Prediction of In-Hospital Mortality after Emergency Laparotomy Using Glasgow Coma Scale, ASA Physical Status Classification, and P-POSSUM Score

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ABSTRACT

Objective: To determine the importance of the Glasgow Coma scale (GCS), ASA physical status classification system, and P-POSSUM score in predicting mortality among patients undergoing emergency laparotomies.

Study Design: An analytical study.

Place and Duration of the Study: Department of General Surgery, Sheikh Khalifa Bin Zayed Al-Nahyan Hospital Muzaffarabad, Pakistan, from October 2020 to January 2022.

Methodology: All emergency laparotomies performed during the above-mentioned period were included consecutively, excluding trauma laparotomies, re-do laparotomies after elective surgery, appendectomies, cholecystectomies, pancreatectomies, organ transplantation surgeries, and laparotomies due to gynaecological or vascular causes such as ruptured abdominal aortic aneurysm. The GCS scores were broken down into mild (14-15), moderate (9-13), and severe (3-8) categories. The ASA scoring was classified into five classes, i.e., Classes I to V. The P-POSSUM scores were assessed for each of the following five groups: (≤10, 11-20, 21-30, 31-40, and ≥41).

Results: Out of 50 patients (mean age: 47 ± 19 years), there were 39 (78%) males and 11 (22%) females. The median values for GCS and P-POSSUM scores were 15 and 11.1, respectively. According to the ASA, most patients (21, 42%) fit into Class II. Twelve (24%) patients died, while 38 (76%) survived. The mortality rate increased with an increasing P-POSSUM score, a lowering GCS score, and a higher class of ASA (all $p < 0.001$). The ROC curve analysis showed that P-POSSUM had the best performance at 0.987, followed by ASA (0.951) and GCS (0.411).

Conclusion: The ASA Physical Status Classification System and P-POSSUM scoring were significantly predictive of mortality after an emergency laparotomy.

Key Words: *ASA Physical Status Classification System*, *Emergency laparotomy*, *Glasgow coma scale*, *Mortality*, *Outcome*, *P-POSSUM*.

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INTRODUCTION

According to reports from various regions of Pakistan, the death rates after emergency laparotomies were 24%, 23.94%, and 23.9%, respectively.[1-3] Thus, in order to escalate the level of care, it is imperative that patients who are at high risk for fatal outcomes should quickly be identified using the right objective risk assessment tools.

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One of the early risk assessment systems for this use is the American Society of Anaesthesiologists Physical Status Classification System (ASA).[4,5] Likewise, another tool is the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) with later Portsmouth modification (P-POSSUM).[6] This modification was created to address the overstatement of hazards estimated by the POSSUM score.

The Glasgow Coma scale (GCS) is an assessment tool primarily used to assess and monitor patients with altered mental status. Though it is not directly implicated in predicting the outcome after emergency laparotomy, it is an essential component of the APACHE II scoring system that evaluates morbidity and mortality following a variety of surgical procedures and has been tested in many academic investigations.[7,8] Moreover, many patients presenting with an indication of emergency laparotomy may have altered mental status, which makes GCS one of the assessment tools to monitor recovery. Thus, GCS cannot be overlooked during the monitoring of critical patients who are candidates for emergency laparotomies. Keeping that in mind, the aim of this study was to evaluate the accuracy of ASA, P-POSSUM, and GCS in predicting in-hospital mortality while utilising a regional cohort so that the results might be more country-specific and would lead to the building up of customised guidelines.

METHODOLOGY

This was an analytical study conducted at the Department of General Surgery, Sheikh Khalifa Bin Zayed Al-Nahyan Hospital, Muzaffarabad, from October 2020 to February 2022, after receiving approval from the hospital's Ethical Review Committee. The study included all consecutively admitted patients' aged 12 years and older undergoing emergency laparotomies. All the patients gave written consent for inclusion in the study. A sample size of 48 was calculated using MedCalc version 19.1.3 (MedCalc Software, Ostend, Belgium). The value used for the area under the receiver operator characteristic (ROC) curve (AUC) was 0.88.[9] The null-hypothesis value was set at 0.5, the α-level was set at 0.005, and the β-level was set at 0.025. The ratio of sample sizes in the negative and positive groups was taken from the previous reference as 111/46.[9] Trauma laparotomies, re-do laparotomies after elective surgery due to leak or collection, appendectomies, cholecystectomies, laparotomies due to gynaecological reasons, and vascular causes such as ruptured abdominal aortic aneurysm, organ transplantation surgeries, and pancreatectomies were considered to be in the exclusion criteria. A concomitant head injury or stroke was also included in the exclusion criteria. The seniority of anaesthetists and surgeons was ensured as senior registrars or consultants. The primary outcome measure was in-hospital mortality, defined as death before discharge from the hospital. Data were collected on printed patient proformas and later shifted to Statistical Package for Social Sciences (SPSS) version 22 for statistical analysis.

The GCS scores were broken down into mild (14–15), moderate (9–13), and severe (3–8) categories. The ASA scoring was classified into five classes: Class-I, which denoted a healthy and fit patient; Class-II, which signified a mild systemic disease; Class-III, which represented a severe, but not incapacitating, systemic illness; class-IV, which symbolised a disease that was debilitating and posed a persistent danger to life; and Class-V, which denoted a patient who, with or without surgery, was not expected to live for 24 hours. The P-POSSUM scores were assessed for each of the following five groups: (≤10, 11-20, 21-30, 31-40, and ≥41).

Before calculation, the scale data were analysed for normality by means of the Shapiro-Wilk's test using SPSS. The GCS and P-POSSUM scores did not follow a normal distribution. The authors recorded medians and interquartile ranges (IQR) for the scale data and numbers and percentages for the categorical data. The Pearson's Chi-square test was used to compare the two groups while assessing the descriptive statistical parameters. A p-value ≤0.05 was considered significant. During the course of the investigation, twelve (24%) patients died. The effectiveness of GCS, ASA, and P-POSSUM scoring systems in terms of accurate evaluation of mortality was assessed using the ROC curve analysis. Accordingly, AUC = 0.5 denoted no distinction, AUC >0.5 and <0.7 denoted that the discriminative ability of the test was not significant statistically, AUC >0.7 and <0.8 was acceptable, AUC >0.8 and <0.9 was considered very good, and AUC >0.9 and <1 was deemed perfect.

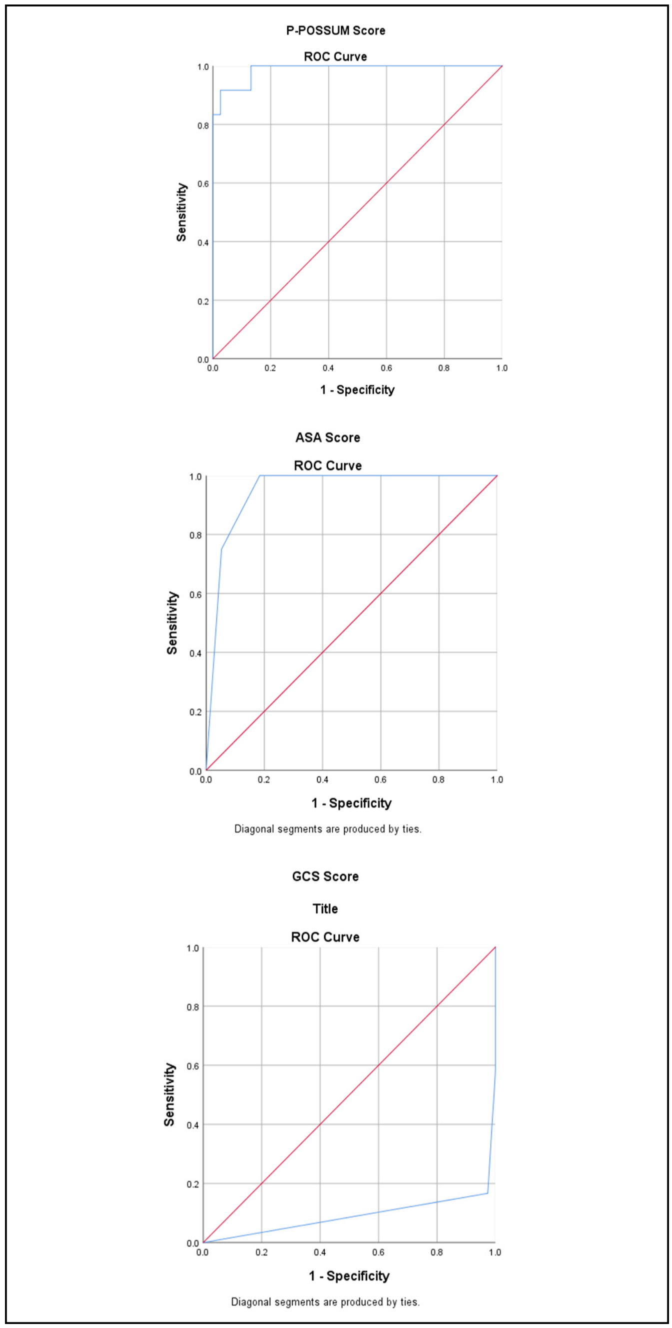

Figure 1: The ROC curve analysis for P-POSSUM, ASA, and GCS scores.

Table I: Frequencies and percentages for qualitative variables and medians and IQR for quantitative variables.

Variables	n (%)	Variables	Median (IQR^{ʊ})
ASA* physical status classification system		P-POSSUM^{f} score	11.1 (24.17)
Class-I	10 (20%)		
Class-II	21 (42%)		
Class-III	8 (16%)		
Class-IV	11 (22%)		
Class-V	0		
Per-operative findings		GCS$^{€}$ score	15 (0)
Bowel contents	18 (36%)		
Serous fluid	15 (30%)		
Free pus	9 (18%),		
Localised pus	5 (10%)		
Blood	1 (2%)		
No abnormal peritoneal content	2 (4%)		

**American Society of Anaesthesiologists. ʊInterquartile Ranges. fPortsmouth modification of Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity. €Glasgow Coma Scale.*

Table II: The association of GCS, ASA physical status classification system, and P-POSSUM scores with mortality.

Variables	Survived 76%, n = 38	Dead 24%, n = 12	p-value*
GCS$^{€}$ Score			<0.001
GCS ≤8	0	3 (100%)	
GCS 9-12	0	2 (100%)	
GCS 13-15	38 (84.4%)	7 (15.6%)	
ASA^{ʊ} physical status classification system score			<0.001
Class-I	10 (100%)	0	
Class-II	21 (100%)	0	
Class-III	5 (62.5%)	3 (37.5%)	
Class-IV	2 (18.2%)	9 (81.8%)	
Class-V	0	0	
P-POSSUM^{f} score			<0.001
≤10	24 (100%)	0	
11-20	9 (100%)	0	
21-30	4 (66.7%)	2 (33.3%)	
31-40	0	1 (100%)	
≥41	0	9 (100%)	

**Pearson's Chi-Square analysis. €Glasgow Coma Scale. ʊAmerican Society of Anaesthesiologists. fPortsmouth modification of Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity.*

RESULTS

Out of 50 individuals added to the research, there were 39 (78%) males and 11 (22%) females. The mean age of the sample was 46.9 ± 19.5 years (range: 13-88 years). The frequencies, percentages, medians, and IQR for the variables are given in Table I.

Forty-five (90%) patients had normal cognition or mild cognitive disability, two (4%) patients had moderate, and three (6%) patients had a severe cognitive disability. The different peritoneal contents extracted during operation are provided in Table I. Twelve (24%) patients died, while 38 (76%) survived.

The ASA scoring was divided into five classes, and a statistically significant difference could be seen between the mortality rates of ASA Class IV and the other classes (p <0.001, Table II). The association between the death rate and different groups based on the P-POSSUM score is given in Table II.

The ROC curve analysis revealed that P-POSSUM had the best performance at 0.987, followed by ASA, which also had a perfect level at 0.951. The GCS score, on the other hand, was 0.411 and was deemed to have statistically poor discriminative power (Figure 1).

DISCUSSION

The burden of emergency surgeries, especially laparotomies, is enormous but still not properly quantified in the authors' region. Several international efforts have been undertaken to increase insight into patient risk factors, and measures have been adopted to improve outcomes through the development of various risk reduction interventions, however, still mortality and morbidity remain high. The overall mortality in the present study was 24%, which was comparable to the mortality rate reported by other local investigations by Sultan and Zafar[2] and Jafferi *et al.*[3] but it was higher than the mortality frequency of 19.3% in a Zimbabian study by Ngulube *et al.*[10] and slightly lower than the 29.3% mortality frequency found in a Swedish study by Cao *et al.*[9] The factors analysed in this article were all relevant to an emergency laparotomy. The reason for higher mortality rates in local studies is probably the late arrival of patients in hospitals, as reported by other studies.[11]

There is a strong correlation between high ASA grades and mortality.[5,12] ASA is a readily available and easy-to-calculate method of predicting postoperative morbidity and mortality. In this study, there was no mortality in ASA Class I and II, but it rose to 37% in Class III and nearly 82% in Class IV patients. In a British meta-analysis, a higher ASA grade showed a direct association with mortality, especially in males.[5] An Indian study found that ASA-IV had the highest death rate, at 80%, followed by ASA-III with 84.2%, ASA-II with 35.9% and ASA-I with 3.7% death rates.[13] Similarly, Kisa *et al.*[14] found that ASA Class-IV death rates were nearly three times higher than those of other classes.

P-POSSUM scoring showed the best association in predicting the postoperative mortality in the present study by grasping the highest value for AUC, i.e., 0.987. There was no mortality in patients scoring below 20, but it rose to 33% in the group with P-POSSUM scores between 20 and 30, which is similar to the results reported by Grigorescu *et al.* that had P-POSSUM scores of ≥20 and had a mortality rate of more than 22%.[15] The present study showed a mortality rate of 100% for scores above 30, which is similar to the results of Nag *et al.* that a P-POSSUM score of ≥63 was attributed to a 91.3% death rate.[16] The ROC curve analysis showed that P-POSSUM had the best performance with an area of 0.987 out of the three assessment scores being tested, which was similar and comparable to the results obtained by Cao *et al.*, Ngulube *et al.*, and Maitra *et al.*[9,10,17] Echara *et al*. on the other hand, commented that P-POSSUM overestimated mortality in their patient population as the O/E ratio for P-POSSUM was 0.44.[18] It also did not show a significant correlation (p = 0.85) between observed and expected mortality.

The GCS score in the present study had a strong correlation with mortality, especially for the lower GCS score, yet the AUC observed for GCS predicted a poor predictive value for mortality (AUC = 0.411). There are very few other investigations that have evaluated the usefulness of GCS as a predictive tool for mortality in emergency laparotomies. Those too, unlike the authors, have sampled only the abdominal trauma patients who were candidates for emergency laparotomies. Chai *et al*. identified the GCS score as a significant factor in mortality (p <0.001) in emergency laparotomies.[19]

There are limited studies to provide a direct comparison of GCS, ASA Physical Status Classification System, and P-POSSUM scores in predicting in-hospital mortality among cases of emergency laparotomy. Sharrock *et al*. reported an AUC of 0.784 for P-POSSUM and 0.771 for ASA scoring.[20] Aggarwal *et al*. did not provide a direct comparison but established ASA and P-POSSUM as positive predictors of early deaths and GCS as a negative predictor of early deaths.[21] In summary, while the GCS, ASA Physical Status Classification System, and P-POSSUM score are all useful in predicting patient outcomes, they have different focuses and limitations. The GCS assesses neurological impairment, the ASA classification system evaluates preoperative health status, and the P-POSSUM score combines physiological and operative variables. To accurately predict in-hospital mortality, it may be beneficial to consider multiple scoring systems and factors in combination with clinical judgement.

This study is limited by a small sample size, so the results cannot be representative of the general population. Furthermore, only the surgical department of a single hospital was chosen as the recruitment area, thus there was a high probability of selection bias as only the willing participants from a relatively smaller population locality were included.

Keeping in view the high mortality rate associated with emergency laparotomies, it is highly recommended that high-risk surgical patients be promptly identified using the objective risk assessment tools and stratified into high- and low-operative risk groups so that appropriate timing for surgery can be assigned. Input from specialist surgeons, radiologists, and anaesthetists should be sought early in high-risk patients, in addition to the timely administration of antibiotics and fluid resuscitation. Hospitals expecting such patients should have dedicated emergency theatres and trained staff available round the clock, and maximum operation theatre time should be allocated to such patients during working hours.

CONCLUSION

The ASA Physical Status Classification System and P-POSSUM scoring were significantly predictive of mortality after an emergency laparotomy. They can be used as a guide as well as a justification for assigning the appropriate and highest level of care to the patients presenting with indications of emergency laparotomies. The GCS score, however, was deemed to have a suboptimal predictive value.

ETHICAL APPROVAL:
The study protocol was approved by the Ethical Review Committee of Sheikh Khalifa Bin Zayed Al Nahyan Hospital, Muzaffarabad Azad Jammu and Kashmir (ERC Approval Number: Ethical Committee/DME-713 dated 22 September 2020).

PATIENTS' CONSENT:
Informed consent has been obtained from patients to publish the data concerning this case.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
MA: Conceived the idea, collected data from the patients, performed the literature search, critically revised the manuscript, wrote the initial manuscript, and handled the submission process.
SBA: Performed the literature search, critically revised the manuscript, handled the submission process, performed the literature search, and critically revised the manuscript.
FH: Performed the literature search, critically revised the manuscript, and handled the submission process.
MNI, NA: Conceived the idea, and collected data from the patients.
AM: Collected data from the patients.

All authors approved the final version of the manuscript to be published.

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