

Contributing Factors to Postoperative Length of Stay in Laparoscopic Cholecystectomy

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ABSTRACT

Background: Laparoscopic cholecystectomy for gallbladder disease is a common surgical procedure performed in hospitals throughout the world. This study evaluates the major factors that contribute to postoperative length of stay for patients undergoing laparoscopic cholecystectomy.

Methods: We analyzed data for patients undergoing laparoscopic cholecystectomy in a 5-hospital community health system from December 1, 2008 to January 31, 2009. The natural logarithm of postoperative length of stay was modeled to evaluate significant factors and contributions.

Results: Included in the analysis were 232 patients. Three preoperative patient factors were significant contributors: body mass index was associated with decreased postoperative length of stay, while white blood cell count and the presence of biliary pancreatitis were associated with increased postoperative length of stay. The operative factors of fluids administered and ASA class were significant contributors to increased postoperative length of stay, with an increasing contribution with a higher ASA class. The utilization factor of nonelective status was a significant contributor to increased postoperative length of stay.

Conclusion: Several factors were major contributors to postoperative length of stay, with ASA class and nonelective status having the most significant increased contribution. Efforts to optimize efficient elective care delivery for

patients with symptomatic gallbladder disease may demonstrate a benefit of decreased hospital utilization.

Key Words: Laparoscopic Cholecystectomy, Length of Stay, Utilization.

INTRODUCTION

Laparoscopic cholecystectomy has become the preferred procedure for cholelithiasis-related disease.¹⁻⁶ Population-based studies have found that the rate of cholecystectomy has increased since the introduction of the laparoscopic approach.^{7,8} Given this ubiquity, hospital utilization for laparoscopic cholecystectomy is an important area for study to better manage the care for patients requiring intervention for symptomatic gallbladder disease.

Results have been disparate when differences in hospital length of stay between laparoscopic and traditional small incision cholecystectomy have been analyzed, as well as when costs and charges between the 2 have been compared.⁹⁻¹⁸ Several studies have demonstrated a shorter hospital stay but longer operative time for laparoscopic cholecystectomy compared with traditional small incision cholecystectomy.⁹⁻¹⁷ However, Keus and colleagues¹⁸ found in their analysis that there was no statistical difference in hospital stay between these groups. When examining early versus delayed laparoscopic cholecystectomy, several studies have demonstrated a decreased hospital stay with early laparoscopic cholecystectomy.^{19,20}

The differing results for hospital length of stay and cost/charge analysis suggest that there is a need for better understanding of the relationship between hospital length of stay and cholecystectomy. The focus of this article is to better characterize the components that are contributing factors and their relative influence on postoperative length of stay.

METHODS

This study was conducted by retrospective review of patients undergoing elective and nonelective cholecystec-

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Table 1.

Preoperative Patient Factors Evaluated in Model with Cohort Values

Preoperative Patient Factors	n=232
Average (SD) age (years)	50.9 (19.4)
Men (n,%)	76 (32.8)
Average (SD) BMI (kg/m ²)	30.3 (7.4)
Diabetes (n,%)	50 (21.6)
Hypertension (n,%)	92 (39.7)
Median (IQR) time to presentation (days)	4 (1, 60)
Mean (SD) admission temperature (°F)	97.8 (0.9)
Mean (SD) admission WBC (k/ μ L)	10.1 (5)
Median (IQR) admission total bilirubin (mg/dL)	0.8 (0.6, 1.2)
Biliary pancreatitis on admission (n, %)	15 (6.5)

tomy in a 5-hospital community health system in San Antonio, Texas. Using the data collected by retrospective review, we modeled postoperative length of stay to better characterize its contributing factors.

The inclusion criteria for patients for this study were all adult patients (age >18) undergoing laparoscopic cholecystectomy at any of the 5 hospitals from December 2008 through January 2009. The exclusion criterion for this study was incomplete chart documentation.

Specific data were collected to model postoperative length of stay. The specific factors and cohort values are shown in **Tables 1, 2, and 3**. These factors include preoperative patient factors such as patient characteristics and admission data, operative factors such as operative type and duration, and utilization factors such as time from registration to operation and elective status. These factors were chosen, because they are commonly associated with the pathophysiology and/or treatment of gallbladder disease.

It is important to note that 2 utilization outcomes were defined in the following manner. Time from registration to operation was defined as the time from registration to operative start. Postoperative length of stay (POLOS) was defined as the time from operative end to discharge from the hospital.

The modeling of postoperative length of stay was performed using the natural logarithm of postoperative length of stay as a better fit. The natural POLOS logarithm was chosen because the data were skewed and bounded by zero (ie, no patient can have a POLOS <0). Regression models assume that the residuals (defined as the predicted

Table 2.

Operative Factors Evaluated in Model with Cohort Values

Operative Factors	n=232
Mean (SD) operative duration (min)	47 (26.2)
ASA ^a 1 (%)	35 (15.1)
ASA ^a 2 (%)	113 (48.7)
ASA ^a 3 (%)	78 (33.6)
ASA ^a 4 (%)	6 (2.6)
Anesthesia Start Time	
0700–1459 (%)	194 (83.6)
1500–1859 (%)	33 (14.2)
1900–0659 (%)	5 (2.2)
Operative Type	
Laparoscopic cholecystectomy Only (%)	54 (23.3)
Laparoscopic cholecystectomy with Intraoperative cholangiogram (%)	160 (69)
Laparoscopic cholecystectomy with other abdominal procedure (%)	18 (7.8)

^aASA Class=American Society of Anesthesiologists classification.

Table 3.

Utilization Factors Evaluated in Model with Cohort Values

Utilization and Postoperative Factors	n=232
Elective (n, %)	113 (48.7)
Non-elective (n,%)	119 (51.3)
Median (IQR) time from registration to operation	0.2 (0.1, 1.2)
Preoperative ERCP (%)	9 (3.9)
Postoperative ERCP (%)	7 (3.0)
Median (IQR) postoperative length of stay (days)	0.7 (0.6, 1.3)
Mortality (n,%)	0 (0)

value minus the actual value of an observation) are normally distributed. This assumption is often violated when the data are skewed and bounded. To ameliorate this violation of assumptions, the natural POLOS logarithm was chosen. This removes the bounding and causes skewed data to have a distribution that is close to a normal distribution. The last fact translates to the residuals becoming more normal in their distribution and allowing for more accurate modeling.

Moreover, it is important to explain the method of modeling using the natural logarithm of postoperative length

of stay in a backwards model selection. First, the model was created using all of the factors that are shown in **Tables 1, 2, and 3**. Using the iterative process of backwards model selection, we started by fitting a model with all possible factors of interest included. At each iteration, the factor with the highest P value (ie, that which contributes least to the prediction of POLOS) was removed from the consideration and the model refit. This process was continued until a maximum model fit, as measured by AIC, was reached.

By this process, the best fit model for POLOS is shown in **Table 4** with contributing factors and associated coefficients. Categorical contributing factors in this model, such as biliary pancreatitis on admission or American Society of Anesthesiologists (ASA) classifications are presented with their associated contributing factor. Continuous contributing factors in this model, such as white blood cell count and fluids administered, are presented with their base associated contributing factor. To determine the contribution of continuous variables, the base associated contributing factor is raised to the value for each patient. For example, the base contributing factor for white blood cell count is raised to the value of the white blood cell count for a subject to determine the white blood cell count contribution to POLOS.

Table 4.		
Best Fit Model of Contributing Factors to POLOS with Multiplier Estimates (n=232)		
	Odds Ratio (95% CI)	P Value
Baseline POLOS in Model (Intercept)	2.14 (1.69, 2.72) days	
Preoperative Patient Factors		
BMI (kg/m ²)	0.98 (0.98, 0.99)	<0.001
White Blood Cell Count (k/ μ L)	1.02 (1.01, 1.03)	0.047
Biliary Pancreatitis on Admission	1.75 (1.51, 2.02)	<0.001
Operative Factors		
ASA2	1.17 (1.04, 1.3)	0.168
ASA3	1.51 (1.34, 1.7)	<0.001
ASA4	2.02 (1.59, 2.56)	0.004
Fluids Administered (mL)	1.0003 (1.0002, 1.0003)	0.004
Utilization Factors		
Nonelective Status	2.27 (2.08, 2.5)	<0.001

^aASA Class=American Society of Anesthesiologists classification.

RESULTS

Included in the analysis were 232 subjects who met inclusion criteria. As stated before, **Table 1, 2, and 3** demonstrate the preoperative patient, operative, and utilization factors for the study cohort that was modeled.

Specific focus should be placed on the following factors. First, there was a near equal distribution of nonelective cases and elective cases within the cohort, which allowed for a balanced evaluation of POLOS based on the acute and chronic manner in which gallbladder disease affects patients. Next, the median time from registration to the start of operation was 0.2 days (4.8 hours) with an interquartile range of 0.1 to 1.2 days (2.4 to 28.8 hours). Lastly, the median postoperative length of stay for the group was 0.7 days with an interquartile range of 0.6 to 1.3 days.

The best fitting model for describing postoperative length of stay demonstrated 6 contributing factors that were significant (**Table 4**).

In terms of preoperative patient factors, biliary pancreatitis on admission, admission body mass index, and admission white blood cell count contribute to postoperative length of stay. The most significant preoperative patient factor that contributes to POLOS is biliary pancreatitis on admission, which has an odds ratio of 1.75 (CI, 1.51 to 2.02). Stated another way, patients with biliary pancreatitis on admission have a 75% increased POLOS compared with similar patients without biliary pancreatitis on admission. Next, white blood cell count per unit of k/ μ L also increases POLOS and has an odds ratio of 1.02 (CI, 1.01 to 1.03). Because white blood cell count is a continuous variable, the effect is compounded with increasing leukocytosis. Lastly, body mass index has an odds ratio of 0.98 (CI, 0.98 to 0.99) that corresponds to a slightly decreased postoperative length of stay per unit of kg/m². As with white blood cell count, this effect is compounded with increasing body mass index. In terms of operative factors, ASA and fluids administered in the operative room contributed to the best fit model. ASA3 has an odds ratio of 1.51 (CI, 1.34 to 1.7), and ASA4 has an odds ratio of 2.02 (CI, 1.59 to 2.56) compared to ASA1. This corresponds to an increased postoperative length of stay for patients classified as ASA3 of 51% and ASA4 of 102%, respectively, compared to patients classified as ASA1; an ASA2 classification does not contribute any more to POLOS compared to ASA1. Lastly, fluids administered in the operating room had an odds ratio of 1.0003 (CI, 1.0002 to 1.0003). This corresponds to an increase in postoperative length of stay per milliliter administered with a compounded

effect with increasing fluid administration. In terms of utilization factors, patient status (elective vs nonelective) contributed to postoperative length of stay. Specifically, patient status was the strongest contributor to postoperative length of stay of a nonelective operation and had an odds ratio of 2.27 (CI, 2.08 to 2.5). A patient undergoing a nonelective cholecystectomy has a 127% longer POLOS compared with a similar patient undergoing an elective operation.

DISCUSSION

The primary finding of this study is that patients undergoing laparoscopic cholecystectomy have several factors that significantly contribute to postoperative length of stay. The factors that increase postoperative length of stay include nonelective status, ASA classification, biliary pancreatitis, white blood cell count, and fluids administered. The factor that decreased postoperative length of stay was BMI. The limitations of this study must be discussed. These data for modeling were based on a retrospective chart review, which has inherent limitations of consistency and quality of documentation. Additionally, the review was performed for 2 months, albeit in 5 separate hospitals, which may have contributed to bias in patient selection or temporal variability of cholelithiasis-related disease. Modeling for postoperative length of stay has inherent limitations as the model is made to fit the data set in question. This is apparent when examining the fact that BMI appeared to contribute to a decreased POLOS, which does not follow many surgeons' experiences or reports in the literature. Lastly, there were 8 postoperative complications (4 retained common bile duct stones, 1 case of postoperative biliary pancreatitis, 1 case of gastrointestinal bleeding, 1 cerebrovascular accident, and 1 bile leak) and no mortalities in the cohort examined, which did not allow for complications or mortality to be examined in the model as a contributing factor, given the low incidence.

CONCLUSION

This study provides an initial descriptive understanding of the factors that contribute to postoperative length of stay with estimates on the relative effects of these factors. Three factors had the highest relative effect in contributing to increased postoperative length of stay: biliary pancreatitis on admission, ASA classes of 3 or 4, and nonelective status.

Unfortunately for health care delivery organizations, these high impact factors are often not controllable, because

many patients present to hospitals with comorbid conditions, which contributes to ASA class, and with complicated biliary disease including biliary pancreatitis. It appears that the most controllable element for such organizations is nonelective status. There may be a benefit to hospital utilization by focusing on optimizing elective laparoscopic cholecystectomy care delivery for patients with symptomatic gallbladder disease given the large effect on postoperative length of stay if similar patients present in a nonelective manner. Continued study needs to be performed to further evaluate the effects found in this analysis.

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