Hepatopancreaticobiliary Surgical Outcomes at a Community Hospital

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Abstract

There is a national trend towards regionalizing complex hepatopancreaticobiliary (HPB) surgeries to high-volume institutions. Due to geographic and socioeconomic constraints, however, many patients in the United States continue to undergo HPB surgery at local community hospitals. This study evaluated complex HPB surgeries performed by a single surgeon at a low-volume community hospital from May 2007 to June 2021. A retrospective review of medical records (n=163) was done to collect data on patient demographics and outcomes. Surgical outcomes of HPB procedures were compared to published data from high-volume centers. Overall mortality within 30 days of the procedure was 1% (n=1). Using Clavien-Dindo classification, the major complication rate was 10%, including 8% grade III and 2% grade IV complications. Reoperation (2%) and readmission (3%) were rare in this population. Median length of stay was 7 days and median estimated blood loss was 500 milliliters. Surgical outcomes from the community hospital were comparable to high-volume centers. For pancreatic cancer patients treated at the community hospital, Kaplan-Meier curves revealed comparable 5-year survival time to national data. Complex HPB procedures can be safely performed at a low-volume hospital in Hawai'i with outcomes comparable to large tertiary centers.

Keywords

HPB surgery, pancreatic resection, liver resection, low-volume center, postoperative outcome

Abbreviations

EBL = estimated blood loss
GI = gastrointestinal
HPB = hepatopancreaticobiliary
LOS = length of stay
MGH = Massachusetts General Hospital
MSKCC = Memorial Sloan-Kettering Cancer Center

Introduction

Hepatopancreaticobiliary (HPB) surgeries are complex procedures performed to treat cancer and diseases of the gastrointestinal system (GI), specifically in the liver, pancreas, and biliary tract. In the past decade, mortality and complication rates from major HPB surgeries, including pancreaticoduodenectomy, hepatic resection, and liver transplantation, have declined due to improved surgical techniques and patient selection.[1,2]

There is ongoing debate regarding the optimal setting for the performance of HPB surgeries. A number of studies have shown that institutions with high volumes of HPB cases have lower mortality and morbidity rates.[3,4,5] For example, a recent article published by the *Journal of the American College of Surgeons* found that hospitals ranked in the *US News & World Report* listing of the best hospitals performed a 4-fold higher volume of complex GI cancer resections, which were associated with improved outcomes.[6] These findings suggest that complex HPB surgeries should be regionalized to high-volume tertiary institutions and National Cancer Institute-designated cancer centers for better outcomes.[7,8,9] However, other studies have discovered that low-volume hospitals produce mortality and morbidity statistics that are consistent with those of high-volume hospitals.[10,11,12,13,14] Additionally, for patients in many areas of the country, HPB surgical care at specialized high-volume centers can be difficult to access due to travel and socioeconomic factors. A recent publication found that an additional cost of $7884 per surgery was associated with receiving HPB surgical treatment at high-volume centers.[15] As a consequence, around 40% of complex HPB surgeries are still performed at low-volume, community centers.[16]

For Hawai'i patients, receiving treatment from high-volume cancer centers on the continental United States requires significant travel expenses, long-distance travel, and prolonged accommodations away from home. As a result, many Hawai'i patients may prefer to receive treatment at a local hospital. This study described the outcomes of complex HPB surgeries performed by a single surgeon at a community hospital. Surgical outcomes and patient survival were compared to national data to evaluate differences.

Methods

A retrospective medical record review was conducted for all patients who underwent a major HPB surgery by a single general surgeon trained in liver and gastrointestinal transplantation between May 2007 and June 2021. All operations were performed at Straub Medical Center, a 150-bed community hospital in Honolulu, Hawai'i. HPB procedures included hepatectomies (major and partial), Whipple procedures (removal of the head of the pancreas), distal pancreatectomies (open and laparoscopic), bile duct reconstructions, enucleations, and cystogastrostomies. Minor HPB procedures, such as cholecystectomy, were excluded. All surgeries were performed in accordance with standard surgical techniques. No cases were transferred to a high-volume tertiary center due to surgical complications. Only a handful of patients with HPB conditions were referred to other centers because of transplant techniques and instrumentation not available at Straub Medical Center. A total of 163 patient records were included in the final cohort. The study was reviewed by

the Hawai'i Pacific Health Research Institute and determined to be exempt from Institutional Review Board review.

The following variables were collected for each patient: sex, age, procedure type, diagnosis, estimated blood loss (EBL), length of stay (LOS), major complications, reoperation, readmission, mortality, anastomotic leak, fistula, and death and disease status (alive or dead; with or without disease). Mortality was defined as death within 30 days of the HPB surgery, irrespective of whether the death occurred during or after hospitalization. LOS was calculated from the date of the operation to the hospital discharge date. EBL was measured in milliliters (mL). All postoperative complications were graded according to the validated Clavien-Dindo classification system.[17] Complications graded as III, IV, or V were considered to be major complications. Major complications included renal insufficiency, prolonged biliary leaks, postoperative pancreatitis, liver failure, evisceration, and postoperative hemorrhage. Only the single highest complication grade for each patient was reported. Pancreatic fistulas were graded into 3 groups: grade A, B, and C. According to the International Study Group of Pancreatic Fistula, grade A had no clinical effect (mostly an elevation of amylase from the surgical drain fluid called a "biochemical leak"), grade B fistulas required interventional radiology or prolonged hospitalization, while grade C fistulas required a reoperation.[18] Biliary fistulas were reported if prolonged biliary drainage was observed. Readmissions were reported if the patient was hospitalized within 30 days of the original discharge date. Date of death and disease status at the time of death were determined using medical records and publicly available death notices. If the exact day of death was unknown, the date was recorded as the first day of the known month of death. For pancreatic cancer patients, data on node status and surgical margins were collected.

Subjects were stratified by surgical site and type. Data were transformed into categorical variables to match published literature and facilitate comparisons. For pancreatic surgeries, age, sex, malignancy, EBL, LOS, readmission, reoperation, ICU admission, fistula, 30-day mortality, and 90-day mortality were compared with published data from Massachusetts General Hospital (MGH).[19] For liver surgeries, age, sex, malignancy, operative mortality, LOS, EBL, and ICU admission were compared with published data from Memorial Sloan-Kettering Cancer Center (MSKCC).[20] Binomial probability tests were done to compare study proportions to reported data. T-test was done to compare means. High- and low-volume institutions were defined as hospitals that performed greater or fewer than 11 pancreatic resections per year, and greater or fewer than 11 liver resections per year. Stata IC 15.0 software was used for statistical analyses (StataCorp, College Station, TX). Findings were considered statistically significant at $P<.05$.

For the subset of pancreatic cancer patients (n=49), Kaplan-Meier curves were generated. Subjects were stratified by node status and year of procedure. Survival curves were compared using the log-rank test. Lymph node status was obtained from the surgical pathology report. Procedures were split into 2 time periods (2007-2013 vs. 2014-2021) due to the widespread implementation of neoadjuvant chemotherapy in 2014. The 5-year survival Kaplan-Meier curve was visually compared to data from the National Cancer Institute's Surveillance, Epidemiology, and End Results Program.[21]

Results

From May 2007 to June 2021, a total of 163 patients who underwent complex HPB operations were identified. The cohort consisted of 45% (n = 73) women and 55% (n = 90) men with an average age of 63.8 years. Surgeries in the sample included Whipple procedures (n=57), distal pancreatectomies (open and laparoscopic; n=30), major hepatectomies (n=25), partial hepatectomies (n=38), bile duct tumor excisions (n=4), double bypass (n=2), bile duct injury repair (n=1), revision of hepaticojejunostomy after Whipple performed elsewhere (n=1), and "other" procedures (pancreatic enucleations and cystogastrotomies; n=5). Out of the 163 HPB surgeries, a total of 22 procedures required extensive resection, including 4 Klatskin tumors, 7 vascular reconstructions, and 10 multi organ resections associated with colectomy (n=4), gastrectomy (n=3), nephrectomy (n=2), and small bowel resection (n=1). A majority of patients (94%) underwent surgery secondary to a cancer diagnosis. The overall 30-day mortality rate was 1% (n=1; **Table 1**). The single mortality occurred on the sixth day after an uneventful Whipple procedure due to a myocardial infraction. The overall major complication rate was 10% (n=17; **Table 1**). Four (2%) patients required reoperations for postoperative complications. One reoperation was to address postoperative bleeding after a Whipple procedure. The second reoperation was a re-exploration with negative findings secondary to postoperative hypotension following a Whipple procedure. The third reoperation was performed due to an evisceration after a Whipple procedure combined with a nephrectomy. The last reoperation was secondary to an anastomotic colonic leak during an associated extended right hepatectomy. The readmission rate within 30 days of the discharge date was 3% (n=5). The causes for readmission included transient postoperative liver failure after bile duct tumor excision, diabetic ketoacidosis after Whipple procedure, delayed gastric emptying, treatment for superficial wound infection, and pancreatic fistula abscess formation after distal pancreatectomy. The remainder of the complications included 2 biliary leaks requiring endoscopic stenting, fluid collections requiring percutaneous drain, acute myocardial infarction, and renal failure.

Of the 87 patients who underwent a pancreatectomy, 57 (66%) required a Whipple procedure and 30 (34%) required a distal pancreatectomy. Seven Whipple procedures required vascular reconstruction. Indications for pancreatic resections included pancreatic cancer (n=30), neuroendocrine pancreas tumor (n=15), cystic pancreatic neoplasm (n=12), ampullary cancer

(n=8), cholangiocarcinoma (n=5), metastatic colorectal cancer (n=3), splenic cancer (n=3), pancreatitis (n=3), and metastatic kidney cancer (n=1). There were 23 open and 7 laparoscopic distal pancreatectomies. There was 1, 30-day postoperative mortality, resulting in a 1% overall mortality rate (**Table 1**). The major complication rate for the whole group was 10% and included 6 (7%) grade II, 2 (2%) grade IV, and 1 (1%) grade V complications. The most common complication was fistulas, which occurred in 25 (29%) patients. Two patients developed grade B fistulas, while the remaining 23 patients developed grade A fistulas (**Table 2)**. Table 1 displays the remaining operative details.

There were 63 hepatectomies recorded in the study period. Within this group, 25 (40%) underwent a major hepatectomy and 38 (60%) underwent a partial hepatectomy. The major hepatectomy group included trisegmentectomies, left liver lobectomies, and right liver lobectomies. Four cases involved the presence of a Klatskin tumor. The most common indication for liver resections was metastatic colorectal cancer (n=23), followed by hepatocellular carcinoma (n=18), gallbladder cancer (n=6), giant hemangioma (n=2), metastatic lung cancer (n=1), metastatic gastric cancer (n=1), metastatic uterus cancer (n=1), metastatic melanoma cancer (n=1), metastatic breast cancer (n=1), and metastatic leiomyosarcoma (n=1). The mortality rate was zero (**Table 1**). Overall, 6 patients developed a grade III and 1 patient developed a grade IV complication for a total complication rate of 11%. Four patients developed fistulas (**Table 1**). All fistulas developed after extended left hepatectomies indicated for Klatskin tumors (2), intrahepatic cholangiocarcinoma (1), and hepatocellular carcinoma (1). All biliary fistulas resolved after stent placement. Additional hepatic surgery operative details are displayed in Table 1.

There were 13 HPB surgeries that were not pancreatectomy or hepatectomy and included the following procedures: bile duct excisions (n=4), pancreatic enucleations (n=4), double bypass (n=2), bile duct injury repair (n=1), cystogastrotomy (n=1), and revision of hepaticojejunostomy following a Whipple procedure performed elsewhere (n=1). One patient was readmitted due to transient liver failure after a bile duct cancer excision. The remaining operative outcomes of these surgeries are shown in Table 2.

Table 3 shows comparison data from Whipple procedures done at the Straub Medical Center with MGH reported outcomes. Age and sex were similar. Prevalence of malignancy was high in both groups with Straub's cohort having a significantly higher percentage of patients who were diagnosed with a form of cancer (P=.005). Surgical outcome data, including EBL, LOS, grade IV complication, 30- and 90-day mortality, fistula, and reoperation, were comparable between the 2 institutions (**Table 3**). MGH had a significantly higher readmission rate within 30 days of the procedure than Straub Medical Center (22% vs. 5%, P=.003).

Table 1. Operative Details by Surgery Location of HPB Surgeries Performed at Straub Medical Center, 2007-2021

Variables	Total (N=163) %(n)	Pancreas[a] (n=87) %(n)	Liver[b] (n=63) %(n)	Bile Duct Excision (n=8) %(n)	Other[c] (n=5) %(n)
Mortality	1% (1)	1% (1)	0% (0)	0% (0)	0% (0)
Major Complications	10% (17)	10% (9)	11% (7)	0% (0)	8% (1)
Median LOS (days)	7	8	5	7	6
Median EBL (cc)	500	500	500	500	200
Reoperation	2% (4)	3% (3)	2% (1)	0% (0)	0% (0)
Readmission	3% (5)	5% (4)	0% (0)	8% (1)	0% (0)

Abbreviations: LOS, length of stay; EBL, estimated blood loss. [a] Pancreas includes Whipple and distal pancreatectomy (open and laparoscopic) procedures. [b] Liver includes major hepatectomy and partial hepatectomy procedures. [c] Other includes enucleation and cystogastrotomy procedures.

Table 2. Complication Details by Surgery Location of HPB Surgeries Performed at Straub Medical Center, 2007-2021

	Total (N=163) %(n)	Pancreas (n=87) %(n)	Liver (n=63) %(n)	Other (n=13) %(n)
Grade III	8% (13)	7% (6)	11% (7)	0% (0)
Grade IV	2% (3)	2% (2)	0% (0)	8% (1)
Grade V	1% (1)	1% (1)	0% (0)	0% (0)
Total	10% (17)	10% (9)	11% (7)	8% (1)
Fistula	19% (31)	29% (25)	6% (4)	15% (2)
Anastomotic Leak	0% (0)	0% (0)	0% (0)	0% (0)

Comparison between the study's hepatic surgery outcome data and the MSKCC data revealed that the mean EBL, grade IV complication rate, and operative mortality rate were comparable (**Table 4**). Straub Medical Center had a significantly lower mean LOS than MSKCC (7.8 vs. 10.0, *P*=.022) Patient demographics were similar to that of the present study (**Table 4**). Differences between median age and malignancy were not clinically significant.

Kaplan-Meier survival curves of the 49 patients diagnosed with pancreatic cancer revealed that 5- and 10-year overall survival was approximately 30 percent and 24 percent, respectively (**Figure 1**). Figure 2 shows the Kaplan-Meier curve for pancreatic cancer patients by node status. Patients with negative lymph node status at time of surgery were significantly more likely to survive long-term compared to those diagnosed with a positive node status (*P*=.004). At 5 years post-surgery, about 60 percent of pancreatic cancer patients with negative node status were still living, while only about 10 percent of patients with positive node status were still living (**Figure 2, Table 5**). Furthermore, the Kaplan-Meier curve showing survival rates depending on year of surgery (2007-2013 vs. 2014-2021) revealed significant improvement in survival rates for the 2014 to 2021 group (*P*<.001; **Figure 3**). Straub's 5-year survival data for pancreatic cancer patients who underwent a pancreatic resection were comparable to published national data.[22] Both Kaplan-Meier curves revealed a 5-year survival percentage of about 30 percent (**Figure 3**). [22]

Table 3. Comparison of Whipple Procedure Outcomes Performed at Straub Medical Center, 2007-2021 with Massachusetts General Hospital (MGH)

Variables	MGH[a] (n=634) %(n)	Straub (n=57) %(n)	*P*-value[b]
Age (>70 years)	35% (222)	39% (22)	.59
Sex (% male)	49% (313)	44% (25)	.43
Malignancy[c]	82% (519)	97% (55)	.01
EBL (>600 cc)	45% (288)	40% (23)	.47
LOS (>5 days)	90 % (573)	93% (53)	.52
ICU Admission	7% (43)	4% (2)	.33
30-Day Mortality (%)	1% (3)	2% (1)	.23
90-Day Mortality (%)	3% (16)	4% (2)	.65
Reoperation	2% (13)	5% (3)	.13
Readmission	22% (137)	5% (3)	.003
Fistula	17% (106)	18% (10)	.88

Abbreviations: LOS, length of stay; EBL, estimated blood loss. [a] MGH data were obtained from Lee, et al. (2014).[20] [b] Statistical significance was set at *P*<.05. [c] Statistically significant difference in malignancy proportion was not considered clinically significant.

Table 4. Comparison of Hepatic Resection Outcomes Performed at Straub Medical Center, 2007-2021 with Memorial Sloan-Kettering Cancer Center (MSKCC)

Variables	MSKCC[a] (n=1,803) %(n)	Straub (n=63) %(n)	*P*-value[b]
Mean age[c]	58.6	62.7	.01
Sex (% male)	49% (879)	57% (36)	.16
Malignancy	91% (1642)	100% (63)	.01
Mean EBL	871	806.2	.55
ICU Admission	6% (112)	2% (1)	.14
Operative Mortality	3% (55)	0% (0)	.16
Mean LOS	10	7.8	.02

Abbreviations: LOS, length of stay; EBL, estimated blood loss. [a] MSKCC data were obtained from Jarnagin et al. (2002).[19] [b] Statistical significance was set at *P*<.05. [c] Statistically significant difference in age was not considered clinically significant.

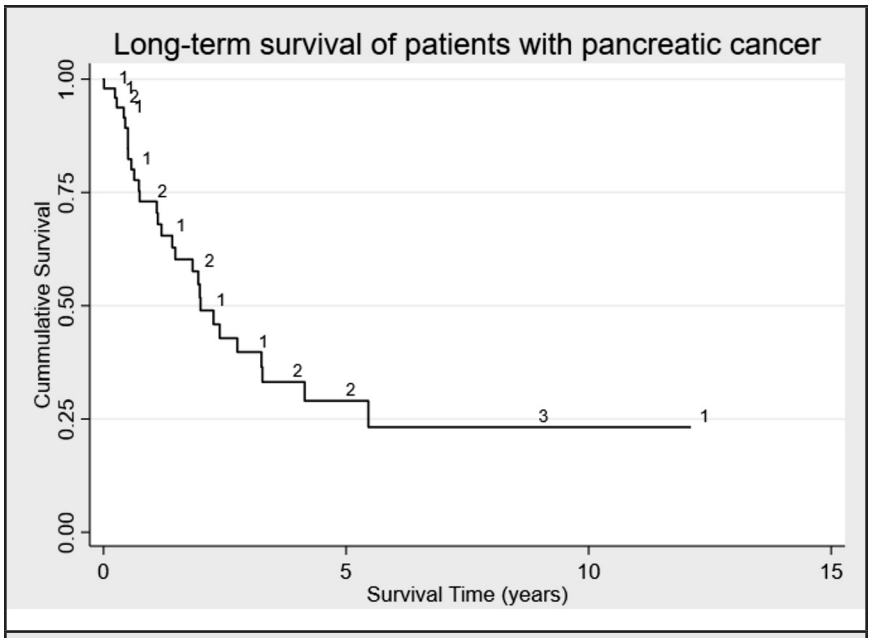

Figure 1. Long-Term Survival of Straub Medical Center Patients Diagnosed with Pancreatic Cancer (N = 49). The Kaplan-Meier curve represents survival time in years for pancreatic cancer patients who underwent a complex HPB surgery ($n_{Whipple}$ = 42, n_{distal} pancreatectomy = 7). Numbers above the curve represent the number of patients lost at the given time.

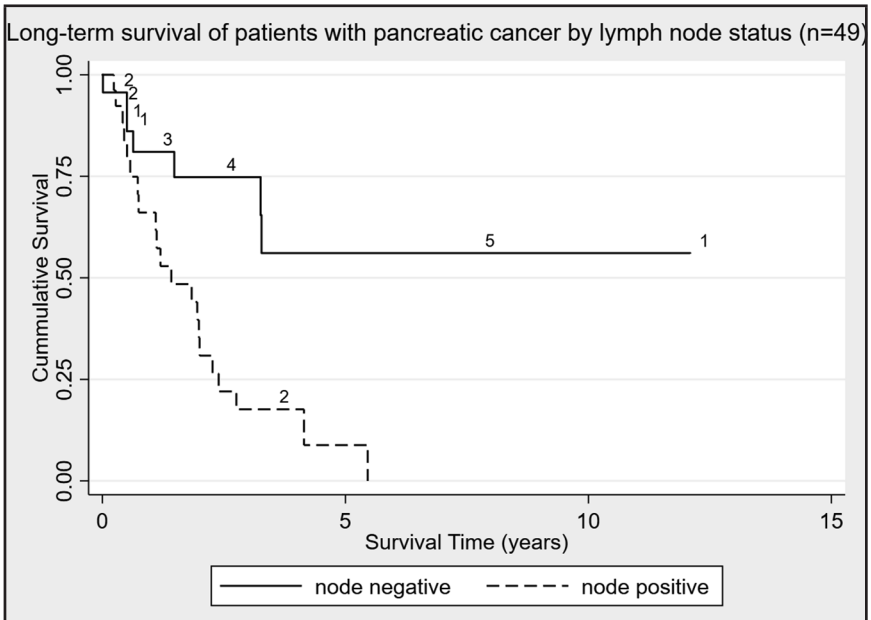

Figure 2. Effect of Lymph Node Status on the Long-term Survival of Straub Medical Center Patients Diagnosed with Pancreatic Cancer (N = 49). The Kaplan-Meier survival estimate represents survival time in years for pancreatic cancer patients who underwent a complex HPB surgery ($n_{Whipple}$ = 42, n_{distal} pancreatectomy = 7). "Node negative" defined as lack of cancer in lymph nodes ($n_{negative}$ = 23). "Node positive" defined as presence of cancer in lymph nodes ($n_{positive}$ = 26). Numbers above the curve represent the number of patients lost at the given time.

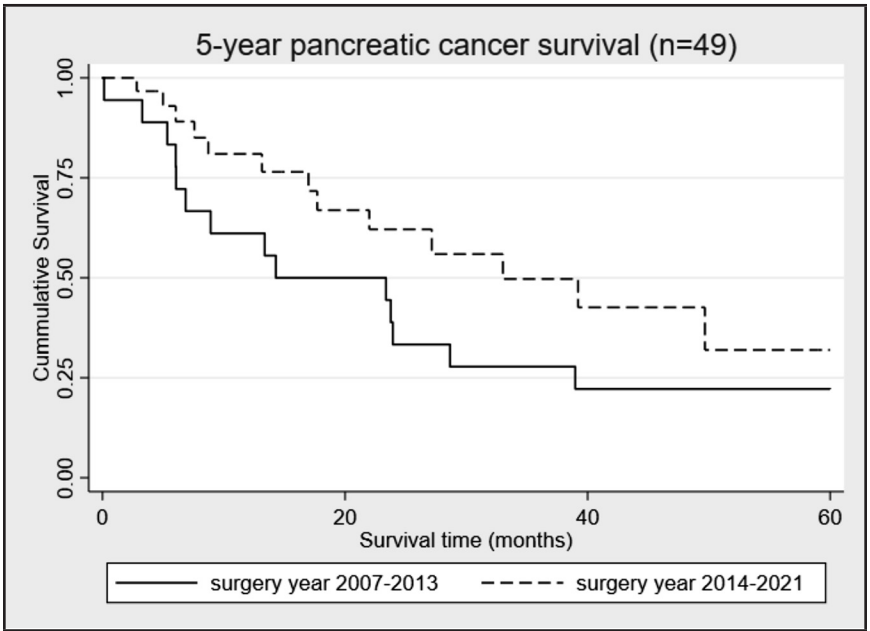

Figure 3. Survival of Pancreatic Cancer Patients at Straub Medical Center. Kaplan-Meier curve shows 5-year survival data from Straub Medical Center. The sample consisted of a total of n=49 pancreatic cancer patients who either underwent surgery between 2007 and 2013 or 2014 and 2021.

Table 5. Effect of Lymph Node Status on 2- and 5-year Survival of Pancreatic Cancer Patients at Straub Medical Center, 2007-2021

Lymph Node Status	Baseline	2-year Survival % (n)	5-year Survival % (n)
Negative	23	44% (10)	26% (6)
Positive	26	27% (7)	8% (2)

Discussion

This study found comparable surgical outcomes for patients who received HPB surgeries at Straub Medical Center to high-volume tertiary centers in the continental United States, suggesting that patients may not require referral to tertiary, high-volume hospitals for complex HPB surgeries. Despite low operation volumes, the overall mortality (1%), major complication rates (10%), median EBL (806.2 mL), and median LOS (7.8 days) were similar to published data from high-volume institutions.[20,21] This is particularly relevant for patients in Hawai‘i because care on the continental United States can be difficult to access due to long-distance and expensive travel.[15]

In addition to similar surgical outcomes, 5-year survival for pancreatic cancer patients in Hawai‘i appears to be comparable to national data. The introduction of neoadjuvant chemotherapy prior to pancreatic resection significantly improved survival as reflected by the time period curves (2007-2013 vs. 2014-2021). Node status is another important predictor of survival of pancreatic cancer patients, as patients with a negative lymph node status had longer survival rates. These findings suggest that pancreatic cancer patients treated at Straub Medical Center receive care that is comparable to the care provided at high-volume hospitals on the continental United States.

Limitations

Several limitations of the present study should be addressed. First, the overall results may not be applicable to all community hospitals in Hawai‘i due to varying levels of resources (eg, fellowship-trained surgeon) and the data resulting from surgeries performed by 1 surgeon. Secondly, as is the case with any retrospective chart review, the potential of missing charts and inconsistency in information coding were a concern. However, effort was made by the authors to carefully report and review all data entries to ensure that the information was as accurate as possible. Lastly, data on minor complications, including grade I and grade II complications, were excluded, which may have affected median LOS.

Conclusion

The results of this study suggest that patients in Hawai‘i do not necessarily need to travel to the continental United States for major HPB surgery, as surgical outcomes for pancreatic and hepatic resections at a community hospital in Hawai‘i are comparable to outcomes at high-volume hospitals. Additionally, a prior study found that patients who were readmitted to their index hospital, the location of the original HPB procedure, had significantly lower mortality rates compared to patients who were readmitted to non-index hospitals due to the index hospital's familiarity with the patient's treatment plan.[23] Thus, a major advantage for patients who underwent surgery at the local community hospital was easy access to the index hospital and surgeon upon readmission, which eliminated the non-index hospitalization risk.

However, it is important to consider that low-volume hospitals can have differing surgical outcome data due to disparate availability of clinical resources and fellowship-trained surgeons.[10] Therefore, these results may be attributable to the presence of a surgeon with HPB surgical experience and ample clinical resources needed to perform complex surgeries. Additional data points, such as comorbidities, patient acuity, and operative time, should be included to permit additional comparisons between high- and low-volume hospitals.

Conflict of Interest

None of the authors identify any conflict of interest.

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