Section: General Surgery

Original Research Article

EFFICACY OF POSSUM SCORING SYSTEM IN PREDICTING MORTALITY AND MORBIDITY IN PATIENTS OF PERITONITIS UNDERGOING LAPAROTOMY IN A TERTIARY CARE INSTITUTE

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ABSTRACT

Background: Perforative peritonitis is associated with significant morbidity and mortality, and the postoperative course is often unpredictable. This highlights the need for a reliable scoring system to assess and predict patient outcomes following surgery. The POSSUM (Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity) scoring system serves this purpose by estimating the risk of postoperative complications and death. It utilizes a combination of 12 physiological parameters and 6 operative factors to provide an objective assessment of surgical risk in patients with conditions such as perforative peritonitis. We aimed to evaluate this score in Indian scenario.

Materials and Methods: We evaluated 100 patients of perforative peritonitis to analyse the postoperative outcome in this high-risk group in tertiary care institute in the department of general surgery in single unit from June 2015 to June 2017. We analysed morbidity and mortality of patients.

Results: Statistical analysis revealed no significant difference between the observed and predicted mortality rates ($\chi^2 = 3.54$, $p = 0.316$). The observed-to-expected (O:E) mortality ratio was calculated to be 1.43. This aligns closely with findings from previous studies.

Conclusion: Although the small sample size is a limitation of this study, the POSSUM scoring system proved to be a valuable tool for predicting postoperative outcomes in patients with perforative peritonitis and was effectively applicable in our clinical setting. It helps in identifying high-risk patients, allowing for prioritization of care to improve outcomes. Incorporating additional factors such as the time interval between perforation and surgery, as well as the patient's co-morbid conditions, could enhance the accuracy of the scoring system and support more targeted and effective perioperative management.

Keywords: POSSUM, mortality rate, morbidity rate, laparotomy.

INTRODUCTION

Perforative peritonitis continues to pose significant health challenges, even in the modern medical era, due to its high rates of morbidity and mortality. In countries like India, where access to healthcare may be delayed, peritonitis resulting from hollow viscus perforation remains a common surgical emergency. Despite timely hospital admission and surgical intervention, patient outcomes can be unpredictable during the postoperative period. Secondary peritonitis arises when the peritoneal cavity becomes contaminated with the contents of abdominal organs. This condition is most frequently associated with perforations in the stomach, duodenum, small intestine, appendix, and colon.[1] Reported mortality rates for hollow viscus perforations vary widely, typically ranging from 10% to 40%.[2]

Surgical risk prediction models play a crucial role in modern clinical practice, offering surgeons valuable insights into patient outcomes. Effective risk stratification not only aids in informed decision-making for patients but also enhances treatment planning and selection, ultimately leading to improved surgical results.[3] To estimate the likelihood of perioperative complications or death, several scoring systems have been introduced—one of the most widely recognized being the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM).[4]

This system allows early identification of high-risk patients, ensuring timely and appropriate intervention while supporting efficient resource utilization. Although surgical expertise remains central to patient outcomes, factors such as the individual's medical history, the underlying pathology, and perioperative care also significantly impact recovery. The POSSUM system integrates these elements by evaluating 12 physiological and six operative parameters, using a linear analytical model established by Copeland to estimate morbidity and mortality risks across patient groups.

This study was undertaken to assess the validity of POSSUM scoring system in patients with perforative peritonitis to analyse the postoperative outcome in this high-risk group.

MATERIALS AND METHODS

This prospective observational study was conducted in tertiary care institute in the Department of General Surgery in single unit from June 2015 to June 2017 after institutional ethics committee approval. All patients diagnosed with established peritonitis due to hollow viscus perforation of more than 18 years of age were included in the study. However, individuals with primary peritonitis, peritonitis resulting from gynaecological causes, or trauma-related peritonitis were excluded. Additional exclusion criteria included patients presenting with altered mental status, paraplegia, or significant immunosuppression—such as those with poorly controlled diabetes mellitus, chronic steroid use, post-transplant status, or HIV positivity.

Informed consent was obtained from all patients prior to inclusion in the study. Patients presenting with peritonitis were thoroughly evaluated through a detailed medical history and clinical examination. Preoperative physiological parameters were recorded for each patient. All cases underwent emergency laparotomy, during which intraoperative data were collected. Based on these findings, each patient's physiological and operative scores were determined using the established parameters and scoring criteria [Tables 1 and 2]. These scores were then used to calculate the POSSUM score for predicting morbidity and mortality.

Table 1: Variables for the POSSUM physiological score in emergency gastrointestinal surgical patients

Score → / Variable ↓	1	2	4	8
Age (years)	< 60	61–70	71–80	> 80
Cardiac signs	Normal	Medication for heart failure	Peripheral oedema, warfarin therapy	Raised JVP
Chest radiograph	Normal		Borderline cardiomegaly	Cardiomegaly
Respiratory history	Normal	Mild Dyspnoea on exertion	Limiting dyspnoea	Dyspnoea at rest
Chest radiograph	Normal	Mold COAD	Moderate COAD	Fibrosis/ consolidation
Systolic BP (mmHg)	110-130	100–109 or 131-170	90–99 or >171	< 89
Pulse rate (bpm)	50–80	81–100 or 40-49	101–120 or <50	>120
GCS (Glasgow Coma Scale)	15	12–14	9–11	<9
Hemoglobin (g/dL)	>13	11.5-12.9 16.1-17.0	11.4 18.0	<9
WBC count (×10⁹/L)	4–10	10.1-20.0 3.1-3.9	>20 or <3	—
Urea (mmol/L)	<7.5	7.6–10.0	10.1–15.0	>15
Sodium (mmol/L)	136–145	131–135	126–130	<126 or >155
Potassium (mmol/L)	3.5–5.0	3.2–3.4 or 5.1–5.3	2.9–3.1 or 5.4–5.9	<2.9 or >6.0
ECG	Normal	-	Atrial fibrillation	Any other abnormal rhythm or > 5 ectopics /min. Q waves or ST- T wave changes

POSSUM: Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity; JVP: jugular venous pressure; COPD: chronic obstructive pulmonary disease; BP: blood pressure; ECG: electrocardiogram

Table 2: Variables for the POSSUM operative score in emergency gastrointestinal surgical patients.

Score Variable	1	2	4	8
Operative severity	Minor	Moderate	Major	Major+ / complex
Number of procedures	1	-	2	>2
Blood loss (mL)	<100	101–500	501–999	>1000

Peritoneal contamination	None	Serous	Local pus	Free bowel content / gross pus
Presence of malignancy	None	Primary, confined	Nodal metastasis	Distant metastases
Timing of operation	Elective	-	Emergency resuscitation of > 2hr possible: Operation < 24hr after	Emergency (Immediate Surgery)

The predicted risk of morbidity (R1) was calculated using the POSSUM equation for mortality as follows:

ln [R/(1 − R)] = -7.04 + (0.13 × physiological score) + (0.16 × operative severity score)

The predicted risk of mortality (R) was calculated using the following equation:

ln [R/(1 − R)] = -9.37 + (0.19 × physiological score) + (0.15 × operative severity score)

After surgery, each patient was monitored for 30 days for postoperative morbidity/mortality.

Statistical analysis: The data was collected in individual patient proforma and was entered systematically in a Microsoft excel sheet (Redmond, WA, USA). Statistical analysis deter-mined using Statistical Package for the Social Sciences (SPSS) 19.0 software (IBM Corp., Armonk, NY, USA). The data on categorical variables, such as gender and clinical characteristics were expressed as frequency and percentages. The normal distribution of data was tested using Kolmogorov-Smirnov (K-S) test. The expected mortality rate was obtained using linear regression analysis and the O:E ratio (Observed: Expected ratio) was calculated. Chi-square test applied to obtain the p value to note any significant difference between the predicted rate and the actual outcome. Rate of increment in complication for each risk factor was calculated based on the hypothesis and "t" test will apply to validate the hypothesis.

RESULTS

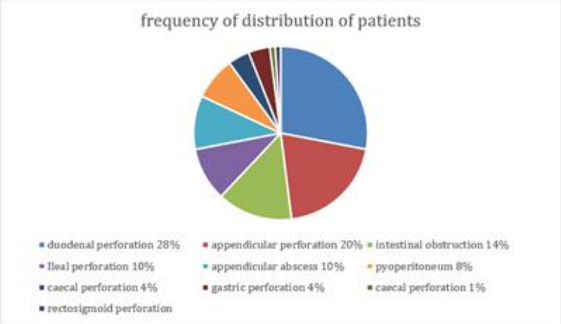

Figure 1: Frequency of distribution of patients according to diagnosis.

Out of 100 patients, 28 patients were diagnosed to have duodenal perforation,24 patients had gastric perforation,14 had intestinal obstruction, while 10 patients were operated for Ileal perforation. 10 patients had appendicular abscess, 8 patients pyoperitoneum, and 4 jejunal perforation while 1 patient each had rectosigmoid and caecal perforation.

Table 3: Frequency distribution of complications

Complications	Number	Percentage
Wound infection	25	25%
Wound Dehiscence	12	12%
Pneumonia	12	12%
Septicaemia	7	7%
Respiratory failure	5	5%
UTI	5	5%
Anastomotic leak	2	2%
Pulmonary embolism	0	0

Out of 100, 43% patient developed and wound infection was most frequent complication followed by wound dehiscence and pneumonia.

Figure 2: POSSUM score in relation to observed and predicted morbidity.

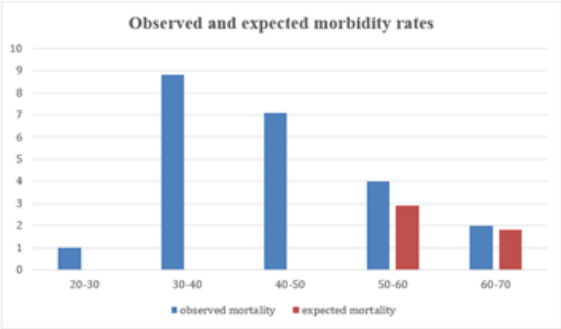

Figure 3: Observed and expected morbidity rates

The POSSUM Score could be used as a tool for initial assessment for predicting morbidity in patients with peritonitis especially in patients with POSSUM Score more than 40, as there was no

significant difference between observed and expected mortality rates, in chi square test applied in which there was found to be no significant difference.

The POSSUM Score could be used as a good tool for initial assessment for predicting mortality in patients with peritonitis, as there was no significant difference between observed and expected mortality rates, chi square test applied was found to be no significant difference.

Table 4: Average morbidity risk as calculated by possum in patients who died or survived.

Outcome	No. of patients	Average morbidity risk(%)	Expected morbidity	Observed morbidity	O:Eratio	2x calculated value
Survived patients	94	65.7	54.53	28	0.51	25.14 Significant difference
Died patients	6	96.98	5.82	6	1.03	0.01 not significant

In patients who died, (n- 6) average morbidity risk as estimated by POSSUM is 96.98% corresponding to expected morbidity in 5.82 patients out of 6 patients, with O:E Ratio 1.03(x2-test = not significant difference). Similarly, in patients who survived, (n-94) average morbidity risk as calculated by POSSUM is 65.7 % corresponding to expected morbidity in 54.53 patients out of 94 patients, showing a significant difference between Observed and expected values (s2-test = significant difference).

Table 5: Average mortality risk as calculated by possum in patients who died or survived

Outcome	No. of patients	Average mortality risk(%)	Expected mortality	Observed mortality	O:Eratio	2x calculated value
Survived patients	94	20.1	16.6	0	0.0	NA
Died patients	6	70.22	4.21	6	1.43	0.53 not significant

In patients who died, (n- 6) average mortality risk as estimated by POSSUM is 70.22% corresponding to expected mortality in 4.21 patients out of 6 patients (x2-test - not significant difference). Therefore POSSUM Score is a good indicator of mortality in patients of peritonitis.

Average morbidity risk calculated by POSSUM morbidity equation in patients who died was 96.98% with O: E Ratio 1.03 (chi square test - no significant difference), while in patients who survived average morbidity risk calculated was 65.7 % with O: E Ratio 0.51 (chi square test — significant difference). POSSUM Morbidity equation over predicted morbidity in patients who survived after surgery.

Average mortality risk in patient who died was 70.22% with 0:E Ratio 1.43 (chi square test — no significant difference). POSSUM Mortality equation is a good indicator of mortality especially in high risk group.

DISCUSSION

Over recent years, surgical audits have gained significant importance, serving not only to evaluate the quality of surgical care but also as a valuable educational tool. Traditional measures such as crude mortality rates may provide a distorted view of surgical outcomes, particularly in varied clinical settings. To address this limitation, the risk-adjusted POSSUM (Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity) system was introduced, offering a more accurate method for predicting patient outcomes. In developing countries like India, delayed medical attention due to socioeconomic factors often results in advanced disease presentation, increased complications, and higher mortality. Implementing the POSSUM scoring system can help identify high-risk patients more effectively. However, for optimal accuracy and applicability, it must be tailored to reflect the health status and demographic characteristics of the local population.

Several scoring systems have been developed to objectively assess patient risk and improve outcome prediction across various medical and surgical contexts. These include the ASA (American Society of Anesthesiologists) classification for general risk assessment5, the APACHE III (Acute Physiology and Chronic Health Evaluation III) for intensive care patients6, the Goldman Index for predicting perioperative cardiac complications,[7] and the ACPGBI system for colorectal surgery.[8,9] For general surgical procedures, the POSSUM (Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity) scoring system and its subsequent adaptations have been widely used. POSSUM, introduced by Copeland et al,[10] in 1991, was designed primarily for surgical audit and is based on 12 physiological and six operative parameters, each graded and summed to estimate postoperative morbidity and mortality using a logistic regression model. The P-POSSUM, a refined version, utilizes the same parameters but applies a different equation to improve accuracy in predicting mortality.[11] These systems have been validated across various surgical specialties,

including genera,[12] vascular,[13] colorectal,[9] oesophageal, and laparoscopic procedures.[14] However, most validations have been conducted in high-resource settings. In contrast, developing countries like India face unique challenges such as late presentation of disease and resource limitations, which can significantly influence surgical outcomes. Therefore, it is essential to validate and possibly adapt the POSSUM model to better suit the Indian healthcare environment, ensuring it accurately reflects local patient profiles and healthcare infrastructure.[15,16]

This study evaluated the accuracy of the POSSUM scoring system in predicting outcomes for 100 patients who underwent emergency laparotomy due to perforative peritonitis within a single surgical unit. The observed mortality was 6 out of 100 patients, resulting in a crude mortality rate of 6%. Septicaemia emerged as the leading cause of death.

Prytherach DR et al,[17] reported a comparable overall mortality rate of 19.1%. In the present study, the POSSUM scoring system predicted a mortality rate of 6%. Statistical analysis revealed no significant difference between the observed and predicted mortality rates ($\chi^2 = 3.54$, $p = 0.316$). The observed-to-expected (O:E) mortality ratio was calculated to be 1.43. This aligns closely with findings from previous studies, including Prytherach DR et al, (O:E = 0.9), Sagar PM et al,[17] (O:E = 0.87),[18] and Parihar V et al,[24] (O:E = 0.97).[16]

Several studies have evaluated the accuracy of different surgical risk scoring systems in predicting outcomes such as mortality, morbidity, and hospital stay. Das et al,[19] compared APACHE II, P-POSSUM, and SAPS II, concluding that P-POSSUM was the most reliable for predicting overall hospital stay. Vishwani A et al,[20] assessed the performance of the POSSUM scoring system in 89 peritonitis patients undergoing laparotomy and found it to be a fairly accurate predictor of both mortality (observed-to-expected ratio [O:E] = 0.6) and morbidity (O:E = 0.7). In a study by Teleanu G et al,[21] CR-POSSUM was validated in 58 patients and demonstrated prognostic utility in cases of colonic peritonitis with abdominal sepsis. Sunil Kumar,[22] analysed POSSUM and P-POSSUM in 172 cases over two years and observed that POSSUM tended to overestimate both mortality and morbidity. Further validation by Sunil Kumar et al,[23] in patients with enteric perforation peritonitis confirmed that POSSUM was effective in predicting morbidity (O:E = 0.85) but significantly over-predicted mortality (O:E = 0.47).

Our study has survival rate of 94 % out of which 43% developed complications and remaining patient did not show any evidence of complications. An observed to expected ratio (O:E) of 1.003 was obtained and there was no significant difference between the predicted and observed values.

Postoperative mortality can be influenced by several physiological and clinical factors. These include ventilation-perfusion mismatch, which impairs effective gas exchange, and reduced tissue perfusion or ischemia to vital organs, both of which can compromise organ function. Electrolyte imbalances such as hyponatremia and hypokalemia may lead to altered mental status and cardiac instability. Additionally, conditions like cancer cachexia weaken the patient's overall physiological reserve, and prolonged operative time increases the risk of surgical and anesthetic complications—all of which collectively contribute to higher postoperative mortality. Further, we observed postoperative complications including wound infections (25%), wound dehiscence (12%), pneumonia(12%), septicaemia (7%), and a combination of multiple complications in few patients. These adverse outcomes can be largely attributed to extensive peritoneal contamination, compromised immune function, elevated diaphragm positioning, upper abdominal surgical incisions, and the presence of co-morbid conditions including asthma, chronic obstructive pulmonary disease, diabetes mellitus, anaemia, and hypo-proteinaemia.

Limitations of this study are its relatively small sample size and single centric study.

CONCLUSION

Nevertheless, the findings indicate that the POSSUM scoring system is a useful tool for predicting mortality and morbidity in patients undergoing surgery for perforative peritonitis. Enhancing the scoring model by incorporating variables such as the time interval between perforation and surgical intervention, as well as the patient's co-morbid conditions, may improve its predictive accuracy. Ensuring strict monitoring and timely correction of these contributing factors can help improve patient outcomes and reduce postoperative complications. Further research involving larger cohorts is necessary to validate and refine the scoring system. Additionally, increasing general awareness, promoting early referrals, facilitating prompt diagnosis, and ensuring timely surgical treatment are essential steps in minimizing the delay between perforation and surgery, and in better managing co-morbidities.

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