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Patterns of readmission among the elderly after hepatopancreatobiliary surgery☆

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ABSTRACT

Background: The objective of this study was to examine risk factors and outcomes of hospital readmission following complex hepatopancreatobiliary (HPB) surgery among the elderly.
Methods: The Nationwide Readmissions Database was queried for patients ≥ 60 years who underwent HPB surgery during 2010–2015.
Results: The incidence of 30- and 90-day readmission was similar among patients 60–74 vs. ≥75 ($P > 0.05$). Patients age 60–74 years with ≥2 comorbidities had an increased odds of 30-day (OR 1.13, $p = 0.021$) and 90-day (OR 1.13, $p = 0.005$) readmission. Patients ≥75 years with ≥2 comorbidities had the highest in-hospital mortality (5%) whereas patients 60–74 years with 0 or 1 comorbidity had the lowest in-hospital mortality on readmission (3%).
Conclusion: Following an HPB procedure, roughly 1 in 7 elderly patients were readmitted within 30 days and 1 in 4 patients within 90 days. Elderly patients with multiple comorbidities were more likely to be readmitted at non-index hospitals.

Introduction

The proportion of persons aged 65 years or older is expected to more than double in the next fifty years and by 2050, over 20% of adults 65 years or older will be 85 or older. The incidence of hepatopancreatobiliary (HPB) malignancies increases with age. More than 80% of pancreatic cancer diagnoses are among individuals 60 years or older and the incidence of intrahepatic cholangiocarcinoma has tripled since the 1970s among patients greater than 65 years of age.[1] A similar association of age and increased incidence has been reported for extrahepatic cholangiocarcinoma and hepatocellular carcinoma (HCC).[1,2] Surgical resection, with or without chemotherapy or radiation therapy, remains the mainstay treatment for localized HPB cancers. However, the impact of older age on the outcomes of HPB surgery remains controversial. Some studies have reported that older age is an important risk factor for postoperative morbidity, perioperative mortality, and worse overall survival following gastrointestinal surgeries.[3] In contrast, other more recent studies have noted that patients 80 years or older can safely undergo major HPB surgery without an elevated risk of postoperative complications.[4]

One particular area that remains poorly understood among the elderly population is the risk for hospital readmission. For example, published data on thirty-day readmission among the elderly are highly variable, ranging from 11 to 41%.[5,6] In addition, risk factors and the clinical impact of hospital readmission remain understudied. Therefore, the objective was to characterize the effects of age and comorbidity on readmission patterns among elderly patients undergoing HPB surgery, as well as to evaluate factors associated with all-cause 30- and 90-day readmission. We hypothesized that age and number of comorbidities would be a predictor of post-discharge readmission and impact readmission to index versus non-index hospitals.

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Material and methods

Data source and patient characteristics

The Nationwide Readmissions Database (NRD) is sponsored by the Agency for Healthcare Research and Quality (AHRQ) and is designed specifically for readmission analyses. States involved in the NRD assign patient linkage numbers that are used to track patients within and across hospitals in a particular state.[7] The study was deemed exempt by the institutional review board at The Ohio State University.

The NRD was queried for elderly patients (age ≥ 60 years) who underwent HPB surgeries, other than cholecystectomy and laparoscopic wedge resection of the liver, from 2010 to 2015 using ICD-9CM codes. Patients discharged in the months of October, November and December were excluded to allow for 90-day follow-up of patients, as tracking between years is not possible in the NRD. Furthermore, patients who died during index hospitalization, with missing length of hospital stay (LOS) data or discharged and readmitted on the same day were excluded.

Variables

AHRQ variables were used to generate a comorbidity score for each patient based on the number of comorbidities recorded (0, 1, 2, ≥3 comorbidities). Severity of illness was defined as "the extent of physiologic decompensation or organ system loss of function" whereas risk of mortality was defined as "the likelihood of dying".[8] Index events were based on ICD-9-CM procedure codes. Time to readmission was based on date of admission and LOS for index event, and date of readmission. For patients who experienced more than one readmission, only the first readmission was analyzed.

Statistical analysis

The cohort was subdivided based on age (60–74 vs. ≥75 years). Characteristics of the two cohorts were compared and age was examined relative to 30- and 90-day readmission. In order to examine the influence of physiologic age, patients were subsequently divided into four categories: 60–74 years with 0 or 1 comorbidity, ≥ 75 years with 0 or 1 comorbidity, 60–74 years with ≥2 comorbidities, and ≥75 years with ≥2 comorbidities. Non-normally distributed continuous variables were summarized using median and interquartile range and compared using Kruskall-Wallis tests. Normally distributed continuous variables were summarized using mean and standard deviation and compared using student's t-tests. Frequencies and percentages were used to summarize categorical variables and compared using chi-square and Fisher's exact tests, as appropriate. Multivariable logistic regression models were used to examine predictors of readmission. Results were reported as odds ratio (OR) where appropriate, with a 95% confidence interval (CI). A *P* value of <0.05 was considered statistically significant. Analysis was completed using Stata 14.0 MP (StataCorp, LLC, College Station, TX).

Results

Patient characteristics

25,595 patients met inclusion criteria. Median age was 69 years (60–74 years, n = 18,808, 73.5% vs. ≥75 years, n = 6,787, 26.5%). Patients were equally matched with regards to sex (female, n = 12,880, 50%; male, n = 12,715, 50%). Comorbidities were common, as half of patients had ≥3 comorbidities (n = 12,788, 50%) and many patients (n = 9,552, 37%) had moderate loss of function due to comorbidities. The majority of patients were classified as having a high risk of mortality (moderate to extreme likelihood of dying: n = 17,551, 69%). The majority of patients underwent liver surgery (n = 13,964, 55%), while a subset underwent pancreas (n = 7,722, 30%) or biliary (n = 3,909, 15%) operations. Most patients underwent surgery for a malignant (n = 19,941, 78%) rather than a benign (n = 5,605, 22%) indication. Cause of surgical intervention was unknown for 49 patients. The median LOS for the entire cohort on index hospitalization was 7 days (IQR: 5-10d). Among patients 60–74 years of age, 59% (n = 11,173) had a mean LOS of stay less than 7 days, while among patients ≥75 years of age only 52% had a LOS less than 7 days (n = 3496) (P < 0.001). Following the index hospitalization, a greater proportion of patients ≥75 years were discharged to skilled nursing facilities (60–74 years, n = 1,413, 8% vs. ≥75 years, n = 1,450, 21%; P < 0.001) or with home health care (n = 6,775, 27%) (60–74 years, n = 4,670, 25% vs. ≥75 years, n = 2,105, 31%; P < 0.001) versus patients 60–74 years.

Factors associated with readmission

Following HPB surgery, 6313 patients (25%) were readmitted within 90 days of index hospitalization discharge (60–74 years, n = 4,662, 25% vs. ≥75 years, n = 1,651, 24%, P = 0.450); 3464 (14%) patients were readmitted within 30 days of discharge (60–74 years, n = 2,588, 14% vs. ≥75 years, n = 876, 13%; P = 0.078). In general, similar risk factors were associated with both 30- and 90-day readmission. Specifically, on multivariable analysis, moderate (OR 1.28, 95% CI 1.13–1.44; P < 0.001), major (OR 1.52, 95% CI 1.32–1.75; P < 0.001) and extreme loss of function (OR 1.78, 95% CI 1.48–2.14, P < 0.001), LOS > 7 days (OR 1.50, 95% CI 1.40–1.61; P < 0.001), as well as pancreas (OR 1.43, 95% CI 1.34–1.54; P < 0.001) or biliary (OR 1.33, 95% CI 1.22–1.45; P < 0.001) procedures were associated with 90-day readmission. Patients ≥75 years had a longer median length of stay (5 days) on readmission compared with patients 60–74 years old (4 days) (P = 0.003). Of note, reasons for readmission, as well as in-hospital readmission mortality and overall total charges associated with the readmission were similar among patients 60–74 years versus ≥75 years (all P > 0.05).

Readmission: impact of age and comorbidities

In assessing the entire cohort, patients ≥75 years had a lower risk of both 30-day and 90-day readmission (both P < 0.05). The proportion of patients with an illness severity classified as "extreme loss of function" (4%, 6%, 14%, 16%, respectively), as well as patients classified as being at an "extreme likelihood of dying" (3%, 4%, 11%, 15%) increased in an incremental fashion across the four subgroups: 60–74 years with 0 or 1 comorbidity, ≥ 75 years with 0 or 1 comorbidity, 60–74 years with ≥2 comorbidities, and ≥75 years with ≥2 comorbidities (both P < 0.001). The majority of patients across all four groups had an operation for a malignant diagnosis (60–74 years with 0 or 1 comorbidity: 72%, ≥75 years with 0 or 1 comorbidity: 70%, 60–74 years with ≥2 comorbidities: 81%, ≥75 years with ≥2 comorbidities: 80%; p < 0.001). Of note, patients ≥75 years with ≥2 comorbidities who were readmitted, had a longer median LOS (9 days, IQR 6-15d) on index admission versus other patient groups (60–74 years old with 0–1 comorbidity, 7 days, IQR 5–9; >75 years old with 0–1 comorbidity 7 days, IQR 5–10; 60–74 years old with ≥2 comorbidities, 8 days, IQR 6–14; P < 0.001). Patients ≥75 years with ≥2 comorbidities had the highest index in-hospital mortality (5%) compared with patients who were 60–74 years with ≥2 comorbidities (4%), ≥75 years with 0–1 comorbidity (3%), or 60–74 years with 0–1 comorbidity (3%) when readmitted (P = 0.03) (Table 1). Patients ≥75 years with ≥2 comorbidities had the highest median total charges for index admission ($103,702, IQR $62,050–$172,605) (P < 0.001).

Table 1
Comparison of short-term outcomes and patterns of 90-day readmission in patients undergoing Hepatopancreatobiliary surgery by age/comorbidity category.

	60-74y with 0–1 comorbidity N = 1026	≥75y with 0–1 comorbidity N = 258	60-74y with ≥2 comorbidities N = 3636	≥75y with ≥2 comorbidities N = 1393	P-Value
Admission LOS, median (IQR)	7 (5–9)	7 (5–10)	8 (6–14)	9 (6–15)	**<0.001**
Admission Total Charge, median (IQR)	$79,819 (52,431–129,942)	$79,279 (55,556–147,241)	$100,707 (63,169–176,815)	$103,702 (62,050–172,605)	**<0.001**
Reason for 90-day Readmission					**0.001**
Infections	349 (34%)	83 (32%)	1238 (34%)	457 (33%)	
Other GI complications	241 (23%)	58 (22%)	770 (21%)	278 (20%)	
Cardiac and Renal	79 (8%)	27 (10%)	476 (13%)	214 (15%)	
Endocrine and Pancreatic	99 (10%)	20 (8%)	294 (8%)	112 (8%)	
Bleeding	47 (5%)	12 (5%)	139 (4%)	62 (4%)	
Other	211 (20%)	58 (23%)	719 (20%)	270 (20%)	
Procedures During Readmission					**0.012**
Other Treatments	337 (33%)	90 (35%)	1250 (34%)	497 (36%)	
Medical Treatments	269 (26%)	74 (29%)	1040 (29%)	434 (31%)	
Operative Procedure	420 (41%)	94 (36%)	1346 (37%)	462 (33%)	
Readmission - In-Hospital Mortality	28 (2.7%)	8 (3.1%)	145 (4.0%)	70 (5.0%)	**0.034**
Readmission - LOS, median (IQR)	4 (2–7)	5 (3–8)	4 (3–8)	5 (3–9)	**0.001**
Readmission - Total Charge, median (IQR)	29,950 (16,979–57,820)	35,027 (17,965–67,780)	31,665 (17,321–61,215)	33,937 (17,375–65,132)	0.071

Bold was used to signify the p-value was less than 0.05.
AbbreviationsLOS length of stay; IQR interquartile range.

Readmission was also associated with age relative to comorbidity status (Table 2). On multivariable analysis, compared with patients 60–74 with 0 or 1 medical comorbidity, patients with ≥2 comorbidities had a 13% increased risk of 30- and 90-day readmission (both $P < 0.05$). Of note, patients age >75 years with 0 or 1 medical comorbidity had lower risk of 90-day readmission (OR 0.83, 95%CI 0.71–0.97; $P = 0.020$). Older age with multiple comorbidities was not associated with 30- or 90-day readmission ($P > 0.05$). Interestingly, among patients with ≥2 comorbidities, individuals ≥75 years of age were more likely to be readmitted to a non-index hospital compared with patients aged 60–74 years (27.0% vs. 23.1%, respectively; $P < 0.001$). The median charges associated with readmission were also higher among patients ≥75 years with ≥2 medical comorbidities ($33,937, IQR

Table 2
Logistic regression model predicting 30-day and 90-day readmission after Hepatopancreatobiliary surgery by age/comorbidity category.[a]

Variable	30-Day Readmission			90-Day Readmission		
	OR	95% CI	P-value	OR	95% CI	P-value
Age/Comorbidity Category						
60–74 years old with 0–1 comorbidity	Ref.			Ref.		
≥75 years old with 0–1 comorbidity	0.84	0.69, 1.03	0.087	0.83	0.71, 0.97	**0.020**
60–74 years old with ≥2 comorbidities	1.13	1.02, 1.26	**0.021**	1.13	1.04, 1.23	**0.005**
≥75 years old with ≥2 comorbidities	1.01	0.89, 1.15	0.859	0.97	0.88, 1.08	0.609
Female	0.87	0.81, 0.93	**<0.001**	0.91	0.86, 0.96	**0.001**
Mortality Category						
Minor likelihood of dying	Ref.			Ref.		
Moderate likelihood of dying	1.00	0.92, 1.11	0.984	1.09	1.00, 1.18	0.54
Major likelihood of dying	1.06	0.92, 1.22	0.372	1.20	1.08, 1.35	**0.001**
Extreme likelihood of dying	0.97	0.80, 1.18	0.754	1.19	1.02, 1.39	**0.03**
Illness Severity Category						
Minor loss of function	Ref.			Ref.		
Moderate loss of function	1.22	1.05, 1.41	**0.008**	1.28	1.14, 1.45	**<0.001**
Major loss of function	1.46	1.23, 1.73	**<0.001**	1.53	1.33, 1.76	**<0.001**
Extreme loss of function	1.13	090, 1.42	0.296	1.81	1.51, 2.17	**<0.001**
Type of HPB Procedure						
Liver	Liver	Ref.			Ref.	
Pancreas	1.42	1.30, 1.54	**<0.001**	1.44	1.34, 1.54	**<0.001**
Biliary	1.29	1.15, 1.44	**<0.001**	1.33	1.22, 1.45	**<0.001**
Malignant Versus Benign						
Benign	Ref.			Ref.		
Malignant	1.11	1.01, 1.22	**0.031**	1.23	1.14, 1.33	**<0.001**
Length of Stay						
<= 7 Days	Ref.			Ref.		
>7 Days	1.22	1.11, 1.33	**<0.001**	1.50	1.40, 1.61	**<0.001**

Bold was used to signify the p-value was less than 0.05.
Abbreviations: OR odds ratio.
[a] Model also included primary payer status, household income, size of hospital, and teaching status.

$17,375–$65,132) compared with patients 60–74 years with ≥2 medical comorbidities ($31,665, IQR $17,321–$61,215) (P = 0.071).

Discussion

Surgical management of the elderly poses unique challenges due to medical comorbidities, physiologic fitness (i.e. frailty), psychological factors, social support, as well as level and extent of dependence. The American College of Surgeons (ACS) has recognized the need to evaluate processes of care that can help optimize outcomes of elderly patients undergoing surgery.[9] Readmission among this complex and aging population has not, however, been well studied. Readmissions not only represent an inconvenience for patients, but also can lead to adverse patient outcomes, as well as increased health care costs.[10]

The current study is important as it defined risk factors associated with readmission among the elderly with a focus on the interplay between age and preoperative comorbidities. Of note, roughly 1 in 7 patients age ≥60 years experienced a readmission within 30 days of an HPB procedure; by 90 days, 1 in 4 patients were readmitted. The incidence of readmission was impacted both by patient age, as well as baseline comorbidity status. Given that nearly three fourths of the elderly population had at least two medical comorbidities, and one fifth of surgical readmissions may in fact be preventable, this data can help stratify patients with regards to risk of readmission and inform discharge planning. Based on the current study, elderly individuals with multiple medical comorbidities should be specifically targeted for interventions to reduce readmission. To this point, the "hospital to home" transitional care program, in which a social worker performs home visits to explain discharge instructions, new medications and facilitate implementation of home health services, has been associated with decreased readmission.[11]

The current study expanded on previous work by specifically examining the impact of comorbidities on readmission. Physiologic age, which generally considers chronologic age and overall health status, may serve as a better determinant of outcomes versus chronological age – especially among older patients.[12] In the current study, the incorporation of chronologic age with number of comorbidities was able to further stratify older patients relative to their risk of readmission. In turn, the data strongly suggests that older patients should not be evaluated solely on chronological age. Rather, providers should assess and incorporate overall preoperative comorbidities when discussing and assessing patients for surgical interventions.

Several limitations should be considered when interpreting results from the current study. Patients who were readmitted to a hospital in a state differing from the index hospital were not captured in the dataset. Though, the impact of missed readmissions to other states on "true" readmission rate has been shown to be minimal.[7] Limited information was also available on operative details, hospital course, and post-discharge planning. In addition, the intent of surgery (e.g. palliative versus curative-intent) was not available in the NRD.

In conclusion, patients 60–74 with 2 or more comorbidities were more likely to be re-admitted within 30 and 90-days in comparison to similarly aged individuals with 0 or 1 comorbidities. Further research is needed to investigate the hospital course of individuals >75 years with multiple comorbidities who are readmitted as this patient population is at greatest risk of in-hospital mortality.

Conflicts of interest

The authors have no conflicts of interest.

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