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"An Analytical Study To Compare The Effectiveness Of P-Possum And Possum Scores In Predicting Mortality And Morbidity Following Emergency Laparotomy"

Author

Abstract
Background: *Surgical outcomes are increasingly scrutinized as part of efforts to ensure accountability and improve the quality of care. The Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) and its modification, the Portsmouth POSSUM (P-POSSUM), are widely used tools for predicting surgical outcomes.*
Objective: *This study aimed to assess the accuracy of POSSUM in predicting morbidity and P-POSSUM in predicting mortality for patients undergoing emergency laparotomies in a North Indian tertiary care center.*
Methods: *A hospital-based, analytic observational study was conducted at S.M.S. Medical College and Hospital, Jaipur, involving 160 patients who underwent emergency laparotomy. Preoperative physiological and intraoperative data were collected and used to calculate POSSUM and P-POSSUM scores. Mortality predictions were compared using linear and exponential analyses, and the observed-to-expected (O:E) mortality ratio was calculated. Statistical significance was determined using the Chi-square test.*
Results: *The mean age of the cohort was 49.65 years, with males comprising 64.37% of the population. Peptic perforation (20.6%) was the most common cause of surgery. POSSUM significantly over-predicted mortality (O:E ratio = 0.26, p=0.04), while P-POSSUM provided a more accurate prediction (O:E ratio = 0.45, p=0.81). POSSUM also overestimated morbidity (O:E ratio = 0.8, p=0.51).*
Conclusion: *While POSSUM tends to over-predict both mortality and morbidity, P-POSSUM offers a more accurate prediction of mortality in patients undergoing emergency laparotomy. These scoring systems can serve as valuable tools for surgical audits and improving the quality of care, though careful selection of the appropriate predictive model is essential.*
Keywords: *POSSUM and P-POSSUM, Physiological score, Operative score, observed morbidity, predicted morbidity, observed mortality, Predicted mortality*

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I. Introduction:

In today's environment of increased accountability, health professionals, particularly surgeons, are subject to scrutiny not only from their professional bodies but also from health authorities, the government, the media, and the public they serve. Surgeons must now demonstrate their performance through transparent and accurate comparative audits of surgical outcomes. This emphasis on accountability has driven interest in assessing the quality of surgical care, leading to the adoption of patient-centered approaches. However, crude morbidity and mortality rates can be misleading as they do not account for patients' physiological conditions or overall health at the time of surgery.[1]

For meaningful comparison to be undertaken, some form of risk-adjusted analysis needs to be performed.[2]

A scoring system quantifies a patient's risk of morbidity and mortality based on early-stage hospital data, providing crucial insights into illness severity. The ideal system for surgical audits should evaluate both mortality and morbidity while enabling comparisons across institutions, surgical teams, and individual surgeons. Recognizing the importance of standardized health outcome measures for surgical audits led to the development of the Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM). This system is now widely accepted for assessing surgical outcomes through risk-adjusted analysis.[3] The POSSUM scoring system was first introduced by Copeland et al. in 1991 as a method to standardize patient data, allowing for direct comparisons of surgical outcomes across different healthcare settings. By accounting for varying patterns of referral and demographic characteristics, POSSUM enables fair and accurate comparisons of patient outcomes, regardless of differences in patient populations or referral practices.[4]

POSSUM was found to over-predict mortality, prompting Whiteley et al. to develop the Portsmouth predictor equation for mortality (P-POSSUM) as a more accurate tool. P-POSSUM maintains the same physiological and operative scoring methods introduced by Copeland et al., but it uses linear analysis for mortality prediction, in contrast to the exponential analysis used by the original POSSUM system. This adjustment is believed to provide more precise mortality estimates in surgical patients.[1,3] therefore this study was planned to assess the value of POSSUM in predicting the morbidity rate and the value of P-POSSUM in predicting the mortality rate in general surgical patients of India.

II. Materials And Methods:

This hospital-based analytic observational study was conducted in the Department of General Surgery at S.M.S. Medical College and Hospital, Jaipur, a tertiary care centre. The study included all cases of emergency laparotomies performed at the hospital. Patients were selected based on specific inclusion and exclusion criteria. Inclusion criteria required patients to be aged 18 years or older, have undergone emergency laparotomy, and provided informed consent. Elective surgeries and patients lost to follow-up were excluded. The sample size was calculated using expected mortality rates from the POSSUM and P-POSSUM scores, with a range of 40% to 27%. Using a confidence level of 90% and 80% power, a total of 160 cases were required. A pre-designed proforma was used for data collection, which included preoperative physiological scores and intraoperative scores. These scores were calculated and used in the POSSUM and P-POSSUM scoring equations to predict postoperative mortality. Data were entered into an Excel sheet and analysed using both linear and exponential methods. The observed-to-expected mortality ratio (O:E ratio) was calculated, and the significance was determined using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

III. Results:

The mean age was 49.65 years, with most patients aged 31-50 (43.1%) and 51-60 (30.62%). Males comprised 64.37% of the cohort, while females made up 35.62%. Peptic perforation (20.6%) was the leading cause of surgery, followed by ileal perforation (18.75%), appendicular pathology (14.3%), and small bowel obstruction (10.62%). Other causes included gut gangrene (8.7%), obstructed hernia (8.1%), ruptured liver abscess (5%), caecal perforation (6.25%), and necrotizing pancreatitis (1.25%).

Mortality analysis by possum and p-possum: (A) Possum: The number of deaths predicted by POSSUM when done by linear analysis was 38 and there were 10 observed deaths. The O:E ratio was 0.26 and POSSUM significantly over predicted death by linear analysis (χ^2 =8.4, p=0.04) as shown in Table 1. Whereas number of deaths predicted when exponential method of analysis was used was 40 with O:E ratio of 0.09; there was also significant difference between observed and predicted values (χ^2 =8.3, p=.04) as shown in Table 3. (B)P-Possum: P-POSSUM predict mortality well in both linear as well in exponential method of analysis. By linear analysis method it predicts 22 deaths with O:E ratio of .45 and there was no significant difference between the observed and predicted values (χ^2 =3.01, p=0.81) as shown in Table 2. When exponential method of analysis used it predict 24 deaths, with an O: E of 0.41 and there was no significant difference between observed and predicted deaths (χ^2 =2.3, p=0.12) as shown in Table 4.

Morbidity Analysis POSSUM: POSSUM equation for morbidity with linear method of analysis estimated 102 patients with complications with O:E ratio of 0.8, with χ^2 = 4.5, p = 0.51. POSSUM over predict morbidity by linear analysis as shown in Table 5. With exponential method of analysis, it predicted 96 patients with complications with O:E ratio of 0.8 with χ^2 = 0.86 d.f. 1 p = 0.67 with no significant difference in observed and predicted morbidity as shown in Table.6.

IV. Discussion:

In our study, the mean age was 49.65 years, with most patients aged 31-50 (32.7%), and males predominating (64.37%), similar to findings by **Kimani et al.**[5] (67%) and **Echara ML et al.**[6] (M: F ratio 6.1:1), while other studies, like **Mohammad Ziual Haqm et al.**[7] reported a ratio of 1.45:1; our Jaipur study recorded 1.8:1.

Peptic perforation was the most common cause of emergency laparotomy (20.6%), followed by ileal perforation (18.75%), appendicular pathology (14.3%), and small bowel obstruction (10.62%). Other causes included gut gangrene (8.7%), obstructed hernia (8.1%), and ruptured liver abscess (5%). Rare but severe cases like cecal perforation (6.25%) and necrotizing pancreatitis (1.25%) added to the complexity. **Mohammad Ziual Haq et al.**[7] **(2012)** reported enteric perforation as the most common cause (30%), while **Vishwani et al.**[8] **(2014)** found peptic perforation to be the leading cause (35.9%). **Kumar A et al.**[9] **(2016)** also identified gastroduodenal perforation as the most frequent etiology (26%), consistent with the present study's focus on peptic perforation as a major contributor.

We observed 6.25% (n=10) mortality rate in our study which aligns closely with average mortality rates reported in various studies, ranging from 6% to 19.1%. Notably, the highest mortality was associated with patients undergoing emergency laparotomy for gut gangrene. For comparison, **Mohammad Ziual Haq et al.** [7] **(2012)** noted 21.3%. **Vishwani et al.** [8] **(2014)** found a lower rate of 6.75%.

The present study reported a morbidity rate of 63.75% (n=102), comparable to **Vishwani et al.**[8] (48.3%) and **Kumar et al.**[9] 39(50.0%). The most common complication was surgical site wound infection, affecting 30.6% (n=46) of patients, consistent with rates from **Vishwani et al.**[8] (28%) and **T.H. Chieng et al.**[10] (39.3%). Chest infections affected 18.75% of cases, superficial wound dehiscence 15%, septicemia 13.12%, hypotension 9.3%, and respiratory failure 8.1%. Less common complications included cardiac failure (1.87%), multiple organ dysfunction syndrome (2.5%), and deep wound dehiscence (2.5%).

POSSUM: On application of linear regression analysis POSSUM mortality equation, showed O: E ratio of 0.26: , POSSUM mortality significantly over predict mortality which also seen in study by **Mohil R S et al** [11] with O:E ratio of 0.39:1 but original study by **Copeland GP et al** [4] for gastrointestinal surgery showed O:E ratio of 1.04:1 validating its use in patients undergoing gastrointestinal surgery.

On application of exponential regression analysis POSSUM mortality equation, showed O: E ratio of 0.09: 1, similar seen in study by **Mohil R S et al** [11] with O:E ratio of 0.91:1, **Vishwani et al** [8] with O: E of 0.74:1. While study by **Khan et al** [12] showing no improvement in results by exponential analysis as compared to linear analysis showing O:E ratio of 1.15:1.

POSSUM predicted 38 deaths using linear analysis but observed only 10 (OE ratio 0.26), showing significant overprediction ($X^2 = 8.4$, $p = 0.04$). The exponential method predicted 40 deaths (OE ratio 0.09), also significantly different ($X^2 = 8.3$, $p = 0.04$), highlighting variability in predictive accuracy.

On application of linear regression analysis P- POSSUM mortality equation, showed O: E ratio of 0.45: 1, similar results by **Mohil R S et al** [11] and **T.H Chieng et al** [10] showing O:E ratio of 0.66:1 and 0.6:1 respectively.

On application of exponential regression analysis P- POSSUM mortality equation, showed O: E ratio of 0.41: 1, similar results also seen in study by **Mohil R S et al.**[11] with O:E ratio of 0.88:1, **Yii M K et al** [13] with O: E of 1.28:1, **Tekkis et al** [14] with O:E ratio of 0.98:1.

In our study, the P-POSSUM equation, using both linear and exponential methods, accurately predicted mortality rates. The linear method closely matched observed outcomes, suggesting it provided reliable mortality estimates for our patient population. While the exponential method gave similar predictions, likely due to the small sample size, the study highlights the importance of using the correct analytical method—specifically linear—in assessing predictive models like P-POSSUM for accurate mortality risk estimation in clinical practice.

On application of linear regression analysis P- POSSUM mortality equation, showed O: E ratio of 0.8: 1, similar results also seen in **study Whitelely et al** [1] with O:E ratio of 1:1. While study by **Mohil R S et al.** [11] and **T.H Chieng et al** [10] showing O:E ratio of 0.66:1 and 0.6:1 respectively.

On application of exponential regression analysis POSSUM morbidity equation, the O:E ratio improved to 0.8:1, similar improvement also seen in study by **Mohil R S et al.**[11] with O:E ratio of 0.91:1, While study by **Khan et al** [12] showing no improvement in results by exponential analysis as compared to linear analysis showing O:E ratio of 0.62:1.

Our analysis showed an increase in postoperative mortality rates linked to factors like malignancy, ischemia, impaired immunity, blood loss, uremia, toxaemia, and hyponatremia. Addressing these risk factors through timely interventions—improving immune function, managing blood loss, correcting uremia, and stabilizing electrolytes—can significantly reduce adverse outcomes. This highlights the importance of comprehensive management to improve patient recovery and outcomes.

V. Conslusion:

P-POSSUM is a better overall predictor of mortality in patients undergoing laparotomy in this hospital compared to POSSUM. POSSUM and P-POSSUM were found to overestimate mortality and morbidity in our patient's population. However, further refinement is needed to improve its predictive value in specific areas and increase its utility in our local setting.

VI. Limitations:

The POSSUM system is not intended to guide decisions against life-saving surgeries, as the operative severity score is assessed post-operation and relies on subjective factors like blood loss estimates. Recovery is also influenced by the organ system involved, hospital stay duration, and hospital resources, including staff availability and training, which impact mortality and morbidity rates.

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Conflict of Interests: None.

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Table 1: Linear Analysis for POSSUM

Mortality group (%)	Number of patients	Observed deaths	Predicted*	O: E
< 10	62	0	14	-
10-20	54	2	6	0.33
20-30	23	3	7	0.42
30-40	15	3	7	0.42
40-50	2	1	1	1
50-60	2	1	2	0.5
60-70	2	0	1	-
70-80	0	0	0	-
80-90	0	0	0	-
90-100	0	0	0	-
0-100	**160**	**10**	**38**	**0.26**

$\chi^2 = 8.4$ p = 0.04 (S)

Table 2: Linear Analysis for P. POSSUM

Mortality group (%)	Number of patients	Actual deaths	Predicted*	O: E
< 10	134	0	6	-
10-20	16	3	7	0.42
20-30	5	3	4	0.75
30-40	3	2	3	0.6
40-50	1	1	1	1
50-60	1	1	1	1
60-70	0	`0	0	-
70-80	0	0	0	-
80-90	0	0	0	-
90-100	0	0	0	-
Total	**160**	**10**	**22**	**0.45**

X2=3.01, p=0.81

Table 3: Exponential Analysis for POSSUM

Mortality group (%)	Number of patients	Actual deaths	Predicted*	O: E
0-39	154	8	35	0.05
10-39	89	8	21	0.06
20-39	7	6	13	0.11

40-100	6	2	4	0.25
50-100	4	1	3	0.3
60-100	0	0	0	-
70-100	0	0	0	-
80-100	0	0	0	-
90-100	0	0	0	-
0-100	**160**	**10**	**40**	**0.09**

X2=8.3, p=.04

Table 4: Exponential Analysis for P-POSSUM

Mortality group (%)	**Number of patients**	**Actual deaths**	**Predicted***	**O:E**
0-9	134	0	5	-
10-19	16	0	7	-
20-49	9	2	11	0.18
30-49	4	1	4	0.25
40-49	1	0	1	-
50-100	1	0	1	-
60-100	0	0	0	-
70-100	0	0	0	-
80-100	0	0	0	-
90-100	0	0	0	-
0-100	**160**	**10**	**24**	**0.41**

(X2=2.3, p=0.12)

Table 5: Morbidity Analysis POSSUM Linear Method

Morbidity group (%)	**Number of patients**	**Observed morbidity**	**Predicted***	**O: E**
< 10	0	0	0	-
10-19	2	0	0	-
20-29	17	8	10	0.8
30-39	25	10	12	0.83
40-49	21	10	15	0.66
50-59	26	11	13	0.84
60-69	24	15	19	0.78
70-79	22	15	19	0.78
80-89	17	7	8	0.8
> 90	6	6	6	1
0-100	160	82	102	0.8

χ^2 = 4.50; p =0.51