



Thirty days are inadequate for assessing readmission following complex hepatopancreatobiliary procedures

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Abstract

Introduction Early readmissions (30 days) have been used as a measure of health care quality. The purpose of our study was to evaluate patterns of readmission for a longer period (up to 2 years) following Hepatopancreatobiliary (HPB) surgery in the state of New York.

Methods The State Planning and Research Cooperative System database was utilized to identify patients undergoing complex HPB procedures between 2010 and 2012. Patients were followed for 2 years following surgery to identify all-cause readmissions. Factors for readmissions included patient demographics, comorbidities, perioperative complications, surgery type, and academic status. Multivariable generalized linear mixed models were performed to evaluate risk factors for readmissions.

Results There were 6207 complex HPB procedures with 1272 (20.49%) unplanned 30-day readmissions, 816 (13.15%) unplanned 31–90-day readmissions, 1678 (27.03%) unplanned 91-day to 1-year readmissions, and 1404 (22.62%) 1–2-year readmissions. After adjusting for other possible confounding factors, risk factors for 30-day readmissions include surgery type, as pancreatectomy and gallbladder patients are more likely to have a 30-day readmission than hepatectomy patients, facility type, as academic centers are more likely to have a readmission, male gender, presence of any comorbidity, and perioperative complications. Risk factors for 31–90-day readmissions include race, insurance group, any comorbidity or any peri-operative complication, and 30-day readmissions. Risk factors for 91-day to 1-year readmissions include male gender, race, any comorbidity, 30-day readmissions, and 31–90 days' readmissions. Risk factors for 1–2-year readmissions include presence of any comorbidity, and previous 91-day to 1-year readmissions.

Conclusion The 30-day readmission window is an inadequate, but predictive, measure of total readmission following complex HPB procedures.

Keywords Readmissions · Outcomes · Hepatopancreatobiliary · HPB · Liver · Pancreas

One of the pivotal topics in surgery today is the measurement of outcomes in order to assess and deliver high-quality

medical care and reduce costs and resource utilization [1]. A number of tools are reliably used to provide information and 30-day readmission is one of the surrogate markers being used to represent health care quality. The emphasis on reducing readmissions has led to the implementation of reducing payments to hospitals with high readmission rates [2, 3]. However, studies have questioned the use of 30-day readmissions as a true quality measure [4–7]. Joynt et al. have pointed out the disparities among outcomes, as hospitals providing care to the lowest income and sicker patients would be associated with higher readmission rates [6, 7]. Telem et al. showed that for more complex surgical procedures, while 30-day readmissions can be as low as 5.8%, 2-year readmission rates are significantly higher (26%) [8]. Thus, true health care utilization following certain surgical procedures may not be captured in the 30-day period.

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Although complex hepatopancreatobiliary (HPB) procedures have an improved mortality, they are technically challenging and are associated with higher morbidity [9, 10]. Complication rates following these procedures are reported from 18% and up to 59% for some procedures [11, 12]. In addition, these patients are generally sicker, thus do not represent typical elective procedures. Several studies have looked into readmissions following several complex procedures [13–17]. Yermilov et al. reported a readmission rate of 59% in the year after pancreaticoduodenectomy, as the majority of readmissions were related to the disease progression [16]. Reddy et al. reported 30-day and one-year readmissions of 16% and 53% following pancreatectomy [13]. The authors reported that early (30 days) readmissions were associated with surgical complications and not due to disease progression, while late readmissions were related to recurrence (48%), operative complications (25%), and unrelated diagnoses (27%) [13]. However, the majority of these studies are limited to either Medicare population or single-center studies.

The purpose of this study was to evaluate patterns and risk factors that were associated with readmissions for a longer period (up to 2 years) following HPB surgery in the State of New York (NY). In addition, the cause of these readmissions was investigated.

Methods

The Statewide Planning and Research Cooperative System (SPARCS) administrative database was utilized. The SPARCS database, established in 1979, is an all-payer data reporting system collected by the NY Department of Health from all licensed hospitals or hospital extension clinics and treatment centers, as required by Sect. 28.16 of the Public Health Law. Data collected included all hospital admissions and ambulatory procedures. The hospitals are required to submit their reports via a secure website.

Through the use of International Classification of Disease-9 (ICD-9) procedure codes, patients undergoing complex HPB procedures between 2010 and 2012 were identified. ICD-9 codes used to identify pancreatectomy included 52.51, 52.52, 52.53, 52.59, 52.7; hepatectomy 50.3, 50.4; and complex gallbladder procedures 51.31–39, 51.61–69. Patients' age < 18 and with missing information were excluded from the analysis.

With the use of a unique identifier, patients were followed for at least 2 years following surgery to identify all-cause readmissions. Readmissions were divided into four periods early (0–30 days), 31–90 days, 91 days–1 year and 1–2 years. Readmission was defined as admission to the hospital for more than 23 h. Factors studied for peri-operative hospital admission included patient demographics, presence

of co-morbid conditions, peri-operative complications, surgery type (pancreatectomy, hepatectomy, and gallbladder), and academic versus non-academic status of a hospital. 30 days, 31–90 days, and 91 days–1-year admissions were also evaluated as predictors of long-term readmissions. Hospital volume was also considered, where a high volume was defined as yearly volume ≥ 25 cases/year. Specific comorbidities included alcohol abuse, deficiency anemia, rheumatoid arthritis/collagen vas, chronic blood loss anemia, congestive heart failure, chronic pulmonary disease, coagulopathy, depression, diabetes w/o chronic complications, diabetes with chronic complications, drug abuse, hypertension, hypothyroidism, liver disease, lymphoma, fluid and electrolyte disorders, metastatic cancer, other neurological disorders, obesity, paralysis, peripheral vascular disease, psychoses, pulmonary circulation disease, renal failure, solid tumor w/ out metastasis, peptic ulcer disease, bleeding, and valvular disease. Peri-operative complications included abscess, anastomotic leakage, cardiac arrest, cardiac complications, dehiscence, mechanical ventilation, myocardial infarction, pneumonia, pulmonary edema, pulmonary embolus, renal failure, reoperation for hemorrhage, respiratory arrest, respiratory failure, shock, tracheostomy, hemorrhage, and liver disease.

Univariate generalized linear mixed models (GLMM) were fit to estimate the marginal association between outcomes such as 30-day, 31–90-day, 91-day–1-year, and 1–2-year readmissions/ED visits and possible risk factors. Univariate logistic regression with firth bias correction was used when GLMM had convergence issues because of rare events. Facilities and the operating physicians were considered as two random effects to take into account of the clustering nature of patients from the same facility or the same physician in all mixed models. Surgery subtype and facility type, as well as variables which were significant in the univariate analysis at a significance level of 0.05 were further included in the multivariable GLMMs. Any comorbidity and any complication were utilized in the final multivariable regression models instead of specific ones because a large number of them had small p-values in the univariate models. Finally, top reasons for readmissions and ED visits were identified. Statistical analysis was performed using SAS 9.4 and significance level was set at 0.05 (SAS Institute Inc., Cary, NC).

This study was approved by the Institutional Review Board and New York State Department of Health.

Results

Between 2010 and 2012, 6207 complex HPB procedures were identified. From these, there were 3900 (62.83%) pancreatectomies, 949 (15.29%) hepatectomies, and 1358 (21.88%) complex gallbladder procedures. There

were 1272 (20.49%) unplanned 30-day readmissions, 816 (13.15%) unplanned 31–90-day readmissions, 1678 (27.03%) unplanned 91-day to 1-year readmissions, and 1404 (22.62%) 1–2-year readmissions. Majority of patients ($n = 4465$, 71.93%) who had undergone surgery were age > 55 years. There was no difference between different genders (51.94% vs 48.06%). Majority of procedures were performed in high-volume hospitals ($n = 5637$, 90.82%).

After adjusting for other possible confounding factors, risk factors for 30-day readmissions include surgery type, as pancreatectomy and gallbladder patients are more likely to have a 30-day readmission than hepatectomy patients (OR 1.95, 95% CI 1.58–2.41, and OR 1.77, 95% CI 1.39–2.25, respectively), facility type, as academic centers are more likely to have a readmission (OR 1.55, 95% CI 1.20–2.00), male gender (OR 1.14, 95% CI 1.00–1.29), presence of any comorbidity (OR 1.40, 95% CI 1.13–1.72), and peri-operative complications (OR 1.47, 95% CI 1.29–1.67) (Table 1). Risk factors for 31-day to 90-day readmissions include race, insurance group, any comorbidity (OR 1.45, 95% CI 1.09–1.94) or any peri-operative complication (OR 1.43, 95% CI 1.22–1.67), and 30-day readmissions (OR 3.25, 95% CI 2.77–3.81) (Table 2). Risk factors for 91-day to 1-year readmissions include male gender (OR 1.20, 95% CI 1.07–1.35), race, any comorbidity (OR 1.81, 95% CI 1.47–2.23), 30-day readmissions (OR 1.27, 95% CI 1.11–1.46), and 31–90 days' readmissions (OR 2.47, 95% CI 2.11–2.89) (Table 3). Risk factors for 1–2-year readmissions include presence of any comorbidity (OR 1.34, 95% CI 1.09–1.63), and previous 91-day to 1-year readmissions (OR 2.19, 95% CI 1.93–2.49) (Table 4).

Patients who had a 30-day ED visit were significantly associated with both 31 days' and 90 days' ED visit (P value < 0.0001), 91-day to 1-year ED visits (P value < 0.0001), and 1–2 years' ED visits (P value < 0.0001). 31–90 days' ED visits were significantly associated with both 91-day and 1-year ED visits (P value < 0.0001), and

1–2 years' ED visits (P value = 0.0004). In addition, 91-day to 1-year ED visits were significantly associated with 1–2 years' ED visits (P value < 0.0001).

Tables 5, 6, and 7 listed out top frequent reasons for readmissions during different post-surgery time intervals by surgery types. Among pancreatectomy patients, top frequent five reasons for 30-day readmissions were post-op infection ($n = 268$, 25.60%), unrelated to surgery ($n = 260$, 24.83%), complications of procedure ($n = 57$, 5.44%), dehydration ($n = 45$, 4.30%), and abdominal pain ($n = 38$, 3.63%); In the 31–90-day period, top five reasons for readmissions included unrelated to procedure ($n = 275$, 38.90%), post-op infection ($n = 114$, 16.12%), complication of procedure ($n = 39$, 5.52%), dehydration ($n = 20$, 2.83%), and acute pancreatitis ($n = 19$, 2.69%). Top five reasons for 91-day to 1-year readmissions included unrelated to procedure ($n = 860$, 44.17%), post-op infection ($n = 137$, 7.04%), complication of procedure ($n = 114$, 5.86%), complication of disease ($n = 109$, 5.60%), and ventral hernia ($n = 61$, 3.13%). Top five reasons for 1–2-year readmissions were unrelated to procedure ($n = 677$, 40.35%), complications of disease ($n = 108$, 6.44%), post-op infection ($n = 105$, 6.26%), complication of procedure ($n = 103$, 6.14%), and ventral hernia ($n = 70$, 4.17%). Similarly, the reasons for readmissions for hepatectomies and gallbladder patients were displayed in Tables 5 and 6, respectively. The reasons for ED visits are shown in Tables 8, 9, and 10. Detailed readmission rates by surgery codes can be found in Table 11.

Discussion

Great emphasis has been placed on reduction in the number of hospital readmissions [1, 2]. The 30-day post-operative period is used as a metric to assess quality of care and provider reimbursement. This period, while it may be adequate for certain elective procedures, may not be adequate for

Table 1 Risk factors for readmissions during 30 days

Variable	Level	Odds ratio	95% CI	P value ^a
Surgery type	Gallbladder versus Hepatectomy	1.77	1.39–2.25	< 0.0001
	Pancreatectomy versus Hepatectomy	1.95	1.58–2.41	
Facility type	Academic versus Non-academic	1.55	1.20–2.00	0.0008
Gender	Male versus Female	1.14	1.00–1.29	0.0436
Region	Close to NYC versus West	1.33	0.82–2.15	0.0140
	Long island versus West	1.35	0.95–1.91	
	Mid/North versus West	1.61	1.14–2.27	
	NYC area versus West	1.02	0.78–1.33	
Any comorbidity	Yes versus No	1.40	1.13–1.72	0.0019
Any complication	Yes versus No	1.47	1.29–1.67	< 0.0001

Significant values are given in bold

^a P value was based on Wald-type test from a multivariable generalized linear mixed model

Table 2 Risk factors for readmissions during the 31–90 days' period

Variable	Level	Odds ratio	95% CI	P value ^a
Surgery type	Gallbladder versus Hepatectomy	1.40	1.05–1.87	0.0538
	Pancreatectomy versus Hepatectomy	1.35	1.04–1.75	
Facility type	Academic versus Non-academic	1.27	0.94–1.70	0.1161
Age Group	18–24 versus ≥ 55	0.70	0.33–1.51	0.2319
	25–34 versus ≥ 55	0.58	0.36–0.95	
	35–44 versus ≥ 55	0.89	0.64–1.25	
	45–54 versus ≥ 55	0.88	0.69–1.13	
Race/ethnicity	Asian versus White	0.35	0.21–0.58	0.0020
	Black versus White	1.02	0.79–1.31	
	Hispanic versus White	0.93	0.68–1.26	
	Other versus White	0.87	0.67–1.14	
Region	Close to NYC versus West	1.46	0.86–2.48	0.2278
	Long island versus West	1.23	0.83–1.83	
	Mid/North versus West	1.47	0.99–2.17	
	NYC area versus West	1.06	0.78–1.44	
Insurance	Medicaid versus Commercial	1.32	0.94–1.86	0.0402
	Medicare versus Commercial	1.20	1.01–1.43	
	Other versus Commercial	0.43	0.13–1.43	
Any comorbidity	Yes versus No	1.45	1.09–1.94	0.0117
Any complication	Yes versus No	1.43	1.22–1.67	<0.0001
30-day readmissions	Yes versus No	3.25	2.77–3.81	<0.0001

Significant values are given in bold

^aP value was based on Wald-type test from a multivariable generalized linear mixed model

more complex procedures such as hepatopancreatobiliary surgery, as these procedures are technically challenging and the patient population is usually associated with a higher number of comorbidities.

This study shows that the majority of readmissions occurred past the 30-day post-operative period, as only 20.49% occurred in the 30-day period. Risks factors for readmissions included surgery subtype, facility type, comorbidities, and perioperative complications, and previous readmission, among others. Top five reasons for readmission in the 30-day post-op period, e.g., for pancreatectomy patients, included post-op infection, unrelated to surgery, complications of procedure, dehydration, and abdominal pain. Following the 30-day period and up to 90 days, unrelated to surgery readmissions was the top reason (38.90%); however, many were still procedure related including post-operative infection (16.12%), followed by complication of procedure (5.52%). Dehydration and acute pancreatitis were also common reasons. Between the 91-day and one-year period, the top reason for readmission was unrelated to procedure (44.17%), followed by post-operative infection, complication of procedure, complication of disease, and ventral hernia. Between the one- and two-year period, the top reason for readmission continued to be unrelated to procedure (40.35%), followed by complication of disease, post-operative infection, complication of procedure,

and ventral hernia. Similarly, the reasons for readmissions for hepatectomies and gallbladder patients are displayed in Tables 6 and 7, respectively. The reasons for ED visits are shown in Tables 8 and 9 10. The top reason for readmissions in all studied periods is “unrelated to surgery.” Among pancreatectomy patients, there were 17.36% patients readmitted within 30 days, 9.23% were readmitted between 31 and 90 days, 18.18% were readmitted between 91 days and 1 year, and 15.82% were readmitted between 1 and 2 years. Among hepatectomy patients, there were 9.59% patients readmitted within 30 days, 5.06% were readmitted between 31 days and 90 days, 14.75% were readmitted between 91 days and 1 year, and 12.75% were readmitted between 1 and 2 years. Among complex gallbladder procedures, there were 16.57% patients readmitted within 30 days, 10.38% were readmitted between 31 days and 90 days, 19.81% were readmitted between 91 days and 1 year, and 16.42% were readmitted between 1 and 2 years. Overall, there were 16.00% patients readmitted within 30 days, 8.84% were readmitted between 31 days and 90 days, 18.01% were readmitted between 91 days and 1 year, and 15.48% were readmitted between 1 and 2 years. Surgeons should be aware of the higher readmission rates for these patients, although some of these readmissions may be unavoidable.

Other studies have examined reasons for post-operative readmissions. Fisher et al. performed a meta-analysis and

Table 3 Risk factors for readmissions during the 91 days–1-year period

Variable	Level	Odds ratio	95% CI	P value ^a
Surgery type	Gallbladder versus Hepatectomy	1.03	0.84–1.25	0.6463
	Pancreatectomy versus Hepatectomy	0.96	0.81–1.14	
Facility type	Academic versus Non-academic	1.17	0.94–1.44	0.1539
Age Group	18–24 versus > =55	0.50	0.27–0.95	0.0540
	25–34 versus > =55	0.72	0.51–1.01	
	35–44 versus > =55	1.02	0.80–1.31	
	45–54 versus > =55	1.07	0.89–1.27	
Gender	Male versus Female	1.20	1.07–1.35	0.0019
Race/ethnicity	Asian versus White	0.62	0.46–0.83	0.0021
	Black versus White	1.13	0.94–1.37	
	Hispanic versus White	1.00	0.79–1.26	
	Other versus White	0.81	0.66–0.99	
Region	Close to NYC versus West	0.77	0.50–1.18	0.1053
	Long island versus West	1.17	0.89–1.54	
	Mid/North versus West	1.20	0.91–1.57	
	NYC area versus West	0.97	0.79–1.19	
Insurance	Medicaid versus Commercial	1.16	0.89–1.52	0.3423
	Medicare versus Commercial	1.11	0.98–1.27	
	Other versus Commercial	1.12	0.59–2.11	
Any comorbidity	Yes versus No	1.81	1.47–2.23	<0.0001
Any complication	Yes versus No	1.01	0.90–1.13	0.8976
30-day readmissions	Yes versus No	1.27	1.11–1.46	0.0008
31–90 days' readmissions	Yes versus No	2.47	2.11–2.89	<0.0001

Significant values are given in bold

^aP value was based on Wald-type test from a multivariable generalized linear mixed model**Table 4** Risk factors for readmission during 1–2-year period

Variable	Level	Odds ratio	95% CI	P value ^a
Surgery type	Gallbladder versus Hepatectomy	0.96	0.78–1.17	0.2381
	Pancreatectomy versus Hepatectomy	0.87	0.73–1.04	
Facility type	Academic versus Non-academic	0.92	0.75–1.14	0.4576
Any comorbidity	Yes versus No	1.34	1.09–1.63	0.0045
30-day readmissions	Yes versus No	1.15	0.99–1.33	0.0755
31–90 days' readmissions	Yes versus No	1.12	0.94–1.34	0.1958
91-day–1-year readmissions	Yes versus No	2.19	1.93–2.49	<0.0001

Significant values are given in bold

^aP value was based on Wald-type test from a multivariable generalized linear mixed model

systematic review of the literature for patients undergoing pancreatic resection [18]. Overall 30-day readmission rate was 19.1% across all studies, which is close to the 30-day readmission rate in this study. Infectious complications and gastrointestinal complications accounted for 59% of readmissions [18]. Sadot et al. examined causes for readmissions for up to 90 days following pancreatic resection [19]. Rates of readmission were higher than currently reported as 30- and 90-day readmission rates were 23% and 29%, respectively. Most common causes for readmissions following the 30-day period were failure to thrive and chemotherapy-related

symptoms, comprising 38% of readmissions [19]. Reddy et al. examined readmissions following pancreatectomy for up to a year post-operatively using the Surveillance, Epidemiology, and End Results (SEER)-Medicare linked data [13]. The authors reported the rate of readmission of 16% and 53% for the initial 30-day period (early) and between 30-day and 1-year period (late). Early readmissions were associated with operative complications in majority of cases (80%), while late readmissions were related to recurrence of disease in 48% of cases and operative complications in 25% of cases [13].

Table 5 Top 5 Frequent Reasons for readmissions (Pancreatectomy)

Primary diagnosis category	30-day readmissions		31–90-day readmissions		91-day–1-year readmissions		1–2-year readmissions	
	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank
Post-op infection	268 (25.6%)	1	114 (16.12%)	2	137 (7.04%)	2	105 (6.26%)	3
Unrelated to surgery	260 (24.83%)	2	275 (38.9%)	1	860 (44.17%)	1	677 (40.35%)	1
Complication of procedure	57 (5.44%)	3	39 (5.52%)	3	114 (5.86%)	3	103 (6.14%)	4
Dehydration	45 (4.3%)	4	20 (2.83%)	4	30 (1.54%)	11	27 (1.61%)	12
Abdominal pain	38 (3.63%)	5	12 (1.7%)	11	58 (2.98%)	6	53 (3.16%)	7
Acute pancreatitis	13 (1.24%)	13	19 (2.69%)	5	47 (2.41%)	7	56 (3.34%)	6
Complication of disease	7 (0.67%)	25	14 (1.98%)	8	109 (5.6%)	4	108 (6.44%)	2
Ventral hernia	5 (0.48%)	30	2 (0.28%)	37	61 (3.13%)	5	70 (4.17%)	5

Table 6 Top 5 Frequent Reasons for readmissions (Hepatectomy)

Primary diagnosis category	30-day readmissions		31–90-day readmissions		91-day–1-year readmissions		1–2-year readmissions	
	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank
Unrelated to surgery	38(26.39%)	1	37(37.76%)	1	196(48.51%)	1	187(53.43%)	1
Post-op infection	35(24.31%)	2	21(21.43%)	2	19(4.7%)	3	17(4.86%)	3
Rehab	9(6.25%)	3	2(2.04%)	12	0(0.00%)		4(1.14%)	13
Complication of procedure	8(5.56%)	4	3(3.06%)	4	16(3.96%)	4	9(2.57%)	7
Digestive system complication	8 (5.56%)	5	3 (3.06%)	6	3 (0.74%)	19	2 (0.57%)	15
Complication of disease	2 (1.39%)	12	2 (2.04%)	7	45 (11.14%)	2	42 (12%)	2
Dehydration	2 (1.39%)	14	3 (3.06%)	5	6 (1.49%)	10	2 (0.57%)	14
Kidney failure	2 (1.39%)	15	4 (4.08%)	3	5 (1.24%)	12	4 (1.14%)	12
Respiratory complication	2 (1.39%)	17	1 (1.02%)	25	10 (2.48%)	7	13 (3.71%)	4
Gastrostomy tube problems	0 (0.00%)		0 (0.00%)		13 (3.22%)	5	2 (0.57%)	16
Ventral hernia	0 (0.00%)		0 (0.00%)		12 (2.97%)	6	13 (3.71%)	5

Table 7 Top 5 Frequent Reasons for readmissions (Gallbladder)

Primary diagnosis category	30-day readmissions		31–90-day readmissions		91-day–1-year readmissions		1–2-year readmissions	
	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank	<i>N</i> (%)	Rank
Unrelated to surgery	99 (27.27%)	1	108 (39.42%)	1	310 (40.95%)	1	283 (41.56%)	1
Post-op infection	70 (19.28%)	2	32 (11.68%)	2	76 (10.04%)	2	55 (8.08%)	2
Rehab	29 (7.99%)	3	3 (1.09%)	18	4 (0.53%)	27	3 (0.44%)	32
Complication of procedure	24 (6.61%)	4	23 (8.39%)	3	64 (8.45%)	3	53 (7.78%)	3
Abdominal pain	12 (3.31%)	5	6 (2.19%)	10	15 (1.98%)	8	17 (2.5%)	7
Biliary colic	10 (2.75%)	7	8 (2.92%)	5	25 (3.3%)	4	14 (2.06%)	9
Complication of liver	6 (1.65%)	10	8 (2.92%)	6	13 (1.72%)	11	22 (3.23%)	5
Complication of disease	3 (0.83%)	24	9 (3.28%)	4	22 (2.91%)	5	27 (3.96%)	4

Readmissions following hepatic resections are in up to 15.5% for some studies [17, 20–22]. Brudnik et al. examined 3041 patients undergoing hepatectomy and reported readmission rates of 10.7%, 17.3%, and 31.9% at 30 days, 90 days, and one year after discharge [17]. Lucas et al.

examined patients undergoing both pancreatic resections and hepatectomy through the NSQIP database. Overall 30-day readmission was 16.2% [20]. A study examining 30-day readmissions following hepatic resections at Johns Hopkins Hospital between 2008 and 2012, the authors reported a

Table 8 Top 5 Frequent reasons for ED visits (Pancreatectomy)

Primary diagnosis category	30-day ED visits		31–90-day ED visits		91-day–1-year ED visits		1–2-year ED visits	
	N (%)	Rank	N (%)	Rank	N (%)	Rank	N (%)	Rank
Post-op infection	234 (20.31%)	2	94 (9.83%)	3	127 (4.81%)	3	87 (3.64%)	3
Unrelated to surgery	325 (28.21%)	1	371 (38.81%)	1	1261 (47.75%)	1	1171 (48.98%)	1
Complication of procedure	73 (6.34%)	4	37 (3.87%)	6	101 (3.82%)	4	75 (3.14%)	4
Abdominal pain	122(10.59%)	3	107(11.19%)	2	234(8.86%)	2	263(11%)	2
Nausea/vomiting	34(2.95%)	5	41(4.29%)	5	46(1.74%)	9	41(1.71%)	10
Fever	25(2.17%)	7	45(4.71%)	4	82(3.1%)	5	54(2.26%)	7
Respiratory complication	7(0.61%)	26	15(1.57%)	10	69(2.61%)	7	56(2.34%)	5

Table 9 Top 5 frequent reasons for ED visits (Hepatectomy)

Primary diagnosis category	30-day ED visits		31-day–90-day ED visits		91-day–1-year ED visits		1-year–2-year ED visits	
	N (%)	Rank	N (%)	Rank	N (%)	Rank	N (%)	Rank
Unrelated to surgery	52 (30.77%)	1	41 (32.8%)	1	196 (47.92%)	1	209 (55.44%)	1
Post-op infection	35 (20.71%)	2	20 (16%)	2	16 (3.91%)	5	17 (4.51%)	4
Complication of procedure	10 (5.92%)	3	3(2.4%)	5	13(3.18%)	6	6(1.59%)	9
Abdominal pain	8 (4.73%)	4	16(12.8%)	3	29(7.09%)	2	26 (6.9%)	2
Complication of disease	0 (0.00%)		1(0.8%)	22	23(5.62%)	3	24(6.37%)	3
Constipation	5(2.96%)	5	3(2.4%)	6	2(0.49%)	27	2(0.53%)	15
Nausea/Vomiting	3(1.78%)	15	3(2.4%)	8	6(1.47%)	10	11(2.92%)	5
Fever	3(1.78%)	13	4(3.2%)	4	17(4.16%)	4	6(1.59%)	10

Table 10 Top 5 frequent reasons for ED visits (Gallbladder)

Primary diagnosis category	30-day ED visits		31–90-day ED visits		91-day–1-year ED visits		1–2-year ED visits	
	N (%)	Rank	N (%)	Rank	N (%)	Rank	N (%)	Rank
Unrelated to surgery	108 (30.08%)	1	140 (42.42%)	1	444 (47.23%)	1	485 (49.34%)	1
Post-op infection	63 (17.55%)	2	27 (8.18%)	3	65 (6.91%)	3	46 (4.68%)	3
Complication of procedure	25 (6.96%)	4	12 (3.64%)	5	44 (4.68%)	4	43 (4.37%)	4
Abdominal pain	33 (9.19%)	3	34 (10.3%)	2	90 (9.57%)	2	95 (9.66%)	2
Hemorrhage	13 (3.62%)	5	2 (0.61%)	21	9 (0.96%)	15	18 (1.83%)	8
Fever	6 (1.67%)	10	19 (5.76%)	4	38 (4.04%)	5	24 (2.44%)	6
Respiratory complication	4 (1.11%)	16	7 (2.12%)	9	23 (2.45%)	7	32 (3.26%)	5

30-day readmission rate of 14.2%. Patients more likely to be readmitted had a prior complication [22].

There are several limitations to this study, as data are being utilized from an administrative database and cannot adequately account for factors not captured by billing codes. Thus, we do not have any information regarding preoperative status, location, size or presence of malignancy, nodal status, stage of disease, chemotherapy, or radiation therapy. Certain intra-operative information is not available, such as margin status, times of procedure, or specific complications during procedure, although we do have data for larger complication categories. In addition,

coding inaccuracies can potentially occur and affect the data. While there are certain codes for procedure-specific complications, it is possible that these complications are coded with non-specific codes, thus underestimating the true incidence of procedure-specific complications. Finally, the data are derived from the state of New York, thus further generalizations to the United States or worldwide populations cannot be assumed.

Despite these limitations, the strengths of this study include a large cohort of patients and the ability to accurately capture multicenter readmissions and ED visits due to the unique patient identifiers in the NY-wide database.

Table 11 Readmission and ED-visit rates by specific procedure codes

Surgery type	Procedure code	N	Readmissions (rate)			ED visits (rate)				
			30-day	31–90-day	91-day–1-year	1–2-year	30-day	31-day–90-day	91-day–1-year	1–2-year
Gallbladder	Cholecystectomy	270	67 (24.81%)	39 (14.44%)	77 (28.52%)	76 (28.15%)	59 (21.85%)	45 (16.67%)	85 (31.48%)	94 (34.81%)
	Hepaticojunostomy	1088	221 (20.31%)	157 (14.43%)	304 (27.94%)	246 (22.61%)	228 (20.96%)	187 (17.19%)	345 (31.71%)	295 (27.11%)
Liver	Overall	1358	288 (21.21%)	196 (14.43%)	381 (28.06%)	322 (23.71%)	287 (21.13%)	232 (17.08%)	430 (31.66%)	389 (28.65%)
	503	873	113 (12.94%)	76 (8.71%)	221 (25.32%)	207 (23.71%)	137 (15.69%)	92 (10.54%)	215 (24.63%)	195 (22.34%)
Pancreas	504	76	8 (10.53%)	5 (6.58%)	16 (21.05%)	13 (17.11%)	9 (11.84%)	5 (6.58%)	11 (14.47%)	15 (19.74%)
	Overall	949	121 (12.75%)	81 (8.54%)	237 (24.97%)	220 (23.18%)	146 (15.38%)	97 (10.22%)	226 (23.81%)	210 (22.13%)
Overall	5251	46	8 (17.39%)	6 (13.04%)	12 (26.09%)	9 (19.57%)	11 (23.91%)	5 (10.87%)	14 (30.43%)	11 (23.91%)
	5252	1404	263 (18.73%)	182 (12.96%)	346 (24.64%)	278 (19.80%)	289 (20.58%)	219 (15.60%)	420 (29.91%)	373 (26.57%)
Overall	5253	12	5 (41.67%)	2 (16.67%)	1 (8.33%)	5 (41.67%)	6 (50.00%)	2 (16.67%)	4 (33.33%)	5 (41.67%)
	5259	239	65 (27.20%)	31 (12.97%)	47 (19.67%)	42 (17.57%)	60 (25.10%)	41 (17.15%)	64 (26.78%)	56 (23.43%)
Overall	527	2199	522 (23.74%)	318 (14.46%)	654 (29.74%)	528 (24.01%)	534 (24.28%)	399 (18.14%)	738 (33.56%)	579 (26.33%)
	Overall	3900	863 (22.13%)	539 (13.82%)	1060 (27.18%)	862 (22.10%)	900 (23.08%)	666 (17.08%)	1240 (31.79%)	1024 (26.26%)
Overall	–	6207	1272 (20.49%)	816 (13.15%)	1678 (27.03%)	1404 (22.62%)	1333 (21.48%)	995 (16.03%)	1896 (30.55%)	1623 (26.15%)

Conclusion

The 30-day readmission window is an inadequate, but predictive, measure of total readmission following complex HPB procedures. Complications and previous readmission are significant reasons for readmission up to 2 years following complex HPB procedures.

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Compliance with ethical standards

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