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Discharge destination following pancreaticoduodenectomy: A NSQIP analysis of predictive factors and post-discharge outcomes

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ABSTRACT

Introduction: Pancreaticoduodenectomy is a complex surgical procedure. The purpose of this study was to identify factors associated non-home discharge destination and to characterize outcomes after non-home discharge.

Methods: 10,719 pancreaticoduodenectomy cases contained in the National Surgical Quality Improvement Program (NSQIP) Targeted Pancreatectomy dataset (years 2014–2016) were examined with univariate and multivariate logistic regression.

Results: 1336 patients (12.5%) were discharged to rehabilitation, skilled care, or acute care facilities. Preoperative factors significantly associated with non-home discharge on multivariate analysis were female gender, older age, elevated BMI, poor functional status or dyspnea, smoking, low albumin, COPD, and ascites. Intraoperative factors significantly associated with non-home discharge destination on multivariate analysis were longer operative time, open surgery, softer pancreatic texture, drain placement, and jejunostomy tube placement. A nomogram was generated for estimating probability of non-home discharge immediately after surgery.

Conclusion: Preoperative and intraoperative factors can be used to predict probability of non-home discharge immediately after completion of pancreaticoduodenectomy.

Introduction

Pancreaticoduodenectomy (PD) is a complex surgical procedure for which perioperative mortality rates as low as 1–2% have been reported from select high-volume centers.[1–3] However, perioperative morbidity rates associated with this operation have remained high, even at such centers.[1–3] As a result, a large proportion of patients undergoing PD are discharged to skilled nursing facilities and rehabilitation centers following surgery.

There is an urgent need for understanding both risk factors for non-home discharge as well as outcomes after non-home discharge for two reasons: 1) post-acute care spending is now the fastest growing and major spending category in US healthcare,[4] 2) implementation of bundled payments for surgical care (as driven by the Medicare Access and CHIP Reauthorization Act passed by Congress in 2015) will require precise cost attributions throughout all phases of perioperative care.[5,6] Knowledge of potentially modifiable factors that increase risk of non-home discharge would be of particular value.

Recently, the National Surgical Quality Improvement Program (NSQIP) has begun tracking pancreatectomy-specific variables in a targeted pancreatectomy database, providing granularity to patient outcomes following pancreatic resection.[7] Recent database studies identifying risk factors for non-home discharge after PD[8,9] have not been able to include these variables and it is unknown if further granularity with regard to pancreas-specific variables could further improve non-home discharge prediction. In our study, this NSQIP database was analyzed to determine factors associated with non-home discharge following PD in the pancreatectomy-specific database. Additionally, a nomogram was generated to estimate the probability of non-home discharge which included both

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Table 1
Baseline patient characteristics and intraoperative variables.

Variable	Home (n = 9383)	Non-Home (1336)	p value
Gender			**0.002**
Female (%)	4305 (45.9)	672 (50.3)	
Male (%)	5078 (54.1)	664 (49.7)	
Race			0.335
Caucasian (%)	7165 (84.6)	1082 (86.6)	
African American (%)	748 (8.8)	103 (8.2)	
Asian (%)	361 (4.3)	43 (3.4)	
Hispanic (%)	149 (1.8)	17 (1.4)	
Other (%)	44 (0.5)	4 (0.3)	
Unknown	916	87	
Mean Age (SD)	63.2 (11.5)	72.1 (9.7)	**<0.001**
Mean BMI (SD)	27.26 (5.84)	27.72 (6.33)	**0.007**
BMI > 30	2438 (26.1)	387 (29.0)	**0.026**
Emergent Case (%)	38 (0.4)	11 (0.8)	**0.038**
ASA Class 1 or 2 (%)	2313 (24.7)	161 (12.1)	**<0.001**
Mean Days in Hospital Prior to OR (SD)	0.59 (6.83)	1.03 (3.29)	**0.05**
Preoperative Jaundice (%)	4154 (44.6)	669 (50.6)	**<0.001**
Preoperative Biliary Stent (%)	4681 (52.0)	722 (56.3)	**0.004**
Neoadjuvant Chemotherapy (%)	1608 (17.2)	197 (14.8)	**0.031**
Neoadjuvant Radiotherapy (%)	670 (7.2)	93 (7.0)	0.821
Invasive Cancer (%)	6485 (69.2)	999 (74.9)	**<0.001**
Outside Transfer (%)	215 (2.3)	86 (6.4)	**<0.001**
Comorbidities			
Diabetes Mellitus			**<0.001**
None (%)	7126 (75.9)	891 (66.7)	
Non-Insulin Dependent (%)	1120 (11.9)	225 (16.8)	
Insulin Dependent (%)	1137 (12.1)	220 (16.5)	
Smoking (%)	1780 (19.0)	197 (14.7)	**<0.001**
Dyspnea (%)	415 (4.4)	126 (9.4)	**<0.001**
Non-Independent Function (%)	47 (0.5)	39 (2.9)	**<0.001**
Preoperative Sepsis			**<0.001**
None (%)	9299 (99.1)	1306 (97.8)	
SIRS (%)	58 (0.6)	19 (1.4)	
Sepsis (%)	26 (0.3)	11 (0.8)	
COPD (%)	342 (3.6)	111 (8.3)	**<0.001**
Ascites (%)	18 (0.2)	12 (0.9)	**<0.001**
Hypertension (%)	4731 (50.4)	909 (68.0)	**<0.001**
Renal Failure (%)	3 (0)	4 (0.3)	**0.003**
Dialysis (%)	14 (0.1)	11 (0.8)	**<0.001**
Disseminated Cancer (%)	390 (4.2)	55 (4.1)	0.946
Steroid Use (%)	227 (2.4)	46 (3.4)	**0.027**
Weight Loss >10% (%)	1491 (15.9)	256 (19.2)	**0.002**
Bleeding Disorder (%)	224 (2.4)	54 (4.0)	**<0.001**
Preoperative Blood Transfusion (%)	71 (0.8)	27 (2.0)	**<0.001**
Preoperative Laboratories, Mean (SD)			
Creatinine	0.87 (0.42)	0.95 (0.51)	**<0.001**
Albumin	3.78 (0.61)	3.55 (0.66)	**<0.001**
Bilirubin	1.70 (2.58)	1.66 (2.46)	0.614
Hematocrit	37.9 (5.0)	36.2 (5.4)	**<0.001**
Intraoperative Factors			
Dirty or Infected Wound Class (%)	1498 (16.0)	257 (19.2)	**0.003**
Epidural (%)	2260 (24.1)	326 (24.4)	**<0.001**
Operative Time Mean (SD)	369 (129)	380 (134)	**0.004**
75th percentile or higher	2302 (24.5)	383 (28.7)	**0.001**
Minimally Invasive Approach (%)	494 (5.4)	42 (3.2)	**0.001**
Pancreatic Texture			**0.002**
Soft (%)	3228 (46.2)	523 (51.6)	
Intermediate (%)	751 (10.7)	110 (10.9)	
Hard (%)	3010 (43.1)	380 (37.5)	
Pancreatic duct size			0.097
<3 mm (%)	2269 (31.1)	291 (28.2)	
3–6 mm (%)	3798 (52.0)	545 (52.9)	
>6 mm (%)	1233 (16.9)	195 (18.9)	
Pancreatic Reconstruction			0.432
Pancreaticojejuonstomy (%)	8507 (97.2)	1225 (97.6)	
Pancreaticogastrostomy (%)	243 (2.8)	30 (2.4)	
Drain Placement (%)	8171 (87.3)	1224 (91.8)	**<0.001**
Vascular Reconstruction (%)	1605 (17.3)	225 (17.1)	0.845
Concurrent Procedures			
Splenectomy (%)	44 (0.5)	11 (0.8)	0.096
Diagnostic Laparoscopy (%)	800 (8.7)	137 (10.4)	**0.039**
Jejunostomy Tube Insertion (%)	644 (7.0)	162 (12.3)	**<0.001**
Ablation (%)	19 (0.2)	0 (0)	0.998
Appendectomy (%)	45 (0.5)	10 (0.8)	0.205

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Table 1 (*continued*)

Variable	Home (n = 9383)	Non-Home (1336)	p value
Liver biopsy (%)	746 (8.1)	121 (9.2)	0.182
Colectomy (%)	140 (1.5)	33 (2.5)	**0.009**
Lysis of Adhesions (%)	432 (4.7)	83 (6.3)	**0.011**
Hepatectomy (%)	93 (1.0)	14 (1.1)	0.975
Nephrectomy (%)	28 (0.3)	2 (0.2)	0.343

SD standard deviation, *BMI* body mass index, *ASA* American Society of Anesthesiologists, *OR* operating room, *SIRS* systemic inflammatory response syndrome, *COPD* chronic obstructive pulmonary disease.

preoperative and intraoperative factors. Nomograms are tools that provide the overall probability of an outcome based on multiple independent variables and can be easily utilized in clinical practice.[10] This nomogram could aid in patient counseling and disposition planning immediately after surgery. Lastly, we evaluated for differences in post-discharge complications and readmission associated with non-home discharge destination.

Methods

National Surgical Quality Improvement Program

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) is a quality improvement database which contains both preoperative and postoperative data for a wide variety of surgical procedures.[7] Additionally, since 2014, NSQIP has maintained a pancreatectomy-specific database which includes several pancreatic surgery-specific variables. Pancreas-specific preoperative variables include preoperative obstructive jaundice, preoperative biliary stent, and chemotherapy or radiation therapy within 90 days of surgery. Intraoperative variables included pancreatic gland texture, pancreatic duct size, and vascular reconstruction. Postoperative variables include pancreatic fistula and delayed gastric emptying. The participant use date file (PUF) collected by NSQIP is de-identified and Health Insurance Portability and Accountability Act (HIPAA)-compliant. Institutional Review Board approval was obtained for this study.

Study population

The 2014–2016 NSQIP and Targeted Pancreatectomy PUF datasets were utilized. Patients who underwent PD for any indications were included for analysis and Case ID variables were used to merge the NSQIP and Targeted Pancreatectomy datasets. Pancreaticoduodenectomy was identified using CPT codes 48,150, 48,152, 48,153, or 48,154. A total of 10,971 patients were initially included. Of those, 252 patients were excluded because of unknown discharge destination, they were discharged against medical advice, or they were discharged as deceased. Thus 10,719 patients were available for final analysis. Non-home discharge destination was defined as either hospice, rehabilitation facility, separate acute care, skilled care or unskilled facility.

Statistical analysis

Comparisons of the cohort discharged home with the cohort discharged to a post-acute care facility was performed utilizing Pearson's chi-squared test for categorical variables and Student's t-test for continuous variables. Non-home and home discharge destination cohorts were compared utilizing univariate logistic regression. Variables significant on univariate regression were then compared with multivariate logistic regression for both preoperative factors alone and preoperative and intraoperative factors combined. Stepwise selection of variables using a bidirectional approach was sequentially performed. A nomogram based on significant preoperative and intraoperative factors was generated based on the regression coefficients and standard errors scaled to provide a 0–100 probability of non-home discharge using R3.5.0 with the rms package (http://www.r-project.org/). All other analyses were conducted in SPSS, version 24. A two-sided p-value of less than 0.05 was considered statistically significant in final analyses.

Results

From 2014 to 2016, a total of 10,719 patients underwent pancreaticoduodenectomy with known discharge destination status. Within this sample, 1336 (12.5%) of patients had a non-home discharge from their initial hospitalization. Table 1 shows baseline preoperative characteristics as well as intraoperative variables comparing home versus non-home discharge destination. Univariate logistic regression for all preoperative and intraoperative variables was performed to look for association with non-home discharge. The mean postoperative discharge day for patients discharged home was 9.8 versus 17.3 for those discharged to a non-home destination ($p < 0.001$).

All variables that reached statistical significance on univariate regression were placed into a multivariate regression. Separate multivariate logistic regression was performed for preoperative variables alone and preoperative and intraoperative variables combined to identify predictors of non-home discharge that could be used prior to surgery as well as immediately after surgery. Preoperative variables significantly associated with non-home discharge were female gender (OR 1.309, $p < 0.001$), older age (OR 1.093, $p < 0.001$), higher BMI (OR 1.035, $p < 0.001$), patients transferred from an outside hospital prior to surgery (OR 2.020, $p < 0.001$), non-smokers (OR 1.272, $p = 0.025$), patients being operated on for cancer (OR 1.291, $p = 0.008$), functionally dependent patients (OR 3.327, $p < 0.001$), preoperative dyspnea (OR 1.551, $p = 0.002$), American Society of Anesthesiologists (ASA) Physical status 3 or higher (OR 1.440, $p = 0.001$), lower preoperative albumin (OR 0.733, $p < 0.001$), diabetics (OR 1.254, $p = 0.026$), dialysis patients (OR 4.864, $p = 0.011$), chronic obstructive pulmonary disease (COPD) (OR 1.723, $p < 0.001$), preoperative sepsis (OR 1.978, $p = 0.047$), or ascites (OR 4.931, $p = 0.001$). The area under the curve (c-statistic) was 0.777. Patients who smoked were more likely to have hard pancreatic texture (48.4% vs. 41.0%, $p < 0.001$) and less likely to subsequently develop a pancreatic fistula (15.6% vs. 18.3%, $p = 0.004$) or delayed gastric emptying (14.1% vs. 17.2%, $p = 0.001$).

Once both preoperative and intraoperative variables were analyzed on multivariate regression together, diabetes, smoking, preoperative sepsis, and invasive cancer were no longer significant. Intraoperative variables significantly associated with non-home discharge on multivariate analysis were longer operative duration (OR 1.002, $p < 0.001$), open surgical approach (OR 2.268, $p < 0.001$), non-hard pancreatic texture (OR 1.385, $p = 0.001$), drain placement during surgery (OR 1.441, $p = 0.013$), and concurrent jejunostomy tube insertion (OR 1.635, $p = 0.001$). Categorizing operative time by

quartile showed significance as well for patients with operative time in the 75th or higher percentile (OR 1.465, $p < 0.001$). Multivariate regressions are shown in Table 2. The area under the curve was 0.853. A nomogram was generated using the combined preoperative and intraoperative significant factors and is shown in Fig. 1. For example, a 50 year-old male with a BMI of 25, albumin of 4, and independent functional status who underwent a minimally invasive PD and had a hard pancreas and a drain placed would have a <1% chance of non-home discharge. In contrast, a 70 year-old female transferred from an outside facility with a BMI of 35, partially dependent functional status, COPD, soft pancreatic texture and an albumin of 2 who underwent an open PD, drain and jejunostomy tube placement would have an approximately 42% change of non-home discharge.

The development of any postoperative complication tracked by NSQIP, including unplanned reoperation, was associated with increased ($p < 0.05$) incidence of non-home discharge destination on univariate logistic regression. Complication rates for patients discharged to home and for those discharge to non-home destinations are shown in Table 3. Patients with non-home discharge had a 10.7% unplanned reoperation rate compared to 4.0% for patients discharged home ($p < 0.001$).

Next, complications that were specifically diagnosed after initial discharge were evaluated to assess if there was a higher incidence of complications following discharge to a non-home facility. No postoperative complication occurred with greater incidence in patients discharged to a non-home destination than among patients discharged to home. However, patients discharged to home were more likely to develop superficial, deep, and organ space infections as well as failure to wean off ventilator, deep venous thrombosis, sepsis, and septic shock after their initial discharge (all $p < 0.05$) than patients discharged to non-home destinations (Table 4).

Overall readmission rates were similar regardless of discharge destination (16.9% for home discharge versus 16.6% for non-home discharge, $p = 0.784$). Sepsis, nausea/vomiting, dehydration, and abdominal pain were the most common reasons for readmission. Readmission for renal failure or insufficiency was significantly more likely in non-home discharge patients ($p < 0.001$). Patients initially discharged home were significantly more likely to be readmitted for organ space infection ($p = 0.033$), failure to thrive ($p = 0.035$), nausea/vomiting ($p = 0.005$), and dehydration ($p = 0.022$) (Table 5).

Discussion

This study reports the baseline demographic characteristics, patient comorbidities, and intraoperative details associated with non-home discharge destination in a large patient sample undergoing PD in a validated national cohort which includes pancreatectomy-specific variables. Patient factors significantly predictive of non-home discharge on multivariate analysis were female gender, older age, higher BMI, non-independent functional status, smoking, ASA class 3 or higher, and patients transferred from an outside hospital. Comorbidities significantly predictive included dyspnea, COPD, ascites, dialysis, and hypoalbuminemia. Intraoperative variables associated with non-home discharge were longer operative duration, open surgical approach, softer pancreatic texture, drain placement, and jejunostomy tube insertion. Separate multivariate regressions were performed with preoperative factors alone as well as preoperative and intraoperative factors combined to assist surgeons in preoperative counseling and postoperative disposition planning, respectively. Further, a nomogram was generated to predict non-home discharge immediately following PD to aid the surgeon and their team to facilitate

Table 2
Multivariate regression for non-home discharge.

Preoperative Variables	Odds Ratio (95% CI)	p value
Gender	1.309 (1.128,1.518)	**<0.001**
Age	1.093 (1.083,1.103)	**<0.001**
BMI	1.035 (1.023, 1.049)	**<0.001**
Transfer	2.020 (1.442, 2.831)	**<0.001**
Diabetes	1.254 (1.027, 1.531)	**0.026**
Smoking	1.272 (1.031, 1.569)	**0.025**
Dyspnea	1.551 (1.181, 2.036)	**0.002**
Functional Status	3.327 (1.875, 5.904)	**<0.001**
Preoperative Sepsis	1.978 (1.008, 3.854)	**0.047**
COPD	1.723 (1.292, 2.299)	**<0.001**
Ascites	4.931 (1.859, 13.08)	**0.001**
Hypertension		0.157
Dialysis	4.864 (1.443, 16.40)	**0.011**
Steroid Use		0.081
Weight Loss		0.37
Preoperative Transfusion		0.964
Sodium		0.357
Creatinine		0.477
Albumin	0.733 (0.638, 0.841)	**<0.001**
Hematocrit		0.103
INR		0.459
Emergent Case		0.076
ASA Class 3 or Higher	1.440 (1.159, 1.789)	**0.001**
Preoperative Jaundice		0.497
Preoperative Stent		0.96
Neoadjuvant Chemotherapy		0.981
Invasive Cancer	1.291 (1.070, 1.557)	**0.008**
Gender	1.441 (1.205, 1.723)	**<0.001**
Age	1.101 (1.089, 1.113)	**<0.001**
BMI	1.030 (1.014, 1.045)	**<0.001**
Transfer	2.056 (1.363, 3.101)	**0.001**
Diabetes		0.137
Smoking		0.084
Dyspnea	1.597 (1.171, 2.179)	**0.003**
Functional Status	4.078 (2.059, 8.074)	**<0.001**
Preoperative Sepsis		0.07
COPD	1.793 (1.277, 2.517)	**0.001**
Ascites	3.583 (1.172, 10.956)	**0.025**
Hypertension		0.393
Dialysis	5.421 (1.171, 25.094)	**0.031**
Steroid Use		0.913
Weight Loss		0.751
Preoperative Transfusion		1
Sodium		0.185
Creatinine		0.826
Albumin	0.698 (0.590, 0.826)	**<0.001**
Hematocrit		0.108
INR		0.27
Emergent Case		0.227
ASA Class 3 or Higher	1.365 (1.067, 1.745)	**0.013**
Preoperative Jaundice		0.607
Preoperative Stent		0.477
Neoadjuvant Chemotherapy		0.238
Invasive Cancer		0.154
Intraoperative Variables		
Wound Class		0.578
Epidural		0.609
Operative Time	1.002 (1.001, 1.002)	**<0.001**
Open Surgical Approach	2.268 (1.437, 3.581)	**<0.001**
Non-Hard Pancreatic Texture	1.385 (1.148, 1.671)	**0.001**
Drain Placement	1.441 (1.079, 1.924)	**0.013**
Diagnostic Laparoscopy		0.981
Jejunostomy Tube Placement	1.635 (1.236 2.163)	**0.001**
Colectomy		0.133
Lysis of Adhesions		0.374

Preoperative and intraoperative variables. *CI* confidence interval, *BMI* body mass index, *COPD* chronic obstructive pulmonary disease, *INR* international normalized ratio, *ASA* American Society of Anesthesiologists.
Preoperative variables alone. *CI* confidence interval, *BMI* body mass index, *COPD* chronic obstructive pulmonary disease, *INR* international normalized ratio, *ASA* American Society of Anesthesiologists.

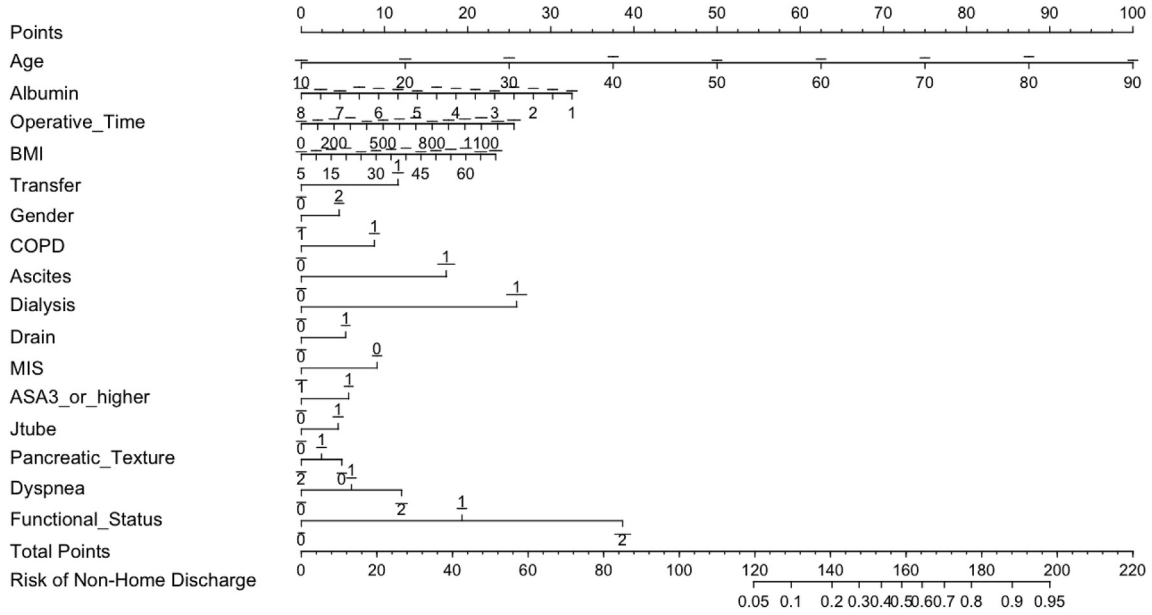

Fig. 1. Nomogram predicting non-home discharge immediately following pancreaticoduodenectomy.
Variables: Gender: Male is 1, Female is 2; MIS = minimally invasive surgery; Pancreatic Texture: 0 is soft, 1 is intermediate, 2 is hard; Dyspnea: 0 is none, 1 is with exertion, 2 is at rest; Functional Status: 0 is independent, 1 is partially dependent, 2 is totally dependent.

discharge planning and enhance patient counseling in the early postoperative period. Importantly, while this nomogram has high internal validity as evidenced by the AUC of 0.853 with both pre-operative and intraoperative variables, it will require external validation with a different dataset. Patients discharged home had lower complication rates overall, however were more likely to develop certain complications after initial discharge, specifically infectious complications, deep venous thrombosis, and unexpected reoperation. Overall readmission rates were similar regardless of discharge destination.

Other studies have sought to identify predictors of non-home discharge destination following PD. Shah et al. looked at the Nationwide Inpatient Sample database from 1993 to 2005 for all patients undergoing pancreaticoduodenectomy and found that age over 70, female gender, smaller hospitals, non-elective admissions, three or more comorbidities, and pancreatic head lesions were associated with non-routine discharge (non-home discharge or with home health care services).[8] A NSQIP study by Nassour et al. was recently published which generated a nomogram to predict non-home discharge in patients undergoing PD utilizing years prior to the pancreatectomy-specific dataset (2011–2013). Nomograms using preoperative factors alone as well as preoperative and post-operative variables were generated. Similar to this study, female gender, older age, higher BMI, low albumin, higher ASA class, and

Table 3
Overall complication rates by discharge destination.

Complication	Home (n = 9383)	Non-Home (n = 1336)	p value
SSI (%)	728 (7.8)	157 (11.8)	**<0.001**
DSSI (%)	153 (1.6)	36 (2.7)	**0.006**
OSSI (%)	1187 (12.7)	341 (25.5)	**<0.001**
Dehiscence (%)	109 (1.2)	34 (2.5)	**<0.001**
Pneumonia (%)	249 (2.7)	128 (9.6)	**<0.001**
Reintubation (%)	152 (1.6)	137 (10.3)	**<0.001**
Pulmonary Embolus (%)	97 (1.0)	26 (1.9)	**0.004**
Failure to Wean >48 h (%)	89 (0.9)	150 (11.2)	**<0.001**
Renal Insufficiency (%)	43 (0.5)	26 (1.9)	**<0.001**
Renal Failure (%)	20 (0.2)	29 (2.2)	**<0.001**
UTI (%)	245 (2.6)	82 (6.1)	**<0.001**
CVA (%)	11 (0.1)	12 (0.9)	**<0.001**
Cardiac Arrest (%)	15 (0.2)	14 (1.0)	**<0.001**
MI (%)	58 (0.6)	39 (2.9)	**<0.001**
Bleeding (%)	1604 (17.1)	409 (30.6)	**<0.001**
DVT (%)	203 (2.2)	77 (5.8)	**<0.001**
Sepsis (%)	770 (8.2)	214 (16.0)	**<0.001**
Septic Shock (%)	115 (1.2)	126 (9.4)	**<0.001**
Clostridium difficile Infection (%)	99 (1.9)	29 (4.1)	**<0.001**
Pancreatic Fistula (%)	1521 (16.4)	372 (28.2)	**<0.001**
Delayed Gastric Emptying (%)	1364 (14.8)	385 (29.4)	**<0.001**
Postoperative Percutaneous Drain (%)	1101 (11.9)	253 (19.2)	**<0.001**
Reoperation (%)	375 (4.0)	143 (10.7)	**<0.001**

SSI superficial surgical site infection, *DSSI* deep surgical site infection, *OSSI* organ space surgical infection, *UTI* urinary tract infection, *CVA* cerebral vascular accident, *MI* myocardial infarction, *DVT* deep venous thrombosis.

Table 4
Rate of complications after initial hospital discharge.

Complication	Home (n = 9383)	Non-Home (n = 1336)	p value
SSI	52.4%	25.7%	**<0.001**
DSSI	68.2%	39.3%	**0.003**
OSSI	62.3%	34.7%	**<0.001**
Dehiscence	72.6%	57.1%	0.225
Pneumonia	34.0%	30.6%	0.641
Reintubation	41.9%	37.0%	0.498
Failure to Wean	40.7%	24.4%	**0.045**
DVT	62.6%	41.4%	**0.027**
Pulmonary Embolus	54.2%	64.3%	0.471
UTI	42.3%	41.9%	0.952
CVA	46.4%	0.0%	0.201
Cardiac Arrest	43.3%	33.3%	0.466
MI	16.7%	26.7%	0.346
Sepsis	40.6%	30.1%	**0.02**
Septic Shock	44.7%	27.7%	**0.028**
Reoperation	27.7%	11.2%	**<0.001**

cancer were predictive of non-home discharge.[9] The predictive power including pancreas-specific variables is slightly higher in the present study (0.777 vs 0.77 for preoperative only variables, 0.853 vs 0.82 for all variables). This study expands on these findings by including more preoperative and intraoperative variables, including the newly collected pancreas specific variables such as operative approach, pancreatic texture, and pancreatic duct size, amongst others. Additionally, a nomogram including these preoperative and intraoperative variables, while excluding postoperative complications, can better expedite early discharge planning.

Numerous potentially modifiable risk factors were identified. Elevated BMI, which has been shown to be associated with increased morbidity and mortality following PD,[11] was associated with non-home discharge. Intraoperative technical factors such as open surgical approach, drain placement, and jejunostomy tube placement are all multifactorial and surgeon preference can vary based on patient-specific factors. Selective drain placement is being studied at some institutions, though relationship to discharge destination is not commonly assessed.[12] The routine use of jejunostomy tube placement during PD is also controversial,[13] with one retrospective study of 256 patients showing a 7.2% feeding-tube specific morbidity rate and significantly higher rates of delayed gastric emptying and longer hospital stays.[14] While this study did not report discharge destination, they did find a decrease in home health services from 66% to 36% with the change from standard to selective jejunostomy tube placement. Finally, while a systematic review and meta-analysis did recently show shorter length of stay and reduced postoperative morbidity with minimally invasive surgical approaches for PD, these studies were likely prone to selection bias, and randomized trials will be needed to better assess its role.[15]

Two risk factors for non-home discharge after PD were associated with frailty: functional status and hypoalbuminemia. The NSQIP modified frailty index has shown that frail patients are significantly more likely to be discharged to skilled nursing or rehabilitation facilities after a variety of surgical procedures, including urologic procedures,[16] paraesophageal hernia repair,[17] and endometrial cancer surgeries.[18] There are ongoing randomized trials focusing on prehabilitation specifically for improved postoperative function for patients with pancreatic cancer.[19,20] Beyond impact of functional recovery after surgery, future studies should also assess for improvement in postoperative complications and discharge destination.[21]

Unsurprisingly, the overall development of postoperative complications was associated with higher rates of non-home discharge. However, patients who went to a rehabilitation facility were more likely to develop any specific complication prior to discharge relative to patients initially discharged home. Importantly, there was not a higher rate of readmission associated with non-home

Table 5
Reasons for readmission after initial hospital discharge.

Readmissions	Home (n = 9383)	Non-Home (n-1336)	p value
Overall (%)	1583 (16.9)	221 (16.6)	0.784
DVT/PE (%)	32 (0.34)	6 (0.44)	0.534
Pneumonia (%)	23 (0.25)	6 (0.44)	0.179
Renal (%)	7 (0.07)	6 (0.44)	**<0.001**
UTI (%)	12 (0.13)	3 (0.22)	0.377
SSI (%)	57 (0.61)	7 (0.52)	0.711
DSSI (%)	50 (0.53)	6 (0.44)	0.691
OSSI (%)	347 (0.37)	34 (0.25)	**0.033**
Abscess (%)	19 (0.20)	1 (0.07)	0.312
Clostridium difficile (%)	11 (0.12)	1 (0.07)	0.665
CVA (%)	3 (0.03)	0 (0)	0.513
Anemia (%)	28 (0.30)	1 (0.07)	0.141
Sepsis (%)	101 (1.08)	20 (1.50)	0.173
Ileus (%)	25 (0.27)	2 (0.15)	0.426
Wound Disruption (%)	26 (0.28)	2 (0.15)	0.393
Fistula (%)	6 (0.06)	0 (0)	0.355
Obstruction (%)	15 (0.16)	0 (0)	0.144
Constipation (%)	9 (0.10)	0 (0)	0.257
Cholangitis (%)	6 (0.06)	1 (0.07)	0.884
Gastrointestinal Bleeding (%)	26 (0.28)	2 (0.15)	0.393
Fever (%)	22 (0.23)	0 (0)	0.076
Abdominal Pain (%)	60 (0.64)	4 (0.30)	0.131
Ascites (%)	18 (0.19)	0 (0)	0.109
Failure to Thrive (%)	31 (0.33)	0 (0)	**0.035**
Malnutrition (%)	9 (0.10)	0 (0)	0.257
Nausea/Vomiting (%)	83 (0.88)	2 (0.15)	**0.005**
Dehydration (%)	74 (0.79)	3 (0.22)	**0.022**
Gastrojejunal Ulcer (%)	7 (0.07)	2 (0.15)	0.375
Gastroparesis (%)	21 (0.22)	0 (0)	0.083
Dyspepsia (%)	44 (0.47)	3 (0.22)	0.206

PE pulmonary embolus.

discharge destination. Interestingly, patients discharged to post-acute care facilities were significantly less likely to be readmitted for failure to thrive, nausea/vomiting, or dehydration, potentially signifying an ability to rescue these patients to prevent avoidable readmissions.

Patients discharged to post-acute care facilities had initial hospitalizations an average of 7.5 days longer than patients discharged home. While some of this difference is undoubtedly related to their higher morbidity and reoperation rates, lack of coordinated discharge planning likely also played a role in some settings. The use of multidisciplinary inpatient teams involving both clinical and non-clinical team members has been shown in multiple settings to improve patient outcomes and decrease length of stay.[22] Discharge planning should begin as early as possible so that patients and their families can make informed decisions based on their therapeutic goals.[23] In a Cochrane review, patients randomized to individualized discharge planning had decreased length of stay and reduced readmissions.[24]

As the current fee-for-service system is becoming untenable with the exponential economic costs of healthcare in the US, there is a push for adopting value-based healthcare utilizing bundled payments.[5,6] Transitioning from a fee-for-service model to a bundled payment model makes understanding of costs imperative for physicians and hospitals. As post-acute care spending is the most rapidly increasing component of healthcare spending,[4] knowing the rate of which patients are discharged to non-home destinations and subsequent costs will be critical. Under a bundled-payment model, health systems will have strong incentives to ensure post-discharge care is sufficient to afford good outcomes and limit preventable readmissions.[25]

Conclusions

In this study, preoperative and intraoperative factors were identified that were significantly associated with non-home discharge destination after PD. Patients with modifiable risk factors should have efforts made to augment their risk preoperatively when possible. Knowledge of risk factors for non-home discharge can be utilized preoperatively for patient counseling. Furthermore, by utilizing the provided nomogram, likelihood of non-home discharge can be quantified immediately following surgery to expedite the care coordination process postoperatively within multidisciplinary teams.

Compliance with ethical standards

All of the authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest in any organization or entity with any financial interest or nonfinancial interest in the subject matter or materials. This original manuscript has only been submitted to American Journal of Surgery and no related material is under consideration or in press elsewhere.

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Author's contribution

DAM, RDU, JSG, and EEW all made direct and substantial contributions to study conception and design. DAM and LMP collected the data and did statistical analysis. DAM wrote the primary draft of manuscript. All authors edited and provided critical revisions to manuscript. All authors have given final approval of the version to be published. All authors agree to be accountable for all aspects of the manuscript.

Appendix A. Supplementary data

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