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Research Article

A prospective study of risk stratification in patients undergoing emergency laparotomy with POSSUM and P-POSSUM

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ABSTRACT

Background: Physiological and operative severity score for enumeration of mortality and morbidity (POSSUM) and its Portsmouth modification (P-POSSUM) have been developed and validated in many studies to assess the risk of mortality and morbidity associated with the various surgical procedures. Prediction of risk of mortality and morbidity involved in a surgical procedure not only helps clinicians in adequate preparation but also patient counselling.
Methods: One hundred and seven consecutive patients who underwent emergency laparotomy in the year 2009 at our center were studied. Mortality and Morbidity risk were calculated in each using POSSUM and P-POSSUM. The ratio of observed to predicted death and morbidity (0: E) were calculated and compared using chi square test. Serum creatinine level and delay in presentation to hospital were also noted in each as adjuncts variables.
Results: POSSUM was found to over predict both mortality and morbidity (O: E = 0.44 and 0.66 respectively). P-POSSUM accurately predicted mortality (O: E =0.98). Both POSSUM and P-POSSUM over predicted mortality in low risk groups (predicted risk of mortality <20%, O: E= 0.00 and 0.34 respectively). Average serum creatinine levels and delay in presentation to hospital among patients who survived and those who expired were 1.67 & 2.42 mg/dl and 2.04 & 2.89 days respectively.
Conclusions: Although both equations are useful tools for risk-adjusted surgical audit of patients undergoing emergency laparotomy, P-POSSUM is a better predictor of mortality than POSSUM. Overall, morbidity and mortality risk were found to be significantly higher with delayed hospital presentation and deranged creatinine levels.

Keywords: POSSUM, P-POSSUM, Morbidity, Emergency laparotomy

INTRODUCTION

Preoperative judgment and prediction of surgical outcome has paramount importance for adequate surgical preparation and adequate patient counselling. The outcome of a surgical procedure would not only depend on the surgical expertise, but also on the patient's clinical status at the time of surgery. It is the acute and chronic physiological status, current illness, nature and extent of surgical intervention required and co-morbid conditions of patient that determine the final outcome.[1]

Laparotomy is one of the most commonly performed surgical procedures in an emergency and it is important to be aware about the risk of morbidity and mortality involved in each of such procedure. A vast majority of patients undergoing laparotomy have associated co-morbidities ultimately bearing a significant impact on the

overall prognosis. Emergency laparotomy has a proven mortality rate considerably greater than that of elective laparotomy, up to the extent of 10-55%.[2,3] POSSUM, a physiological and operative severity score for the enumeration of mortality and morbidity, and its Portsmouth modification (P-POSSUM), a scoring system assessing the peri-operative surgical risks, have been acknowledged as the most appropriate of all currently available surgical scores specially in reference to abdominal laparotomy.[4,5]

The current study aims to determine the value of POSSUM and P-POSSUM in predicting the mortality and morbidity in patients undergoing emergency laparotomies at our tertiary care centre and the influence of serum creatinine values and timing of presentation to hospital on the overall surgical prognosis.

METHODS

A prospective clinical study was carried out in the year 2009 at Medical College Hospital, Indore, MP, India. One hundred and seven consecutive patients were included in the study after informed consent, which underwent emergency laparotomy within twenty four hours of admission to the hospital. All pediatric patients, subjects below 18 years and those who refused to participate in the study were excluded out of study. All subjects were analyzed using POSSUM and P-POSSUM scores besides demographic variables. Mortality and morbidity risk were calculated using POSSUM and P-POSSUM. The ratio of observed to predicted death and morbidity (0: E) was calculated for each analysis and frequency tables were compared for statistical significance by means of chi square test. Two more variables (Serum creatinine level and delay in presentation to hospital) were also analysed as adjuncts.

POSSUM score incorporates two categories of assessment to assess the risk of surgery:

a) 12-factor physiological score (PS) depending on

- Age,
- Cardiac status,
- Pulse rate,
- Systolic blood pressure,
- Respiratory status,
- Glasgow Coma Score,
- Serum urea,
- Serum potassium,
- Serum sodium,
- Haemoglobin concentration,
- White cell count and
- Electrocardiography findings

b) 6-factor operative severity score (OS) depends on

- Type of surgical procedure,
- Number of procedures,
- Blood loss,
- Peritoneal soiling,
- Presence of malignancy and
- Mode of surgery

Each factor was graded with an exponentially increasing score of 1, 2, 4, and 8. Physiological factors were recorded at the time of induction of anaesthesia and OSS recorded intraoperatively. Morbidity and mortality were recorded as defined by Copeland et al.[4] Using outcome (dead/alive or complicated/uncomplicated) as a dichotomous dependent variable, multiple logistic regression equation derived by POSSUM were applied to all patients vis-à-vis both morbidity and mortality.[4]

Equation for morbidity was

$$\ln (R/1-R) = - 5.91 + (0.16 \times \text{Physiological Score}) + (0.19 \times \text{Operative Severity Score})$$

For mortality the equation used was

$$\ln (R/1-R) = -7.04 + (0.13 \times \text{Physiological Score}) + (0.16 \times \text{Operative Severity Score})$$

(Where R is the predicted risk)

Additionally, P-POSSUM equation was applied for mortality as follows:[6]

$$\ln (R/I-R) = -9.37 + (0.19 \times \text{Physiological Score}) + (0.15 \times \text{Operative Severity Score})$$

For all study participants serum creatinine levels and time to presentation to the hospital since the initiation of symptoms (in days) were recorded. All patients were managed as per routine institutional protocol and were observed for development of any complication till the time of discharge from the hospital. Complications were also recorded as defined by Copeland et al.[5] POSSUM and P-POSSUM were applied to all patients and mortality and morbidity risk were calculated. Linear analysis was done by calculating patient's predicted risk of death using the respective equation and then dividing the patients into groups according to their predicted risk of death. For each version of POSSUM, the number of patients falling into each mortality group was multiplied by the average risk of death to give the predicted number of deaths in that group. The ratio of observed to predicted death (0: E) was calculated for each analysis and frequency tables were compared for statistical significance by means of chi square test. The same method was applied for morbidity estimation. Validation of the prediction equation was done by measurement of overall discrimination using the area under the curve (AUC) of Receiver Operating Characteristic (ROC) curve. An AUC ≥ 0.7 is generally

considered acceptable, ≥0.8 as good and ≥0.9 as excellent.[7]

RESULTS

Out of the total 107 patients operated, majority were males (81%). The various indications for hospital admission and emergency laparotomy ranged from prepyloric perforation (23%), ileal perforation (22%), stab injury abdomen (16%), blunt trauma abdomen (15%), intestinal obstruction (14%), appendicular perforation (4%) and caecal perforation, gunshot injury abdomen, pyoperitoneum and duodenal perforation in remaining. In our study, overall the complications were noted in about 38% (41 cases) and while mortality was noted in about 8% (9 cases). The most frequent complications observed were wound infection (21 cases) followed by hypotension (13 cases), septicemia (9 cases), urinary tract infection (6 cases), wound dehiscence (5 cases) and pyrexia of unknown origin (5 cases), respiratory failure (4 cases), and anastomotic leak (2 cases).

Validation of the POSSUM for morbidity and mortality and P-POSSUM mortality was done by measurement of the Area under the Curve (AUC) from receiver operating characteristic (ROC) curve (Table 1). AUC for POSSUM morbidity, POSSUM mortality, and P-POSSUM mortality equation was 0.934, 0.936, and 0.944 respectively showing good discrimination.

Table 1: Area under the curve using POSSUM and P-POSSUM equations.

Test result variable (s)	Area	Std. error	Asymptotic Sig.	Asymptotic 95% confidence interval	
				Lower Bound	Upper Bound
Possum Morbidity	0.934	0.044	0.000	0.847	1.020
Possum Mortality	0.936	0.044	0.000	0.851	1.021
P-Possum Score	0.944	0.042	0.000	0.862	1.027

Both serum creatinine level and mean delay in presentation to hospital since the initiation of symptoms was higher in mortality group than in survivor group. (Table 2).

Using linear analysis, POSSUM over predicted the mortality (E= 20) and morbidity (E= 61) as compared to observed mortality (O= 9; O: E= 0.44, $p<0.05$) and morbidity (O= 41; O: E= 0.66, $p<0.05$). Using same method of analysis P-POSSUM accurately predicted mortality (O= 9; E= 9; O: E = 0.98, $p>0.05$) (Table 3, 4 and 5).

Table 2: Level of serum creatinine, and delay in presentation to hospital in patients who died and who survived (N = 107).

Groups	Average Serum Creatinine (mg/dL)	Delay in presentation (in days)
Patients survived (98 cases)	1.67	2.04
Patients died (9 cases)	2.42	2.89

Table 3: Expected and observed mortality using POSSUM mortality equation.

Range of risk (%)	No. of patients	Mean risk (%)	Expected mortality	Observed mortality	O:E ratio
1-20	77	10.36	7.97	0	0.00
21-40	18	26.22	4.71	1	0.21
41-60	6	52.00	3.12	4	1.28
61-80	6	70.83	4.24	4	0.94
81-100	0	00.00	0.00	0	0.00
1-100	107	18.75	20.06	9	0.44

Table 4: Expected and observed morbidity using POSSUM morbidity equation.

Range of risk (%)	No. of patients	Mean risk (%)	Expected mortality	Observed mortality	O:E ratio
1- 20	0	0	0	0	0.00
21-40	29	31.86	9.23	2	0.21
41-60	29	50.06	14.51	1	0.06
61-80	31	69.74	21.61	19	0.87
81-100	18	91.61	16.48	19	1.15
1-100	107	57.82	61.86	41	0.66

Table 5: Expected and observed mortality using P-POSSUM mortality equation.

Range of risk (%)	No. of patients	Mean risk (%)	Expected POSSUM mortality	Observed POSSUM mortality	O:E ratio
1-20	95	3.07	2.91	1	0.34
21-40	7	33.14	2.31	4	1.73
41-60	3	52.00	1.56	2	1.28
61-80	2	65.00	1.30	2	1.53
81-100	0	00.00	0.00	0	0.00
1-100	107	8.52	9.11	9	0.98

DISCUSSION

POSSUM, a popular system of surgical audit has been widely used for comparative audits, comparisons between surgeons, units, and disease groups. P-POSSUM, a

modification of POSSUM was developed following reports that POSSUM tends to overestimate the mortality.[8] The P-POSSUM equation was found to produce a very close fit with the observed in-hospital mortality.[6,8] P-POSSUM, although applied successfully in vascular and gastrointestinal surgery patients, does not estimate morbidity.[10-13]

Emergency laparotomy is one of the most commonly performed major surgical procedures in emergency. It becomes imperative to assess the risk of morbidity and mortality in each of such patient undergoing emergency laparotomy as often these patients are brought to the hospital in morbid conditions. Risk assessment prior to surgical procedure not only allows proper allocation of resources, psychological preparedness about outcome among relatives but also helps surgeons in medico legal suits.

In our study total 107 patients were studied and using linear analysis POSSUM was found to over predict both morbidity and mortality, specially, in a low risk group which formed the majority of our patients. P-POSSUM predicted mortality with high accuracy using linear analysis. Mohil RS et al studied 120 patients who underwent emergency laparotomy in a single unit. Predicted morbidity and mortality rates were calculated by POSSUM and P-POSSUM equations using both linear regression and the exponential methods of analysis.[13] These were then compared with actual outcomes. When the linear method of analysis was used POSSUM over predicted morbidity, and there was a significant difference between the observed and predicted values (O: E ratio 0.68). POSSUM also significantly over predicted mortality when analyzed by the linear method (O: E ratio 0.39) Applying linear analyses for P-POSSUM, the O: E ratios for mortality were 0.66. They concluded that, if analyzed correctly POSSUM is a good predictor of morbidity and mortality in patients undergoing emergency laparotomy. Both equations may be used for risk-adjusted surgical audit of patients undergoing emergency laparotomy.[13]

Kumar P et al conducted a study involving eighty-two patients who underwent emergency laparotomy.[14] Actual morbidity and mortality rates were compared with the predicted mortality and morbidity rates using both POSSUM and P-POSSUM equations by linear regression and exponential methods of analysis. POSSUM equation significantly over-predicted both morbidity and mortality when linear regression analysis was used, but predicted well when exponential analysis was used.[14]

CONCLUSION

Although, both equations are useful tools for risk-adjusted surgical audit of patients undergoing emergency laparotomy P-POSSUM is a better equation than POSSUM in predicting mortality. However, in cases with delayed hospital presentation and deranged creatinine levels, morbidity and mortality risk were found to be significantly higher and calculation of risk needs to be suitably adjusted.

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