demographics (age, gender and race), primary method of payment, patient comorbid conditions, body mass index, drug/alcohol screen, ICD-10-Clinical Modification (CM) codes, ICD-10-PCS codes, AIS predot code and severity, injury severity score (ISS), type of trauma (blunt or penetrating), injury intent, mechanism of injury, HLOS, blood transfusions (red blood cells, plasma, platelets), laparotomy for hemorrhage control, in-hospital complications, hospital discharge disposition, hospital bed size and trauma center ACS verification level.

ICD-10-CM describes diagnosis codes used for a variety of purposes, including hospital, ambulatory surgical and clinic reimbursement.[19] Each code consists of 3–7 alphanumeric characters, starting with a letter and containing a decimal point after the third character. The first three characters specify the chapter of disease categories that includes the pathology in question. For instance, S36 represents injuries of intra-abdominal organs, with additional numeric values after the decimal point to describe specific anatomic locations (eg, S36.0: injury of spleen, S36.1: injury of liver, gallbladder and bile duct).[18] We identified 39 applicable ICD-10-CM codes and categorized them into the following 10 systems: 'Superficial', 'Major vessels', 'Abdominal blood vessels', 'Spleen', 'Hepatobiliary', 'Pancreas', 'Upper GI', 'Colon/Rectum', 'Kidney', and 'Genital/Urinary' (online supplemental material 4). In the NTDB, the volume of blood transfusions was reported in either 'Units' or 'CCs (mLs)'. To standardize the data for analysis, we converted 'CCs (mLs)' to 'units'. HLOS was defined as the cumulative amount of time spent in the hospital. Each partial or full day was measured as one calendar day, calculated as the discharge date minus the admission date plus 1 day. HLOS was stratified into three groups based on the IQR of our study population: short (< 5 days), medium (5–11 days) and long (>11 days) LOS groups. The IQR was used to define the medium LOS group, and the short and long groups were defined as HLOS less than or greater than the IQR, respectively.

The primary outcomes of interest in this study were to identify factors associated with both short and long LOS in patients who underwent laparotomy following abdominal trauma.

Statistical analysis

HLOS was reported as median values to align with the reporting standards of the ACS in the NTDB and the Trauma Quality Improvement Program.[12] Descriptive statistics were used to calculate proportions and means for patient characteristics across the short, medium and long LOS groups. Missing HLOS data (n=164) were excluded from the analysis, as their limited number was assumed not to introduce bias into the results. In case where included patients had missing data for only a specific variable, it was assumed that the data were missing completely at random, and these cases were excluded from the respective analyses using pairwise deletion. Fisher's exact test was used to assess statistically significant differences in categorical variables across the three HLOS groups, whereas a Kruskal-Wallis test with Bonferroni correction was used for continuous variables. Logistic regression models were employed to explore characteristics associated with short and long HLOS. For the short HLOS outcome, an HLOS of ≥5 days was used as the reference category, while for the long HLOS outcome, an HLOS <11 days was used as the reference category. Models were adjusted for potential confounding variables, including age, gender and ISS. Logistic regression models are presented as ORs with 95% CIs.

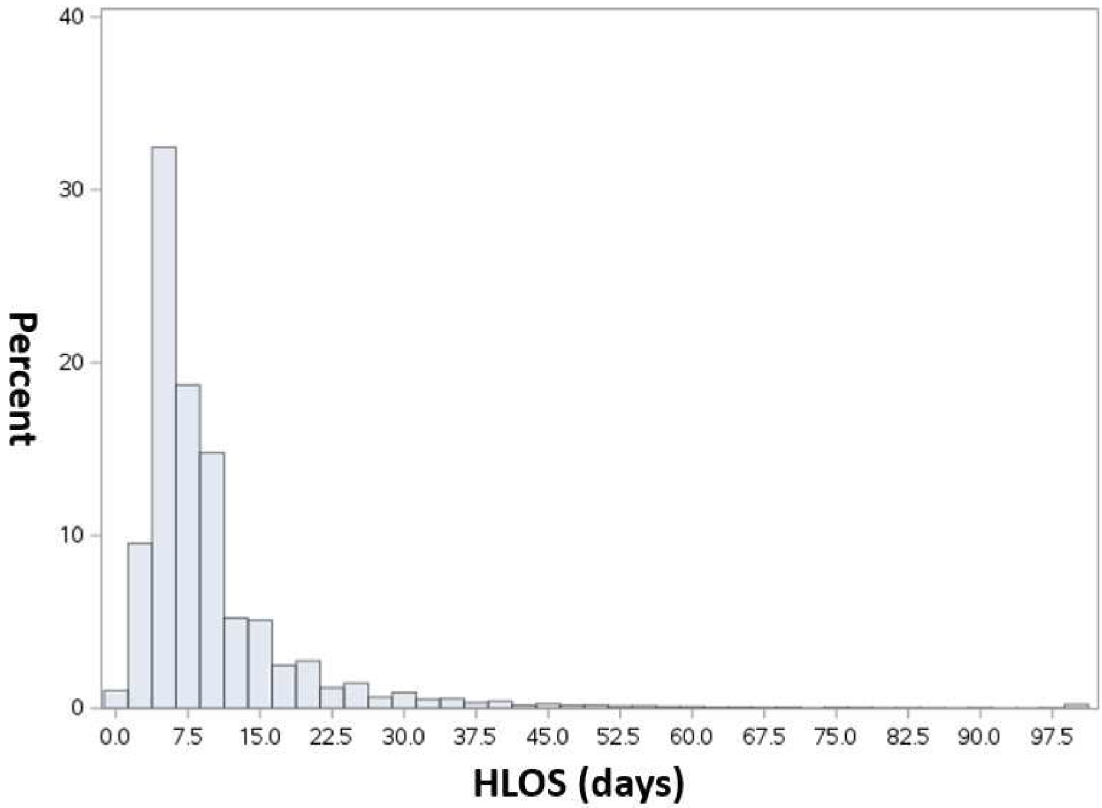

Figure 1 Distribution of hospital length of stay (days) for the overall study population. HLOS, hospital length of stay.

Only the results of models that were statistically significant are presented in the results. P values less than 0.05 and 95% CIs that exclude the null OR were considered statistically significant. All analyses were performed using SAS Studio, release V.3.81 (Enterprise Edition), copyright 2012–2020, SAS Institute, Cary, North Carolina, USA.

RESULTS

Baseline characteristics by HLOS

A total of 27 434 patients were identified as meeting the inclusion criteria during the study period. The overall median HLOS in our study population was 7.0 (5.0, 11.0) days, with a right-skewed distribution (figure 1). There were 5373 patients (19.6%) in the short LOS group (<5 days), 15 621 patients (56.9%) in the medium LOS group (5 to 11 days) and 6440 patients (23.5%) in the long LOS group (>11 days).

Patient demographic characteristics and hospital characteristics, stratified by the three HLOS groups, are presented in table 1. Approximately 80% of patients were men across all groups. Patients with longer HLOS were significantly older, with a mean age of 41.03 years (95% CI 40.63 to 41.44), than those in the short and medium LOS groups. Around 50% of the patients were white, with a higher prevalence in the short LOS group. In contrast, approximately 30% of the patients were black, with a higher prevalence in the long LOS group. The prevalence of patients using self-pay as their primary payment method was highest in the short LOS group (24.6%), whereas Medicare coverage was more prevalent in the long LOS group (12.5%). Those in the long LOS group had significantly higher proportions of comorbidities, including hypertension, diabetes mellitus, chronic obstructive pulmonary disease, congestive heart failure, cirrhosis, chronic renal failure, cerebrovascular accident and anticoagulant therapy, compared with the short and medium LOS groups. Additionally, patients with longer LOS had a higher prevalence of functional dependency and obesity and a lower prevalence of current smoking.

The long LOS group experienced significantly higher proportions of all reported in-hospital complications compared with the short and medium LOS groups. The majority (80.6%) of patients in the short LOS group were discharged to home or self-care. In contrast, approximately half (49.5%) of patients in the long LOS group were discharged to home, while others were more frequently discharged to home with organized home health services (17.7%) or to facilities requiring extended care, such as inpatient rehabilitation centers (11.1%), skilled nursing facilities (7.6%), or long-term care hospitals (3.4%).

Approximately 70% of the patients were treated at level 1 or 2 trauma centers with more than 400 beds across the three HLOS groups.

Trauma-related characteristics by HLOS

The trauma-related characteristics of the study population are presented in table 2. Penetrating mechanisms were more frequent across all groups, with the highest proportion in the short LOS group (73.5%). Among the penetrating mechanisms, stab wounds were significantly more prevalent (55.7%) in the short LOS group, whereas firearm-related injuries were significantly more prevalent (44.0%) in the long LOS group. Most blunt mechanisms, such as falls and motor vehicle traffic-related (MVT) injuries, were more frequent in the long LOS group.

While superficial injuries were more common in the short LOS group, the prevalence of injuries to abdominal organs was successively higher as HLOS increased. The frequency of isolated abdominal injuries was highest (54.3%) in the short LOS group. Additionally, the mean ISS was highest in the long LOS group, with a mean of 13.63 (95% CI 13.4, 13.7). These patients also

Table 1 Patient demographics and hospital characteristics by hospital length of stay category

	LOS<5 days (n=5373)	LOS 5–11 days (n=15 621)	LOS>11 days (n=6440)	P value
Male, n (%)	4409 (82.1)	12 163 (77.9)	5024 (78.0)	<0.0001
Mean age (95% CI)	35.03 (34.68, 35.39)	37.06 (36.82, 37.29)	41.03 (40.63, 41.44)	<0.0001
Racial background				
Asian	87 (1.6)	318 (2.0)	138 (2.1)	0.0937
American Indian	93 (1.7)	189 (1.2)	69 (1.1)	0.0032
Black	1550 (28.9)	4894 (31.3)	2211 (34.3)	<0.0001
White	2864 (53.3)	8143 (52.1)	3183 (49.4)	<0.0001
Other/pacific islander	6580 (12.7)	1772 (11.3)	698 (10.8)	0.0061
Primary payment method				
Medicaid	1585 (29.5)	4465 (28.6)	1835 (28.5)	0.3886
Medicare	293 (5.5)	1187 (7.6)	802 (12.5)	<0.0001
Not billed (for any reason)	53 (1.0)	89 (0.6)	48 (0.8)	0.0054
Self-pay	1321 (24.6)	3320 (21.3)	1183 (18.4)	<0.0001
Private/commercial insurance	1506 (28.0)	5033 (32.2)	1953 (30.3)	<0.0001
Other government	303 (5.6)	631 (4.0)	235 (3.7)	<0.0001
Comorbid conditions				
Anticoagulant therapy	47 (1.3)	303 (2.8)	236 (5.1)	<0.0001
Hypertension	579 (14.9)	2140 (18.5)	1285 (26.0)	<0.0001
Congestive heart failure	38 (0.7)	156 (1.0)	145 (2.3)	<0.0001
COPD	116 (3.1)	382 (3.5)	261 (5.6)	<0.0001
Diabetes mellitus	246 (6.5)	828 (7.4)	547 (11.5)	<0.0001
Chronic renal failure	8 (0.2)	62 (0.6)	56 (1.2)	<0.0001
Alcohol use disorder	335 (8.9)	970 (8.7)	509 (10.8)	0.0001
Cirrhosis	30 (0.8)	128 (1.2)	110 (2.4)	<0.0001
Cerebrovascular accident	19 (0.5)	79 (0.7)	59 (1.3)	0.0001
Mental/personality disorder	776 (19.7)	1743 (15.3)	970 (19.9)	<0.0001
Functionally dependent health status	29 (0.8)	125 (1.1)	118 (2.6)	<0.0001
Current smoker	1769 (41.8)	4708 (38.3)	1702 (33.5)	<0.0001
Substance abuse disorder	734 (19.0)	2030 (17.8)	770 (16.2)	0.0026
Not known/not stated	1473 (27.4)	4512 (28.9)	1759 (27.3)	0.0210
Body mass index (BMI)				<0.0001
Underweight	90 (1.7)	359 (2.3)	128 (2.0)	
Normal	1745 (32.5)	5043 (32.3)	1829 (28.4)	
Overweight	1531 (28.5)	4601 (29.5)	1911 (29.7)	
Obese	1239 (23.1)	3926 (25.1)	1975 (30.7)	
Drug screen				
Positive	1274 (23.7)	3837 (24.6)	1490 (23.1)	0.0631
Alcohol screen	3702 (68.9)	10 570 (67.7)	4324 (67.1)	0.1506
In-hospital complications				
Deep vein thrombosis	2 (0.1)	54 (0.5)	344 (7.4)	<0.0001
Pulmonary embolism	0 (0.0)	39 (0.4)	170 (3.7)	<0.0001
Acute kidney injury	5 (0.1)	43 (0.4)	314 (6.8)	<0.0001
Acute respiratory distress syndrome	0 (0.0)	14 (0.1)	117 (2.6)	<0.0001
Severe sepsis	0 (0.0)	17 (0.2)	226 (4.9)	<0.0001
Surgical site infection	5 (0.1)	101 (0.7)	771 (12.0)	<0.0001
Alcohol withdrawal syndrome	16 (0.4)	99 (0.9)	139 (3.0)	<0.0001
Unplanned return to the OR	8 (0.2)	235 (2.2)	821 (17.2)	<0.0001
Unplanned admission to the ICU	13 (0.4)	233 (2.1)	629 (13.3)	<0.0001
Not known/not recorded	3571 (66.5)	9977 (63.9)	2606 (40.5)	<0.0001
Hospital discharge disposition				
Discharged/transferred to a short-term general hospital for inpatient care	267 (5.0)	156 (1.0)	92 (1.4)	<0.0001
Discharged/transferred to home under care of organized home health service	134 (2.5)	1321 (8.5)	1141 (17.7)	<0.0001
Discharged to home or self-care (routine discharge)	4328 (80.6)	12 074 (77.3)	3186 (49.5)	<0.0001

Continued

Table 1 Continued

	LOS<5 days (n=5373)	LOS 5–11 days (n=15 621)	LOS>11 days (n=6440)	P value
Discharged/transferred to skilled nursing facility	16 (0.3)	286 (1.8)	491 (7.6)	<0.0001
Discharged/transferred to inpatient rehab or designated unit	15 (0.3)	395 (2.5)	712 (11.1)	<0.0001
Discharged/transferred to long-term care hospital	3 (0.1)	15 (0.1)	216 (3.4)	<0.0001
Discharged/transferred to a psychiatric hospital or psychiatric distinct part unit of a hospital	266 (5.0)	625 (4.0)	247 (3.8)	0.0038
Left against medical advice or discontinued care	162 (3.0)	210 (1.3)	67 (1.0)	<0.0001
Hospital bed size				
≤200	388 (7.2)	993 (6.4)	377 (5.9)	0.0096
201–400	1413 (26.3)	4101 (26.3)	1556 (24.2)	0.0033
401–600	1632 (30.4)	4661 (29.8)	1997 (31.0)	0.2183
> 600	1940 (36.1)	5866 (37.6)	2510 (39.0)	0.0058
Trauma center verification level				
Level I	2759 (51.4)	7742 (49.6)	3330 (51.7)	0.0047
Level II	1160 (21.6)	3416 (21.9)	1308 (20.3)	0.0361
Level III	231 (4.3)	470 (3.0)	145 (2.3)	<0.0001

COPD, chronic obstructive pulmonary disease; ICU, intensive care unit; LOS, length of stay; OR, operation room.

received more blood transfusions. The most frequent procedures performed, apart from exploratory laparotomy, were procedures involving the small bowels, followed by those involving the large bowels. Laparotomies for hemorrhage control accounted for 9.9% of the procedures performed in the short LOS group, 22.5% in the medium LOS group and 41.7% in the long LOS group, showing a proportional increase across HLOS groups.

Factors associated with short and long HLOS

Patient, trauma-related, and hospital characteristics associated with short (LOS <5 days vs ≥5 days) and long (LOS <11 days vs ≥11 days) HLOS are presented in tables 3 and 4. Presenting with a penetrating injury was associated with a higher likelihood of a short HLOS (adjusted OR (aOR) 1.13; 95% CI 1.05, 1.21) compared with a long HLOS. Specifically, having a stab wound was strongly associated with a short HLOS (aOR 2.64; 95% CI 2.46, 2.82). Patients who were self-paying or using other government payment methods were more likely to have a short HLOS (aOR 1.12; 95% CI 1.04, 1.20 and aOR 1.24; 95% CI 1.07, 1.43, respectively). Patients with isolated abdominal trauma were more likely to have a short HLOS (aOR 1.16; 95% CI 1.08, 1.23). In terms of specific injuries and procedures, patients with superficial wounds (aOR 1.61; 95% CI 1.50, 1.71), splenic injuries (aOR 1.30; 95% CI 1.17, 1.45) and spleen-related procedures (aOR 1.31; 95% CI 1.17, 1.47) were more likely to have a short HLOS.

Factors associated with long HLOS included identifying as black (aOR 1.44; 95% CI 1.35, 1.53) and presenting with penetrating injuries, particularly firearm-related injuries (aOR 2.57; 95% CI 2.41, 2.74), MVT pedestrian incidents (aOR 2.00; 95% CI 1.55, 2.58) and patients with Medicaid or Medicare (aOR 1.15; 95% CI 1.08, 1.23 and aOR 1.34; 95% CI 1.20, 1.49, respectively). Most comorbidities were associated with a long HLOS, with functional dependency (aOR 1.91; 95% CI 1.48, 2.48), cirrhosis (aOR 1.68; 95% CI 1.30, 2.18) and chronic renal failure (aOR 1.68; 95% CI 1.16, 2.44) having the strongest association. Additionally, patients undergoing laparotomy for hemorrhage control (aOR 2.16; 95% CI 2.02, 2.30), those requiring more transfusions (all components) and those treated at level 1 trauma centers (aOR 1.07; 95% CI 1.01, 1.14) had higher odds of long HLOS. Most injuries and procedures, except spleen-related ones, were positively associated with long HLOS. Notably, injuries to and procedures for major vessels (such as the aorta or inferior vena cava) and the pancreas were strongly associated with long HLOS (diagnoses: aOR 3.09; 95% CI 2.52, 3.77 and aOR 3.33; 95% CI 2.95, 3.76; procedures: aOR 3.84; 95% CI 3.09, 4.78 and aOR 3.23; 95% CI 2.78, 3.76, respectively).

DISCUSSIONS

In our large registry-based study of 27 434 adult patients undergoing laparotomy following abdominal injuries, the median HLOS was 7.0 (5.0, 11.0) days. Penetrating mechanisms, particularly stab wounds, were strongly associated with a short HLOS. Additionally, patients with isolated abdominal trauma, superficial injuries, splenic injuries, or spleen-related procedures were more likely to have a short HLOS. Patients with Medicaid or Medicare showed a higher likelihood of a long HLOS. Most comorbidities were associated with a long HLOS, and the long LOS group experienced higher rates of in-hospital complications. Patients in the long LOS group were more frequently discharged to home with home health services or to extended care facilities.

HLOS is a widely used outcome measure and quality metric within healthcare systems. A reduction in HLOS implies enhanced efficiency and effectiveness of care, including improvements in bed turnover, alignment of demand with hospital capacity, operation room and intensive care unit utilization and facilitation of interhospital transfers.[20] This is particularly important as patients with prolonged HLOS tend to consume substantial hospital resources. Consequently, various interventions have been developed and evaluated to reduce HLOS.[21–24] A systematic review by Siddique *et al*[14] identified eight strategies for reducing HLOS in high-risk populations and concluded that no single intervention was consistently associated with reduced HLOS. Our study indicates that even within a relatively homogenous patient population undergoing trauma laparotomy, there is significant variability in HLOS distribution, with distinctly different patient characteristics associated with different HLOS categories. This suggests that a tailored approach, considering

Table 2 Trauma-related characteristics by hospital length of stay category

	LOS<5 days (n=5373)	LOS 5–11 days (n=15 621)	LOS>11 days (n=6440)	P value
Trauma type				
Blunt	1350 (25.1)	6259 (40.1)	2561 (39.8)	<0.0001
Penetrating	3947 (73.5)	9109 (58.3)	3773 (58.6)	<0.0001
Injury intent				
Unintentional	1734 (32.3)	6630 (42.4)	2690 (41.8)	<0.0001
Self-inflicted	647 (12.0)	1113 (7.1)	541 (8.4)	<0.0001
Assault	2840 (52.9)	7386 (47.3)	2965 (46.0)	<0.0001
Mechanism of injury				
Stab	2993 (55.7)	4142 (26.5)	939 (14.6)	<0.0001
Firearm	953 (17.7)	4964 (31.8)	2832 (44.0)	<0.0001
Fall	286 (5.3)	1077 (6.9)	472 (7.3)	<0.0001
Machinery	21 (0.4)	37 (0.2)	17 (0.3)	0.1734
MVT occupant	551 (10.3)	3094 (19.8)	1305 (20.3)	<0.0001
MVT motorcyclist	57 (1.1)	272 (1.7)	126 (2.0)	0.0003
MVT pedestrian	18 (0.3)	127 (0.8)	120 (1.9)	<0.0001
MVT unspecified/MVT other/pedal cyclist, other	113 (2.1)	516 (3.3)	167 (2.6)	<0.0001
ICD diagnosis				
Major vessels*	18 (0.3)	165 (1.1)	259 (4.0)	<0.0001
Abdominal blood vessels	302 (5.6)	1235 (7.9)	1002 (15.6)	<0.0001
Spleen	533 (9.9)	2751 (17.6)	1241 (19.3)	<0.0001
Hepatobiliary	714 (13.3)	2446 (15.7)	1623 (25.2)	<0.0001
Pancreas	55 (1.0)	520 (3.3)	676 (10.5)	<0.0001
Upper GI	929 (17.3)	6750 (43.2)	3416 (53.0)	<0.0001
Colon/rectum	651 (12.1)	4682 (30.0)	2799 (43.5)	<0.0001
Kidney	135 (2.5)	1115 (7.1)	906 (14.1)	<0.0001
Genital/urinary	280 (5.2)	1192 (7.6)	638 (9.9)	<0.0001
Superficial	3233 (60.2)	6181 (39.6)	2324 (36.1)	<0.0001
ISS	6.5 (6.3, 6.7)	10.7 (10.6, 10.8)	13.6 (13.4, 13.7)	<0.0001
Isolated abdominal injury	2915 (54.3)	6657 (42.6)	2193 (34.1)	<0.0001
ICD procedure				
Major vessels	11 (0.2)	133 (0.9)	231 (3.6)	<0.0001
Abdominal blood vessels	101 (1.9)	504 (3.2)	461 (7.2)	<0.0001
Spleen	448 (8.3)	2447 (15.7)	1057 (16.4)	<0.0001
Hepatobiliary	393 (7.3)	1488 (9.5)	1168 (18.1)	<0.0001
Pancreas	21 (0.4)	328 (2.1)	432 (6.7)	<0.0001
Stomach	329 (6.1)	1475 (9.4)	1075 (16.7)	<0.0001
Small intestine	1128 (21.0)	6992 (44.8)	3673 (57.0)	<0.0001
Large intestine	635 (11.8)	4916 (31.5)	3086 (47.9)	<0.0001
Kidney	44 (0.8)	477 (3.1)	463 (7.2)	<0.0001
Genital/urinary	303 (5.6)	1085 (7.0)	555 (8.6)	<0.0001
Abdominal cavity†	4322 (80.4)	11 845 (75.8)	5143 (79.9)	<0.0001
Laparotomy for hemorrhage control	496 (9.2)	3317 (21.2)	2570 (39.9)	<0.0001
Blood transfusions (unit)				
Red blood cell in 4 hours	0.32 (0.29, 0.36)	0.89 (0.86, 0.93)	3.02 (2.87, 3.16)	<0.0001
Plasma in 4 hours	1.38 (1.16, 1.59)	2.03 (1.94, 2.13)	4.57 (4.34, 4.81)	<0.0001
Platelet in 4 hours	0.34 (0.22, 0.47)	0.51 (0.46, 0.56)	1.08 (1.00, 1.16)	<0.0001

*Abdominal aorta and inferior vena cava.
†Exploratory laparotomy.
GI, gastrointestinal; ICD, International Classification of Diseases; ISS, injury severity score; LOS, length of stay; MVT, motor vehicle traffic.

both clinical and non-clinical factors associated with HLOS, is necessary to effectively reduce HLOS in these patients.

Enhanced recovery protocols (ERPs), including Enhanced Recovery After Surgery (ERAS) pathways, represent an effective intervention for patients in the short and medium LOS groups, where 77% of patients had a HLOS of less than 11 days. ERPs are widely regarded as the standard of care in many elective surgical settings,[25] and their application in emergency surgical populations, including trauma laparotomy patients, has been increasingly studied and integrated into clinical practice.[26] The ERAS society has released specific guidelines advocating for the use of ERPs in emergency laparotomy populations.[27–29] However,

Table 3 Patient, trauma-related and hospital characteristics associated with short hospital length of stay

	LOS<5 days vs ≥5 days (ref.) OR (95% CI)	
	Univariate model	Multivariate model
Racial background		
American Indian	1.49 (1.17, 1.89)*	1.33 (1.03, 1.71)*
White	1.08 (1.02, 1.15)*	1.29 (1.21, 1.38)*
Other/pacific islander	1.15 (1.05, 1.26)*	1.05 (0.96, 1.16)
Mechanism of injury		
Stab	4.2 (3.95, 4.47)*	2.64 (2.46, 2.82)*
Fall	0.75 (0.65, 0.85)*	1.23 (1.07, 1.42)*
Machinery	1.60 (0.97, 2.65)	1.87 (1.08, 3.24)*
Trauma type		
Penetrating	1.97 (1.85, 2.11)*	1.13 (1.05, 1.21)*
Trauma center verification level		
Level I	1.05 (0.99, 1.11)	1.07 (1.01, 1.14)*
Level III	1.57 (1.34, 1.83)*	1.63 (1.38, 1.93)*
Primary payment method		
Not billed (for any reason)	1.60 (1.16, 2.19)*	1.36 (0.96, 1.91)
Self-pay	1.27 (1.19, 1.36)*	1.12 (1.04, 1.20)*
Other government	1.46 (1.28, 1.67)*	1.24 (1.07, 1.43)*
Comorbid conditions		
Mental/personality disorder	1.23 (1.12, 1.34)*	1.03 (0.93, 1.13)
Current smoker	1.23 (1.15, 1.32)*	1.18 (1.10, 1.27)*
Substance abuse disorder	1.12 (1.02, 1.23)*	1.06 (0.96, 1.16)
ICD diagnosis		
Superficial	2.41 (2.27, 2.56)*	1.61 (1.50, 1.71)*
Spleen	0.50 (0.45, 0.55)*	1.30 (1.17, 1.45)*
Isolated abdominal trauma	1.77 (1.67, 1.88)*	1.16 (1.08, 1.23)*
ICD procedure		
Spleen	0.48 (0.43, 0.53)*	1.31 (1.17, 1.47)*
Abdominal cavity	1.23 (1.14, 1.32)*	1.08 (0.99, 1.16)

*:P <0.05 and 95% CIs that exclude the null OR.
ICD, international classification of disease; LOS, length of stay; MVT, motor vehicle traffic.

these guidelines notably exclude trauma laparotomy patients. To date, four studies have examined the implementation of ERPs in abdominal trauma patients requiring laparotomy.[30–33] Across these studies, HLOS was the primary outcome, with three also evaluating in-hospital complications. Consistently, these studies demonstrated a significant reduction in HLOS, while none reported a significant increase in complications. These findings suggest that ERPs have the potential to optimize recovery in this patient population. Furthermore, our study identified several factors associated with a short LOS, including penetrating mechanisms (particularly stab wounds), isolated abdominal trauma and superficial injuries, indicating these patients may be suitable for ERPs. Notably, two of four studies on ERPs in trauma laparotomy focused primarily on isolated penetrating abdominal trauma and demonstrated significant reductions in HLOS.[30 32] High-volume centers with a higher proportion of penetrating trauma, such as those in the USA or South Africa, should consider adopting this approach. Additionally, as splenic injuries and related procedures were linked to short LOS and many candidates for ERPs fall within the medium LOS group, these protocols may also apply to trauma laparotomy patients with blunt mechanisms, provided appropriate patient selection criteria are employed. However, the implementation of ERPs

Table 4 Patient, trauma-related and hospital characteristics associated with long hospital length of stay

	LOS<11 days (ref.) vs ≥11 days OR (95% CI)	
	Univariate model	Multivariate model
Racial background		
Black	1.18 (1.11, 1.25)*	1.44 (1.35, 1.53)*
Mechanism of injury		
Fall	1.14 (1.02, 1.27)*	0.68 (0.61, 0.77)*
Firearm	2.00 (1.89, 2.12)*	2.57 (2.41, 2.74)*
MVT pedestrian	2.73 (2.14, 3.49)*	2.00 (1.55, 2.58)*
Trauma type		
Blunt	1.16 (1.10, 1.23)*	0.69 (0.65, 0.74)*
Penetrating	0.86 (0.81, 0.91)*	1.44 (1.35, 1.54)*
Body mass index (BMI)		
Normal (ref.)	Ref.	
Overweight	1.16 (1.08, 1.24)*	1.12 (1.03, 1.20)*
Obese	1.42 (1.32, 1.53)*	1.42 (1.32, 1.53)*
Blood transfusions		
Red blood cell 4 hours	1.22 (1.21, 1.23)*	1.16 (1.15, 1.18)*
Plasma 4 hours	1.17 (1.15, 1.18)*	1.16 (1.14, 1.17)*
Platelets 4 hours	1.27 (1.22, 1.32)*	1.24 (1.19, 1.28)*
Laparotomy for hemorrhage control	2.20 (1.87, 2.58)*	2.16 (2.02, 2.30)*
Trauma center verification level		
Level I	1.07 (1.01, 1.13)*	1.07 (1.01, 1.14)*
Primary payment method		
Medicaid	0.98 (0.93, 1.05)	1.15 (1.08, 1.23)*
Medicare	1.88 (1.71, 2.05)*	1.34 (1.20, 1.49)*
Comorbid conditions		
Alcohol use disorder	1.26 (1.13, 1.41)*	1.17 (1.04, 1.31)*
Anticoagulant therapy	2.19 (1.85, 2.59)*	1.34 (1.11, 1.62)*
Cirrhosis	2.24 (1.75, 2.86)*	1.68 (1.30, 2.18)*
COPD	1.70 (1.46, 1.98)*	1.28 (1.08, 1.51)*
Cerebrovascular accident	1.93 (1.39, 2.67)*	1.27 (0.90, 1.79)
Diabetes mellitus	1.68 (1.51, 1.87)*	1.32 (1.17, 1.49)*
Functionally dependent health status	2.47 (1.94, 3.15)*	1.91 (1.48, 2.48)*
Congestive heart failure	2.47 (1.99, 3.07)*	1.54 (1.22, 1.94)*
Hypertension	1.64 (1.52, 1.77)*	1.25 (1.14, 1.37)*
Mental/personality disorder	1.27 (1.17, 1.37)*	1.41 (1.29, 1.54)*
Chronic renal failure	2.57 (1.80, 3.66)*	1.68 (1.16, 2.44)*
ICD diagnosis		
Major vessels	4.77 (3.94, 5.77)*	3.09 (2.52, 3.77)*
Abdominal blood vessels	2.33 (2.14, 2.54)*	1.77 (1.59, 1.90)*
Spleen	1.29 (1.20, 1.38)*	0.60 (0.55, 0.65)*
Hepatobiliary	1.90 (1.78, 2.04)*	1.64 (1.52, 1.76)*
Pancreas	4.17 (3.71, 4.67)*	3.33 (2.95, 3.76)*
Upper GI	1.96 (1.85, 2.07)*	2.05 (1.93, 2.18)*
Colon/rectum	2.26 (2.13, 2.39)*	2.42 (2.27, 2.57)*
Kidney	2.59 (2.36, 2.83)*	1.95 (1.77, 2.15)*
Genital/urinary	1.46 (1.32, 1.61)*	1.41 (1.27, 1.56)*
ICD procedure		
Major vessels	5.39 (4.37, 6.64)*	3.84 (3.09, 4.78)*
Abdominal blood vessels	2.60 (2.29, 2.94)*	2.14 (1.88, 2.44)*
Spleen	1.23 (1.14, 1.33)*	0.54 (0.50, 0.59)*
Hepatobiliary	2.25 (2.08, 2.44)*	1.91 (1.76, 2.08)*
Pancreas	4.25 (3.68, 4.91)*	3.23 (2.78, 3.76)*
Stomach	2.13 (1.97, 2.31)*	2.04 (1.87, 2.22)*

Continued

Table 4 Continued

	LOS<11 days (ref.) vs ≥11 days OR (95% CI)	
	Univariate model	Multivariate model
Small intestine	2.11 (1.99, 2.23)*	2.25 (2.12, 2.39)*
Large intestine	2.56 (2.42, 2.71)*	2.74 (2.58, 2.92)*
Kidney	3.04 (2.68, 3.46)*	2.02 (1.76, 2.32)*
Genital/urinary	1.33 (1.20, 1.48)*	1.35 (1.21, 1.50)*
Abdominal cavity	1.18 (1.11, 1.27)*	1.30 (1.21, 1.40)*

*:P<0.05 and 95% CIs that exclude the null OR.
COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; ICD, International Classification of Diseases; LOS, length of stay; MVT, motor vehicle traffic.

in trauma laparotomy patients remains limited, with several challenges requiring consideration. These include variability in patient volume, population heterogeneity, conceptual unfamiliarity and professional preconceptions. Further studies are essential to evaluate the effectiveness of ERPs in this population and to address barriers to their adoption.

Another potential intervention for reducing HLOS, particularly for patients in the short or medium LOS groups, is the adoption of laparoscopic procedures. Laparoscopy has been discussed as a viable alternative to laparotomy in select cases, particularly for penetrating injuries.[34] While the focus of this study was on trauma laparotomy, and the use of laparoscopy in abdominal trauma has yet to reach consensus, patients undergoing laparoscopic procedures were excluded from our analysis. However, as laparoscopic techniques and equipment continue to advance, their increasing utilization should be explored. Our data may provide insights into identifying patients with trauma who could be suitable candidates for laparoscopy. Future studies are warranted to evaluate the feasibility and outcomes of incorporating laparoscopy into the management of abdominal trauma, which may ultimately contribute to further reduction in HLOS.

Prolonged hospitalizations have been a critical issue in the healthcare system, as they can pose significant clinical risks, such as hospital-acquired infections and complications, and lead to increased costs. In this study, we identified several factors associated with a long HLOS. Many of these factors, particularly trauma-related ones such as the mechanism of injury, specific injuries and procedures, injury severity and transfusion requirements, are unmodifiable. The association with long HLOS is likely correlative rather than causal, due to the numerous required interventions, high risk of complications and disposition issues. However, several factors suggest potential interventions that could mitigate prolonged hospitalization. In our study, most comorbidities were associated with long HLOS, consistent with previous studies.[35–37] Although the mean age of the long LOS group was 41.03 years, the cohort includes older patients, and adults aged 65 years and older represent the fastest-growing trauma demographic.[38] These older patients with trauma experience increased morbidity and mortality due to comorbidities, polypharmacy and frailty. Given that patients with trauma face similar challenges to those in other medical disciplines, it is crucial to involve a specialized multidisciplinary team for the initial assessment and management of these high-risk patients. Multidisciplinary care initiatives, including geriatric assessment and medication management, have been adopted by many trauma centers and have demonstrated benefits in patient outcomes.[39 40] Such interprofessional collaboration enhances communication and care coordination, promotes better patient outcomes, reduces adverse events and facilitates the implementation of evidence-based practices.[41]

Demographic factors, including race and insurance status, have been reported as associated factors of HLOS.[42] In Hwabejire's study on excessively prolonged hospitalization,[43] patients covered by Medicare or Medicaid exhibited a higher likelihood of extended HLOS, corroborating the findings of our study. Numerous studies across various medical disciplines have identified public insurance coverage, particularly Medicaid, as a significant factor associated with prolonged hospitalizations.[36 44 45] Insurance status is a crucial determinant of access to postacute care services. Medicaid is characterized by challenges such as low reimbursement rates, regional variability and administrative delays, including mandatory waiting periods.[44] Although Medicare is less frequently highlighted as a factor in HLOS due to its common role as a reference group, it also presents barriers to accessing postacute care. These barriers include coverage limitations, reduced availability of Medicare-covered postacute care services and hospital readmission penalties imposed by the Hospital Readmission Reduction Program.[46] Our study results show that patients in the long LOS group were more frequently discharged to facilities requiring extended care. This suggests that public insurance status partly influences long HLOS and indicates the need for interventions to improve access to postacute care services.

Limitations

This study utilized retrospective administrative data from a large registry and is subjected to several limitations. Variations across institutions contributing to the NTDB, including differences in patient management, outcomes, hospital systems and resources, as well as data collection and reporting processes may have influenced our findings.[47] Missing data also pose a limitation, as pairwise deletion was employed, which necessitates caution in interpreting the results. Prior research suggests that missing data in the NTDB are not entirely random, and imputation methods may provide a more robust approach for handling such gaps.[48] Additionally, inconsistencies in the reporting of injuries and procedures among trauma centers created challenges in accurately assessing specific outcomes. For instance, some centers documented only liver lacerations and liver-related procedures for patients with stab wounds, while others reported both skin and liver lacerations, along with exploratory laparotomies and liver-related procedures. These discrepancies likely led to an overestimation of exploratory laparotomies, complicating the evaluation of patients undergoing only an exploratory laparotomy.

The chosen patient cohort warrants careful consideration. We intentionally restricted the cohort to those who underwent laparotomy following abdominal injuries and excluded patients with severe injuries to body regions other than the abdomen. This approach aimed to facilitate the assessment of factors associated with HLOS in trauma laparotomy patients. However, this restriction resulted in a less representative dataset, particularly for polytrauma patients who underwent trauma laparotomy, thereby limiting the ability to evaluate this specific patient subgroup. Additionally, injuries and procedures were identified using ICD-10 codes, which, due to their detail and specificity, required categorization by organ for the purposes of this study. This approach may have limited the capture of all clinical nuances and context needed to comprehensively evaluate outcomes.

Lastly, the definition of HLOS requires careful interpretation, particularly for the shorter HLOS patient group, as patients admitted at 1:00 and 23:00 or discharged in the morning (eg, 8:00) and at night (eg, 22:00), are counted as having the same LOS. While such detailed timing data cannot be captured through the NTDB, this limitation should be considered when interpreting the results.

CONCLUSIONS

This large registry-based study assessed patients undergoing laparotomy after traumatic abdominal injuries. Even within this relatively homogeneous trauma population, there was significant variability in HLOS distribution. Stratification based on HLOS revealed distinct clinical and non-clinical factors associated with shorter and longer HLOS categories. These findings suggest that tailoring interventions to specific patient groups, such as considering the implementation of ERPs or adopting multidisciplinary approaches, may help optimize care and potentially reduce HLOS. While this study highlights the importance of addressing variability within trauma populations, further research is warranted to evaluate the effectiveness of such interventions, particularly in the context of increasingly constrained healthcare resources.

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REFERENCES

1 Fowler RA, Abdelmalik P, Wood G, Foster D, Gibney N, Bandrauk N, Turgeon AF, Lamontagne F, Kumar A, Zarychanski R, *et al*. Critical care capacity in Canada: results of a national cross-sectional study. *Crit Care* 2015;19:133.
2 Born KB, Levinson W, Pramesh CS, Kerr EA. Choosing Wisely in a time of resource constraints. *BMJ* 2024;385:q166.
3 Marsden MER, Vulliamy PED, Carden R, Naumann DN, Davenport RA, National Trauma Research and Innovation Collaborative (NaTRIC). Trauma Laparotomy in the UK: A Prospective National Service Evaluation. *J Am Coll Surg* 2021;233:383–94.
4 Bentin JM, Possfelt-Møller E, Svenningsen P, Rudolph SS, Sillesen M. A characterization of trauma laparotomies in a scandinavian setting: an observational study. *Scand J Trauma Resusc Emerg Med* 2022;30:43.
5 Kandelaki T, Evans M, Wakeman CJ, McCombie A. A review of trauma laparotomy at Christchurch Hospital. *N Z Med J* 2023;136:53–64.
6 Howes N, Walker T, Allorto NL, Oosthuizen GV, Clarke DL. Laparotomy for blunt abdominal trauma in a civilian trauma service. *S Afr J Surg* 2012;50:30–2.
7 Malik A, Szpunar S, Sharma M, Johnson LB, Saravolatz L, Bhargava A. Predictors of prolonged length of stay in adult patients with respiratory syncytial virus infections - a multi-center historical cohort study. *Front Microbiol* 2024;15:1385439.
8 Swaminathan RV, Rao SV, McCoy LA, Kim LK, Minutello RM, Wong SC, Yang DC, Saha-Chaudhuri P, Singh HS, Bergman G, *et al*. Hospital length of stay and clinical outcomes in older STEMI patients after primary PCI: a report from the National Cardiovascular Data Registry. *J Am Coll Cardiol* 2015;65:1161–71.
9 Vavalle JP, Lopes RD, Chen AY, Newby LK, Wang TY, Shah BR, Ho PM, Wiviott SD, Peterson ED, Roe MT, *et al*. Hospital length of stay in patients with non-ST-segment elevation myocardial infarction. *Am J Med* 2012;125:1085–94.
10 Rosman M, Rachminov O, Segal O, Segal G. Prolonged patients' In-Hospital Waiting Period after discharge eligibility is associated with increased risk of infection, morbidity and mortality: a retrospective cohort analysis. *BMC Health Serv Res* 2015;15:246.
11 Jacobs DG, Sarafin JL, Norton HJ, Christmas AB, Huynh T, Sing RF. Wasted Hospital Days Impair the Value of Length-of-Stay Variables in the Quality Assessment of Trauma Care. *The American Surgeon*TM 2009;75:794–803.
12 Biffl WL, Lu N, Schultz PR, Wang J, Castelo MR, Schaffer KB. Improving length of stay on a trauma service. *Trauma Surg Acute Care Open* 2021;6:e000744.
13 Brasel KJ, Lim HJ, Nirula R, Weigelt JA. Length of stay: an appropriate quality measure? *Arch Surg* 2007;142:461–5;
14 Siddique SM, Tipton K, Leas B, Greysen SR, Mull NK, Lane-Fall M, McShea K, Tsou AY. Interventions to Reduce Hospital Length of Stay in High-risk Populations: A Systematic Review. *JAMA Netw Open* 2021;4:e2125846.
15 Chang MC SR, Rotondo MF, Nathens AB. National Trauma Data Bank 2016 Annual Report. 2016.
16 Atkins K, Schneider A, Charles A. Negative laparotomy rates and outcomes following blunt traumatic injury in the United States. *Injury* 2023;54.
17 ACSCOT. National trauma data standard (NTDS): data dictionary. Available: https://www.facs.org/quality-programs/trauma/quality/national-trauma-data-bank/national-trauma-data-standard/
18 Clark JM, Utter GH, Nuño M, Romano PS, Brown LM, Cooke DT. ICD-10-CM/PCS: potential methodologic strengths and challenges for thoracic surgery researchers and reviewers. *J Thorac Dis* 2019;11:S585–95.
19 CMS. CMS.gov: 2024 ICD-10-CM. Available: https://www.cms.gov/medicare/coding-billing/icd-10-codes/2024-icd-10-cm
20 Bueno H, Ross JS, Wang Y, Chen J, Vidán MT, Normand S-LT, Curtis JP, Drye EE, Lichtman JH, Keenan PS, *et al*. Trends in length of stay and short-term outcomes among Medicare patients hospitalized for heart failure, 1993-2006. *JAMA* 2010;303:2141–7.
21 Mercedes A, Fairman P, Hogan L, Thomas R, Slyer JT. Effectiveness of structured multidisciplinary rounding in acute care units on length of stay and satisfaction of patients and staff: a quantitative systematic review. *JBI Database System Rev Implement Rep* 2016;14:131–68.
22 Grover CA, Sughair J, Stoopes S, Guillen F, Tellez L, Wilson TM, Gaccione C, Close RJH. Case Management Reduces Length of Stay, Charges, and Testing in Emergency Department Frequent Users. *West J Emerg Med* 2018;19:238–44.
23 Okere AN, Renier CM, Frye A. Predictors of Hospital Length of Stay and Readmissions in Ischemic Stroke Patients and the Impact of Inpatient Medication Management. *J Stroke Cerebrovasc Dis* 2016;25:1939–51.
24 Paton F, Chambers D, Wilson P, Eastwood A, Craig D, Fox D, Jayne D, McGinnes E. Effectiveness and implementation of enhanced recovery after surgery programmes: a rapid evidence synthesis. *BMJ Open* 2014;4:e005015.
25 Ljungqvist O, de Boer HD, Balfour A, Fawcett WJ, Lobo DN, Nelson G, Scott MJ, Wainwright TW, Demartines N. Opportunities and Challenges for the Next Phase of Enhanced Recovery After Surgery: A Review. *JAMA Surg* 2021;156:775–84.
26 Uchino H, Nguyen-Powanda P, Tokuno J, Kouyoumdjian A, Fiore JF Jr, Grushka J. Enhanced recovery protocols in trauma and emergency abdominal surgery: a scoping review. *Eur J Trauma Emerg Surg* 2023;49:2401–12.
27 Peden CJ, Aggarwal G, Aitken RJ, Anderson ID, Bang Foss N, Cooper Z, Dhesi JK, French WB, Grant MC, Hammarqvist F, *et al*. Guidelines for Perioperative Care for Emergency Laparotomy Enhanced Recovery After Surgery (ERAS) Society Recommendations: Part 1-Preoperative: Diagnosis, Rapid Assessment and Optimization. *World J Surg* 2021;45:1272–90.
28 Scott MJ, Aggarwal G, Aitken RJ, Anderson ID, Balfour A, Foss NB, Cooper Z, Dhesi JK, French WB, Grant MC, *et al*. Consensus Guidelines for Perioperative Care for Emergency Laparotomy Enhanced Recovery After Surgery (ERAS®) Society Recommendations Part 2-Emergency Laparotomy: Intra- and Postoperative Care. *World J Surg* 2023;47:1850–80.
29 Peden CJ, Aggarwal G, Aitken RJ, Anderson ID, Balfour A, Foss NB, Cooper Z, Dhesi JK, French WB, Grant MC, *et al*. Enhanced Recovery After Surgery (ERAS) Society

Consensus Guidelines for Emergency Laparotomy Part 3: Organizational Aspects and General Considerations for Management of the Emergency Laparotomy Patient. *World J Surg* 2023;47:1881–98.
30 Moydien MR, Oodit R, Chowdhury S, Edu S, Nicol AJ, Navsaria PH. Enhanced recovery after surgery (ERAS) in penetrating abdominal trauma: A prospective single-center pilot study. *S Afr J Surg* 2016;54:7–10.
31 Purushothaman V, Priyadarshini P, Bagaria D, Joshi M, Choudhary N, Kumar A, Kumar S, Gupta A, Mishra B, Mathur P, *et al*. Enhanced recovery after surgery (ERAS) in patients undergoing emergency laparotomy after trauma: a prospective, randomized controlled trial. *Trauma Surg Acute Care Open* 2021;6:e000698.
32 Fonseca MK, Rizental LB, da Cunha CEB, Baldissera N, Wagner MB, Fraga GP. Applying enhanced recovery principles to emergency laparotomy in penetrating abdominal trauma: a case-matched study. *Eur J Trauma Emerg Surg* 2024;50:2123–35.
33 Jain V, Irrinki S, Khare S, Kurdia KC, Nagaraj SS, Sakaray YR, Savlania A, Tandup C, Verma P, Kaman L. Implementation of modified enhanced recovery after surgery (ERAS) following surgery for abdominal trauma; Assessment of feasibility and outcomes: A randomized controlled trial (RCT). *Am J Surg* 2024;238:115975.
34 Elkbuli A, Newsome K, Fanfan D, Sutherland M, Bilski T, Liu H, Ang D. Laparoscopic Versus Laparotomy Surgical Interventions for Trauma Patients With Single Upper Left Quadrant Penetrating Injuries: Analysis of the American College of Surgeons Trauma Quality Improvement Program Dataset. *Am Surg* 2022;88:2182–93.
35 Krell RW, Girotti ME, Dimick JB. Extended length of stay after surgery: complications, inefficient practice, or sick patients? *JAMA Surg* 2014;149:815–20.
36 Anderson ME, Glasheen JJ, Anoff D, Pierce R, Capp R, Jones CD. Understanding predictors of prolonged hospitalizations among general medicine patients: A guide and preliminary analysis. *J Hosp Med* 2015;10:623–6.
37 Doctoroff L, Herzig SJ. Predicting Patients at Risk for Prolonged Hospital Stays. *Med Care* 2020;58:778–84.
38 Eagles D, Godwin B, Cheng W, Moors J, Figueira S, Khoury L, Fournier K, Lampron J. A systematic review and meta-analysis evaluating geriatric consultation on older trauma patients. *J Trauma Acute Care Surg* 2020;88:446–53.
39 Pannick S, Davis R, Ashrafian H, Byrne BE, Beveridge I, Athanasiou T, Wachter RM, Sevdalis N. Effects of Interdisciplinary Team Care Interventions on General Medical Wards: A Systematic Review. *JAMA Intern Med* 2015;175:1288–98.
40 Dugan JP, Burns KM, Baldawi M, Heidt DG. Impact of geriatric consultations on clinical outcomes of elderly trauma patients: A retrospective analysis. *The American Journal of Surgery* 2017;214:1048–52.
41 Urisman T, Garcia A, Harris HW. Impact of surgical intensive care unit interdisciplinary rounds on interprofessional collaboration and quality of care: Mixed qualitative-quantitative study. *Intensive Crit Care Nurs* 2018;44:18–23.
42 McQuistion K, Zens T, Jung HS, Beems M, Leverson G, Liepert A, Scarborough J, Agarwal S. Insurance status and race affect treatment and outcome of traumatic brain injury. *J Surg Res* 2016;205:261–71.
43 Hwabejire JO, Kaafarani HMA, Imam AM, Solis CV, Verge J, Sullivan NM, DeMoya MA, Alam HB, Velmahos GC. Excessively long hospital stays after trauma are not related to the severity of illness: let's aim to the right target! *JAMA Surg* 2013;148:956–61.
44 Cai C, Lindquist K, Bongiovanni T. Factors associated with delays in discharge for trauma patients at an urban county hospital. *Trauma Surg Acute Care Open* 2020;5:e000535.
45 Yue JK, Krishnan N, Chyall L, Vega P, Hamidi S, Etemad LL, Tracey JX, Tarapore PE, Huang MC, Manley GT, *et al*. Socioeconomic and clinical factors associated with prolonged hospital length of stay after traumatic brain injury. *Injury* 2023;54.
46 CMS. cms.gov: hospital readmissions reduction program (HRRP). Available: https://www.cms.gov/medicare/payment/prospective-payment-systems/acute-inpatient-pps/hospital-readmissions-reduction-program-hrrp
47 Haider AH, Saleem T, Leow JJ, Villegas CV, Kisat M, Schneider EB, Haut ER, Stevens KA, Cornwell EE 3rd, MacKenzie EJ, *et al*. Influence of the National Trauma Data Bank on the study of trauma outcomes: is it time to set research best practices to further enhance its impact? *J Am Coll Surg* 2012;214:756–68.
48 Roudsari B, Field C, Caetano R. Clustered and missing data in the US National Trauma Data Bank: implications for analysis. *Inj Prev* 2008;14:96–100.