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30-day adverse events, length of stay and re-admissions following surgical management of pelvic/acetabular fractures

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ABSTRACT

Introduction: Pelvic/acetabular fractures are associated with significant morbidity, mortality and cost to the society. We sought to utilize a national surgical database to assess the incidence and factors associated with prolonged length of stay (LOS), non-home discharge destination, 30-day adverse events and readmissions following surgical fixation of pelvic/acetabular fractures.

Materials & methods: The 2011–2016 ACS-NSQIP database files were queried using CPT codes (27215, 27217, 27218, 27226, 27227, 27228) for patients undergoing open reduction/internal fixation (ORIF) for pelvic/acetabular fractures. Patients undergoing additional procedures for associated fractures (vertebral fractures, distal radius/ulna fractures or femoral neck/hip fractures) were excluded from the analysis to ensure that a relevant population of patients with isolated pelvic/acetabular injuries were included in the analysis. A total of 572 patients were included in the final cohort. Severe adverse events (SAE) were defined as: death, ventilator use >48 h, unplanned intubation, stroke, deep venous thrombosis, pulmonary embolism, cardiac arrest, myocardial infarction, acute renal failure, sepsis, septic shock, re-operation, deep SSI and organ/space SSI. Minor adverse events (MAE) included – wound dehiscence, superficial SSI, urinary tract infection (UTI) and progressive renal insufficiency. An extended LOS was defined as >75th centile (>9days).

Results: Factors associated with AAE were partially dependent functional health status pre-operatively ($p = 0.020$), transfusion $\geq$1 unit of packed RBCs ($p = 0.001$), and ASA > II ($p < 0.001$). Experiencing a SAE was associated with congestive heart failure (CHF) pre-operatively [$p = 0.005$], total operative time >140 min ($p = 0.034$) and Hct <36 pre-operatively ($p = 0.003$). MAE was associated with transfusion$\geq$1 unit of packed RBCs ($p = 0.022$) and ASA > II ($p = 0.007$). Patients with an ASA > II ($p = 0.001$), total operative time>140 min ($p < 0.001$) and Hct <36 ($p = 0.006$) were more likely to have a LOS >9 days. Male gender ($p = 0.026$), prior history of CHF ($p = 0.024$), LOS >9 days ($p = 0.030$) and >10% bodyweight loss in last 6 months before the procedure ($p = 0.002$) were predictors of 30-day mortality.

Conclusion: Patients with ASA grade > II, greater co-morbidity burden and prolonged operative times were likely to experience adverse events and have a longer length of stay. Surgeons can utilize this data to risk stratify patients so that appropriate pre-operative and post-operative medical optimization can take place.

1. Introduction

Although rare in occurrence, accounting for only 2–8% of all fractures,[1] pelvis and acetabular fractures pose a challenging task to an orthopaedic surgeon not only due to the complex surgical technique required for the operative management of these fractures, but also due to increased risk for post-operative morbidity [2,3] and mortality[4–6] associated with these injuries. With open reduction and internal fixation (ORIF) becoming a standard of care for management of these fractures,[7,8] the practice of relying on surgical fixation of pelvic/acetabular fractures as a mainstay of treatment has gradually risen. Buller et al. reported an increase in the incidence of pelvic fractures from 1990 (27.2/100,000) to 2007 (34.3/

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100,000) in the United States, with an associated increase from 7.22% to 10.36% in surgical procedures performed for these fractures.[1] Past literature investigating surgical outcomes following operative management of pelvic/acetabular fractures is largely limited due to smaller sample sizes[6] that may have not enough significant power to detect complications. Furthermore, studies elucidating outcomes for pelvis and acetabular injuries, such as mortality, largely consist of non-US literature which may not necessarily represent the outcomes for the United States population.[4,9–14]

Given the limitations of previous studies, we sought to utilize a large national surgical database to attempt to answer our primary research questions – 1) What are the incidence and risk factors associated with 30-day adverse events? 2) What factors predispose patients to a prolonged length of stay? And 3) What pre-operative and operative factors can predict 30-day readmissions, 30-day mortality and non-home discharge in patients undergoing surgical fixation of pelvic/acetabular fractures.

2. Materials & Methods

2.1. Database

This study was a retrospective review of data from a prospectively collected surgical database. The 2011–2016 American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) database files were used for this study. The ACS-NSQIP is a de-identified surgical database made publicly available to more than 500 participating hospitals in the United States. The ACS-NSQIP database records surgical outcome variables up to 30 days following the procedure, and data are collated using a strict protocol and regular auditing by trained clinical and surgical reviewers. The ACS-NSQIP database is reported to have an inter-reviewer disagreement rate of less than 2%.[15] Current Procedural Terminology (CPT) codes (27215, 27217, 27218, 27226, 27227 and 27228) were used to query for records of patients undergoing open reduction/internal fixation (ORIF) for pelvis or acetabular fractures. Patients undergoing additional procedures for associated fractures such as vertebral fractures, distal radius fractures, proximal humerus fractures, femoral neck fractures and tibial fractures were excluded to ensure that a relevant population of patients undergoing surgical management of isolated pelvic/acetabular injuries were included in the study. Patients with missing data were also excluded from the study. A total of 572 patients were included in the final cohort.

2.2. Baseline demographic and clinical variables

Patient demographics and clinical data that were included as part of the study to allow appropriate analysis were – Age (years; 0–50, 51–65, 66–80 and > 80), gender (male or female), body mass index/BMI (kg/m^2; <25.0, 25.0–29.9, 30.0–34.9 and ≥ 35.0), race (White, Black or African-American, Asian, American Indian or Alaska Native, unknown/not reported), co-morbidities, transfer status (home, acute-care hospital/inpatient, nursing home/chronic care facility, outside emergency department/ED and other/unknown), anesthesia type (general, other and unknown), ASA grade (≤II and >II) and total operative time (0–140 min and >140 min). Additionally, lab parameters for serum sodium (Na), serum albumin (Alb), white blood cell counts (WBC) and hematocrit (Hct) were used to categorize the following variables – Hyponatremia (Na<135meq/L), Hypoalbuminemia (<3.5 g/dL), abnormal WBC counts (<4.5 and >11.0) and low hematocrit (Hct<36).

2.3. Outcome variables

Thirty-day complications, as defined by NSQIP, were grouped into two variables: Severe Adverse Event (SAE) and Minor Adverse Event (MAE). SAE was defined as the occurrence of any of the following 30-day outcome variables – mortality, ventilator use >48 h, unplanned intubation, stroke, deep venous thrombosis (DVT), pulmonary embolism, cardiac arrest, myocardial infarction, acute renal failure, sepsis, septic shock, deep surgical site infection (SSI), organ/space SSI and any re-operations within 30 days. MAE included – wound dehiscence, superficial SSI, urinary tract infection (UTI) and progressive renal insufficiency. An additional variable termed as Any Adverse Event (AAE) was created which recorded the occurrence of at least one SAE or MAE. Another variable termed as "Infectious complications" was created included the presence of at least one post-operative infectious complications (pneumonia, UTI, any SSI, sepsis and septic shock) within 30 days of the procedure. Based on previous NSQIP literature on orthopedic trauma, an extended length of stay (LOS) was defined as the LOS >75th percentile of the study population (9 days). We also analyzed predictors of non-home discharge disposition and mortality following the procedure.

2.4. Statistical analysis

Descriptive analysis was performed to report frequencies of baseline demographics and clinical characteristics of the study population. For each outcome variable (SAE, MAE, AAE, infectious complications, LOS >9 days, non-home discharge, 30-day readmissions and mortality), univariate analysis was performed using Pearson-Chi square test to identify significant associations present between clinical data and outcome variables. Each outcome variable was then entered into individual backward elimination logistic regression models, while adjusting for all baseline demographics and clinical characteristics of the study population. For "mortality", "30-day readmissions" and "non-home discharge", LOS was included as part of multi-variate analysis. In addition, 'non-home discharge' was also included as part of multi-variate analysis of 30-day readmissions, as recent orthopaedic literature has shown that discharge destination is known to significantly impact re-admission rates.[16] All variables, following multivariate analysis, with a p-value<0.05 were considered statistically significant. Significant results from multivariate analyses were reported as odds ratios (OR) with 95% confidence intervals (CI). All statistical analysis was performed using SPSSv22 (IBM, Armonk, NY).

3. Results

3.1. Baseline clinical characteristics

Baseline demographic and clinical characteristics of the study population are shown in Table 1**.** The majority of the patients are in the age group of 66–80 years (N = 160; 28.0%) and 18–50 years (N = 152; 26.6%). Forty-two percent of patients undergoing surgical treatment of pelvis or acetabular fractures had a BMI<25.0 kg/m^2. Three hundred and seventy four patients (65.4%) were admitted directly from home, while 81 (14.2%) patients were admitted from acute-care hospital/inpatient locations and 98 (17.1%) patients were admitted from outside emergency departments. The fracture locations varied, with 22 (3.8%) of the fractures involving the iliac/tuberosity/wing, while 59 (10.3%) were pelvic ring and 491 (85.8%) involved the acetabulum.

Table 1
Baseline clinical characteristics of study population.

Variable	Number(N)	Percentage (%)
Total	572	100.0
Age		
18–50	152	26.6
51–65	116	20.3
66–80	160	28.0
>80	144	25.2
Gender		
Male	291	50.9
Female	281	49.1
BMI(kg/m^2)		
<25.0	240	42.0
25.0–29.9	178	31.1
30.0–34.9	82	14.3
≥35.0	72	12.6
Race		
White	441	77.1
Black or African American	38	6.6
Asian	10	1.7
American Indian or Alaska Native	3	0.5
Unknown/Not Reported	80	14.0
Co-Morbids		
Diabetes Mellitus		
-IDDM	50	8.7
-NIDDM	46	8.0
Smoking	103	18.0
Dyspnea		
-At rest	1	0.2
-Moderate exertion	18	3.1
Functional health status		
-Independent	512	89.5
-Partially dependent	52	9.1
-Totally dependent	6	1.0
-Unknown	2	0.3
Ventilator use	3	0.5
History of severe COPD	44	7.7
Ascites	1	0.2
Congestive Heart Failure (CHF)	9	1.6
Hypertension	294	51.4
Pre-op dialysis	4	0.7
Disseminated cancer	8	1.4
Wound infection	18	3.1
Steroid use	19	3.3
>10% weight loss in last 6 months	6	1.0
Bleeding disorders	52	9.1
Transfusion≥1 unit in last 72 h	42	7.3
Sepsis/Septic Shock/SIRS	48	8.4
Transfer from		
Home	374	65.4
Acute care hospital – inpatient	81	14.2
Nursing home – Chronic Care	14	2.4
Outside Ed	98	17.1
Other	5	0.9
Anesthesia		
General	511	89.3
Unknown	1	0.2
Other	60	10.5
ASA Grade		
≤II	239	41.8
>II	333	58.2
Total Operative Time(mins)		
0–140	289	50.5
>140	283	49.5
Length of stay(days)		
0–9	453	79.2
>9	119	20.8
Hyponatremia(<135meq/L)		
No	454	79.4
Yes	88	15.4
Missing	30	5.2
Hypoalbuminemia(<3.5 g/dL)		
No	143	25.0
Yes	131	22.9
Missing	298	52.1
White Blood Cell Count(WBC)		
4.5–11.0	417	72.9
<4.5	18	3.1
>11.0	111	19.4
Missing	26	4.5
Hematocrit(Hct)		
<36	251	43.9
≥36	301	52.6
Missing	20	3.5
Discharge Disposition		
Home	218	38.8
Non-Home	344	61.2

3.2. 30-Day adverse events

A total of 97 (17.0%) patients experience at least one adverse event (AAE) within 30 days of fracture fixation, with 74 (12.9%) experiencing a SAE and 40 (7.0%) experiencing a MAE (Table 2). Univariate analysis of factors associated with occurrence of AAE, SAE and MAE are shown in Supplementary Tables 1–3 respectively. Following adjustment for baseline clinical characteristics (Table 3), independent significant factors associated with occurrence of AAE were having a partially dependent functional health status prior to surgery (OR 2.16 [95% CI 1.13–4.14]; $p = 0.020$), transfusion≥1 unit of packed RBCs in the 72 h pre-operatively (OR 3.20 [95% CI 1.62–6.32]; $p = 0.001$), and ASA > II (OR 2.90 [95% CI 1.65–5.12]; $p < 0.001$). Experiencing a SAE was associated with CHF [OR 4.91 [95% CI 1.18–20.4]; $p = 0.005$), total operative time>140 min (OR 1.75 [95% CI 1.04–2.94]; $p = 0.034$) and Hct <36 (OR 2.46 [95% CI 1.36–4.45]; $p = 0.003$). Occurrence of MAE was associated with transfusion≥1 unit of packed RBCs (OR 2.61 [95% CI 1.14–5.96]; $p = 0.022$) and ASA > II (OR 2.88 [95% CI 1.34–6.17]; $p = 0.007$).

3.3. Infectious complications

Infectious complications within 30 days of the procedure occurred in 47 (8.2%) patients. Univariate analysis of factors associated with infectious complications is shown in Supplementary Table 4. Following multivariate analysis, transfusion≥1 unit of packed RBCs (OR 2.61 [95% CI 1.14–5.96]; $p = 0.023$) and ASA > II (OR 2.88 [95% CI 1.34–6.17]; $p = 0.007$) were significantly associated with occurrence of infectious complications (Table 3).

3.4. Extended length of stay (LOS) and 30-day readmissions

Length of stay greater than 9 days occurred in 119 (20.8%) patients and 41 (7.2%) patients were re-admitted within 30 days of the operation. Uni-variate analysis of factors associated with an extended LOS and 30-day readmissions are shown in Supplementary Table 5. Patients with an ASA > II (OR 2.61 [95% CI 1.51–4.51]; $p = 0.001$), total operative time>140 min (OR 2.70 [95% CI 1.70–4.30]; $p < 0.001$) and Hct <36 pre-operatively (OR 2.07

Table 2
Post-operative outcomes.

Variable	Number(N)	Percentage (%)
Any adverse event (AAE)	97	17.0
Severe adverse event (SAE)	74	12.9
Minor adverse event (MAE)	40	7.0
Infectious complications	47	8.2
Extended LOS>9 days	119	20.8
30-day readmissions	41	7.2
Non-Home discharge	344	61.2
Mortality	23	4.0

Table 3
Multi-variate logistic regression models for each of the outcome variables adjusted for all baseline clinical characteristics from Table 1. Adjusted/Controlled for age, gender, BMI, race, co-morbidities, transfer status, anesthesia type, ASA grade, total operative time, hyponatremia, hypoalbuminemia, WBC count and hematocrit. For "Mortality", "30-day readmissions" and "non-home discharge", extended LOS>9 days was included as part of multi-variate analysis. In addition, "non-home discharge" was also included as part of multi-variate analysis in 30-day readmissions.

Variable	OR [95% CI]	P-value
Any adverse event(AAE)		
- Partially dependent functional health status	2.16 [1.13–4.14]	0.020
- Transfusion≥1 units of packed RBCs	3.20 [1.62–6.32]	0.001
- ASA > II	2.90 [1.65–5.12]	<0.001
Severe adverse event(SAE)		
- CHF in 30 days before surgery	4.91 [1.18–20.4]	0.005
- Operative Time>140 min	1.75 [1.04–2.94]	0.034
- Hct<36	2.46 [1.36–4.45]	0.003
Minor adverse event(MAE)		
- Transfusion≥1 units of packed RBCs	2.76 [1.16–6.57]	0.022
- ASA > II	2.65 [1.18–5.97]	0.019
Infectious complications		
- Transfusion≥1 units of packed RBCs	2.61 [1.14–5.96]	0.023
- ASA > II	2.88 [1.34–6.17]	0.007
Extended LOS>9 days		
- ASA > II	2.61 [1.51–4.51]	0.001
- Operative Time>140 min	2.70 [1.70–4.30]	<0.001
- Hct<36	2.07 [1.23–3.48]	0.006
30-day readmissions		
- Non-home discharge	3.96 [1.43–10.9]	0.008
Non-Home discharge		
- Age		
51–65	2.02 [1.09–3.76]	0.027
66–80	12.81 [6.65–24.7]	<0.001
>80	34.2 [14.6–80.3]	<0.001
- Bleeding disorders	3.12 [1.02–9.55]	0.046
-Transfer from		
Outside ED	2.02 [1.06–3.88]	0.033
Other	20.9 [2.04–213.1]	0.010
- ASA > II	2.50 [1.52–4.11]	<0.001
- LOS>9 days	2.56 [1.32–4.94]	0.005
Mortality		
- Male gender	2.98 [1.14–7.82]	0.026
–CHF in 30 days before surgery	7.44 [1.30–42.4]	0.024
-LOS>9 days	2.90 [1.11–7.57]	0.030
- >10% bodyweight loss in last 6 months	27.8 [3.29–235.7]	0.002

[95% CI 1.23–3.48]; p = 0.006) were more likely to stay for more than 9 days in the hospital. The only significant independent predictor for 30-day readmissions was a non-home discharge (OR 3.96 [95% CI 1.43–10.9]; p = 0.008) (Table 3).

3.5. Non-home discharge and 30-day mortality

The majority of patients had a discharge destination to a care facility with 344 (61.2%) of patients discharged to a non-home destination following surgery. The overall 30-day mortality rate was 4.0% (N = 23). Univariate analysis of factors associated with non-home discharge and 30-day mortality are shown in Supplementary Table 6. Age >50 years, prior history of bleeding disorders, transfer from outside ED, ASA > II and LOS>9 days were significant predictors of a non-home discharge. Male gender (OR 2.98 [95% CI 1.14–7.82]; p = 0.026), prior history of CHF (OR 7.44 [95% CI 1.30–42.4]; p = 0.024), LOS>9 days (OR 2.90 [95% CI 1.11–7.57]; p = 0.030) and >10% bodyweight loss in last 6 months before the procedure (OR 27.8 [95% CI 3.29–235.7]; p = 0.002) were significantly associated with death within 30 days of procedure (Table 3).

4. Discussion

Despite an increasing trend of surgical fixations being performed for pelvis and acetabulum fractures, the literature largely remains limited to single-institution studies with small sample sizes. The current study using a cohort of 572 patients from a well-audited national surgical database found that patients with higher ASA grades and/or co-morbidity burden and dependent functional health status pre-operatively were more likely to experience an adverse event. Interestingly, the results also showed that having patients being discharged to a non-home destination (e.g. facility) vs. home increased the risk of re-admissions following pelvic/acetabular fracture fixation.

Due to increased co-morbidity burden posed by dependent functionality status and ASA > II, it is not surprising that for the current study, these patients are prone to experiencing adverse events. With a low functional health status, it may be difficult to implement early mobilization in these patients making them more prone to developing thrombo-embolic complications. While literature exploring the impact of blood transfusions in pelvic/acetabular fractures is limited, Kozanek et al. showed that patients receiving allogenic transfusion for proximal humerus fractures tended to stay longer, experience more adverse events and were less likely to discharged home.[17] Furthermore, similar to our findings, pre-operative blood transfusions is known to pre-dispose patients to an increased risk of infections through an unknown etiology.[18,19] Although clinical symptoms and hemoglobin level largely influence the choice of massive transfusions in these patients, providers should consider the use of more sensitive laboratory markers such as serum lactate and base deficit, along with regular measurements of coagulation profiles,[20] to ensure that a judicious protocol of blood transfusion be implemented to minimize risks of adverse events and curb excess health-care resource utilization in the post-operative period. Other alternative approaches such as intraoperative cell-saver therapy,[21] early-on angio-embolization in suspected patients,[22] autologous transfusions and erythropoietin analogs may hold promise for the future.

Our results show that an ASA > II was a common predictor of experiencing AAE, MAE, infectious complications, extended LOS>9 days and a non-home discharge. The ASA grade, first introduced in 1941, aims to risk-stratify patients based on pre-existing co-morbidities to allow providers to gain a subjective assessment of patient's illness severity prior to undergoing a procedure.[23] While increasing ASA score has been shown to be associated with poor post-operative morbidity in surgical literature,[24] few articles have focused on orthopaedic trauma literature with the majority of trauma studies focusing on hip fractures.[25–27] Literature assessing the impact of ASA scores on post-operative outcomes following ORIF for pelvic/acetabular fractures is largely limited. Kay et al. assessed the impact of ASA score on length of stay and inpatient costs for orthopaedic trauma patients by conducting a chart-based review of all orthopaedic trauma procedures performed at a single institution. The authors found that for each increase in ASA grade, the LOS increased by 3.4 days for patients undergoing open treatment of posterior/anterior acetabular wall fractures.[28] However, the findings of the current study are similar to past non-pelvic/acetabular orthopedic trauma literature. Using a variable definition similar to ours, Basques et al. reported an ASA > II to be significantly associated with AAE, SAE and infectious complications in patients undergoing ORIF for ankle fractures.[29] In another study by Basques et al. increasing ASA class was significantly associated with AAE, infectious complications and increased length of stay in patients undergoing ORIF for tibial plateau fractures.[30]

The study also found that a total operative time>140 min and pre-operative anemia (Hct<36) to be associated with higher odds of having a longer operative length of stay. An increased total operative time could be partly explained by the complexity of the case

which may require more-postoperative management and rehabilitation, thus increasing the hospital length of stay in these patients. It is also plausible that these patients might have concurrent chronic diseases, which lowered their tolerance reserve for longer procedures, and thus may have required more post-operative care.

More than 60% of patients were discharged to a destination other than home with older adults, pre-operative bleeding disorders, a transfer from outside ED, ASA > II and LOS >9 days to be significantly associated with a non-home discharge. While doctors can utilize these predictor variables to filter for patients who can be discharged early to inpatient care facilities in an attempt to reduce the risk of contracting nosocomial complications from a prolonged length of stay in these high-risk patients, one must also be cautious of the negative clinical impact of a non-home discharge on post-discharge outcomes.

The overall re-admission rate following surgical fixation of pelvis or acetabular fracture was 7.2%. Previous literature have reported 30-day re-admission rates of isolated acetabular and/or pelvic fractures to range from 4.2% to 8.6%,[31,32] however these numbers are limited by the smaller sample sizes analyzed in studies. The only factor independently associated with 30-day readmissions was a non-home discharge. With recent elective arthroplasty literature reporting the impact of discharge to non-home destinations, such as inpatient care facilities, on post-discharge outcomes and re-admissions, the finding of the current study highlights the need for care pathways aimed at reducing the re-admissions associating with stay in facilities.[16,33]

Our analysis also found that male gender, having CHF within 30 days before surgery, a >10% bodyweight loss in last 6 months to be associated with death within 30 days of the procedure. Basques et al. mentioned that males are in general, more likely to take part in high-risk activities, and therefore more likely to experience adverse outcomes.[30] Given the relatively high amount of blood loss associated with pelvic/acetabular fractures, the odds of developing decompensated heart failure, due to over-activity of sympathetic nervous system on the heart, in these patients would be relatively high and may indirectly lead to mortality. Similarly, a >10% bodyweight loss, may be tied to increased frailty and sarcopenia in these patients, both of which have been known to impact mortality in patients.[34–36] However, currently the NSQIP does not hold granular clinical data that can allow us to assess sarcopenia or fully assess frailty in these patients. Future incorporation of these variables in these databases may hold affirmative answers to these questions.

There are a number of limitations that need to be taken into context when interpreting the results of this study. The NSQIP, despite being a well-audited surgical database, records a number of pre-defined complications up to 30 days following the procedure. Given that certain complications such as SSIs are known to be taking place well beyond the 30-day period,[37] it is plausible that the current capture may not be entirely accurate. Moreover, the lack of functional scores post-operatively is also a major limitation to the study. The NSQIP lacks granular fracture-specific clinical data, such as classifications and differentiation between high-energy and low-energy fractures. The NSQIP only records operative procedures, and therefore we were unable to analyze how the other subset of patients who underwent non-operative treatment may have fared. Finally, hospital-specific and provider-specific data such as surgical case volume are not present in the database, which may implicate the results given that underlying volume-outcome relationships have been discovered in surgically treated pelvic/acetabular fractures.[38] Finally, a majority of the hospitals in the NSQIP are academic medical centers and thus, the results from these hospitals may not be representative of cases being performed at smaller, community hospitals.

5. Conclusion

Patients with higher ASA grades, dependent functional health status, concurrent major co-morbidities (such as CHF prior to surgery, pre-operative blood transfusion) and longer operative times are more likely to experience adverse events following surgery. Furthermore, having patients discharged to a facility vs. home is associated with higher risk of 30-day re-admissions. Given the paucity of research with regard to surgical outcomes in these patients, surgeons can utilize this data to better identify patients who may be at risk of experiencing adverse outcomes following the procedure to ensure that appropriate pre-operative and post-operative medical optimization can take place.

Conflicts of interest and sources of funding

None declared.

Disclosures

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors. Since data was derived from a de-identified database, it was exempt from Institutional Review Board (IRB) approval.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcot.2019.02.010.

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