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ASSESSMENT OF MORBIDITY AND MORTALITY IN EMERGENCY LAPAROTOMY: A COMPARATIVE STUDY OF POSSUM AND PORTSMOUTH-POSSUM SCORING SYSTEMS

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ABSTRACT
Objective: To evaluate the diagnostic performance of the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) and Portsmouth-POSSUM (P-POSSUM) for predicting postoperative morbidity and mortality following emergency laparotomy.
Methodology: This prospective observational study was conducted in the Department of General Surgery, Dow University Hospital, Karachi, from 1st October 2025 to 30th May 2026. One hundred and fifty patients undergoing emergency laparotomy were enrolled. The physiological and operative parameters were recorded using the POSSUM scoring system. The patients were followed-up for 30 days postoperatively. Diagnostic performance was assessed using Area under Curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).
Results: The mean age was 54.55±15.41 years. Observed morbidity was 34.9% and mortality was 9.2%. The POSSUM model demonstrated poor discrimination of morbidity (AUC = 0.523) and moderate discrimination of mortality (AUC = 0.711). P-POSSUM showed better discrimination for mortality (AUC = 0.714). At the optimal cutoff, POSSUM demonstrated a high sensitivity (88.7%) but a low specificity (14.1 %) for predicting morbidity but a low sensitivity (21.4%) and a high specificity (92.5%). Similar to POSSUM score, P-POSSUM also demonstrated a low sensitivity (50%) and high specificity (96.4%).
Conclusion: The P-POSSUM showed slightly better predictive performance with higher specificity for a 30 day mortality than POSSUM. However, neither model achieved sufficient overall performance to support use as a standalone risk assessment tool in patients undergoing emergency laparotomy.

KEYWORDS: Laparotomy, Mortality, POSSUM, P-POSSUM, Risk assessment, Sensitivity and Specificity

INTRODCUTION
Acute Abdomen is one of the most common surgical emergencies encountered in Emergency Departments and frequently requires surgical intervention. Prompt diagnosis and early surgical intervention are essential to reduce associated morbidity and mortality rates. Postoperative morbidity and mortality in patients with acute abdomen are influenced not only by the surgeon's expertise, but also by the patient's psychological condition at presentation, disease severity and availability of healthcare resources.[1-3] Emergency laparotomy is associated with postoperative mortality rate ranging from 13 to 18% which is much higher than the one seen in high-risk elective cases. Morbidity on the other hand is seen to reach up to 50% in such cases.[1,3] Several risk prediction models have been developed to improve the perioperative risk stratification in patients undergoing emergency laparotomy. Accurate perioperative risk assessment is important for clinical decision making, communication with patients and families, allocation of postoperative critical care resources, and risk adjusted surgical audit. The American Society of Anesthesiologists (ASA) score, ASA Physical Status (ASA-PS), Charlson comorbidity index, and national emergency laparotomy audit (NELA) score are some of the tools used in intensive care units (ICUs) to precisely measure morbidity and mortality.[4-6] However, these scoring systems do not comprehensively incorporate operative variables and several patient specific risk factors. Copeland et al. created the Physiological and Operative Severity Score for the enumeration of Morbidity and Mortality (POSSUM) in 1991 to determine the morbidity and mortality in patients who had undergone surgery within the first 30 days after the procedure.[7] It was found that this approach overestimated mortality in low-risk patients. The modified Portsmouth POSSUM (P-POSSUM) scoring method was similarly popularized and used to determine morbidity and mortality following the procedure to solve the aforementioned problem. These scoring systems facilitate a comparison between observed and predicted postoperative outcomes. The P-POSSUM scoring system uses the same physiological and operative variables as POSSUM but applies a modified regression equation resulting in more accurate prediction of postoperative mortality, particularly in low risk patients.[8,9] In several studies, P-POSSUM has been shown to be a more accurate calibration of in-hospital mortality than the original POSSUM model, notably that of the original work by Prytherch et al[10], where the original model significantly over predicted in-hospital mortality in lower risk patients. Asif et al[11] also reported that p-possum scoring had the best assessment performance for observed: expected outcome being 0.987 when predicting mortality compared with other scoring tools.

Evidence from South Asian and Pakistani population is particularly relevant because differences in presentation, disease spectrum, referral pathways, and access to intensive care and perioperative resources may affect the performance of prediction model developed elsewhere. Recent Pakistani studies have continued to evaluate the P-POSSUM scoring system in the emergency laparotomy, but local evidence remains limited and findings are inconsistent. Establishing the diagnostic performance of these scores within a local surgical population may therefore help determine whether they can be used for meaningful perioperative risk stratification rather than a simple audit instrument. This study was conducted to assess the accuracy of POSSUM and P-POSSUM Scoring tools in predicting postoperative outcomes of morbidity and mortality in this geographical belt. This evaluation is clinically relevant because a score that systematically over predicts risk my lea to unnecessary escalation of care, whereas inadequate sensitivity may falsely reassure clinicians and patients. Conversely, high specificity can be useful fort identifying a subgroup at particularly high risk who may benefit from closer postoperative monitoring. By examining discrimination alongside sensitivity and specificity, this study seeks to provide a more clinically informative assessment of the applicability of POSSUM and P-POSSUM in this setting.

METHODOLOGY

This prospective observational validation study was conducted in the Department of General Surgery of Dow University Hospital from 1st October 2025 to 30th May 2026. Ethical approval was obtained from Institutional Review Board of Dow University of Health Sciences (IRB ref No. IRB-3679/DUHS/Approval/2024/367). This study was conducted in accordance with the ethical principles governing research involving human participants. Written and informed consent as obtained from all participants before enrolment. A total of 152 patients who underwent emergency laparotomy using a non-probability consecutive sampling technique were enrolled in this study. The sample size was calculated using a diagnostic test sensitivity and specificity calculator taking sensitivity of P-POSSUM score as 88.9%, specificity as 96.3%, prevalence of its mortality rate as 17.8%, its precision as 12% and a confidence interval of 95%. [12]

Patients aged 18 to 75 years of either gender admitted to the emergency department with a clinical diagnosis of trauma, hollow viscus perforation, intestinal obstruction, intra-abdominal sepsis (tuberculosis, Inflammatory Bowel Disease, acute appendicitis), gut ischemia, intussusception, and volvulus requiring emergency exploratory laparotomy were included in this study. Only patients who provided written informed consent and agreed to complete a 30-day postoperative follow-up either through outpatient visits or phone contact were enrolled. Patients with American Society of Anesthesiologists (ASA) Physical Status classification grades I to IV were included. Immunocompromised patients and those who were lost to follow-up were excluded in this study.

Patient demographics, and clinical data were recorded using a standardized data collection form. The POSSUM physiological score was calculated using twelve physiological parameterincluding age, cardiac status, respiratory status, systolic blood pressure, pulse rate, Glasgow Coma Scale score, Hemoglobin concentration, white blood cell count, serum urea, serum sodium, serum potassium and electrocardiographic findings prior to surgery. The operative severity score was determined using six intra-operative variables including operative severity, number of procedures performed, estimated blood loss, degree of peritoneal contamination, presence of malignancy and urgency of surgery. Each variable was assigned a score of 1, 2, 4 or 8 according to the original POSSUM scoring system. Predicted morbidity and mortality were calculated using the original POSSUM equation, and the predicted mortality was calculated using the P-POSSUM equation.

POSSUM equation

Morbidity: [R / (1 - R) = (0.16 X physiologic score) + (0.19 X operative score)-5.91

Where R = the morbidity score predicted

Mortality: [R/ (1-R) = 0.13 x physiologic score + 0.16 X operative score - 7.04

Here, R = the mortality score predicted.

P-POSSUM equation

Mortality: [R / (1 - R) = (0.19 X physiologic score) + (0.15 X operative score)-9.37

Where R = predicted mortality score

Data were analyzed using IBM SPSS Statistics Licensed version 26. Descriptive statistics were used to summarize the data. Qualitative variables were expressed as frequencies and percentages and quantitative data were expressed as mean ± standard deviation for normally distributed data, and median with interquartile range (IQR) for non-normally distributed data. Normality was assessed using the Shapiro Wilk test. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal cutoff value for predicting morbidity and mortality. Patients with a predicted value greater than or equal to the cutoff were classified as high-risk and those below the cutoff were classified as low-risk. A 2x2 contingency table was constructed to evaluate the diagnostic performance of the scoring system. The sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and Diagnostic Accuracy were calculated for both the POSSUM and P-POSSUM scoring systems. A p-value of < 0.05 was considered statistically significant.

RESULTS

The mean age was 54.55±15.41 years (range: 27-75 years). There were 84 (55.3%) males and 68 (44.7%) females with a male-to-female ratio of 1.2:1. Hypertension was the most prevalent comorbidity, affecting 62 (40.8%) patients, followed by diabetes mellitus in 56 (36.8%), and ischemic heart disease (IHD) in 33 (21.7%) patients. According to the American Society of Anesthesiologists (ASA) physical status classification, most patients were classified as ASA class II with 50 (32.9%) patients, followed by ASA I and III comprising of 38 (25%) patients each while 26 (17.1%) patients were categorized as ASA IV. The most frequent indication for surgery was intestinal obstruction in 64 (42.1%) cases, followed by 41 (27.0%) patients with perforation peritonitis, 36 (23.7%) patients with abdominal trauma, 7 (4.6%) patients with gut ischemia, 3 (2.0%) patients with volvulus and 1 (0.7%) patient with intussusception. A previous history of abdominal surgery was observed in 77 (50.7%) patients (Table 1).

With respect to preoperative physiological parameters, most patients had no evidence of cardiac failure (46.7%), no respiratory compromise (39.5%), normal systolic pressure (39.5%), normal pulse rate (53.3%) and a Glasgow Coma Scale score of 15 (56.6%). The mean pulse rate was 73.31±20.78 beats/minute, mean hemoglobin of 12.09±2.88 g/dl, mean white cell count of 9.59±7.09 x 10^9/L, mean serum urea of 46.71±28.48 mg/dl, mean serum sodium of 138.35±4.60 mmol/L, and mean serum potassium of 4.33±1.06 mmol/L. Normal electrocardiographic findings were observed in 68.4% of patients. There were 55 (36.2%) patients who underwent gut resection and anastomosis, 46 (30.3%) patients underwent gut resection and double barrel stoma made, 19 (12.5%) patients had stoma formation alone without gut resection, 14 (9.2%) had adhesiolysis, 6 (3.9%) underwent Hartmann procedure and 12 (7.9%) patients underwent other surgeries. Only 27 (17.8%) underwent re-exploration surgery. Most surgeries were classified as major (65.1%) and the majority of patients 86.2% underwent a single operative procedure. Estimated blood loss was > 1000ml in 36.2% of the patients. Peritoneal contamination was absent in 29.6% of patients, minor serous fluid in 27.7% of the patients, local pus was seen in 11.8%, and free bowel content in 32.9%. Malignancy was absent in 65.8% of the patients (Table 2).

The overall postoperative morbidity was observed in 53 (34.9%) of the patients and the overall observed mortality was observed in 14 (9.2%) patients. According to Clavien-Dindo classification, grade 2 complications were the most common (13.3%). The mean predictive morbidity according to POSSUM equation was 77.92±17.92%, mean predictive mortality was 34.57±21.44% and mean predictive mortality as per P-POSSUM score was 19.08±9.60 (Table 3).

The Area Under ROC Curve (AUC) for POSSUM morbidity and mortality score was 0.523 and 0.711 respectively, whereas for P-POSSUM mortality, the AUC was 0.714, which was slightly higher reflecting moderate discriminative performance for 30-day mortality. POSSUM morbidity classified 132 patients as high-risk which yielded a high sensitivity (88.7%) but poor specificity (14.1%). The positive predicted value (PPV) was 35.6% and the negative predicted value (NPV) was 70.0%. On the contrary, when predicting mortality, POSSUM scoring had a sensitivity of 21.4%, specificity of 92.5%, PPV of 50% and NPV of 92.5%. P-POSSUM demonstrated a sensitivity of 50% and a specificity of 96.4% with a PPV of 58.3% and NPV of 95%. The discriminative performance metrics of the POSSUM and P-POSSUM models for predicting morbidity and mortality (Table 4).

Table 1: Demographic and clinical parameters of the patients

Parameter		No.	%
Gender	Male	84	55.3
	Female	68	44.7
Comorbidities	Diabetes Mellitus	56	36.8
	Hypertension	62	40.8
	Ischemic heart disease	33	21.7
ASA Status	ASA I	38	25.0
	ASA II	50	32.9
	ASA III	38	25.0
	ASA IV	26	17.1
Diagnosis	Intestinal obstruction	64	42.1
	Perforation peritonitis	41	27.0
	Abdominal trauma	36	23.7
	Gut Ischemia	7	4.6
	Volvulus	3	2.0
	Intussusception	1	0.7

Table 2: Distribution of physiological and operative variables according to POSSUM scoring system

Parameter		No.	%
Physiological score			
Age group (years)	< 60	83	54.6
	61 – 70	32	21.1
	≥ 71	37	24.3
Cardiac signs	No failure	71	46.7
	Diuretic, digoxin, anti-anginal, or antihypertensive therapy	40	26.3
	Peripheral edema, warfarin therapy, borderline cardiomegaly on echocardiography	26	17.1
	Raised JVP, cardiomegaly noted on Echocardiography	15	9.9.
Respiratory signs	No dyspnea	60	39.5
	Dyspnea on exertion, mild COPD on clinical history	33	21.7
	Limiting dyspnea (one flight), moderate COPD on clinical history	31	20.4

	Dyspnea at rest (respiratory rate >30/min), fibrosis or consolidation on chest X-ray	28	18.4
BP (systolic) [mmHg]	110-130	60	39.5
	131-170; 100-109	46	30.3
	≥171; 90-99	20	13.2
	< 89	26	17.1
Pulse (beats/min)	50 – 80	81	53.3
	81-100; 40-49	38	25.0
	101-120	20	13.2
	≥121; < 39	13	8.6
GCS	15	86	56.6
	12-14	36	23.7
	9-11	14	9.2
	≤ 8	16	10.5
Hb (g/dL)	13-16	46	30.3
	11.5-12.9; 16.1-17.0	33	21.7
	10.0-11.4; 17.1-18.0	60	39.5
	≤9.9; >18.1	13	8.6
White cell count (x102/L)	4-10	73	48.0
	10.1-20.0; 3.1-4.0	41	27.0
	>20.1; <3.0	38	25.0
Urea (mg/dl)	≤40	88	57.9
	41-55	28	18.4
	55-80	16	10.5
	>80	20	13.2
Sodium (mmol/L)	≥136	114	75.0
	131-135	30	19.7
	126-130	8	5.3
Potassium (mmol/L)	3.5-5.0	55	36.2
	3.2-3.4; 5.1-5.3	55	36.2
	2.9-3.1; 5.4-5.9	28	18.4
	<2.8; >6	14	9.2
ECG	Normal	104	68.4
	Atrial fibrillation	15	9.9
	Any abnormal rhythm or >5 ectopic/min, Q waves or ST/T wave changes	33	21.7
Operative Score			
Procedure performed	Gut resection + Anastomosis	55	36.2
	Gut resection + double barrel stoma	46	30.3
	Exploratory laparotomy + stoma	19	12.5
	Adhesiolysis	14	9.2
	Hartmann Procedure	6	3.9
	Others	12	7.9
Operative severity	Minor	8	5.3
	Moderate	25	16.4
	Major	99	65.1
	Major +	20	13.2
Multiple Procedure	1	131	86.2
	2	14	9.2
	>2	7	4.6
Total blood loss (ml)	<100	30	19.7
	101-500	47	30.9
	501-999	20	13.2
	≥1000	55	36.2
Peritoneal soiling	None	45	29.6
	Minor (serous fluid)	39	27.7
	Local pus	18	11.8
	Free bowel content	50	32.9

Presence of malignancy	None	100	65.8
	Primary only	47	30.9
	Nodal Metastasis	5	3.3
Mode of surgery	Emergency resuscitation or >2h possible operation within 24 hs after admission	93	61.2
	Emergency (immediate surgery <2 h needed)	59	38.8

Table 3: Postoperative outcome observed in 30-day period

Postoperative outcome		No.	%
Observed Morbidity		53	34.9
Observed Mortality		14	9.2
Clavien-Dindo classification	Grade 1	9	6.6
	Grade 2	20	13.2
	Grade 3	16	10.5
	Grade 4	8	5.3
	Grade 5	14	9.2
POSSUM Score	Physiological	23.75±5.18	
	Operative	19.91±5.07	
Predicted Morbidity POSSUM		77.92±17.92	
Predicted Mortality POSSUM		34.57±21.44	
Predicted Mortality P-POSSUM		19.08±9.60	

Table 4: Discriminative performance metrics of POSSUM and P-POSSUM models in predicting morbidity and mortality

Scoring model	AUC	Sensitivity	Specificity	PPV	NPV
POSSUM Morbidity	0.523	88.7%	14.1%	35.6%	70%
POSSUM Mortality	0.711	21.4%	92.5%	50%	92.5%
P-POSSUM Mortality	0.714	50%	96.4%	58.3%	95%

DISCUSSION

The quality of healthcare delivered to surgical patients is commonly assessed using postoperative morbidity and mortality rates, particularly in developing countries. However, postoperative outcomes, including recovery, complications encountered in the long or short term, and mortality, are not solely determined by surgeons' technical expertise. They are also influenced by patient related factors, disease severity at presentation and healthcare resources, highlighting the need for accurate perioperative risk assessment tools. Several scoring systems have been developed to predict surgical outcomes, among which, the POSSUM and P-POSSUM scoring systems have been widely validated for risk assessment in vascular, laparoscopic, upper gastrointestinal and colorectal surgeries.[14,15]

In the present study, 152 patients who underwent emergency laparotomy were evaluated. The mean age was 54.55±15.41 years, with more than half (54.6%) of the patients being younger than 60 years. These findings are comparable to those reported by another study conducted in Pakistan by Mahjabeen et al[16], who observed the mean age of 56.6±15.9 years in their patient population. Males constituted the majority of the study population, with a male-to-female ratio of 1.2:1 which is consistent with the finding of 1.5:1 reported by Bullagan et al.[12] A higher male predominance has been reported by Delibegovic et al[17] and Naveen et al[18], with male-to-female ratio of 3.1:1 and 5.6:1, respectively. Despite these differences, most published studies have reported a male predominance. The most common indication for surgery in our study was intestinal obstruction (42.1%), whereas Mahjabeen et al[16] reported sepsis as the leading indication for surgery (40%) followed by bowel obstruction (25%). These variations may reflect differences in the disease epidemiology, referral patterns, and institutional cases.

The overall 30-day postoperative morbidity rate in our study was 34.9% which is comparable to findings reported by Rizvi et al.[19] However, considerably high morbidity rates have been reported by Jain et al[20] and Sharma et al[21] (63% and 80.7% respectively). Similarly, the observed mortality rate of 9.2% in our study was comparable to that reported by Mahjabeen et al[16] (9%) but lower than the 19% mortality reported by Shekar et al.[22] These differences may be attributed to differences in patient characteristics, illness severity at presentation, perioperative management and institutional resources.

When comparing the two scoring systems, it was found in our study that the Area Under ROC curve (AUC) for POSSUM was 0.523 for morbidity prediction and 0.711 for mortality prediction whereas the AUC for P-POSSUM in predicting mortality was 0.714 indicating slightly better discriminative performance. Both POSSUM and P-POSSUM over predicted postoperative morbidity and mortality in our study. However, the predictive performance observed in our study was lower than those reported in previous studies.[23,24]

Bullagan et al[12] reported that Possum and P-possum scoring systems demonstrated sensitivity of 83.3% and 88.9%, and specificity of 92.6% and 96.3%, positive predictive value of 88.2% and 94.1%, negative predictive value of 89.3% and 92.9% and diagnostic accuracy of 88.9% versus 93.3% respectively for predicting postoperative mortality. In Comparison, the sensitivity reported in our study was considerably lower for both POSSUM and P-POSSUM (21.4 and 50% respectively) whereas the specificity was comparable (92.5 and 96.4%). The lower sensitivity observed in our study may reflect differences in patient characteristics, disease severity, sample size and institutional practices.

Limitations of the study: It was a single center with a relatively small sample size, which may limit its generalizability. Further multicenter studies with larger patient population are required to validate these results. In addition, the POSSUM and P-POSSUM scoring systems should also be compared with other contemporary risk prediction models systems in our population to determine the most accurate tool for perioperative risk assessment in patients undergoing emergency laparotomy.

CONCLUSION

The P-POSSUM scoring system demonstrated better predictive performance than the original POSSUM model for 30 - day mortality following emergency laparotomy, with higher specificity, positive predictive value and discriminative ability. However, the POSSUM scoring system demonstrated limited predictive performance for postoperative morbidity. Although, P-POSSUM may serve as a useful adjunct in perioperative risk assessment, neither scoring system achieved sufficient accuracy for risk stratification as a standalone risk assessment tool in patients undergoing emergency laparotomy. Future work should focus on validating modernized population specific tools before their routine implementation in a local population.

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