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# Does the timing of surgery for proximal humeral fracture affect inpatient outcomes?

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**Background:** Delayed surgical treatment of hip fractures is associated with adverse medical outcomes, but it is unclear whether the same is true for proximal humeral fractures. The purpose of this study was to evaluate the relationship between surgical delay for proximal humeral fracture and inpatient adverse events, in-hospital death, prolonged postoperative stay, and nonroutine discharge.

**Methods:** Of the more than 70,000 patients with an operatively treated proximal humeral fracture identified in the Nationwide Inpatient Sample between 2008 and 2011, 87% underwent surgery within 2 days of admission and 13% underwent surgery 3 days or more after admission. Multivariable logistic regression analyses were performed to evaluate the effect of surgical delay on inpatient outcomes and to identify risk factors associated with late surgery.

**Results:** Surgery 3 days or more after admission for fracture of the proximal humerus had no influence on in-hospital death but was independently associated with inpatient adverse events (odds ratio [OR], 2.1; 95% confidence interval [CI], 2.0-2.2), prolonged postoperative stay (OR, 1.7; 95% CI, 1.7-1.9), and increased nonroutine discharge (OR, 2.7; 95% CI, 2.6-2.9). Risk factors for surgery 3 days or more after admission included advanced age, male sex, Elixhauser comorbidity score, polytrauma, Hispanic race or black race, no insurance coverage, low household income, and weekend admission.

**Conclusions:** Even when comorbidities and complexity are controlled for, delaying surgery for proximal humeral fracture is likely to increase inpatient morbidity, postoperative length of stay, and nonroutine discharge. It appears that avoiding nonmedical delays is advantageous.

**Level of evidence:** Level II, Retrospective Design, Prognosis Study.



**Keywords:** Surgery; delay; proximal humeral fracture; perioperative; mortality; outcomes; risk factors; discharge; epidemiology

Fractures of the proximal humerus are increasingly common in the elderly, and many require surgery.[2,10,11,16,26,34] Operative treatment for proximal humeral fracture carries important short-term medical risks.[24] An understanding of preoperative factors affecting outcome can help with decision making and management strategies.[3,25,39]

The time spent awaiting surgery has been shown to influence postoperative outcomes in patients with hip fracture.[1,7,15,23,29,31,36] Although early surgical repair does not appear to have a beneficial effect on the inpatient mortality

No institutional review board approval is mandatory for this study. The data are deidentified and commercially available for use. The study has been performed in accordance with the ethical standards in the 1964 Declaration of Helsinki and has been carried out in accordance with relevant regulations of the US Health Insurance Portability and Accountability Act.

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rate compared with late surgery, it is consistently associated with a decreased risk of early postoperative complications, an improved ability to return to independent living, and a reduced hospital stay.[1,7,15,23,29,31,36] Studies have shown that reasons for delay in operative treatment for hip fracture can be patient related (eg, waiting for medical stabilization or test results) or system related (eg, availability of operating staff or operating room), some of which are potentially avoidable.[28,29] Limited data are available on the in-hospital effect of and risk factors for surgical delay after proximal humeral fracture.[12]

Using a large administrative database and controlling for known confounders, we aimed to evaluate the existing relationship between surgical delay for proximal humeral fracture and inpatient adverse events, in-hospital death, prolonged postoperative stay, and nonroutine discharge disposition. In addition, we identified patient- and system-related factors contributing to delay in surgical treatment for proximal humeral fracture.

## Materials and methods

This retrospective population-based study was conducted using 2008-2011 discharge data from the Nationwide Inpatient Sample (NIS). First endorsed by the Agency for Healthcare Research and Quality in 1988, the NIS is currently the largest all-payer inpatient care database in the United States.[9,17] Each dataset year contains records on approximately 8 million discharges from over 1,000 nonfederal hospitals, which reflect a 20% stratified sample of all discharges from randomly selected institutions in participating states.[18] The NIS provides weights that allow for statistically valid national estimates.[21] More than 100 clinical and nonclinical data elements, including medical diagnoses (up to a number of 25), procedures (up to a number of 15), patient demographic data (eg, age, sex, and race), payment source, length of hospital stay, and discharge disposition, are included in the NIS. We used *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes to identify the primary diagnosis for admission, the type of treatment received, and the prevalence of concurrent medical comorbidities and inpatient adverse events.

All patients with an ICD-9-CM primary diagnosis code of closed (812.00-812.03 or 812.09) or open (812.10-812.13 or 812.19) fracture of the proximal humerus treated operatively (internal fixation or arthroplasty) were identified and included in the analysis. Patients were further stratified according to operative delay (days elapsed from admission to surgery), modeled as an independent 2-way categorical variable: early surgery (surgery within 2 days of hospital admission) and late surgery ($\geq$3 days from hospital admission to surgery). In line with the hip fracture literature, the time threshold used to define operative delay in our study was 2 days.[5,13,36,38] Among an estimated 71,059 patients with an operatively treated proximal humeral fracture in 2008 to 2011, 87% underwent surgery within 2 days of admission and 13% underwent late surgery.

Patient demographic and provider-related characteristics were compared between patients who underwent early surgical repair and those who underwent late surgical repair for proximal humeral fracture (Table I). Explanatory variables were age (both continuous and categorized into the following age groups: <60 years, 60-79 years, and $\geq$80 years), sex, comorbidity burden (quantified with the Elixhauser comorbidity score),[4,33] race/ethnicity (white, black, Hispanic, and other), insurance status (private insurance, public insurance, and no insurance), household income based on postal ZIP code analysis ($1-$38,999, $39,000-$47,999, $48,000-$62,999, and $\geq$$63,000), fracture type (closed and open), treatment type (nonoperative and operative), trauma type (single trauma and polytrauma), weekend or weekday admission, length of hospitalization, discharge disposition (home, home health care, rehabilitation/skilled nursing facility, hospital transfer, and other), hospital location (urban and rural), and hospital teaching status (nonteaching and teaching). Our study sample was aged 67 $\pm$ 16 years and predominantly comprised female patients (75%) and white patients (79%).

A normal distribution of the data was assumed on the basis of the large weighted sample size. The Pearson $\chi^2$ test was used for analysis of categorical data, and the independent-samples *t* test was used for continuous data. To evaluate the independent effect of late surgery on inpatient outcomes (adverse events, death, prolonged postoperative stay, and nonroutine discharge) after proximal humeral fracture, multivariable binary logistic regression analyses were performed. A prolonged postoperative stay was defined as an average length of stay greater than the 75th percentile.[8,20] Subsequently, an additional multivariable logistic regression analysis was undertaken to determine medical and nonmedical risk factors associated with late surgery for proximal humeral fracture. All regression models were adjusted for known patient- and provider-related confounding variables. $P < .001$ was considered statistically significant in all analyses.

## Results

When compared with patients who underwent early surgery, those who underwent late surgery had a higher incidence of surgical-site infection (0.30% vs 0.10%), pneumonia (0.60% vs 0.10%), peripheral thrombosis events (1.9% vs 0.40%), urinary tract infection (16% vs 5.6%), acute myocardial infarction (1.4% vs 0.40%), acute renal failure (10% vs 2.5%), blood transfusion (32% vs 17%), acute posthemorrhagic anemia (20% vs 15%), unplanned reintubation (2.8% vs 0.70%), pulmonary insufficiency (2.1% vs 0.80%), and induced mental disorder (7.2% vs 2.1%) ($P < .001$) (Table II). After potential confounding factors such as age, comorbidity burden, and the presence of polytrauma were accounted for, multivariable logistic regression analysis showed higher odds for inpatient adverse events in patients who underwent late surgery (odds ratio [OR], 2.1; 95% confidence interval [CI], 2.0-2.2; $P < .001$) (Table III).

The in-hospital mortality rate was significantly higher in patients who underwent late surgery (0.70%) than in patients who underwent early surgery (0.40%) ($P < .001$). However, after isolating the independent effect of late surgery on in-hospital mortality rate with the use of regression analysis, we found no significant difference in risk of death (OR, 1.1; 95% CI, 0.79-1.4; $P < .001$) (Table III).