



EVALUATING THE ROLE OF SURGICAL VOLUME IN ENHANCING SURVIVAL OUTCOMES FOR GERIATRIC EMERGENCY SURGERY PATIENTS

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ABSTRACT

The increasing prevalence of emergency operations in the growing geriatric population necessitates a focus on quality indicators to improve surgical outcomes. This study investigates the impact of emergency operative volume on mortality in geriatric general surgery (EGS) patients aged 65 and older. Utilizing beta-logistic generalized linear regression, hospital mortality was quantified, and operative volume thresholds were determined to optimize survival probability. The analysis encompassed 299 hospitals and 41,860 operations, revealing that an increase in hospital emergency operations volume significantly reduces mortality. Specifically, mortality decreased from 14% to 61% with each operation, as the logarithm of volume doubled. A median of 14 operations was identified as the threshold for achieving a 95% estimated survival probability. However, two-thirds of hospitals did not meet these benchmarks for more than half of their patients. The findings highlight that higher operative volumes correlate with better survival rates, supporting the Surgeons' Quality Programs, which advocate using operative volume as a quality metric for emergency surgeries in geriatric patients.

Key words: Geriatric Surgery; Emergency Operations; Mortality; Operative Volume; Surgical Quality Indicators.

INTRODUCTION

As the geriatric population continues to grow, ensuring that older adults receive safe, high-quality surgical care has become increasingly crucial [1]. In response to this need, over 50 stakeholder organizations have forces with the to form an alliance focused on enhancing geriatric surgical care [2]. This study emphasizes the importance of specific quality measures for elderly patients experiencing surgical complications, as endorsed by the National Quality Forum, a leading patient safety organization. To improve the quality of geriatric surgery, data sets are being developed and tested through the NSQIP Geriatric Surgery Pilot Program. These data sets encompass key aspects such as cognitive ability, decision-making processes, mobility, and functional abilities. The overarching goal is to optimize surgical outcomes for older adults, particularly in the context of elective surgeries. However, it is anticipated that

the number of emergency surgeries performed on older adults will continue to rise, necessitating a deeper focus on this area.

Emergency surgeries present unique challenges for older patients compared to their younger counterparts, with higher rates of complications, mortality, and associated costs [3,4]. Therefore, enhancing treatment protocols for older adults with acute surgical conditions is imperative. The quality programs offer a framework for improving the quality of geriatric emergency surgery, leveraging accredited surgery centers across various disciplines to provide quality care and achieve optimal outcomes [5]. Additionally, multispecialty programs are required to meet volumetric requirements in areas such as bariatric surgery, trauma surgery, and pediatric surgery.

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This study examines the relationship between hospital mortality and emergency operative volume in older surgical patients. Specifically, it investigates whether hospital emergency operative volumes impact mortality rates for geriatric patients undergoing emergency general surgery (EGS). The hypothesis posits that hospitals with higher volumes of such surgeries will exhibit lower postoperative in-hospital mortality rates. By reaching a certain threshold in emergency surgery volumes, hospitals are expected to achieve average or lower mortality rates for older patients.

METHODOLOGY

Ten specific operations were analyzed, including appendectomy, cholecystectomy, colectomy, inguinal hernia repair, adhesion lysis without bowel removal, small intestine resection, and umbilical hernia repair. The data were sourced from two datasets, capturing hospital-based metrics, demographics, and death rates. The analysis included only those patients who underwent emergency or urgent surgery, with a specific set of core operations required before considering secondary procedures. The study excluded children's hospitals, government hospitals, and hospitals performing fewer than three procedures annually. The primary outcome measure was the mortality rate, defined as the number of deaths following emergency admissions divided by the number of emergency surgeries performed at each hospital. The relationship between emergency operative volumes and postoperative inpatient mortality was examined using beta-logistic generalized linear regression, adjusting for hospital case-mix and other relevant characteristics. Natural logarithms were employed to predict operative volume, with the primary analysis focusing on the impact of the natural logarithm of volume on mortality rates. The study utilized the Elixhauser-van Walraven comorbidity index to account for chronic disease burden among patients, incorporating patient demographics such as mean age, gender, race, and payer status. Odds ratios from unadjusted and multivariate risk-adjusted analyses were used to represent the effect of hospital volume on in-hospital mortality.

To assess the proportion of variance explained by each predictor in the beta regression models, pseudo-R2 statistics were utilized. Unlike standard R2 values in linear regression, pseudo-R2 statistics offer a broader range of

possibilities for evaluating model fit in beta regression models. The characteristics of survivors and deceased patients were compared using Chi-squared tests for categorical variables, with data summarized as frequencies and percentages. For normally distributed continuous variables, mean and standard deviation values were compared using two-sample t-tests. The study aimed to identify the hospital operating volume associated with the lowest mortality rate for emergency surgery patients. Beta regression models were used to analyze volume thresholds, with a focus on achieving a risk-adjusted mortality rate of 95% for hospitals performing 2,000 surgeries or more per year. The analysis highlighted that hospitals with high non-elective cholecystectomy operative volumes, adjusted by hospital mortality ratio, exhibited lower death rates compared to the average risk-adjusted mortality for all cholecystectomy hospitals. A risk-adjusted mortality rate was calculated for each emergency general surgery (EGS) procedure performed in acute care hospitals, providing insights into the optimal volume thresholds for minimizing mortality in emergency surgical care.

RESULTS

In the study, 299 emergency surgeries were performed across 425 acute care hospitals. Among these, 62 hospitals performed cholecystectomies, while 288 hospitals performed umbilical hernia repairs. Annually, approximately 17,427 cholecystectomy procedures were conducted, alongside 268 umbilical hernia repairs, 666 necrotizing soft tissue infection (NSTI) expulsions, and 871 peptic ulcer repairs. A total of 42,860 emergency general surgery (EGS) procedures were recorded, with an overall mortality rate of 5.5%.

The mortality rates varied significantly across different types of operations. The breakdown is as follows: appendectomy surgeries had a mortality rate of 0.6%, cholecystectomy procedures 1.5%, colectomy procedures 14.2%, inguinal and femoral hernia repairs 2.3%, laparoscopic procedures 6.2%, NSTI excisions 11.4%, peptic ulcer procedures 17.7%, small bowel resections 12.6%, umbilical hernia repairs 1.1%, and ventral hernia repairs 2.4%. Detailed patient-level data for these procedures are available in the study's supplementary materials

Table: 1 Estimation of hospital mortality rates is based on beta regression:

Operation	Multivariable risk-adjusted model		
	Estimate ^a	95% CI	p Value
Apexectomy	0.20	0.18-0.21	<0.001
Cystectomy	0.25	0.24-0.28	<0.001
Colectomy	0.43	0.40-0.50	<0.001
The repair of femoral and inguinal hernias	0.23	0.20-0.25	<0.001

Operation	Multivariable risk-adjusted model		
	Estimate ^a	95% CI	p Value
Ascending adhesions lyse	0.30	0.27-0.35	<0.001
Infection of the soft tissues leading to necrosis	0.26	0.20-0.35	<0.001
Peptic ulcer surgery for perforated ulcers	0.32	0.25-0.41	<0.001
Surgical resection of small bowels	0.35	0.34-0.42	<0.001
Repairing umbilical hernias	0.20	0.16-0.25	<0.001
Surgical repair of ventral hernias	0.23	0.20-0.26	<0.001

DISCUSSION

The study revealed that higher volumes of emergency operations in hospitals were associated with improved survival rates for geriatric patients undergoing emergency general surgery (EGS) [6]. This finding underscores the importance of establishing operational performance thresholds to optimize outcomes in elderly patients. However, the study did not specify the exact number of surgeries performed by each hospital, raising concerns about the accuracy of surgical volume measurements as a quality indicator [7]. Quality improvement initiatives are vital for reducing variability in medical and surgical outcomes, particularly in EGS operations within this geriatric cohort [8]. The study found that hospital operative volume significantly impacted survival variability, whereas patient-level characteristics did not consistently correlate with outcomes. This suggests that traditional risk-adjustment measures may not fully capture the complexities of geriatric patients. There is potential in exploring geriatric-focused variables, which were not included in the SID dataset used for this study.

Hospital cultures, such as those of highly reliable organizations, may also contribute to the observed survival variability. Although qualitative in nature, these cultural factors can be partially captured by beta regression models [9]. The study emphasizes the need for a better understanding of the processes, structures, and cultures that contribute to patient outcomes. It highlights the limitation of using traditional metrics and advocates for a more nuanced approach to evaluating hospital performance based on procedural volumes [10,11]. The study further discusses the operational challenges faced by high-volume centers in providing timely diagnosis and treatment for surgical emergencies. It emphasizes the importance of

conducting emergency procedures in a timely manner, ideally during daylight hours, to optimize patient outcomes. However, the study acknowledges the potential difficulties in transferring patients from rural to intensive centers, which may delay therapy and negatively impact outcomes.

The variability in outcomes for procedures like cholecystectomy and appendectomy across different hospitals suggests that some institutions may classify low-risk emergency operations as high-risk, and vice versa [12]. This inconsistency points to the need for further research and the establishment of best practices for managing less complex procedures in older patients.

Surgeon volume is another critical factor that may influence EGS outcomes in geriatrics. While extensive research has been conducted on the impact of hospital and surgeon volumes, the study notes that geriatric patients undergoing EGS may not have the option to choose their surgeon, and the experience of the surgeon may not be as critical in these emergency situations.

CONCLUSION

The study demonstrates that geriatric survival rates significantly improve in hospitals with higher volumes of emergency geriatric surgeries, highlighting operational volume as a critical quality indicator. To mitigate the variability in survival rates observed at lower-volume hospitals, consolidating emergency surgeries at higher-volume accredited centers may benefit geriatric patients. Future research should focus on investigating and validating additional factors that influence morbidity and mortality in geriatric patients undergoing surgical emergencies, to further enhance the quality and outcomes of their care.

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