

Risk Factors for Unplanned Readmissions Following Excisional Breast Surgery

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■ **Abstract:** Thirty-day hospital readmission has emerged as an important variable in health care quality improvement. Our purpose was to investigate the unplanned readmission rate following excisional breast surgery and to identify risk factors associated with readmission. The 2011 National Surgical Quality Improvement Program registry was retrospectively reviewed for patients undergoing excisional breast surgery. Logistic regression was used to investigate the relationship between pre- and perioperative variables and 30-day readmission. Of 13,610 women identified, 292 (2.15%) were readmitted within the 30-day tracking period. The readmitted cohort demonstrated significantly more comorbidities and postoperative complications, as well as longer operative times and hospital stays. Postoperative complications were the best predictors for readmission; however, age, a history of bleeding disorders, immunosuppression, cardiovascular disease, and inpatient hospitalization were also significant independent predictors for readmission. Risk factors for readmission include both pre- and perioperative variables. Perioperative complications, most often infectious in nature, are the strongest predictors; however, comorbidities including immunosuppression, bleeding disorders, and cardiovascular disease also significantly increase the risk for readmission. Although readmission is relatively rare, identifying and managing high-risk patients in addition to more effective methods to prevent and manage postoperative complications will be critical to reducing readmissions and improving patient care. ■

Key Words: 30-day, excisional breast surgery, outcomes, readmission, risk factors

Unplanned hospital readmissions have become an important metric for assessing health care quality, though its use remains controversial (1–8). Defined as an admission occurring within 30 days of discharge from the same or another hospital, the Centers for Medicare and Medicaid Services (CMS) began publishing readmissions data for certain conditions in June of 2009 (9). Although the focus will initially be on readmission for certain medical conditions, the CMS has confirmed that by 2015, it will monitor readmissions for vascular surgery procedures, and has left the door open to extend this policy to other surgical procedures as well (6,10). These policies have prompted a focus on decreasing postoperative readmissions following a variety of surgical procedures (10–12).

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Surgical and medical patients are readmitted for similar underlying comorbidities, however, surgical patients have added risks associated with undergoing an invasive procedure (13). Fortunately, operations are often elective and planned in advance, providing an opportunity to intervene. To date, few studies have addressed readmissions among surgical patients (10,14–20). There is a particular dearth of information regarding readmission following breast conserving surgery. Excisional breast procedures are used to remove a variety of breast lesions including atypical change and benign or malignant tumors or lesions. For carefully selected cancer patients, the favorable cosmetic results and equivalent survival rates for excisional procedures, when compared to mastectomy, have led to a relatively high volume of these procedures in many hospitals across the United States (21–23). Only two studies of Australian cohorts, however, have attempted to address the issue of readmission following breast conserving surgery (24,25).

The National Surgical Quality Improvement Program (NSQIP) was established by the American College of Surgeons (ACS) as a means to quantify and

improve surgical outcomes. Trained surgical nurses from over 250 institutions prospectively collected data from randomly selected patients. Utilizing the comprehensive nature of the NSQIP registry, the objective of this study was to evaluate the 30-day readmission rate following excisional breast procedures and to identify preoperative and perioperative variables associated with readmission.

METHODS

Data Acquisition and Patient Selection

Data from the 2011 ACS-NSQIP participant use files were retrospectively analyzed. Data collection methods for the NSQIP registry have been previously described in detail (26,27). In brief, 240 variables, including demographics, comorbidities, and perioperative details are prospectively collected for each patient. Postoperative outcomes are tracked for 30 days following the primary operation. Data are independently abstracted by trained surgical nurses and is subject to random audits providing high quality, standardized data that have demonstrated a disagreement rate of less than 1.8% (27).

To identify patients undergoing excisional breast surgery, the NSQIP registry was queried using the primary *Current Procedural Terminology* codes pertaining to excisional breast procedures (19120, 19125, 19126, 19301, and 19302). Male patients and cases without readmission data were excluded.

Outcomes and Risk Adjustment Variables

The primary outcome of interest was unplanned readmission following the primary excisional breast procedure. Readmissions included hospitalization to either the same or another hospital after the initial surgical procedure. Hospitalizations within 30 days of discharge that were planned at the time of surgery were not included. The ACS-NSQIP participant use file readmission data have been previously validated and shown to accurately capture unplanned readmission events (28).

Other variables for analysis and risk adjustment included patient demographics, comorbidities, overall morbidity, surgical complications, medical complications, outpatient status, and operative length. Patient demographics included age, BMI, race, active smoking status, steroid use, radiotherapy within 90 days of the

operation, chemotherapy within 30 days of the operation, and prior operations within 30 days. Comorbidities of interest included diabetes, dyspnea, hypertension, chronic obstructive pulmonary disorder, congestive heart failure, bleeding disorders, previous percutaneous coronary intervention (PCI) or cardiac surgery, and previous stroke or transient ischemic attack.

Overall morbidity was defined as the presence of one or more of the following complications: superficial, deep, and organ/space surgical site infections (SSI), wound dehiscence, deep vein thrombosis (DVT), pulmonary embolism (PE), unplanned re-intubation, ventilator dependence >48 hours, renal insufficiency, acute renal failure, coma, stroke, cardiac arrest, myocardial infarction, peripheral nerve injury, pneumonia, urinary tract infection (UTI), bleeding requiring transfusion, and sepsis/septic shock. Surgical complications consisted of superficial, deep, and organ/space SSI and wound dehiscence. Medical complications consisted of DVT, PE, unplanned re-intubation, ventilator dependence >48 hours, renal insufficiency, acute renal failure, coma, stroke, cardiac arrest, myocardial infarction, peripheral nerve injury, pneumonia, UTI, bleeding requiring transfusion, and sepsis/septic shock. Outpatients were defined as patients discharged on the same day as the primary procedure. Additionally, the sum of the relative value units for additional procedures were also used to adjust for added complexity and risk of concurrent procedures, as has been described previously (29,30).

Statistical Analysis

Descriptive statistics and two-tailed p-values were calculated for the study population using Pearson's chi-squared or Fisher's exact tests for categorical variables and student *t*-tests or Mann-Whitney *U*-tests for quantitative variables. Multivariate regression models were used to control for potential confounding variables and to identify independent risk factors for readmission. This analysis was used to quantify the association of various pre- and perioperative variables including patient demographics, comorbidities, surgical complications, medical complications, and length of operation with 30 day readmission. These variables underwent univariate screening using Pearson's chi-squared and independent *t*-tests for categorical and continuous variables, respectively, and variables with a significance value of $p < 0.2$ were included in the

regression models. To improve model precision, variables with fewer than ten events were excluded (31). Hosmer-Lemeshow and c-statistics were computed to assess model calibration and discrimination (32).

Ethical Approval

De-identified patient information is freely available to all institutional members who comply with the ACS-NSQIP Data Use Agreement. The Data Use Agreement implements the protections afforded by the Health Insurance Portability and Accountability Act of 1996 and the ACS-NSQIP Hospital Participation Agreement.

RESULTS

Unplanned readmission following excisional breast surgery was rare. Of the 13,610 women identified to have undergone an excisional breast procedure during 2011, 292 (2.15%) were readmitted within the 30-day tracking period. A comparison between readmitted patients and those who were not readmitted is summarized in Table 1. On average, readmitted patients were older and demonstrated a slightly greater BMI than those patients who were not readmitted ($p < 0.001$ and $p = 0.046$, respectively). With the exception of steroid use, the cohorts did not significantly differ with respect to clinical characteristics (Table 1). Importantly, readmitted patients had a greater number of comorbidities prior to surgery when compared to patients who were not readmitted. Although comorbidities were common within in both groups, each of the comorbidity analyzed was significantly more prevalent within the readmitted cohort (Table 1).

Overall perioperative morbidity was rare in the cohort that was not readmitted (1.58%), whereas 19.18% of readmitted patients experienced a 30-day complication ($p < 0.001$). Wound complications were almost exclusively wound infections, and were almost 10 times more common within readmitted patients (11.64% versus 1.22%; $p < 0.001$). Individual medical complications were rare in both cohorts, and with the exception of acute renal injury, stroke, myocardial infarction, pneumonia, UTI and sepsis/septic shock, did not differ significantly between these cohorts. Of these complications, however, only pneumonia, UTI, and sepsis/septic shock occurred in more than 10 instances. Overall, fewer medical complications were observed in the cohort that was not readmitted

Table 1. Unadjusted Cohort Characteristics

	Readmitted <i>n</i> = 292 (2.15%)	Not readmitted <i>n</i> = 13,318 (97.85%)	<i>p</i>
Age*	62.28 ± 14.39	56.49 ± 15.22	<0.001
Body mass index*	29.71 ± 7.47	28.82 ± 7.52	0.046
Race			
White	208 (71.23%)	9624 (72.26%)	0.792
Black	35 (11.99%)	1716 (12.88%)	
Asian	14 (4.79%)	605 (4.54%)	
Other	35 (11.99%)	1373 (10.31%)	
Clinical characteristics			
Active smoker	34 (11.64%)	1776 (13.34%)	0.400
Steroid use*	12 (4.11%)	174 (1.31%)	<0.001
Radiotherapy <90 days	1 (0.34%)	15 (0.11%)	0.293
Chemotherapy <30 days	7 (2.40%)	185 (1.39%)	0.148
Previous operation <30 days	7 (2.40%)	281 (2.11%)	0.736
Comorbidities			
Diabetes*	54 (18.49%)	1463 (10.99%)	<0.001
Dyspnea*	31 (10.62%)	685 (5.14%)	<0.001
Hypertension*	167 (57.19%)	5344 (40.13%)	<0.001
COPD*	19 (6.51%)	326 (2.45%)	<0.001
Congestive heart failure*	2 (0.68%)	15 (0.11%)	0.050
Bleeding disorders*	15 (5.14%)	191 (1.43%)	<0.001
Previous PCI/cardiac surgery*	18 (6.16%)	254 (1.91%)	<0.001
Previous stroke/TIA*	12 (4.11%)	249 (1.87%)	0.006
Overall complications*	56 (19.18%)	211 (1.58%)	<0.001
Wound complications*	34 (11.64%)	163 (1.22%)	<0.001
Wound infection*	34 (11.64%)	156 (1.17%)	<0.001
Wound disruption	0 (0.00%)	9 (0.07%)	0.999
Medical complications*	30 (10.27%)	49 (0.37%)	<0.001
DVT	1 (0.34%)	2 (0.02%)	0.063
Pulmonary embolism	1 (0.34%)	3 (0.02%)	0.083
Unplanned re-intubation	0 (0.00%)	2 (0.02%)	0.999
Vent. >48 hours	0 (0.00%)	2 (0.02%)	0.999
Renal insufficiency	0 (0.00%)	1 (0.01%)	0.999
Acute renal failure*	1 (0.34%)	1 (0.01%)	0.042
Coma	0 (0.00%)	0 (0.00%)	–
Stroke*	2 (0.68%)	1 (0.01%)	0.001
Cardiac arrest	0 (0.00%)	0 (0.00%)	–
Myocardial infarction*	5 (1.71%)	1 (0.01%)	<0.001
Peripheral nerve injury	0 (0.00%)	1 (0.01%)	0.999
Pneumonia*	10 (3.42%)	2 (0.02%)	<0.001
UTI*	3 (1.03%)	23 (0.17%)	0.018
Transfusion	1 (0.34%)	10 (0.08%)	0.212
Sepsis/septic shock*	7 (2.40%)	3 (0.02%)	<0.001
Outpatient regimen*	239 (81.85%)	12248 (91.97%)	<0.001
Length of surgery (minutes)*	63.34 ± 39.45	55.07 ± 43.171	0.001

*Denotes statistical significance <0.05. Continuous variables are given as mean ± SD. COPD, chronic obstructive pulmonary disease; PCI, percutaneous coronary intervention; TIA, transient ischemic attack; DVT, deep vein thrombosis; Vent., ventilator dependence; UTI, urinary tract infection.

(Table 1). Longer operative times were also noted in readmitted patients, averaging 63 minutes compared to 55 minutes ($p = 0.001$). Nearly 92% of those patients who were not readmitted underwent an outpatient procedure, whereas only 82% of the patients who were readmitted were discharged on the day of the operation ($p < 0.001$).

The distributions of the postoperative day of discharge for both cohorts are described in Table 2. Although the majority of patients were discharged on the day after the procedure, patients who would ultimately be readmitted tended to be discharged later than those who were not readmitted (Mann–Whitney *U*-test, $p < 0.001$).

After adjusting for potential confounders, three pre- and perioperative variables were identified as significant risk factors for readmission: a previous PCI or cardiac surgery, steroid use, and a history of bleeding disorders (Table 3). Most notably, both medical and wound complications were identified as significant independent risk factors for readmission. While a wound complication was associated with a nine times increased risk for readmission (95% CI: 5.88–12.80;

Table 2. Distribution of Cases by Postoperative day of Discharge

Day of discharge*	Readmitted N (%)	Not readmitted N (%)
0	239 (81.85)	12,248 (91.98)
1	41 (14.04)	870 (6.53)
2	6 (2.05)	102 (0.77)
3	3 (1.03)	37 (0.28)
4	0 (0.00)	13 (0.10)
5	0 (0.00)	7 (0.05)
6	0 (0.00)	6 (0.05)
7	0 (0.00)	4 (0.03)
8+	3 (1.03)	29 (0.22)

*Mann–Whitney *U*-test *p*-value comparing readmitted & not readmitted <0.001.

Table 3. Association of Pre- and Perioperative Factors with Readmission

Variable	Readmission			<i>p</i>
	Odds ratio	95% CI	<i>p</i>	
Age*	1.015	1.005	1.025	0.002
Body mass index (kg/m ²)	0.997	0.980	1.014	0.702
Diabetes	1.191	0.849	1.672	0.312
Dyspnea	1.321	0.858	2.034	0.205
COPD	1.572	0.918	2.691	0.100
Previous PCI/cardiac surgery*	2.027	1.181	3.479	0.010
Hypertension	1.305	0.976	1.745	0.072
Previous stroke or TIA	1.143	0.594	2.199	0.688
Steroid use*	2.111	1.091	4.083	0.026
Bleeding disorders*	2.197	1.209	3.993	0.010
Length of surgery (min)	1.000	0.997	1.003	0.958
Outpatient*	0.686	0.475	0.993	0.046
Medical complication*	19.232	11.446	32.312	<0.001
Wound complication*	9.001	5.876	13.789	<0.001
HL	0.642			
C-statistic	0.711			

*Denotes statistical significance

COPD, chronic obstructive pulmonary disease; PCI, percutaneous coronary intervention; TIA, transient ischemic attack; HL, Hosmer-Lemeshow.

$p < 0.001$), a medical complication yielded a 19.2 fold increase in risk (95% CI: 11.45–32.31; $p < 0.001$). Conversely, outpatients were only 0.69 times as likely to be readmitted (Table 3). The risk of readmission was also increased with each year of patient age (Table 3).

DISCUSSION

With the recent policies implemented by the CMS and the Patient Protection and Affordable Care Act, 30-day hospital readmission has emerged as an important variable on the forefront of healthcare quality improvement. The Agency for Healthcare Research and Quality has begun funding programs like Project Re-Engineered Discharge, aimed at improving patient safety and reducing readmission rates (33). Given the current healthcare climate, it is critical to understand the risk factors for postoperative readmission and how this event can be prevented. As a high volume procedure, often performed in older patients, excisional breast surgery presents an important opportunity to both improve patient care and reduce hospital costs.

To date, only two studies have attempted to address the issue of readmission following a lumpectomy (24,25). Both studies analyzed cohorts from Western Australia, identifying tumor size and patient demographic variables to be among the most significant predictors for readmission. The impact of these results was limited by the lack of information regarding patient comorbidities and postoperative complications and may not directly apply to American cohorts. The NSQIP registry, with its large, multicenter series of procedures and unbiased, validated data for 240 patient variables, offers robust and relevant information enabling a comprehensive evaluation of the risk factors associated with 30-day readmission following an excisional breast procedure for U.S. patients (34).

It is not surprising that readmitted patients tended to be older, had a higher BMI, more comorbidities, more perioperative complications, and both longer operative times and postoperative hospital stays (Tables 1 and 2). After adjusting for confounding factors, however, only seven of these pre- and perioperative variables were identified as significant independent predictors for 30-day readmission (Table 3). An analysis of Medicare data estimated that nearly 70% of surgical readmissions were due to underlying medical issues (35); however, more recent studies suggest that postoperative complications play a

larger role in surgical readmissions than underlying comorbidities (10,36–38). In our series, the strongest predictors for readmission were perioperative medical and wound complications, with adjusted odds ratios of 19 and 9, respectively. The most common underlying cause for perioperative complications within the study cohort was infection. Wound complications were almost exclusively infections, and the most common, significant medical complications included pneumonia, UTI, and sepsis/septic shock. In addition to the inherent risk of readmission due to a complication, the risk for readmission is further augmented by complicated discharge plans including wound care and antibiotic regimens (39). Although complications are rare, increased efforts to effectively prevent and manage these complications could have a great impact on future readmission rates.

The vast majority of operations in this series were performed as outpatient procedures; however, nearly 20% and 10% of the readmitted and not readmitted cohorts respectively were hospitalized at least 1 night postoperatively. Our analysis suggests that those patients who require hospital admission experienced a significantly increased risk for readmission within 30-days, independent of their age, comorbidities, and any postoperative complications. There are several challenges of postoperative recovery, both from the anesthesia and the surgical injury in and of itself, including pain, nausea, impaired pulmonary function, and risk of thromboembolism (40). The decision to discharge a patient is not always straightforward, and often requires a case-by-case evaluation of a patient's recovery. That outpatients experienced a decreased likelihood of readmission suggests that a rapid, unremarkable recovery period is less likely to be associated with a serious health issue contributing to readmission. Furthermore, in those patients who are admitted, the extra care that they receive may not be effectively addressing their condition, resulting in an increased readmission rate despite the additional inpatient care. These findings also suggest that an outpatient treatment plan is appropriate following excisional breast procedures, especially with respect to readmission, whereas with other surgical procedures readmission may be increased by shorter hospital stays (41).

Only three comorbidities were identified that substantially affect the risk of 30-day readmission following excisional breast surgery. It is not surprising that patients with a bleeding disorder were at an increased risk for readmission. The management of bleeding

disorders presents a unique challenge to surgeons, both before and after surgery (42,43). When a bleeding disorder is suspected, identifying the underlying coagulopathy is often crucial to preventing potentially life threatening bleeding events (44). Preoperative coagulation screening, however, is not currently indicated in patients with a negative bleeding history and physical examination (45,46). Even when the coagulopathy is identified, patients with a bleeding disorder are at greater risk for readmission, highlighting the need for more careful pre- and postoperative management in this high-risk patient population.

Immunosuppression has also been associated with a worse postoperative recovery, supporting our finding that steroid use was linked to a doubled risk of readmission (47,48). The reasons for this association are not clear from our data; however, it is conceivable that preoperative immunosuppression puts the patient at increased risk of postoperative infectious complications leading to readmission. Although further studies are required, these patients may benefit from stricter perioperative infection control regimens, potentially improving outcomes and leading to fewer unplanned readmissions. Finally, using a previous PCI or cardiac surgery as a surrogate for poor cardiovascular health, our results add to the literature suggesting a high 30-day readmission rate in patients with heart disease (49–51). These high-risk patients require careful pre- and postoperative considerations in order to minimize exacerbations of their underlying condition and improve perioperative outcomes.

Although the NSQIP database allows for unbiased and statistically powerful studies, there are nuanced confounders that limit our analyses. Despite the 240 variables that are tracked for each patient, NSQIP does not include data on socioeconomic information, hospital characteristics, hospital costs, and satisfaction, and thus we are unable to comment on how any of these variables affect, or are affected by, readmission. The reasons for readmission as well as the day postdischarge on which it occurred are also not captured by the data base. Furthermore, although our C-statistic of 0.711 for the logistic regression models was acceptable, it reconfirms the concern that important variables may have been omitted. While this study benefits from a large, multi-centered population, future studies with more thorough demographic and socioeconomic data should be used to build upon our results and develop a validated predictive model for the risk of unplanned readmission.

With an incidence of 2.15%, unplanned readmission following an excisional breast procedure is a fairly rare event, but there is clearly room for improvement. Given the current health care climate, reducing 30-day readmissions by even a small amount could have a large impact on both improving patient safety/satisfaction and reducing hospital costs. Essential to achieving this goal is the development of guidelines to help identify and manage high-risk patients following excisional breast surgery. Despite the controversy regarding the use of readmission to assess hospital performance, every readmission prevented will undoubtedly decrease the burden placed upon our patients and the healthcare system.

CONFLICTS OF INTEREST

The authors have no financial disclosures relevant to this paper.

DISCLOSURE

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.

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