Early Hospital Readmission and Mortality Risk after Surgical Treatment of Proximal Humerus Fractures in a Community-Based Health Care Organization

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ABSTRACT

Context: Surgical treatment for proximal humerus fractures has increased exponentially. Recent health care policies incentivize centers to reduce hospital readmission rates. Better understanding of risk factors for readmission and early mortality in this population will assist in identifying favorable risk-benefit patient profiles.

Objective: To identify incidence and risk factors of 30-day hospital readmission rate and 1-year mortality rate after open surgery of proximal humerus fractures.

Design: Retrospective cohort analysis from Kaiser Permanente Southern California Region database.

Methods: Using International Classification of Diseases, Ninth Revision, diagnosis and procedure codes, all operative proximal humerus fractures were validated. Hospital readmission, one-year mortality, and demographic and medical data were collected. A logistic regression test was performed to assess potential risk factors for outcomes.

Results: From 1387 surgical patients, the 30-day all-cause readmission rate was 5.6%. Forty percent of hospital readmissions were due to surgery-related reasons. Severe liver disease (odds ratio [OR], 3.48, 95% confidence interval [CI] = 1.42-8.55) and LACE (length of stay, acuity of admission, comorbidities, and number of Emergency Department visits in the previous 6 months) index score ≥ 10 (OR, 4.47, 95% CI = 2.54-7.86) were independent risk factors of readmission on multivariate analysis. The 1-year mortality rate was 4.86%. Multivariate analysis showed length of hospital stay (OR 1.11, 95% CI = 1.05-1.19), cancer (OR 3.38, 95% CI = 1.61-7.10), 30-day readmission (OR 3.31, 95% CI = 1.34-8.21), and Charlson comorbidity index greater than or equal to 4 (OR 13.94, 95% CI = 4.40-44.17) predicted higher mortality risk.

Conclusion: After open treatment of proximal humerus fractures, there was a 5.6% all-cause 30-day hospital readmission rate. Surgical complications accounted for 40% of readmissions. Severe liver disease and LACE score correlated best with postoperative 30-day readmission risk. Length of hospital stay, preexisting cancer, 30-day readmission, and Charlson comorbidity index were predictive of 1-year mortality.

INTRODUCTION

More than 19% of Medicare patients who have been hospitalized were readmitted within 30 days, costing Medicare more than $17 billion.[1] More than 2600 hospitals in 2015 will have reimbursements from Medicare reduced because of the Hospital Readmissions Reductions Program.[2] Medicare has begun evaluating readmissions for elective knee or hip replacements and has fined hospitals if they had higher than expected complication and readmission rates.[3] Expansion of these quantitative measures to other surgeries may be implemented in the future. To prepare for future health care policies and to improve surgical patient selection, it is important to determine current morbidity, mortality, and readmission rates for other procedures.[4-7] Because surgical treatment of proximal humerus fractures has grown considerably, there is a need to investigate what procedure-specific variables are associated with this metric.[8-11]

The objective of this study was to identify the incidence and risk factors of 30-day hospital readmission rate and 1-year mortality rate after open surgery of proximal humerus fractures.

METHODS

After institutional review board approval, a retrospective cohort of all patients undergoing surgical treatment of proximal humerus fractures in 2005 to 2013 at a statewide integrated community health care organization, Kaiser Permanente Southern California, was analyzed to investigate the 30-day hospital readmission rate. Patients aged 18 years and older who underwent surgery were identified using the health care organization's electronic medical records database and confirmed by medical chart review.

None of the hospitals studied were of a level I trauma center designation. Specific surgical procedures were captured using International Classification of Diseases, Ninth Revision, codes (79.11, 79.31, 78.52) and Current Procedural Terminology codes (23615, 23640, 23670, 23680). Inclusion criteria included patients who underwent surgery for open reduction and internal fixation of the surgical neck, anatomic neck, humeral head, and greater tuberosity and/or lesser tuberosity

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of the proximal humerus. Only patients who kept their insurance with the health care organization at least 30 days after the surgical procedure were included in the study. Exclusion criteria included humerus fractures located at, or distal to, the diaphysis of the proximal humerus. Medical charts were validated by the study's authors to confirm anatomic location of the fracture and surgical procedure. A subpopulation of these patients (1068 patients) was analyzed to assess the 1-year mortality after surgery. Mortality was determined by using the California State Death Master Files. The Charlson comorbidity index (CCI) and LACE (length of stay, acuity of admission, comorbidities, and number of Emergency Department visits in the previous 6 months) index scores were calculated on the basis of these data.[12,13] For LACE scores, we compared patients with an index less than 10 with those with an index ≥ 10 because prior studies have identified this as a useful criterion to differentiate high-risk patients.[14]

Table 1. Demographic and clinical characteristics of study population by 30-day readmission status

	Readmission within 30 days	
Population characteristics	**Yes (n = 78)**	**No (n = 1309)**
Length of stay, mean days ± SD	4.18 ± 6.19	2.06 ± 2.77
Age, mean years ± SD	63.31 ± 18.11	60.00 ± 15.98
Female sex, %	55.1	66.2
Race/ethnicity, %		
White	73.1	70.1
Hispanic	15.4	19.3
Black	5.1	4.7
Asian/Pacific Islander	5.1	3.9
Other	1.3	0.6
Unknown	0.0	1.5
Charlson comorbidity index, %		
0	25.6	48.1
1	23.1	21.0
2	12.8	9.4
3	9.0	8.3
≥ 4	29.5	13.1
Disposition status, %		
Home	10.3	17.0
Skilled nurse	1.3	3.1
Long-term care	2.6	1.3
Short-term care	5.1	1.8
Unknown	80.8	76.7
Characteristics, %		
Current smoker	21.8	20.7
Diabetes	32.1	18.6
Transfusion	11.5	4.9
Severe renal disease	12.8	7.5
Severe liver disease	9.0	2.6
Peripheral vascular disease	11.5	
Sepsis/shock	3.9	0.6
COPD	6.4	3.6
Cancer	12.8	7.4
Hemoglobin < 12 g/dL	91.9	74.2
Hemoglobin A_{1c} < 7%	61.5	52.7
LACE score < 10	51.3	86.6

COPD = chronic obstructive pulmonary disease; LACE = length of stay, acuity of admission, comorbidities, and number of Emergency Department visits in the previous 6 months; SD = standard deviation.

Table 2. Univariate analysis on association between demographic and clinical factors with 30-day readmission among patients who have undergone open reduction internal fixation

	Univariate analysis
Factors	**Odds ratio (95% CI)**
Length of stay, mean days	1.12 (1.07 - 1.17)
Age, years	
< 70	Reference
≥ 70	1.72 (1.08 - 2.74)
Sex	
Women	Reference
Men	1.59 (1.00 - 2.52)
Race/ethnicity	
White	Reference
Hispanic	0.76 (0.40 - 1.44)
Black	1.05 (0.37 - 3.00)
Asian/Pacific Islander	1.26 (0.44 - 3.61)
Current smoker	1.11 (0.64 - 1.94)
Charlson comorbidity index	
0	Reference
1	2.06 (1.07 - 3.96)
2	2.56 (1.17 - 5.61)
3	2.02 (0.84 - 4.90)
≥ 4	4.21 (2.26 - 7.85)
Hemoglobin	
< 12 g/dL	Reference
≥ 12 g/dL	0.25 (0.10 - 0.64)
Hemoglobin A_{1c}	
< 7 %	Reference
≥ 7%	0.7 (0.22 - 2.24)
LACE	
< 10	Reference
≥ 10	6.16 (3.84 - 9.87)
Disposition status	
Home	Reference
Skilled nurse	0.68 (0.08 - 5.58)
Long-term care	3.28 (0.65 - 16.67)
Short-term care	4.65 (1.30 - 16.58)
Unknown	1.75 (0.83 - 3.70)
Other factors	
Diabetes	2.06 (1.25 - 3.38)
Transfusion	2.54 (1.21 - 5.31)
Severe renal disease	1.82 (0.91 - 3.64)
Severe liver disease	3.7 (1.58 - 8.63)
Sepsis/shock	6.51 (1.69 - 25.04)
Cancer	1.84 (0.92 - 3.68)

LACE = length of stay, acuity of admission, comorbidities, and number of Emergency Department visits in the previous 6 months.

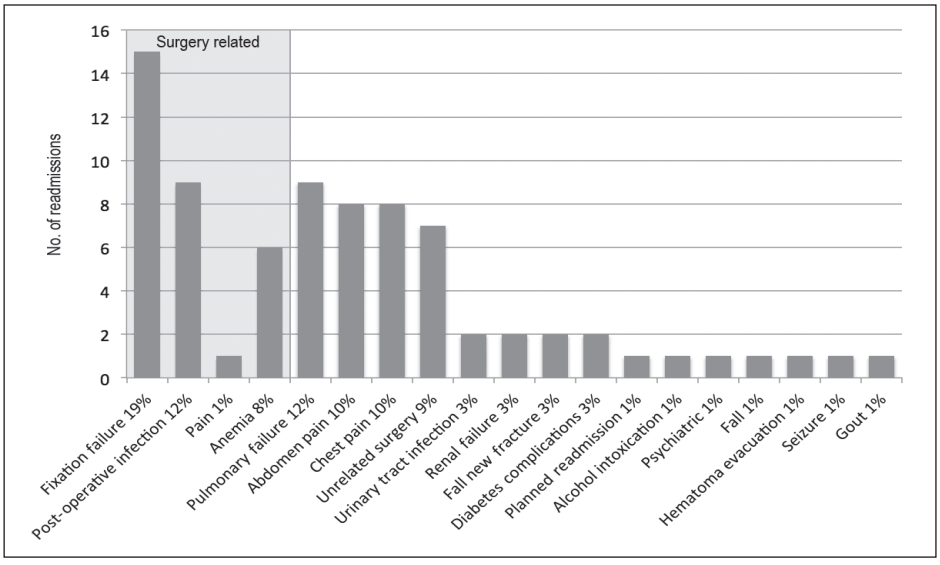

Figure 1. Summary of hospital readmission reasons.

Frequencies/proportions or mean (standard deviation [SD]) were used to describe the characteristics of study population. A logistic regression test was performed to assess the potential risk factors of two outcomes. Odds ratios (ORs) and 95% confidence intervals (CIs) are reported. Ordinary least squares regression analysis was used to determine the amount of variance answered by the CCI and LACE score for readmission and mortality. Data were analyzed using SAS Enterprise Guide, version 5.1 (SAS Institute, Cary, NC).

RESULTS

From 14 hospital centers, 1387 surgical patients met inclusion criteria. The 30-day all-cause readmission rate was 5.6% (78 among 1387 patients; Table 1). In univariate analysis, readmitted patients were older, were hospitalized longer, had diabetes, had severe liver disease (cirrhosis), and had higher CCI and LACE scores (Table 2). CCI and LACE score predicted 1.60% and 5.20% of variance, respectively, for 30-day hospital readmission risk. In the multivariate analysis, only severe liver disease (OR 3.48; 95% CI = 1.42-8.55) and LACE ≥ 10 (OR 4.47; CI = 2.54-7.86) were significant independent risk factors of readmission after adjustment for age, sex, length of hospital stay, and diabetes (Table 3).

Thirty-one of 78 hospital readmissions (40%) were due to surgery-related reasons (Figure 1). The reasons for readmission were primarily medically related and included pulmonary- and abdominal-related comorbidities, as well as chest pain diagnosis with management.

The 1-year mortality rate was 4.86% (52 of 1068 patients). CCI predicted 11.50% and LACE predicted 8.30% of the variance for 1-year mortality risk. Univariate logistic analysis showed age, sex, diabetes, severe renal disease, sepsis, cancer, 30-day readmission, LACE, and CCI correlated with risk of mortality within 1 year (Table 4). Multivariate logistic analysis showed length of hospital stay (OR 1.11; 95% CI = 1.05-1.19), cancer (OR 3.38; CI = 1.61-7.10), CCI ≥ 4 (OR 13.94; CI = 4.40-44.17), and 30-day readmission (OR 3.31; CI = 1.34-8.21) predicted a higher mortality risk within 1 year (Table 5).

Table 3. Multivariate analysis on association between demographic and clinical factors with 30-day readmission among patients who have undergone open reduction and internal fixation

Demographic and clinical factors	Odds ratio (95% CI)
Length of stay, mean days	1.04 (0.98 - 1.09)
Age, years	
< 70	Reference
≥ 70	1.36 (0.82 - 2.26)
Sex	
Women	Reference
Men	1.62 (0.99 - 2.63)
Diabetes	
No	Reference
Yes	1.30 (0.76 - 2.21)
Severe liver disease[a]	
No	Reference
Yes	3.48 (1.42 - 8.55)
LACE	
< 10	Reference
≥ 10	4.47 (2.54 - 7.86)

[a] Liver cirrhosis and hepatic failure, determined using International Classification of Diseases, Ninth Revision.
CI = confidence interval; LACE = length of stay, acuity of admission, comorbidities, and number of Emergency Department visits in the previous 6 months.

DISCUSSION

The 30-day hospital readmission penalties after surgical procedures are in development. Hospital readmission rates have been reported between 4% to 15% after elective orthopedic surgical procedures.[15-17] Most studies focus on lower extremity joint arthroplasty patient populations from large administrative databases, or nationwide samples with significant variability in medical care organizational resources, patient follow-up, and insurance status.[17-20] Past studies suggest that readmission rates in the trauma patient population after surgical procedures may differ.[21,22] This study's patient cohort consisted of a proximal humerus fracture population that received surgical care within a community health care organization network. Multiple integrated care delivery resources were implemented, including an integrated electronic medical records system, coordinated home health care resources, and multidisciplinary care management.

Table 4. Univariate analysis on association with death within one year of open reduction and internal fixation

Demographic and clinical factors	Univariate analysis Odds ratio (95% CI)
Length of stay, mean days	1.16 (1.09 - 1.22)
Age, years	
< 70	Reference
≥ 70	2.94 (1.67 - 5.15)
Sex	
Women	Reference
Men	1.89 (1.08 - 3.31)
Race/ethnicity	
White	Reference
Hispanic	1.07 (0.52 - 2.20)
Black	1.38 (0.41 - 4.65)
Asian/Pacific Islander	1.01 (0.24 - 4.34)
Charlson comorbidity index	
0	Reference
1	4.03 (1.17 - 13.91)
2	5.32 (1.31 - 21.66)
3	5.82 (1.43 - 23.73)
≥ 4	31.9 (11.1 - 91.69)
Hemoglobin, g/dL	
< 12	Reference
≥ 12	0.46 (0.19 - 1.10)
Hemoglobin A_{1c}	
< 7%	Reference
≥ 7%	0.89 (0.22 - 3.53)
LACE	
< 10	Reference
≥ 10	8.94 (5.00 - 15.99)
Other clinical factors	
Current smoker	1.2 (0.58 - 2.48)
Diabetes	2.01 (1.10 - 3.66)
Transfusion	3.46 (1.61 - 7.44)
Severe renal disease	3.17 (1.53 - 6.58)
Severe liver disease	2.43 (0.71 - 8.31)
Sepsis/shock	12.38 (2.88 - 53.29)
Cancer	10.08 (5.48 - 18.53)
30-day readmission	5.14 (2.42 - 10.82)

CI = confidence interval; LACE = length of stay, acuity of admission, comorbidities, and number of Emergency Department visits in the previous 6 months.

By providing quality-based incentives, current health care policy favors hospitals that can redistribute and increase health care resources to susceptible patient populations. Various predictive models have been proposed to estimate readmission and mortality risk. Most have been applied to broad populations with varying surgical indications. Although some have shown correlation, they may account for only a small percentage of the variation in readmission or mortality.[23,24] The CCI and LACE score have both shown some value in predicting readmission probability, but they have not been shown to be as predictive in other specific patient populations, such as patients with congestive heart failure.[23-26] It is important to determine whether specific patient cohorts, such as postoperative shoulder fracture patients, provide consistent correlations for these predictive models.

Zhang et al[8] studied a large administrative multistate database and found a 30-day readmission rate of 8% in a population of proximal humerus fracture patients treated with both surgical fixation methods and arthroplasty. They found that 75% of readmissions were because of medical reasons, although surgical fixation procedures (compared with arthroplasty) led to a higher rate (29%) of surgically related readmissions. Although they did not find any added risk with older age, they noted that female sex, race, discharge home with home health services, and discharge to a nursing facility all carried higher future readmission risk. On the other hand, Hageman et al[23] found a significant association between 30-day readmission and older age in their postoperative general orthopedic skeletal trauma patient cohort. In our study, we found a 30-day readmission rate of 5.6%, with 60% of readmissions for nonsurgical-related (medical) reasons. We did not find a correlation of age or sex with readmission. It is interesting to note that despite the use of improved technology for fracture fixation (ie, locking plates), the most common reasons for surgical procedure failure and subsequent readmission for revision surgery were fixation failure and infection.

Our study supports the notion that patient comorbidities contribute to higher readmission risk. Although readmission metrics may offer hospitals financial incentives, they must also provide improvement in health care quality to be pertinent to the patient. This study identifies hospital readmission as a risk factor for early 1-year mortality after shoulder fracture surgery, highlighting the importance of reducing readmission risk. Risk stratification for future shared preoperative patient counseling may assist the decision for surgical fracture treatment as well as medical optimization of comorbidities before surgery. Interestingly, we did not find any significant correlation of specific medical conditions such as diabetes status, hemoglobin A_{1c} levels, or severe renal disease with early one-year mortality or hospital readmission. However, we found LACE, CCI score, and severe liver disease to be correlative

Table 5. Multivariate analysis on association with one-year death of open reduction and internal fixation

Variable	Odds ratio (95% CI)
Mean length of stay, days	1.11 (1.05-1.19)
Age	
< 70	Reference
≥ 70	1.75 (0.91-3.34)
Gender	
Female	Reference
Male	1.86 (0.98-3.53)
Cancer	
No	Reference
Yes	3.38 (1.61-7.10)
30-day readmission	
No	Reference
Yes	3.31 (1.34-8.21)
Charlson comorbidity index score	
0	Reference
1	3.28 (0.92-11.73)
2	3.09 (0.71-13.35)
3	4.05 (0.93-17.72)
≥ 4	13.94 (4.40-44.17)

CI = confidence interval.

with 30-day hospital readmission risk. In our analysis, we noted that the LACE score predicted a higher proportion of the variability for 30-day hospital readmission, compared with the CCI. However, similar to the findings of Hageman et al,[23] most variability could not be accounted for by the factors studied, which highlights the difficulty in developing an accurate predictive model for this outcome.

Mahoney et al[27] analyzed 680 shoulder arthroplasties at a single academic medical center and found a 30-day readmission rate of 3.4%. Their surgical indications combined elective and traumatic shoulder diagnoses, which may produce differing readmission rates if analyzed separately. They reported a 1.0% incidence of "never events," including inhospital falls, postoperative infections, and catheter-associated urinary tract infections, which eliminate reimbursement payments for avoidable complications. Our study found a similar 0.9% "never event" incidence, although our cohort strictly encompassed those with proximal humerus fractures.

Recent studies suggest that early mortality is increased after surgery for proximal humerus fractures. Petrigliano et al[11] studied a large statewide database of hospital discharges from 1994 to 2005, after surgical fixation of proximal humeral fractures. They noted that older patients with comorbidities were at increased risk for perioperative complications. CCI (OR, 1.5), age older than 75 years (10.2), and male sex (1.7) carried increased risk of early 90-day mortality. Neuhaus et al[28] reported from a nationwide database of proximal humerus fractures and found a 2.3% inhospital mortality rate. They found that sex, age, associated femur fracture or head trauma, and operative fracture care influenced the risk of inpatient adverse events and death. Johnell et al[29] studied 237 patients and found that mortality immediately after shoulder fracture in the 60- to 80-year-old population was significantly higher compared with the general population and decreased after the first year. They found mortality was not influenced by sex when adjusted for sex-specific population risks. In our study, cancer history, CCI, LACE score, as well as 30-day hospital readmission all carried a greater degree of increased risk of 1-year mortality. Unlike their study, we did not find a significant correlation with age or sex. Morin et al[30] found 1-year mortality rates ranging from 5.3% to 22.6% in a Canadian database of older patients with shoulder fracture surgery. Our lower mortality rate (4.86%) may be owing to other factors that were not studied, including social support network, integrative medical care structure, and socioeconomic differences. Contrary to readmission risk, the CCI provided a better point estimate to predict 1-year mortality compared with the LACE score.

Strengths of the study include that our study sample's data were individually reviewed and validated to confirm data accuracy. In very large sample databases, validity and accuracy may be compromised because the data are not individually confirmed and input is based upon multiple discretions.[15,18,31] However, our study did not control for surgeon experience or intraoperative parameters such as blood loss, which may influence postoperative patient recovery and fracture fixation outcomes.

CONCLUSION

After open treatment of proximal humerus fractures, there was a 5.6% all-cause hospital readmission rate. Surgical complications accounted for 40% of readmissions. LACE scores higher than 10 and liver disease correlated best to predict postoperative 30-day readmission. CCI higher than 4, cancer history, 30-day hospital readmission, and length of hospital stay were predictive of 1-year mortality. ❖

This study's patient cohort consisted of a proximal humerus fracture population that received surgical care within a community health care organization network. Multiple integrated care delivery resources were implemented, including an integrated electronic medical records system, coordinated home health care resources, and multidisciplinary care management.

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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Best Hospitals

Medicine is an advancing science and the best hospitals in the world are not those which merely use new knowledge, but those which create it.

— Sir George W Pickering, FRS, 1904-1980, British medical doctor and academic