

Original Research Article

Efficacy of the P-POSSUM scoring system as a prognostic indicator in patients undergoing emergency laparotomy

Karthic Anbarasu*, Rohit Chandak

Department of Surgery, RNT Medical College, Udaipur, Rajasthan, India

Received: 22 July 2019

Revised: 04 September 2019

Accepted: 05 September 2019

***Correspondence:**

Dr. Karthic Anbarasu,

E-mail: vagetak91@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Continuous audit of surgical practice is essential in enhancing patient care and lowering health care cost. This prospective study aimed to assess the validity of the Portsmouth- physiologic and operative severity score for the enumeration of mortality and morbidity (P-POSSUM) score in predicting the risk of morbidity and mortality and to identify the risk factors for poor outcome at a tertiary care teaching hospital in India.

Methods: A prospective study of 100 patients (70 emergency and 30 elective) undergoing exploratory laparotomy admitted in Department of General Surgery over a 10 months period at Rabindranath Tagore Medical College, Udaipur, Rajasthan, were included in the study group. The risks of mortality and morbidity were calculated by using P-POSSUM equation. The predicted risks were compared with the observed risks of mortality and morbidity and statistically analysed.

Results: The overall mortality rate of 11% with (O:E=0.85, p=0.59) and morbidity rate of 41% with (O:E=0.78, p=0.089). Higher percentage of mortality and morbidity were found with patients not able to be resuscitated successfully before surgery. Chest infections (18%), pyrexia (15%) and wound infections (14%) are areas requiring prompt care to minimize mortality rate.

Conclusions: Even though P-POSSUM over predicted mortality it was not statistically significant as concluded by other studies. With P-POSSUM outcome of the patient and operative risk can be predicted and pre-operative counselling, optimization, implementing resuscitative measures and adequate care in specific high risk groups can be given with targeted interventions; improving quality of care and cost reduction.

Keywords: P-POSSUM, Observed expected ratio, Prognostic indicator, Emergency laparotomy

INTRODUCTION

Internationally reported mortality rates following emergency laparotomy ranges from 13% to 18% at 30 days, this is second only to mortality after repair of ruptured abdominal aortic aneurysm (AAA).¹

Reduction of the considerable morbidity and mortality after emergency laparotomy is the focus of several programs like National Emergency Laparotomy Audit (NELA), American College of Surgeons National

Surgical Quality Improvement Program (NSQIP), Enhanced perioperative care for high-risk patients (EPOCH) study.

Central to each of these programs is the identification of high-risk patients to target perioperative interventions and augmented pathways of care.²

In an era where resources are constrained and the expectations on medical personnel are insurmountable, scoring systems provide us with an indispensable tool for

triage of critically ill patients and provide a quantitative assessment of the degree of severity to provide a more realistic expectation of the patient's outcome. Their treatment outcome is not only dependant on the performance of individual surgeon but also on the acute and chronic physiological status of the patient, severity of his current illness, nature and extent of surgical intervention and co- morbid conditions.

Scoring systems that group patients based on the severity of illness at an early stage can allow a meaningful analysis of morbidity and mortality rates. Risk-adjusted comparisons can then be made between surgeons and hospitals to identify different standards of care and to allocate adequate resources.

POSSUM was developed by Copeland from a cohort of 1372 patients in 1991 for surgical audits. The P-POSSUM (Portsmouth) uses different equation, which provides a better fit to the observed mortality rate. It was proposed as a risk adjusted scoring system to allow for direct comparison between the observed and expected adverse outcome rates.³

It is composed of 18 components: 12 physiological and 6 operative variables. Each factor is scored against a 4-graded score value, which the individual sum of physiological and operative severity scores were used to predict 30 days post-operative morbidity and mortality using equations derived from logistic regression analysis.

Hence, there is a need to test the validity of P-POSSUM scoring system in our population, where malnourishment is a common problem, presentation frequently delayed and resources limited, all of which can influence the patient's complication rate, even with adequate quality of care provided. This study was undertaken to assess the validity of P-POSSUM scoring system in patients undergoing emergency laparotomy in our setup and try to analyse the causes for poor outcome in high-risk groups.

METHODS

Source of data

100 cases (70 Emergency and 30 elective laparotomy) meeting the inclusion and exclusion criteria, admitted in the Department of Surgery, Rabindranath Tagore Medical College, Udaipur.

Type of study and study period

A prospective study with 30 day post-operative follows up of each patient. The study period was from January 2017 to October 2018.

Method of data collection

Patients were informed regarding the aims and objectives of the study and a detailed informed written consent were

taken prior to inclusion in this study. All the patients had their physiological scores recorded as close to the time of operation as possible i.e. the last recorded values before the patient entered the anaesthetic room. An operative severity score were calculated based on the intra-operative findings recorded by the operating surgeon.

Inclusion criteria

Inclusion criteria were all patients undergoing laparotomy; patient who presented within 72 hours of initial onset of symptoms who were operated within 24 hrs of initial presentation and who died in index hospital admission within 30 days.

Exclusion criteria

Exclusion criteria were patients with significant immunosuppressant conditions (patients who are HIV positive and those on immunosuppressive drugs / anti cancer chemotherapeutic drugs); patient who underwent damage control surgery; patients admitted with Blunt trauma abdomen / Stab injury.

Equation

$$\text{Log}_e(\text{R}/1-\text{R}) = -9.065 + (0.1692 \times \text{PS}) + (0.1550 \times \text{OS})$$

Where, R = risk of mortality, PS = physiological score, OS = operative score.

Data recording and statistical analysis

Data collected via Performa. Complications on 1st, 3rd, 5th, 7th and 30th post-op days for morbidity and mortality were noted.

The expected mortality rate was obtained using linear regression analysis and the O: E ratio was calculated.

Using outcome (dead / alive or complication / no complication) as a dichotomous dependent comparison between predicted and observed rates of morbidity and mortality was assessed using 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 $p < 0.05$ using a two-tailed test was taken as being of significance for all statistical tests.

Logistic regression analysis was used to assess the mortality and morbidity variables.

Rate of increment in deaths for each risk factor was calculated based on the hypothesis that deaths were linearly related with the score for each of the studied risk factors and 't' test was applied to validate this hypothesis.

Practical applicability of P-POSSUM

Applications (iOS - Possum by Kenrick Turneran, Android - P-Possum by JT Binary) or <http://www.risk-prediction.org.uk/index-pp.php>.

RESULTS

The test group contained emergency cases who were divided into patients who were able to resuscitated 52 (52%) and patients who were not able to be resuscitated 18 (18%) before operation. The elective group were taken as controls who were 30 (30%) in number.

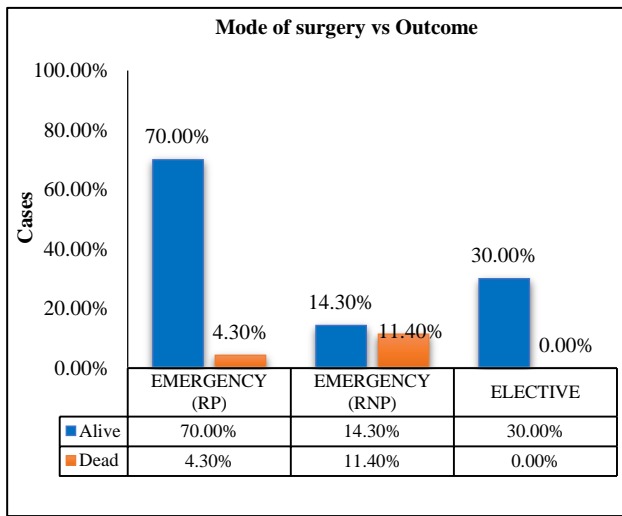


Figure 1: Prevalence of elective, emergency (RP-resuscitation possible, RNP-resuscitation not possible) surgeries in study group.

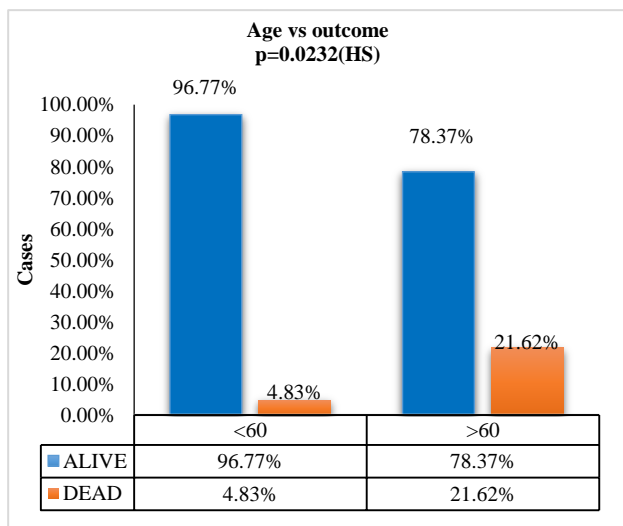


Figure 2: Age versus outcome.

More than 71 percent of our patients were males, with a Male: Female ratio was 2.4:1. The patients ranged from 14 years to 80 years. There were a greater number of patients in the age group between 60-70 years in

emergency group compared to elective 18 vs. 5. In total nearly 47% of patients belonged to the >50 age group, this being significant, due to more prevalence of co-morbid factors in the older age group.

Older age people >60 had 21.62% while < 60 had 4.83% mortality rate.

Table 1: Indications for laparotomy and procedures done.

Indications	No	Procedure	No
Appendicular perforation	2	CBD exploration	3
Obstruction (bands)	7	Cholecystectomy	5
Obstruction (malignancy)	6	Appendicectomy	2
Choledocholithiasis	4	Cystogastrostomy	3
Cholelithiasis	3	Hydatid cyst excision	7
Pseudocyst	8	Gastrojejunostomy	4
Perforation (duodenal)	21	Herniorrhaphy	1
Gastric outlet obstruction	1	Resection anastomosis	16
Perforation (ileal)	16	Band release	4
Malignancy	15	Perforation repair	29
Perforation (prepyloric)	8	Feeding jejunostomy	2
Perforation (strangulated hernia)	6	Ileostomy / colostomy	23
Obstructed hernia	1	Whipple's	1
Obstruction (volvulus)	2		

The main causes for laparotomy leading to surgery were Perforation 45% (prepyloric 8%, first part of duodenum 21% and ileal 16%), obstruction 23% and malignancy 15%.

Perforation repair was the most common procedure done accounting for 31% with feeding jejunostomy in 2 cases followed by ileostomy or colostomy 23% and resection anastomosis 16%.

The Table 2 shows us the increasing trend of morbidity and death as patients physiological score keeps increasing. Patients having physiological score <25 were alive 100% while those having physiological score >25, 60% were found to be alive and 40% died. It also shows the increasing trend of morbidity and death as patients operative score keeps increasing. Patients having physiological score <15 were alive 98.5% while those having physiological score >15, 68% were found to be alive and 32% died.

Table 2: Physiological score distribution and operative score distribution.

Scores	Total	Morbidity	Deaths	
PS	11-15	20	2 (1)	0
	16-20	32	9 (28)	0
	21-25	21	8 (38)	0
	26-30	12	8 (67)	2 (17)
	31-35	6	6 (100)	3 (50)
	36-40	6	5 (83)	3 (50)
	41-45	1	1 (100)	1 (100)
	46-50	2	2 (100)	2 (100)
OS	<10	12	1 (8)	0
	10-14	28	3 (11)	0
	15-19	47	26 (55)	4 (9)
	20-24	12	10 (83)	6 (50)
	>25	1	1 (100)	1 (100)

Table 3: Complications.

Complications	Emergency		
	RP	RNP	%
Pneumonia/basal atelectasis	19	14	18
ARDS	0	2	1
Wound infection	13	12	14
Pyrexia	13	14	15
Dehiscence	5	6	6
Deep space infections	4	5	5.5
Septicemia	8	9	9.5
AKI	9	7	9
Hypotension	12	10	12
Anastomotic leak	3	1	2
Cardiac failure	2	1	1.5
DVT	1	0	0.5
UTI	2	7	5

Table 4: Analysis for significance of p-possu score for morbidity mortality.

	Morbidity		Morbidity		O:E	Mortality		Mortality	
	No	E	Yes	E		No	Yes	O	E
(%)	O	E	O	E	O:E	O	E	O	E
0-10	0	0	0	0	0	72	70.3	0	1.69
10-20	17	14.4	0	2.59	0	8	6.81	0	1.19
20-30	8	5.92	0	2.08	0	2	1.59	0	0.41
30-40	10	7.07	1	3.93	0.25	3	2.69	1	1.32
40-50	11	9.97	7	8.03	0.87	2	2.12	2	1.88
50-60	4	4.18	5	4.82	1.03	1	1.44	2	1.56
60-70	2	1.80	3	3.20	0.94	1	1.10	2	1.90
70-80	2	1.38	3	3.62	0.83	-	-	-	-
80-90	2	1.07	6	6.93	0.87	0	0.19	1	0.81
90-100	3	1.58	16	18.4	0.87	0	0.27	3	2.72
0-100	59	47.4	41	53.6	0.76	89	86.5	11	13.5

O-observed, E-expected.

The Table 4 shows the relationship between the observed and expected mortality rates which was found to be closer to 1.00 above 40%. The overall O: E ratio was 0.85 which is closer to 1.00 which concludes that P- POSSUM

The common complications are chest infections (18%) due to COPD, Old age and smoking history, PUO (15%) due to Foley's catheters, wound and drain related sites, followed by wound infection (14%) which may be attributed to anemia, malnutrition, peritoneal contamination. Major complications like hypotension (12%), septicemia (9.5%), AKI (9%) were also noted in patients with morbidity score >40%.

Significance of P-POSSUM scores for morbidity

- P=0.089 (NS)
- Sensitivity 78%, specificity 100%
- PPV 76%, NPV 100%

The Table 4 shows the relationship between the observed and expected morbidity rates which was found to be closer to 1.00 above 40%. The overall O: E ratio was 0.76 which is closer to 1.00 which concludes that P-POSSUM over predicts morbidity but only with small margin and with a p>0.05 it indicates good levels of specificity and sensitivity.

The observed complications were 41 (41%) whereas the predicted deaths were 54 (54%), suggesting the P-POSSUM scoring was over predicting morbidity with p=0.089 which is not significantly different.

Significance of P-POSSUM scores for mortality

- P=0.59 (NS)
- Sensitivity 98%, specificity 100%
- PPV 85%, NPV 100%.

over predicts mortality but only with small margin and with a p>0.05 it indicates good levels of specificity and sensitivity.

The observed deaths were 11 (11%) whereas the Predicted deaths were 13 (13%), suggesting the P-POSSUM scoring was over predicting mortality with $p=0.59$ which is not significantly different.

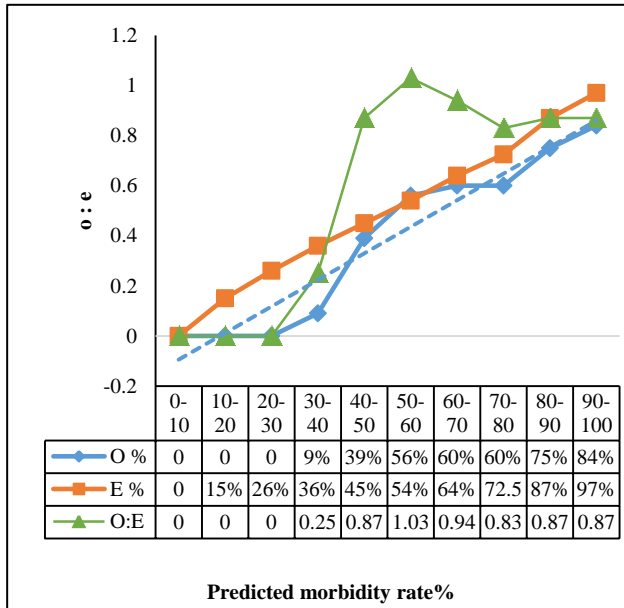


Figure 3: The relationship between observed and expected morbidity.

Figure 3 shows that the predicted morbidity rates were almost parallel to the observed morbidity rates for morbidity rates above 40% which strengthens the predictive power of P-POSSUM scoring.

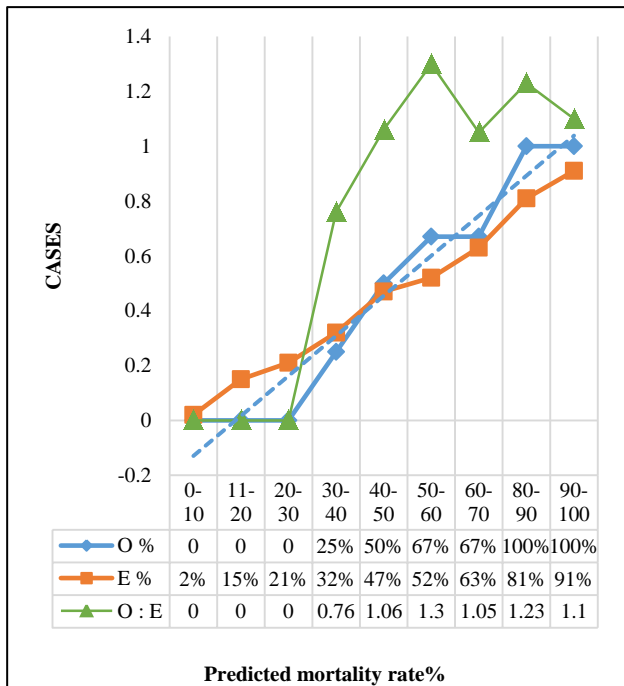


Figure 4: The relationship between observed and expected mortality.

Figure 4 shows that the predicted mortality rates were almost parallel to the observed mortality rates for mortality rates above 40% which strengthens the predictive power of P-POSSUM scoring.

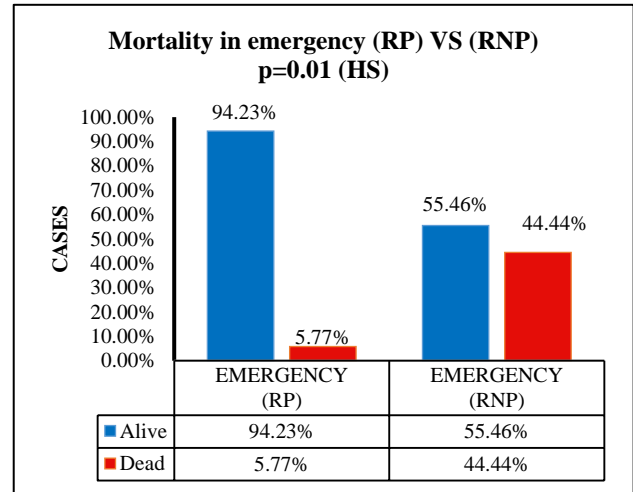
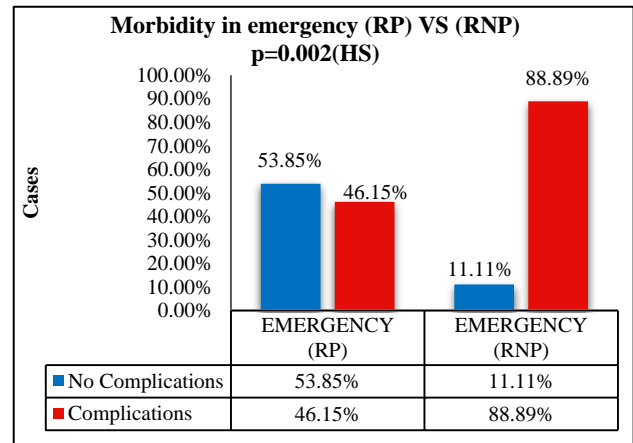


Figure 5: Mortality in emergency (RP versus RNP) groups.

The Figure 5 shows us that out of 52 patients who were resuscitated 94% were alive, 6% died and out of 18 patients who were not able to be resuscitated adequately and whose systemic injury were not able to be reversed 54% were alive, 44% died.



On comparison with chi square test it was found the result was statistically significant with $[\chi^2=12.322, d.f=1, p=0.0002 (HS)]$.

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 a developing nation like India, where the general condition of the patients is poor and has a high incidence of anaemia, apart from malnutrition due to poverty and delayed presentation due to ignorance leading to an

increased number of death rates and complications. The use of P-POSSUM scoring system can identify those patients who are at increased risk of death or complications.

P-POSSUM on mortality

In our study the validity of P-POSSUM scoring system in 100 patients undergoing laparotomy was assessed by comparing the observed and expected mortality and morbidity rates. 11 patients died; a crude mortality rate of 11%. The most common cause of mortality was septicemia.

Copeland has applied POSSUM for comparative audit in 344 patients undergoing reconstructive vascular surgery to assess its efficiency in a comparative audit between 2 units. Estimated mortality rates were 10.2% for unit A (observed 9.4%) and 20.2% for unit B (observed 20.2%). Using ROC curves they proved that there was no statistically significant difference between the 2 units.³

Prytherch obtained similar results of overall mortality rate of 19.1%. P-POSSUM predicted mortality rate in our study was 13%. On analysis we found no statistical difference between observed and expected mortality rate ($p = 0.59$). An O:E ratio of 0.85 was obtained in our study and similar finding was obtained by Prytherch (O:E = 0.9).⁴

Sagar reported the observed mortality rate in major hepatectomy 6.6% and POSSUM system over predicted mortality (14.2%). The mortality rate predicted by P-POSSUM was 4.2%. This shows P-POSSUM is more accurate with (O:E = 0.87).⁵

Tekkis reported that in esophagogastric surgery a total of 505 consecutive patients undergoing major gastrointestinal surgeries (elective 66.1%, emergency 33.9%) were analyzed. Observed mortality rate was 56 deaths. Using P-POSSUM, the expected rate was 57 (χ^2 test=3.34, $p=0.51$).⁶

Sutton reported the observed mortality rate 8.4% while mean mortality predicted by SRS (surgical risk score), POSSUM and P-POSSUM were 5.9, 12.6, and 7.3% respectively. This shows P-POSSUM is more accurate.⁷

Wakabayashi reported that in elective digestive surgery, the POSSUM system can be useful in the risk assessment for surgery in elderly patients.⁸

P-POSSUM on morbidity

In our study out of 89 patients who survived, 30 patients suffered complications and the remaining 59 patients did not show any evidence of complications. An observed to expected ratio (O:E) of 0.76 was obtained and there was no significant difference between the predicted and observed values ($p=0.089$).

The mean total P-POSSUM score of the study was 18.76. The mean total score of the mortality group was 64.91 whereas for survival group was 7.15. There was a significant statistical difference between the two groups; $p<0.01$. This shows that patients with total P-POSSUM score more than 18.76 in our study had an increase in mortality.

Using logistic equations, positive predictive value was 85%, negative predictive value 100%, sensitivity 98% and specificity 100% for mortality. For morbidity, the positive predictive value was 76%, negative predictive value 100%, sensitivity 78% and specificity 100%.

Similar studies were done by Sagar to compare adverse outcomes, following colorectal resection in 438 patients among 5 surgeons. While crude mortality rates varied from 5.6% to 6.9% and morbidity rates between 13.6% and 30.06%, risk adjusted analysis using POSSUM showed no statistically significant difference and the overall observed to expected ratio for mortality was found to be 0.87 and for morbidity, it was 0.97. This shows that POSSUM can be used for meaningful comparison of individual surgeon's efficiency as it is a good predictor of adverse outcomes.⁵

Mohil used POSSUM for predicting the adverse outcome rates in patients undergoing emergency laparotomy. 120 patients who underwent emergency laparotomy at Safdurjung Hospital, Delhi, were studied to assess the applicability in their setup. 16 patients (13.3%) died within 30 days of surgery and 62 (51.7%) had complications. An analysis, they found an O:E ratio of 0.62 for mortality ($\chi^2=10.71$, $p=0.148$).⁹

On analysis of risk factors, statistically significant factors for mortality were respiratory system, blood pressure, Glasgow coma scale, serum sodium, and serum potassium, peritoneal contamination, total blood loss, presence of malignancy and mode of surgery amongst the P-POSSUM scoring system factors.

In our study two risk factors were separately validated that affect the mortality significantly in patients with laparotomy - operation time and presence of co-morbid status (diabetes, hypertension, obesity, metabolic syndrome). A statistical significance was established with these factors.

Hence, strict vigilance and prompt correction of these factors can improve the general condition of the patient and decrease the mortality and morbidity.

If these findings can be validated in a larger set of data including all types of surgeries, it may be possible to look into the reasons that might have caused this increase in mortality and undertake the appropriate corrective measures to prevent similar occurrences in the future, hence contributing ultimately to the improvement in the quality of health care provided.

Parihar in an effort to reduce the over prediction in low risk general surgical patients. They validated P-POSSUM over predicts mortality in some low risk patients (predicted risk of mortality <10% and predicted risk of morbidity <40%). A correction factor of 0.257 for mortality and 0.619 for morbidity for P-POSSUM was obtained as correlation coefficient for low risk group.¹⁰

But on comparing patients who were resuscitated successfully before surgery with those who were not able to be resuscitated we found that patients who were resuscitated successfully had better prognosis than patients who were not able to be resuscitated with mortality rate of 5.7% and 44% respectively and morbidity rate of 59% and 87%.

This proves that pre-op resuscitation of the patient and the improved quality of care during pre-op, intra-op and post-op periods care followed in our setup resulted in decreased mortality and morbidity rates than predicted by P-POSSUM. The protocols followed in our institution were as follows,

Management of the emergency laparotomy patient: a practical guideline

- Initial Assessment.
- Early identification of the patient at high risk by high risk of death (HROD) criteria.¹¹
- Recognize and treat sepsis.
- Recognize and treat acute kidney injury.
- Pre-operative considerations
 - Adequate resuscitation of patient with IV fluids.
 - Reducing ongoing systemic injury.
 - Maintain normoglycemia and normothermia.
- Intra operative considerations
 - Keeping duration of laparotomy < 100mins
 - Thorough peritoneal wash.
 - Maintenance of sterile techniques.
 - Securing hemostasis.
 - Avoid primary anastomosis if on significant vasoactive support.
 - Consider laparostomy if intra-abdominal hypertension likely.
 - Consider Nasogastric tube placement.
 - PEEP of at least 5cmH2O.
 - Tidal Volume 5-7 ml/kg.
 - Peak airway pressure <30 cmH2O.
 - Antifungal if significant peritoneal soiling.
 - Mean arterial pressure >65 mmHg.
 - Urine output >0.5 ml/kg/hr.
 - Anticipate coagulopathy in septic patients and infusion of fresh frozen plasma.
- Postoperative considerations
 - Oxygenation.
 - Anticipation of imminent complications and systemic failures

- Following ERAS protocol, early mobilization, DVT prophylaxis, early feeds, early removal of catheters and drain tubes.
- Supplementation with adequate nutrition.
- Antibiotics selection based on culture and sensitivity.
- Correction of metabolic disorders and maintaining adequate urine output.

CONCLUSION

Our study suggests that P-POSSUM is an accurate scoring system for predicting post-operative adverse outcome among patients undergoing major general surgeries.

All the studied risk factors were found to have a positive rate of increment of deaths with higher scores. Hence adequate and prompt correction of these factors before surgery could decrease the mortality rate.

Using P-POSSUM, pre-operative counseling to care takers, pre-optimization in high risk patients can be evaluated, determining operative risk, choosing the nature of surgery (damage control vs. definitive procedure), selecting patients for intensive care, implementing corrective measures groups thereby improving results, with targeted interventions improving quality of care and cost reduction.

Successful resuscitation of patients and halting further systemic injury before surgery greatly reduces mortality and morbidity.

Our study shows that even though P-POSSUM over predicts mortality in some low risk patients, with sensitivity of 98% and specificity of 100% for mortality this system can be applied for the surgical audit in our setup.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Davidson, Schneider HJ. *Audit. Clinical surgery in general* 4th Ed. Author Kirk RM. Publisher Churchill Livingstone; 2004: 428-435.
2. *Surgical audit and peer review: A guide* by Royal Australasian College of surgeons, 3rd edition, 2008: 3-4.
3. Copeland GP, Jones D, Wilcox A, Harris PL. Comparative vascular audit using the POSSUM scoring system. *Ann R Coll Surg Engl.* 1993;75(3):175.
4. Prytherch DR, Whiteley MS, Higgins B, Weaver PC, Prout WG, Powell SJ. POSSUM and

- Portsmouth POSSUM for predicting mortality. *Br J Surg.* 1998;85(9):1217-20.
5. Sagar PM, Harley MN, Mancey Jones B, Sedman PC, May J. Comparative audit of colorectal resection with the POSSUM scoring system. *Br J Surg.* 1994;81(10):1492-94.
 6. Tekkis PP, Kocher HM, Bentley AJ. Operative mortality rates among surgeons: comparison of POSSUM and p-POSSUM scoring systems in gastrointestinal surgery. *Diseases of the Colon and Rectum.* 2000;43(11):1528-32.
 7. Brooks MJ, Sutton R, Sarin S. Comparison of surgical risk score, POSSUM and P-POSSUM in higher-risk surgical patients. *BJS.* 2005;92:1288-92.
 8. Wakabayashi, Sano, Yachida, Okano. Validation of risk assessment scoring systems for an audit of elective surgery for gastrointestinal cancer in elderly patients: An audit. *Int J Surg.* 2007;5(5):323-7.
 9. Mohil RS, Bhatnagar D, Bahadur L, Dev DK, Magan M. POSSUM and P-POSSUM for risk-adjusted audit of patients undergoing emergency laparotomy. *Br J Surg.* 2004;91(4):500-3.
 10. Parihar V, Sharma D, Kohli R. Risk adjustment for audit of low risk general surgical patients by Jabalpur-POSSUM score. *Indian J Surg.* 2005;67(1):38-42.
 11. The higher risk general surgical patient towards improved care for a forgotten group. The Royal College of Surgeons of England and Department of Health. Royal College of Surgery England, London 2011. Available at: www.rcseng.ac.uk/publications/docs/higher-risk-surgical-patient/. Accessed on 3 June 2019.

Cite this article as: Anbarasu K, Chandak R. Efficacy of the P-POSSUM scoring system as a prognostic indicator in patients undergoing emergency laparotomy. *Int Surg J* 2019;6:3600-7.