International Surgery Journal
*Vasave PS et al. Int Surg J. 2026 Oct;13(10):1952-1956*
https://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20263352

**Original Research Article**

# Study on evaluation of P-POSSUM scoring system in patients undergoing exploratory laparotomy

**Priya Shivram Vasave*, Avinash Pawara, Parvez Mujawar**

Department of General Surgery, Shri Bhausaheb Hire Government Medical College and Hospital, Dhule, Maharashtra, India

**Received:** 20 August 2026
**Accepted:** 19 September 2026

***Correspondence:**
Dr. Priya Shivram Vasave,
E-mail: priya_111@yahoo.com

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## ABSTRACT

**Background:** Emergency exploratory laparotomy carries substantially higher morbidity and mortality than elective surgery, and accurate risk stratification is essential for perioperative decision-making, patient counselling and surgical audit. The Portsmouth Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (P-POSSUM) is widely used for this purpose, but its performance in Indian tertiary surgical units requires local validation. This study aimed to evaluate the validity of P-POSSUM in predicting 30-day postoperative mortality and to characterize the complication profile in patients undergoing emergency exploratory laparotomy.
**Methods:** This prospective observational study was conducted over two years (November 2023 to October 2025) in the Department of Surgery of a tertiary teaching hospital in Northern Maharashtra. A total of 134 patients aged 13 years or older undergoing emergency exploratory laparotomy were enrolled by convenience sampling. Preoperative physiological and intraoperative operative severity variables were recorded and P-POSSUM scores calculated using the standard logistic regression equation. Observed 30-day mortality was compared with P-POSSUM-predicted mortality, and observed-to-expected (O:E) ratios were calculated. Associations between clinical parameters and mortality were assessed using the chi-square test.
**Results:** The mean age was 56.25±15.04 years, with a male predominance (53.7%). Perforation peritonitis (41.79%) was the commonest diagnosis, followed by acute intestinal obstruction (29.10%) and appendicular perforation (20.90%). The mean physiological score was 12.05±5.06, operative score 9.31±3.36, and mean predicted mortality was 33.72±24.39%. Overall observed mortality was 23.88% (32/134) compared with an expected mortality of 33.72%, giving an O:E ratio of approximately 0.71, indicating that P-POSSUM overestimated mortality in this surgical cohort. Physiological score >18, higher operative severity, greater blood loss, degree of peritoneal soiling and presence of malignancy were significantly associated with mortality ($p<0.05$). Postoperative complications occurred in 59.7% of patients, most commonly sepsis (20.90%) and renal failure (19.40%); 63.43% required ICU admission and 40.30% required ventilatory support.
**Conclusions:** P-POSSUM remains a clinically useful risk-stratification tool for patients undergoing emergency exploratory laparotomy in an Indian tertiary surgical unit, but it systematically overestimates mortality, indicating a need for population-specific recalibration to improve its predictive accuracy and surgical audit utility.

**Keywords:** P-POSSUM, Emergency laparotomy, Surgical audit, Risk stratification, Postoperative mortality, General surgery

## INTRODUCTION

Emergency exploratory laparotomy represents one of the most challenging areas of surgical practice because patients present in urgent, often physiologically compromised states with limited scope for preoperative optimization.[1] Published surgical literature shows that 30-day mortality after emergency abdominal surgery ranges from 8% to 17%, with morbidity rates of 30% to 60%, considerably higher than after elective procedures.[2,3] Accurate risk stratification is therefore essential in general surgical practice to guide perioperative management, resource allocation and realistic counselling of patients and families.[4] The Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM), developed by Copeland et al. in 1991, was among the first validated tools for risk-adjusted surgical audit, incorporating 12 physiological and 6 operative variables.[5] Because POSSUM tended to overestimate mortality, particularly in low-risk surgical patients, Whiteley et al. introduced the Portsmouth modification (P-POSSUM) in 1996, which retains the same variables but applies a revised logistic regression equation with improved calibration.[6,7]

P-POSSUM has since been validated extensively across surgical specialties and geographic regions, but its performance in resource-limited, non-Western surgical units such as those in India remains variable, with reported observed-to-expected (O:E) mortality ratios ranging widely across studies.[8,9] Differences in patient demographics, disease severity at presentation, comorbidity burden and availability of perioperative resources may all influence the accuracy of a scoring system developed in a Western surgical population when applied to Indian patients.[10]

Given these considerations, local validation of P-POSSUM in Indian tertiary surgical units is important to ensure that risk predictions reflect the local case-mix, to enable meaningful surgical audit through O:E ratio comparisons, and to support evidence-based discussions with patients regarding expected surgical outcomes.[11] This study was therefore designed to evaluate the validity of P-POSSUM in predicting 30-day mortality and to characterise the pattern of postoperative complications in patients undergoing emergency exploratory laparotomy at a tertiary surgical centre in Western India.

The objectives of this study were to calculate the observed 30-day mortality rate in patients undergoing emergency laparotomy; to calculate the expected mortality rate using the P-POSSUM scoring system; and to assess the validity of P-POSSUM by comparing observed and expected mortality rates.

## METHODS

This prospective observational study was conducted in the Department of Surgery of a tertiary teaching hospital in Northern Maharashtra, India, serving as a referral centre for emergency surgical pathology from surrounding districts. The study was conducted over a two-year period from November 2023 to October 2025, after approval from the Institutional Ethics Committee in accordance with ICMR and ICH-GCP guidelines. Written informed consent was obtained from all participants, or their legally authorised representatives, in the vernacular language (Marathi or Hindi).

All patients admitted with acute abdominal conditions requiring emergency exploratory laparotomy during the study period were considered for inclusion. Patients aged 13 years or older with availability for complete perioperative follow-up were included. Patients aged 12 years or younger, those undergoing repeat laparotomy during the same admission, those with incomplete data required for P-POSSUM calculation, and those who withdrew consent were excluded. Convenience sampling was used, and a total of 134 patients were enrolled, consistent with sample sizes used in comparable P-POSSUM validation studies in general surgery.

Demographic data, comorbidities, and 12 preoperative physiological variables (age, cardiac signs, respiratory history, systolic blood pressure, pulse rate, Glasgow Coma Scale score, haemoglobin, white blood cell count, blood urea, serum sodium, serum potassium and electrocardiogram findings) were recorded and scored on the standard exponential scale (1, 2, 4, 8) as per the POSSUM system. Six operative variables (operative severity, number of procedures, blood loss, peritoneal soiling, presence of malignancy and mode of surgery) were similarly scored intraoperatively by the operating surgical team. The predicted probability of mortality (R) was calculated using the P-POSSUM logistic regression equation: $\text{Loge}(R/(1-R)) = -9.065 + (0.1692 \times \text{Physiological Score}) + (0.155 \times \text{Operative Score})$. The primary outcome was 30-day postoperative mortality; secondary outcomes included postoperative surgical complications (assessed using the Clavien-Dindo classification), intensive care unit admission, ventilator requirement and length of hospital stay.

Data were analysed using SPSS software. Continuous variables were expressed as mean ± standard deviation or median with range, and categorical variables as frequency and percentage. The predictive accuracy of P-POSSUM was assessed by comparing observed and expected mortality using chi-square goodness-of-fit tests and by calculating observed-to-expected (O:E) ratios. A p-value $<0.05$ was considered statistically significant.

## RESULTS

A total of 134 patients undergoing emergency exploratory laparotomy were enrolled. The mean age was 56.25±15.04 years (range 16-97 years), with the majority (49.3%) aged between 50 and 69 years. There was a slight male predominance (53.7% male, 46.3% female;

male:female ratio 1.16:1). Comorbidities were present in 55.22% of patients, most commonly diabetes mellitus (22.38%) and hypertension (22.38%).

**Table 1: Distribution of patients according to primary diagnosis.**

| Diagnosis | Frequency (n) | Percentage (%) |
|---|---|---|
| **Perforation peritonitis** | 56 | 41.79 |
| **Acute intestinal obstruction** | 39 | 29.1 |
| **Appendicular perforation** | 28 | 20.9 |
| **Bowel and mesenteric ischaemia** | 5 | 3.73 |
| **Malignant mass** | 6 | 4.48 |
| **Total** | 134 | 100.0 |

**Table 2: Observed versus P-POSSUM-expected mortality by operative severity.**

| Severity | Total | Deaths | Observed mortality (%) | Expected mortality (%) |
|---|---|---|---|---|
| **Minor** | 21 | 5 | 23.81 | 32.62 |
| **Moderate** | 41 | 9 | 21.95 | 31.52 |
| **Major** | 57 | 9 | 15.79 | 30.68 |
| **Major+** | 15 | 9 | 60.0 | 52.83 |
| **Total** | 134 | 32 | 23.88 | 33.72 |

**Table 3: Association between clinical parameters and 30-day postoperative mortality.**

| Parameter | Category | Total (n) | Death (n) | p-value |
|---|---|---|---|---|
| **Physiological score** | ≤18 / >18 | 92 / 42 | 11 / 21 | <0.0001 |
| **Operative severity** | Minor to Major+ | 134 | 32 | 0.002 |
| **Blood loss** | <500 to >1500 mL | 134 | 32 | <0.001 |
| **Peritoneal soiling** | Clear/Turbid/Fecal | 134 | 32 | 0.004 |
| **Malignancy** | Absent/Present | 128 / 6 | 25 / 3 | <0.001 |

Operative severity was classified as major in 42.54% and major-plus in 11.19% of cases. Peritoneal contamination was present in 86.6% of patients, with local pus (32.8%) being the commonest finding. The mean physiological score was 12.05±5.06, mean operative score 9.31±3.36, and mean total POSSUM score 21.37±6.04. The mean P-POSSUM predicted mortality was 33.72±24.39% (range 5.96-95.00%). Based on P-POSSUM risk category, 59.7% of patients were classified as low risk, 10.45% as medium risk and 29.85% as high risk.

Out of the 134 patients, 32 (23.88%) died within 30 days postoperatively, compared with a P-POSSUM-predicted mortality of 33.72%, giving an overall observed-to-expected (O:E) ratio of approximately 0.71, indicating systematic overestimation of mortality by the model, particularly in the minor, moderate and major severity categories. In the major-plus category, however, observed mortality (60.00%) exceeded expected mortality (52.83%), suggesting relative underestimation in the most severely ill surgical patients. A similar pattern of overprediction was observed across most primary diagnoses and age groups, with the exception of elderly patients (≥80 years), among whom observed mortality (66.67-100%) approached or exceeded expected mortality. Postoperative complications occurred in 80 patients (59.7%), most commonly sepsis (20.90%) and renal failure (19.40%), followed by wound infection (16.42%) and urinary tract infection (13.43%). 63.43% of patients required ICU admission (mean stay 7.48±4.84 days) and 40.30% required ventilatory support (mean duration 5.15±2.92 days). The mean hospital stay was 16.23±8.10 days.

On chi-square analysis, physiological score >18, higher operative severity, greater blood loss, higher grades of peritoneal soiling and presence of malignancy were significantly associated with increased mortality ($p<0.05$ for all).

## DISCUSSION

In this prospective study of 134 patients undergoing emergency exploratory laparotomy at a tertiary surgical centre in Western India, the observed 30-day mortality was 23.88%, considerably lower than the P-POSSUM-predicted mortality of 33.72%, giving an O:E ratio of approximately 0.71. This finding is consistent with several other Indian surgical studies that have reported systematic overestimation of mortality by P-POSSUM, with O:E ratios typically ranging between 0.62 and 0.89.[12,13] This overprediction appears to be more pronounced for common Indian surgical emergencies such as perforation peritonitis and appendicular

perforation, where observed mortality was substantially lower than predicted, and less pronounced, or even reversed, in the most physiologically deranged patients (major-plus operative severity, malignancy, and advanced age), where observed mortality approached or exceeded expected mortality. These findings mirror the global surgical literature, which consistently shows that while P-POSSUM demonstrates satisfactory discrimination for mortality (area under the curve typically 0.67-0.86), its calibration varies across populations, diagnoses and age groups, necessitating population-specific recalibration for optimal accuracy.[14,15] Comparative studies from Indian surgical centres, including a recent report from a Rajasthan tertiary centre, have shown that newer scoring systems such as the National Emergency Laparotomy Audit (NELA) score may offer superior discrimination compared with P-POSSUM, although P-POSSUM continues to be the most widely used tool in general surgical units because of its extensive validation history, simplicity and free availability.[16]

The significant association observed between higher physiological score, operative severity, blood loss, degree of peritoneal soiling, and presence of malignancy with mortality in this cohort is consistent with the pathophysiological rationale underlying the P-POSSUM model, and supports its continued use as a bedside surgical tool for risk stratification, even where absolute mortality predictions require local calibration. The high proportion of patients requiring ICU admission (63.43%) and ventilatory support (40.30%) in this cohort underscores the resource-intensive nature of emergency laparotomy care in a tertiary surgical referral setting and highlights the potential utility of P-POSSUM-based risk stratification for proactive critical care resource planning.

This study has several strengths, including its prospective design, complete follow-up for the primary outcome, and a case-mix reflective of real-world emergency general surgical practice in a tertiary Indian surgical unit.

### *Limitations*

Limitations include the use of convenience sampling from a single centre, which may limit generalisability, and the relatively modest performance of P-POSSUM for predicting individual postoperative surgical complications compared with mortality, consistent with previous reports.[17]

Larger, multicentric surgical studies incorporating population-specific recalibration, and comparison with newer risk models such as NELA, are warranted to refine risk prediction for emergency laparotomy in the Indian population.

## CONCLUSION

P-POSSUM is a clinically useful tool for risk stratification, informed consent, and resource planning in patients undergoing emergency exploratory laparotomy in a general surgical unit in India. However, it systematically overestimates mortality in this population, particularly for common surgical emergencies such as perforation peritonitis and appendicular perforation, indicating that population-specific recalibration is required to improve its predictive accuracy and surgical audit utility in Indian surgical practice.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Vasave PS, Pawara A, Mujawar P. Study on evaluation of P-POSSUM scoring system in patients undergoing exploratory laparotomy. Int Surg J 2026;13:1952-6.