Variation in the Use of Laparoscopic Cholecystectomy for Elderly Patients With Acute Cholecystitis

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Hypothesis: There is regional variation in the use of laparoscopic cholecystectomy (LC) for acute cholecystitis in the New England (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut) Medicare population.

Design: Population-based, cross-sectional study.

Setting: Hospital service areas (HSAs), small geographic areas reflecting local hospital markets, in New England.

Patients: We identified from the claims database 21,570 Medicare patients undergoing cholecystectomy between 1995 and 1997. Patients with acute calculous cholecystitis but no bile duct stones (n = 6,156) were then identified using International Classification of Diseases, Ninth Revision diagnostic codes. To reduce variation by chance, we excluded patients residing in HSAs with fewer than 26 cases, leaving 5,014 patients in 77 HSAs.

Main Outcome Measures: For each HSA, we assessed the rate of cholecystectomies performed laparoscopically, mortality, and hospital length of stay.

Results: Overall, 53.5% of patients with acute cholecystitis underwent LC. There was wide regional variation in the rate of patients undergoing laparoscopic surgery, from 30.3% in the Salem, Mass, HSA to 75.5% in the Hyannis, Mass, HSA. Seventeen HSAs had rates below 40%, while 9 had rates above 70%. The average length of stay (7.6 days) was approximately 1 day shorter in HSAs with high rates of patients undergoing LC than in other HSAs. There was no correlation between regional use of laparoscopic surgery and 30-day mortality (3.1% overall).

Conclusions: The likelihood of elderly patients with acute cholecystitis receiving LC depends strongly on where they live. Efforts to reduce regional variation should focus on disseminating techniques for safe LC in this high-risk population.


INCE ITS introduction a decade ago, laparoscopic cholecystectomy (LC) has quickly become the most widely used treatment for gallstone disease. Among the many reasons for the rapid dissemination of this technology are (1) patients undergoing this procedure have substantially less postoperative pain and (2) patients have a shorter recovery time. Despite higher risks of bile duct injury, patients undergoing LC have fewer overall complications and lower mortality rates than patients undergoing open surgery.1-3 Its dissemination is driven by both patient demand and clinical efficacy, and LC now accounts for more than 75% of all cholecystectomies in many populations.3-4

However, in some patient subgroups, many patients continue to undergo open cholecystectomy (OC). For example, patients with acute cholecystitis are only 30% as likely to undergo LC as patients with nonacute disease.7 Other population-based studies have made similar observations.6,8,9 The low rate of patients with acute cholecystitis undergoing LC likely reflects the greater technical difficulty of performing the procedure on these patients (reflected by high rates of conversion to open surgery) or surgeons’ concerns about increased risks of bile duct injury.5,10-12 Although likely explained in part by the increased prevalence of acute cholecystitis in this group, the elderly population is also more likely to undergo OC than other patient groups.6,8,12,13

We describe a population-based study of Medicare patients undergoing surgery for acute cholecystitis in New England (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut) between 1995 and 1997. First we assess regional variation in the
**SUBJECTS AND METHODS**

**SUBJECTS AND DATABASES**

As part of our work on the Dartmouth Atlas of Health Care, we studied patients undergoing cholecystectomy using the Health Care Financing Administration’s 100% MEDPAR file. This file contains diagnosis and procedure codes from hospital discharge abstracts for all Medicare patient hospitalizations (except those of the approximately 10% of Medicare patients enrolled in risk-bearing health maintenance organizations during this time period). The study sample consisted of all hospital discharges for New England Medicare patients (aged 65-99 years) undergoing cholecystectomy between January 1, 1995, and December 31, 1997.

Figure 1 shows an overview of our study design, with inclusion and exclusion criteria. In creating the study sample, we first identified all hospital discharges for Medicare patients undergoing cholecystectomy between January 1, 1995, and December 31, 1997. We restricted the analysis to patients residing in New England hospital services areas (HSAs), discrete geographic areas reflecting local hospital markets. Most often centered around a single hospital (though frequently more hospitals in urban areas), HSAs reflect an area in which a plurality of residents receives their hospital-based care. Of the 3436 HSAs in the United States, New England contains 166, which range in size from approximately 643 (Townshend, Vt) to 75 226 (Boston, Mass) Medicare enrollees. Because HSAs are not constrained by state boundaries, several HSAs centered around hospitals located in New England contain New York State residents. A more detailed description of HSAs and methods used to create them is available elsewhere.

Hospitalizations for cholecystectomy (N = 21 570) were identified using the appropriate International Classification of Diseases, Ninth Revision (ICD-9) procedure codes (OC, 51.21-51.22; LC, 51.23-51.24). Although discharge abstracts for most hospitalizations contained 2 or more diagnostic codes for biliary tract disease, we included only those patients (n = 6 818) with at least 1 code for acute calculous cholecystitis (ICD-9 codes 574.00 and 574.01). In this way, we sought to exclude patients undergoing incidental cholecystectomy or surgery for chronic cholecystitis or acute acalculous cholecystitis. Because our primary goal was to study the use of laparoscopy for uncomplicated acute cholecystitis, we also excluded 662 hospitalizations with codes indicating bile duct stones (ICD-9 codes 574.30-574.91).

A total of 284 patients had codes for both OC and LC (n = 12) or codes for both OC and diagnostic laparoscopy (ICD-9 code 54.21) (n = 272). These cases likely represent procedures converted to open surgery. To link subsequent outcomes to the initial procedure choice, we classified these cases as LC. To test the effect of this assumption, we performed a second analysis in which these cases were classified as OC. Because this analysis produced nearly identical results, these data are not shown here.

**ANALYSIS**

Our analysis had 2 primary objectives: (1) to describe regional variation in the propensity to perform LC for acute cholecystitis and (2) to examine the relationship between propensity to perform laparoscopic surgery and patient outcomes. For the first objective, our unit of analysis was the individual HSA. Patients were assigned to HSAs according to their residence, not where they underwent surgery. Thus, a resident of New London, NH, undergoing surgery at Dartmouth-Hitchcock Medical Center in the Lebanon, NH, HSA would be assigned to the New London HSA. We used this population-based analytic approach (rather than hospital-based) to minimize confounding by differences in patient case-mix across hospitals of different types.

For each HSA, we first calculated the observed rate of LCs to total cholecystectomies. To account for potential confounding by differences in patient characteristics across HSAs, we used a multivariable logistic regression model to calculate adjusted rates. Variables considered in the model included age, sex, race (black or nonblack), comorbidity score (assessed using a claims-based version of the Charlson score), acuity of admission (elective, urgent, and emergent), and admission source (percentage through emergency department). Variables significantly associated with the likelihood of undergoing LC in the univariate analysis were included in the final multivariable model. Adjusted rates of LCs to total cholecystectomies were calculated based on observed to expected ratios predicted for each HSA by the model.

To reduce variation observed by chance alone, we do not report on 83 HSAs in which fewer than 26 Medicare patients underwent cholecystectomy during the 3-year period. For patient confidentiality reasons, we suppressed an additional 6 HSAs with sufficient total cholecystectomies but less than 11 open or 11 laparoscopic procedures.

To assess the relationship between laparoscopy use and patient outcomes, HSAs were collapsed into 5 groups for comparison. The 77 HSAs meeting minimum sample size criteria were first ranked according to their propensity to perform laparoscopic surgery. We then divided the list into 5 approximately even groups (quintiles)—3 containing 16 HSAs each, 1 with 13, and 1 with 14—each containing a similar number of patients (Figure 1).

For each HSA quintile, we assessed 2 primary outcome measures: length of stay (LOS) (both total and postoperative) and 30-day mortality. We used analysis of variance and multivariable linear regression techniques to calculate adjusted LOS for each HSA quintile and to compare means across groups. We used χ² tests and multivariable logistic regression techniques to assess differences in 30-day mortality. Independent variables considered for these models and methods used for selecting variables for the final model are described previously in this section.

propensity to perform LC for acute cholecystitis: Does a patient’s chance of receiving laparoscopic surgery depend on where he or she lives? Second, we examine the relationship between the propensity to perform laparoscopic surgery and patient outcomes: Do patients residing in regions with high rates of LC for acute cholecystitis have lower mortality rates or shorter hospital stays?
Patients Excluded: No Diagnosis of Acute Cholecystitis (n = 14,752)

Patients Excluded: Diagnosis of Bile Duct Stones (n = 862)

Patients Excluded: Patients Living in HSAs That Do Not Meet Volume Criteria (n = 1142)

Patients Living in HSAs That Meet Volume Criteria (n = 5014)

Quintile 1, 15 HSAs (With Lowest % Laparoscopic Cholecystectomies)

Quintile 2, 16 HSAs

Quintile 3, 16 HSAs

Quintile 4, 16 HSAs

Quintile 5, 14 HSAs (With Highest % Laparoscopic Cholecystectomies)

New England Medicare Patients Undergoing Cholecystectomy 1995-1997 (N = 21,570)

Diagnosis of Acute Cholecystitis (ICD-9 Code, 574.00-574.01) (n = 6818)

No Diagnosis of Bile Duct Stones (n = 6156)

Regional Variation in the Rate of Patients Undergoing Cholecystectomy for Acute Cholecystitis Receiving Laparoscopic Surgery, by State. Each mark represents 1 of 77 hospital service areas included in the analysis. Open diamonds represent hospital service areas containing medical schools; closed circles represent the remaining “nonacademic” hospital service areas.

RESULTS

REGIONAL VARIATION IN THE USE OF LC

Overall, about half (53.5%) of patients with acute cholecystitis underwent LC. However, there was marked regional variation in the use of laparoscopy, from 30.3% in the Salem, Mass, HSA to 75.5% in the Hyannis, Mass, HSA. Residents of the Salem; Norwich, Conn; Northampton, Mass; Cambridge, Mass; and Derby, Conn, HSAs were least likely to undergo LC. Residents of the Hyannis; Meriden, Conn; Attleboro, Mass; Rutland, Vt; and Concord, NH, HSAs were most likely to undergo laparoscopy. There were 17 HSAs with rates lower than 40% and 9 with rates higher than 70%. The observed variation in laparoscopy rates could not be attributed to chance alone: 21% of the HSAs had rates outside 3 SDs from the New England mean (8 above, 8 below; overall, P < .001).

Wide variation in the use of LC for acute cholecystitis was equally apparent within individual states (Figure 2). Practice styles in “academic” HSAs (those containing medical schools) did not differ substantially from nonacademic HSAs. The Burlington HSA (University of Vermont) had among the lowest rates of LC for acute cholecystitis (35.4%), while the Hartford HSA (University of Connecticut) had among the highest (71.3%). The Boston HSA had an intermediate rate (40.5%).

RELATIONSHIP BETWEEN LAPAROSCOPY RATES AND PATIENT OUTCOMES

To assess the relationship between regional laparoscopy rates and patient outcomes, we divided the HSAs into 5 groups. Quintile 1 contained HSAs with the lowest rates of LC (35% overall); quintile 5 included HSAs with highest rates (72% overall). As given in Table 1, there were no significant trends in patient age, sex, race, or comorbidities across HSA quintiles. Overall, more than 85% of patients in the study population were classified as “urgent” or “emergent.” However, there was not a significant linear trend in surgical acuity across HSA quintiles. Patients in HSAs with high laparoscopy rates (quintiles 4 and 5) were less likely to be admitted through the emergency department than patients in other HSAs (P = .03), but these differences were small (Table 1).

Overall, patients undergoing LC had lower mortality rates (1.6%) than those undergoing OC (4.8%). Lower mortality rates in patients undergoing laparoscopy was apparent within each of the HSAs quintiles (Table 2). However, regional propensity to perform LC for acute cholecystitis was not related to overall rates of surgical mortality (Figure 3). Patients in quintile 1 (HSAs with low laparoscopy rates) had overall mortality rates similar to those in quintile 5 (HSAs with high laparoscopy rates). Although fewer patients in quintile 5 received OCs, mortalities in this selected group were high (6.6%), effectively offsetting the lower mortality rates achieved with the higher number of patients undergoing LC.

Overall, total and postoperative LOS was 7.6 and 5.5 days, respectively. Patients undergoing LC had shorter total LOS (5.5 days) than those undergoing OC (10.0 days). However, regional propensity to perform LC for acute cholecystitis was only modestly related to overall LOS. Hospital stays were approximately 1 day shorter in quintile 5 (HSAs with high laparoscopy rates) than in the other quintiles (Figure 4).

Our study has 2 primary findings. First, for elderly patients with acute cholecystitis, the use of LC varies widely, ranging from 30.3% to 75.5% across HSAs in New England. Compared with the overall laparoscopy rate of 53.5%, 9 regions had rates higher than 70%, while 17 regions had rates lower than 40%. Second, regions with relatively high rates of LC for acute cholecystitis have shorter overall hospital stays (approximately 1 day shorter). However, regional propensity to use laparoscopy does not seem to affect mortality risks for patients with acute cholecystitis.

Table 1

<table>
<thead>
<tr>
<th>Quintile 1</th>
<th>Quintile 2</th>
<th>Quintile 3</th>
<th>Quintile 4</th>
<th>Quintile 5</th>
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<td>16 HSAs</td>
<td>16 HSAs</td>
<td>16 HSAs</td>
<td>14 HSAs</td>
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<tr>
<td>(With Lowest % Laparoscopic Cholecystectomies)</td>
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<td>(With Lowest % Laparoscopic Cholecystectomies)</td>
<td>(With Lowest % Laparoscopic Cholecystectomies)</td>
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Table 2

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<td>(With Lowest % Laparoscopic Cholecystectomies)</td>
<td>(With Lowest % Laparoscopic Cholecystectomies)</td>
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</tbody>
</table>

Figure 1. Overview of the study design, with inclusion and exclusion criteria. HSA indicates hospital service area. ICD-9 indicates International Classification of Diseases, Ninth Revision.

Figure 2. Regional variation in the rate of patients undergoing cholecystectomy for acute cholecystitis receiving laparoscopic surgery, by state. Each mark represents 1 of 77 hospital service areas included in the analysis. Open diamonds represent hospital service areas containing medical schools; closed circles represent the remaining “nonacademic” hospital service areas.
Geographic variation in surgery rates has been well described for numerous procedures. Most of these studies have focused simply on per capita procedure rates and thus variation in the use of surgery vs nonoperative treatment. However, some have assessed geographic variation in the rate of patients treated with different surgical techniques. For example, with femoral neck fracture, a patient’s chance of receiving simple, open fixation, un-

**Table 1. Patient Characteristics**

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* Ellipses indicate not applicable.

**Table 2. Patient Outcomes**

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<tr>
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<td>Total</td>
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<td>5.6</td>
<td>4.9</td>
<td>.04</td>
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* For length of stay and postprocedure length of stay analysis, reported P value is for an overall F test of any difference among adjusted (age, sex, Charlson Comorbidity Score, and admission acuity) mean values. For 30-day mortality, reported P value is the Wald χ² for the overall effect of laparoscopy quintile.

Geographic variation in surgery rates has been well described for numerous procedures. Most of these studies have focused simply on per capita procedure rates and thus variation in the use of surgery vs nonoperative treatment. However, some have assessed geographic variation in the rate of patients treated with different surgical techniques. For example, with femoral neck fracture, a patient’s chance of receiving simple, open fixation, un-
polar arthroplasty, or bipolar arthroplasty depends on where he or she lives.21 Our study reaches similar conclusions about the importance of geography in the likelihood of a patient undergoing LC. Although restricted to a specific patient population (elderly patients with acute cholecystitis), the results of our analysis are consistent with other population-based studies of LC.6,13 For example, Hannan et al6 describe wide variation in the use of this procedure across counties in New York State.

It is unlikely that regional variation in the use of LC can be explained by differences in patient characteristics across geographic areas. Based on clinical experience and previous research, variables most strongly associated with low rates for the laparoscopic approach include sex (male), advanced age, and acuity.3,6,9,12,22 In our analysis, we found no evidence that age or sex varied across HSA quintile. The limitations of Medicare claims data for classifying clinical diagnoses and acuity are well known.23,24 However, we do not believe that coding inaccuracies or regional differences in illness severity explain our results. First, given the relatively long hospital stays and high mortality rates observed in our study (overall and in each HSA quintile), patients selected for our study sample seemed to have "relatively" acute cholecystitis. Second, our analysis was population based, not hospital based. Although illness severity may vary systematically across hospitals, there is no reason to suspect similar variation in patient characteristics across geographic areas. In other words, it is unlikely that patients in some New England HSAs have consistently more "severe" acute cholecystitis than patients in other HSAs.

Because our analysis was population based, patients were categorized according to where they resided, not where they underwent surgery. It is likely that many patients underwent cholecystectomy outside their HSA. Out of area care would tend to dilute the observed variation in the local use of LC—each HSA’s rate is to some degree a composite of the practice styles of multiple HSAs. In this way, our analysis is biased toward the null hypothesis (no significant variation in LC rates across HSAs).

If not attributable to differences in patient case-mix, geographic variation in performing LC for acute cholecystitis must reflect real differences in surgeon practice style. When the first series of LCs were reported, it was thought that acute cholecystitis was a contraindication to a laparoscopic approach.20 This caution reflected the greater technical difficulty of performing LC in this setting (reflected by high rates of conversion to open surgery) and concerns about increased risks of bile duct injury. It is possible that these initial concerns continue to dissuade many surgeons from even attempting laparoscopic surgery in patients with acute cholecystitis. However, results from our analysis and other published series suggest that LC can be safely and effectively performed on most patients with acute cholecystitis.22,25

Although regional use of LC for acute cholecystitis varied markedly, we were surprised that the net effect of differences in practice style on patient outcomes was so small. Previous observational studies have consistently shown that patients undergoing LC have lower mortality rates than patients undergoing open surgery.1,3,20 We made similar observations: laparoscopic surgery patients had substantially shorter hospital stays (5.5 vs 10.0 days) and lower mortality rates (1.6% vs 4.8%). However, when viewed from a population perspective, patients residing in regions with high rates of laparoscopic surgery do not have substantially different mortality rates or hospital stays than patients in other regions. In “aggressive” laparoscopy regions, lower mortality rates in laparoscopy patients were almost entirely offset by higher mortality rates in remaining patients treated with OC (presumably the “sickest”). Our results suggest that the underlying disease process determines mortality and LOS more than the choice of procedure. Our findings also suggest the risks of selection bias inherent in studies simply comparing outcomes in patients undergoing LC and OC.

Although we did not find a strong effect on mortality rates, use of LC may be related to other nonfatal but important clinical outcomes. Clearly, patients undergoing LC have less postoperative pain and return to normal activity sooner than those undergoing open surgery.23 Given limitations in the accuracy of identifying nonfatal surgical complications with Medicare claims data, we were unable to assess directly whether LC influences complication rates.24 However, other published studies suggest that it does. For example, a recent randomized trial demonstrated a clear advantage of LC vs open surgery for acute cholecystitis.25 Among patients randomized to OC, 23% and 19% had major and minor complication rates, respectively. Only 1 patient (3%) in the laparoscopy arm experienced a complication. Although hospital stays were also shorter for patients undergoing LC, this trial lacked a sufficient sample size to compare mortality rates with the 2 procedures.

Our analysis documents a wide variation in rates of LC; however, it does not by itself answer the question, “Which rate is right?” In terms of mortality risks alone, the value of more “aggressive” use of laparoscopy in patients with acute cholecystitis remains uncertain. However, given the established benefits of LC in numerous other outcome measures, we believe that higher rates are better than lower rates. Improving laparoscopy rates—"raising the tide"—will require disseminating information about technical maneuvers known to increase rates of successful laparoscopic surgery in patients with acute cholecystitis. These include early decompression of the gallbladder, use of angled laparoscopes, and placement of additional trocars.26 Operating earlier rather than later also improves chances of successful LC in patients with acute cholecystitis.25,27 Without these efforts, patients’ chances of undergoing laparoscopic surgery for acute cholecystitis will continue to be determined less by their disease than by where they happen to live.

This study was supported by a Career Development Award from the Veterans Affairs Health Services Research and Development program, Washington, DC (Dr Birkmeyer). The study was also supported in part by the Dartmouth Atlas of Health Care, with funding from the Robert Wood Johnson Foundation, Princeton, NJ.


The views expressed herein do not necessarily represent the views of the Department of Veterans Affairs,
REFERENCES


DISCUSSION

John C. Russell, MD, New Britain, Conn: This paper builds upon previous work from Dr Wennberg's group showing significant regional variations in medication practice. To paraphrase Tip O'Neil, all surgery, like politics, is local. In analyzing their data, the authors chose to consider cases begun as laparoscopic procedures but then converted to open cases as laparoscopic cases based upon the surgeon's intention to perform laparoscopic cholecystectomy. If the rate of laparoscopic cholecystectomy in a region is to be considered a surrogate measure of the quality of surgical care provided, I believe the rate of completed, rather than intended, laparoscopic cholecystectomies would be a better choice. The Connecticut experience shows that laparoscopic cholecystectomies converted to open procedures, which were 5.67% of the total cases in this study, have the same average length of hospital stay, rate of complications, and hospital charges as open procedures.

If the 282 conversion cases in your study are reclassified as open rather than laparoscopic procedures, how do the regional variations in laparoscopic cholecystectomy rates change? A region with a high attempted laparoscopic cholecystectomy rate may not be doing better from the population outcome standpoint than one with a lower attempted laparoscopic cholecystectomy rate but also a lower conversion rate. Is it always better to try, but sometimes fail, at laparoscopic cholecystectomy rather than to do primary open cholecystectomy in selected cases? Should surgeons with low completed laparoscopic cholecystectomy rates refer their elderly patients to surgeons or centers with higher laparoscopic cholecystectomy completion rates and/or with lower overall morbidity and mortality rates for cholecystectomy?

Mark P. Callery, MD, Worcester, Mass: Your study provides a nice database by which to make a recommendation of another possible treatment. As you know, sometimes interval cholecystectomy following initial treatment with antibiotics and/or percutaneous cholecystostomy can be useful in elderly patients with presumed prohibitive inflammation or comorbidities. Did you pick up any additional information on how that procedure is being applied in New England?

Blake Cady, MD, Providence, RI: I was surprised as a non-participant in this surgical area at the length of hospital stay for laparoscopic cholecystectomy. How much is affected by the higher conversion rates and what is the reason for this? The operation is advertised as markedly reducing the length of stay so it only has 1 day. I think it actually was 7 or 5.5 days; what was the difference?

Dr Laycock: Those 280 or so cases that were coded, we really don't know the denominator, how many cases were initially started laparoscopically and converted. There is now a new code that will allow that to be evaluated in the future. However, that was a hard number to nail down, and just at face value, a 3% conversion rate probably understimates that total actual number.

Should patients who are in low laparoscopy utilization areas be transferred to a high utilization area to get into more of a regionalization of health care? I would advocate more of a dissemination of information to those surgeons that laparoscopic surgery in the setting of acute cholecystitis is indeed safe. There is a recent randomized trial in the Lancet for open vs laparoscopic surgery for acute cholecystectomy, and what they showed was a significantly smaller number of perioperative complications in the laparoscopic group.

Dr Callery, in terms of interval cholecystectomy, we did not evaluate that. However, there was another recent randomized trial looking at acute cholecystitis specifically waiting and then operating vs operating within the first 72 hours, and that also showed a benefit of operating early for acute cholecystitis.

Dr Cady, in terms of overall length of stay, in our study at 5.5 days for this group would be among the highest length of stay for laparoscopic cholecystectomy. However, we are very accurate in our ability to capture in this Medicare elderly population those who truly have acute cholecystitis, and that is actually at face value one of the ways we can document that we have captured the acute group.