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Drivers of hospital length of stay in 56,000 orthopaedic trauma patients: The impact of postoperative cardiac events

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ABSTRACT

Purpose: To determine whether postoperative cardiac complications following orthopaedic trauma treatment are associated with longer lengths of stay.
Methods: This was a retrospective cohort study. We analyzed orthopaedic trauma patients in the United States for whom data was collected in the ACS-NSQIP database between the years of 2006 and 2013. The patient population included 56,217 orthopaedic trauma patients meeting any 1 of the 89 CPT codes selected in the ACS-NSQIP database. The main outcome measure was hospital length of stay following orthopaedic trauma treatment.
Result: Of the 56,217 orthopaedic trauma patients, 749 (1.3%) developed postoperative adverse cardiac events. There was a significant difference in total length of stay ($p < 0.001$): patients with cardiac complications on average stayed 10.6 days compared to 5.2 days for patients who did not experience such cardiac complications. This amounted to a difference of $24,316 in total hospital costs. Through multiple linear regression modeling controlling for multiple patient and surgical factors, the presence of cardiac complications significantly added 1.5 days in total hospital stay ($p < 0.05$).
Conclusion: Orthopaedic trauma patients sustaining postoperative cardiac events have significantly longer hospital lengths of stay when compared to those who do not develop cardiac complications. This difference amounts to significantly higher health care costs.
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1. Introduction

As health care costs in the United States continue to rise there has been increased emphasis on cost containment. With health care spending totaling close to 20% of the United States' Gross Domestic Product (GDP) it becomes increasingly important to determine those factors driving increased spending. In the surgical patient, a major determinant of hospital costs and measure of the quality of care is length of hospital stay. Currently, little data exists on whether postoperative cardiac events prolong the length of stay for orthopaedic trauma patients. Previous literature has documented a correlation between post-operative cardiac events and increased length of stay in specific cohorts, but there has yet to be a study that examines this relationship within the orthopaedic trauma population.[1–3] This study utilized the American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) database to determine whether postoperative cardiac complications were associated with longer lengths of stay in a large, multicenter, prospective cohort of orthopaedic trauma patients.

Following noncardiac surgery, adverse cardiovascular events are the largest contributor to morbidity and mortality, driving increased length of hospital stay and hospitalization costs.[4] Postoperative myocardial injury was found to increase hospital length of stay by five to eleven days.[4,5] Increased length of stay is a function of the need for increased hemodynamic monitoring following cardiac events and monitoring of concomitant chronic disease in these patients. There have been a number of studies that examine the factors affecting the length of stay among orthopaedic patients. Pugely et al. showed that medical comorbidities in patients undergoing total knee arthroplasty, including obesity, diabetes, and hypertension, increases hospital length of stay, resource utilization, and hospital costs.[6] Medical comorbidities showed an incremental effect on hospital costs and length of stay; each additional comorbidity was found to add to costs and length of stay. Belmont et al. showed age greater than 80, hypertension,

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and history of cardiac disease to be significant independent predictors for the development of post-operative cardiac complications in patients undergoing primary unilateral total knee arthroplasty and total hip arthroplasty.[7] However, despite these data, the effect of post-operative cardiac events on length of stay for orthopaedic trauma patients has not been evaluated.

The American College of Cardiology (ACC) and the American Heart Association (AHA) reported orthopaedic surgery is associated with significant perioperative cardiovascular morbidity and mortality with up to 5% of patients experiencing postoperative cardiac complications.[8] However, limited data exists that investigates which types of orthopaedic patients are at greatest risk for developing postoperative cardiac complications. Even fewer data exist to determine the financial impact of sustained postoperative cardiac events in orthopaedic trauma patients due to increased length of hospital stay. With a healthcare system in which postoperative complications are continually assessed and examined as indicators of

quality of care and possess potential consequence on reimbursement models, understanding the financial impact of these complications and working to reduce them will be of great significance for practicing orthopaedists.[9]

The purpose of this study was to determine the incidence of postoperative cardiac complications in the orthopaedic trauma patient and the relationship of such events with hospital length of stay and total hospital costs in a large, diverse, multicenter patient cohort. The ACS-NSQIP database was used in conjunction with Current Procedural Terminology codes (CPT) to identify over 56,000 orthopaedic trauma patients and assess the impact of postoperative cardiac complications on length of hospital stay.

2. Materials and methods

2.1. Data

Retrospective identification of 361,402 patients from 2006 to 2013 in the ACS-NSQIP database was conducted through a Current Procedural Terminology (CPT) code search. Of these patients 56,217 orthopaedic trauma cases were identified through a search of 89 CPT codes (Appendix A).

Cases were deemed to have developed a postoperative cardiac event, the main associated factor of interest, if either (1) a myocardial infarction or (2) cardiac arrest occurred within 30 days following treatment of an orthopaedic trauma event. These two variables were represented in the NSQIP data as their respective frequencies within the 30-day postoperative period. Therefore, both myocardial infarction and cardiac arrest were recoded into a single binary variable represented by adverse cardiac event.

A total of thirty-one independent variables, including adverse cardiac events, were chosen based on their suspected relationship with hospital length of stay to be used in a linear regression model further characterizing those factors influencing hospital length of stay in orthopaedic trauma patients. These associated factors included the following: gender, type of anesthesia, diabetes status, smoking status, body mass index, chronic obstructive pulmonary disease, hypertension, preoperative renal failure, preoperative dialysis, American Society of Anesthesiologists (ASA) Grade 2, preoperative pneumonia, postoperative pneumonia, urinary tract infection, prior operation within 30 days, failure to wean off of ventilation, cancer, previous myocardial infarction, postoperative acute renal failure, congestive heart failure, superficial surgical site infection, deep surgical site infection, emboli, organ space infection, postoperative chronic renal insufficiency, radiation therapy, wound disruption, need to reintubate, stroke, peripheral nerve damage, and ventilator use prior to operation.

2.2. Analysis

Statistical analyses were conducted utilizing IBM SPSS Statistics ™ Software Version 22. A *t*-test was performed to determine the difference in mean hospital length of stay for those individuals experiencing a postoperative adverse cardiac event versus those who did not experience such an event. Following, a multiple linear regression model was fit to hospital length of stay data to determine the impact of all independent variables on length of stay following orthopaedic trauma treatment. This regression model controlled for multiple patient and surgical factors including type of anesthesia used, diabetes status, smoking status, body mass index, chronic obstructive pulmonary disease, hypertension, preoperative renal failure, and preoperative dialysis. The difference in hospital costs between patients who sustained cardiac complications and those who did not was determined

Table 1
Baseline characteristics of entire orthopaedic trauma cohort and subset of those experiencing adverse cardiac events postoperatively.

Patient and Surgical Factor	Orthopaedic Trauma Cohort		Adverse Cardiac Event Cohort	
n (Total)	*56,217*	*100%*	*749*	*100%*
Male	19,900	35.4	289	38.6
Female	36,316	64.6	460	61.4
Smokers	9782	17.4	98	13.1
History of COPD	4497	8.0	157	21
ASA 1	5453	9.7	2	0.3
ASA 2	17,708	31.5	63	8.4
ASA 3	26,253	46.7	443	59.1
ASA 4	6690	11.9	238	31.8
ASA 5	56	0.1	3	0.4
General Anesthesia	44,692	79.5	542	72.4
Diabetes	8995	16	214	28.6
Hypertension	29,964	53.3	601	80.2
Body Mass Index Heavy	12,861 (56,160)	22.9	124 (692)	17.9
Congestive Hearth Failure	1237	2.2	67	8.9
Myocardial Infarction	211 (21,533)	1.0	11 (267)	4.1
Cancer	1278	2.3	14	1.9
Prior Operation	553 (21,625)	2.6	2 (270)	0.7

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