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A propensity score matched comparison of readmissions and cost of laparoscopic cholecystectomy vs percutaneous cholecystostomy for acute cholecystitis

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ABSTRACT

Background: Percutaneous cholecystostomy (PC) is an initial alternative to laparoscopic cholecystectomy (LC) for complicated acute cholecystitis (AC). No studies have directly compared costs of index hospitalization and readmissions between PC and LC patients.

Methods: The Nationwide Readmissions Database was queried for patients undergoing PC or LC for AC from 2013 through 2014. Primary outcomes including length of stay, and index and total hospital costs at 30- and 60-days were evaluated after 1:1 propensity score matching for patient and hospital characteristics.

Results: PC patients had increased index hospital length of stay: 6 days vs 5 days ($p < 0.01$). Index admission cost was cheaper for PC ($12,839 vs $13,345, $p = 0.028$). Total cost, including readmissions, was significantly increased in PC patients: 30-days (LC: $13,947, PC: $14,592, $p = 0.029$) and 60-days (LC: $14,280, PC: $16,518, $p < 0.0001$).

Conclusions: PC patients were more frequently readmitted, had longer hospital stays, and increased hospital costs compared to those undergoing LC.

Introduction

Acute cholecystitis occurs in 1–3% of the 20–25 million patients with gallstones in the United States per year[1,2] resulting in approximately 200,000 inpatient hospital admissions per year.[3] The healthcare burden of acute cholecystitis is tremendous, with approximately 120,000 laparoscopic cholecystectomies[4] and 7000 percutaneous cholecystostomies[5] performed annually. Studies have shown that laparoscopic cholecystectomy (LC) and percutaneous cholecystostomy (PC) are both safe and effective as initial management of acute cholecystitis.[6–11] There is growing evidence that LC is safe for most patients with acute cholecystitis[6,8,9] but that PC may be more appropriate for patients with more severe disease and/or significant comorbidities. Most patients initially managed with PC (~60–70%) never undergo interval cholecystectomy.[5,12–17] Despite such evidence, PC utilization is increasing.[5,12,16,17]

Interestingly, despite the large volume of patients with acute cholecystitis, several important questions remain unanswered. Anecdotally, patients undergoing PC return to the hospital with some frequency for tube dislodgement, contrast studies, and dysfunction. Presumably, such readmissions add to total healthcare expenditure. But the true readmission rate and cost of modern practice is unknown. Even the true readmission rate following these procedures, particularly in patients undergoing PC, remains elusive due, in part, to the inability to track patients across multiple healthcare systems.

This study assesses and compares the readmission rates and costs between LC and PC after matching for patient and hospital characteristics.

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Methods

Data source

The Nationwide Readmission Database (NRD) of the Healthcare Cost and Utilization Project (HCUP) was queried for patients with acute cholecystitis.[18] This database contains deidentified patient data in accordance with the Health Insurance Portability and Accountability Act of 1996. The NRD is a nationally representative database consisting of approximately 17 million annual discharges. The database contains information on all payers, including the uninsured, and can track patients and their readmissions across different hospitals, cities, and states. The NRD is collected by HCUP via Federal-State-Industry partnerships under an agreement with the Agency for Healthcare Research and Quality, a branch of the Department of Health and Human Services. The Data Use Agreement for the Nationwide Databases from the Healthcare Cost and Utilization Project Agency for Healthcare Research and Quality was submitted and signed by the authors. The Yale University Institutional Review Board granted an exemption for this study.

Patient population

We selected patients undergoing laparoscopic cholecystectomy or percutaneous cholecystostomy for acute cholecystitis; patients undergoing procedures for symptomatic cholelithiasis were excluded from the analysis. The *Current Procedural Terminology (CPT)* codes for laparoscopic cholecystectomy and percutaneous cholecystostomy (LC: 47562, 47563, 47564; PC: 47490) were identified and cross matched with *International Statistical Classification of Diseases and Related Health Problems (ICD)-9* codes for acute cholecystitis to identify study patients in the NRD for the years 2013 and 2014 (575.0.575.10, 575.11, 575.12, 575.2).

Outcome measures

30-day and 60-day readmission rates, index hospitalization costs, and total hospital costs for all readmissions within 30- and 60- days of the index procedure were selected as primary outcomes. Readmission was defined as subsequent admission within 30-days or 60-days following the index admission discharge date. Patients who died during their first admission or who had their first discharge date in December (30-day data) or November (60-day data) were excluded due to lack of necessary follow up data. Index and total length of stay was calculated as a sum of all inpatient admissions including the patient's index admission. The index and total costs for the 30-day and 60-day groups are not the same; while there is a large amount of overlap the 60-day group lacks all information from patients undergoing procedures during November of 2013 and 2014.

Costs were calculated using the cost-to-charge ratio files provided by HCUP.[19] These ratios exist at the hospital level and contain information on total hospital costs for each hospital discharge present in the database. While inpatient costs may vary across patients and hospitals,[20] this methodology has been previously utilized to estimate the cost of healthcare at the level of the individual hospital where a given individual received their care.[21,22]

Statistical analysis

Baseline demographics were analyzed using χ^2 test for categorical variables and *t*-test for continuous variables. For these and the remainder of the analyses, $P < 0.05$ signifies a statistically significant association. Both univariate and multivariable analyses were conducted to identify the variables associated with readmission, index hospital costs, and total hospital costs. Subsequently, stepwise multivariable logistic regression was used to identify predictors of readmission.

To analyze 30-day and 60-day readmissions and cost, separate propensity score matched analysis were performed for each time period given the loss of index admission patient data from the month of November and December in the 60-day analysis. Propensity score matching was utilized to minimize confounding due to treatment and selection bias for patients in the study population. Following 1:1 propensity score matching[23,24] for baseline patient (age, race, gender, illness and mortality subclassification, individual comorbidities, insurance status, and disposition) and hospital characteristics (number of hospital beds, urban-rural designation, teaching status, and hospital ownership status), outcomes of interest including 30-day and 60-day readmission rates, length of stay, index admission costs, and total costs were analyzed. LC and PC models were fitted separately using a stepwise selection approach for predictors of readmission. Multivariable conditional logistic regression was performed to identify risk for readmission within the matched cohorts. In this analysis, the median value was used as the reference range for non-normally distributed variables (length of stay, index cost, total cost). Median and interquartile ranges are presented for non-normally distributed variables and Mood's median test is used where appropriate. All data analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

Results

Patient population

There were 92,942 laparoscopic cholecystectomies (LC) (5092 30-day readmissions and 6125 60-day readmissions) and 3368 percutaneous cholecystostomies (PC) (698 30-day readmissions and 1021 60-day readmissions) available for analysis. Patients in the laparoscopic group were more likely to be younger, female, have lower rates of tracked comorbidities, have routine discharge disposition, be treated at a non-teaching hospital, and have significantly lower rates of readmission within 30 days (Table 1). Overall, there was a 5.5% 30-day readmission and 7.2% 60-day readmission rate after laparoscopic cholecystectomy for acute cholecystitis compared to a 20.7% 30-day readmission rate and 30.3% 60-day readmission rate after percutaneous cholecystostomy for acute cholecystitis.

Propensity matched outcomes

After propensity score matching there were no significant differences in patient characteristics between groups except for age and hypertension status. Table 2 demonstrates the demographics for matched patients for 30-day and 60-day outcomes. Patients undergoing PC had significantly increased length of stay for their index hospitalization by 1 hospital day for each group at both 30 days and 60 days following index admission (Table 2, $p < 0.0001$ for both). Total hospital length of stay including readmissions was also significantly increased in the PC group at both 30 and 60 days (Table 2, $p < 0.0001$ for both). Index costs were significantly cheaper for PC patients in the 30-day analysis. Both analyses demonstrated increased total cost of PC compared to LC when accounting for readmissions at 30-days and 60-days following index discharge date ($p = 0.029$ and $p < 0.0001$, respectively).

When evaluating both 30-day and 60-day readmission time periods, those patients undergoing PC had a significantly increased risk of readmission (OR 2.2 (1.9–2.5) and OR 3.0 (2.6–3.5) respectively, $p < 0.0001$ Table 3). When evaluating index cost, patients undergoing PC had significantly decreased risk for incurring costs

Table 1
Patients undergoing laparoscopic cholecystectomy (LC) or percutaneous cholecystostomy from 2013 to 2014 in the nationwide readmissions database.

Characteristics	30-Day Readmission Data			60-Day Readmission Data		
	LC n = 92,942 (%)	PC n = 3368 (%)	P-Value	LC n = 85,376 (%)	PC n = 3072 (%)	P-Value
Age, years						
0–60	64,814 (69.7)	866 (25.7)		59,599 (69.8)	790 (25.7)	
61–74	18,107 (19.5)	864 (25.7)		16,604 (19.4)	779 (25.3)	
75–84	7426 (8.0)	849 (25.2)		6814 (8.0)	776 (25.3)	
≥85	2595 (2.8)	789 (23.4)	<.0001	2359 (2.8)	727 (26.7)	<.0001
Gender						
Male	31,479 (33.9)	1869 (55.5)		28,787 (33.7)	1704 (55.5)	
Female	61,463 (66.1)	1499 (44.5)	<.0001	56,589 (66.3)	1368 (44.5)	<.0001
Severity of Illness Subclass						
Minor or moderate	80,996 (87.1)	1374 (40.8)		74,471 (87.2)	1242 (40.4)	
Major or extreme	11,946 (12.9)	1994 (59.2)	<.0001	10,905 (12.8)	1830 (59.6)	<.0001
Risk of Mortality Subclass						
Minor or moderate likelihood	88,887 (95.6)	1813 (53.8)		81,684 (95.7)	1640 (53.4)	
Major or extreme likelihood	4055 (4.4)	1555 (46.2)	<.0001	3692 (4.3)	1432 (46.6)	<.0001
Comorbidity						
AIDS	75 (0.1)	5 (0.2)	0.21	72 (0.1)	5 (0.2)	0.15
Alcohol	1592 (1.7)	167 (5.0)	<.0001	1471 (1.7)	156 (5.1)	<.0001
Anemia	6064 (6.5)	659 (19.6)	<.0001	5583 (6.5)	600 (19.5)	<.0001
Arthritis/collagen vascular disease	1504 (1.6)	94 (2.8)	<.0001	1368 (1.6)	87 (2.8)	<.0001
Chronic anemia	259 (0.3)	13 (0.4)	0.25	237 (0.3)	13 (0.4)	0.14
Congestive heart failure	2108 (2.3)	582 (17.3)	<.0001	1946 (2.3)	539 (17.6)	<.0001
Chronic pulmonary disease	10,967 (11.8)	630 (18.7)	<.0001	10,088 (11.8)	571 (18.6)	<.0001
Coagulopathy	1511 (1.6)	370 (11.0)	<.0001	1390 (1.6)	345 (11.2)	<.0001
Depression	7622 (8.2)	307 (9.1)	0.06	7027 (8.2)	285 (9.3)	0.04
Diabetes	13,659 (14.7)	891 (26.5)	<.0001	12,547 (14.7)	825 (26.9)	<.0001
Diabetes with complications	1788 (1.9)	201 (6.0)	<.0001	1648 (1.9)	189 (6.2)	<.0001
Drug abuse	1810 (2.0)	78 (2.3)	0.13	1667 (2.0)	73 (2.4)	0.10
Hypertension	3,6917 (39.7)	2191 (65.1)	<.0001	33,880 (33.7)	1991 (64.8)	<.0001
Hypothyroidism	8129 (94.7)	453 (13.5)	<.0001	7468 (8.8)	414 (13.5)	<.0001
Liver disease	5015 (5.4)	109 (3.2)	<.0001	4580 (5.4)	103 (3.4)	<.0001
Lymphoma	221 (0.2)	29 (0.9)	<.0001	202 (0.2)	29 (0.9)	<.0001
Fluid/electrolyte disorders	13,944 (15.0)	1441 (42.8)	<.0001	12,739 (14.9)	1303 (42.4)	<.0001
Metastatic cancer	318 (0.3)	135 (4.0)	<.0001	297 (0.4)	128 (4.2)	<.0001
Neurological disorder	2809 (3.0)	327 (9.7)	<.0001	2585 (3.0)	300 (9.8)	<.0001
Obesity	20,269 (21.8)	553 (16.4)	<.0001	18,637 (21.8)	505 (16.4)	<.0001
Paralysis	519 (0.6)	138 (4.1)	<.0001	484 (0.6)	133 (4.3)	<.0001
Peripheral vascular disease	1916 (2.1)	335 (10.0)	<.0001	1733 (2.0)	307 (10.0)	<.0001
Psychoses	2684 (2.9)	118 (3.5)	<.0001	2466 (2.9)	106 (3.5)	0.07
Pulmonary circulation disorders	569 (0.6)	131 (3.9)	<.0001	516 (0.6)	119 (3.9)	<.0001
Renal failure	3098 (3.3)	549 (16.3)	<.0001	2839 (3.3)	504 (16.4)	<.0001
Solid tumor without metastasis	492 (0.5)	119 (3.5)	<.0001	457 (0.5)	110 (3.6)	<.0001
Peptic ulcer disease	24 (0.03)	3 (0.1)	0.07	23 (0.03)	3 (0.1)	0.06
Valvular disease	1817 (2.0)	263 (7.8)	<.0001	1673 (2.0)	248 (8.1)	<.0001
Weight loss	1185 (1.3)	350 (10.4)	<.0001	1085 (1.3)	325 (10.6)	<.0001
Insurance status						
Insured	80,403 (86.5)	3169 (94.1)		73,848 (86.5)	2896 (94.3)	
Other	12,539 (13.5)	199 (5.9)	<.0001	11,528 (13.5)	176 (5.7)	<.0001
Disposition of patients						
Routine	87,969 (94.7)	1375 (40.8)		80,790 (94.6)	1238 (40.3)	
Non-routine	4973 (5.4)	1993 (59.2)	<.0001	4586 (5.4)	1834 (59.7)	<.0001
Hospital bedsize						
Medium	38,384 (41.3)	1211 (36.0)		35,199 (41.2)	1109 (3.61)	
Large	54,558 (58.7)	2157 (64.0)	<.0001	50,177 (58.8)	1963 (63.9)	<.0001
Hospital urban-rural designation						
Large metropolitan	55,994 (60.3)	2047 (60.8)		51,434 (60.2)	1873 (61.0)	
Small metropolitan	36,948 (39.7)	1321 (39.2)	0.54	33,942 (39.8)	1199 (39.0)	0.42
Teaching Status						
Non-teaching	48,650 (42.3)	1181 (35.1)		44,677 (32.3)	1077 (35.1)	
Teaching	44,292 (47.7)	2187 (64.9)	<.0001	40,699 (47.7)	1995 (46.9)	<.0001
Hospital Ownership						
Non-private	12,405 (13.4)	403 (12.0)		11,389 (13.3)	363 (11.8)	
Private	80,537 (86.7)	2965 (88.0)	0.02	73,987 (86.7)	2709 (88.2)	0.01
Readmission						
No	87,850 (94.5)	2670 (79.3)		79,251 (92.8)	2051 (66.8)	
Yes	5092 (5.5)	698 (20.7)	<.0001	6125 (7.2)	1021 (33.2)	<.0001
Age, years, mean (SD)	49.9 (18.4)	70.3 (16.5)	<.0001	49.8 (18.4)	70.3 (16.5)	<.0001
Length of stay, days, median (IQR)	2 (2–4)	6 (4–10)	<.0001	2 (2–4)	6 (4–10)	<.0001

Table 2
Demographics of Propensity Matched Patients undergoing PC or LC, 30-day and 60-day groups.

Characteristics	30-Day Matched Data			60-Day Matched Data		
	LC n = 3180 (%)	PC n = 3180 (%)	P-Value	LC n = 2894 (%)	PC n = 2894 (%)	P-Value
Age, years						
0–60	727 (22.9)	850 (26.7)		676 (23.3)	775 (26.8)	
61–74	843 (26.5)	822 (25.9)		787 (27.2)	747 (25.8)	
75–84	854 (26.8)	802 (25.2)		801 (27.7)	722 (25.0)	
≥85	756 (23.8)	706 (22.2)	0.00	630 (21.8)	650 (22.4)	0.01
Gender						
Male	1750 (55.0)	1726 (54.3)		1616 (55.8)	1573 (54.3)	
Female	1430 (45.0)	1454 (45.7)	0.55	1278 (44.2)	1321 (45.7)	0.26
Severity of Illness Subclass						
Minor or moderate	1384 (43.5)	1373 (43.2)		1252 (43.3)	1236 (42.7)	
Major or extreme	1796 (56.5)	1807 (56.8)	0.78	1642 (56.7)	1658 (57.3)	0.67
Risk of Mortality Subclass						
Minor or moderate likelihood	1880 (59.1)	1804 (56.7)		1682 (58.1)	1634 (56.5)	
Major or extreme likelihood	1300 (40.9)	1376 (43.3)	0.05	1212 (41.9)	1260 (43.5)	0.20
Comorbidity						
AIDS	3 (0.1)	5 (0.2)	0.48	4 (0.1)	5 (0.2)	0.74
Alcohol	144 (4.5)	150 (4.7)	0.72	116 (4.0)	138 (4.8)	0.16
Anemia	591 (18.6)	598 (18.8)	0.82	555 (19.2)	540 (18.7)	0.61
Arthritis/collagen vascular diseases	89 (2.8)	87 (2.7)	0.88	68 (2.4)	83 (2.9)	0.22
Chronic anemia	16 (0.5)	13 (0.4)	0.58	15 (0.5)	11 (0.4)	0.43
Congestive heart failure	495 (15.6)	517 (16.3)	0.45	470 (16.2)	474 (16.4)	0.89
Chronic pulmonary disease	615 (19.3)	602 (18.9)	0.68	566 (19.6)	534 (18.5)	0.28
Coagulopathy	278 (8.7)	320 (10.1)	0.07	270 (9.3)	289 (10.0)	0.40
Depression	293 (9.2)	296 (9.3)	0.90	272 (9.4)	271 (9.4)	0.96
Diabetes	885 (27.8)	825 (25.9)	0.09	846 (29.2)	769 (26.6)	0.02
Diabetes with complications	190 (6.0)	188 (5.9)	0.92	189 (6.5)	174 (6.0)	0.42
Drug abuse	84 (2.6)	76 (2.4)	0.52	78 (2.7)	70 (2.4)	0.51
Hypertension	2188 (68.8)	2064 (64.9)	0.00	2013 (69.6)	1876 (64.8)	0.00
Hypothyroidism	455 (14.3)	430 (13.5)	0.37	425 (14.7)	394 (13.6)	0.24
Liver disease	97 (3.1)	107 (3.4)	0.48	90 (3.1)	100 (3.5)	0.46
Lymphoma	25 (0.8)	28 (0.9)	0.68	30 (1.0)	26 (0.9)	0.59
Fluid/electrolyte disorders	1333 (41.9)	1307 (41.1)	0.51	1218 (42.1)	1176 (40.6)	0.26
Metastatic cancer	92 (2.9)	104 (3.3)	0.38	87 (3.0)	96 (3.3)	0.50
Neurological disorder	314 (9.9)	302 (9.5)	0.61	264 (9.1)	275 (9.5)	0.62
Obesity	542 (17.0)	538 (16.9)	0.89	531 (18.4)	491 (17.0)	0.17
Paralysis	117 (3.7)	114 (3.6)	0.84	103 (3.6)	112 (3.9)	0.53
Peripheral vascular disease	310 (9.8)	303 (9.5)	0.77	277 (9.6)	271 (9.4)	0.79
Psychoses	117 (3.7)	114 (3.6)	0.84	106 (3.7)	97 (3.4)	0.52
Pulmonary circulation disorders	125 (3.9)	121 (3.8)	0.79	120 (4.2)	112 (3.9)	0.59
Renal failure	501 (15.8)	510 (16.0)	0.76	486 (16.8)	460 (15.9)	0.36
Solid tumor without metastasis	85 (2.7)	94 (3.0)	0.50	83 (2.9)	91 (3.1)	0.54
Peptic ulcer disease	2 (0.1)	2 (0.1)	1.00	2 (0.1)	2 (0.1)	1.00
Valvular disease	232 (7.3)	233 (7.3)	0.96	211 (7.3)	227 (7.8)	0.43
Weight loss	258 (8.1)	284 (8.9)	0.24	230 (8.0)	271 (9.4)	0.06
Insurance status						
Insured	3016 (94.8)	2982 (93.8)		2736 (94.5)	2721 (94.0)	
Other	164 (5.2)	198 (6.2)	0.07	158 (5.5)	173 (6.0)	0.40
Patient Disposition						
Routine	1352 (42.5)	1374 (43.2)		1217 (42.0)	1237 (42.7)	
Non-routine	1828 (57.5)	1806 (56.8)	0.58	1677 (58.0)	1657 (57.3)	0.59
Hospital Bedsize						
Medium	1207 (38.0)	1153 (36.3)		1079 (37.3)	1060 (36.6)	
Large	1973 (62.0)	2027 (63.7)	0.16	1815 (62.7))	1834 (63.4)	0.60
Hospital urban-rural designation						
Large metropolitan	1852 (58.2)	1918 (60.3)		1705 (58.9)	1747 (60.4)	
Small metropolitan	1328 (41.8)	1262 (39.7)	0.09	1189 (41.1)	1147 (39.6)	0.26
Teaching status						
Non-teaching	1190 (37.4)	1154 (36.3)		1064 (36.8)	1050 (36.3)	
Teaching	1990 (62.6)	2026 (63.7)	0.35	1830 (63.2)	1844 (63.7)	0.70
Hospital Ownership						
Non-private	388 (12.2)	385 (12.1)		342 (11.8)	354 (12.2)	
Private	2792 (87.8)	2795 (87.9)	0.91	2552 (88.2)	2540 (87.8)	0.63
Index cost						
≤$13,000	1609 (50.6)	1693 (53.2)		1464 (50.6)	1536 (53.1)	
>$13,000	1571 (49.4)	1487 (46.8)	0.04	1430 (49.4)	1358 (46.9)	0.06
Total cost						
≤$13,000	1503 (47.3)	1468 (46.2)		1330 (46.0)	1182 (40.8)	
>$13,000	1677 (52.7)	1712 (53.8)	0.38	1564 (54.0)	1712 (59.2)	<.0001
30-day readmission						
No	2855 (89.8)	2539 (79.8)		2466 (85.2)	1938 (67.0)	
Yes	325 (10.2)	641 (20.2)	<.0001	428 (14.8)	956 (33.0)	<.0001
Length of index stay, days, median (IQR)	5 (3–8)	6 (4–9)	<.0001	5 (3–8)	6 (4–9)	<.0001
Total length of stay, days, median (IQR)	5 (3–8)	6 (4–11)	<.0001	5 (3–9)	7 (4–13)	<.0001

Table 2 (*continued*)

Characteristics	30-Day Matched Data	60-Day Matched Data
		(*continued on next page*)
Index cost, dollars, median (IQR)	13,345 (9681–18,862)	12,839 (8475–20,782)

Table 3
Multivariable conditional logistic regression for readmission after PC, 30- and 60-day.

30-Day Readmission	OR[a] (95%CI)	P-Value
Laparoscopic	Ref	
Percutaneous	2.2 (1.9–2.5)	<0.0001
Length of Stay > 5 days		
Laparoscopic	Ref	
Percutaneous	1.7 (1.5–1.9)	<0.0001
Index Cost > $13,000		
Laparoscopic	Ref	
Percutaneous	0.9 (0.77–0.96)	0.007
Total Cost > $13,000		
Laparoscopic	Ref	
Percutaneous	1.0 (0.9–1.1)	0.54
60-Day Readmission	**OR[b] (95%CI)**	**P-Value**
Laparoscopic	Ref	
Percutaneous	3.0 (2.6–3.5)	<0.0001
Length of Stay > 5 days		
Laparoscopic	Ref	
Percutaneous	1.9 (1.6–2.1)	<0.0001
Index Cost > $13,000		
Laparoscopic	Ref	
Percutaneous	0.9 (0.78–0.98)	0.02
Total Cost > $13,000		
Laparoscopic	Ref	
Percutaneous	1.3 (1.1–1.4)	<0.0001

[a] Multivariable logistic regression controlling for age and hypertension status.
[b] Multivariable logistic regression controlling for age and hypertension status.

greater than $13,000 on both 30-day and 60-day analysis. Contrasting this, PC patients have significantly increased risk to incur 60-day total hospital costs greater than $13,000 compared to those patients undergoing LC (OR 1.3 (95%CI 1.1–1.4, $p < 0.0001$)). Table 4 demonstrates primary readmission diagnosis codes for patients readmitted within 30- or 60-days after PC or LC, the majority of which are related to acute cholecystitis for all subgroups.

Discussion

PC has increased in frequency over the last 20 years without evidence-based guidelines for patient selection.[5,12,16,25] Recognizing the true readmission rate and healthcare cost associated with percutaneous management of acute cholecystitis is particularly relevant as more data emerges supporting laparoscopic cholecystectomy as the preferred primary mode of treatment for acute cholecystitis. It is important to consider that patients undergoing uncomplicated LC require no additional therapy whereas patients with PC may still need an interval cholecystectomy. Selection of patients where PC is considered definitive therapy is difficult and debated.[26] Recurrent cholecystitis in those who undergo PC may be common, ranging from 11 to 41%.[16,27–31] Available data suggests that interval cholecystectomy occurs in approximately 30–40% of patients,[12,16,32] although nationally representative data assessing this is lacking.

Readmissions

This study uniquely tracks a propensity score matched sample of patients to compare PC to LC for acute cholecystitis. Previously, readmission rate was uncertain given the inability to track patients who do not present at the index hospital. Anderson et al.[17] noted increased length of stay, higher mortality, and higher total costs with PC compared to patients undergoing cholecystectomy in the Nationwide Inpatient Sample. Due to the structure of this data, readmissions cannot be tracked. Our results corroborate previous, single centered studies regarding the high readmission rate among patients undergoing PC.[16,27,28,33,34] Readmissions may be scheduled

Table 4
10 most frequent readmission diagnoses after laparoscopic cholecystectomy and percutaneous cholecystostomy at 30- and 60-days.

Laparoscopic Cholecystectomy	Percutaneous Cholecystostomy
30-day Readmission Primary Diagnosis	30-day Readmission Primary Diagnosis
Calculus of gallbladder with acute cholecystitis, without obstruction	Mechanical complication due to implant/internal device, not elsewhere classified
Acute cholecystitis	Other digestive system complications
Calculus of gallbladder with other cholecystitis, without obstruction	Other postoperative infection
Acute and chronic cholecystitis	Hearing loss
Calculus of gallbladder with acute cholecystitis, with obstruction	Calculus of gallbladder with acute cholecystitis, without mention of obstruction
Chronic cholecystitis	Acute cholecystitis
Sprains and strains of ankle and foot	Hematoma complicating a procedure
Mastoiditis and related conditions	Disorders of external ear
Diabetes with ketoacidosis, type I, uncontrolled	Chronic serous otitis media
Calculus of gallbladder and bile duct with other cholecystitis, without obstruction	Perforation of tympanic membrane
60-day Readmission Primary Diagnosis	**60-day Readmission Primary Diagnosis**
Calculus of gallbladder with acute cholecystitis, without obstruction	Mechanical complication due to implant/internal device, not elsewhere classified
Calculus of gallbladder with other cholecystitis, without obstruction	Calculus of gallbladder with acute cholecystitis, without mention of obstruction
Acute cholecystitis	Other digestive system complications
Acute and chronic cholecystitis	Other postoperative infection
Cholecystitis, unspecified	Acute cholecystitis
Chronic cholecystitis	Hearing loss
Calculus of gallbladder with acute cholecystitis, with obstruction	Hematoma complicating a procedure
Sprains and strains of ankle and foot	Cholecystitis, unspecified
Mastoiditis and related conditions	Disorders of external ear
Unspecified disorder of tympanic membrane	Chronic serous otitis media

or unplanned, and may be due to underlying comorbidities, tube related complications, or planned cholecystectomy for patients who have recovered enough to tolerate surgical intervention. Exact rates of complications after PC are unknown, though are thought to be between 3 and 11%.[29,35,36] Although we report readmission rate, this only reflects inpatient admissions, and may miss additional healthcare contacts for outpatient tube management. Similarly, we are limited by the primary diagnosis code for readmissions and whether or not it is related to the antecedent procedure. We are likely underestimating the true incidence of patient-provider contact, and consequently, the cost of these encounters.

Cost

Cost containment has been an increasing area of focus for Centers for Medicare and Medicaid as readmissions are costly.[37] Previous assessments of cost have suggested PC is cheaper compared to LC,[38] though they have not done so in a national database assessing all payers, including the uninsured. This study demonstrates that the index cost for PC is cheaper. However, these data only reflect the index admission. Intuitively patients who do not require a surgical procedure at the time of index admission will have lower costs than those who undergo operative intervention. Several small studies and one evaluating CMS data suggested that readmission rates after PC are widely ranging from 20 to 40%,[12,28,34] though single centered analysis and selection bias based on payer status limits the generalizability of these studies. Comparatively, studies assessing readmission rate after laparoscopic cholecystectomy show much lower rates ranging from 2.2 to 6.6%, though these studies suffer from similar limitations.[38–40] Again these variances are likely reflective of the definitive nature of cholecystectomy for the management of acute cholecystitis, while those patients who undergo PC will ultimately require further intervention, if feasible given their underlying comorbidities.

This review is subject to those limitations of large, retrospective national databases, including treatment and selection bias. Additionally, we have limited outcomes data for specific patients and are unable to evaluate outcomes based on detailed patient or provider characteristics. Despite propensity matching for available patient and hospital characteristics, there may be unmeasured patient characteristics that play a role in the outcomes evaluated. In addition, the presence or absence of a comorbidity does not account for disease severity – propensity matching using a comorbidity scale such as the Charlson Comorbidity Index may have allowed for better matching, though matching on individual comorbidities may yield similar results.[41] In addition, we are unable to account for clinical encounters that do not result in admission given that the database is an inpatient sample only. Some patients who were readmitted for their interval cholecystectomy would be included in the database; however, those who had an elective interval cholecystectomy or did not have any interval cholecystectomy would not be included in this data. Given these limitations, we did not pursue interval cholecystectomy outcome analysis. Patients were selected via *ICD- 9* procedure and diagnosis codes and thus our analysis depends on the fortitude of these codes. Acalculous cholecystitis, while it can be distinguished from calculous cholecystitis based on *ICD-9* diagnosis codes, demonstrates similar rates of readmission after PC (unpublished data) and did not change our primary outcomes.

Conclusions

This study demonstrates that patients with acute cholecystitis who undergo PC are at increased risk for readmission at both 30- and 60-days following index, have longer total hospital stays, and have greater total hospital costs at both 30-day and 60-day periods when compared to LC. Readmission and cost information should be considered when deciding between LC and PC. These data suggest that laparoscopic cholecystectomy should be utilized whenever possible in patients with acute cholecystitis. Randomized trials are urgently needed to assist clinicians in determining appropriate utilization of PC.

Short summary

Little is known about the cost of percutaneous cholecystostomy (PC) relative to laparoscopic cholecystectomy (LC) for patients with acute cholecystitis. We performed a propensity matched analysis of patients to evaluate readmission risk, length of stay, and index and total hospital costs at 30 and 60 days. PC patients had higher rates of readmission, longer index hospitalizations, and increased costs at 30- and 60-days compared to LC patients.

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