

ORIGINAL RESEARCH

General Medicine

Patients with complicated gallstone disease in the emergency department: clinical impact and cost-effectiveness of emergency department disposition decision

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Abstract

Objective: The objective of this study was to assess the 1-year outcomes of emergency department (ED) patients with complicated gallstone disease, including surgery rates, initial admission rates, ED revisits, repeat hospitalizations, and cost.

Methods: Using 3 linked statewide databases from the Maryland Healthcare Cost and Utilization Project, we identified patients with a primary diagnosis of complicated gallstone disease treated in an ED between 2016 and 2018. We measured the health-care use and direct costs in the ambulatory surgery, inpatient, and ED settings for 1 year after the initial ED visit. Finally, we performed a multivariate logistic regression analysis comparing initially admitted versus discharged patients.

Results: Of the 8751 patients analyzed, 86.8% were admitted to the hospital and 13.2% were discharged on their initial ED visit. Of the admitted patients, 78.7% received a cholecystectomy during the initial hospitalization plus 6.1% at a later date; of the discharged patients, 41.5% received a cholecystectomy. Admitted patients demonstrated lower recurrent gallbladder complications compared with those discharged (7.5% vs 44.5%), fewer ED revisits (4% vs 20.3%), and fewer repeat hospitalizations (4.5% vs 16.7%). Despite this, the 1-year cost in the admitted patients was higher (\$9448 vs \$2933). Obesity, age, and mood disorders but not race, ethnicity, or zip code were associated with admission at initial ED visit.

Conclusions: In our single-state analysis of ED patients with complications of gallstone disease, most patients are admitted on the initial visit and receive a cholecystectomy during that hospitalization. The discharged group had higher rates of 1-year complications, ED revisits, and repeat hospitalizations but lower cost.

KEYWORDS

Acute cholecystitis, Biliary Colic, Biliary disease, Choecystectomy, Emergency Department, Gallstones, HCUP

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1 | INTRODUCTION

1.1 | Background

Complicated gallstone disease, including such entities as acute cholecystitis, cholangitis, or pancreatitis, are common presentations in the emergency department (ED), representing $\approx 200,000$ ED visits in the United States annually.¹ Surgical interventions, most commonly laparoscopic cholecystectomy, are recommended for most cases of complicated gallstone disease.² Cholecystectomy is the most common general surgical procedure in the United States. If a patient does not receive a cholecystectomy at the initial visit, the patient may be referred to follow-up with a physician for a scheduled cholecystectomy at a later date.

1.2 | Importance

A better understanding of the outcomes associated with the initial ED management of patients with complicated gallstone disease is crucial to making informed decisions regarding this common and serious condition.

1.3 | Goals of this investigation

The goals of this study are to determine the 1-year direct costs and clinical outcomes of ED patients with complications of gallbladder disease. In addition, we aim to compare risk factors, direct costs, clinical outcomes, and characteristics of those patients initially admitted to the hospital versus those who are discharged.

2 | METHODS

2.1 | Study design and setting

This study was a retrospective observational study using linked administrative data sets. Patient records were obtained from the state of Maryland's linked databases collected by the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP) between the years 2016 and 2018.¹ These data sets contain a census of all hospital and ambulatory surgery visits in the state for the years listed. Deterministic linkage was performed by the database provider and represented 100% of patients seen in the ED and inpatient and ambulatory surgery settings in the state. The linked databases included the State Emergency Department Database (SEDD), the State Ambulatory Surgery Database (SASD), and the State Inpatient Database (SID). The SEDD contains records of ED visits that did not result in an inpatient floor admission, the SASD contains records of visits to ambulatory surgery centers, and the SID contains records of patients who were admitted to the hospital. All 3 data sets contain demographic information, diagnoses (International Classification of Diseases, Tenth

The Bottom Line

An analysis of a Maryland State database showed that most patients who had complicated gallstone disease were admitted and received a cholecystectomy after their first emergency department visit. However, patients who were discharged from the emergency department had higher rates of 1-year complications, revisits, and repeat hospitalizations but at a lower overall financial cost.

Revision, Clinical Modification codes), procedures performed (Current Procedural Terminology [CPT]/International Classification of Diseases, Tenth Revision, Procedure Coding System codes), length of stay, and the year and quarter of the visit. A unique patient identifier was used to link charts across databases. This study was institutional review board exempt because the data sets did not include personally identifiable health information.

2.2 | Selection of participants

We identified patients with complications of gallstone disease defined by International Classification of Diseases, Tenth Revision (ICD-10) codes K80.0, K80.1, K80.3, K80.4, K80.6, K81, K85.1, and K82.A (corresponding to acute cholecystitis, cholangitis, or biliary pancreatitis) in the SEDD and SID. We excluded patients who died either during the initial visit or as a result of causes unrelated to gallstone disease. We also excluded patients with missing cost or charge data. Finally, we excluded patients whose initial visit occurred within the first recorded 6 months of the data set because of the higher possibility that these visits represented an ED revisit from a recent prior visit in 2015. (Justification for this exclusion was based on the finding that >90% of revisits occurred within the first 3 months after initial visit.) The surgical procedure cholecystectomy was identified using the CPT codes 47562, 47563, 47564, 47600, 47605, 47610, 47612, and 47620. Comorbidities were identified using categorical code definitions and ICD-10 codes (complete list is available in Appendix 1).

2.3 | Measurements and outcomes

The primary goal of our analysis was to assess the 1-year clinical outcomes—specifically, surgery rates, ED revisits, subsequent hospitalizations, and costs—in ED patients who presented with complications of gallstone disease. The percent revisit rate represents the number of revisits per 100 patients. To construct outcomes related to cost, HCUP charge-cost ratio files were used to calculate SID costs, whereas Medicare relative value unit files were used to calculate SEDD and SASD costs. All costs were summed together and analyzed as a single outcome. In addition, costs were inflation-adjusted and presented in 2018

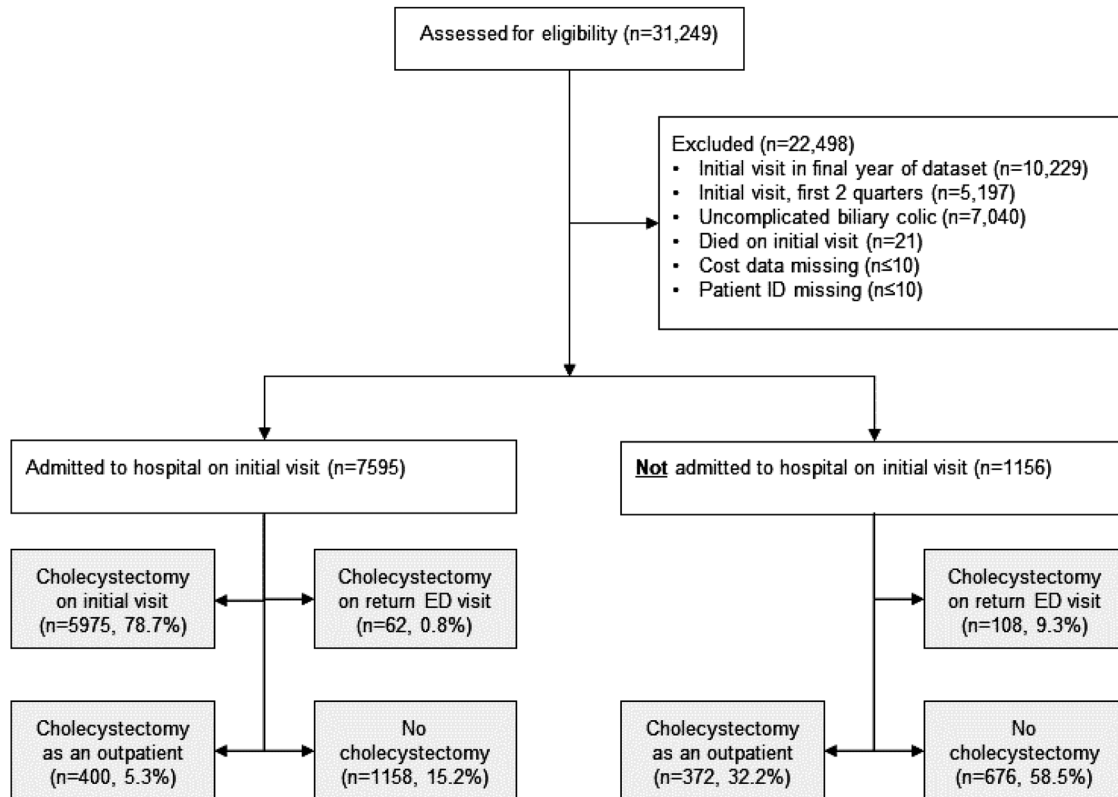


FIGURE 1 Study flow diagram. ED, emergency department; ID, identifier

values. Cost outcomes did not reflect patient out-of-pocket expenses because those were not present in the data set.

We compared patients who were initially hospitalized with those who were initially discharged from the ED using a logistic regression to better understand the associated characteristics.³⁻⁵ Variables for the logistic regression were selected by clinician investigators based on expert opinion, literature search, and feasibility (Appendix 1). We include a continuous variable for the patient's age and Charlson Comorbidity Index; categorical variables for the patient's race and ethnicity, sex, and insurance status; and a binary variable for the remainder of variables in Appendix 1. Separate subgroup analyses were performed for all discharged patients to compare those who received surgery at 1 year versus those who did not receive surgery at 1 year. *P* value cutoff for all logistic regression analyses was 0.05.

3 | RESULTS

3.1 | Characteristics of study patients

Of the total cohort, the mean age was 54 years. White patients accounted for 57.9% and African American or Hispanic patients accounted for 35.2%. Female patients accounted for 62.2%, and married, 48.8%; Medicaid insurance, 21.4%; Medicare insurance, 30.6%; private insurance, 40.8%; and uninsured, 5.0% (with the rest missing or self-pay). Patients had multiple comorbidities, including diabetes mel-

litus (19.4%), hyperlipidemia (29.1%), obesity (25.3%), hypertension (49.2%), ischemic heart disease (13.0%), and mood disorder (18.9%).

3.2 | Main results

Of the 8751 patients analyzed in this study, 86.8% ($n = 7595$) were admitted to the hospital and 13.2% ($n = 1156$) were discharged on their initial visit (Figure 1). Of the 7595 patients admitted, 5975 (78.7%) received a cholecystectomy during that initial hospitalization, 62 (0.8%) returned to the ED within 1 year after discharge to receive an emergency cholecystectomy, 400 (5.3%) underwent interval cholecystectomy after discharge, and 1158 (15.2%) did not receive a cholecystectomy within 1 year. Of the 1156 patients discharged at their initial visit, 108 (9.3%) returned to the ED within 1 year for emergency cholecystectomy, 372 (32.2%) underwent interval cholecystectomy after discharge, and 676 (58.5%) did not receive cholecystectomy within 1 year (Table 1).

Patients discharged on their initial visit had higher rates of subsequent repeat ED visits for acute cholecystitis or gallstone pancreatitis within 1 year than the admitted patients (44.5% vs 7.5%; $P < 0.0001$). They also had lower death rates (0.9% vs 1.6%; $P = 0.0163$). Discharged patients were more likely to return to the ED than admitted patients (20.3% vs 4.0%; $P < 0.0001$) and had more repeat hospitalizations (16.7% vs 4.5%; $P < 0.0001$). Despite this, the cost was significantly higher if patients were admitted on the initial visit rather than

TABLE 1 Baseline characteristics of admitted versus discharged patients

	Admitted at initial visit	Discharged at initial visit	P value ^a
Total	7595 (86.8%)	1156 (13.2%)	
Age, mean years	54.0 (53.6, 54.5)	47.2 (46.2, 48.3)	<0.001
Pediatric, aged <18 years	0.7% (0.5%, 0.9%), 53.0	1.6% (0.8%, 2.3%), 18.0	0.02
White	57.9% (56.8%, 59.0%), 4397.0	52.3% (49.5%, 55.2%), 605.0	<0.001
African American/Hispanic	35.2% (34.2%, 36.3%), 2676.0	39.7% (36.9%, 42.5%), 459.0	0.004
Female	62.2% (61.1%, 63.3%), 4726.0	65.5% (62.7%, 68.2%), 757.0	0.03
Married	48.8% (47.7%, 49.9%), 3706.0	46.0% (43.1%, 48.9%), 532.0	0.08
Medicaid	21.1% (20.1%, 22.0%), 1599.0	23.4% (21.0%, 25.9%), 271.0	0.07
Medicare	32.4% (31.4%, 33.5%), 2461.0	18.8% (16.5%, 21.0%), 217.0	<0.001
Private Insurance	40.0% (38.9%, 41.1%), 3039.0	46.1% (43.2%, 49.0%), 533.0	<0.001
Uninsured	4.4% (4.0%, 4.9%), 336.0	8.6% (6.9%, 10.2%), 99.0	<0.001
Zip code income, mean quartile	3.2 (3.2, 3.2)	3.2 (3.2, 3.3)	0.91
Charlson Comorbidity Index, mean	0.6 (0.6, 0.6)	0.5 (0.5, 0.5)	<0.001
Diabetes mellitus	19.4% (18.5%, 20.3%), 1471.0	12.5% (10.6%, 14.4%), 144.0	<0.001
Hyperlipidemia	29.1% (28.0%, 30.1%), 2207.0	16.7% (14.5%, 18.8%), 193.0	<0.001
Obesity	25.3% (24.4%, 26.3%), 1925.0	15.7% (13.6%, 17.8%), 181.0	<0.001
Hypertension	49.2% (48.0%, 50.3%), 3733.0	36.0% (33.2%, 38.8%), 416.0	<0.001
Ischemic heart disease	13.0% (12.3%, 13.8%), 989.0	6.3% (4.9%, 7.7%), 73.0	<0.001
Mood disorders	18.9% (18.0%, 19.8%), 1435.0	13.5% (11.5%, 15.5%), 156.0	<0.001
Aspirin	10.9% (10.2%, 11.6%), 828.0	5.3% (4.0%, 6.6%), 61.0	<0.001
Nicotine dependence	32.7% (31.7%, 33.8%), 2486.0	31.1% (28.5%, 33.8%), 360.0	0.28
Alcohol-related disorders	2.8% (2.5%, 3.2%), 215.0	1.1% (0.5%, 1.7%), 13.0	<0.001

Note: Data are provided as N (%); mean (95% CI); or % (95% CI), n.

Abbreviation: CI, confidence interval.

^aCalculated using a univariate Welch's t-test.

discharged (\$9448 vs \$2933; $P < 0.0001$) (Table 2). Specifically, when analyzed at every level of surgical management, admission on the initial visit increased costs at least 2.5 times ($P < 0.0001$) (Table 3).

A multivariable logistic regression was performed to identify the risk factors of admission (Table 4A) and to determine which discharged patients were more likely to obtain cholecystectomy within 1 year (Table 4B). Discharge on initial visit was negatively associated with obesity (odds ratio [OR] = 0.76; 95% confidence interval [CI]: 0.72, 0.81), age (OR = 0.72; 95% CI: 0.64, 0.80), and mood disorders (OR = 0.90; 95% CI: 0.85, 0.94). Immediate cholecystectomy after initial admission was positively associated with obesity (OR = 1.23; 95% CI: 1.18, 1.27) and negatively associated with ischemic heart disease (OR = 0.88; 95% CI: 0.83, 0.92), Charlson Comorbidity Index (OR = 0.88; 95% CI: 0.82, 0.93), and alcohol-related disorders (OR = 0.92; 95% CI: 0.87, 0.96). There was no association between either admission or postdischarge cholecystectomy and race, sex, or insurance status.

3.3 | Limitations

This study analyzed data from a single state over 3 years and thus could be limited by the short duration of follow-up and lack of prospective validation of the presented results. It is possible that patients

followed up across state lines, and we were not able to capture that data. Because the study analyzed billing and administrative data, it is limited by the nature of such data, including possible issues of data integrity, lack of clinical context, inconsistencies in documentation between facilities, and so on. Both of these points may reduce the external validity of the results presented. Our results can only be interpreted as associations and not causations. There might be unobserved patient characteristics that explain the differences across the groups. For example, other factors that are unavailable in our data set could underly a cost differential besides admission itself, including the overall medical complexity of patients who required admission or immediate surgery, psychosocial considerations influencing physicians' confidence in outpatient follow-up, and patients' individual preferences in their care.

4 | DISCUSSION

Consistent with established guidelines, the vast majority of patients with complications of biliary stone disease get admitted to the hospital. Once admitted, most patients also receive a cholecystectomy during the initial visit, and we observed very few returns (<1%) to the ED within 1 year after hospital admission. If a patient with complications of

TABLE 2 Multivariable logistic regression: multivariate predictors of (A) discharge versus admission at the initial visit and (B) immediate cholecystectomy (n = 5975) versus non-surgical management at the initial visit (n = 1620) in the subgroup of admitted patients (n = 7595)^a

(A)		
Characteristics of patients with complications of gallbladder disease who presented to ED in Maryland, 2016–2017	Odds ratio of discharge (95% CI)	P value
Obesity	0.76 (0.72, 0.81)	<0.001
Age	0.72 (0.64, 0.8)	<0.001
Mood disorders	0.9 (0.85, 0.94)	<0.001
Alcohol-related disorders	0.93 (0.88, 0.97)	<0.001
Hyperlipidemia	0.93 (0.88, 0.98)	0.006
(B)		
Characteristics of admitted patients	Odds ratio of cholecystectomy (95% CI)	P value
Obesity	1.23 (1.18, 1.27)	<0.001
Ischemic heart disease	0.88 (0.83, 0.92)	<0.0
Charlson Comorbidity Index	0.88 (0.82, 0.93)	<0.001
Alcohol-related disorders	0.92 (0.87, 0.96)	<0.001
Zip code income	1.09 (1.04, 1.14)	<0.001
Age	0.92 (0.84, 1.0)	0.0495

Abbreviations: CI, confidence interval; ED, emergency department.

gallstone disease is discharged, there is about a 10% chance of returning to the ED for an emergency cholecystectomy within a year. Overall, ≈60% of discharged patients do not receive a cholecystectomy at 1 year versus ≈15% of the admitted patients. The groups differed significantly by obesity, mood disorders, and advanced age, suggesting a generally sicker cohort in the admitted group. We found no association between race, sex, and income zip code with either admission or interval cholecystectomy.

Regarding comorbidities, obesity was associated with both initial admission and cholecystectomy. Although obesity is a well-established risk factor for gallstone disease,⁶ it is unknown if obesity directly increases the likelihood of a more severe disease course. Some data even suggest a negative association between body mass index

and inflammatory severity of acute cholecystitis, presenting a challenge to the clinical correlation between obesity and more aggressive treatment.⁷ However, as a component of metabolic syndrome, obesity plays a known role in immune dysfunction, infection susceptibility, and development of sepsis, placing patients with complicated gallstone disease who are obese at higher risk of significant morbidity and mortality without prompt treatment.⁸

Other studies have found that underlying factors such as obesity, male sex, cardiovascular disease, diabetes mellitus, and cerebrovascular accidents increase the risk of complications of gallstone disease.^{9,10} Although our analysis found congruent results regarding obesity, we demonstrated a negative correlation between ischemic heart disease and immediate cholecystectomy likely attributed to the risk posed by surgery for patients with ischemic heart disease and the necessity of preoperative testing and risk-reduction strategies.¹¹

Our analysis suggests that hospital admission itself comprises a significant component of direct 1-year costs in the treatment of complications of gallstone disease, regardless of operative status (Table 3). Interestingly, 1-year costs were comparable between admitted patients who received immediate cholecystectomy and those who never underwent the operation (\$9128.7 vs \$9409.9), also suggesting that admission itself produces most of the cost. If a patient was initially admitted, immediate cholecystectomy was the least costly option for the patient due to reduced repeat ED visits and decreased need for repeat hospitalizations. Patients who did not receive a cholecystectomy after the initial admission were more likely to receive a repeat admission for cholecystectomy, which was associated with increased 1-year costs by >2.5 times (\$9128 vs \$25,034). Importantly, the overall cost associated with admission may be confounded by the increased medical complexity and therefore increased level of care required within the admitted cohort.

Although hospital admission is a known driver of medical costs, we initially surmised that admission at the initial visit may lead to cumulative savings due to a reduced risk of future costs such as ED revisits and additional complications. Ultimately, we observed increased costs for initially admitted patients despite observing increased repeat visits and increased subsequent surgeries in the discharged group. Elective ambulatory surgical operations incur lower costs than urgent or emergent inpatient surgical operations due to staffing requirements, facility charges, and reimbursement rates. This research underscores how delayed cholecystectomy may be a safe cost-saving option for

TABLE 3 The 1-year clinical and cost outcomes per ED disposition

	Admitted, n = 7595	Not admitted, n = 1563	P value
New cholecystitis	7.5% (6.9%, 8.0%), 566.0	44.5% (41.6%, 47.3%), 514.0	<0.001
Recurrent ED visits	4.02% (3.53%, 4.50%)	20.3% (17.4%, 23.2%)	<0.001
Repeat hospitalizations	4.53% (4.01%, 5.05%)	167.0% (14.4%, 19.0%)	<0.001
Cost	\$9447.5 (\$9247.9, \$9647.2)	\$2933.4 (\$2598.9, \$3267.8)	<0.001
Deaths	1.6% (1.3%, 1.9%), 122.0	0.9% (0.3%, 1.4%), 10.0	0.0163

Note: Data are provided as% (95% CI), n; % (95% CI); or total \$ (95% CI). Abbreviations: CI, confidence interval; ED, emergency department.

TABLE 4 Cost of admission versus cost of surgery

	Admitted	Not admitted	P value
Total	7595 (86.8%)	1156 (13.2%)	<0.001
Immediate cholecystectomy	\$9128.7 (\$8909.9, \$9347.5), 5975	N/A	
Cholecystectomy during ED revisit	\$25,034.4 (\$19,902.4, \$30,166.4), 62	\$9222.0 (\$7434.3, \$11,009.7), 108	<0.001
Delayed cholecystectomy	\$12,267.5 (\$11,247.2, \$13,287.8), 400	\$3572.7 (\$2963.1, \$4182.3), 372	<0.001
Did not obtain cholecystectomy	\$9409.9 (\$8579.2, \$9520.6), 1158	\$1576.6 (\$1274.7, \$1878.5), 676	<0.001

Note: Data are provided as N (%) or total\$ (95% CI), n.

Abbreviations: CI, confidence interval; ED, emergency department; N/A, not applicable.

both patients and healthcare systems. Further research is needed to determine in which patients delayed cholecystectomy is a safe clinical option.

In conclusion, in ED patients with complicated gallstone disease from a single state, most patients receive definitive care during the first visit as evidenced by high rates of admission and surgery and low rates of repeat visits. Patients not admitted had lower overall surgery rates but higher rates of return ED visits and subsequent hospitalizations. The total 1-year cost of care closely matches initial admission rates. Future studies should explore the risk factors associated with morbidity and mortality from gallstone complications to produce a decision-making framework for emergency physicians that can accurately identify which candidates are safe for discharge with delayed or no surgical intervention.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Michael Makutonin and Andrew C. Meltzer conceived the study. Michael Makutonin conducted the analysis. Sophia Newton and Justin Tse contributed to the study writing. Ali Moghtaderi and Yan Ma contributed statistical oversight and editing. Andrew C. Meltzer was responsible for the study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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