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Evaluation of possum score for outcome prediction in patients undergoing emergency midline laparotomy in tertiary health care center of central India: A prospective observational study

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Abstract
Reduction in morbidity and mortality is the basic and ultimate aim of any surgical intervention whether it is emergency or elective procedure, which must be determined to cause evolution and help in faster adaptation of more effective treatment regimens. Surgical audit being one the most important factor in public health sector in terms of patient care management and legal issues numerous scoring system have been developed for it such as POSSUM (Physiological and Operative Severity Scoring system for the en Umeration of Morbidity and mortality) for observed and expected adverse outcome rates of surgical procedures. Emergency midline laparotomy is a common procedure having mortality rate considerably greater than that of elective laparotomy. So in Indian scenario we found that there is need to validate the POSSUM scoring system as delayed presentation and limited resources majorly affect the outcome and also the quality care provided by any health care system. This study was undertaken to assess the validity of POSSUM scoring system in patients undergoing emergency midline laparotomy in our setup in
a Tertiary health care center of central India and to analyze the outcome and compare the observed and expected values (O:E)in mortality and morbidity of these patients.

Keywords: POSSUM, emergency laparotomy, surgical scoring, surgical audit, predictive value, post-operative outcomes

Introduction
Reduction in morbidity and mortality is the basic and ultimate aim of any surgical intervention whether it is emergency or elective, which must be determined to cause evolution and help in faster adaptation of more effective treatment regimens. Surgical audit being one the most important factor in public health sector in terms of patient care management and legal issues numerous scoring system have been developed for it such as POSSUM(Physiological and Operative Severity Scoring system for the en Umeration of Morbidity and mortality) for observed and expected adverse outcome rates of surgical procedures, [1, 2, 8, 9] ASA (American Society of Anaesthesiologist) for general risk prediction [3], APACHE III (Acute Physiology and Chronic Health Evaluation III) for intensive care [4], Goldman Index for cardiac related complications peri-operatively and ACPGBI (Association of Colo Proctology of Great Britain and Ireland) [5-7].

As the outcome is directly related to risks associated with surgery because of differences in general health of local population and variable presentation of patient's condition, it is important to compare the risk adjusted mortality and morbidity rates instead of crude rates. It is very much difficult and unrealistic to directly compare one patient with other as the mode and time of presentation of clinic-pathological condition is very much variable in Indian scenario. Emergency midline laparotomy is a common procedure having mortality rate considerably greater than that of elective laparotomy. So in Indian scenario we found that there is need to validate the POSSUM scoring system as delayed presentation and limited resources majorly affect the outcome and also the quality care provided by any health care system. This study was undertaken to assess the validity of POSSUM scoring system in patients undergoing emergency midline laparotomy in our setup , Tertiary health care center of central India and to analyze the outcome and compare the observed and expected values (O:E).

Physiological score				
Score →	1	2	4	8
Age	≤ 60	61–70	≥ 71	
Cardiac signs Chest radiograph	No failure Normal	Cardiac drugs or steroids	Peripheral edema, anticoag treatment Borderline cardiomegaly,	↑JVP, Cardiomegaly
Respiratory history	No dyspnoea	Dyspnea on exertion	Limiting dyspnea (One flight)	Dyspnoea at rest (>30/mt)
Chest radiograph	Normal	Mild COAD	Moderate COAD	Any other change
B.P(Systolic) mm Hg	110–130	131–170 100–109	≥ 171 90–99	≤ 89
Pulse	50–80	81–100 40–49	101–120	≥ 121 ≤ 39
GCS	15	12–14	9–11	≤ 8
Hb	13–16	11.5–12.9 16.1–17	10–11.4 17.1–18	≤ 9.9 ≥ 18.1
WBC(×10³/cu mm)	4–10	10.1–20 3.1–4.0	≥ 20.1 ≤ 3.0	
Bl. Urea	≤ 7.5	7.6–10	10.1–15.0	≥ 15.1
Na+	≥ 136	131–135	126–130	≤ 125
K+	3.5–5.0	3.2–3.4 5.1–5.3	2.9–3.1 5.4–5.9	≤ 2.8 ≥ 6.0
ECG	Normal		Atrial fibrillation (rate 60–90)	Any other abnormal rhythm or ≥ 5 ectopics/min, Q waves or ST/T wave changes
Operative Severity Score				
Score →	1	2	4	8
Operative severity	Minor	Moderate	Major	Major+
Multiple procedure	1		2	>2
Total blood Loss	≤ 100	101 – 500	501 – 999	≥ 1000
Peritoneal soiling	None	Minor Serous fluid	Local Pus	Free bowel contents, pus or blood
Malignancy	None	Primary only	Nodal Mets	Distant Mets
Mode of surgery	Elective		Emergency resusc of > 2 hrs possible, Op <24 hrs after admission	Emergency surgery, 2 hrs of resusc not possible

Materials and Methods

Within 3 years of study period with sample size of 140, study was undertaken. 140 emergency midline laparotomies were studied and POSSUM scoring system applied to predict the post operative outcome in terms of morbidity that is post operative complication if any and mortality that is post operative death.

POSSUM scoring system-(Table)

Scoring system involves total 18 variable which includes 12 physiological variable (pre-operative) and rest 6 are intraoperative variables, every variable is divided in 4 grades.

After calculating POSSUM score derived values are put in standard POSSUM equation to get predicted values(E) of morbidity and mortality in terms of percentages, which compare with actual post operative outcome(O) (morbidity and mortality). (O:E)

POSSUM equation for Morbidity

Logn R1/1-R1= -5.91 + (0.16 x Physiological score) + (0.19 x Operative severity score), where R1 is the predicted risk of morbidity.

POSSUM equation for Mortality

Logn R2/1-R2 = -7.04 + (0.13 x Physiological score) + (0.16 x Operative severity score), where R2 is the predicted risk of mortality.

Inclusion Criteria: Patients undergoing emergency midline laparotomy were included in the study population.

Exclusion Criteria

The following patients were excluded from the study:

a. Patient age <15 years and >75 years.
b. Patient died before intubation.
c. Re-exploration.
d. Laparotomy other than midline.

Findings of patient's history and detailed clinical examination, physiological score at the time of admission and operative score of the patients undergoing emergency midline laparotomy were recorded after formal ethical consent. The patients were followed up till the 30th postoperative day, and complications if any, were noted depending upon the criteria as defined in POSSUM scoring system. All relevant data was recorded on predesigned proforma and analyzed properly.

Data was entered in Microsoft excel sheet and analysis using statistical software epi.info (7.2.1.0). Appropriate statistical tests were applied. Chi square test was applied for cantorial data. P value <0.05 is considered significant.

Results and Observation

A total 140 emergency midline laparotomies were studied with POSSUM scoring system their expected values for morbidity and mortality derived and compared with actual outcome, among 140 cases majority of cases were from age group of 41-60 years of age (66 cases). 106 were males.

Peptic perforation found to be the most common indication for emergency midline laparotomy followed by intestinal obstruction.

Within 30 days of post operative follow-up period around 64 patients suffered with post operative complication where respiratory complications (pneumonia, ARDS, atelectasis) and surgical site infections were highest.

Among 140 cases 38 died post operatively, majorly are due to MODS and respiratory complications, we got our mortality rate of 27.1%

In our study which was held during COVID pandemic we observed out of 140 patients 47 were COVID positive patients Among total mortality 38(27%) non COVID were 22(15.7%) and COVID positive were 16(11.5%).

Operative Variables

This study includes midline emergency laparotomy, so operative severity comes out to be major in all cases, mode of surgery is also emergency (2-24 hours) in all cases. These two operative variables become constant in this study.

Also, as our study include all non-traumatic cases so every patient having GCS 15/15 which makes again constant variable.

Table 1: Indication of laparotomies

Diagnosis	Number	Percentage
Peptic Perforation	77	55.0
Intestinal Obstruction	47	33.6
Other Viceral Perforation	14	10.0
Others	2	1.4
Total	140	100

Table 2: Post-Operative complications

Post-operative complication	Number of Patients Suffered
Respiratory complication	22
Surgical site infection	20
Abdominal wound dehisence	9
Anastomotic leak	4
Enterocutaneous fitsula	3
Stomal complication	6
Total	64

Table 3: comparison of observed and expected mortality rates (O:e)

Predicted Mortality Rate (%)	No. of procedures	Observed No. of Deaths	Expected No. of Deaths	O:E
<10	8	1	2	0.5
>10 to <20	28	0	8	0.00
>20 to <30	20	0	5	0.00
>30 to <40	15	2	4	0.5
>40 to <50	10	0	3	0.00
>50 to <60	6	0	2	0.0
<60 to >70	19	9	5	1.8
>70 to <80	18	12	5	2.4
>80 to <90	10	9	3	3.0
>90 to <100	6	5	2	2.5
Total	140	38	38	1.07

On Comparing the observed and POSSUM predicted mortality rates, an observed to expected ratio (O: E) of 1.07 was obtained. There was a significant difference between the predicted and observed values ($x2$ =73.865, 9 df., and P< 0.0001). Thus, there were significantly fewer than 97 expected deaths in lower deciles of risk but these increased as the risk increased to > 60%.

Table 4: Comparison of observed and expected morbidity rates (O:E)

Predicted Morbidity Rate (%)	No. of Procedure	Observed No. of Deaths	Expected No. of Deaths	O:E
<10	2	1	1	1
>10 to <20	0	0	0	0
>20 to <30	0	3	3	1
>30 to <40	3	0	1	0
>40 to <50	4	2	2	1
>50 to <60	5	3	3	1
<60 to >70	19	6	5	1.2
>70 to <80	19	8	11	0.72
>80 to <90	21	15	18	0.83
>90 to <100	67	27	28	0.96
TOTAL	140	64	70	0.91

On Comparing the observed and POSSUM predicted morbidity rates, an observed to expected ratio (O: E) of 0.91 was obtained. There no a significant difference between the predicted and observed values ($x2$ = 43.7904, 9 df., and P< 0.0001). Thus, there were almost equal number of actual observed morbidities as compared to the expected of risk (>90 to ≤ 100).

Discussion

In the era of modern medicine, patient's safety and proper management is of paramount importance to effectively reduce morbidity as well as mortality associated with medical or surgical interventions. Therefore, identifying patients at high risk for complications or mortality would be useful in taking appropriate precautions for better case management.

For this purpose, several scoring systems like ASA and APACHE II are utilized for predicting both mortality and morbidity. These scoring systems are based on very few

parameters that fail to effectively predict outcomes or are highly complex and hence are of limited use universally. POSSUM score is being recognized as one of the best scoring systems that can effectively predict the morbidity and mortality risk with favorable accuracy. It has also been validated by previous studies and is successfully used as a tool for surgical audit [1].

In the present study, 140 patients undergoing emergency midline laparotomy were observed for assessing the efficacy of the POSSUM`s score for predicting the outcome in terms of morbidity i.e. post-operative complications and mortality. Among the 140 cases who participated in this study, the commonest condition was perforation peritonitis in 77 (55.0%), followed by intestinal obstruction in 47 (33.6%) and perforation in 14 (10.0%) of the cases, with 2 (1.4%) cases of other conditions. The male female ratio in the present study was found to be 3:1 with 106 (75.71%) males as compared to 34 (24.29%) females in the study. Similar male: female ratio of 2.1:1 and 2:1 was reported by Afridi SP *et al*. [2] in 2008 and Kitara DL *et al*. [3] in 2006. Interestingly, another study by Jhobta RS *et al*. [3] showed higher male: female ratio of 5.25: 1 than that of our study. This variation in the male: Female ratio might be due smaller sample sizes of the other studies.

Our study showed that perforation peritonitis was the commonest diagnosis in 77 (55.0%), followed by intestinal obstruction in 47 (33.6%). This was similarly reported by other studies by Vishwani *et al*. (2014) [5] in 32 (36%) cases, Dorairajan *et al*. [6] in 32%, Quereshi *et al*. [7] in 44.9%, Afridi SP *et al*. [2] in 21.6%, Jhobta RS *et al*. [4] in 65%, Nishida *et al*. [8] in 40.2%, and Chen *et al*. [9] in 71.3% respectively.

The POSSUM score takes into account the physiological state of the patient and the operative findings. However, other factors like surgical expertise, competency of the anesthetists and operating time that may have a considerable influence on the outcome is not directly accounted for in the POSSUM score. But these being the differences in the standards of surgical care, and hence perhaps on the outcome, are supposed to be highlighted by POSSUM [10-13].

Due to the unavailability of standard methodologies for application of POSSUM mortality equation to a given population, standard logistic regression methods are generally used to apply the equation to the population being studied [14-16]. It was observed that this method for deducting the POSSUM mortality equation overestimated deaths, particularly in the lowest risk groups. This over prediction of the mortality could lead to a false sense of security that may subsequently give rise to the incidence of poor outcomes or downplaying them in actual practice. Therefore-POSSUM, which is a modification of POSSUM score, was developed as a better scoring system as it shows a better correlation with the observed mortality rates. The only condition that P- POSSUM should fulfil in order to be effective is that it has to be correlated with the general condition of the local populations. This is especially true in the context of developing countries like India where the general health of the population is poor, malnutrition is a common problem and presentation frequently delayed [17-19].

In our study, the mortality rate was 38 (27.1%) which was similar to that reported by a study by Arun D, which reported death among 14 patients (9%) among the elective surgeries and 20% in the patients undergoing emergency surgery [20]. The observed mortality in the present study was greater than that reported by some other studies (9.2%–10.6%) [2, 4, 6]. This might be chiefly attributed to the fact that present study mostly included emergency surgical cases that may be already moribund and presenting with complications leading to a comparatively higher mortality rate also as study was undertaken during COVID pandemic, patients with COVID positive status affected the mortality proportion significantly. The study by Tekkis *et al*. also showed similar findings with a mortality rate of 25% in patients undergoing emergency surgeries [21].

Our study showed a significant difference between the POSSUM predicted and observed mortality rates ($x2$ = 73.865, 9 df. and P< 0.0001) in higher deciles of risk with an observed to expected ratio of 1.07. There were significantly fewer than expected deaths in lower deciles of risk, but deaths increased as the risk increased to > 60%. There was a no significant difference between the predicted and observed morbidity rates ($x2$ = 43.7904, 9 df. and P< 0.0001) in higher deciles of risk (>90 to ≤ 100) with an observed to expected ratio of 0.91.

The previously conducted studies on the other hand showed no significant difference between the observed and expected mortality rates ($x2$ = 1.667, 9 df. p = 0.9957) with an O: E ratio of 0.93[20]. The other studies by Yii MK and Ng KJ (O: E = 1.28)[22], Tekkis15 (O: E = 0.98) [21] and Mohil 20(O: E = 0.66, $x2$ = 5.33, 9 df. p=0.619) [23]. Therefore, POSSUM score was able to accurately predict the adverse outcome following major surgery in our study particularly in the higher deciles of risk for mortality.

On univariate analysis, physiological parameters that were associated with higher mortality were heart rate in the range of 121-130 beats per minute (p =0.000), dyspnea on exertion (p =0.000) and systolic blood pressure of < 100 mm hg (p<0.0001). The hematological parameters that increased the risk of mortality were hemoglobin levels of < 10 gm% (p=0.017) and WBC counts < 4000 cells/mm^3 (p = 0.001). The biochemical parameters that were associated with increased risk of mortality included abnormal ECG pattern (p = 0.001), soiling due to bowel contents, excess blood loss, serum sodium levels of < 135 mEq/L, serum potassium levels of <3.5 mmol/l (p<0.0001) and blood urea levels of greater than 60 mg/dl (p = 0.004). On multivariate analysis, the factors that were significantly associated with mortality in the present study were blood loss > 300 ml (p=0.035) and serum sodium <135 mEq/L (p = 0.031).

The study by Arun D also similarly reported greater risk for poor outcomes in cases with higher total blood loss (p= 0.0321), raised serum sodium (p =0.0329), blood urea (p =0.004) and white cell counts (p =0.019) [20].

These factors likely contributed to the poor outcomes due to decreased immunity, ischemia and impaired hemostasis resulting from blood loss, uremia leading to decreased healing rates, impaired immunity, leukocytosis correlating with the degree of infection and inflammation. Whereas toxemia, and hyponatremia may cause impaired physiological response affecting the post operative mortality rate. Therefore, identifying as well as promptly correcting these hematological and biochemical imbalances is the key for preventing adverse outcome rates. Other studies have also mentioned wound infection (34%) and chest infections (26%) [20] as the major contributors to poor outcomes. Similar results were obtained by Mohil RS (35% and 20% respectively) [23]. The wound infections may have resulted from gross peritoneal contamination resulting from hollow visceral perforation resulting in local contamination of the incision site. Similarly, raised diaphragm, use of upper abdominal incision for exploratory laparotomy and gross peritoneal contamination could have led to higher rates of infections.

Table 5: Multivariate regression analysis for mortality (n=140)

Variable	Odds Ratio	95%C.I.	Coefficient	S.E.	Z-Statistic	P-Value
Age	1.00	0.95 - 1.05	-0.0005	0.02	-0.02	0.984
Total Blood Loss	1.01	1 - 1.02	0.01	0	1.89	0.058
Heart Rate	1.02	0.94 - 1.1	0.02	0.04	0.41	0.68
Respiratory symptoms (Dyspnoea on Exertion Vs No Dyspnoea)	0.48	0.11 - 2.08	-0.73	0.36	-0.98	0.328
SBP	0.85	0.77 - 0.94	-0.16	0.04	-3.2	0.001
ECG Findings (Within limit vs Abnormal)	4.08	0.66 - 25.43	1.41	3.81	1.51	0.132
Haemoglobin	1.02	0.55 - 1.89	0.02	0.32	0.07	0.947
WBC count	1.0001	0.9999 - 1.0003	0.0001	0.0001	1.35	0.177
Serum Na	0.88	0.78 - 0.99	-0.13	0.05	-2.16	0.031
Serum K	0.74	0.3 - 1.83	-0.3	0.34	-0.65	0.518
Blood Urea	1.02	0.93 - 1.1	0.02	0.04	0.35	0.724
Peritoneal soiling (Local pus vs bowel content)	0.78	0.17 - 3.52	-0.25	0.6	-0.33	0.742

Conclusion

Surgical audit is one of the most important factor in public health sector in terms of patient care management and legal issues, hence numerous scoring system have been developed for it such as POSSUM (Physiological and Operative Severity Scoring system for the en-Umeration of Morbidity and mortality) for observed and expected adverse outcome rates of surgical procedures. On Comparing the observed and POSSUM predicted morbidity rates, an observed to expected ratio (O: E) of 0.91 was obtained. On Comparing the observed and POSSUM predicted mortality rates, an observed to expected ratio (O: E) of 1.07 was obtained. There was a significant difference between the predicted and observed values (x2 =73.865, 9 df and $p< 0.0001$). The observed mortality in the present study was greater than that reported by some other studies (9.2%–10.6%) 2, 4, 6. This might be chiefly attributed to the fact that present study mostly included emergency surgical cases that may be already moribund and presenting with complications leading to a comparatively higher mortality rate also as study was undertaken during COVID pandemic, patients with COVID positive status affected the mortality proportion significantly. Therefore P-POSSUM, which is a modification of POSSUM score, was developed as a better scoring system as it shows a better correlation with the observed mortality rates.

Conflict of Interest

Not available

Financial Support

Not available

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