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Predictors of 30-day readmission following pancreatic surgery: A retrospective review☆

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ABSTRACT

Background: Pancreatectomies have been identified as procedures with an increased risk of readmission. In surgical patients, readmissions within 30 days of discharge are usually procedure-related. We sought to determine predictors of 30-day readmission following pancreatic resections in a large healthcare system.
Methods: We retrospectively collected information from the records of 383 patients who underwent pancreatic resections from 2004–2013. To find the predictors of readmission in the 30 days after discharge, we performed a univariate screen of possible variables using the Fisher's exact test for categorical variables and the Mann–Whitney *U* test for continuous variables. Multivariate analysis was used to determine the independent factors.
Results: Fifty-eight (15.1%) patients were readmitted within 30 days of discharge. Of the patients readmitted, the most common diagnoses at readmission were sepsis (17.2%), and dehydration (8.6%). Multivariate logistic regression found that the development of intra-abdominal fluid collections (OR = 5.32, $P < 0.0001$), new thromboembolic events (OR = 4.08, $P = 0.016$), and pre-operative BMI (OR = 1.06, $P = 0.040$) were independent risk factors of readmission within 30 days of discharge.
Conclusion: Our data demonstrate that factors predictive of 30-day readmission are a combination of patient characteristics and the development of post-operative complications. Targeted interventions may be used to reduce the risk of readmission.

Introduction

Unplanned readmissions to hospital after initial discharge have a significant impact on healthcare costs. Readmissions also take a physical, psychological, and emotional toll on patients and healthcare providers. From 2003 to 2004, 19.5% of all Medicare beneficiaries who were discharged from hospital were readmitted within 30 days, leading to a cost of $17.4 billion [1]. Kassin et al. identified pancreatectomies, colectomies, and liver resections as procedures associated with an increased risk of readmission [1]. Kent et al. estimated that a single readmission after pancreatic resection costs an average of $16,000 or more [2].

Surgical patients like all other patients have some underlying medical conditions; and in addition to their medical problems, undergoing surgical procedures places them at additional risk of readmission [1]. Previous studies looking at patients who had undergone cardiac, colorectal, and pancreatic surgical procedures demonstrated that factors associated with hospital readmission were patient factors; particularly comorbidities, hospital length of stay, and the development of post-operative complications [3–5].

Kassin et al. pointed out that gastrointestinal complications and surgical infections accounted for nearly half of all readmissions [1]. Patients undergoing pancreatectomy had the highest readmission rate at 17.9% [1]. Other studies have demonstrated the increased risk of readmissions with the occurrence of post-operative complications, including wound infections, bleeding, dehydration, pancreatic fistulas, and delayed gastric emptying [4–10].

Sadot et al. studied 490 patients who underwent pancreatoduodenectomies, central, and distal pancreatectomies, and reported a 30-day readmission rate of 28% [11]. This study found that the in-

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dependent predictors of 30-day readmission were central pancreatectomy, discharge with a drain, a pancreatic duct less than 3 mm in diameter, previous abdominal surgery, and post-operative length of stay. Readmissions after pancreatic operations were procedure-related in the first 30 days, but readmissions after 30 days were influenced by the natural history of the underlying diagnosis [11]. Patients undergoing pancreatic operations are expected to have higher readmission rates, since they are older, have more comorbidities, and undergo complex procedures [12–15].

Since patients who undergo surgery on the pancreas have a higher risk of readmission due to a variety of factors, we sought to determine the risk factors for 30-day readmission using a cohort of all patients who underwent any type of surgery on the pancreas from two tertiary healthcare centers (both part of the Northwell Health System in New York). We surmise that post-operative complications would be the most significant predictor of 30-day readmission following pancreas surgery.

Methods

Subjects included in this study were patients who had pancreatic resections of any kind at two tertiary teaching hospitals which are part of the Northwell Health System in New York: the North Shore University Hospital in Manhasset (764 beds) and the Long Island Jewish Medical Center in New Hyde Park (1025 beds), from 2004 to 2013. Regulatory approval was obtained from the Northwell Health Institutional Review Board (IRB). Charts were reviewed, and data entered into a Research Data Electronic Capture database (REDCap). Most recent charts were in paper and electronic form, while older records were archived as microfilms.

Descriptive statistics were presented for the entire cohort of 383 patients. The Mann–Whitney U test was used to compare those who were readmitted within 30-days after discharge to those who were not readmitted within 30 days for continuous variables. The χ^2-test or Fisher's exact test as deemed appropriate was used for categorical variables. Continuous data are reported as median unless otherwise specified and categorical data are reported as frequencies and percentages.

Variables that appeared to be associated with 30-day readmission in the univariate analysis (using a threshold level of $P < 0.10$) were included in a multivariable logistic regression model. Backwards selection was used to remove variables which did not significantly contribute information to the model, given other factors included in the model. A receiver operating characteristic (ROC) curve was constructed to look at the final model's ability to predict the outcome. A numerical measure of the accuracy of the model was obtained from the area under the curve (AUC), where an area of 1.0 signifies near perfect accuracy, while an area of less than 0.5 indicates that the model is worse than just flipping a coin. The following was used as a guide to assess the accuracy of the AUC: Excellent, 0.9–1.0; Very good, 0.8–0.9; Good, 0.7–0.8; Average, 0.6–0.7; and Poor, 0.5–0.6. The Hosmer and Lemeshow Goodness-of-Fit test was also used to test how well the model fits the data.

Unless otherwise specified, a result was considered statistically significant at the $P < 0.05$ level of significance. All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

Results

There were 383 patients in our cohort who had pancreatic surgery at the two hospitals mentioned above from 2004–2013. The mean age at diagnosis was 64.2 ± 14.4 years. 57.4% of the cohort was female, 8.6% were Hispanic, and 62.4% were White (Table 1). 58 (15.1%) out of 383 patients were readmitted within 30-day of discharge (Table 2). The diagnoses at readmission are also found in Table 2.

Table 1
Characteristics of all subjects who had pancreatic resections ($n = 383$).

Characteristics	Value
Gender	
Male	163 (42.6%)
Female	220 (57.4%)
Age at diagnosis (mean ± SD, yr)	64.2 ± 14.4
Ethnicity	
Hispanic/Latino	33 (8.6%)
Non-Hispanic/Non-Latino	263 (68.7%)
Unknown/missing	87 (22.7%)
Race	
White	239 (62.4%)
Black	61 (15.9%)
Other	56 (14.6%)
Unknown	27 (7.1%)
Type of malignant disease	
Adenocarcinoma	150 (39.2%)
Cystadenocarcinoma	3 (0.8%)
Malignant neuroendocrine tumor	31 (8.1%)
Malignant islet cell tumor	6 (1.6%)
Lymphoma	3 (0.8%)
Metastases	16 (4.2%)
Other	26 (6.8%)
Type of benign disease	
IPMN	26 (6.8%)
Pseudocyst	16 (4.2%)
MCN	26 (6.8%)
Serous cystadenoma	24 (6.3%)
Pancreatitis	28 (7.3%)
Benign islet cell tumor	6 (1.6%)
Benign neuroendocrine tumor	10 (2.6%)
Other	26 (6.8%)
Type of pancreatic resection	
Total	2 (0.5%)
Partial	381 (99.5%)
Type of partial resection	
Whipple	145 (37.9%)
Subtotal	11 (2.9%)
Distal	151 (39.4%)
Enucleation	13 (3.4%)
Other	63 (16.4%)
30-day readmission rate	58 (15.1%)
Mortality rate	161 (42.0%)

IPMN: intraductal papillary mucinous neoplasm; MCN: mucinous cystic neoplasm.

The factors found to be associated with 30-day readmission on univariate analysis are: history of tobacco use ($P = 0.037$), pre-operative BMI ($P = 0.025$), post-operative intensive care unit (ICU) admission ($P = 0.015$), post-operative thromboembolic events ($P = 0.002$), development of intra-abdominal fluid collections of any type post-operatively ($P < 0.0001$), superficial surgical site infections (SSSI) ($P = 0.007$), and deep incisional surgical site infections (DSSI) ($P = 0.006$) (Table 3). On multivariate analysis, the risk factors found to be independent predictors of 30-day readmission are pre-operative BMI (OR = 1.06, $P = 0.040$), post-operative thromboembolic events (OR = 4.08, $P = 0.016$), and development of intra-abdominal fluid collections (OR = 5.32, $P < 0.0001$) (Table 4). Fig. 1 is the ROC curve for the multivariate logistic regression model.

Discussion

Early unplanned readmissions place a significant burden on limited healthcare resources and are particularly demoralizing to patients and healthcare providers alike. Identifying drivers of early readmission in specific patient populations would be beneficial in the planning and provision of optimal medical care, by carrying out targeted interventions before or during hospitalization, aimed at preventing unplanned readmissions after discharge. This study was to determine the predictors of 30-day readmission in all pa-

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