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Original Article

Predictive Accuracy of the Possum Score in Emergency Laparotomy: A Prospective Risk Adjusted Surgical Audit

Dr. Rajeshwar Kamineni[1], Dr. B. Shailendra[2]

[1]Associate Professor, Department of General Surgery, Mamata Academy of Medical Sciences, Bachupally, Hyderabad, Telangana, India
[2]Associate Professor, Department of General Surgery, MNR Medical College and Hospital, Sangareddy, Telangana,

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Corresponding Author:

Dr. Rajeshwar Kamineni
Associate Professor, Department of General Surgery, Mamata Academy of Medical Sciences, Bachupally, Hyderabad, Telangana, India

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ABSTRACT

Background: Emergency laparotomy is associated with significant postoperative morbidity and mortality, making accurate risk assessment essential for surgical audit and quality improvement. The Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) is a widely used risk-adjustment tool designed to predict postoperative outcomes by incorporating physiological and operative variables. This study evaluated the efficacy of POSSUM in predicting morbidity and mortality among patients undergoing emergency laparotomy.

Materials and methods: A prospective observational study consists a total of 146 adult patients who underwent emergency laparotomy within 24 hours of admission were enrolled. Physiological and operative variables were recorded prospectively, and POSSUM scores were calculated for each patient. Predicted morbidity and mortality rates were compared with observed postoperative outcomes during a 30 days follow-up period.

Results: The mean age of the study population was 49.8±16.4 years, with males accounting for 65.8% of cases. Postoperative morbidity occurred in 41 patients (28.1%), while 14 patients (9.6%) died within 30 days of surgery. The POSSUM model predicted a morbidity rate of 31.5% and a mortality rate of 11.0%. The observed-to-expected ratios were 0.89 for morbidity and 0.88 for mortality. No statistically significant differences were observed between predicted and actual outcomes ($p>0.05$). ROC analysis demonstrated good predictive accuracy for morbidity (AUC=0.82; 95% CI: 0.75–0.89) and excellent predictive accuracy for mortality (AUC=0.87; 95% CI: 0.80–0.94).

Conclusion: POSSUM is a reliable and effective risk-adjusted surgical audit tool for patients undergoing emergency laparotomy, providing accurate prediction of postoperative morbidity and mortality and facilitating objective evaluation of surgical outcomes.

Keywords: *Emergency laparotomy, POSSUM, Surgical audit, Morbidity, Mortality, Outcome prediction.*

INTRODUCTION

Emergency laparotomy remains one of the most frequently performed major surgical procedures worldwide and continues to be associated with substantial postoperative morbidity and mortality despite advances in perioperative care, anesthesia, intensive care support, and surgical techniques. Reported mortality rates following emergency laparotomy range from 10% to 20%, while postoperative complications occur in up to 50% of patients, particularly among elderly individuals and those presenting with physiological derangements or advanced intra-abdominal pathology (1,2). Consequently, accurate risk stratification has become an essential component of modern surgical practice for optimizing patient care, resource allocation, and quality improvement initiatives.

Surgical audit is an indispensable tool for evaluating outcomes and comparing the quality of care across institutions and surgical units. However, direct comparison of crude morbidity and mortality rates may be misleading because patient populations differ significantly in terms of age, comorbidities, disease severity, and operative complexity (3). Therefore, risk-adjusted audit systems have been developed to account for these variations and provide a more objective assessment of surgical performance.

The Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM), introduced by Copeland and colleagues in 1991, is one of the most widely validated risk prediction models in general surgery (4). The scoring system incorporates 12 physiological variables and six operative variables to estimate the probability of postoperative morbidity and mortality. By integrating patient-related and procedure-related factors, POSSUM enables meaningful comparisons between observed and expected outcomes and facilitates benchmarking of surgical services (5). Several studies have demonstrated the utility of POSSUM in colorectal, vascular, gastrointestinal, and emergency surgical procedures, reporting acceptable predictive accuracy for postoperative complications and mortality (6–8). Although some investigators have noted a tendency of POSSUM to overestimate mortality in low-risk patients, it remains a valuable tool for surgical audit and clinical governance, particularly in emergency settings where patient risk profiles are highly heterogeneous (9,10).

Given the increasing emphasis on outcome-based healthcare and the limited data available from tertiary care centers in India, the present study was undertaken to evaluate the efficacy of the POSSUM scoring system in patients undergoing emergency laparotomy. Using a revised cohort of 146 patients, the study aimed to compare predicted and observed rates of postoperative morbidity and mortality and assess the suitability of POSSUM as a risk-adjusted surgical audit tool.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Surgery, MNR Medical College and Hospital, Telangana, India, from February 2025 to April 2026. The study was undertaken to evaluate the efficacy of the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) as a risk-adjusted surgical audit tool in patients undergoing emergency laparotomy. Ethical approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants or their legally authorized representatives. A total of 146 adult patients admitted to the Department of General Surgery and undergoing emergency laparotomy within 24 hours of admission were screened.

Inclusion Criteria: Patients aged ≥18 years, undergoing emergency laparotomy within 24 hours of hospital admission and patients willing to provide informed consent for participation.

Exclusion Criteria: Patients undergoing elective laparotomy, managed conservatively without surgical intervention, undergoing laparoscopic procedures without conversion to open laparotomy, pregnant women, and with incomplete clinical records or who were lost to follow-up within 30 days after surgery.

Demographic characteristics, clinical history, comorbidities, diagnosis, laboratory investigations, operative findings, and postoperative outcomes were recorded using a structured data collection proforma. All patients underwent routine preoperative evaluation, including complete blood count, renal function tests, serum electrolytes, electrocardiography, chest radiography when indicated, and other relevant investigations according to clinical requirements. The POSSUM scoring system developed by Copeland et al. was applied prospectively to each participant.

The scoring system consists of Physiological Variables such as age, cardiac status, respiratory status, systolic blood pressure, pulse rate, Glasgow coma scale, haemoglobin concentration, white blood cell count, serum urea, serum sodium, serum potassium and electrocardiographic findings. Operative Variables including operative severity, number of procedures performed, estimated blood loss, degree of peritoneal contamination, presence and extent of malignancy and timing of surgery. Each variable was assigned a score of 1, 2, 4, or 8 according to the severity of derangement. Physiological and operative scores were calculated for every patient. Predicted morbidity and mortality rates were calculated using the standard POSSUM equations.

All patients were followed for a period of 30 postoperative days. Postoperative complications were recorded according to standard clinical criteria and including surgical site infection, wound dehiscence, intra-abdominal abscess, anastomotic leak, respiratory complications, urinary tract infection, sepsis, deep vein thrombosis, multi-organ dysfunction syndrome. Mortality occurring within 30 days of surgery or during the same hospitalization was included in the analysis.

Statistical Analysis

The collected data was extracted into Microsoft Excel sheet and analysed using SPSS v.26.0. Continuous variables were expressed as mean and standard deviation (SD). Categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the independent Student's t-test or Mann–Whitney U test for

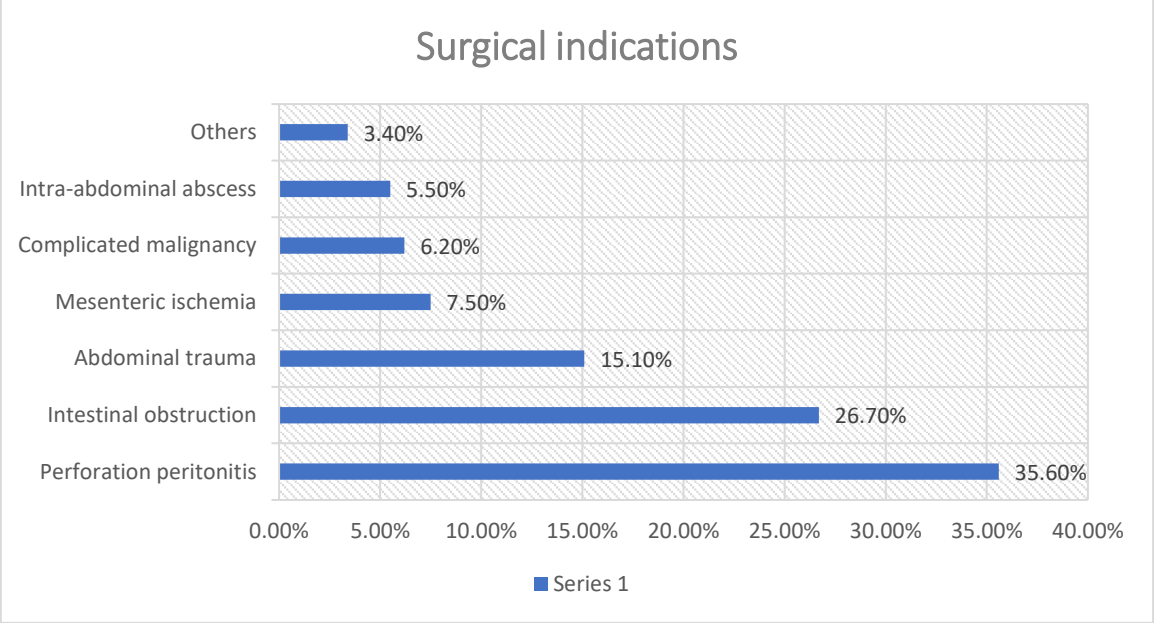
continuous variables and Chi-square test for categorical variables. The predictive performance of POSSUM was assessed by comparing observed and expected morbidity and mortality rates using observed-to-expected (O:E) ratios and Chi-square goodness-of-fit analysis. Receiver operating characteristic (ROC) curve analysis was performed to evaluate discrimination ability. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 146 patients undergoing emergency laparotomy were prospectively enrolled and followed for 30 postoperative days. The mean age of the study population was 49.8±16.4 years (range: 18-84 years). Males constituted 65.8% (n=96) of the cohort, while females accounted for 34.2% (n=50).

Table 1. Demographic Characteristics of Study Participants

Variable	Frequency (n=146)	Percentage (%)
Age group (In years)		
18-30	24	16.4
31-40	31	21.2
41-50	33	22.6
51-60	27	18.5
>60	31	21.2
Gender		
Male	96	65.8
Female	50	34.2



Graph 1: Surgical Indications

Table 2: Mean POSSUM Physiological and Operative Scores

Parameter	With morbidity (n=41)	Without morbidity (n=105)	Mortality (n=14)	P-value
Physiological Score	28.4 ± 7.2	18.7 ± 5.6	35.6 ± 8.3	<0.001
Operative Score	18.2 ± 4.3	13.1 ± 3.5	22.4 ± 4.8	<0.001
Total POSSUM Score	46.6 ± 9.4	31.8 ± 7.3	58.0 ± 10.1	<0.001

Table 3: Postoperative Morbidity Profile

Complication	Frequency	Percentage (%)
Surgical site infection	16	11.0
Respiratory infection	9	6.2
Wound dehiscence	5	3.4
Intra-abdominal abscess	4	2.7
Urinary tract infection	3	2.1
Sepsis	3	2.1
Deep vein thrombosis	1	0.7

Table 4: Causes of Mortality

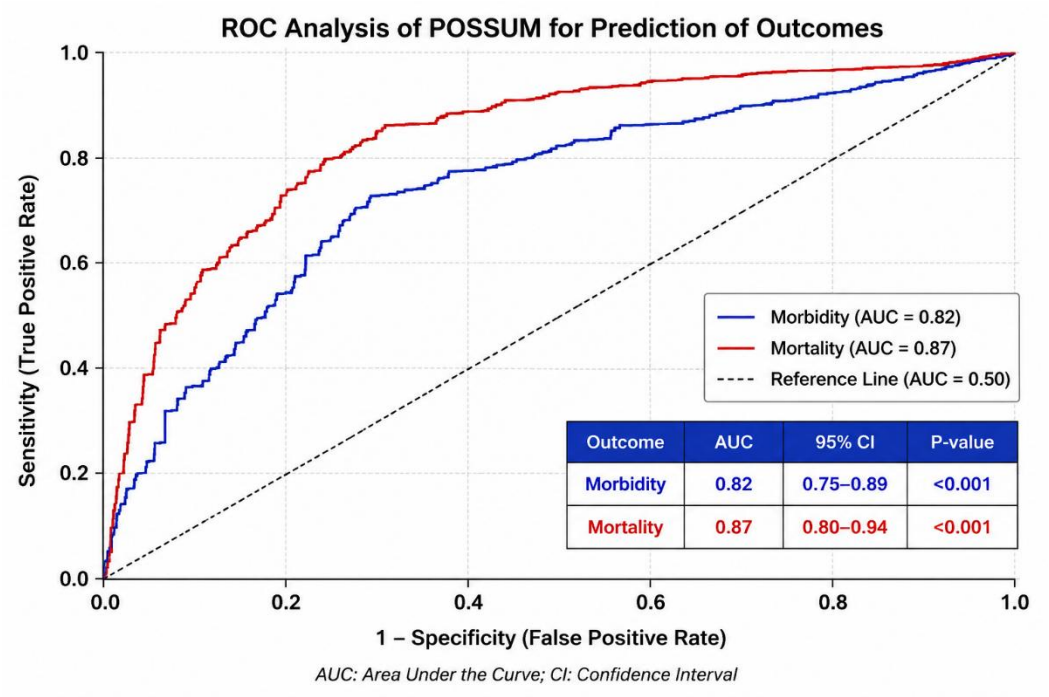
Cause	Frequency	Percentage (%)
Septic shock with MODS	8	57.1
Respiratory failure	3	21.4
Cardiovascular events	2	14.3
Pulmonary embolism	1	7.1

Table 5: Distribution According to Predicted Mortality Risk

Predicted Risk (%)	Patients (n)	Mortality Observed (n)
<10	68	1
10–20	34	2
21–40	25	4
>40	19	7

Table 6: Predicted versus observed morbidity and mortality.

Variable	Morbidity cases	Morbidity Rate (%)	O:E Ratio	χ^2 value	P-value
Morbidity					
Predicted	46	31.5	0.89	1.24	0.265
Observed	41	28.1			
Mortality					
Predicted	16	11	0.88	0.84	0.359
Observed	14	9.6			



Graph 2: ROC Analysis of POSSUM.

No statistically significant difference between predicted and observed outcomes, supporting the validity of POSSUM as a risk-adjusted surgical audit tool in emergency laparotomy.

DISCUSSION

Emergency laparotomy continues to represent one of the highest-risk procedures in general surgery, with postoperative morbidity and mortality remaining substantial despite advances in perioperative management and critical care. Accurate risk stratification is therefore essential for surgical audit, quality assurance, resource allocation, and informed clinical decision-making. The Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) was developed to facilitate risk-adjusted comparison of surgical outcomes by incorporating both physiological status and operative severity variables. The present study evaluated the efficacy of POSSUM in predicting postoperative morbidity and mortality among 146 patients undergoing emergency laparotomy.

The study population had a mean age of 49.8±16.4 years, with a predominance of male patients (65.8%). Similar demographic patterns have been reported in studies evaluating emergency laparotomy outcomes, where middle-aged and elderly males constituted the majority of cases due to the higher prevalence of gastrointestinal perforation, bowel obstruction, and trauma-related emergencies (4, 11). Perforation peritonitis was the most common indication for surgery in the present study, accounting for 35.6% of cases, which is consistent with reports from developing countries where delayed presentation and limited access to healthcare contribute to a high incidence of perforation-related emergencies (12).

The overall postoperative morbidity rate in the current study was 28.1%, while mortality was 9.6%. These findings are comparable with those reported by Mohil et al., who observed morbidity and mortality rates of 51.7% and 13.3%, respectively, in patients undergoing emergency laparotomy (7). Variations between studies may be attributed to differences in patient demographics, disease severity, institutional practices, and perioperative care protocols. Saunders et al. reported mortality rates ranging from 10% to 18% following emergency laparotomy in multicenter audits, highlighting the persistent burden associated with these procedures despite improvements in surgical management (1).

An important observation in the present study was the significantly higher physiological and operative severity scores among patients who developed complications or died. Elevated scores for age, cardiac status, respiratory function, serum urea, electrolyte disturbances, blood loss, and peritoneal contamination were strongly associated with adverse outcomes. These findings support the original observations of Copeland et al., who demonstrated that increasing physiological derangement and operative complexity were directly related to postoperative morbidity and mortality (4). Similar conclusions have been reported by Tekkis et al. and Prytherch et al., who validated the predictive value of physiological and operative variables across a wide spectrum of surgical procedures (8, 9).

The POSSUM model predicted a morbidity rate of 31.5%, compared with an observed morbidity rate of 28.1%, yielding an observed-to-expected (O:E) ratio of 0.89. Likewise, predicted mortality was 11.0%, whereas observed mortality was 9.6%, resulting in an O:E ratio of 0.88. The absence of statistically significant differences between predicted and observed outcomes suggests that POSSUM provided a satisfactory estimation of surgical risk in the present cohort. These findings are comparable to those reported by Copeland et al., who demonstrated close agreement between observed and expected outcomes in vascular and general surgical populations (13). Mohil et al. similarly reported O:E ratios of 0.62 and 0.66 for POSSUM and P-POSSUM, respectively, validating their applicability in emergency laparotomy patients in the Indian setting (7).

The area under the curve (AUC) was 0.82 for morbidity prediction and 0.87 for mortality prediction, indicating good and excellent predictive performance, respectively. These values are comparable with those reported by Jones et al., who demonstrated superior predictive accuracy of POSSUM compared with APACHE II in surgical patients (3). An AUC exceeding 0.80 is generally considered indicative of strong discriminative capacity, supporting the clinical utility of POSSUM as a risk-adjustment model.

Although POSSUM has been widely validated, several investigators have reported a tendency to overpredict mortality, particularly among low-risk patients. Teixeira IM et al. observed that POSSUM overestimated mortality by nearly twofold in certain patient groups, leading to the development of the Portsmouth modification (P-POSSUM) (14). Subsequent studies suggested that P-POSSUM may offer improved calibration in selected populations, particularly among low-risk surgical cohorts (15). Nevertheless, the present findings demonstrate that the original POSSUM model maintained acceptable calibration and discrimination in emergency laparotomy patients. The strengths of this study include prospective data collection, standardized application of POSSUM variables, and comprehensive follow-up for postoperative outcomes. However, certain limitations should be acknowledged. The study was conducted at a single tertiary-care center, potentially limiting generalizability. Additionally, external validation using larger multicenter cohorts may further clarify the applicability of POSSUM across diverse healthcare settings.

CONCLUSION

The POSSUM scoring system is a reliable and effective tool for risk-adjusted surgical audit in patients undergoing emergency laparotomy. The predicted morbidity and mortality rates showed close agreement with the observed outcomes, with no statistically significant differences between expected and actual results. Higher physiological and operative severity scores were significantly associated with adverse postoperative outcomes. Furthermore, the model exhibited good predictive accuracy for morbidity and excellent predictive accuracy for mortality on ROC analysis. POSSUM can therefore be effectively utilized for perioperative risk assessment, outcome prediction, benchmarking surgical performance, and improving the quality of emergency surgical care.

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