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Original Research Article

Evaluation of the validity of POSSUM and P-POSSUM score in predicting the risk of morbidity and mortality respectively in patients undergoing emergency laparotomy

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ABSTRACT

Background: Aim of this study is to examine the efficacy of Physiological and operative severity score for the enumeration of mortality and morbidity (POSSUM) and Portsmouth predictor modification (P-POSSUM) equations in predicting morbidity and mortality in patients undergoing emergency laparotomy, to study the morbidity and mortality patterns in patients undergoing emergency laparotomy at Malla Reddy Institute of Medical Sciences, Hyderabad.
Methods: The study was conducted for a period of 2 years from February 2018 to February 2020. 100 Patients undergoing emergency laparotomy were studied in the Department of General surgery MRIMS, Hyderabad. POSSUM and P-POSSUM scores are used to predict mortality and morbidity. The ratio of observed to expected deaths (O:E ratio) was calculated for each analysis.
Results: The study included total 100 patients, 83 men and 17 women. Observed mortality rate was compared to mortality rate with POSSUM, the O:E ratio was 0.62, and there was no significant difference between the observed and predicted values (χ^2=10.79, 9 degree of freedom (df) p=0.148). Observed morbidity rates were compared to morbidity rates predicted by POSSUM, there was no significant difference between the observed and predicted values (χ^2=9.89, 9 df, p=0.195) and the overall O:E ratio was 0.91. P-POSSUM predicted mortality equally well when the linear method of analysis was used, with an O:E ratio of 0.65 and no significant difference between the observed and predicted values (χ^2= 5.33, 9 df, p= 0.617).
Conclusion: POSSUM and P-POSSUM scoring is an accurate predictor of mortality and morbidity following emergency laparotomy and is a valid means of assessing adequacy of care provided to the patient.

Keywords: Physiological score, Crude mortality rate, Linear analysis, Exponential analysis

INTRODUCTION

A patient's risk of mortality and morbidity is assessed by a risk scoring that is based on the severity of the disease which is obtained from the data available at an early stage of the hospital admission. Physiological and operative severity score for the enumeration of mortality and morbidity (POSSUM) was first described by Copeland et al[1] in 1991 as a method for normalizing patient data so that outcome of the patients can be compared directly in spite of different patterns of referral and population. Originally POSSUM used 48 physiological and 14 operative and post-operative factors for every patient. These were reduced to 12 physiological and 6 operative findings using multivariate analysis.[1] The physiological operative severity score for the enumeration of mortality and morbidity (POSSUM) is widely used to predict morbidity and mortality in many emergency surgical cases, and is a

good tool for risk adjustment and comparison. POSSUM takes operative findings into consideration, whereas APACHE II does not. The variables required for POSSUM scoring that are 12 physiological and 6 operative variables can be recorded easily and reproduced satisfactorily with ease.[2] POSSUM was intended to be used in comparative surgical audit.[3] Calculated risks of death can be compared with the actual outcomes to give an observed to expected ratio.[3] The Portsmouth predictor modification (P-POSSUM) proposed by Whiteley et al counters the over prediction of mortality in low-risk patients by POSSUM.[4] Both POSSUM and P-POSSUM use the same variables but a different formula to predict the risk of mortality. Differences in predictive values of two scoring systems are related to the method of analysis. Wijesinghe et al explained how the original POSSUM equation used exponential analysis while P-POSSUM used linear analysis.[5] POSSUM has been used to compare the performance of individual surgeons. It has been used to compare the type of treatment in different hospitals. POSSUM has also been used to compare treatment of surgical patients in different countries even when their health care systems differ from each other. POSSUM can still predict outcome even where resources, facilities and pre-hospital care differ.

Classification of operative severity

Moderate surgery

Cholecystectomy, appendectomy, mastectomy, transurethral resection of prostate.

Major surgery

Any laparotomy, bowel resection, cholecystectomy with choledochotomy, peripheral vascular procedure or major amputation.

Major surgery

Any aortic procedure, abdominoperineal resection, pancreatic or liver resection, oesophagogastrectomy.

Aim of this study is to examine the efficacy of POSSUM and P-POSSUM equations in predicting morbidity and mortality in patients undergoing emergency laparotomy, to study the morbidity and mortality patterns in patients undergoing emergency laparotomy.

METHODS

Sample size:

The present study included 100 study subjects.

Study population:

Patients undergoing emergency laparotomy, Department of General surgery, Malla Reddy Institute of Medical Sciences, Hyderabad.

Study design

The study design was prospective observational study.

Duration of study

The study was conducted for a period of 2 years from February 2018 to February 2020.

Inclusion criteria

Inclusion criteria was as follows: age >14 years and patients undergoing emergency exploratory laparotomy acute abdomen, blunt trauma abdomen, penetrating trauma abdomen.

Exclusion criteria

Exclusion criteria was as follows: age less than or equal to 14 years, patients not followed up for minimum follow up period of 30 days and patients who were managed conservatively.

Data was collected prospectively for the study. All patients had their physiological score recorded on admission. An operative severity score was calculated based on the findings of the operative surgeon. Any Post-operative morbidity and death within 30 days were recorded. The study was approved by the Institutional Ethics Committee (IEC).

The variables used in both POSSUM and Portsmouth POSSUM (P-POSSUM) are the same (12 physiological and 6 operative criteria) but the formulae used are different, as described by Copeland et al and Whiteley et al.[1,4]

POSSUM equation

For morbidity: ln [R/(1−R) = (0.16 X physiologic score) + (0.19 X operative score)-5.91

where R is the predicted morbidity score.

For mortality

ln [R/(1−R)=(0.13×physiologic score)+(0.16 X operative score)-7.04

where R is the predicted mortality score.

P-POSSUM equation

For mortality

ln [R/(1−R)=(0.1692×physiologic score)+(0.1550× operative score)-9.065

where R is the predicted mortality score.

Table 1: Physiological score.

Score	1	2	4	8
Age	<60	61-70	>71	
Cardiac signs	Normal	Diuretic digoxin antianginal antihypertensive steroid	Peripheral edema warfarin borderline cardiomegaly	Raised JVP cardiomegaly
Respiratory history	No dyspnoea	Dyspnoea on exertion	Limiting dyspnoea (one flight of stairs) mild coad	Dyspnoea at rest Respiratory rate (RR)> 30/min fibrosis/ consolidation
BP (mmHg)	110-130	131-170 100-109	>171 90-99	<89
Pulse (beats/min)	50-80	81-100 40-49	101-120	>121 <39
GCS	15	12-14	9-11	<8
Hemoglobin	13-16	11.5-12.9 16.1-17	10-11.4 17.1-18	<9.9 >18.1
WBC	4-10	10.1-20 3.1-4	>20.1 <3.1	
Urea (mmol/l)	<7.5	7.6-10	10.1-15	>15.1
Sodium (mmol/l)	>136	131-135	126-130	<125
Potassium (mmol/l)	3.5-5	3.2-3.4 5.2-5.3	2.9-3.1 5.4- 5.9	<2.8 >6
ECG	Normal	-	Atrial fibrillation rate-60-90	Any other abnormal rhythm >5 ectopics/min Q waves or ST/T wave changes

Table 2: Operative severity score.

Score	1	2	4	8
Operative severity	Minor	Intermediate	Major	Major+
Multiple procedures	1		2	>2
Total blood loss (ml)	<100	100-500	501-999	>1000
Peritoneal soiling	None	Minor serous fluid	Local pus	Free bowel content, pus, blood
Presence of malignancy	None	Primary only	Nodal metastasis	Distant metastasis
Mode of surgery	Elective		Emergency resuscitation of >hours operation <24 hours admission	Emergency immediate surgery <2 hours needed

POSSUM and P-POSSUM scores are a part of regression analysis but use different and constant values for physiological and operative scores to predict mortality and morbidity. Data were analyzed using both exponential and linear methods of analysis described by Wijesinghe et al.[5] The ratio of observed to expected deaths (O:E ratio) was calculated for each analysis.

A chi-square test (x^2) was used to detect any differences between predicted and observed rates of morbidity and mortality. $P<0.050$ was accepted as significant.

RESULTS

The study included total 100 patients, 83 men and 17 women. Thirteen patients (13%) died within 30 days of surgery and 51 (51%) developed significant complications. Patients who were subjected to emergency laparotomy were most commonly between the age group of 36 to 45 years. The next largest group being 26 to 35 years.

Crude mortality rate was 13%. Most common cause of mortality was respiratory infections attributed to hospital

acquired pneumonia and ventilator associated pneumonia. Second most common cause for mortality was septicemia.

Morbidity was observed in 51 patients. Most common major complication was chest infection, in 30 patients, second most common complication was wound Infections, in 28 patients. crude morbidity rate was 58.6%.

O/E ratio

An O/E ratio (observed /expected ratio) of greater than one signifies worse outcomes in the study cohort than expected, less than one indicates better expected outcomes in the study cohort, and a ratio of 1 indicates that the study cohort's results are consistent with our expectations.

Comparison of predicted and observed mortality rates by POSSUM using exponential analysis, the O:E ratio was 0.62.

POSSUM

The number of deaths predicted with POSSUM using exponential analysis. The O:E ratio was 0.62, and there was no significant difference between the observed and predicted values (χ^2=10.79, 9 degree of freedom (df) p=0.148).

Table 3: Comparison of predicted and observed mortality rates by POSSUM using exponential analysis (n=100).

Predicted mortality rate (%)	No. of patients	Predicted no. of deaths	Observed no. of deaths	Observed: expected ratio
0-29	52	7	3	0.43
10-29	32	3	3	1.00
20-29	16	3	3	1.00
30-100	48	14	10	0.71
40-100	36	14	10	0.71
50-100	22	10	7	0.70
60-100	18	10	7	0.70
70-100	11	9	6	0.67
80-100	9	7	5	0.71
90-100	5	4	3	0.60
0-100	100	21	13	0.62

Comparison of predicted and observed morbidity rates by POSSUM using exponential analysis, the O:E ratio was 0.91.

Table 4: Comparison of predicted and observed morbidity rates by POSSUM using exponential analysis (n=100).

Predicted morbidity rate {%}	No. of patients	Predicted no. with Morbidity	Observed no. with Morbidity	Observed: expected ratio
0-29	5	1	1	1.00
10-29	5	1	1	1.00
20-29	5	1	1	1.00
30-69	26	8	5	0.63
40-69	17	6	3	0.50
50-69	12	6	3	0.50
60-69	9	5	3	0.60
70-100	68	47	45	0.96
80-100	56	45	39	0.87
90-100	36	33	25	0.76
0-100	100	56	51	0.91

Comparison of predicted and observed mortality rates by P-POSSUM using Linear analysis, the O:E ratio was 0.65.

Table 5: Comparison of observed and predicted mortality rates by P-POSSUM using linear regression analysis (n=100).

Predicted mortality rate (%)	No. of patients	Predicted no. of deaths	Observed no. of deaths	Observed: expected ratio
≤10	50	2	2	1.00
>10 to ≤20	22	2	1	0.50
>20 to ≤30	9	2	2	1.00

Continued.

Predicted mortality rate (%)	No. of patients	Predicted no. of deaths	Observed no. of deaths	Observed: expected ratio
>30 to ≤40	3	2	1	0.50
>40 to ≤50	4	2	1	0.50
>50 to ≤60	1	1	1	1.00
>60 to ≤70	1	1	0	0
>70 to ≤80	3	2	0	0
>80 to ≤90	5	4	4	1.00
>90 to ≤100	2	2	1	0.50
Total	100	20	13	0.65

The observed morbidity rates and those predicted by POSSUM using the exponential method of analysis. There was no significant difference between the observed and predicted values (χ^2=9.89, 9 df, p=0.195) and the overall O:E ratio was 0.91.

P-POSSUM

P-POSSUM predicted mortality equally well when the linear method of analysis was used, with an O:E ratio of 0.65 and no significant difference between the observed and predicted values (χ^2=5.33, 9 df, p=0.617).

DISCUSSION

The present study was undertaken in the department of General surgery, Malla Reddy Institute of Medical Sciences, Hyderabad from February 2018 to February 2020 and the total number of patients studied were 100.

The raw mortality and morbidity rates are inaccurate and misleading for comparative surgical audit. For this purpose, different scoring systems were developed to predict risk adjusted mortality and morbidity.

Morbidity rate was found to be 58.6% (51 patients). Most common complications were chest infection and wound infection 30% and 28% respectively. In study conducted by Ambarish et al and Sreeharsha et al the morbidity rate was 61% and 84%.[6,7] The most common complication being septicemia 10% and chest infection 29% respectively, and in study by Yadav et al and Mohil et al the morbidity rate was 54% and 51.7% and the most common complication to occur was wound infection 14% and 35% respectively.[8,9]

In our study we applied POSSOM and P-POSSUM scoring in 100 major general surgeries by comparing the observed mortality rate with expected mortality rate. 13 patients died (crude mortality rate of 13%). Ambarish et al, Sreeharsha et al obtained similar results and overall mortality rate of 18% and 15%.[6,7] However, on using POSSUM the expected mortality rate was 21 deaths and on using P-POSSUM the expected mortality rate was 20 deaths.

The present study compared POSSUM and P- POSSUM for predicting the adverse outcome rate in patients undergoing emergency exploratory laparotomy. On analysis using POSSUM, there was no statistically significant difference between the observed and expected mortality rates (χ^2=10.79, 9 df, p=0.148). An O:E ratio of 0.62 was obtained and there was no statistically significant difference between the observed and expected morbidity rates (χ^2=9.89, 9 df, p=0.195) and the overall O:E ratio was 0.91.

On analysis using P- POSSUM, with an O:E ratio of 0.65, there was no statistically significant difference between the observed and expected mortality rates (χ^2=5.33, 9 df, p=0.617).

Similar findings were obtained by Ambarish et al (POSSUM Mortality O:E=1.005, POSSUM morbidity O:E =1.001) and.Sreeharsha et al (POSSUM mortality O:E = 0.71, POSSUM morbidity O:E=0.991), Yadav K et al8 (POSSUM morbidity O:E=1.13 and P-POSSUM mortality O:E=0.845) and Mohil et al.[6,7,9]

(POSSUM mortality O:E=0.62, POSSUM morbidity O:E=0.91, P-POSSUM mortality O: E=0.65, χ^2=5.33, 9 df, p=0.617). It is observed that the various quoted studies had similar results.

Mohit et al compared POSSUM and P- POSSUM for predicting the adverse outcome rate in patients undergoing emergency laparotomy.[9] Mohit et al in 2004 observed that POSSUM was a good predictor of morbidity and mortality, whereas P-POSSUM predicted mortality well in patients undergoing emergency laparotomy.[9] The results of this study are remarkably similar to our study.

CONCLUSION

POSSUM and P-POSSUM scoring is an accurate predictor of mortality and morbidity following emergency laparotomy and is a valid means of assessing adequacy of care provided to the patient. Most common complications observed were chest infection and wound infection 30% and 28% respectively. POSSUM generally over-predicts mortality particularly in lower-risk groups. POSSUM predicts morbidity closely to observed morbidity better in high-risk than low-risk groups. P-POSSUM proved to be a

better predictor of mortality than POSSUM in all risk groups. This scoring system can also be used for risk adjusted audit in general surgery department to assess and improve the quality of surgical care provided and result in a better outcome to the patient. The POSSUM and P-POSSUM data sets provide a good tool for monitoring the quality of care provided by a particular institution. The variables required are assessed routinely in all emergency laparotomies and the calculations are simple to perform.

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