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Efficacy of the P-POSSUM scoring system in prediction of post-operative mortality and morbidity in patients undergoing emergency exploratory laparotomy in a tertiary institute in East India

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ABSTRACT

Background: The tenet of any surgery is to reduce the morbidity and mortality. The outcome is not solely dependent on surgeon's operative expertise alone, but also significantly influenced by a lot of patient factors. The Physiological and Operative Severity Score for the enUmeration of Morbidity and Mortality (POSSUM), a risk-adjusted scoring system, has already been used in various parts of India. There is scarcity of published research using this tool in the population of Eastern India. **Aims and Objectives:** The aim of the study was to determine the efficacy of modified version Portsmouth-POSSUM (P-POSSUM) scoring system in predicting the post-operative morbidity and mortality in population of East India. **Materials and Methods:** The study was carried out in 50 patients of either gender, of age group 13–80 years, undergoing emergency laparotomy and followed up to 30-day post-operative follow-up of all patients till the sample size of 50 was reached. The physiological scores were recorded during admission and the operative severity score was recorded according to the intra-operative findings of operating surgeon. Any post-operative morbidity or death was recorded during hospital stay or on follow-up for a period of 30 days. The Hosmer–Lemeshow test was used for goodness-of-fit in logistics regression for mortality risk prediction model. The ratio of observed and expected rates (O: E ratio) was calculated. **Results:** Using the scoring tool, no significant difference was observed between the expected and observed mortality (Chi-square 2.166; df = 8; P = 0.976, O: E ratio 1.4) but a considerable difference was observed between the observed between the expected morbidity rates ($\chi^2 = 22.806$, df = 8, P = 0.004, O: E ratio 1.137). **Conclusion:** The P-POSSUM score was able to accurately predict the mortality in Eastern India surgical settings. However, the model was not that accurate in prediction of morbidity.

Key words: Hosmer-Lemeshow test; Logistic regression; Observed morbidity; Observed mortality; Operative score; Peritonitis; Physiological score; Predicted morbidity; Predicted mortality; Risk scoring

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INTRODUCTION

The aim of any surgical procedure is to cause reduction in post-operative morbidity and mortality. The outcome of any surgical intervention, be it death or an uncomplicated survival, depends not only on the expertise of a surgeon but also influenced by a multitude of patient factors. Over the past several decades, multiple scoring tools have been developed and have been utilized for risk stratification. Some of the most commonly used tools for assessing risks

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are the American Society of Anesthesiologists (ASA) score, Charlson Comorbidity Index, Elixhauser Comorbidity Index, and National Emergency Laparotomy Audit score.[1-3] Although the ASA physical status (ASA-PS) classification is not originally intended to predict risk, but increased ASA-PS class has been associated with increased perioperative mortality.[4] Despite it is being used by anesthesiologists worldwide, it has certain limitations such as it does not account for effect of age, body mass index, pregnancy, and type of surgical procedure. Moreover, the objectivity is reduced by the interobserver variability.[5]

The adequacy of surgical care can be assessed by comparing the adverse outcome rates. It can help in evolving new treatment strategies. However, comparison of crude mortality rates can be misleading as it cannot adequately account for the patient's general condition and the disease process for which surgery is done. To overcome this shortcoming, the Physiological and Operative Severity Score for the enUmeration of Morbidity and Mortality (POSSUM) – a risk adjusted scoring system was developed. It was originally described by Copeland et al.,[6] in 1991 with the goal of providing a simple objective tool to assess morbidity and mortality risks in general surgical patients. Subsequently, its modified version Portsmouth-POSSUM (P-POSSUM) scoring system has been assessed in many clinical studies to predict the post-operative morbidity and mortality in patients undergoing variety of elective or emergency surgeries.

In a study, Kumar et al.,[7] observed P-POSSUM as a better tool than POSSUM in predicting mortality, and exponential method was found better than linear regression analysis. Both were found to be useful tools for risk-adjusted surgical audit of patients undergoing emergency laparotomy.[7] In another study[8] involving 887 patients presenting with enteric perforation and having features of peritonitis, both POSSUM and P-POSSUM were found as accurate tools for predicting morbidity and mortality, respectively. However, the authors[8] also cautioned that the tools may sometime over- or under- predict morbidity as well as mortality. Moreover, a recent study[9] in South Indian clinical scenario has also reported that the tool is useful for predicting mortality but not completely accurate to assess post-operative morbidity. Thus, it appears that there is varied mention about the efficacy of this tool in prediction of morbidity and mortality in different subset of population. To the horizon of our knowledge, no study has evaluated the efficacy of this tool in the population of Eastern India and there is a need to determine its efficacy in this geographical belt. Hence, the present study was designed to assess the efficacy of P-POSSUM scoring system among patients undergoing emergency exploratory laparotomies in the Eastern India clinical scenario.

Aims and objectives

The aim of the study was to determine the accuracy of P-POSSUM scoring system in predicting post-operative morbidity and mortality in patients undergoing emergency exploratory laparotomy. Furthermore, a comparative analysis was done between the accuracy of this scoring tool regarding prediction of morbidity and mortality.

MATERIALS AND METHODS

This prospective and analytical clinical study was carried out in the department of general surgery of a tertiary care center (Nil Ratan Sircar Medical College and Hospital, a Government Medical College), in Kolkata from March 2019 to August 2020. The study was started after obtaining the approval (No. NMC/10088, dated 09.01.2019) from the Institute's Ethics Committee. The study was carried out in 50 patients of either gender, of age group 13–80 years, undergoing emergency laparotomy and followed up to 30 days in the post-operative period till the sample size of 50 was reached.

Exclusion criteria

The following criteria were excluded from the study:

1. Patients aged 12 years and less
2. Those whose follow-up criteria was not met
3. Patients with significant immunosuppression (HIV/HBsAg positive) and those on immunosuppressive drugs/anti-cancer chemotherapeutic drugs.

Patients were informed regarding the aims and objectives of the study and a detailed informed written consent was taken before inclusion into the study. During hospitalization, relevant history was collected and appropriate investigations as deemed necessary were done using standard procedures. The patients were then scored depending on their physiological parameters and the intra-operative findings. The final expected mortality rate was calculated. In some variables, signs were assessed clinically and/or by changes in results on chest X-ray film. Any post-operative morbidity or death in the hospital was recorded. The patients were then followed up for a period of 30 days following the surgical procedure and complications if any were noted according to the criteria as defined for POSSUM scoring system.

This POSSUM scoring system is a multivariant discriminant analysis to yield a score which translates into prediction of risk.[3,6,9,10] It consists of 12-factor physiological severity assessment score such as age, cardiac status and ECG findings, pulse rate, systolic blood pressure, respiratory status, Glasgow coma score, serum concentrations of sodium and potassium, white cell count, blood levels of

hemoglobin, and urea (Table 1). This is combined with a six-factor operative severity score which includes type and number of procedures, volume of blood loss, peritoneal contamination, presence and extent of malignancy, and the timings of surgery (Table 2).[10]

Data collection was done using a proforma prepared for the study from all patients undergoing emergency exploratory laparotomy in the stipulated time period. All the patients had their physiological scores recorded at the time of admission and the operative severity score was recorded as per the intra-operative findings observed by the operating surgeon. The following equations were used to calculate the morbidity and mortality rates.[10]

POSSUM equation for morbidity: Log [R/1-R] = −5.91 + (0.16×physiological score) + (0.19×operative score); where R is the predicted risk of morbidity

POSSUM equation for mortality: Log [R/1-R] = −7.04 + (0.13×physiological score) + (0.16×operative score); where R is the predicted risk of mortality.

Statistical analysis

Categorical variables are expressed as number of patients and percentage. The number of observed and expected (predicted) morbidity and mortality across the groups (2×2 table) was analyzed using Pearson's Chi-square test/Fisher's exact test, as appropriate. The Hosmer–Lemeshow (H-L) test is used for goodness of fit in logistics regression for mortality risk prediction model. The statistical software "Statistical Package for the Social Sciences" (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. IBM Corp. Released 2012) has been used for the analysis. An alpha level of 5% has been taken, that is, if any $P<0.05$, it has been considered as significant.

The risk of morbidity and death is calculated using POSSUM and P-POSSUM equations. The expected mortality rate was obtained using linear regression analysis and the ratio of observed and expected rates (O: E ratio) was calculated. Chi-square test was then applied to obtain the P-value to note any significant difference between the predicted death rate and the actual (observed) outcome.

Table 1: Physiological severity assessment for POSSUM system

Score	1	2	4	8
Age (in years)	≤60	61–70	≥71	-
Cardiac signs	Normal	Cardiac drugs or receiving steroids	Edema, receiving warfarin, borderline cardiomegaly	JVP raised, Cardiomegaly
Respiratory signs, CXR	Normal	Breathlessness on exertion, mild COPD	Breathlessness on walking, moderate COPD	Breathlessness on rest, any other changes in lungs
Systolic BP (mm Hg)	110–130	13–170, 100–109	≥171, 90–99	≤89
Pulse (beats/min)	50–80	80–100, 40–49	101–120	≥120 or≤39
GCS	15	12–14	9–11	≤8
Urea nitrogen (mMol/L)	<7.5	7.6–10	10.1–15	≥15.1
Serum [Na] (mEq/L)	>136	131–135	126–130	≤125
Serum [K] (mEq/L)	3.5–5.0	3.2–3.4; 5.1–5.3	2.9–3.1; 5.4–5.9	≤2.8; ≥6.0
Hb (g/dL)	13–16	11	10–11.4; 17.1–18	≤9.9; ≥18.1
WBC (×10^{12}/L)	4–10	11.0–20.0	≥20.1; ≤3	-
ECG	Normal	-	AF (60–90)	Any other change

Table 2: Operative severity assessment for POSSUM system

Score	1	2	4	8
Operative magnitude	Minor	Intermediate	Major	Major plus (+)
Number of procedures during operation	1	-	2	>2
Blood loss per operation (in ml)	<100	101–500	501–999	>1000
Peritoneal contamination	No	Serous	Local pus	Free bowel content, pus or blood
Presence of malignancy	No	Primary cancer only	Node metastases	Distant metastases
Timing of operation	Elective	-	Emergency (resuscitation possible), operation within 24 hours	Emergency (immediate), Operation within 2 hours

Rate of increment in deaths for each risk factor was calculated based on the hypothesis that deaths were linearly related with the score for each of the studied risk factor and "t" test was applied to validate this hypothesis. An O: E ratio of 1 represented the best prediction.

RESULTS

Demography

In the present study, out of the 50 patients, 14 individuals (28%) were females and 36 individuals (72%) were males. Probably, a higher incidence of infection and alcohol-induced complications might have caused a male preponderance.

The predominant age group in the study was 50–60 years constituting 30% of all the patients, possibly due to the fact that old age and infection-related complications were highest in this age group (Table 3). The youngest patient was 13-years-old and the oldest patient was 86-years-old.

The most common indication for emergency exploratory laparotomy in the present study was peptic perforation, which included 24% of all cases **(**Table 4**).**

Intra-operative diagnosis

The most common indication for emergency laparotomy was a peptic perforation (duodenal perforation), which included 24% of all cases. Ten cases were due to blunt trauma abdomen (20%) and eight cases due to acute intestinal obstruction (16%) due to causes other than sigmoid volvulus which included a total of 5 cases (10%). Out of the 50 cases taken up for emergency exploratory laparotomy, modified Graham's patch repair was the most commonly performed procedure with a total of 12 cases (24%), followed by ileostomy/colostomy placement in 12 cases (24%) (Table 5).

Mortality and morbidity encountered

Out of the 50 cases taken for emergency exploratory laparotomy, seven patients expired (14% mortality rate). The most common post-operative complication being wound (surgical site) infections which affected 12 patients (24%), closely followed by and experienced chest infections in 7 patients (14%). Total 26 patients suffered from significant complications (morbidity) post-surgery and 17 patients recovered without any significant post-operative complications (Table 6).

The contingency Table 7 shows the observed and expected (predicted) rates of mortality using the P-POSSUM score. The expected number of deaths was five and observed number of deaths was seven (Tables 7 and 8). The O: E ratio=1.4 (7/5) (Table 8). There was no significant difference between the expected and observed mortality (P-value of 0.976, Table 7). Hence, the P-POSSUM score can be an accurate predictor of mortality.

The contingency Table 9 shows the observed and the expected rates of morbidity. The O: E ratio is 1.137 (33/29) (Table 8). The morbidity using the POSSUM score showed P-value of 0.004 (χ^2=22.806, df=8, P=0.004). As P<0.05

Table 3: Age distribution and the frequencies

Age group	Frequency (%)	Age range	Frequency (%)
10–20 years	03 (6%)	≤60	40 (80%)
20–30 years	05 (10%)		
30–40 years	09 (18%)		
40–50 years	08 (16%)		
50–60 years	15 (30%)		
60–70 years	05 (10%)	61–70	5 (10%)
70–80 years	04 (8%)	≥71	5 (10%)
80–90 years	01 (2%)		

Table 4: Indications for emergency laparotomy

Indications	Frequency (%)
Peptic perforation	12 (24%)
Blunt trauma abdomen	10 (20%)
Acute intestinal obstruction (other than sigmoid volvulus)	08 (16%)
Jejunal perforation	01 (2%)
Sigmoid volvulus	05 (10%)
Ruptured liver abscess	01 (2%)
Biliary peritonitis	01 (2%)
Appendicitis with Meckel's diverticulitis	01 (2%)
Appendicular mass	02 (4%)
Pelvic abscess	02 (4%)
Gastric outlet obstruction	01 (2%)
Appendicular abscess	03 (6%)
Ileal perforation	02 (4%)
Sigmoid perforation	01 (2%)
Total	50 (100%)

Table 5: Procedure performed

Surgery Procedure	Frequency (%)
Modified Graham's Patch	12 (24%)
Hartmann's procedure	6 (12%)
Ileostomy	6 (12%)
Left Hemicolectomy	1 (2%)
Right hemicolectomy	1 (2%)
Resection and anastomosis	2 (4%)
Splenectomy	1 (2%)
Anterior gastrojejunostomy	1 (2%)
Appendicectomy	1 (2%)
Resection of Meckel's diverticulum and appendectomy	1 (2%)
Band adhesion lysis	3 (6%)
Evacuation of hematoma	2 (4%)
Peritoneal lavage and drain placement	10 (20%)
Reduction of internal herniation	1 (2%)
Primary repair of perforation	1 (2%)
Repair of rectus sheath	1 (2%)
TOTAL	50 (100%)

Table 6: Complications observed

Complication	Frequency (%)
Delirium	2 (4%)
Paralytic ileus	2 (4%)
Respiratory tract infection	7 (14%)
Urinary tract infection	3 (6%)
Wound infection	12 (24%)
Expired	7 (14%)
No complications	17 (34%)
Total	50 (100%)

Table 7: Mortality analysis

Mortality=No		Mortality=Yes		Total
Observed	Expected	Observed	Expected	
5	4.999	0	0.001	5
5	4.999	0	0.001	5
5	4.998	0	0.002	5
5	4.998	0	0.002	5
5	4.996	0	0.004	5
5	4.992	0	0.008	5
5	4.964	0	0.036	5
4	4.643	1	0.357	5
4	3.161	1	1.839	5
0	0.249	5	4.751	5

Hosmer and Lemeshow test. Chi-square 2.166; df=8; *P*=0.976

Table 8: Classification table for mortality and morbidity

	Predicted mortality No	Predicted mortality Yes	Percentage Correct	O: E ratio
Observed mortality No	43	0	100	1.4
Observed mortality Yes	2	5	71.4	
Overall percentage			96	
	Predicted morbidity No	**Predicted morbidity Yes**	**Percentage Correct**	**O: E ratio**
Observed morbidity No	6	11	35.3	1.137
Observed morbidity Yes	4	29	87.9	
Overall percentage			70	

The cut value is 0.500

(significant difference between the O: E ratio), it translates in to having a considerable difference between the expected and observed mortality rates. Thus, the POSSUM score was not found to be an accurate predictor of morbidity.

The percentage correct of the predicted "no mortality" was 100% (43 out of [43+0]). The percentage of predicted "yes mortality" was 71.4% (predicted mortality "yes" in 5 out of observed [5+2] mortality). Overall percentage of prediction (43 as "no" and 5 as "yes" out of total 50 patients) was 96% ([43+5]/50). Similarly, the percentage correct of

Table 9: Morbidity analysis

Morbidity=No		Morbidity=Yes		Total
Observed	Expected	Observed	Expected	
2	4.129	3	0.871	5
4	3.113	1	1.887	5
5	2.186	0	2.814	5
4	1.713	1	3.287	5
0	1.425	5	3.575	5
1	1.166	4	3.834	5
1	0.966	4	4.034	5
0	0.831	5	4.169	5
0	0.909	6	5.091	6
0	0.562	4	3.438	4

Contingency table for Hosmer and Lemeshow test. Chi-square 22.806; df=8; P=0.004

the predicted "no morbidity" was 35.3%% (6/[6+11]). The percentage of predicted "yes morbidity" was 87.9% (predicted morbidity "yes" in 29 out of total observed [29+4] morbidity). Overall percentage of correct prediction (6 as "no" and 29 as "yes" out of total 50 patients) was 70% ([6+29]/50) (Table 8).

DISCUSSION

The present study shows a significant difference between the observed and expected morbidity rates whereas no considerable difference between the observed and expected mortality rates. On analyzing the prediction based on the initial POSSUM scores and the final outcome observed, and their ratio (O: E) analyzed, it translates in to the fact that the scoring system appears to be accurate in predicting the mortality of a particular scenario (exploratory laparotomy patients in this geographical area), while the same accuracy is not achieved with respect to morbidity. The O: E ratio for mortality was 1.4 and that for morbidity was 1.137. The findings of the present study are in line with the observations of some cotemporary studies by Chatterjee and Renganathan[13] and Kumar et al.[10] A glimpse of contemporary studies using POSSUM in Indian population has been depicted in Table 10 for a comprehensive view.

In a seminal article, Sagar et al.,[16] mentioned that the overall O: E ratio for the whole group of patients (undergoing colorectal resection, n=248) was 0.87 for mortality and 0.97 for morbidity. The authors[16] concluded that while comparing the surgeon's performance between units, the direct comparison of crude rates of morbidity and mortality might be misleading, and the risk-adjusted analysis (O: E ratio) allows more meaningful comparison. An audit[17] analyzing the quality of care (data of 334 patients undergoing reconstructive vascular surgery) revealed that the POSSUM scoring system was found to be better predictor of adverse outcome following surgery and a better tool in comparison with crude mortality rates.

Table 10: Review of POSSUM studies in India

Study and year	Geographical area	Population	Number of patients	Ratio of Observed to Expected mortality and morbidity (O: E): (POSSUM or P-POSSUM scoring system)
Mohil et al., 2004[11]	India (Delhi)	Emergency laparotomy	120	0.68 (POSSUM morbidity)^{L} 0.91 (POSSUM morbidity)^{E} 0.66 (P-POSSUM mortality)^{L} 0.88 (P-POSSUM mortality)^{E}
Kumar et al., 2011[8]	India (Delhi)	Ileal perforation peritonitis	380	0.47 (POSSUM mortality), 0.85 (POSSUM morbidity)
Yadav et al., 2011[12]	India (Haryana)	General surgical	100	1.13 (POSSUM morbidity) 1.5 (P-POSSUM mortality)
Chatterjee et al., 2015[13]	India (Tamil Nadu)	Perforation peritonitis	50	1.005 (POSSUM mortality) 1.001 (POSSUM morbidity)^{L},
Kumar et al., 2016[10]	India (Bihar)	Perforation peritonitis	100	1.005 (POSSUM mortality) 1.001 (POSSUM morbidity)
Echara et al., 2019[14]	India (Rajasthan)	Emergency laparotomy	100	0.87 (POSSUM morbidity)^{O} 0.29 (POSSUM mortality)^{O} 0.44 (P-POSSUM mortality)^{O}
Paul et al., 2020[15]	India (Telangana)	Emergency laparotomy	100	0.91 (POSSUM morbidity) 0.62 (POSSUM mortality) 0.65 (P-POSSUM mortality)
Present study	India (West Bengal)	Emergency laparotomy	50	1.4 (P-POSSUM mortality)^{L} 1.1 (P-POSSUM morbidity)^{L}

The superscripts L and E indicate linear and exponential analysis, respectively. The superscript O means "overestimates" as interpreted by the respective authors.

Whiteley et al.,[18] observed an over-prediction of mortality by a factor of 2 using the POSSUM scoring system and the researchers modified the equation using the same variables to obtain the P-POSSUM score.

Prytherch et al.,[19] reported that P-POSSUM tool can be used as an accurate method for comparative surgical audit. In a study comparing the POSSUM and P-POSSUM for predicting the adverse outcome rate in patients undergoing emergency laparotomy, Mohil et al.,[11] concluded that both scoring systems are valid for accurate prediction of post-operative mortality rates even in the Indian scenario where a majority of patients come from low socioeconomic strata with very limited resources.

Kumar et al.,[8] validated POSSUM score in enteric perforation peritonitis and concluded that POSSUM is a good predictor of morbidity (O: E=0.85) and over-predicts mortality (O: E=0.47). In another study involving 100 general surgical patients, Yadav et al.,[12] reported that the POSSUM and P-POSSUM appear to be good and valid indices for use in the risk prediction of morbidity and mortality in the north Indian population. In a recent study,[20] the P-POSSUM score was analyzed for all patient undergoing craniotomies over the span of 1 year and the authors concluded that the P-POSSUM score was an accurate predictor of mortality in both elective and emergency surgical patients. In another recent study[13] involving 50 patients with perforation peritonitis, the POSSUM scoring system is found to be a good indicator of post-operative outcome. The authors commented that the tool can be useful in identifying high risk patients and thereby catering preferential care for better outcome. They also suggested that inclusion of factors such as "perforation to operation time" and comorbid status can improve the scoring system further to provide better care. However, two recent studies[14,15] reported contradictory findings; one study found that POSSUM and P-POSSUM scoring overestimate[14] mortality and morbidity while the other study reports that both can be an accurate[15] predictor of mortality and morbidity following emergency laparotomy and is a valid means of assessing adequacy of care provided to the patient. In another study[9] involving 50 patients undergoing emergency laparotomy, the authors found that POSSUM is not accurate predictor of morbidity while P-POSSUM is an accurate predictor of mortality.

The H-L test is the most widely used method for assessing the accuracy of a logistic regression model. It is assessed by determining the "discrimination measures" (how well a model can distinguish between patients who die versus those who survive) and "calibration measures" (the ability of a model to generate predictions that are on an average close to the average observed outcome).[21] The H-L test examines how well the percentage of Observed death matches with the percentage of predicted (Estimated) deaths over deciles of predicted risk. The high P-value (non-significant) in the H-L test indicates that the numbers of observed deaths are not significantly different from those predicted by the model and that the overall model fit is good.[22] The risk-adjusted mortality ratio (RAMR) is the

ratio of observed and predicted (Expected)-- the O/E ratio. An O/E ratio of 1.0 indicates about the score predicting mortality perfectly. In other words, if the observed number of deaths is equal to the expected number of deaths (as predicted by the scoring system), the RAMR would have a value of 1.0. An O/E ratio > 1.0 can be interpreted that the model underpredicts mortality while an O/E ratio < 1.0 can be translated that the model overpredicts mortality.[8,23]

Due to the simplicity, easy applicability, and usage of routine pre-operative investigations, the POSSUM and P-POSSUM scoring systems are being utilized widely in many centers. It can serve as an important risk scoring tool.[24] The scoring system can be used for surgical audit to assess the adequacy of care provided to the patient and can be utilized as a stimulus to improve the quality of surgical care for better outcome. However, P-POSSUM has to be correlated to the general condition of the local population for its better utility. This is especially true in patients in developing countries like India where the general health of the population is poor, malnutrition is a common problem and presentation to health-care facility if often delayed.

The scoring systems were found valid not only in general but also in vascular surgery settings. One potential disadvantage of POSSUM is that it can overpredict the risk of mortality and may require further tuning. Its modified version P-POSSUM has been proposed as a better scoring system as it better correlates with the observed mortality rate.[25,26] It does not take into account the importance of good post-operative care protocols to prevent complications; like adequate chest physiotherapy and heparin prophylaxis in the prevention of post-operative pneumonia and deep vein thrombosis.

Limitations of the study

In this study, only the patients undergoing emergency laparotomy were included. The sample size was also small. The sensitivity and specificity of this score was also not analyzed. A multicentric study recruiting a larger sample of diverse population, might reveal other outcome, and the predictive accuracy and validity of this model can be analyzed further.

CONCLUSION

The present study finds that the P-POSSUM scoring tool can be used as an accurate predictor of mortality while the system was not that accurate in predicting the morbidity. However, the P-POSSUM scoring system can be used as a record during the course of surgical management of patients.

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REFERENCES

1. Horvath B, Kloesel B, Todd MM, Cole DJ and Prielipp RC. The evolution, current value, and future of the American society of anesthesiologists physical status classification system. Anesthesiology. 2021;135(5):904-919. https://doi.org/10.1097/ALN.0000000000003947
2. Menendez ME, Neuhaus V, van Dijk CN and Ring D. The Elixhauser comorbidity method outperforms the Charlson index in predicting inpatient death after orthopaedic surgery. Clin Orthop Relat Res. 2014;472(9):2878-2886. https://doi.org/10.1007/s11999-014-3686-7
3. Johns WL, Strong B, Kates S and Patel NK. POSSUM and P-POSSUM Scoring in Hip Fracture Mortalities. Geriatr Orthop Surg Rehabil. 2020;11:2151459320931674. https://doi.org/10.1177/2151459320931674
4. Knuf KM, Maani CV and Cummings AK. Clinical agreement in the American Society of Anesthesiologists physical status classification. Perioper Med (Lond). 2018;7:14. https://doi.org/10.1186/s13741-018-0094-7
5. Daabiss M. American Society of Anaesthesiologists physical status classification. Indian J Anaesth. 2011;55(2):111-115. https://doi.org/10.4103/0019-5049.79879
6. Copeland GP, Jones D and Walters M. POSSUM: A scoring system for surgical audit. Br J Surg. 1991;78(3):355-360. https://doi.org/10.1002/bjs.1800780327
7. Kumar P and Rodrigues GS. Comparison of POSSUM and P-POSSUM for risk-adjusted audit of patients undergoing emergency laparotomy. Ulus Travma Acil Cerrahi Derg. 2009;15(1):19-22.
8. Kumar S, Gupta A, Chaudhary S and Agrawal N. Validation of the use of POSSUM score in enteric perforation peritonitis results of a prospective study. Pan Afr Med J. 2011;9:22. https://doi.org/10.4314/pamj.v9i1.71197
9. Thirunavukkarasu S and Subramanian AM. Efficacy of the P-POSSUM scoring system in prediction of post-operative mortality and morbidity in patients undergoing emergency laparotomy in a tertiary institute. Int Surg J. 2018;5:2523-2527. https://doi.org/10.18203/2349-2902.isj20182766
10. Kumar A, Suman S, Kundan K and Kumar P. Evaluation of POSSUM scoring system in patients with perforation peritonitis. Int Surg J. 2016;3(4):2181-2186. https://doi.org/10.18203/2349-2902.isj20163597
11. Mohil RS, Bhatnagar D, Bahadur L, Rajneesh, Dev DK and Magan M. POSSUM and P-POSSUM for risk-adjusted audit of patients undergoing emergency laparotomy. Br J Surg. 2004;91(4):500-503. https://doi.org/10.1002/bjs.4465
12. Yadav K, Singh M, Griwan M, Mishra TS, Kumar N and Kumar H. Evaluation of POSSUM and P-POSSUM as a tool for prediction of surgical outcomes in the Indian population. Australas Med J.

2011;4(7):366-373.

https://doi.org/10.4066/AMJ.2011.558

13. Chatterjee AS and Renganathan DN. POSSUM: A scoring system for perforative peritonitis. J Clin Diagn Res. 2015;9(4):PC05-PC09.

https://doi.org/10.7860/JCDR/2015/12720.5854

14. Echara ML, Singh A and Sharma G. Risk-adjusted analysis of patients undergoing emergency laparotomy using POSSUM and P-POSSUM score: A prospective study. Niger J Surg. 2019;25(1):45-51.

https://doi.org/10.4103/njs.NJS_11_18

15. Paul VA, Anusha A and Chandra AS. Evaluation of the validity of POSSUM and PPOSSUM score in predicting the risk of morbidity and mortality respectively in patients undergoing emergency laparotomy. Int Surg J. 2020;7(10):3224-3229.

http://dx.doi.org/10.18203/2349-2902.isj20203968

16. Sagar PM, Hartley MN, MacFie J, Taylor BA and Copeland GP. Comparison of individual surgeon's performance. Risk-adjusted analysis with POSSUM scoring system. Dis Colon Rectum. 1996;39(6):654-658.

https://doi.org/10.1007/BF02056945

17. Copeland GP. The POSSUM system of surgical audit. Arch Surg. 2002;137(1):15-19.

https://doi.org/10.1001/archsurg.137.1.15

18. Whitely MS, Prytherch DR, Higgins B, Weaver PC and Prout WG. An evaluation of the POSSUM surgical system. Br J Surg. 1996;83(6):812-815.

https://doi.org/10.1002/bjs.1800830628

19. Prytherch DR, Whiteley MS, Higgins B, Weaver PC, Prout WG and Powell SJ. POSSUM and Portsmouth POSSUM for predicting mortality. Physiological and operative severity score for the enUmeration of mortality and morbidity. Br J Surg. 1998;85(9):1217-1220.

https://doi.org/10.1046/j.1365-2168.1998.00840.x

20. Mercer SJ, Guha A and Ramesh VJ. The P-POSSUM scoring systems for predicting the mortality of neurosurgical patients undergoing craniotomy: Further validation of usefulness and application across healthcare systems. Indian J Anaesth. 2013;57(6):587-591.

https://doi.org/10.4103/0019-5049.123332

21. Kramer AA and Zimmerman JE. Assessing the calibration of mortality benchmarks in critical care: The Hosmer-Lemeshow test revisited. Crit Care Med. 2007;35(9):2052-2056.

https://doi.org/10.1097/01.CCM.0000275267.64078.B0

22. Bewick V, Cheek L, Ball J. Statistics review 14: Logistic regression. Crit Care. 2005;9(1):112-118.

https://doi.org/10.1186/cc3045

23. Nezic D, Borzanovic M, Spasic T and Vukovic P. Calibration of the EuroSCORE II risk stratification model: Is the Hosmer-Lemeshow test acceptable any-more? Eur J Cardiothorac Surg. 2013;43(1):206.

https://doi.org/10.1093/ejcts/ezs346

24. Jones HJ and de Cossart L. Risk scoring in surgical patients. Br J Surg. 1999;86(2):149-157.

https://doi.org/10.1046/j.1365-2168.1999.01006.x

25. Wijesinghe LD, Mahmood T, Scott DJ, Berridge DC, Kent PJ and Kester RC. Comparison of POSSUM and the Portsmouth predictor equation for predicting death following vascular surgery. Br J Surg. 1998;85(2):209-212.

https://doi.org/10.1046/j.1365-2168.1998.00709.x

26. Midwinter MS, Tytherleigh M and Ashley S. Estimation of mortality and morbidity risk in vascular surgery using POSSUM and the Portsmouth predictor equation. Br J Surg. 1999;86(4):471-474.

https://doi.org/10.1046/j.1365-2168.1999.01112.x

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