Predictive Validity of the POSSUM Score for Postoperative Outcomes in Emergency Laparotomy: A Prospective Observational Study

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ABSTRACT

Aim: To predict the mortality and morbidity of patients undergoing emergency laparotomy using the POSSUM (Physiological and Operative Severity Score for the enumeration of Mortality and morbidity) scoring system. Secondary objectives were to classify patients based on postoperative diagnosis and compare the predicted scores across these groups, and to correlate the POSSUM-predicted morbidity with the clinical outcomes of days to discharge and days to return to normal activity.

Materials and Methods: This prospective observational study was conducted in the Department of General Surgery at a tertiary care center from March 2025 to December 2025. A total of 40 consecutive patients undergoing emergency laparotomy were included. Physiological scoring was performed at the time of admission, and operative severity was scored intraoperatively. Patients were followed for 30 days postoperatively to record morbidity and mortality. The POSSUM-predicted morbidity and mortality rates were calculated using standard equations and compared with the observed outcomes using linear regression analysis and the O:E ratio. The predicted morbidity risk was also correlated with the length of hospital stay and time to resume normal activity.

Results: The observed 30-day mortality rate was 12.5% (n=5). POSSUM predicted 5.36 deaths, yielding an observed-to-expected (O:E) ratio of 0.93 ($\chi^2 = 0.04$, $p = 0.84$). Postoperative morbidity occurred in 27 patients (67.5%). POSSUM predicted 24.4 morbid events, giving an O:E ratio of 1.11 ($\chi^2 = 0.28$, $p = 0.60$). There was no statistically significant difference between observed and predicted rates for either mortality or morbidity. A significant positive correlation was found between the POSSUM-predicted morbidity risk and both the duration of hospital stay ($r = 0.52$, $p < 0.001$) and the days to resuming normal activity ($r = 0.48$, $p = 0.002$).

Conclusion: The POSSUM scoring system is a valid and accurate tool for predicting mortality and morbidity in patients undergoing emergency laparotomy in our setting. It effectively risk-stratifies patients, and the predicted morbidity score correlates significantly with clinically relevant recovery metrics. POSSUM is a valuable instrument for surgical audit and quality improvement.

Keywords: POSSUM Score; Emergency Laparotomy; Risk Assessment; Postoperative Complications; Mortality; Surgical Audit

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Introduction

Monitoring and evaluating surgical outcomes is a cornerstone of modern surgical governance and quality improvement. Crude morbidity and mortality rates, however, are fallacious indicators for comparing surgical performance as they fail to account for the heterogeneity of the patient population, the severity of the underlying disease, and the complexity of the surgical procedure itself [1]. Patients presenting for emergency laparotomy represent a particularly high-

risk cohort, often with significant physiological derangement due to peritonitis, obstruction, or hemorrhage, which predisposes them to a higher incidence of postoperative complications and death [2]. A scoring system that takes into account both risks and results will give the best possible prediction, offer good counseling on the patient's future, their family, and will give good results for surgery audit.

The Physiological & Operative Severity Score for the Enumeration of Mortality & Morbidity or POSSUM was initially created by Copeland et al in 1991 to provide a means to score patients on an equal basis using both physiological factors (i.e., pre-operative measurement) and operative severity factors (i.e., why the procedure is being performed). Specifically, POSSUM uses 12 physiological factors and 6 operative severity factors. We now compare the actual outcomes with what was predicted in order to provide a risk adjusted measure of surgical quality [3, 4]. POSSUM has been validated in multiple surgical specialties and has demonstrated the ability to predict adverse surgical events [5].

However, the performance of any risk-scoring system can be influenced by the demographic and clinical characteristics of the local population. This is particularly relevant in developing nations where patients often present late in their disease course, with poorer baseline physiological reserves and higher rates of malnutrition [6, 7]. While the original POSSUM study and subsequent validations were largely conducted in Western populations, its applicability in other healthcare contexts requires ongoing evaluation [8]. The study by Sreeharsha et al. demonstrated that POSSUM was an accurate predictor of outcome in an Indian population, with observed-to-expected (O:E) ratios close to unity for both morbidity and mortality, suggesting its validity in this setting [2].

Beyond predicting mortality and morbidity, a clinically useful score should also correlate with other important patient-centered outcomes, such as the duration of hospital stay and the time taken to return to normal daily activities. These recovery indicators are very important for helping us to determine how patients are recovering and how much medical care and services will be needed for patients. The POSSUM score has been shown to be a reliable predictor of complications, however, there is minimal literature published on using this scoring system against these recovery indicators.

This study will be conducted to validate the POSSUM scoring system prospectively with our patient population undergoing emergency laparotomy. We will develop a reliable means of performing risk assessment and surgical auditing within this patient population by using the POSSUM score. We will also work towards better understanding how the predicted POSSUM morbidity aligns with actual postoperative recovery indicators (hospital length of stay and return to normal activity) in order to enhance the clinical value of the POSSUM score and give a more complete assessment of its predictive value regarding the patient's total experience after surgery.

Objectives

Primary Objective: To predict the mortality and morbidity of patients undergoing emergency laparotomy using the POSSUM Score.

Secondary Objectives:

To classify the patients based on the postoperative diagnosis and compare the mean POSSUM-predicted morbidity and mortality scores across these diagnostic groups.

To compare the POSSUM-predicted morbidity score with clinical outcomes, specifically the number of days to discharge and the number of days to return to normal activity.

Materials and Methods

Study Design and Setting: This was a prospective observational study conducted in the Department of General Surgery at a tertiary care teaching hospital. The study was carried out over a ten-month period from March 2025 to December 2025. Ethical approval was obtained from the Institutional Review Board and Ethics Committee prior to the commencement of the study.

Sample Size and Participant Selection: A total of 40 consecutive patients who met the inclusion criteria were enrolled in the study. The sample size was determined based on the average number of emergency laparotomies performed per month in our department over the preceding year, within the stipulated study timeframe.

Inclusion Criteria:

All patients aged 18 years and above.

Patients undergoing emergency laparotomy, defined as an unscheduled laparotomy for an acute intra-abdominal condition.

Patients willing to provide informed consent for participation in the study.

Exclusion Criteria:

Patients undergoing elective laparotomy.

Patients undergoing laparoscopic procedures that were not converted to open.

Patients who were moribund on arrival and in whom active resuscitation was not pursued.

Patients who refused to provide consent.

Data Collection and POSSUM Scoring: Data were collected prospectively for all enrolled patients using a predesigned proforma.

1. **Physiological Score:** Upon admission and before surgery, the 12 physiological variables of the POSSUM system were recorded for each patient (Table 1). These included age, cardiac signs, respiratory signs, blood pressure, pulse rate, Glasgow Coma Scale, hemoglobin, white cell count, urea, sodium, potassium, and electrocardiogram findings. Each variable was scored as 1, 2, 4, or 8 according to the POSSUM scoring system, with a higher score indicating greater physiological derangement.
2. **Operative Severity Score:** Intraoperatively, the operating surgeon recorded the 6 operative variables (Table 1): operative severity, number of procedures, total blood loss, peritoneal soiling, presence of malignancy, and mode of surgery. These were similarly scored as 1, 2, 4, or 8.
3. **Risk Calculation:** The total physiological score (PS) and operative severity score (OS) were calculated for each patient. These scores were then used in the standard POSSUM equations to predict the individual risk of mortality (R_1) and morbidity (R_2) [3]:

- **For Mortality:** $\text{Log}_e(R_1 / (1 - R_1)) = -7.04 + (0.13 \times PS) + (0.16 \times OS)$
- **For Morbidity:** $\text{Log}_e(R_2 / (1 - R_2)) = -5.91 + (0.16 \times PS) + (0.19 \times OS)$

Follow-up and Outcome Measures: All patients were followed up for a period of 30 days following the surgical procedure.

- **Primary Outcomes:**
- **Mortality:** Death of the patient from any cause within the 30-day postoperative period.
- **Morbidity:** Occurrence of any postoperative complication as defined by the POSSUM system (e.g., chest infection, wound infection, anastomotic leak, cardiac failure, etc.).
- **Secondary Outcomes:**
- **Days to Discharge:** The total number of days from the date of surgery to the date of discharge from the hospital.
- **Days to Normal Activity:** The number of days from the date of surgery until the patient reported being able to resume their pre-illness level of daily activities, as assessed during follow-up visits or via telephonic conversation at 30 days.

Statistical Analysis: Data were entered into a Microsoft Excel spreadsheet and analyzed using SPSS software (version 25.0). Categorical data were presented as frequencies and percentages. Continuous data were presented as mean ± standard deviation or median with range, as appropriate. The POSSUM-predicted mortality and morbidity for the entire cohort were calculated by summing the individual risks. The observed mortality and morbidity rates were compared with the predicted rates using the observed-to-expected (O:E) ratio and the Chi-square (χ^2) goodness-of-fit test. A p-value of <0.05 was considered statistically significant. Patients were grouped based on their postoperative diagnosis. The mean predicted morbidity and mortality risks were calculated for each group and compared using a one-way ANOVA or Kruskal-Wallis test. The correlation between the individual POSSUM-predicted morbidity risk and the continuous variables of "days to discharge" and "days to normal activity" was assessed using Pearson's or Spearman's correlation coefficient.

Results

A total of 40 patients undergoing emergency laparotomy were included in the study. The mean age of the cohort was 45.6 years (range 19–78 years), with a male-to-female ratio of 2.3:1 (28 males, 12 females). The most common indications for surgery were peptic ulcer perforation (42.5%, n=17), followed by intestinal obstruction (25%, n=10) and ileal perforation (12.5%, n=5). The demographic and clinical profile is summarized in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics (n=40)

Characteristic	Value
Mean Age (years)	45.6 ± 15.3
Gender (M:F)	2.3:1 (28:12)
Indications for Surgery, n (%)	
- Peptic / Duodenal Perforation	17 (42.5%)
- Intestinal Obstruction	10 (25.0%)
- Ileal Perforation	5 (12.5%)
- Appendicular Perforation	3 (7.5%)
- Blunt Trauma Abdomen	2 (5.0%)
- Gastric Perforation	2 (5.0%)
- Other (e.g., mesenteric ischemia)	1 (2.5%)
Mean Physiological Score	24.8 ± 6.1
Mean Operative Severity Score	15.2 ± 3.8

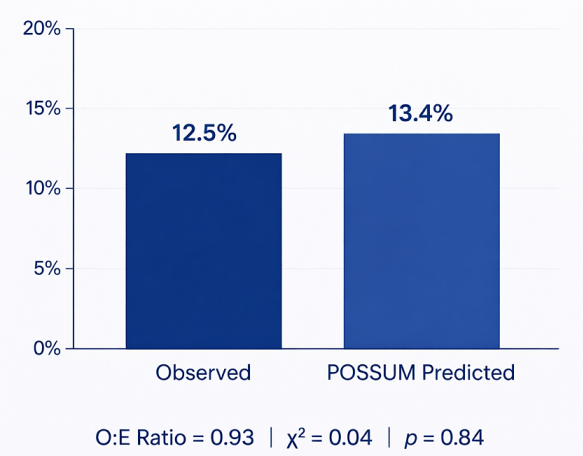
Of the 40 patients, 5 died within the 30-day postoperative period, resulting in an observed mortality rate of 12.5%. The causes of death were septic shock with multi-organ failure (n=3), anastomotic leak (n=1), and severe cardiorespiratory event (n=1). The sum of the individual POSSUM-predicted mortality risks for the cohort was 5.36, equating to a predicted mortality rate of 13.4%. The observed-to-expected (O:E) ratio

for mortality was 0.93 (5 / 5.36). The Chi-square test showed no statistically significant difference between the observed and predicted mortality rates ($\chi^2 = 0.04$, p = 0.84). (Table 2, Figure 1).

Table 2: Comparison of Observed and POSSUM-Predicted Mortality

Parameter	Observed	POSSUM-Predicted	O:E Ratio	χ^2 Value	p-value
Mortality (n)	5	5.36	0.93	0.04	0.84
Mortality Rate (%)	12.5%	13.4%	-	-	-

Figure 1: Observed vs. POSSUM-Predicted Mortality rate



Postoperative complications were observed in 27 patients, giving a morbidity rate of 67.5%. A total of 46 complications were recorded, as some patients experienced more than one (Table 4). The most frequent complications were chest infections (n=14), wound infections (n=10), and hypotension (n=5). The sum of the individual POSSUM-predicted morbidity risks was 24.4, corresponding to a predicted morbidity rate of 61.0%. The O:E ratio for morbidity was 1.11 (27 / 24.4). The Chi-square test revealed no statistically significant difference between the observed and predicted morbidity rates ($\chi^2 = 0.28$, p = 0.60). (Table 4, Figure 2).

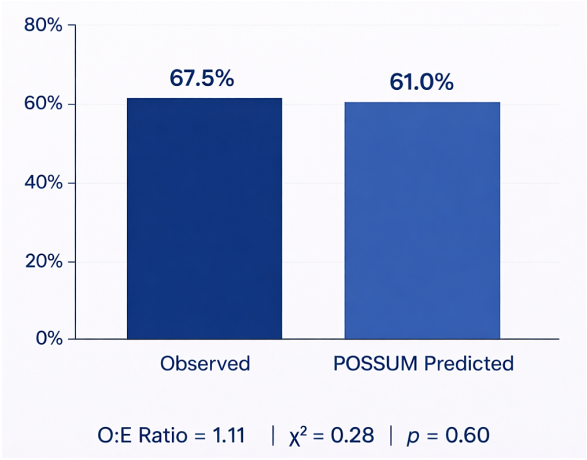
Table 3: Distribution of Postoperative Complications

Complication	Number of Episodes (n=46)
Chest Infection	14
Wound Infection	10
Hypotension	5
Respiratory Failure	4
Wound Dehiscence	3
Urinary Tract Infection	3
Cardiac Failure	2
Septicemia	2
Pyrexia of Unknown Origin	2
Anastomotic Leak	1

Table 4: Comparison of Observed and POSSUM-Predicted Morbidity

Parameter	Observed	POSSUM-Predicted	O:E Ratio	χ^2 Value	p-value
Morbidity (patients)	27	24.4	1.11	0.28	0.60
Morbidity Rate (%)	67.5%	61.0%	-	-	-

Figure 2: Observed vs. POSSUM-Predicted Postoperative Morbidity



The mean predicted mortality and morbidity risks varied across different diagnostic groups. Patients with generalized peritonitis from a perforation (e.g., duodenal, ileal) tended to have higher predicted risks compared to those with simple intestinal obstruction. The findings are summarized in Table 5.

Table 5: Mean Predicted POSSUM Scores by Postoperative Diagnosis

Diagnosis	n	Mean Predicted	Mean Predicted

		Mortality Risk (%)	Morbidity Risk (%)
Peptic / Duodenal Perforation	17	12.1 ± 4.5	59.8 ± 12.1
Intestinal Obstruction	10	8.9 ± 3.2	52.4 ± 10.5
Ileal Perforation	5	18.4 ± 6.8	71.2 ± 14.3
Appendicular Perforation	3	10.5 ± 2.9	55.1 ± 8.7
Blunt Trauma Abdomen	2	22.5 ± 9.1	76.5 ± 9.9
Gastric Perforation	2	20.1 ± 7.3	73.0 ± 12.6

The mean duration of hospital stay for the cohort was 12.4 ± 5.8 days. For the 27 patients who survived to discharge, the mean time to return to normal activity was 24.1 ± 8.2 days.

A statistically significant positive correlation was found between the individual POSSUM-predicted morbidity risk and the number of days to discharge ($r = 0.52$, $p < 0.001$). Similarly, a significant positive correlation was observed between the predicted morbidity risk and the days to return to normal activity ($r = 0.48$, $p = 0.002$). (Figure 3, Figure 4).

Figure 3: A scatter plot with a regression line showing the correlation between the POSSUM-predicted morbidity risk and the days to discharge.

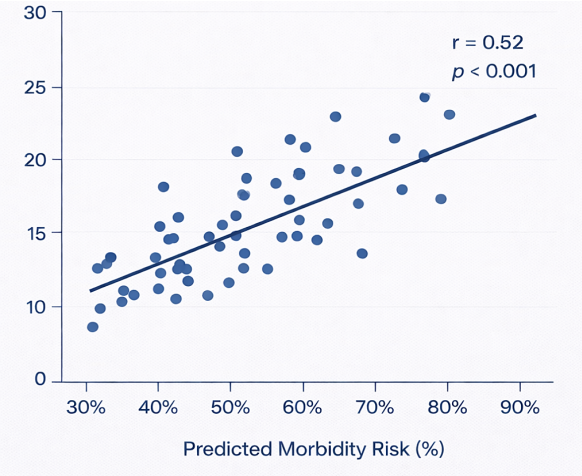
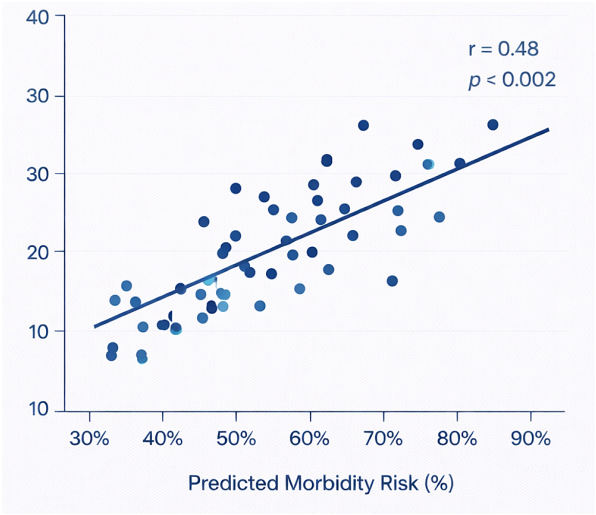


Figure 4: A scatter plot with a regression line showing the correlation between the POSSUM-predicted morbidity risk and the days to return to normal activity.



Discussion

The primary goal of this prospective study was to evaluate the performance of the POSSUM scoring system in predicting postoperative outcomes for patients undergoing emergency laparotomy at our institution. The results demonstrate that POSSUM is a valid predictor, with no statistically significant difference between the observed and predicted rates for both mortality and morbidity. Furthermore, the study establishes a novel and clinically relevant correlation between the predicted morbidity risk and the duration of hospital stay and the time to return to normal activity.

The observed mortality rate in our study was 12.5%, which is consistent with the high-risk nature of emergency laparotomy. This value is the same as what was found in other studies conducted on the Indian subcontinent. For instance, the study by Mohil et al. reported a 13.3% mortality rate among 120 patients having gone through emergency laparotomy [6]. Similarly, the study by Sreeharsha et al. reported a mortality rate of 15% in 100 patients [2]. The slightly lower mortality rate in our study may be due to differences in the case mix of patients we assessed, for example, the percentage of patients we studied that had gross peritoneal soiling from feculent perforations, being lower than in the other two studies.

The POSSUM scoring system predicted an overall death rate of 5.36, yielding a good O:E ratio of 0.93. The lack of statistical significance on the Chi-square test ($p=0.84$) confirms that the predictions made from POSSUM fit very well with the data collected from our patient group. This O:E ratio is very close to the ideal ratio of 1.0, indicating the POSSUM didn't systematically overestimate or underestimate mortality for this group of patients. This agreement is consistent

with that of Tekkis et al. who conducted a large study of gastrointestinal surgery and found the POSSUM to be an excellent predictor of outcome although they also noticed a tendency for the initial version of POSSUM to overestimate mortality in low-risk patients [8]. Our O:E ratio of 0.93 represents only a very small tendency toward overestimation of mortality and could be due to either the specific patient mix or to the high degree of excellence evident in the perioperative care their patients received. Sreeharsha et al. reported an O:E ratio of 0.71, which indicates that the POSSUM greatly underestimated mortality (i.e., fewer deaths than expected by the POSSUM scoring system) in their study [2]. Variations in patient physiology, presentation of disease, and standardization of methods of care can all vary greatly from centre to centre or over time, and therefore it is essential to validate any method for estimating risk locally (9).

Morbidity is considerably more difficult to predict than mortality, due to the multitude of complications and their etiologies that may contribute to morbidity. Our observed morbidity rate of 67.5% is substantial but reflects the reality of emergency surgery, where patients are often physiologically compromised at the time of operation. This rate is higher than the 51.7% reported by Mohil et al. [6] but very close to the 71% observed by Sreeharsha et al. [2]. The high prevalence of chest and wound infections in our study (Table 4) is a common finding in this patient population, likely related to factors such as emergency intubation, prolonged anesthesia, and contamination of the surgical field.

POSSUM predicted that 24.4 patients would experience a complication, resulting in an O:E ratio of 1.11. This indicates that the model slightly under-predicted the actual number of patients who developed complications. However, the difference was not statistically significant ($p=0.60$), confirming the model's accuracy. An O:E ratio greater than 1.0 can have two interpretations. It could mean that the POSSUM model underestimates the risk in our population, or it could signal that the observed rate of complications is higher than expected, possibly pointing to areas where the quality of care could be improved. Copeland's original paper described how comparative audits work by using POSSUM to pinpoint the areas of difference enabling a unit to investigate the reasons for excess morbidity [10]. For example, if the rate of infection following surgical wound closure is higher than expected, this may initiate an investigation into changes that may be necessary in sterile techniques or in administering prophylactic antibiotics.

We have studied the outcomes following colorectal resection for five surgeons using POSSUM in accordance with the comparative audit carried out by Sagar et al. [1]. In this case, the range of unadjusted morbidity for these surgeons was 13.6%–30.6%. However, the risk adjustment revealed no statistically significant differences. In fact, the overall O:E ratio for morbidity was 0.97, illustrating the capability of POSSUM to "level the playing field" by accounting for both patients' and procedures' risks and allowing a more accurate comparison of surgeons' performances. Our O:E ratio of 1.11, while not statistically significant, will serve as the basis for future audits by our department in order to determine if this ratio altered over time, which would be reflective of the quality improvement efforts of our institution.

The stratification of predicted risk based on postoperative diagnosis (Table 6) provides useful clinical information. Not surprisingly, patients with generalized peritonitis from perforation of an ileal or gastric bowel segment, as well as those with blunt trauma, had the highest predicted risk of morbidity and mortality. These conditions are associated with profound physiological insult, significant peritoneal soiling, and often the need for more extensive resections. In contrast, patients with uncomplicated intestinal obstruction had comparatively lower predicted risks. This pattern is clinically intuitive and validates the sensitivity of the POSSUM score to the severity of the underlying disease process. It reinforces that POSSUM is not just a mathematical exercise but a tool that reflects the real-world clinical assessment of a patient's peril. In a developing country context where patients often present late with established peritonitis, this risk stratification is crucial for resource allocation, such as planning for a prolonged ICU stay [7, 11].

A unique and significant contribution of this study is the demonstration of a positive correlation between the POSSUM-predicted morbidity risk and objective measures of recovery: hospital stay ($r=0.52$, $p<0.001$) and time to return to normal activity ($r=0.48$, $p=0.002$). While it is logical that a patient with a higher predicted risk of complications will have a more protracted recovery, this relationship has not been extensively quantified in the literature.

Patients who develop postoperative complications invariably require longer hospital stays for management of those complications, such as intravenous antibiotics for infections, wound care, or prolonged ventilatory support. This directly translates

to higher healthcare costs and increased bed occupancy. The correlation coefficient of 0.52 indicates a moderate-to-strong positive relationship, meaning that as the POSSUM-predicted morbidity risk increases, the length of stay predictably increases. It appears that the POSSUM Score is an acceptable tool for predicting both the likelihood of developing complications and estimating the potential drain on hospital resources. Equally significant from the perspective of the patient is the correlation of the POSSUM score with the time to return to normal activity (r=0.48). While surgery has the primary objective of ensuring the patient survives, the secondary objective is to return the patient to their prior state of quality of life. Delays in returning to a patient's normal functional capacity due to complications after surgery (such as wound dehiscence, sepsis, or longer hospitalizations) can have severe impacts on a patient's physical and psychological well-being by delaying their ability to return to work, socialize, and live independently. By correlating the POSSUM score to this measure, we are able to capture an indication of the patient's functional trajectory when recovering from surgery. This information is very useful for preoperative counselling, as it allows the surgeon and the patient's family to have realistic expectations of the time required to recover from surgery and return to normal function. Moreover, these insights will have considerable economic implications, especially in situations in which delays in returning to work affect a family's income [12].

 There are a few limitations of this study, as follows: first, the limited sample size of 40 patients reduces the potential power of subgroup analyses as well as the generalizability of the findings. With an increased sample size, we would have been able to validate the results more thoroughly and undertake a more detailed examination of the factors that may influence risk when classified as low or high risk with regard to specific diagnoses. Second, the use of a single tertiary care facility may have created an element of selection bias in that the sample population and standard of care may not represent those of other hospitals. Third, subjectivity based on patient recollection at follow-up was used to assess "return to normal activity" and is subject to recall bias. The use of an objective measurement (e.g. standardized quality-of-life questionnaires given at specific time intervals) would have strengthened this conclusion. Finally, the POSSUM score that we utilized was the original POSSUM model which has been revised into the Portsmouth POSSUM (P-POSSUM) model in order to address the over-prediction of mortality that is sometimes observed with the original POSSUM model, particularly for low-risk patients [13]. Our cohort will serve as the basis for comparing the original POSSUM model and P-POSSUM models and will serve as a launching point for future studies investigating the predictive capabilities of these 2 scoring systems.

Conclusion

In conclusion, this prospective study confirms that the POSSUM scoring system is an accurate and valid predictor of 30-day mortality and morbidity in patients undergoing emergency laparotomy in our setting. The close agreement between observed and expected outcomes, as demonstrated by O:E ratios close to unity and non-significant Chi-square tests, supports its use as a reliable tool for risk stratification. The system's ability to differentiate risk across various postoperative diagnostic groups further underscores its clinical utility. Moreover, the significant positive correlation of the POSSUM-predicted morbidity risk with the duration of hospital stay and the time to return to normal activity enhances its value, linking it directly to tangible patient recovery metrics and healthcare resource utilization. We advocate for the integration of POSSUM scoring into routine surgical practice for emergency laparotomies. It serves as a vital instrument for preoperative counseling, guiding clinical decision-making, and conducting meaningful surgical audits aimed at improving the quality of patient care.

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