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Original Article

Surgery Section

POSSUM: A Scoring System for Perforative Peritonitis

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ABSTRACT

Background and Objectives: Perforative peritonitis carries considerable morbidity and mortality with the postoperative period unpredictable most of the times. It therefore becomes necessary for a scoring system that predicts the post-operative outcome. POSSUM *(Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity)* helps in predicting the post-operative morbidity and mortality in these patients. POSSUM scores are based on 12 physiological factors and 6 operative factors. In our study, we included two more factors, which are specifically important in perforative peritonitis; they are, perforation to operation time and the presence of co-morbidity. The presence of these factors significantly affects the post-operative status. Through this prospective study, we can predict which patients are at a higher risk of death or complication and give appropriate management as necessary.

Materials and Methods: Our sample size was 50 patients with perforative peritonitis. The study was conducted in single unit from September 2013 to August 2014. Data was collected based on POSSUM scoring system. Outcome of the patients was recorded as death / alive; complicated / uncomplicated and statistical analysis was done by comparing the expected and observed outcomes.

Results: By applying linear analysis, an observed to expected ratio of 1.005 was obtained for mortality and 1.001 for morbidity. There was no statistically significant difference between the observed and expected mortality rates (χ^2 = 3.54, p = 0.316) and morbidity rates (χ^2 = 2.40, p = 0.792). It was found to be comparable with other studies. The factors independently studied; perforation to operation time and presence of co-morbidity were statistically significant with respect to outcome (p<0.05).

Conclusion: Although a small sample size is the limitation of this study, POSSUM scoring system is a good indicator of postoperative outcome in patients with perforative peritonitis and was applicable in our setup. It is useful in identifying high risk patients and give preferential care to them for better outcome. Inclusion of factors like perforation to operation time and co-morbid status can improve the scoring system and better care can be provided.

Keywords: Co-morbidity, Perforation to operation time

INTRODUCTION

Even in modern era, perforative peritonitis has a high mortality and morbidity. Peritonitis developing as a result of hollow viscus perforation is a common condition in a developing country like India. Even if the patient reaches the hospital in time and is operated, the postoperative period is still unpredictable. Secondary peritonitis is the consequence of contamination of the peritoneal cavity due to contents of organ within the peritoneal cavity. Majority of these episodes are due to lesions in stomach, duodenum, small intestines, appendix and colon [1]. Mortality due to hollow viscus perforation ranges from 10% to 40 % [2]. Due to delay in operative intervention and co-morbidities, there is significant postoperative mortality and morbidity. In surgical practice, where major invasive procedures are being performed, audits are mandatory for improving the standard of care and are indicators for allotting resources [3]. POSSUM would help to identify those patients who are at increased risk of developing complications and death. POSSUM was developed by Copeland et al., [4]. This study was undertaken to assess the validity of POSSUM scoring system in patients with perforative peritonitis to analyse the postoperative outcome in this high risk group. In our study, we have analysed two more variables; perforation to operation time and presence of co-morbidity as these factors significantly affect the outcome in patients with perforative peritonitis.

MATERIALS AND METHODS

Fifty patients scheduled to undergo emergency laparotomy in a single unit of General Surgery department from September 2013 to August 2014 were selected based on inclusion and exclusion criteria and scored according to POSSUM score. Additional 2 factors were taken into consideration.

1. Perforation – Operation time, i.e. the time duration between the occurrence of perforation and the operation being conducted for the same.
2. Co-morbid status like diabetes mellitus, hypertension, chronic liver disease and chronic renal failure.

Inclusion Criteria

1. Age above 12 y. Patients less than 12 y of age are managed by the Department of Paediatric Surgery in our hospital.
2. Patients with established peritonitis following hollow viscus perforation.
3. Patients with intra-peritoneal abscess due to hollow viscus perforation.

Exclusion Criteria

1. Age 12 y and below.
2. Patients undergoing emergency explorative laparotomy due to other causes like abdominal trauma.
3. Patients with primary peritonitis due to tuberculosis alcoholic cirrhosis, nephrotic syndrome, cardiac failure or systemic lupus erythematosus.

Scores were allotted to the physiological and operative factors in the study and expected mortality and morbidity rate were calculated. Complications were assessed by clinical observation. Routine bacteriological screening and postoperative radiological scanning were not carried out, but confirmatory bacteriological and radiological tests were done when clinical suspicion existed.

POSSUM equation for morbidity:

Ln R/1 - R = - 5.91 + (0.16 x physiological score) + (0.19 x operative severity score)

POSSUM equation for mortality:

Ln R/1 - R= -7.04+ (0.13 x physiological score) + (0.16 x operative severity score)

Where R = predicted risk [4].

The patients were then followed up for a period of 2 months post operatively and complications were noted upon the criteria as defined by POSSUM scoring system [4].

ETHICS

The study conducted was in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975 that was revised in 2000. Permission from the ethical committee of the institute was obtained.

STATISTICAL ANALYSIS

Using outcome (dead/alive or complicated/uncomplicated) as a dichotomous dependent variables, comparison between predicted and observed rates of morbidity and mortality was assessed using chi-square (χ^2) test and statistical significance was determined. The differences in quantitative variables between groups were assessed by means of the unpaired t test. A p-value of < 0.05 using a two-tailed test was taken for its significance in all statistical tests. Logistic Regression analysis was used to assess the mortality and morbidity variables.

RESULTS

The causes of perforative peritonitis in our study are given in [Table/Fig-1] and the types of surgeries performed are given in [Table/Fig-2]. Out of 50 patients studied, death occurred in 9 patients resulting in crude mortality rate of 18%. Of the 41 patients alive, 25 patients had at least one complication, resulting in crude morbidity rate of 61%. The remaining 16 patients showed no evidence of any complication. The complications during the 2 months follow up period were as follows in [Table/Fig-3]. Comparison of observed and POSSUM predicted mortality and morbidity rates was done using linear analysis is represented in [Table/Fig-4,5] respectively. Observed to expected mortality and morbidity ratios were 1.005 and 1.001 respectively and there was no statistical significant difference between the predicted and observed values ($\chi^2 = 3.54$, $p = 0.316$) and ($\chi^2 = 2.40$, $p = 0.792$) respectively. Of the POSSUM score factors, 9 factors were found to be statistically significant in predicting mortality and have been mentioned in [Table/Fig-6].

In our study, we analysed the mortality in patients with early and delayed perforation to operation time. Patients were categorized into 3 groups; group 1 with <24 h, group 2 with 24 – 48 h and group 3 with >48 h duration. Results are shown in [Table/Fig-7].

In our study, we have analysed the mortality in patients having co-morbidities like hypertension, diabetes mellitus, asthma, renal failure and hypo-proteinaemia. Statistically significant differences were obtained and are depicted in [Table/Fig-8].

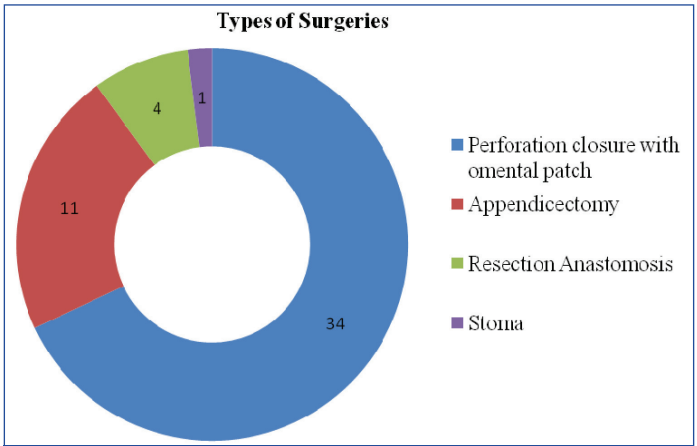
Using logistic equations, the predicted risk of mortality and morbidity was calculated and compared with the observed mortality and morbidity, shown in [Table/Fig-9,10] respectively. For mortality and morbidity, positive predictive value was 100% and 94%, negative predictive value 78% and 82%, sensitivity 95% and 71%, specificity 100% and 96% respectively. Receiver Operating Characteristic Curves for mortality and morbidity are depicted in [Table/Fig-11,12] with the area under the curve being 0.943 and 0.93 respectively.

DISCUSSION

The importance of surgical audit has increased over the past years both, as a means of assessing the quality of surgical care and as an educational process. In this era, the use of crude mortality rate can be misleading.

Indications		No. of patients
a.	Gastric malignancy perforation	2
b.	Duodenal and antral perforation	27
c.	Ileal perforation	8
d.	Appendicular perforation	12
e.	Sigmoid volvulus perforation	1
	Total	50

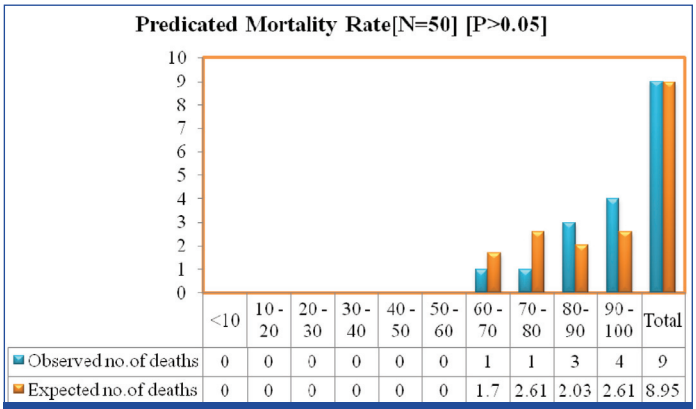
[Table/Fig-1]: Causes of peritonitis



[Table/Fig-2]: Types of Surgery

Complication	[n]	Percentage
Urinary tract infection	1	2
Deep infection	4	8
Wound infection	4	8
Chest infection	3	6
Septicaemia	5	10
Pyrexia of unknown origin	1	2
Impaired renal function	1	2
Multiple complications	15	30
No complication	16	32
Total	50	

[Table/Fig-3]: Complications

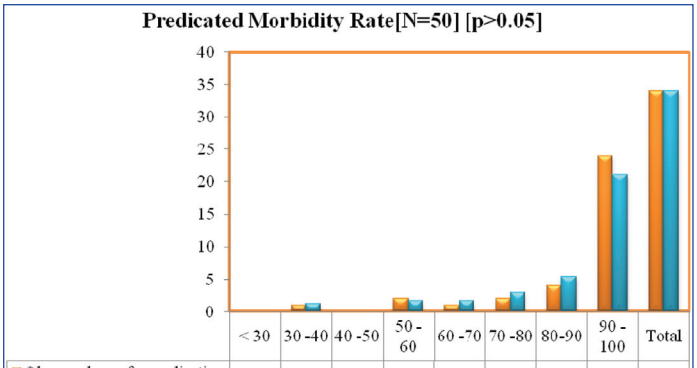


	<10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	80 - 90	90 - 100	Total
Observed no.of deaths	0	0	0	0	0	0	1	1	3	4	9
Expected no.of deaths	0	0	0	0	0	0	1.7	2.61	2.03	2.61	8.95

[Table/Fig-4]: Observed and expected mortality rates

A risk adjusted POSSUM was proposed to overcome these short-comings. In a developing nation like India, due to poverty and ignorance, the presentation of a particular illness is delayed leading to an increased number of complications and high death rates. The use of POSSUM scoring system can identify those patients who are at increased risk of death or complications. However, it has to be correlated to the general condition of the local population to be more precise.

Numerous scoring systems have been developed such as ASA (American Society of Anaesthesiologist) [5] for general risk



	< 30	30 -40	40 -50	50 - 60	60 -70	70 -80	80-90	90 - 100	Total
Observed no. of complication	0	1	0	2	1	2	4	24	34
Expected no. of complication	0	1.24	0	1.66	1.66	2.9	5.39	21.1	33.95

[Table/Fig-5]: Observed and expected morbidity rates

Significant (p<0.05)	Not Significant (p>0.05)
Respiratory system	Age
Blood pressure	Cardiovascular system
Glasgow coma scale	Pulse rate
Sodium	Hemoglobin
Potassium	White cell count
Multiple procedures	Blood urea
Total blood loss	ECG
Malignancy	Operative complexity
Mode of Surgery	Peritoneal contamination

[Table/Fig-6]: Risk factors analysis (Mann Whitney U-test)
Factors are as per POSSUM scoring system

PO vs. OUTCOME			
	Outcome of Surgery		
PO	Alive	Death	Total
<24 hours	18	1	19
24 to 48 hours	17	2	19
>48 hours	6	6	12
Total	41	9	50

[Table/Fig-7]: PO vs. Outcome
PO – Perforation to Operation time

CO vs. OUTCOME			
	Outcome of Surgery		
CO	Alive	Death	Total
Yes	13	8	21
No	28	1	29
Total	41	9	50

[Table/Fig-8]: CO vs. Outcome
CO – Co-morbidity

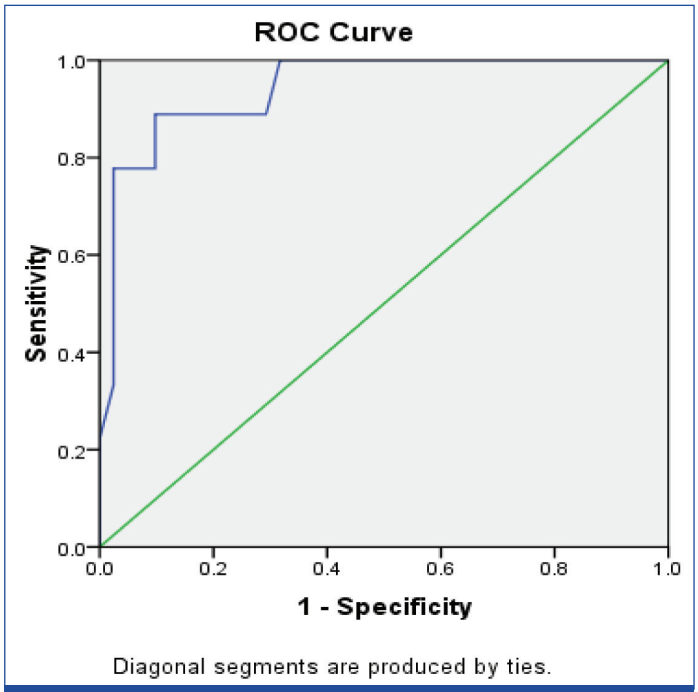
Predicted risk of mortality [derived from logistic equation]			
	Expected		
Observed	Alive	Death	Total
Alive	41	0	41
Death	2	7	9
Total	43	7	50
Overall Percentage	86%	14%	

[Table/Fig-9]: Predicted risk of mortality

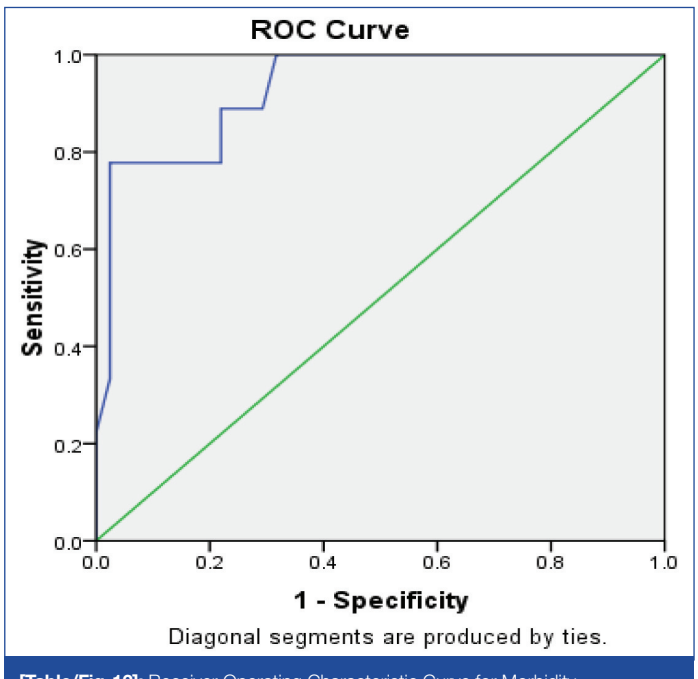
prediction, APACHE III (Acute Physiology and Chronic Health Evaluation III) [6] for intensive care, Goldman Index [7] for cardiac related complications peri-operatively and ACPGBI (Association of ColoProctology of Great Britain and Ireland) [8,9]. These scoring systems have provided an objective assessment of patients' health and therefore a meaningful comparison can be made. For general

Predicted risk of morbidity [derived from logistic equation]			
	Expected		
Observed	Uncomplicated	Complicated	Total
Uncomplicated	15	1	16
Complicated	6	28	34
Total	21	29	50
Overall Percentage	42%	58%	

[Table/Fig-10]: Predicted risk of morbidity



[Table/Fig-11]: Receiver Operating Characteristic Curve for Mortality



[Table/Fig-12]: Receiver Operating Characteristic Curve for Morbidity

surgical procedures, POSSUM and its subsequent modifications incorporate physiological, operative and pathological information and provide a comparison of outcomes between surgeons, units and healthcare systems [10,11]. POSSUM was developed by Copeland et al., from a cohort of 1372 patients in 1991 mainly for surgical audits. It is a scoring system based on 12 preoperative physiological factors and six operative factors. Each factor is scored with 4 graded score values; the sum of individual scores was used to predict 30 days' postoperative morbidity and mortality

after deriving equations from logistic regression analysis [4]. The P-POSSUM is a modification of POSSUM, which incorporates the same variables and grading system, but uses a different equation, which provides a better fit to the observed mortality rate [11]. It has already been used in general [12], vascular [13-16], colorectal [17-19], oesophageal [20] and laparoscopic [21] procedures. However, the studies mostly have been done in developed countries where patient characteristics, presentation and hospital resources differ from our setup [22]. Hence, there is a need to validate POSSUM in Indian scenario where problems like delayed presentation and limited resources can affect the outcome even with adequate quality care [23-25].

In this study, the validity of POSSUM scoring system in 50 patients undergoing emergency laparotomy for perforative peritonitis in a single surgical unit was assessed by comparing the observed and expected mortality and morbidity rates. 9 patients died; a crude mortality rate of 18%. The most common cause of mortality was septicaemia. Prytherach DR et al., [26] obtained similar results of overall mortality rate of 19.1%. POSSUM predicted mortality rate in our study was 17.9%. On analysis we found no statistical difference between observed and expected mortality rate (χ^2 = 3.54, p = 0.316). An O: E ratio of 1.005 was obtained, similar finding was obtained by Prytherach DR et al., [26] (O: E = 0.9), Sagar PM et al [17] (O: E = 0.87) and Parihar V et al., [24] (O: E = 0.97). Koray Das et al., [27] compared APACHE II, P-POSSUM and SAPS II scoring system and found P-POSSUM scoring system reliable for prediction of overall hospital stay. Vishwani A et al., [28] studied the efficacy of POSSUM in predicting mortality and morbidity in patients of peritonitis undergoing laparotomy in 89 patients in single surgical unit and found that POSSUM scoring system is reasonably good predictor of mortality (O:E = 0.6) and morbidity (O:E = 0.7) using exponential and linear analysis respectively. Teleanu G et al., [29] validated CR-POSSUM in 58 patients and concluded that it has prognostic value for patients with abdominal sepsis in colonic peritonitis. Sunil Kumar [30] compared POSSUM and P-POSSUM in 172 cases studied in single surgical unit over period of two years and found that POSSUM over predicted mortality and morbidity by linear and exponential analysis. Sunil Kumar et al., [31] 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).

Out of 41 patients who survived, 25 patients suffered complications and the remaining 16 patients did not show any evidence of complications. An observed to expected ratio (O:E) of 1.001 was obtained and there was no significant difference between the predicted and observed values (χ^2 = 2.40, p = 0.792).

For mortality and morbidity, positive predictive value was 100% and 94%, negative predictive value 78% and 82%, sensitivity 95% and 71%, specificity 100% and 96% respectively.

Factors like ventilation perfusion mismatch, impaired tissue perfusion and ischemia to vital organs, impaired mental status due to hyponatremia and hypokalaemia, cancer cachexia and prolonged operative time could be attributed to postoperative mortality.

In our study two risk factors were separately validated that affect the mortality significantly in patients with perforative peritonitis; perforation – operation time and presence of co-morbid status. A statistical significance was established with these factors. In our study, complications noted were septicaemia (10%), deep Infections (8%), wound infections (8%), chest infections (6%), and multiple complications (wound dehiscence, deep infection, chest infection, urinary infection, impaired renal function and anastomotic leak) (30%). These complications can be attributed to gross peritoneal contamination, depressed immune function, raised diaphragm, upper abdominal incisions and presence of co-morbidities like asthma, chronic obstructive airway disease, diabetes mellitus, anaemia and hypo-proteinaemia.

CONCLUSION

A small sample size is the limitation of this study. However, findings of our study suggest that POSSUM scoring system can be used as a tool to predict the mortality and morbidity of patients operated for perforative peritonitis. Inclusion of factors like perforation to operation time and co-morbid status can improve the scoring system. Strict vigilance and prompt correction of the validated factors can improve the general condition of the patient and decrease the mortality and morbidity. Studies with larger sample size can further validate this scoring system. In addition, general awareness, early referrals, early diagnosis and timely treatment need to be implemented to reduce the perforation to operation time duration and control the co-morbidities.

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