ecp
EFFECTIVE CLINICAL PRACTICE

March/April 1999
Volume 2 Number 2

ORIGINAL ARTICLE

# Diffusion of Laparoscopic Cholecystectomy in the Veterans Affairs Health Care System, 1991–1995

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*Effective Clinical Practice. 1999;2:49–55.*

**CONTEXT.** Laparoscopic cholecystectomy has become the most widely used treatment for gallbladder disease. In HMO, Medicare, and fee-for-service settings, cholecystectomy rates increased 28% to 59% after introduction of laparoscopic cholecystectomy.

**OBJECTIVE.** To investigate the impact of the introduction of laparoscopic cholecystectomy on cholecystectomy rates and the operative mortality rate in Veterans Affairs (VA) hospitals.

**DESIGN.** Sequential cross-sectional study.

**PATIENTS.** All patients who underwent cholecystectomy from 1991 (before introduction of laparoscopic cholecystectomy) to 1995.

**SETTING.** 133 VA hospitals.

**OUTCOME MEASURES.** Cholecystectomy rates, use of laparoscopic or open cholecystectomy, and operative mortality rate.

**RESULTS.** The annual number of cholecystectomies in the VA system increased by 10% from 1991 to 1995; the laparoscopic procedure accounted for 25% of the caseload in 1992 and 52% in 1995. Compared with patients having laparoscopic cholecystectomy, those having open cholecystectomy were more likely to be older, be male, and have acute cholecystitis or comorbid illnesses ($P<0.001$). The operative mortality rate of open cholecystectomy increased by 46% during this 4-year period (from 2.4% to 3.4%) and was constant for laparoscopic cholecystectomy (about 0.5%). Given the increasing use of the laparoscopic procedure, however, the overall mortality rate of cholecystectomy during surgery decreased by 22% (from 2.4% to 1.8%). Despite increased use of the surgery, the absolute number of deaths decreased by 9%.

**CONCLUSIONS.** The introduction of laparoscopic cholecystectomy in the VA system was not accompanied by a large increase in cholecystectomy rates, as it was in fee-for-service, Medicare, and HMO systems. Because the rate of operations has changed only slightly, the total number of cholecystectomy-related deaths has decreased.

The diffusion of laparoscopic cholecystectomy in health care is unprecedented.[1, 2] Since its introduction in 1989, the laparoscopic procedure has rapidly become the most widely used treatment for gallstone disease.[3] By 1992, laparoscopic cholecystectomy accounted for 50% of all cholecystectomies in Medicare populations and 75% to 80% of all cholecystectomies in younger populations.[3–7] Increases in the overall rate of cholecystectomy (from 28% to 59%) were observed after the introduction of the new procedure in fee-for-service, Medicare, and for-profit HMO systems.[4–9]

*The abstract of this paper is available at ecp.acponline.org.*

Why laparoscopic cholecystectomy diffused so rapidly is not known. Financial incentives for physicians in the fee-for-service setting might have led to a lower threshold for intervention.[10] In addition, hospitals were offered financial incentives to use laparoscopic intervention. For hospitals participating in the Medicare system, diagnosis-related group (DRG) reimbursement resulted in better payments for laparoscopic cholecystectomy because the new procedure was associated with a shorter hospital stay. Finally, the existence of a procedure associated with less morbidity might have made it more likely for physicians to recommend and for patients to undergo surgery.[4, 11]

In this study, we evaluated the clinical and economic impact of the introduction of laparoscopic cholecystectomy in the Veterans Affairs (VA) system. We analyzed data from all of the 133 VA hospitals that performed cholecystectomy for the years 1991 (the year before laparoscopic cholecystectomy was performed in the VA hospitals) through 1995. Our goal was to determine whether the impact of laparoscopic cholecystectomy in an equal-access health care system (with fewer financial considerations directly affecting patients, physicians, and hospitals) was as large as has been reported elsewhere.

## Methods

### Source of Data

Data were obtained from the VA Patient Treatment Files, a national database of computerized discharge information for all VA medical centers that offer inpatient care; the database includes data from October 1990 to September 1995 (fiscal years 1991 to 1995). For each patient's hospitalization, the patient treatment files include demographic information (such as age, sex, ethnicity, and marital status), length of hospital stay, disposition at discharge, and codes from the International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) for up to 10 diagnoses and 5 procedures. To maintain hospital confidentiality, VA hospitals were categorized by geographic regions defined by the Centers for Disease Control and Prevention.

### Criteria for Inclusion

To identify hospitalizations associated with open or laparoscopic cholecystectomy, we used a combination of discharge diagnosis and procedure code. The first criterion for inclusion was a primary or secondary diagnosis code for gallbladder disease (ICD-9-CM codes 574.00 to 576.99). Cases that met the first criterion and had a procedure code for total cholecystectomy (ICD-9-CM code 51.22) were included as open cholecystectomy cases; cases that met the first criterion and had a procedure code for laparoscopic cholecystectomy (ICD-9-CM code 51.23) were included as laparoscopic cholecystectomy cases.

Laparoscopic cholecystectomy was introduced in the VA system in 1992; the procedure code for laparoscopic cholecystectomy had been created in 1991. Therefore, in 1991, all cholecystectomies performed at VA hospitals were open procedures and were coded accordingly. From 1992 to 1995, 82 cases were coded with both ICD-9-CM code 51.23 (laparoscopic cholecystectomy) and ICD-9-CM code 51.22 (open cholecystectomy). These cases were classified as laparoscopic cholecystectomy because they may include procedures that "converted" from laparoscopic cholecystectomy to open cholecystectomy and because subsequent outcomes should be attributed to the initial procedure.

### Comorbid Conditions

Comorbid conditions were identified from the database listing of primary and secondary diagnoses unrelated to gallbladder disease (maximum of five) by using an algorithm previously developed by Steiner and colleagues.[7] The presence of acute cholecystitis and bile duct stone was identified by ICD-9-CM codes (574.0, 574.3, 574.6, 574.8, and 575.0 for acute cholecystitis and 574.30 to 574.91 for bile duct stone).

### Operative Mortality Rate

Mortality rate was defined as the percentage of patients undergoing cholecystectomy who died during hospitalization. To exclude cases in which death might have been related to another procedure, our mortality analysis included only cases that contained a primary surgical diagnosis for laparoscopic or open cholecystectomy.

### Statistical Analysis

The primary analysis of rates of cholecystectomy included all cases of open and laparoscopic cholecystectomy, according to our inclusion criteria. We performed a secondary analysis including only patients with a primary surgical diagnosis of cholecystectomy. Procedure rates were calculated for each year. The denominator for the procedure rates for each year was obtained from the VA Health Administration Files (Patient Treatment Files, VA Outpatient Files, and Extended Care Files).[12] We analyzed differences in patient characteristics (according to whether the patient underwent laparoscopic or open cholecystectomy) with the Student *t*-test for the continuous variable (age) and the chi-square test for all categorical variables (sex, ethnicity, marital status, age group, presence of comorbid conditions, region in which

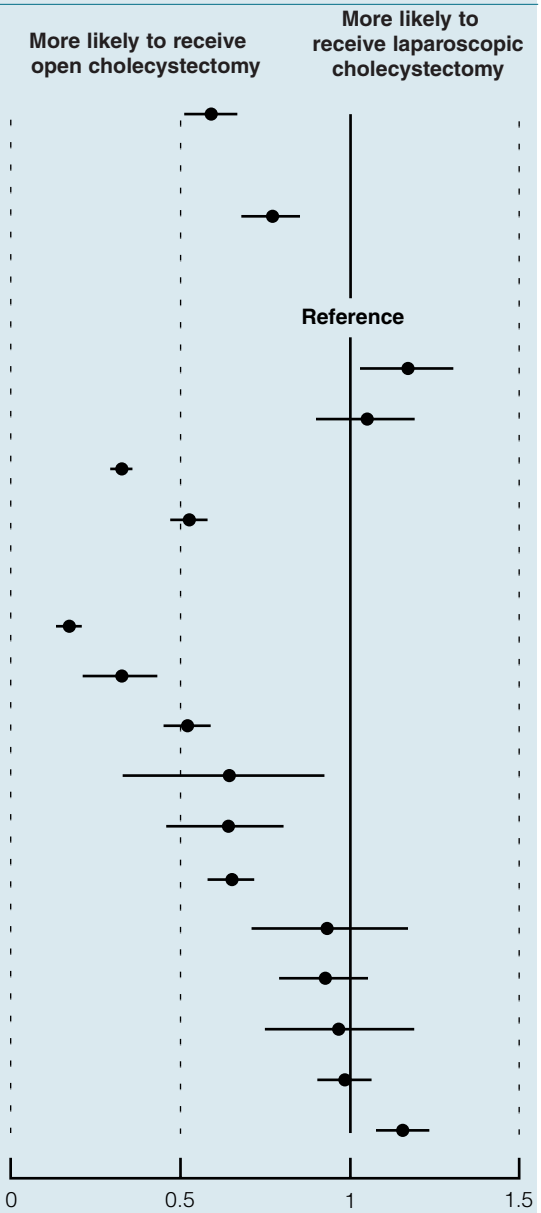
the hospital was located, and year in which surgery was done). We performed a multiple logistic regression analysis to identify factors independently associated with an increased likelihood of undergoing laparoscopic rather than open cholecystectomy. All statistical calculations were performed with Stata software (Stata Corp., College Station, Texas).[13]

## Results

**Table 1** compares the characteristics of veterans receiving laparoscopic and open cholecystectomy. Patients undergoing a laparoscopic procedure were more likely to be younger, of nonblack ethnicity (adjusted odds ratio [OR], 1.33 [95% CI, 1.19 to 1.50]), and female (adjusted

**TABLE 1**
**Characteristics of 17,939 Patients Who Underwent Cholecystectomy at Veterans Affairs Hospitals, 1992–1995**

| CHARACTERISTIC | TYPE OF CHOLECYSTECTOMY | |
|---|---|---|
| | LAPAROSCOPIC (*n* = 7492) | OPEN (*n* = 10,447) |
| Male sex, % | 92.0 | 96.7 |
| Race, % | | |
| Black | 9.1 | 12.0 |
| Marital status, % | | |
| Widowed | 5.9 | 8.1 |
| Married | 57.2 | 56.3 |
| Single, divorced, or separated | 36.7 | 35.4 |
| Acute cholecystitis, % | 16.1 | 35.5 |
| Common bile duct stone, % | 5.9 | 11.1 |
| Comorbid conditions, % | | |
| Cancer | 1.8 | 9.0 |
| Pneumonia | 0.59 | 2.3 |
| Liver disease | 2.9 | 5.3 |
| Acute myocardial infarction | 0.36 | 0.77 |
| Kidney disease | 0.92 | 1.9 |
| Gastrointestinal disease | 23.3 | 30.5 |
| Cerebrovascular disease | 1.5 | 2.0 |
| Conduction disease/arrhythmia | 4.9 | 6.4 |
| Heart failure | 2.0 | 2.6 |
| Diabetes mellitus | 14.7 | 15.5 |
| Hypertension | 22.8 | 21.1 |




**Adjusted odds ratios were obtained by multiple logistic-regression analysis in which each ratio was adjusted for all other characteristics shown, in addition to age group, geographic region, and year of surgery.*

OR, 1.69 [CI, 1.45 to 1.96]). However, laparoscopic cases were less likely to be complicated by acute cholecystitis (adjusted OR, 0.34 [CI, 0.31 to 0.36]), a common bile duct stone (adjusted OR, 0.53 [CI, 0.47 to 0.59]), or other coexistent medical conditions (such as acute myocardial infarction, pneumonia, kidney disease, liver disease, other gastrointestinal diseases, and cancer).

**Figure 1** shows utilization patterns over the 4-year period and highlights the fact that laparoscopic cholecystectomy largely served as a substitute for open cholecystectomy. From 1991 to 1994, the absolute number of cholecystectomies performed in the VA system increased from 3908 to 4575 and the cholecystectomy rate increased from 1.65 per 1000 patients to 1.87 per 1000 patients (a 13% increase). In 1995, the absolute number of cholecystectomy cases decreased to 4512 and the overall cholecystectomy rate decreased to 1.82 per 1000 patients. The rate of performance of open cholecystectomy decreased by half over the 4-year period (from 1.65 per 1000 patients to 0.88 per 1000 patients).

Clinical outcomes of the patients undergoing laparoscopic or open cholecystectomy also differed. **Table 2** shows the 22% decrease in the overall operative mortality rate from 1991 to 1995. During the same period, the absolute number of cholecystectomy-related deaths decreased by 9%.

The economic impact of the open and laparoscopic procedures also differed. For the years 1992 to 1995, the average postoperative hospital stay was almost two thirds shorter for patients undergoing laparoscopic cholecystectomy (4.0 days versus 11.3 days; $P<0.001$). As a consequence of the differences in the duration of postoperative hospital stay between the two procedures and the increase in the proportion of laparoscopic cholecystectomy, total postoperative hospital days for all patients having cholecystectomy decreased by 16% (from 35,372 days in 1991 when all cholecystectomies were open to 29,805 days in 1995 when 50% were performed laparoscopically).

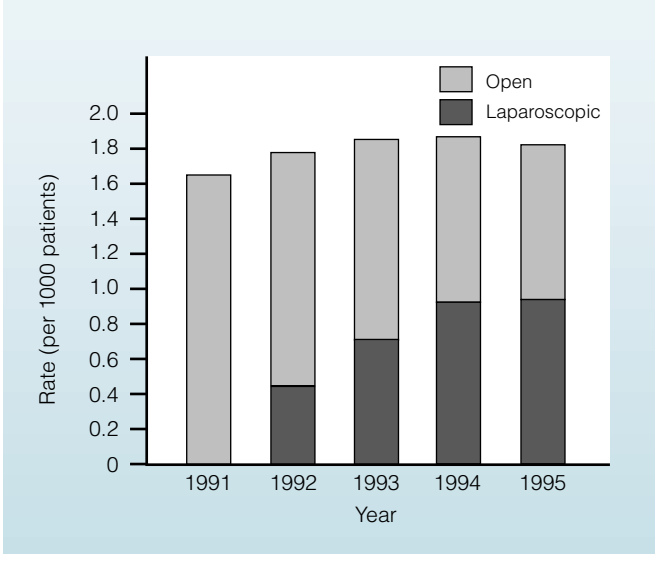



**FIGURE 1. Rates of open and laparoscopic cholecystectomy by year in the Veterans Affairs system. The increase in the rate for all cholecystectomies is significant over time ($P<0.001$ by the chi-square test for linear trend).**

**TABLE 2**
**Operative Mortality Associated with Cholecystectomy by Type of Procedure***

| YEAR | OVERALL† | OPEN‡ | LAPAROSCOPIC |
|---|---|---|---|
| 1991 | 2.35% | 2.35% | – |
| 1992 | 2.42% | 3.17% | 0.46% |
| 1993 | 2.04% | 2.96% | 0.79% |
| 1994 | 1.81% | 3.43% | 0.40% |
| 1995 | 1.83% | 3.43% | 0.52% |

**Operative mortality is defined as the percentage of patients who underwent cholecystectomy and died during the hospitalization. This analysis includes only patients with a primary surgical diagnosis of cholecystectomy.*
*†The decrease in the mortality rate of combined open and laparoscopic cholecystectomy is significant over time (P=0.021 by the chi-square test for linear trend).*
*‡The increase in the mortality rate of open cholecystectomy is significant over time (P=0.016 by the chi-square test for linear trend).*

## Discussion

Our study, which is based on claims data from the 133 VA hospitals that performed cholecystectomy for the years 1991 to 1995, found small changes in cholecystectomy caseloads, hospital days, and operative mortality rate after the introduction of laparoscopic cholecystectomy in the VA medical system. In particular, the overall cholecystectomy rate increased by 10%, the operative mortality rate decreased by 22%, the absolute number of cholecystectomy-related deaths decreased by 9%, and total postoperative hospital days for cholecystectomy patients after the introduction of the laparoscopic technique decreased by 16%.

The results of this study provide insight into factors behind the rapid dissemination of laparoscopic cholecystectomy. First, the presence of financial incentives is likely to lead to early adoption of new technologies. **Figure 2** shows that the diffusion of the laparoscopic procedure was fastest in the for-profit HMO setting, was intermediate in the Medicare setting, and was slowest in the VA system.[10] In

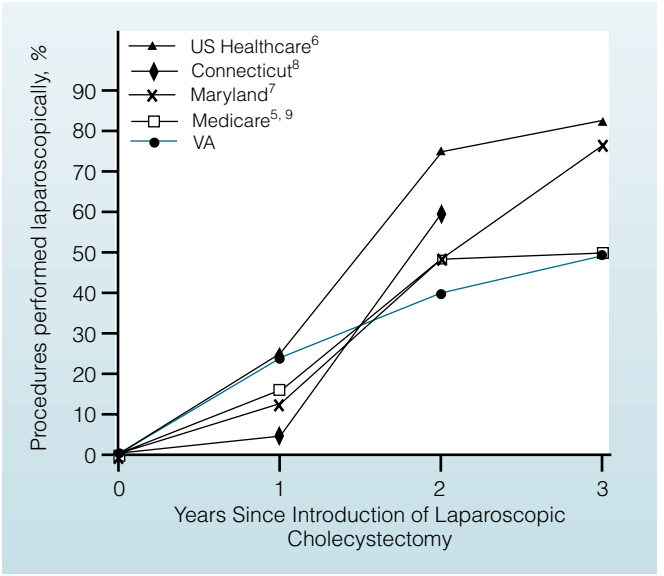



**FIGURE 2. Percentage of cholecystectomy procedures performed laparoscopically in the Veterans Affairs (*VA*) system and in five published studies during the 3 years after the introduction of the laparoscopic procedure. Year 0 is defined as the last year in which laparoscopic cholecystectomy accounted for fewer than 5% of all cholecystectomies.**

the fee-for-service and HMO settings, financial oversight of individual physicians led to pressures to rapidly adopt new procedures that were associated with shorter hospital stays and lower health care expenditures.[14] Similarly, at the hospital level, the DRG reimbursement for Medicare patients resulted in higher net payments for laparoscopic than for open cholecystectomy because of the shorter hospital stay associated with laparoscopic cholecystectomy; this created incentives to rapidly adopt the new procedure.

The overall rates of cholecystectomy also increased. **Figure 3** shows that cholecystectomy rates rose the most in the for-profit HMO setting and rose the least in the VA system. Although use of the laparoscopic procedure was associated with a shorter hospital stay and lower costs than open cholecystectomy,[14] the total hospital days used for cholecystectomy care increased in the non-VA setting but not in the VA setting.[6]

However, although the VA system did not face the same financial incentives as those presented to the private sector with respect to implementing laparoscopic cholecystectomy, it was subject to other financial constraints. The initial costs of setting up the equipment to perform laparoscopic cholecystectomy might have limited the ability of some VA hospitals to perform the procedure. This factor could also explain the slower diffusion rate of the new procedure in the VA system. In addition, at the patient level in the general population, the laparoscopic procedure is associated with a shorter recovery period and has the advantage of requiring less time away from work; these features could translate into a financial incentive for the patient to undergo the laparoscopic procedure. In contrast, the VA system serves a more vulnerable population, many of whom are retired, disabled, or unemployed; for a patient from this population, the same financial incentive may not exist.

Clinical and sociodemographic characteristics of the patient population are an important determinant of the rate of diffusion of new technologies. Health care systems might have had pools of mildly symptomatic or high-risk patients who chose medical therapy over an open cholecystectomy procedure. Escarce and coworkers[4] found that patients undergoing laparoscopic cholecystectomy had milder gallstone disease, which suggests that open cholecystectomy was used for more severe cases and the laparoscopic procedure was used for less severe cases.[4] These findings are consistent with the finding of an overall lower threshold for cholecystectomy since the introduction of the laparoscopic procedure, especially among younger patients. In addition, the highest overall rate of increase of cholecystectomy was in the setting with the lowest percentage of older patients, a for-profit managed care provider. The VA population is older and mostly male. Gallstone disease is more common among women; this may result in a smaller pool of patients requiring cholecystectomy in the VA system and could contribute to the modest increase in cholecystectomy rates.

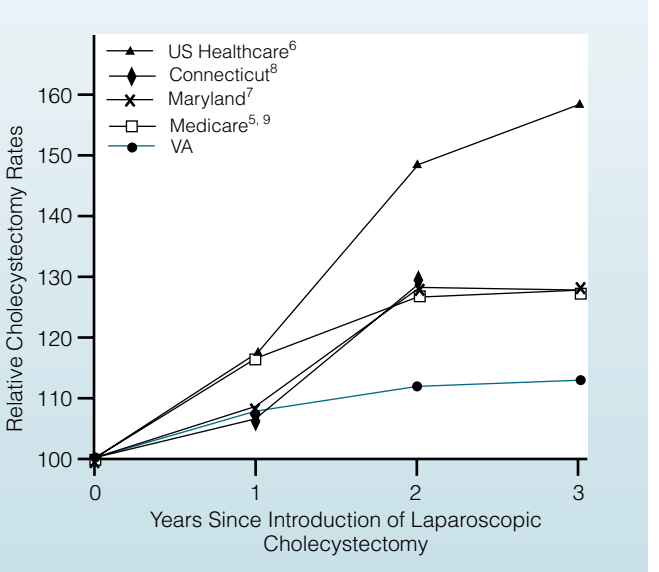



**FIGURE 3. Increase in cholecystectomy rates in the Veterans Affairs (*VA*) system and in five published studies during the 3 years after the introduction of laparoscopic cholecystectomy. Year 0 is defined as the last year in which laparoscopic cholecystectomy accounted for fewer than 5% of all cholecystectomies.**

### Operative Mortality Rate

The impact of the introduction of the laparoscopic procedure on the operative mortality rate was lowest in the VA system. For cholecystectomy patients covered by the New York Medicare program and for cholecystectomy patients in Maryland, the operative mortality rate associated with open cholecystectomy more than doubled in the 3 years after introduction of the laparoscopic procedure; in contrast, an increase of only 46% was noted in the VA system.[5,7] The increase in the open cholecystectomy mortality rate has been attributed to changes in patient selection; greater relative percentages of older patients with comorbid medical illnesses or complicated gallbladder surgical cases have had the open procedure. In the New York Medicare program, the overall operative mortality rate increased by 20%, whereas in Maryland and in the VA system, the rate decreased by 33% and 22%, respectively. The total number of cholecystectomy-related operative deaths increased by 50% in the New York Medicare program, whereas in Maryland and in the VA system it decreased by 10% and 9%, respectively.

Although laparoscopic cholecystectomy is considered a major advance in the treatment of gallstone disease, our findings suggest that a slower diffusion of this new procedure, as was found in our study, may be associated with some benefits. The most important benefit is the change in cholecystectomy-related mortality. Mortality rates and post-cholecystectomy deaths increased in the Medicare population but decreased in the VA system, which also treats predominantly older patients. In addition, the impact on overall health resources was smaller in the VA system, as evidenced by a decrease in post-cholecystectomy hospital days.

### Comparisons with the Veterans Affairs Surgical Risk Study

Our estimate of a 10% increase in cholecystectomies in the VA system after the introduction of the laparoscopic procedure contrasts with the finding from the National VA Surgical Risk Study of no increase.[15,16] There are several possible explanations for this difference. First, the VA Surgical Risk Study included all 43 tertiary care VA medical centers; our study included information on 90 additional primary and secondary care medical centers. Of the approximately 4200 primary cholecystectomies performed annually in the VA system, only 35% were performed in tertiary care centers.

Second, our study included 1991 (the year before the laparoscopic procedure was introduced) as the baseline and continued through 1995; the Surgical Risk Study began in 1992 and continued for 27 months. In our study, the greatest increase in the total number and rate of cholecystectomy procedures occurred during 1991 and 1992. In the later years (1993 to 1995), essentially no change occurred in cholecystectomy rates in the 43 tertiary care VA medical centers (a finding that is consistent with the Surgical Risk Study report) or in the primary and secondary VA medical centers (data not shown).

Finally, the Surgical Risk Study compared the number of cholecystectomies performed with the total number of non-cholecystectomy intra-abdominal general surgical operations. During the 2-year study period, the number of non-cholecystectomy surgical cases decreased by 13% and the number of cholecystectomies remained stable. The authors explained this finding by noting that cholecystectomy rates probably did not increase or increased, at most, by 13% (that is, the amount that rates of other general procedures declined). Our study used the number of unique VA patients treated at any VA medical center during each fiscal year as a denominator to approximate the number of veterans at risk for cholecystectomy and adjusted the procedure rates accordingly.

### Limitations

Our study has several limitations. First, because all cases were identified through the Patient Treatment Files, we relied on appropriate coding of diagnoses and procedures by data entry personnel. In contrast to the Surgical Risk Study, the absence of clinical information in this study did not allow for consideration of cases that were begun laparoscopically and then converted to open procedures and did not allow for evaluation of 30-day mortality rates.[15,16]

Some procedures that were begun laparoscopically and were then converted to open procedures might have been coded solely as open cholecystectomy. This misclassification could have influenced our findings by affecting the characteristics of patients undergoing either of the two procedures. In addition, it may influence the findings on operative mortality for each type of procedure.

Second, we adjusted for differences in comorbidity using ICD-9-CM codes. These codes do not distinguish between comorbid conditions that are present at admission and complications that occur after surgery. Therefore, some of the variations observed in the use of open and laparoscopic cholecystectomy and in their respective mortality rates may represent unmeasured comorbidity differences.

Third, we cannot account for cholecystectomies that might have been performed outside of the VA system. Because some patients receive care in both the VA and the private setting, we might have underestimated the total number of procedures performed in our population. In addition, we used the number of unique VA patients for each year as the denominator to calculate

yearly cholecystectomy rates. However, that number would not have much effect on our cholecystectomy rates because it increased only slightly during our study.

In conclusion, the introduction of laparoscopic cholecystectomy in the VA system resulted in a 10% increase in the overall rate of cholecystectomy, a 9% decrease in the total number of operative deaths, and a 16% decrease in the total number of postoperative hospital days for cholecystectomy patients. Our findings contrast sharply with those from Medicare, fee-for-service, and for-profit managed care systems, all of which found large increases in the rate of cholecystectomy and in the amount of medical resources being used for patients receiving cholecystectomy. Compared with the non-VA setting, the VA system offers no financial incentives for physicians and hospitals to use the laparoscopic procedure; in addition, patients in the VA system are older and more seriously ill. Both of these financial and demographic factors probably caused a more measured diffusion of the laparoscopic procedure and reduced the economic impact on overall health care resources.

## Take-Home Points

- **In most health care settings, the rate of cholecystectomy increased dramatically after introduction of the laparoscopic procedure.**
- **The introduction of laparoscopic cholecystectomy had a much smaller effect on cholecystectomy rates in the VA system.**
- **The slower diffusion of laparoscopic cholecystectomy in the VA system may be explained by the absence of substantial financial incentives for physicians and hospitals to use the procedure and the fact that the VA system cares for older, more seriously ill patients.**
- **The introduction of laparoscopic cholecystectomy was associated with a 22% decrease in the operative mortality rate for cholecystectomy.**

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### Grant Support


Dr. Ferreira was supported by National Research Service Award F32 HS00125-01 from the Agency for Health Care Policy and Research. Dr. Bennett was a Senior Career Development Awardee of the Health Services Research and Development Division of the Veterans Administration.


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