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Gallstone Pancreatitis in Older Patients: Are We Operating Enough?

Marc D. Trust, B.S., **Kristin M. Sheffield, Ph.D.**, **Casey A. Boyd, M.D.**, **Jaime Benarroch-Gampel, M.D.**, **Dong Zhang, Ph.D.**[*], **Courtney M. Townsend Jr., M.D.**, and **Taylor S. Riall, M.D., Ph.D.**

Department of Surgery, The University of Texas Medical Branch Galveston, TX

[*]Department of Internal Medicine, The University of Texas Medical Branch Galveston, TX

Abstract

Background—The recommended therapy for mild gallstone pancreatitis is cholecystectomy on initial hospitalization.

Methods—Using a 5% national Medicare sample (1996–2005) we evaluated adherence to current guidelines (cholecystectomy rates on initial hospitalization and the use of ERCP/sphincterotomy). We evaluated predictors of cholecystectomy, gallstone-related readmissions, and 2-year mortality.

Results—Adherence to current guidelines was low. Only 57% of 8,452 Medicare beneficiaries presenting to an acute care hospital with a first episode of mild gallstone pancreatitis had cholecystectomy on initial hospitalization. Of the patients who did not receive cholecystectomy, 55% were never evaluated by a surgeon. Likewise, only 28% of patients who did not undergo cholecystectomy had a sphincterotomy. 2-year readmission rates were higher in patients who did not undergo cholecystectomy (44% vs. 4%, P<0.0001), and 33% of these patients required cholecystectomy after discharge. In the no cholecystectomy group, ERCP prevented readmissions (HR=0.53, 95% CI 0.47–0.61) and when readmissions occurred they were less likely to be for gallstone pancreatitis in patients who had an ERCP (27.8% vs. 53.2%, P<0.0001). In a multivariate analysis, patients who were older, black, admitted to a non-surgical service, lived in certain US regions, and had specific comorbidities were less likely to undergo cholecystectomy.

Conclusions—Adherence to current recommendations for the management of mild gallstone pancreatitis is low in older patients. Our data suggest that over 40% of patients who did not undergo cholecystectomy would have benefited from early definitive therapy. Implementation of policies to increase adherence to guidelines would prevent gallstone-related morbidity and mortality in older patients.

INTRODUCTION

Gallstone obstruction is the most common cause of acute pancreatitis, accounting for 35–75% of cases.[1–4] Older patients with gallstones have a higher incidence of common bile duct stones and gallstone pancreatitis due to an age-related increase in common bile duct diameter.[5] After an initial episode, recurrent gallstone pancreatitis occurs in 25–76% of patients.[6–11] Recurrent attacks are associated with a mortality rate of 10% and a major morbidity rate of up to 40%.[12] Cholecystectomy provides the only definitive therapy,

Corresponding author: Taylor S. Riall, M.D., Ph.D., John Sealy Distinguished Chair in Clinical Research, Associate Professor, Department of Surgery, The University of Texas Medical Branch, Galveston, TX 77555-0541, Phone: 409-772-1846, Fax: 409-747-2253, tsriall@utmb.edu.

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reducing the risk of recurrent gallstone pancreatitis to almost zero.[7, 8, 10–12] In patients who are not candidates for cholecystectomy, endoscopic retrograde cholangiopancreatography (ERCP) with sphincterotomy will decrease, but not eliminate, the recurrence of gallstone pancreatitis. However, ERCP does not definitively prevent other gallstone-related problems such as acute cholecystitis.[13–19]

For patients with mild gallstone pancreatitis, current guidelines recommend early definitive therapy to prevent recurrent episodes. Formal recommendations for early cholecystectomy are endorsed by the British Society of Gastroenterology (1998),[20] the UK Working Party on Acute Pancreatitis (2005),[21] the International Association of Pancreatology (IAP, 2002),[22] the American Gastroenterological Association (AGA, 2007),[23] and the Japanese Society of Hepato-Biliary-Pancreatic Surgery (2006).[24] For mild gallstone pancreatitis, the 2002 IAP guidelines recommend: 1) cholecystectomy as soon as the patient has recovered from the acute episode, ideally during the same hospitalization, and 2) endoscopic sphincterotomy as an alternative to cholecystectomy in patients who are not fit to undergo surgery.[22]

Despite clear guidelines for early cholecystectomy, population-based studies in the U.K., Sweden, and U.S. show adherence to these guidelines in only 10 – 60% of patients.[2, 11, 25, 26] In addition, adherence to these guidelines in older patients has not been systematically studied. This study uses 5% national Medicare claims files from 1996–2005 to evaluate adherence to current guidelines. Specifically, we evaluate rates of cholecystectomy during initial hospitalization in patients with mild gallstone pancreatitis and rates of endoscopic sphincterotomy in patients who did not undergo cholecystectomy. We evaluate changes in cholecystectomy rates with introduction of various guidelines. Finally, we evaluate the subsequent gallstone-related health care trajectory of patients who did not undergo cholecystectomy to determine gallstone-related readmission rates and identify factors predicting readmission.

METHODS

The study was approved by the Institutional Review Board at the University of Texas Medical Branch at Galveston.

Data Source

The Medicare Claims Data System collects information on all services provided to Medicare beneficiaries covered under Parts A and B. The 5% national Medicare sample Research Identifiable File (RIF) includes a random sample of Medicare beneficiaries. Medicare files used for this study included the Denominator file (demographics and eligibility), the Medicare Provider Analysis and Review file (MEDPAR, includes all inpatient claims), the Physician/Supplier Standard Analytical File (includes claims from service providers, such as physicians, that are not facilities), and the Outpatient Standard Analytical File (includes claims from institutional outpatient providers such as hospital clinics). The Provider of Services (POS) file was used to obtain individual facility information for each hospital in the study.

Cohort Selection

The 5% national Medicare sample claims data were available from 1995–2007. Using claims data from 1996–2005 we identified a cohort of patients admitted to an acute care hospital with an initial episode of gallstone pancreatitis. All patients were followed two years (through 2007) after their initial hospitalization for gallstone pancreatitis. As previously described,[2] patients admitted for gallstone pancreatitis were identified in the MEDPAR files using the following criteria: 1) a primary International Classification of

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Disease-9-Clinical Modification (ICD-9-CM) discharge diagnosis code for acute pancreatitis (577.0) and a concurrent ICD-9-CM discharge diagnosis code in any position for gallstones, common duct stones, and/or acute cholecystitis (574.xx, 575.0x – 575.4x) or vice versa (primary diagnosis of gallstones and secondary diagnosis of acute pancreatitis).

After identification of individuals with the above diagnoses, the following inclusion criteria were applied: 1) patients ≥66 years of age, 2) patients admitted to acute care facilities only, 3) first hospitalization for each patient (no admissions for the same diagnoses in the year prior), 4) patients enrolled in Medicare Parts A and B without HMO for 12 months before and 24 months after initial hospitalization, and 5) patients who did not have a gallstone-related hospitalization in the year prior to the admission analyzed. We chose patients 66 and older in order to evaluate Elixhauser comorbidities in the year prior to initial hospitalization in their Medicare claims.

In an attempt to exclude patients with severe pancreatitis, patients in the hospital >14 days or in the ICU >4 days were eliminated from the cohort. 1,299 patients were excluded based on these criteria. 336 of those excluded were in the ICU >4 days and had a LOS > 14 days. 558 only met the LOS criteria and 405 only met the ICU criteria.

Statistical Analysis: Initial Hospitalization

We identified the number of patients undergoing cholecystectomy and/or ERCP during initial hospitalization. Cholecystectomy was identified using ICD-9-CM procedure codes 51.21, 51.22 (open) and 51.23 and 51.24 (laparoscopic). ERCP was identified using ICD-9-CM procedure codes 51.1x, 51.82, 51.84, 51.85 – 51.88, 51.99, 52.93, and 52.94. Time trends in the use of different procedures were evaluated using a Cochran-Armitage test for trend.

We determined admitting physician by searching the physician/supplier files for evaluation and management codes for "first encounter by an admitting physician" (99221–99223) corresponding to within 24 hours of the date of admission in the MEDPAR file. Medicare specialty codes were used to determine the admitting physician specialty. Patients admitted to a general practitioner (01), family practitioner (08), internist (11) or geriatrician (38) were classified as being admitted to a general medical service. A patient was considered to have been evaluated by a gastroenterologist if we identified an evaluation and management bill for consultation (99251–99255) by a physician with a corresponding specialty code of 10, if the patient was admitted to gastroenterologist, or if the patient underwent an ERCP. Likewise, a patient was considered to have undergone surgical evaluation if we identified an evaluation and management bill for consultation by a physician with specialty code of 02, if the patient was admitted to a surgical service, or if he/she had a cholecystectomy.

We used the Elixhauser comorbidity index to measure the effect of patient comorbidities on the receipt of cholecystectomy and subsequent healthcare trajectory. The Elixhauser index measures 30 comorbid conditions and is known to predict hospital mortality.[27] Using DRGs, the index distinguishes comorbidities from complications by considering only secondary diagnoses unrelated to the principal diagnosis. Individual Elixhauser comorbidities were used in the models to determine specific comorbidities that predicted both receipt of cholecystectomy and survival.

Summary statistics were performed for the overall cohort. Demographic and health care delivery factors were compared between patients who underwent cholecystectomy during initial hospitalization and those who did not. Chi-square tests were used to determine differences between categorical variables. Students t-tests (normally distributed continuous variables) and Wilcoxon rank sum tests (non-normally distributed) were used to compare

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differences between groups for continuous variables. For normally distributed variables, summary measures are expressed as means +/− SD and for non-normally distributed variables, summary measures are expressed as medians and range. Significance was accepted at the $P<0.05$ level. All statistical analyses were performed using SAS software, version 9.2 (Cary, N.C.).

Multivariate logistic regression was used to determine the factors that independently predicted receipt of cholecystectomy on initial hospitalization. Stepwise backwards methods were used to generate a parsimonious model and the likelihood ratio test and AIC criteria were used to determine goodness-of-fit.

Statistical Analysis: Readmissions

Gallstone-related readmissions were identified by a primary discharge diagnosis of gallstones (574.xx) or acute cholecystitis (575.0x – 575.4x) with or without a concurrent code for pancreatitis. To calculate gallstone-related readmission rates in the two years following initial hospitalization (including complications from surgery and cholecystectomy after discharge), we used a Kaplan-Meier time-to-event analysis. The analysis measures the time to readmission or subsequent cholecystectomy (whichever occurred first) to obtain cumulative gallstone-related readmission rates. In patients readmitted more than one time, the time to first readmission was analyzed. Patients who died before readmission or before subsequent cholecystectomy were censored at the time of death since they were no longer at risk for gallstone-related readmissions. However, Figures 4a and 4b show the raw readmission rates (deaths uncensored) for comparison. In the no cholecystectomy group, a multivariate Cox proportional hazards model was used to determine the effect of patient demographics, comorbidities, and receipt of ERCP/sphincterotomy on gallstone-related acute care readmissions.

Statistical Analysis: Survival

Two-year survival rates from the time of discharge were calculated using the Kaplan-Meier method. Survival rates were compared in the cholecystectomy and no cholecystectomy groups using a log-rank test. A Cox proportional hazards model was used to determine the independent effect of cholecystectomy on 2-year survival after controlling for patient demographics, Elixhauser comorbidities, and diagnosis.

RESULTS

Overall Cohort and Receipt of Cholecystectomy (Table 1)

Between 1996 and 2005, 8,452 patients were admitted to an acute care facility with a diagnosis of gallstone pancreatitis. As this is a 5% national sample, the actual number of admissions would be approximately 20 times this number (14,000 – 20,000 annual admissions). Patient demographics, number of Elixhauser comorbidities, and the distributions of admissions by hospital size (number of beds) and U.S. region are summarized in Table 1. The mean age was 78.1±7.4 years. The majority of patients were white, female, admitted emergently, admitted on a weekday, and admitted to non-teaching hospitals. The overall in-hospital mortality was 1.9%.

Of the 8,452 patients presenting with gallstone pancreatitis, 4,763 (56.6%) underwent cholecystectomy on initial hospitalization. By univariate analysis, beneficiaries in the no cholecystectomy group were more likely to be older, non-white, sicker, admitted urgently or emergently, and admitted to a teaching hospital or a hospital with <200 beds.

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Intervention with either cholecystectomy and/or ERCP was performed in 68.4% of patients. In the cholecystectomy group, the mean time from admission to cholecystectomy was 3.5±2.1 days (median = 3, range 0 – 14 days). 16.5% of these patients required an open procedure. The in-hospital mortality was lower in the cholecystectomy group (0.9% vs. 3.1%, P<0.0001), while median length of stay (LOS) was two days longer (6 vs. 4, P<0.0001) compared to the no cholecystectomy group.

Admitting Service (Table 2)

Admitting service is summarized in Table 2. The majority of patients were admitted to a non-surgical service. Although a majority (76.1%) of the overall cohort underwent surgical evaluation, only 45.3% of patients in the no cholecystectomy group were seen by a surgeon. In addition, 26.0% of patients did not receive cholecystectomy on initial presentation even after surgical evaluation, and 30.1% of patients admitted by a surgeon did not undergo cholecystectomy. Evaluation by gastroenterology was more common in the no cholecystectomy group (70.4%) compared to the cholecystectomy group (42.7%, P<0.0001).

Rates of ERCP and Intraoperative Cholangiogram (IOC) (Table 2)

In the overall cohort, 31.2% of patients underwent an ERCP/sphincterotomy on initial hospital admission. Receipt of ERCP was more common in the cholecystectomy group than in the no cholecystectomy group (33.9% vs. 27.7%, P<0.0001). In the cholecystectomy group, 74.7% underwent some biliary imaging either with ERCP or IOC. Overall, 33.9% of patients in the cholecystectomy group had an ERCP and 54.4% had an IOC. Specifically, 20.3% had ERCP only, 40.8% had IOC only, and 13.6% had both ERCP and an IOC performed. ERCP/sphincterotomy alone was performed in 27.7% of the 3,689 patients who did not undergo cholecystectomy.

Time Trends in Cholecystectomy and ERCP Use

The U.K. guidelines for early cholecystectomy for gallstone pancreatitis were published in 1998[20] and the IAP guidelines in 2002. Figure 1 shows the time trends in cholecystectomy on initial hospitalization. There was slight but steady increase in the use of cholecystectomy starting in 1996, peaking at 60% in 2001. After publication of the IAP guidelines in 2002 there was actually a downward trend in cholecystectomy rates from 2002–2005 (Figure 1).

There was no change in the use of ERCP/sphincterotomy in the overall cohort (P=0.14 for trend) or the no cholecystectomy group (P=0.86 for trend) over the time period. There was also no change in the use of cholecystectomy after ERCP over the time period.

Factors Predicting Cholecystectomy During Initial Hospitalization (Table 3)

In the multivariate logistic regression model evaluating the odds of receiving cholecystectomy, patients who were older, black, admitted to a non-surgical service, or evaluated by a gastroenterologist were less likely to have a cholecystectomy. Of the 30 Elixhauser comorbidities, patients with congestive heart failure, peripheral vascular disease, chronic lung disease, renal failure, liver failure, metastatic cancer, and electrolyte abnormalities were less likely to undergo cholecystectomy on initial hospitalization. Patients who underwent ERCP were more likely to undergo cholecystectomy.

Various hospital characteristics also influenced receipt of cholecystectomy, as patients admitted to a hospital in a smaller medical service area (<100,000 vs. >1 million) were also less likely to undergo definitive treatment. Regional variations were also noted, with beneficiaries in the Mountain West and Pacific West being more likely to receive cholecystectomy than those in the Northeast (see also Table 5 and section on regional variation). Gender and hospital teaching status did not predict cholecystectomy rates.

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Health Care Trajectory

The healthcare trajectory of patients undergoing cholecystectomy is shown in Figure 2. Of the 4,763 patients who underwent cholecystectomy on initial hospitalization, 4,718 (99.1%) were discharged alive from the hospital. After discharge, 173 patients were readmitted 297 times. Eighty-eight patients were readmitted for surgical complications, while 85 were readmitted for gallstone-related complications. For each readmission, the median LOS was 5 days (mean 7.9±10.4 days, range 1–100 days)

In comparison, of the 3,689 patients who did not receive definitive therapy (Figure 3 on initial hospitalization, 3,573 (96.8%) were discharged alive. Of these patients, 1,022 (27.7%) had undergone ERCP/sphincterotomy. After discharge, 980patients required 1,191 gallstone-related readmissions. Recurrent gallstone pancreatitis was the reason for readmission in 48.0% of patients. The median LOS was 4 days (mean 5.8±6.8 days, range 1–88 days).

Of the patients who did not undergo cholecystectomy initially, a total of 1,231 (33.4%) required a subsequent cholecystectomy; 509 patients underwent the procedure electively, while 722 patients underwent cholecystectomy during hospital readmission for gallstone-related complications. Thirty percent of the subsequent cholecystectomies required an open procedure, compared to only 16.5% of cholecystectomies performed on initial hospitalization (P<0.0001). In addition, in-hospital mortality from cholecystectomy on readmission was 2.4% compared to only 0.9% when done on initial admission (P<0.0001).

Of the 509 elective cholecystectomies, 156 (30.6%) were performed within 2 weeks, 144 (28.3%) within 14–31 days, and 209 (41.1%) 31 or more days after initial discharge. Of the 722 cholecystectomies performed during a subsequent emergent acute care readmission, 248 (34.3%) were done within 14 days, 153 (21.2%) between 14–31 days, and 321 (44.6%) 31 or more days after initial discharge. If you consider elective cholecystectomy (not requiring emergent readmission) within 2 weeks of discharge “guideline adherent” (though not on the same admission) this would increase the cholecystectomy rate from 57% to 58%. In those patients who had an ERCP but no cholecystectomy, only 25.6% required cholecystectomy compared to 38.0% of those who did not have an ERCP (P<0.0001).

Readmission Rates and Factors Predicting Readmission

The 2-year gallstone- or surgery-related readmission-free survival was 96.2% in the cholecystectomy group (3.8% 2-year readmission rate) and 56.5% in the no cholecystectomy group (43.5% 2-year readmission rate, Figure 4A, p<0.0001). In the no cholecystectomy group, gallstone pancreatitis was the reason for acute care readmission in 48% of cases, while 52% were for other gallstone-related complications such as acute cholecystitis and common bile duct stones. ERCP/sphincterotomy in patients who did not undergo cholecystectomy decreased 2-year readmission rates from 48.5% in the no ERCP group to 31.1% in the ERCP group (Figure 4B, P<0.0001). Furthermore, readmissions in patients undergoing ERCP were less likely to be for gallstone pancreatitis than in patients not undergoing ERCP (27.8% vs. 53.2%, P<0.0001).

In a Cox proportional hazards model (Table 4), patients who were older and black were less likely to require readmission. Patients admitted to a non-surgical service and patients with a history of complicated diabetes, liver disease, neurologic disorders, and weight loss were less likely to require readmission. Congestive heart failure and chronic lung disease approached significance as negative predictors of readmission. Patients who underwent ERCP/sphincterotomy were nearly 50% less likely to require readmission.

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Regional Variation in Cholecystectomy and ERCP (Table 5)

Rates of cholecystectomy and ERCP varied by U.S. region. Cholecystectomy rates on initial hospitalization ranged from 49.1% in the Northeast to 70.0% in the Mountain West (P<0.0001). Rates of ERCP varied, but inversely, with rates being somewhat higher in regions where cholecystectomy rates were lower.

Regional 2-year Kaplan-Meier readmission rates were inversely correlated with cholecystectomy rates. The Mountain West, which had the highest cholecystectomy rates, had the lowest 2-year Kaplan-Meier readmission rates for the overall cohort, and the Northeast, which had the lowest cholecystectomy rates, had the highest readmission rates (Table 5, log-rank P-value = 0.002). In-hospital mortality rates for patients undergoing cholecystectomy were similar across regions (Table 5). However, in-hospital mortality rates for patients who did not undergo cholecystectomy were higher in regions with higher cholecystectomy rates on initial hospitalization (with the exception of U.S. territories), likely reflecting patient selection.

Two-Year Survival

The two-year mortality from the time of discharge after initial hospitalization was higher in the group that did not receive cholecystectomy. The 30-day, 90-day, 1-year, and 2-year mortality rates for this group were2.7%, 5.9%, 14.2%, and 22.1%, respectively, compared to 0.7%, 2.0%, 5.7%, and 10.9%, respectively, in the cholecystectomy group (P<0.0001).

In a multivariate Cox proportional hazards model (not shown), even after controlling for patient comorbidity, those who did not receive cholecystectomy were 64% more likely than those who did have cholecystectomy to die within 2 years (HR=1.64, 95% CI=1.55–1.95). Increasing age, male gender, and increasing number of comorbidities also predicted higher 2-year mortality.

DISCUSSION

For patients with mild gallstone pancreatitis, current guidelines recommend early cholecystectomy to prevent recurrent episodes.[20–24, 28] In patients who cannot tolerate cholecystectomy, endoscopic sphincterotomy is recommended.[22] The current study uses Medicare claims data to evaluate adherence to current guidelines for the management of mild gallstone pancreatitis in older patients. Fifty-seven percent of Medicare beneficiaries presenting to an acute care hospital with a first episode of mild gallstone pancreatitis underwent cholecystectomy during the initial hospitalization. Adherence only increased to 58% if elective cholecystectomy within two weeks of the initial hospitalization was considered guideline adherent. In addition, more than half of the patients who did not receive cholecystectomy were never evaluated by a surgeon. Likewise, only 28% of patients who did not undergo cholecystectomy had an ERCP/sphincterotomy.

Failure to perform cholecystectomy was associated with gallstone-related readmissions and/or subsequent cholecystectomy in 44% of patients, and over a quarter of readmissions or subsequent cholecystectomies involved an additional emergent acute care hospitalization. In patients who do not undergo cholecystectomy, ERCP during the initial hospitalization decreases gallstone-related readmission rates and decreases the proportion of admissions due to biliary pancreatitis versus other gallstone-related complications such as acute cholecystitis. Despite this decrease, the gallstone-related readmission rates remains much higher than in patients treated definitively with cholecystectomy.

A recent U.S. population-based study using the Nationwide Inpatient Sample (NIS) data from 1998 to 2003 showed similar findings with only 51% of patients receiving

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cholecystectomy on initial hospitalization for a first episode of gallstone pancreatitis.[2] Observed cholecystectomy rates during the initial hospitalization were actually higher in Medicare beneficiaries than the reported rates from the NIS.[2] Many factors predicting lower odds of cholecystectomy were similar in the two studies including increased age, black race, region, and increasing comorbidities. In the NIS study, uninsured patients were less likely to receive cholecystectomy. This can account for the higher cholecystectomy rates observed in the Medicare patients who, by definition, are insured. Because the NIS data does not contain any unique identifying information, the subsequent gallstone-related healthcare trajectory for those who did not undergo cholecystectomy could not be studied. Furthermore, the NIS study ended in 2003 and could not adequately assess U.S. trends after introduction of the IAP guidelines in 2002.

Publication of the IAP guidelines (2002)[22] regarding cholecystectomy for mild gallstone pancreatitis had no effect on observed cholecystectomy rates, with rates actually dropping after 2001. The European experience reinforces the difficulty in implementing national guidelines. Two surveys of physician practice in the U.K. after publication of the guidelines showed continued poor adherence. Senapati et al.[26] (2003) surveyed 1086 surgeons in England and Ireland found that only 58% performed cholecystectomy during the initial admission or within 4 weeks of discharge. A 2008 study by Campbell et al.[25] showed similar findings with only 62% of surgeons in Scotland performing urgent cholecystectomy in accordance with guidelines.

A population-based study in Sweden showed similar findings with only 20% of patients undergoing cholecystectomy on initial hospitalization.[11] Readmission rates were 63% in patients who underwent sphincterotomy only and 76% in patients who had neither cholecystectomy nor sphincterotomy. The lower readmission rates in the current study compared to the Swedish study are likely a direct result of increased cholecystectomy rates. This is also confirmed by the regional analysis in the current study where readmission rates were inversely correlated with cholecystectomy rates.

There is clear selection bias in this retrospective cohort study, with healthier patients undergoing cholecystectomy. This is evidenced by the increasing number of comorbidities, the increased in-hospital mortality, and the increased 2-year mortality in the no cholecystectomy group. The study evaluates all-cause mortality. As such, the increased short- and long-term mortality reflects the increased severity of illness in the no cholecystectomy group and may indicate appropriate patient selection for non-surgical management. Likewise, lower cholecystectomy rates in patients admitted to a medical service are certainly partly attributed to the fact that patients with multiple medical problems are being admitted to non-surgical services.

Population-based data cannot be used to assess the appropriateness of treatment in any individual patient, but only in the population as a whole. Despite the inherent selection bias, the high gallstone-related readmission rates and high need for subsequent cholecystectomy demonstrate that there is a large population of elderly patients who will benefit from early cholecystectomy. Conversely, the data suggest that there is a subset of the older population who, due to major comorbidities or markedly advanced age, may never require cholecystectomy in their remaining lifetime. This study identifies specific factors associated with decreased likelihood of gallstone-related readmission including advanced age, complicated diabetes, liver disease, neurologic disorders, weight loss, congestive heart failure, and chronic lung disease. These factors should not be absolute contraindications to cholecystectomy but should be taken into account when making difficult operative decisions in older patients.

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We recognize that this study has several limitations. As this is an administrative dataset, it is difficult to identify mild versus moderate to severe pancreatitis. We eliminated patients who were in the hospital over two weeks or in the ICU more than four days in an attempt to eliminate patients with severe pancreatitis. Sandzen et al. defined severe pancreatitis as anyone with a length of stay >10 days or death in the hospital.[11] We chose not to exclude in-hospital mortalities as some may be a result of comorbidities in the setting of mild pancreatitis.

Despite controlling for Elixhauser comorbidities, this is a retrospective cohort study and subject to selection bias as previously discussed. Administrative data does not allow us to measure important factors such as frailty, medications that might have delayed surgery (aspirin, Plavix, coumadin), and performance status, nor does it allow us to evaluate who made the decision not to perform cholecystectomy.

Our cohort includes 7.6% of patients who were admitted electively. Coding for emergency admissions is accurate and defined as admissions through the emergency room. Urgent admissions are unscheduled direct admissions to the hospital, whereas elective admissions are scheduled. The patients who were admitted electively most likely had mild gallstone pancreatitis diagnosed in the outpatient setting, underwent subsequent admission for elective cholecystectomy, and had an admitting diagnosis of gallstone pancreatitis. In the multivariate analysis of factors predicting cholecystectomy, patients admitted electively were more likely to undergo cholecystectomy than those admitted emergently as would be expected in the above case. There were no differences in the likelihood of cholecystectomy in the emergent and urgent groups. We repeated the analysis without these 644 patients (N=7,808) and the results were unchanged.

The in-hospital mortality of patients who underwent cholecystectomy was similar across U.S. regions, suggesting that increasing cholecystectomy rates is safe. Moreover, the in-hospital mortality of patients who did not undergo cholecystectomy was higher in regions with higher guideline adherence, which implies that these regions are appropriately selecting patients for operative vs. non-operative management. We recently implemented a critical pathway at our institution for all patients presenting to the Emergency Department with complicated gallstone disease. The goal was to perform cholecystectomy on the index admission in all patients without an absolute contraindication. We increased our cholecystectomy rates from 57% to 79% in patients with mild gallstone pancreatitis, with no change in operative morbidity and mortality and marked decrease in gallstone-related readmissions.[29]

Data from this study have important public health implications. Currently, there is only 57% adherence to guidelines recommending cholecystectomy during initial hospitalization in older patients with mild gallstone pancreatitis. The data suggest that over 40% of patients who do not undergo cholecystectomy would benefit from early definitive therapy. It is unlikely that we will reach 100% adherence to guidelines, as some older patients will not be candidates for cholecystectomy. However, it is likely that we can safely improve cholecystectomy rates to over 70%, thereby minimizing gallstone-related readmissions and the associated morbidity. Cholecystectomy should be performed during the initial hospitalization in older patients without clear contraindications whenever possible. Implementation of pathways[29] and implementing policies that encourage surgical evaluation for all patients with gallstone pancreatitis will contribute to increased cholecystectomy rates. Some patients may not be able to undergo cholecystectomy during initial hospitalization due to use of medications such as aspirin and Plavix or comorbidities that are not adequately controlled. Such patients should undergo sphincterotomy prior to discharge and, when possible, be medically optimized for cholecystectomy within two weeks or as soon as

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possible after discharge. In patients who are not operative candidates and whose operative risk cannot be adequately minimized, ERCP and sphincterotomy alone should be performed. Implementation of policies for gastroenterology evaluation in this settings, or transfer to a facility where such treatment is available may allow us to maximize sphincterotomy rates in patients not considered surgical candidates.

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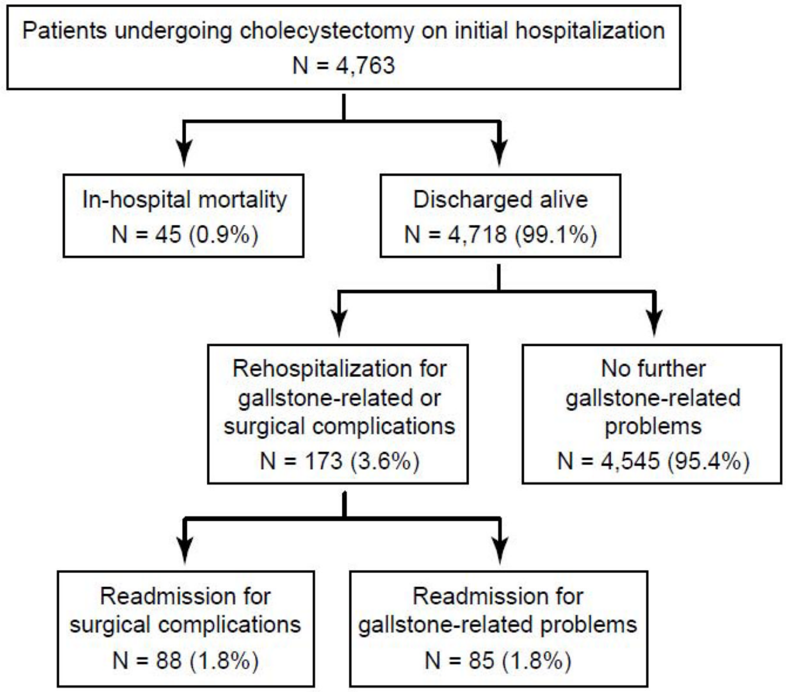

Figure 1.
Time trends in the use of cholecystectomy during initial hospitalization. The U.K guidelines were introduced in 1998 and the IAP guidelines in 2002.

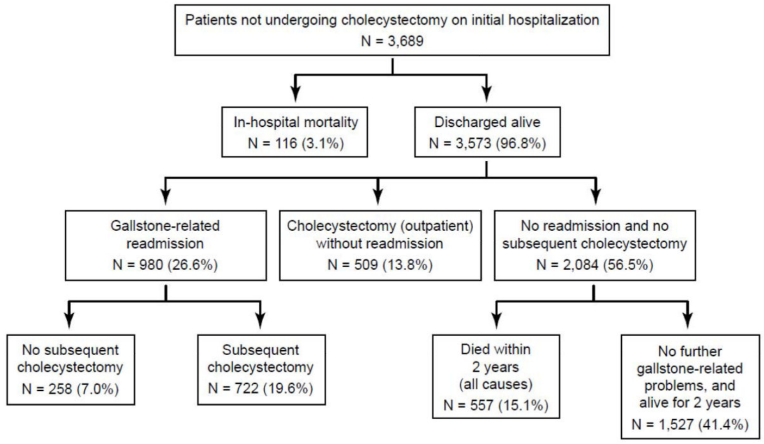

Figure 2.

Subsequent gallstone-related healthcare trajectory in patients undergoing cholecystectomy during initial hospitalization for gallstone pancreatitis.

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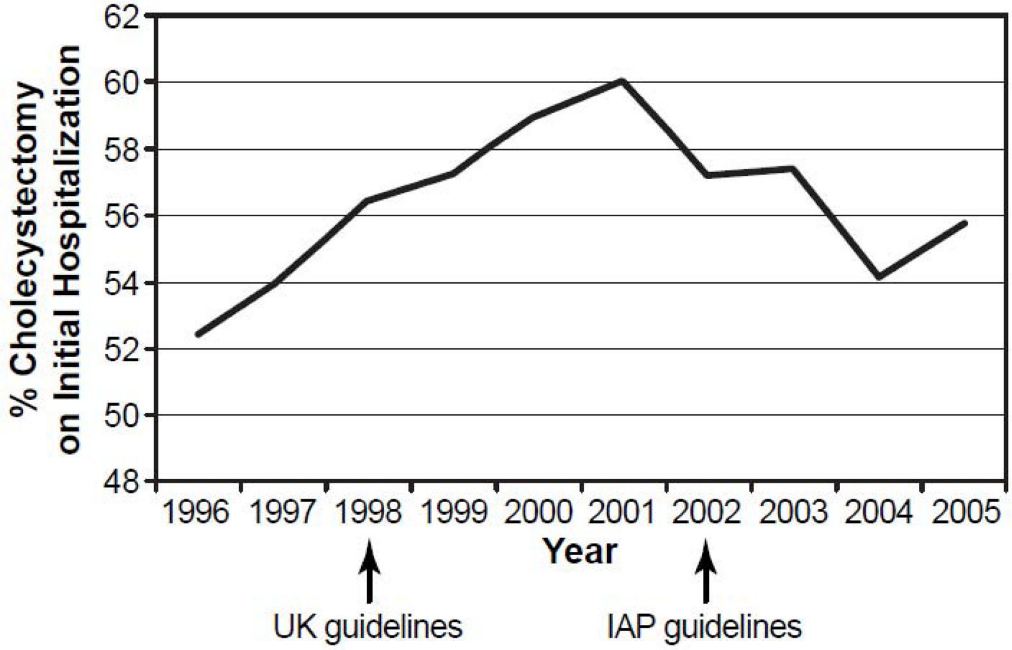

Figure 3.

Subsequent gallstone-related healthcare trajectory in patients not undergoing cholecystectomy during initial hospitalization for gallstone pancreatitis.

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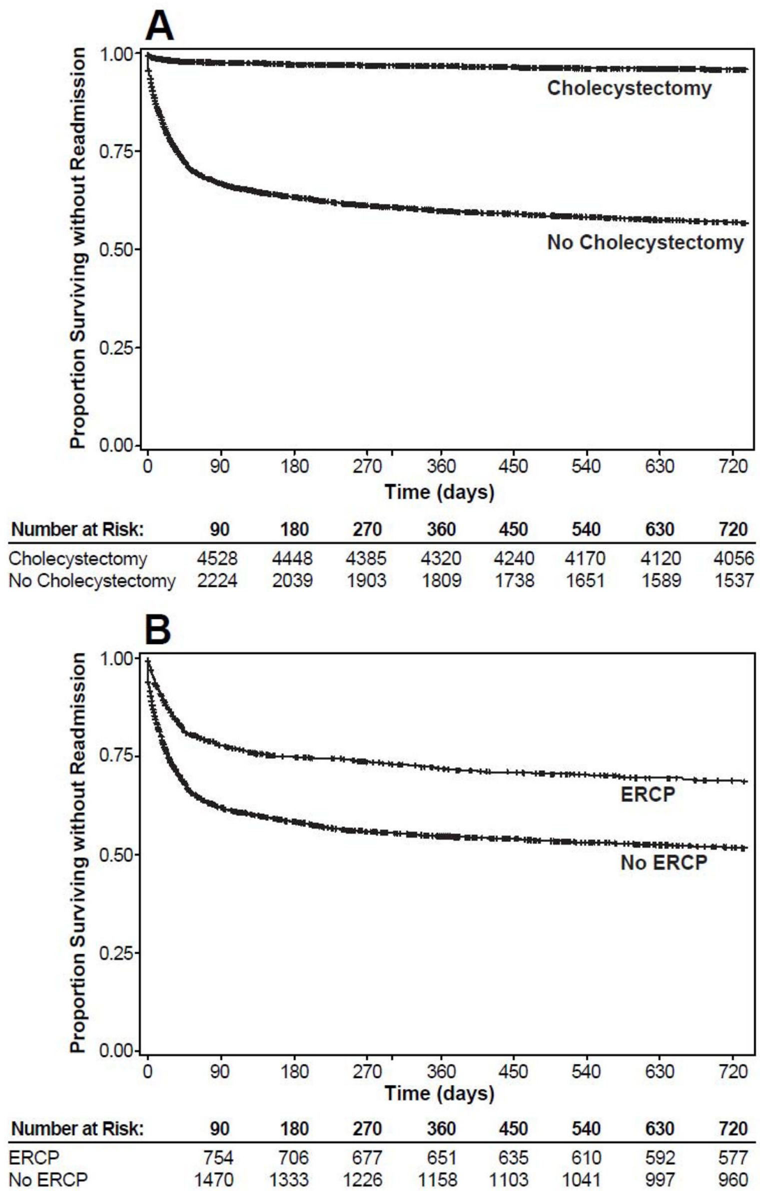

Figure 4.

Figure 4a. Kaplan-Meier readmission-free survival in patients who did and did not undergo cholecystectomy during initial hospitalization for gallstone pancreatitis. The 2-year readmission-free survival was 96.2% in the cholecystectomy group (3.8% 2-year readmission rate) and 56.5% in the no cholecystectomy group (43.5% 2-year readmission rate, $p<0.0001$).

Figure 4b. Kaplan-Meier readmission-free in patients in the no cholecystectomy group who did and did not undergo ERCP during initial hospitalization for gallstone pancreatitis. The 2-year readmission-free survival was 68.9% in the ERCP group (31.1% 2-year readmission rate) compared to 51.5% in the no ERCP group (2-year readmission rate 48.5%, $P<0.0001$).

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Table 1

Demographics, Clinical Characteristics, and Health Care Delivery Factors

	Overall Cohort N=8,452 N (%)	Cholecystectomy N=4,763 N (%)	No Cholecystectomy N=3,689 N(%)	P-value
Age (mean ± SD)	78.1 ± 7.4	77.1 ± 6.9	79.3 ± 7.9	<0.0001
Female	5,103 (60.4)	2,879 (60.5)	2,224 (60.3)	0.88
Race				
White	7,428 (87.9)	4,232 (88.9)	3,196 (86.6)	<0.0001
Black	590 (7.0)	279 (5.9)	311 (8.4)	
Other race	434 (5.1)	252 (5.3)	182 (4.9)	
Elixhauser Comorbidities				
0	2,136 (25.3)	1,302 (27.3)	834 (22.6)	<0.0001
1	2,203 (26.1)	1,335 (28.0)	868 (23.5)	
2	1,582 (18.7)	920 (19.3)	662 (18.0)	
≥3	2,531 (29.9)	1,206 (25.3)	1,325 (35.9)	
Type of Admission				
Emergent Admission	5,735 (67.9)	3,199 (67.2)	2,531 (68.6)	<0.0001
Urgent Admission	2,073 (24.5)	1,142 (24.0)	931 (25.2)	
Elective Admission	644 (7.6)	422 (8.9)	222 (6.0)	
Weekend Admission	2,349 (27.8)	1,328 (27.9)	1,021 (27.7)	0.84
Teaching Status				0.02
Major teaching hospital	1,402 (16.6)	746 (15.7)	656 (17.8)	
Minor teaching hospital	1,817 (21.5)	1,057 (22.2)	760 (20.6)	
Non-teaching hospital	5,231 (61.9)	2,959 (62.1)	2,272 (61.6)	
Hospital size				<0.0001
<200 beds	3,175 (37.6)	1,682 (35.3)	1,493 (40.5)	
200–349 beds	2,364 (28.0)	1,402 (29.4)	962 (26.1)	
350–499 beds	1,402 (16.6)	831 (17.5)	571 (15.5)	
≥500 beds	1,509 (17.9)	847 (17.8)	662 (17.9)	
Hospital type				0.12
Non-profit	6,239 (73.8)	3,487 (73.2)	2,752 (74.6)	
Profit	1,024 (12.1)	607 (12.8)	417 (11.3)	
Government	1,187 (14.1)	668 (14.0)	519 (14.1)	
US Region				<0.0001
Northeast	1,585 (18.8)	778 (16.3)	807 (21.9)	
Midwest	2,215 (26.2)	1,170 (24.6)	1,045 (28.3)	
South	3,470 (41.1)	2,105 (44.2)	1,365 (37.0)	
Mountain West	406 (4.8)	284 (6.0)	122 (3.3)	
Pacific West	696 (8.2)	381 (8.0)	315 (8.5)	
US territories	78 (0.9)	44 (0.9)	34 (0.9)	
Type Cholecystectomy				
Open	NA	784 (16.5)	NA	NA

	Overall Cohort N=8,452 N (%)	Cholecystectomy N=4,763 N (%)	No Cholecystectomy N=3,689 N(%)	P-value
Laparoscopic	NA		NA	NA
Days to cholecystectomy (median and range)	NA	3 (0–14)	NA	NA
In-hospital mortality	161 (1.9)	45 (0.9)	116 (3.1)	<0.0001
Length of stay in days (median and range)	5 (1–14)	6 (1–14)	4 (1–14)	<0.0001

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Table 2

Admitting Service, Biliary Imaging, and Cholecystotomy Tube Placement on Initial Hospitalization

	Overall Cohort N=8,452 N (%)	Cholecystectomy N= 4,763 (56.6%) N (%)	No Cholecystectomy N= 3,689 (43.4%) N (%)	P-Value
Admitting Service				
Surgery	1798 (21.3)	1256 (26.4)	542 (14.7)	<0.0001
Medicine	3890 (46.0)	2002 (42.0)	1888 (51.2)	
GI	1258 (14.9)	671 (14.1)	587 (15.9)	
Other	1506 (17.8)	834 (17.5)	672 (18.2)	
GI evaluation	4633 (54.8)	2035 (42.7)	2598 (70.4)	0.58
Surgeon evaluation	6435 (76.1)	4763 (100)	1672 (45.3)	<0.0001
Other Procedures				
ERCP	2637 (31.2)	1615 (33.9)	1022 (27.7)	<0.0001
IOC	2593 (30.7)	2593 (54.4)	NA	
Both ERCP and IOC	648 (7.7)	648 (13.6)	NA	
Cholecystostomy tube	11 (0.13)	0 (0.0)	11 (0.3)	0.0002

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Table 3

Factors predicting cholecystectomy on initial hospitalization (N = 8450)

Factor (reference group)	Odds Ratio	95% CI
Age	0.83	0.80 – 0.85
Black race (white)	0.68	0.57 – 0.82
Urgent admission (emergency)	0.94	0.85 – 1.05
Elective admission (emergency)	1.40	1.17 – 1.68
Medical service area <100,000 (>1 million)	0.84	0.74 – 0.96
ERCP at admission (no)	1.51	1.33 – 1.70
Admitting physician - medicine (surgeon)	0.48	0.43 – 0.54
Admitting physician - GI (surgeon)	0.49	0.41 – 0.58
Admitting physician – other (surgeon)	0.58	0.50 – 0.67
Gastroenterology evaluation (no)	0.77	0.68 – 0.87
Congestive heart failure (no)	0.72	0.63 – 0.83
Peripheral vascular disease (no)	0.86	0.72 – 1.00
Chronic lung disease (no)	0.84	0.74 – 0.96
Renal failure (no)	0.59	0.43 – 0.79
Liver disease (no)	0.27	0.15 – 0.48
Metastatic cancer (no)	0.49	0.29 – 0.83
Electrolyte abnormalities (no)	0.78	0.67 – 0.92
Midwest (Northeast)	1.14	0.99 – 1.30
South (Northeast)	1.63	1.43 – 1.85
Mountain West (Northeast)	2.26	1.77 – 2.89
Pacific West (Northeast)	1.26	1.05 – 1.53
U.S. Territories (Northeast)	1.37	0.85 – 2.20

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Table 4

Cox proportional hazards Model: Factors predicting readmission in patients not undergoing cholecystectomy on initial hospitalization (N = 3,689)

Factor (reference group)	Hazard Ratio	95% CI
Age (per increasing year of age)	0.96	0.95 – 0.97
Black race (white)	0.80	0.65 – 0.98
Admitting physician - medicine (surgeon)	0.76	0.65 – 0.88
Admitting physician - GI (surgeon)	0.68	0.57 – 0.82
Admitting physician – other (surgeon)	0.70	0.58 – 0.84
Complicated diabetes (no)	0.76	0.59 – 0.99
Liver disease (no)	0.54	0.30 – 0.99
Neurologic disorders (no)	0.59	0.44 – 0.79
Weight loss (no)	0.50	0.31 – 0.82
Congestive heart failure (no)	0.85	0.72 – 1.01
Chronic lung disease (no)	0.86	0.73 – 1.01
ERCP at admission (no)	0.53	0.47 – 0.61

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Table 5

Rates of cholecystectomy, ERCP and IOC on initial hospitalization by U.S. Region

	Cholecystectomy	ERCP	K-M 2-year readmission rates	In-hospital mortality (cholecystectomy group)	In-hospital mortality (no cholecystectomy group)
Mountain West	70.0%	29.6%	17.6%	1.4%	7.4%
South	60.7%	31.0%	18.7%	0.9%	3.6%
U.S. Territories	56.4%	24.4%	22.3%	2.3%	8.8%
Pacific West	54.7%	28.3%	20.7%	0.8%	1.6%
Midwest	52.8%	28.8%	22.5%	1.2%	2.6%
Northeast	49.1%	37.2%	22.8%	0.6%	2.9%
P-value	<0.0001	<0.0001	<0.0001	0.65	<0.0001