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Association of Discharge Home with Home Health Care and 30-day Readmission after Pancreatectomy

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Abstract

Background—We sought to determine if discharge home with home health care (HHC) is an independent predictor of increased readmission following pancreatectomy.

Study Design—We examined 30-day readmissions in patients undergoing pancreatectomy using the Healthcare Cost and Utilization Project State Inpatient Database for California from 2009 to 2011. Readmissions were categorized as severe or non-severe using the Modified Accordion Severity Grading System. Multivariable logistic regression models were used to examine the association of discharge home with HHC and 30-day readmission using discharge home without HHC as the reference group. Propensity score matching was used as an additional analysis to compare the rate of 30-day readmission between patients discharged home with HHC to patients discharged home without HHC.

Results—3,573 patients underwent pancreatectomy and 752 (21.0%) were readmitted within 30 days of discharge. In a multivariable logistic regression model, discharge home with HHC was an

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independent predictor of increased 30-day readmission (OR=1.37; 95%CI=1.11-1.69, p=0.004). Using propensity score matching, patients who received HHC had a significantly increased rate of 30-day readmission compared to patients discharged home without HHC (24.3% vs 19.8%, p<0.001). Patients discharged home with HHC had a significantly increased rate of non-severe readmission compared to those discharged home without HHC by univariate comparison (19.2% vs 13.9%, p<0.001), but not severe readmission (6.4% vs 4.7%, p= 0.08). In multivariable logistic regression models, excluding patients discharged to facilities, discharge home with HHC was an independent predictor of increased non-severe readmissions (OR=1.41; 95%CI=1.11-1.79, p=0.005), but not severe readmissions (OR=1.31; 95%CI=0.88-1.93, p=0.18).

Conclusions—Discharge home with HHC following pancreatectomy is an independent predictor of increased 30-day readmission; specifically, these services are associated with increased non-severe readmissions, but not severe readmissions.

Background

Hospital readmissions are being used as a quality metric for patient care. The Patient Protection and Affordable Care Act contains a number of provisions intended to reduce preventable readmissions by reducing Medicare payments to hospitals with high preventable readmission rates.¹ However, studies that investigate factors which contribute to increased rates of readmission, especially in high-risk surgical populations, are lacking. To date, most studies regarding surgical readmissions have focused on patient-^{2, 3} or procedure-⁴⁻⁸ specific risk factors, which are generally non-modifiable. However, readmission following complex surgical procedures is likely multifactorial, and requires a comprehensive approach to analysis.

Pancreatectomy has a complication rate of 30-60%^{5, 9} and a readmission rate ranging from 11 to 59%.^{3, 6} Previous studies have identified comorbidities,^{2, 3} length of hospital stay,^{3, 5} patient age,^{3, 5, 6} and complications⁴⁻⁸ as being independently associated with readmission following pancreatectomy. However, most of these studies have not examined the role of a patient's discharge disposition in their analyses. Discharge home with a home health care agency has recently been implicated as a risk factor for readmission after major abdominal operations, including pancreatectomy.^{7, 10} However, the role of home health care in readmission has not been extensively studied in a large multi-institutional study of high-risk surgical patients, such as pancreatectomy patients.

There are little definitive data regarding the role of home health care as an adjunct to patient discharge.¹¹ The intended goal of this service is to assist patients who are recovering after a hospital stay, or need additional support to remain safely at home and avoid unnecessary hospitalization. Unfortunately, most of these agencies are underfunded and understaffed.¹² Home health care services generally send a home health nurse or aide of varying experience and expertise to the home of patients to assist in their care.¹³ By doing this, patients may be assessed more frequently by less familiar home health staff, which could increase patients' chances of being readmitted for less severe reasons. This would have important implications, as roughly one third of patients receive these services after pancreatectomy.¹⁴ We used the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization Project (HCUP) California State Inpatient Database (SID) for the years 2009 to

2011 to examine whether an association exists between home health care and 30-day readmission following pancreatectomy. We hypothesized that patients discharged home with home health care are at increased risk of 30-day readmission following pancreatectomy compared to patients discharged without these services after risk-adjustment for patient, perioperative, and hospital factors.

Methods

Study Design and Patient Population

This was a retrospective cohort study using the AHRQ HCUP SID for California from 2009 to 2011 to identify patients undergoing pancreaticoduodenectomy (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD9-CM] procedure codes: 52.51 and 52.7), total pancreatectomy (ICD9-CM procedure code: 52.6), and distal pancreatectomy (ICD9-CM procedure codes: 52.52). HCUP provides variables in the California SID to track sequential visits for a patient within a state and across facilities and hospital settings. These variables include a person-level identifier (VisitLink) and a timing variable (DaysToEvent) that can be used to determine the days between hospital events for an individual.

Using this approach, we identified patients with readmission to any hospital from 1 to 30 days post-discharge. For simplicity, only the first readmission was considered. We excluded patients under the age of 18 years, patients who died prior to index discharge, patients who underwent more than one pancreatectomy during the interval, and patients with missing VisitLink or DaysToEvent variables. One hundred and twenty-nine patient admissions were deleted because these were duplicate records, 106 patient admissions were deleted because their pancreatectomy took place in December of 2011 and there was not complete 30 day follow up, and 1 admission was deleted because it was missing the DaysToEvent variable.

Study Variables

We identified common postoperative complications and procedures using ICD9-CM diagnosis and procedure codes based on our previous work in pancreatectomy patients (Appendix 1, online only [Supplemental Table 1], and Table 1).^{15, 16} Complications were classified as severe (grade 3-5) if an invasive intervention was performed based on criteria in the contracted form of the Modified Accordion Severity Grading System.^{17, 18} Complications which did not require invasive interventions were classified as non-severe (grade 1 or 2). Similarly, readmissions were classified as severe if an invasive intervention was performed during the readmission hospitalization; otherwise, readmissions were considered non-severe. When categorizing the primary diagnoses for readmission, we defined the failure to thrive/nature of illness category as all diagnoses related to failure to thrive and associated metabolic disturbances (including electrolyte and glycemic disorders) as well as patients readmitted with a similar primary diagnosis as the initial pancreatectomy admission without other substantive secondary diagnoses to explain readmission. We also added abdominal pain, fevers, and intestinal abnormalities to the previously defined complications as additional primary readmission diagnoses (Appendix 1, online only [Supplemental Table 2]). Readmission for surgery-specific complications included:

gastroparesis/gastric outlet obstruction/nausea/vomiting; superficial wound infection; non-infectious wound complication (e.g. seroma/dehiscence/non-healing); intraabdominal infection/abscess; intestinal abnormalities; and other surgical complications (e.g. bleeding/hematoma/postoperative fistula).

We used the AHRQ comorbidity software, version 3.7 to identify comorbidities present at initial surgical admission by utilizing measures defined by Elixhauser et al. based on ICD9-CM diagnosis codes.¹⁹ The other race category included Asians, Pacific Islanders, Native Americans, and Hispanics. We defined the hospital volume quartiles using the total number of pancreatectomies performed at individual hospitals between 2009 and 2011. We defined the postoperative length of stay quartiles using the postoperative length of stays for all patients undergoing any pancreatectomy (i.e. pancreaticoduodenectomy, total pancreatectomy, or distal pancreatectomy) between 2009 and 2011. The median value for income is calculated by HCUP using the patient's zip code and the state of California's income data, and patients are categorized accordingly. Cells with fewer than 11 patients per variable were relabeled as "<11" in compliance with the HCUP data use agreement. The primary outcome was readmission within 30 days of discharge. Secondary outcomes were severe and non-severe readmission. The primary exposure was patient disposition (home, home with home health care, or other facility).

Statistical Analysis

Chi-square and Student's t tests were used for univariate comparisons. Multivariable logistic regression was used to examine the association of home health care and 30-day readmission. A cluster analysis was performed to rule out any significant impact of individual hospitals on readmission using hospital id in a random effects model. The "Postoperative Length of Stay" variable was excluded from multivariable analyses as it showed strong collinearity with the variable "Complications." Specifically, we observed erratic changes in our coefficient estimates with small changes in the model when both "Length of Stay" 4th quartile and "Severe Complications" were included, with a variance inflation factor of "Length of Stay" >2.5.²⁰ Because there is an obvious cause and effect relationship between complications and length of stay and the major reason for a patient to be in the hospital for a substantially prolonged period of time is because they are having severe complications, we excluded the "Length of Stay" variable in the final multivariable models. Only 4.7% of patients with severe complications did not have a length of stay in the 4th quartile.

Among patients discharged home (i.e. with or without home health care), excluding patients discharged to other facilities, propensity scores were estimated using a nonparsimonious multivariable logistic regression model using home health care as the dependent variable.²¹ Patients discharged home with home health care were then matched 1:1 to patients discharged home without home health care using a greedy matching algorithm with a caliper width of 0.2 standard deviations of the logit of the propensity score.²² Covariate balance between matched pairs was assessed using the standardized difference, with values less than 10% indicating minimal imbalance.²³ McNemar's test was used to compare the frequency of readmission between pairs.²⁴ All P-values were two-sided and values <0.05 were considered

statistically significant in all analyses. All statistics were performed using SAS version 9.3 (SAS Inc. Cary, NC).

Results

Discharge home with home health care and 30-day readmission following pancreatectomy

After excluding 119 patients (3.2%) who died during their initial hospital stay, there were 3,573 pancreatectomies performed at 180 hospitals from 2009 to 2011 in California who met study inclusion criteria: 2,470 pancreaticoduodenectomies, 122 total pancreatectomies, and 981 distal pancreatectomies. Their characteristics are displayed in Table 2. Seven hundred and fifty-two patients (21.0%) were readmitted within 30 days of discharge. The mean time from discharge to readmission was 10.1 days (standard deviation [SD]: 7.9 days) and the mean length of readmission stay was 7.1 days (SD: 8.7 days). The top 7 most common primary diagnosis categories for readmission (accounting for over 80% of readmissions) were: surgery-specific complications (n=363, 48.3%); failure to thrive/nature of illness (n=106, 14.1%), septicemia (n=43, 5.7%); gastrointestinal bleeding (n=31, 4.1%); healthcare-associated infections (i.e. urinary tract infection, *Clostridium difficile* colitis, and central venous catheter infections) (n=26, 3.4%); pulmonary complications, including pneumonia (n=22, 2.9%); and pain (n=19, 2.5%) (Figure 1).

In univariate analysis, male sex, diabetes, weight loss, hypertension, complications during surgical admission, postoperative length of stay, and postoperative discharge disposition other than home were associated with increased readmission. In a multivariable logistic regression model including age, sex, race, comorbidities (congestive heart failure, chronic lung disease, diabetes, chronic renal failure, obesity, weight loss, hypertension, alcohol abuse, and drug abuse), median income, pancreatectomy type, cancer status, complications, hospital volume, and discharge disposition, discharge home with home health care was an independent predictor of increased 30-day readmission (OR=1.37, 95% CI = 1.11 – 1.69, p=0.004) with discharge home only as the reference group. In addition, severe complications (1.43, 95% CI = 1.10 – 1.86, p=0.008) with no complications as the reference group, benign pathology (1.35, 95% CI = 1.11 – 1.64, p=0.003) with cancer as the reference group, hypertension (1.28, 95% CI = 1.07 – 1.54, p=0.008) with no hypertension as the reference group, and diabetes (1.22, 95% CI = 1.02 – 1.47, p=0.032) with no diabetes as the reference group were also independently associated with increased 30-day readmission following pancreatectomy (Table 3). We also assessed for effect modification by repeating the model including an interaction term between home health care and severe complications, but this was not statistically significant (p=0.08).

A propensity score matched comparison of readmission among patients discharged home with and without home health care

In order to further clarify the association between home health care and 30-day readmission, we limited our further analyses to the 3,071 patients discharged home (i.e. with or without home health), excluding patients discharged to other facilities. Since a randomized trial of home only versus home with home health care is likely not feasible, propensity score matching can be used as a statistical technique to investigate the effect of a treatment on an

outcome using observational data.^{25, 26} In this method, treated and un-treated patients are matched based on having equal probabilities to receive treatment - home health care, in this case. Following 1:1 propensity score-matching using age, sex, race, comorbidities (congestive heart failure, chronic lung disease, diabetes, chronic renal failure, obesity, weight loss, hypertension, alcohol abuse, and drug abuse), median income, pancreatectomy type, cancer status, complications, postoperative length of stay, and hospital volume to generate propensity scores, we obtained 682 matched pairs for the readmission comparison, a match rate of 90.5% for the 754 home health care patients. The mean propensity scores of the two groups were nearly identical: 0.336 (SD: 0.166) in the home with home health care group versus 0.335 (SD: 0.166) in the home without home health care group. Also, the groups were well balanced with standardized differences of less than 10% for all variables (Table 4). Patients discharged home with home health care had significantly increased 30-day readmission compared to matched patients discharged home only (166 [24.3%] vs 135 [19.8%], $p<0.001$).

Discharge home with home health care and the severity of 30-day readmissions following pancreatectomy

We hypothesized that discharge home with home health care is an independent predictor of 30-day readmission, because patients with less severe complications may be disproportionately detected by home health care personnel and subsequently readmitted to the hospital as a result. To investigate this hypothesis, we classified readmissions as severe or non-severe based on whether a patient required an invasive intervention during their readmission stay; again, including only patients discharged home (i.e. with or without home health). Of the 3,071 patients discharged home, 624 (20.3%) were readmitted: 74.7% (466/624) were non-severe readmissions and 25.3% (158/624) were severe readmissions (Table 5). Patients with severe readmissions had a mean length of stay more than twice that of non-severe readmissions (11.8 vs. 5.1 days, $p<0.001$).

Among all patients discharged home, 24.6% (754/3071) received home health care and 75.4% (2317/3071) did not. Patients receiving home health care had a significantly increased rate of non-severe readmission (145/754 [19.2%] vs 321/2317 [13.9%], $p<0.001$), but not severe readmission (48/754 [6.4%] vs 110/2317] 4.7%, $p=0.08$) (Figure 2A). In univariate analysis, male sex, diabetes, hypertension, complications during the surgical admission, postoperative length of stay, and discharge home with home health care were all associated with increased 30-day readmission (Table 5). In a multivariable logistic regression model excluding patients with severe readmissions, discharge home with home health care (OR=1.41; 95%CI: 1.11 – 1.79, $p=0.005$) and severe complications during the surgical admission (OR=1.44; 95%CI: 1.02 – 2.03, $p=0.040$) were independent predictors of increased non-severe readmission (Table 6). We assessed for effect modification by repeating the model including an interaction term between home health care and severe complications, but this was not statistically significant ($p=0.07$).

On the other hand, in a multivariable logistic regression model excluding patients with non-severe readmissions, male sex (OR=1.45; 95%CI: 1.03 – 2.04, $p=0.047$), benign disease (OR=1.60; 95%CI: 1.09 – 2.33, $p=0.016$), and severe complications during the surgical

admission (OR=1.85; 95% CI: 1.10 – 3.12, $p=0.021$) were independent predictors of increased severe readmission (Table 6). We also assessed for effect modification by repeating the model including an interaction term between home health care and severe complications, but this was not statistically significant ($p=0.25$).

Finally, we examined the primary readmission diagnoses for patients who required non-severe readmissions. Surgical complications accounted for significantly fewer non-severe readmissions for patients receiving home health care compared to those discharged home only (56/145 [38.6%] vs 158/321 [49.2%], $p=0.034$) (Figure 2B). In contrast, failure to thrive/nature of illness accounted for significantly more non-severe readmissions among patients receiving home health care (32/145 [22.1%] vs 44/321 [13.7%], $p=0.024$).

Discussion

Our study demonstrates that discharge home with home health care is an independent predictor of readmissions following pancreatectomy. We used multivariable logistic regression and propensity score matching to risk-adjust for variables that could confound this relationship. Furthermore, we identified discharge home with home health as being independently associated with non-severe readmission, but not severe readmission. We speculate that this finding could be the result of more frequent patient assessments by home health care personnel with varying levels of experience with pancreatectomy patients. More examinations by less familiar home health care staff may increase a patient's chance of being readmitted for a less severe reason; however, we recognize that there is also the possibility of residual confounding. We used propensity score matching to examine the effect of discharge home with home health care on 30 day readmission using observational data. While a prospective randomized trial of home alone versus home with home health is unlikely, perhaps a more feasible trial would be comparing readmission rates among patients receiving visits by home health nurses with specific training in caring for pancreatectomy patients versus standard home health nurses.

When a patient at home without home health care has a non-urgent problem, they (or a caregiver) often notify their surgeon in person, or, in some cases, their primary care physician. When this is the case, there is frequently an attempt to manage non-urgent issues as an outpatient, which may or may not involve an office visit. However, when home health care staff notifies a surgeon that a patient is having problems at home, it has been our experience that patients are often empirically readmitted. This may be a reflection of the surgeon's unfamiliarity with the home health care staff's experience with pancreatectomy patients as well as possible concerns over the medicolegal implications of being notified about a patient's worsening condition by health care personnel without readmission and formal evaluation.

We specifically did not use the terms “avoidable” or “preventable” readmissions because we cannot definitively conclude that any of these readmissions were unnecessary based on these findings. Whether or not readmission to the hospital in all of these instances is mandatory requires further investigation. We did not expect merely having home health care staff visiting patients at home to be associated with an increased risk of severe readmissions, as

these readmissions are more likely to reflect complications related to the nature of the procedure itself. Indeed, there was no significant difference in the rate of severe readmission for patients discharged home with or without home health care in adjusted analyses. Furthermore, there was no difference in in-hospital mortality among readmitted patients discharged home with versus without home health care (data not shown).

The history of home health care in the United States dates back to the 1800s when wealthy inhabitants of large cities hired nurses to prevent the spread of uncontrolled infection.²⁷ The home health care industry was revolutionized in 1965 with the introduction of Medicare, which created a post-hospital home benefit component covered by Part A.¹³ The introduction of the hospital prospective payment system in the 1980s resulted in patients being discharged from hospitals “quicker and sicker.”²⁸ This led to a rapid, uncontrolled growth of the home health care industry, which went from 2,924 agencies in 1980 to 10,444 in 1997.¹³ However, widespread reports of financial fraud and abuse resulted in the implementation of a prospective home healthcare payment system to control Medicare spending.^{13, 29} Under this system, home health agencies have financial incentives to provide fewer visits and shorten the duration of home care.¹³

Reduced funding has left home health care agencies unable to compete with higher paying hospitals and other health organizations. The US Department of Labor – Bureau of Labor Statistics projects that the supply of home health care nurses will fall short of demand by 29% by the year 2020.³⁰ Due to the vast heterogeneity in services provided by different home health care agencies, creating standards to which these organizations should conform has been difficult. As a result, there are few federal regulations or comprehensive quality metrics for home health care agencies.¹⁰

Discharge home with home health care has been implicated as an independent risk factor for readmission following major abdominal operations, including pancreaticoduodenectomy.^{7, 10} Our findings are consistent with this association using both multivariable logistic regression and propensity score matching in a large population-based analysis. Most studies examining readmission after pancreatectomy have, to some extent, found that postoperative complications are independent predictors of increased readmission.⁴⁻⁸ We also found that complications, specifically severe complications, were independently associated with readmission after pancreatectomy. Previous studies have also demonstrated the importance of patient comorbidities in readmission.^{2, 3} In our multivariable logistic regression model, diabetes and hypertension were both independent predictors of readmission. Our finding that benign disease is associated with increased readmission is interesting, and could reflect a higher rate of pancreaticoenteric anastomotic failure from soft pancreatic glands.

As with any study utilizing administrative data, there are limitations to this work. Since the data used in our study were at the population level, we could not examine individual patient records. This prevented us from being able to know the precise details surrounding initial discharges and readmissions. For example, discharge home with drains is often a reason for home health visits, and there is practice variation with regards to drainage versus no drainage, early versus late drain removal, and utilization of external pancreatic duct stents.

Since the SID is limited to inpatient data, we were only able to examine complications which occurred during patients' initial postoperative stay, and could not account for any complications diagnosed in the outpatient setting. As other factors, such as baseline functional status and social support, are not included in the SID, there is also the possibility of residual confounding, which could result in incomplete risk-adjustment, as well as selection bias.

Strengths of our study include having a relatively large number of patients from 180 different hospitals as well as using rather broad patient inclusion criteria. Yermilov et al. demonstrated that approximately 47% of readmissions following pancreaticoduodenectomy are to hospitals other than where the original procedure was performed.³ Our population level approach allowed us to include readmissions at any hospital in the state of California, irrespective of where the original surgery took place. We chose California because it is the largest state (in terms of population) that is included in the HCUP SID databases. Additionally, we believe that the large geographic land mass of the state makes it less likely that patients left the state to seek care at out-of-state hospitals, which would not be captured. However, we recognize that California may not be completely representative of national trends. Also, unlike SEER-linked medicare data, the HCUP SID is not limited to cancer patients over the age of 65, which allowed us to study readmissions in patients of all ages with both benign and malignant disease.

In conclusion, discharge home with home health care following pancreatectomy is an independent predictor of increased 30-day hospital readmission. We found that this association was restricted to readmissions requiring less invasive interventions. While further study is needed to elucidate the precise mechanism of this finding, surgeons should be aware of this association and its possible unintended consequences.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Precis

Readmission rates after pancreatectomy are high, and 30-day readmissions are being used as a quality metric for patient care. In this work, we identify discharge home with home health care as an independent predictor of increased 30-day readmission following pancreatectomy after risk-adjustment for patient, perioperative, and hospital factors.

Figure 1.

Most frequent primary diagnosis categories for readmission as percentages of total readmissions (n = 752). Surgical Comp, surgery-specific complications; FTT/Nature, failure to thrive/nature of illness; Healthcare Infections, UTI, *C. difficile* colitis, and central venous catheter infections; Pulmonary Comp, respiratory failure/insufficiency, including pneumonia.

Figure 2.

(A) Comparison of readmission rates for non-severe (n = 466) and severe (n = 158) readmissions between patients discharged home without (n=2317) and with (n=754) home health care. (B) Comparison of the top three primary readmission diagnosis categories for non-severe readmissions (n = 466) between patients discharged home without (n=321) and with (n=145) home health care. Surgical Comp, surgery-specific complications; FTT/Nature, failure to thrive/nature of illness. p Values are by Chi-square test.

Table 1

Postoperative Complications and Invasive Interventions Examined (n=3,573)

Postoperative Complications (n / %)	Invasive Interventions (n / %)
Gastroparesis, nausea/vomiting, gastric outlet obstruction (406/11.4%)	Upper GI endoscopy (219/6.1%)
Acute GI bleeding (50/1.4%)	Percutaneous abdominal drainage (270/7.6%)
Superficial surgical site infection (362/10.1%)	Bronchoscopy (27/0.8%)
Non-infectious wound complications (91/2.5%)	Angioembolization/therapeutic blood vessel occlusion (27/0.8%)
<i>C. difficile</i> colitis (105/2.9%)	Prolonged mechanical ventilation >96 h (68/1.9%)
CVC infections (36/1.0%)	Exploratory laparotomy/reoperation (18/0.5%)
Intra-abdominal Infection (218/6.1%)	
Septicemia (213/6.0%)	
Sepsis, including septic shock (173/4.8%)	
UTI (246/6.9%)	
Acute renal failure (149/4.2%)	
Acute respiratory failure (121/3.4%)	
Pneumonia (181/5.1%)	
Myocardial infarction (28/0.8%)	
Shock (42/1.2%)	
Venous thromboembolism (85/2.4%)	
Other surgical complications – bleeding/hematoma, postoperative fistula, others (735/20.6%)	

[C.E. mark as 2-column list, with no rule lines between rows.]

Table 2

Characteristics of the Non-Readmitted and Readmitted (30-Day) Patients (n=3573)

Characteristic	No Readmission (n=2821, 79.0%), n (%)	Readmission (n=752, 21.0%), n (%)	p Value
No readmission (n=2,821)			
Age, y			
<50	408 (14.5%)	95 (12.6%)	0.71
50-59	553 (19.6%)	147 (19.5%)	
60-69	878 (31.1%)	233 (31.0%)	
70-79	749 (26.6%)	210 (27.9%)	
80	233 (8.3%)	67 (8.9%)	
Sex			
Male	1373 (48.7%)	385 (51.2%)	0.027
Female	1417 (50.2%)	366 (48.7%)	
Missing	31 (1.1%)	<11	
Race			
White	1666 (59.1%)	427 (56.8%)	0.52
African American	154 (5.5%)	42 (5.6%)	
Other	1001 (35.5%)	283 (37.6%)	
Comorbidities			
Congestive heart failure	73 (2.6%)	29 (3.9%)	0.06
Chronic lung disease	317 (11.2%)	97 (12.9%)	0.21
Diabetes	788 (27.9%)	257 (34.2%)	0.001
Chronic renal failure	144 (5.1%)	50 (6.6%)	0.10
Obesity	253 (9.0%)	80 (10.6%)	0.16
Weight loss	350 (12.4%)	116 (15.4%)	0.029
Hypertension	1413 (50.1%)	436 (58.0%)	<0.001
Alcohol abuse	101 (3.6%)	29 (3.9%)	0.72
Drug abuse	28 (1.0%)	13 (1.7%)	0.09
Income			
State median	1138 (40.3%)	298 (39.6%)	0.94

Characteristic	No Readmission (n=2821, 79.0%), n (%)	Readmission (n=752, 21.0%), n (%)	p Value
> State median	1623 (57.5%)	438 (58.2%)	
Missing	60 (2.1%)	16 (2.1%)	
Pancreatectomy type			
Whipple	1939 (68.7%)	531 (70.6%)	0.08
Total	89 (3.2%)	33 (4.4%)	
Distal	793 (28.1%)	188 (25.0%)	
Diagnosis			
Malignant	1958 (69.4%)	498 (66.2%)	0.09
Benign	863 (30.6%)	254 (33.8%)	
Complications			
None	1589 (56.3%)	362 (48.1%)	<0.001
Nonsevere	913 (32.4%)	265 (35.2%)	
Severe	319 (11.3%)	125 (16.6%)	
Postoperative length of stay quartile			
1st (<7 d)	627 (22.2%)	139 (18.5%)	0.003
2nd (7-9 d)	851 (30.2%)	209 (27.8%)	
3rd (10-15 d)	737 (26.1%)	198 (26.3%)	
4th (>15 d)	606 (21.5%)	206 (27.4%)	
Hospital volume quartile			
1st (<26 procedures)	696 (24.7%)	196 (26.1%)	0.09
2nd (26-56 procedures)	714 (25.3%)	164 (21.8%)	
3rd (57-149 procedures)	722 (25.6%)	218 (29.0%)	
4th (>149 procedures)	689 (24.4%)	174 (23.1%)	
Discharge disposition			
Home	1886 (66.9%)	431 (57.3%)	<0.001
Home with home health	561 (19.9%)	193 (25.7%)	
Other facility	374 (13.3%)	128 (17.0%)	

Cells with fewer than 11 patients per variable are relabeled as "<11" in compliance with the HCUP data use agreement.

Table 3

Multivariable Logistic Regression of Factors Associated with 30-Day Readmission (n=3,573)

Characteristic	OR	95% CI		p Value
Age, y				
<50	[reference]			
50-59	1.03	0.76	1.40	0.84
60-69	1.02	0.76	1.37	0.89
70-79	0.99	0.72	1.34	0.93
80	1.00	0.68	1.48	>0.99
Sex				
Male	[reference]			
Female	0.94	0.80	1.11	0.48
Race				
White	[reference]			
African American	1.04	0.72	1.52	0.82
Other	1.13	0.95	1.35	0.17
Comorbidities				
Congestive heart failure	1.24	0.78	1.97	0.36
Chronic lung disease	1.09	0.84	1.40	0.53
Diabetes	1.22	1.02	1.47	0.032
Chronic renal failure	1.08	0.76	1.54	0.68
Obesity	1.04	0.79	1.38	0.78
Weight loss	1.10	0.86	1.40	0.46
Hypertension	1.28	1.07	1.54	0.008
Alcohol abuse	1.02	0.65	1.58	0.95
Drug abuse	1.51	0.76	3.02	0.24
Income				
State median	1.07	0.90	1.27	0.46
> State median	[reference]			
Pancreatectomy type				
Whipple	1.11	0.89	1.37	0.37
Total	1.38	0.88	2.16	0.16
Distal	[reference]			
Diagnosis				
Malignant	[reference]			
Benign	1.35	1.11	1.64	0.003
Complications				
None	[reference]			
Nonsevere	1.15	0.95	1.39	0.14
Severe	1.43	1.10	1.86	0.008

Characteristic	OR	95% CI		p Value
Hospital volume quartile				
1st (Lowest)	1.02	0.80	1.30	0.85
2nd	0.85	0.66	1.09	0.19
3rd	1.21	0.96	1.53	0.10
4th (Highest)	[reference]			
Discharge disposition				
Home	[reference]			
Home with home health	1.37	1.11	1.69	0.004
Other facility	1.26	0.97	1.62	0.08

108 patients were not used in analysis due to missing variable values. Reference group for comorbidities were those without the condition

Table 4
Comparison of Propensity Score Matched and Unmatched Patients Discharged Home with and without Home Health

Characteristic	Unmatched home health (n=72), n (%)	Matched home health (n=682), n (%)	Matched home only (n=682), n (%)	Standardized difference, %*
Age, y				
<50	<11	63 (9.2%)	59 (8.7%)	3.9
50-59	<11	123 (18.0%)	122 (17.9%)	
60-69	20 (27.8%)	221 (32.4%)	222 (32.6%)	
70-79	34 (47.2%)	206 (30.2%)	215 (31.5%)	
80	11 (15.3%)	69 (10.1%)	64 (9.4%)	
Sex				
Male	40 (55.6%)	363 (53.2%)	363 (53.2%)	0.0
Female	30 (41.7%)	319 (46.8%)	319 (46.8%)	
Missing	<11	0	0	
Race				
White	41 (56.9%)	394 (57.8%)	400 (58.7%)	6.1
African American	<11	38 (5.6%)	29 (4.3%)	
Other	28 (38.9%)	250 (36.7%)	253 (37.1%)	
Comorbidities				
CHF	<11	19 (2.8%)	26 (3.8%)	5.8
Chronic lung disease	12 (16.7%)	80 (11.7%)	80 (11.7%)	0.0
Diabetes	21 (29.2%)	211 (30.9%)	219 (32.1%)	2.5
Chronic renal failure	<11	39 (5.7%)	41 (6.0%)	1.3
Obesity	11 (15.3%)	72 (10.6%)	74 (10.9%)	1.0
Weight loss	26 (36.1%)	103 (15.1%)	90 (13.2%)	5.5
Hypertension	49 (68.1%)	366 (53.7%)	376 (55.1%)	2.9
Alcohol abuse	<11	17 (2.5%)	21 (3.1%)	3.6
Drug abuse	<11	<11	<11	1.6
Income				
Median	20 (27.8%)	282 (41.3%)	262 (38.4%)	6.0

Characteristic	Unmatched home health (n=72), n (%)	Matched home health (n=682), n (%)	Matched home only (n=682), n (%)	Standardized difference, %*
> Median	40 (55.6%)	400 (58.7%)	420 (61.6%)	
Missing	12 (16.7%)	0	0	
Pancreatectomy type				
Whipple	65 (90.3%)	558 (81.8%)	570 (83.6%)	4.9
Total	<11	26 (3.8%)	25 (3.7%)	
Distal	<11	98 (14.4%)	87 (12.8%)	
Diagnosis				
Malignant	64 (88.9%)	525 (77.0%)	526 (77.1%)	0.4
Benign	<11	157 (23.0%)	156 (22.9%)	
Complications				
None	<11	276 (40.5%)	287 (42.1%)	3.5
Nonsevere	18 (25.0%)	296 (43.4%)	291 (42.7%)	
Severe	49 (68.1%)	110 (16.1%)	104 (15.2%)	
Postoperative length of stay quartile				
1st (<7 d)	0	62 (9.1%)	45 (6.6%)	6.0
2nd (7-9 d)	<11	160 (23.5%)	167 (24.5%)	
3rd (10-15 d)	<11	244 (35.8%)	265 (38.9%)	
4th (>15 d)	60 (83.3%)	216 (31.7%)	205 (30.1%)	
Hospital volume quartile				
1st (<26 procedures)	15 (20.8%)	168 (24.6%)	177 (26.0%)	8.6
2nd (26-56 procedures)	12 (16.7%)	176 (25.8%)	169 (24.8%)	
3rd (57-149 procedures)	22 (30.6%)	183 (26.8%)	163 (23.9%)	
4th (>149 procedures)	23 (31.9%)	155 (22.7%)	173 (25.4%)	
Readmission outcomes				
Any readmission	27 (37.5%)	166 (24.3%)	135 (19.8%)	11.0
Non-severe readmission	17 (23.6%)	128 (18.8%)	101 (14.8%)	10.6
Severe readmission	<11	38 (5.6%)	34 (5.0%)	2.6

Cells with fewer than 11 patients per variable are relabeled as "<11" in compliance with the HCUP data use agreement.

* Standardized difference compares propensity score matched patients discharged home with and without home health. A standardized difference > 10% indicates imbalance between propensity matched cohorts (Austin et al. Stat Med. 2009).

Table 5

Characteristics of Patients Discharged Home with Severe and Non-Severe Readmissions (n=3,071)

Characteristic	No readmission (n=2447)		Non-severe readmission (n=466)		Severe readmission, (n=158)		p Value
	n	%	n	%	n	%	
Age, y							
<50	383	15.7	69	14.8	24	15.2	0.91
50-59	525	21.5	105	22.5	35	22.2	
60-69	790	32.3	145	31.1	52	32.9	
70-79	580	23.7	120	25.8	40	25.3	
80	169	6.9	27	5.8	<11		
Sex*							
Male	1,191	48.7	236	50.6	91	57.6	0.037
Female	1,225	50.1	229	49.1	67	42.4	
Missing	31	1.3	<11		0		
Race							
White	1,437	58.7	254	54.5	95	60.1	0.47
African American	134	5.5	27	5.8	<11		
Other	876	35.8	185	39.7	53	33.5	
Comorbidities							
CHF	51	2.1	13	2.8	<11		0.27
Chronic lung disease	255	10.4	57	12.2	20	12.7	0.38
Diabetes	653	26.7	149	32.0	50	31.6	0.035
Chronic renal failure	114	4.7	25	5.4	15	9.5	0.024
Obesity	221	9.0	46	9.9	19	12.0	0.41
Weight loss	254	10.4	60	12.9	17	10.8	0.28
Hypertension	1,186	48.5	251	53.9	91	57.6	0.013
Alcohol abuse	88	3.6	17	3.6	<11		0.78
Drug abuse	21	0.9	<11		<11		0.22
Income							

Characteristic	No readmission (n=2447)		Non-severe readmission (n=466)		Severe readmission, (n=158)		p Value
	n	%	n	%	n	%	
State median	952	38.9	183	39.3	66	41.8	0.96
> State median	1,441	58.9	272	58.4	89	56.3	
Missing	54	2.2	11	2.4	<11		
Pancreatectomy type							
Whipple	1,635	66.8	321	68.9	106	67.1	0.56
Total	75	3.1	19	4.1	<11		
Distal	737	30.1	126	27.0	48	30.4	
Diagnosis							
Malignant	1,666	68.1	308	66.1	94	59.5	0.07
Benign	781	31.9	158	33.9	64	40.5	
Complications							
None	1,472	60.1	241	51.7	83	52.5	<0.001
Nonsevere	760	31.1	163	35.0	50	31.6	
Severe	215	8.8	62	13.3	25	15.8	
Postoperative length of stay quartile							
1st (<7 d)	571	23.3	85	18.2	29	18.4	0.004
2nd (7-9 d)	816	33.3	141	30.3	52	32.9	
3rd (10-15 d)	658	26.9	137	29.4	39	24.7	
4th (>15 d)	402	16.4	103	22.1	38	24.1	
Hospital volume quartile							
1st (<26 procedures)	573	23.4	129	27.7	33	20.9	0.06
2nd (26-56 procedures)	624	25.5	92	19.7	46	29.1	
3rd (57-149 procedures)	634	25.9	136	29.2	40	25.3	
4th (>149 procedures)	616	25.2	109	23.4	39	24.7	
Discharge disposition							
Home	1,886	77.1	321	68.9	110	69.9	<0.001
Home with home health	561	22.9	145	31.1	48	30.4	

* Cells with fewer than 11 patients per variable are relabeled as "<11" in compliance with the HCUP data use agreement.

Table 6

Significant Variables in Multivariable Logistic Regression Models Associated with Non-Severe and Severe Readmission among Patients Discharged Home after Pancreatectomy (n=3071)

Variable	OR	95% CI	p Value
Non-severe readmission (n=2,913) *			
Complications			
None	[reference]	—	-
Non-severe	1.19	0.95, 1.50	0.13
Severe	1.44	1.02, 2.03	0.040
Discharge disposition			
Home	[reference]	—	-
Home health care	1.41	1.11, 1.79	0.005
Severe readmission (n=2,605) †			
Sex			
Male	[reference]	—	-
Female	0.69	0.49, 0.97	0.033
Diagnosis			
Cancer	[reference]	—	-
Benign	1.60	1.09, 2.33	0.016
Complications			
None	[reference]	—	-
Non-severe	1.11	0.75, 1.62	0.61
Severe	1.85	1.10, 3.12	0.021

Models included age, sex, race, comorbidities (congestive heart failure, chronic lung disease, diabetes, chronic renal failure, obesity, weight loss, hypertension, alcohol abuse, and drug abuse), median income, pancreatectomy type, cancer status, complications, hospital volume, and discharge disposition.

* Analysis excluded patients with 30-day severe readmissions. 97 patients were not used in analysis due to missing variable values.

† Analysis excluded patients with 30-day non-severe readmissions. 88 patients were not used in analysis due to missing variable values.