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RESEARCH ARTICLE

COMPARISON AND PROSPECTIVE EVALUATION OF IN-HOSPITAL POST OPERATIVE MORATLITY IN PATIENTS UNDERGOING MAJOR SURGERY USING POSSUM AND P- POSSUM SCORING SYSTEM

***Sudheer Kanchodu and Manjusha M. Litake**

Department of General Surgery, B. J Government Medical College and Sassoon Hospital, Pune, 411001, India

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Corresponding author:* **Sudheer Kanchodu

ABSTRACT

Background: POSSUM AND P-POSSUM are two well known scoring systems for the evaluation of mortality and morbidity. It uses both preoperative and intra operative parameters of the patient for calculation of the score. Mortality rate alone cannot be used to compare the outcome of surgery between units or institutions. These scores can be used for the prediction of mortality and also for surgical audit, thus help in improvisation of our skill and proper documentation of patient details. ***Materials and Methods****:* This study was conducted in a tertiary care hospital in 300 patients above the age of 12 years from 2016 to June 2018, undergoing major surgery. This is a prospective observational study. ***Results:*** POSSUM and P-POSSUM had cut off of 42.3% and 22.3% respectively from ROC curve, above which proved equally good in predicting mortality. Overall mortality was 13.7%, of which 9.6% was from emergency. Both scores accurately predicted mortality in 81% of total patients. The discriminative ability to predict mortality was excellent. The area under the ROC curve (AUC), for POSSUM with 95% CI = 0.879 [0.810 – 0.938], P-value<0.001; P-POSSUM: AUC with 95% CI = 0.852 [0.795 – 0.928], P-value<0.001. O/E ratio for mortality was 0.32, 0.57, 0.5 respectively for POSSUM score and 0.28, 0.61, 0.57 respectively for P-POSSUM, in <60, 60-70, >70 year age group. ***Conclusion:*** Both POSSUM and P-POSSUM can be used as tool for prediction of mortality. But both POSSUM and P-POSSUM slightly over predicted the mortality in younger and low risk age group. Patients with higher scores can be given special attention, thus may help to bring down the mortality to some extent. They can be good tool for surgical audit as well.

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INTRODUCTION

In this era of evidence based medicine there is need for improvisation of our skill and proper documentation of all details from time of admission to the time of discharge or death. Morbidity and mortality rates continue to be the main end-points by which quality of care is judged in most institutions in developing countries such as India. Patients seeking medical help in government institutions mostly belong to low socioeconomic strata with very limited resources. Under such circumstances, measuring the quality of care using morbidity and mortality alone may be inappropriate. Although patient care is the responsibility of individual surgeons, the outcomes often depend on a large multidisciplinary team comprising surgeons, anesthetists, intensive care staff, junior doctors and nurses, all of whom may affect the complication and death rates. It is unfair to look at complications purely in terms of surgical or anesthetic blame. Where audit shows a change in mortality rates and a significant increase in observed: expected ratio, the practice of an entire team should be reviewed. POSSUM (Physiologic and Operative Severity Score for the en Umeration of Mortality and morbidity) and P-POSSUM (Portsmouth modification of POSSUM) are simply a tool for fair comparative audit. Among many mortality scores have been published and a few have been validated, POSSUM (Copeland *et al.,* 1991) and P-POSSUM are the two well-known indices of prediction of mortality and morbidity in the west. In the previous studies POSSUM score is said to over predict the mortality in low risk patients and under estimate in elderly and emergency patients (Whiteley *et al.,* 1996; Menon, 2002; Tekkis *et al.,* 2004). P-POSSUM (Prytherch *et al.,* 1998) was developed to overcome the draw backs of POSSUM score. P-POSSUM uses the same scoring parameters as POSSUM and has largely replaced POSSUM as a risk prediction score due to its better mortality prediction ability. The POSSUM system is a 2-part scoring system that includes a physiological assessment and a measure of operative severity. The physiological part of the score includes 12 variables, each divided into 4 grades with an exponentially increasing score (1, 2, 4, and 8). The physiological variables are those apparent at the time of surgery and include clinical symptoms and signs, results of simple biochemical and hematological investigations, and electrocardiographic changes. The operative severity part of the score includes 6 variables, each divided into 4 grades with an exponentially

increasing score (1, 2, 4, and 8). The number of operations indicates the chronology of the procedure(s) within 30 days (Copeland *et al.,* 1991). The physiological parameters in the score are collected before the surgery and operative parameters are collected during and after the surgery and the score is calculated using the POSSUM and P-POSSUM calculators based on the equations and results are obtained. The POSSUM scoring system requires collection of simple physiological and operative scores within the scope of basic surgical cares. This has obvious advantages over more sophisticated scoring systems such as the APACHE. The linear comparison analysis using the P-POSSUM equation is straightforward and easy to apply, which is relevant in developing countries with limited resources. It allows comparative audit to monitor our quality of care to achieve the best possible results (Yii *et al.,* 2003).

MATERIALS AND METHODS

All patients undergoing major surgery above 12 years of age on elective or emergency basis in our tertiary care center during the study period of 2016 to 2018 were included as a part of the study. Sample size was 300 cases. This study was a clinical observational study. After obtaining written informed consent, detailed history, examination and the required parameters were obtained according to the format below. (Table 1)

In POSSUM the predicted mortality rate is calculated using formula:

Ln[R/(1-R)]= -7.04+(0.13×physiological score)+(0.16×operative score)

Where in P-POSSUM same parameters are used to calculate the predicted mortality using the formula,

Ln[R/(1-R)= -9.065+(0.1692×physiological score)+(0.1550×operative score)

Here 'R' indicates mortality.

The discriminating ability of individual scoring system for prediction of mortality was assessed by receiver operator curve and the area under the curve. O/E ratio for mortality was calculated. The ability of both scores in predicting mortality was studied by categorizing the surgeries, according to the systems involved like major amputations, breast and endocrine, gastrointestinal, and renal surgeries and was compared.

Major surgeries included in the study:

1. Exploratory laparotomy for trauma/non traumatic abdominal pathologies.
2. Bowel resection surgeries.
3. Cholecystectomy for various aetiologies.

Table 1.

Physiological

Score	1	2	4	8
Age, y	≤60	61-70	≥71	...
Cardiac Signs	Normal	Cardiac drugs or steroids	Edema; warfarin	JVP
CXR	Normal	...	Borderline cardiomegaly	Cardiomegaly
Respiratory signs	Normal	SOB exertion	SOB stairs	SOB rest
CXR	Normal	Mild COAD	Mod COAD	Any other change
Systolic BP, mm Hg	110-130	131-170 100-109	≥171 90-99	≤89
Pulse, beats/min	50-80	81-100 40-49	101-120	≥121 ≤39
Coma score	15	12-14	9-11	≤8
Urea nitrogen, mmol/L	<7.5	7.6-10	10.1-15	≥15.1
Na, mEq/L	>136	131-135	126-130	≤125
K, mEq/L	3.5-5	3.2-3.4 5.1-5.3	2.9-3.1 5.4-5.9	≤2.8 ≥6
Hb, g/dL	13-16	11.5-12.9 16.1-17	10-11.4 17.1-18	≤9.9 ≥18.1
WCC $x10^{12}$/L	4-10	10.1-20 3.1-3.9	≥20.1 ≤3	...
ECG	Normal	...	AF (60-90)	Any other change

General Surgery POSSUM

Operative Severity

Score	1	2	4	8
Operative magnitude	Minor	Intermediate	Major	Major +
No. of operations within 30 d	1		2	>2
Blood loss per operation, mL	<100	101-500	501-999	>1000
Peritoneal contamination	No	Serious	Local pus	Free Bowel content, pus or blood
Presence of malignancy	No	Primary cancer only	Node metastases	Distant metastases
Timing of operation	Elective		Emergency resuscitation possible, operation <24 h	Emergency immediate, operation <2 h

Operation classification, see Table 1
If not documented, pick appropriate operation group

Patient name:

Unit number:

DOB:

Consultant:

Operating surgeon: _____

Anesthetist: _____

Operation date: _____

Date admitted: _____

Date discharged: _____

4. Emergency craniotomy.
5. Major genitourinary surgeries like: Pyelolithotomy/ Nephrolithotomy/Nephrectomy.
6. Major amputation: traumatic and non traumatic.
7. Surgeries for malignancies.

RESULTS

The mean ± standard deviation of age of the entire study group is 45.8 ± 16.8 years. Male to female ratio was 1.63:1. Overall mortality was 41(13.7%). Among 152 elective cases, there was 4.6% mortality and in 148 emergency cases mortality was (23.0%). The distribution of incidence of mortality differs significantly between emergency and elective surgery (P-value<0.001) (Table 2). O/E ratio in <60, 60-70, >70 year age group 0.32, 0.57, 0.5 respectively for POSSUM score and 0.28, 0.61, 0.57 respectively for P-POSSUM. The mortality significantly increases with increasing blood loss with a P value of 0.012 (Graph 1).

Cut off value for possum through ROC: The cut-off of POSSUM score by ROC was (>42.3%), had relatively high sensitivity (78%) and specificity (81%) in predicting the incidence of mortality. The area under the ROC curve with 95% CI = 0.879 [0.810 – 0.938], P-value<0.001 with an accuracy of 81.0%. The distribution of incidence of mortality is significantly higher among the group of cases with POSSUM score more than 42.3% (P-value<0.001) (Graph 2).

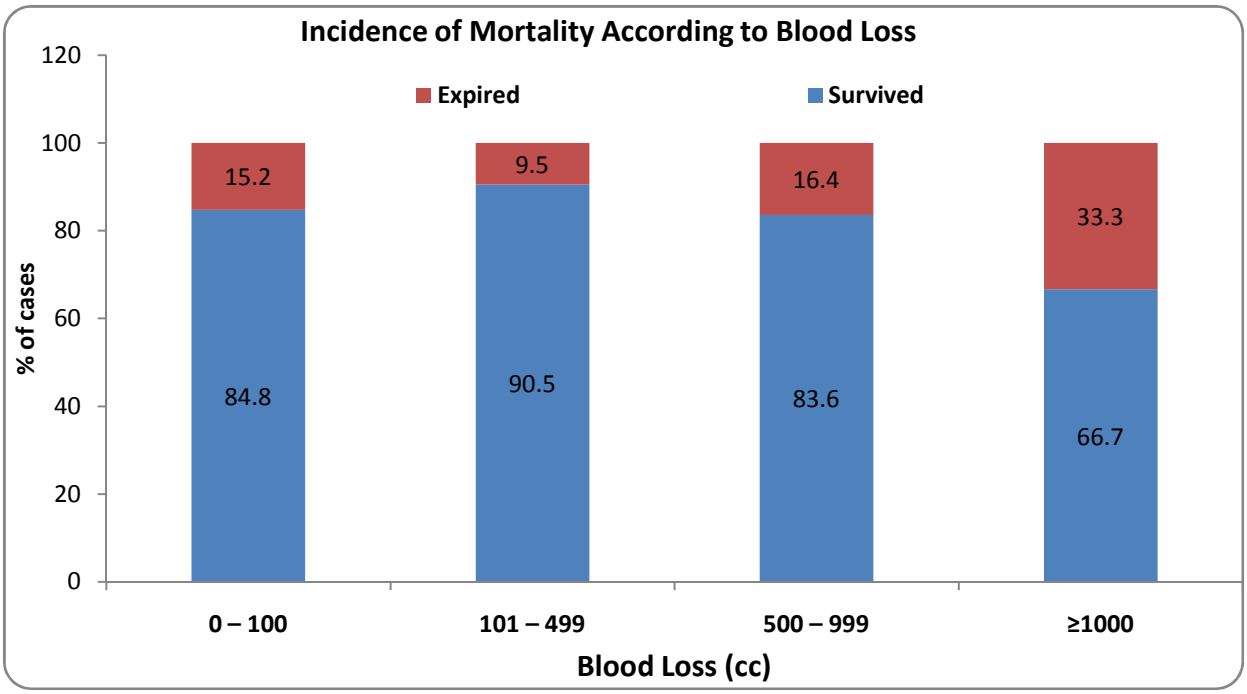
Cut off value for p- possum through ROC: The cut-off of P-POSSUM by ROC was (>22.30%), had relatively high sensitivity (76%) and specificity (80%) in predicting the incidence of mortality. The area under the ROC curve with 95% CI = 0.852 [0.795 – 0.928], P-value<0.001 with an accuracy of 79.0%. In P-POSSUM group the distribution of incidence of mortality is significantly higher among patients with score more than 22.3% compared to the cases with P-POSSUM score less than 22.3% (P-value<0.001) (Graph 2).

Table 2. The distribution of incidence of mortality according to mode of surgery (n= 300)

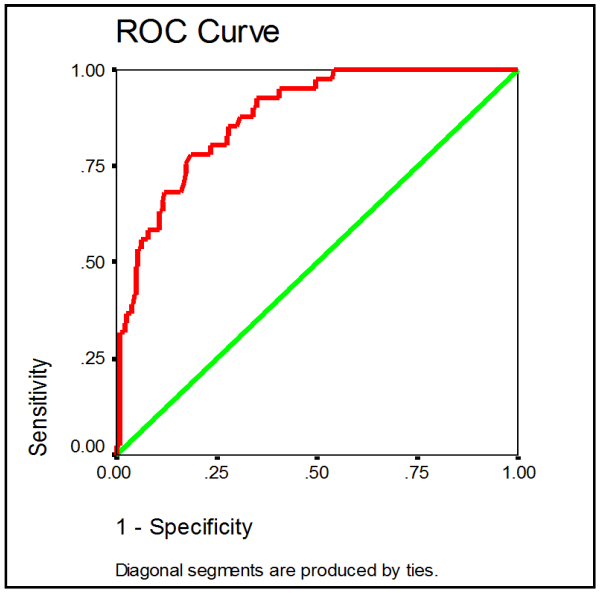
Mode of surgery	Survived		Expired		Total		P-value (Chi-square)
	n	%	N	%	n	%	
Elective	145	95.4	7	4.6	152	100.0	0.001***
Emergency	114	77.0	34	23.0	148	100.0	
Total	259	86.3	41	13.7	300	100.0	

Table 3. Comparison of possum and p-possum in predicting mortality according to system wise surgery

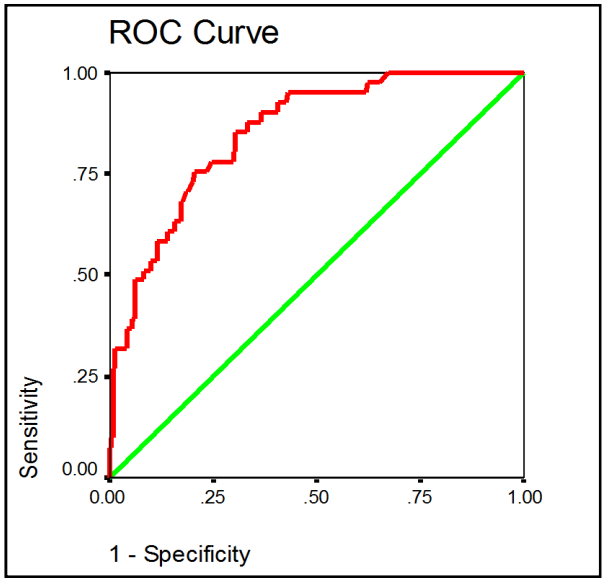
		Mortality						
		Observed		Estimated		Total		
Surgery	Score (ROC Cut-off)	n	%	n	%	n	%	O/E Ratio
Major amputation	POSSUM (>42.3%)	3	11.5	7	26.9	26	100.0	0.43
	P-POSSUM (>22.3%)	3	11.5	7	26.9	26	100.0	0.43
Endocrine and Breast	POSSUM (>42.3%)	0	0.0	1	4.5	22	100.0	0.00
	P-POSSUM (>22.3%)	0	0.0	3	13.6	22	100.0	0.00
GI Surgery	POSSUM (>42.3%)	24	13.4	64	35.7	179	100.0	0.37
	P-POSSUM (>22.3%)	23	12.8	61	34.1	179	100.0	0.38
Head and Neck	POSSUM (>42.3%)	4	11.8	6	17.6	34	100.0	0.67
	P-POSSUM (>22.3%)	4	11.8	8	23.5	34	100.0	0.50
Renal	POSSUM (>42.3%)	1	2.6	2	5.1	39	100.0	0.50
	P-POSSUM (>22.3%)	1	2.6	5	12.8	39	100.0	0.20



Graph 1. The incidence of mortality according to blood loss (n= 300)



ROC OF POSSUM



ROC OF P-POSSUM

Graph 2. Receiver Operating Characteristics (ROC) curve for POSSUM and P-POSSUM Score as a predictor incidence of mortality

DISCUSSION

In our study we included all major surgeries including general surgeries, urosurgeries, oncosurgeries, and neurosurgeries, both on emergency and elective basis in a single study. These two scoring systems also help in documentation of patient details and help in surgical audit (Paul). Many mortality scores have been published and a few have been validated. POSSUM and morbidity P-POSSUM are the two well known indices of prediction of mortality and morbidity in the west. The distribution of incidence of mortality differs significantly between emergency and elective surgery (P-value<0.001). The incidence of mortality is significantly higher in the emergency mode of surgery compared to the elective mode of surgery (P-value<0.001) (Table 2). Mortality rate among the patients undergoing elective surgery is comparable with other similar studies by Yadav *et al.* (2011) (6%) (Jones *et al.,* 1999), Yii *et al.* (2003) (6.4%) (Yii *et al.,* 2003). Among the patients undergoing emergency major surgeries we had 23% mortality which is comparable with Elias *et al.* (22.3%) (Adriana Cristina Galbiatti Parminondi Elias *et al.,* 2009). In the study done by Singh et al the reported mortality rate was 17.8 % of the 84 patients enrolled (Singh *et al.,* 2011). And another study by Nachiappan et al on perforative peritonitis had mortality rate of 16% (Nachiappan and Litake, 2016). There was over prediction of mortality in younger age group inour study could be because of not considering individual risk factor involved in each surgery, pre-operative resuscitation (Whiteley *et al.,* 1996; Menon *et al.,* 2002; Tekkis *et al.,* 2004). We have observed that the mortality significantly increases with increasing blood loss with a P value of 0.012(graph 1). Similar results were obtained in other studies (Wang *et al.,* 2014; Pratt *et al.,* 2008). Both scores are good predictors of mortality in major amputation, head and neck surgeries and renal surgeries (Table 3 and Graph 2 showing ROC). In gastro intestinal surgery group both scores over predicted the mortality where, there is a need for further study using large sample size and addition of some risk factors like serum protein level and acidosis and other possible risk factors that predict the outcome of surgery. And also because of combining both emergency and elective surgeries may have caused over estimation of mortality by both the scores. Whereas, in studies by Khan *et al.* (2004) and Lam *et al.*, where only elective surgeries were studied P-POSSUM nearly predicted mortality where as POSSUM score over predicted mortality; Pratt *et al.* (2008) found POSSUM was found to be better.

Analysis of cause of death

On analysing the cause of death at individual level, 34 patients who died had both POSSUM and P-POSSUM score above cut off level and 7 cases had scores below the cut off , suggesting their efficacy in predicting the mortality. Out of 7 deaths, that had lower cut off values, 2 were operated for head injuries, died because of sequel of head injury. Both had advanced age as an additional risk factor. Two patients had myocardial infarction post operatively both of them had diabetes mellitus and were on insulin. For 1 male patient, operated case of Whipple's had post operative pancreatico-jejunostomy leak, and another patient who had symptomatic splenomegaly with glycogen storage disorder died of post operative sepsis. One patient of radical cystectomy with ileal conduit died because of blood transfusion complication. Some patients succumbed even with low predicted mortality rates, the reason being an untoward post operative event.

Conclusion

- It is evident that POSSUM and P-POSSUM scores are good predictors of mortality in our set up and can be effective tool for surgical audit. Even though it was developed initially for general surgery patients, on applying them to renal or head and neck surgeries, they yielded good results.
- High scores definitely alarm the operating surgeons and help in better patient care.
- The drawbacks the scores are that, they do not take into account, the factors like malnutrition and hypoproteinemia which is one of the major causes of anastomotic leak and poor wound healing in developing countries like India. They also do not take into account metabolic derangements like acidosis or alkalosis, hypothermia which if not treated can be fatal.

Diverse biological response of individual patients to the treatment may prevent accurate prediction of mortality by the scores in some of the patients. Unforeseen complications may also decrease the accuracy of the score. In this respect, in these group of patients having inaccurate predictions we must find out, with further studies, addition of certain parameters to the score or further modifications to make it even more better at an individual level as well as on a large scale.

Conflict of interest: None.

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