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Evaluation of POSSUM Score for Outcome Prediction in Patients undergoing Major Gastrointestinal Surgery in Population of Central Nepal

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ABSTRACT

Introduction

The POSSUM score is one of the several risk scores to predict postoperative morbidity and mortality in the surgical domain.This study was designed to assess the validity of POSSUM scoring system in patients undergoing gastrointestinal surgeries in our setup and to analyse the outcome and compare the observed and expected values.

Methods

An analytical cross sectional study was conducted among 100 patients in the Department of Surgical Gastroenterology after taking ethical approval from COMS-IRC. Data was analysed using SPSS -20 via descriptive and inferential statistical tools. p-value <0.05 was considered statistical significant.

Results

Using POSSUM score the expected morbidity was 52.2% and mortality was 21.47%. The observed morbidity was 54% and mortality was 13%. The observed to expected (O: E) morbidity was 1.03 and mortality was 0.61 and there was no statistically significant difference between observed and expected value. The area under curve for POSSUM mortality score was 0.896 and the sensitivity and specificity of POSSUM score to predict mortality was 93.2 and 83.9 respectively.

Conclusions

POSSUM score is a good mathematical tool in predicting morbidity and mortality in patients undergoing gastrointestinal surgeries.

Keywords: gastrointestinal surgeries; central Nepal; expected morbidity and mortality; observed morbidity and mortality; POSSUM score.

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INTRODUCTION

Prediction of complications is an essential part of risk management in surgery. Knowing which patient is at risk of developing complications contributes to the quality of surgical care and cost reduction in surgery. It is therefore essential to identify and make appropriate decision on those patients who are at high risk of developing serious complications.[1]

Several risk scoring systems have been developed for surgical audit such as POSSUM (Physiological and Operative Severity Scoring system for the enUmeration of Morbidity and mortality) for observed and expected adverse outcome rates of surgical procedures,[2,3] ASA(American Society of Anaesthesiologist) for general risk prediction, APACHE III (Acute Physiology and Chronic Health Evaluation III) for intensive care, Goldman Index for cardiac related complications peri-operatively and ACPGBI (Association of ColoProctology of Great Britain and Ireland).[4]

The POSSUM audit system (Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity) was designed to be easy and rapid to use and to have wide application across the general surgical spectrum, both in the elective and emergency settings and to be applicable in most health care systems.[2]

The physiological part of score includes 12 variables, each divided into 4 grades with an exponentially increasing score (1, 2, 4 and 8).[5] 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).[5]

As the POSSUM system uses a logistic model, predictions of less than 0% and greater than 100% are impossible.[6]

By using the predictions from individual patients, it is possible to extrapolate from groups of patients the likely number of adverse outcomes and thus obtain a risk adjustment quality measure. This measure, the ratio of observed number of adverse outcomes (O/E ratio), can be used to assess differences between surgeons and to observe changes over time. A ratio of 1.00 indicates average performance; greater than 1.00, performance better than expected.[5]

POSSUM scoring system has been found to be valid in accurately predicting the mortality and morbidity rates, although, a bit over prediction in low risk cases.[7]

In Nepalese scenario where problems like delayed presentation and limited resources can affect the outcome even with adequate quality care, hence, there is a need to validate POSSUM scoring system in our setup.

This study was undertaken to assess the validity of POSSUM scoring system in patients undergoing major gastrointestinal surgeries in our setup, and to analyse the outcome and compare the observed and expected values.

METHODS

This was an analytical cross-sectional study in the Surgical Gastroenterology Department at College of Medical Sciences –a tertiary care hospital at Bharatpur, Chitwan in central Nepal conducted over a period of 6 months from October 1st 2020 to march 31st 2021.

Patients undergoing major abdominal surgeries either elective or emergency at the Surgical Gastroenterology Department of college of medical Sciences, Bharatpur were enrolled. The purposive sampling technique was used.

Inclusion Criteria:

1. All patients undergoing laparotomy

Exclusion Criteria:

1. Age less than 15 years
2. Traumatic patients
3. Patients who died intra-operatively
4. Patients lost to follow-up

The first 100 patients who underwent laparotomy who fulfilled inclusion and exclusion criteria and who gave consent for the study were enrolled. Ethical clearance was taken from Institutional Review Committee (COMSTH-IRC) prior to commencement of the study. All elective patients were optimized prior to laparotomy. For those patients who presented to emergency where resuscitated prior to laparotomy depending on the urgency of the surgical conditions. Patients demographic and POSSUM score was calculated prior to laparotomy in a pretested proforma. Postoperative complications were noted till 30 days of laparotomy.

Data management and statistical analysis: Collected data was entered into SPSS data software version 20.0 and analysed accordingly. For descriptive statistics categorical variables were described using frequency and percentage, continuous variables were described using mean with Standard Deviation (SD). For inferential statistics non parametric test like chi-square test was used to test the association between dependent and independent variables at 95% confidence interval,significance level will be defined as $p<0.05$. Expected morbidity and mortality was calculated using linear regression analysis using POSSUM morbidity and mortality score. Receiver Operating Characteristic Curve (ROC) curve was calculated to see predictability of POSSUM mortality with observed mortality and its sensitivity and specificity in predicting mortality.

RESULTS

Out of 100 patients 56 were males and 44 were females. The mean age of the patients was 49.04 ±18.931 years. Most of the patients (70%) were less than 60 years of age. Mode of surgery was elective in 43%, emergency with resuscitation of more than 2 hrs in 53% and emergency without resuscitation in 4% patients. The common indications for surgery are shown in Table 3.

The POSSUM physiological score and operative score of the patients are depicted in Table 4 and 5. The most common morbidities were wound infection (superficial and deep), chest infection and impaired renal function in 39%, 21% and 18% cases respectively. Mortality was seen in 13 patients (13%) out of which 9 patients were in emergency surgeries with resuscitation, 3 patients in emergency surgeries without resuscitation and 1 in patient in elective surgery. Sepsis was the most common cause of death.The characteristics of patients having mortality is shown in Table 7.

When individual physiological and operative score were tabulated with mortality, systolic BP, Presence of significant respiratory history, heart rate, WBC count, urea, peritoneal soiling and mode of surgery were significantly associated with higher mortality with p value <0.05.

Expected morbidity and mortality score for POSSUM calculated by linear regression analysis was 52.2% and 21.47% respectively. The observed morbidity and mortality were 54 and 13 respectively. The O: E ratio for morbidity and mortality were 1.03 and 0.61 respectively and this findings were not statistically significant with p-value >0.05. The area under curve on Receiver Operator Curve (ROC) was 0.896 which is close to 90% showing POSSUM has a good discrimination for picking those who will become a mortality.

Table 1. Age and sex distribution

Age group (yrs)	Percentage
≤60	70
61-70	18
≥71	12
Mean age ± SD	49.04 ± 18.931 years
Minimum and maximum age	16 years and 92 years
Males	56
Females	44

Table 2. Mode of surgery.

Mode of surgery	Frequency	Percentage
Elective	43	43
Emergency (with resuscitation >2hrs)	53	53
Emergency (immediate surgery)	4	4

Table 3. Common indications for surgery.

Common indications for surgery	Frequency	Percentage
Appendicular perforation peritonitis	18	18
Small and large bowel obstruction	15	15
Small and large bowel perforation	12	12
CBD stone/biliary stricture	14	14
GI tract cancer	6	6
Carcinoma Gallbladder	4	4
Gall bladder perforation	4	4
Gastric outlet obstruction	4	3
Pancreatic Pseudocyst	3	3

Table 4. Distribution of physiological score.

Physiological score	1	2	4	8
Age	70	18	12	
Cardiac signs/CXR	93	7		
Respiratory signs/CXR	79	16	3	2
Systolic BP	58	25	13	4
Pulse rate	38	38	17	7
GCS score	93	7		
Urea nitrogen	31	23	25	21
NA+	74	22	4	
K+	80	13	6	1
Hb	32	33	18	17
WBC count	49	47	4	
ECG	92		6	2

Table 5. Distribution of operative score.

Operative score	1	2	4	8
Operative magnitude		14	81	5
No.of operations	90	10		
Blood loss per operation	40	49	8	3
Peritoneal contamination	50	19	1	30
Presence of malignancy	86	5	9	
Timing of operation	43	53		4

Table 6. Causes of morbidity in study population.

Morbidity	Frequency	Percentage
Wound infection (superficial)	24	24
Wound infection (deep)	15	15
Chest infection	21	21
Impaired renal function	18	18
Anastomotic leak	6	6
Relaparotomy	2	2
Wound dehiscence	2	2

Table 7. Characteristics of patients having mortality.

Serial no.	Age	Sex	Total physiological score	Total operative score	Possum morbidity score	Possum mortality score	Mode of surgery (1 = elective, 4 = emergency with resuscitation, 8-emergency without resuscitation)
1	60	M	33	19	95.20%	57.20%	4
2	24	M	32	19	94.4%	54%	8
3	65	F	29	27	97.90%	74.10%	8
4	65	M	43	19	99%	83.10%	4
5	60	M	40	19	98.4%	76.9%	4
6	45	M	35	19	96.4%	63.4%	4
7	72	F	30	14	82.4%	28.9%	4
8	65	M	44	21	99.2%	85.6%	4
9	42	M	34	20	96.5%	64.10%	4
10	66	F	41	20	98.80%	81.60%	4
11	71	F	27	18	86.20%	34.30	8
12	54	F	16	10	19%	3.4%	1
13	55	M	30	19	92.4%	47.5%	4

Table 8. Comparison of expected and observed mortality using POSSUM mortality equation.

Range of risk (%)	No .of patients	Mean risk %	Expected mortality	Observed mortality	O:E ratio	χ^2-value	p-value
<10%	49	4.4	2.17	1	0.5	0.63	0.427
10-20%	16	15.1	2.42	0	0.00	NA	NA
20-30%	11	24.7	2.72	1	0.4	1.09	0.296
30-40%	3	32.8	0.98	1	1.0	0.002	0.988
40-50%	4	45.3	1.81	1	0.6	0.36	0.549
50-60%	6	55.3	3.31	2	0.6	0.52	0.471
60-70%	4	63.8	2.55	2	0.8	0.12	0.729
70-80%	4	75.3	3.01	2	0.7	0.34	0.559
80-90%	3	83.4	2.50	3	1.2	0.10	0.751
>90%	None	None	NA	NA	NA	NA	
Total	100	21.5	21.47	13	0.61	3.32	0.670

Table 9. Comparison of expected and observed morbidity using POSSUM morbidity equation.

Range of risk %	No.of patients	Mean risk	Expected morbidity	Observed morbidity	O:E ratio	χ^2-value	
</=20%	26	13.9	3.6	4	1.1	0.04	0.841
20-40%	15	29.2	4.4	5	1.1	0.09	0.764
40-60%	15	47.5	7.1	8	1.1	0.11	0.740
60-80%	17	70.4	12.0	12	1.0	0.0001	0.992
80-100%	27	93.0	25.1	25	1.0	0.0004	0.984
Total	100	52.2	52.2	54	1.03	0.06	0.806

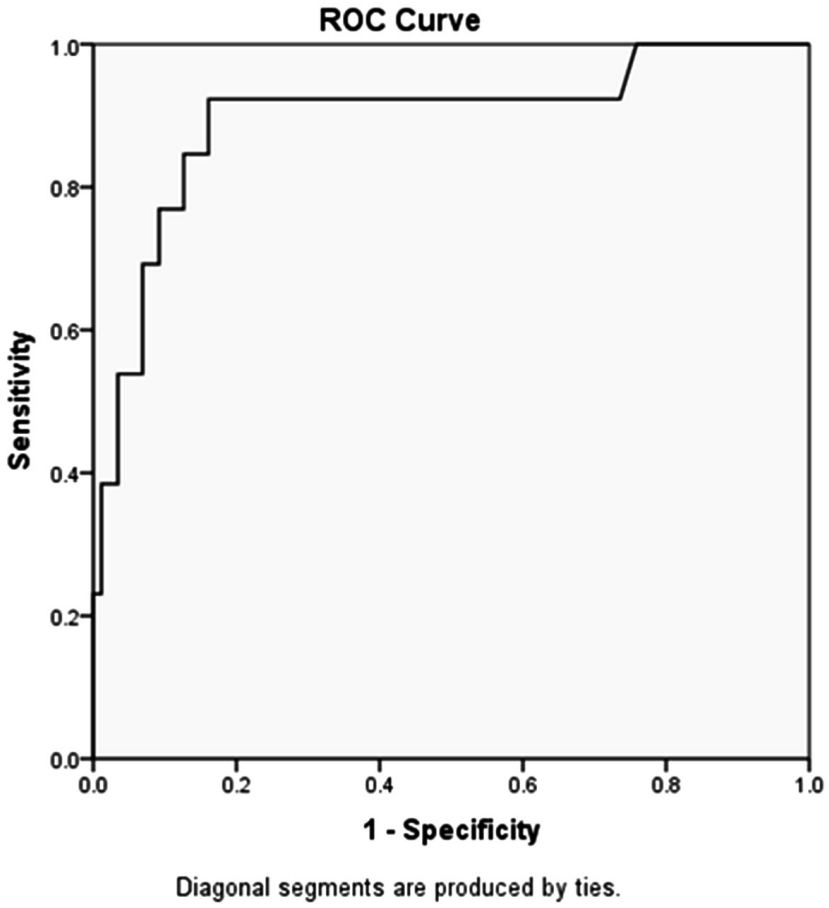

Figure 1. ROC curve for predicting Mortality by Possum score.

Area Under the Curve				
Test Result Variable(s): POSSUMMORTALITYSCORE				
Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.896	.056	.000	.787	1.000

DISCUSSION

The target of any surgical procedure is to decrease the morbidity and mortality associated with it. The patient's physiological status, the disease that requires operative intervention, severity of disease, the type of operation and the perioperative services have a major role on the patient's outcome.

POSSUM (Physiological and operative severity score for the enumeration of mortality and morbidity) was first described by Copeland et al.,[2] in 1991 as a method for normalizing patient data so that direct comparisons of patient outcome could be made despite differing patterns of referral and population.

In the current study POSSUM was studied in 100 patients, 56% males and 44% females. In this study, 57 patients underwent emergency laparotomy with or without resuscitation and 43 patients underwent elective laparotomy. The mean age of the patient was 49.04+/-18.931 years.

In a similar study by Manoharan et al.,[8] out of 154 patients studied, 60.39% patients were males and 39.61% were females, 57.8% patients underwent emergency laparotomy and 42.2% underwent elective laparotomy.

Similarly in a study by Uddin et al.[9] out of 120 patients studied 52.5% were males,47.5 were females,75% patients underwent elective procedures and 25% patients underwent emergency procedures.

In another study done by Ngulube et al.,[12] out of 181 study participants 68% were males and 32% females. The mean age was 48+/- 17.7 years. Emergency surgery was done in 65% patients and elective surgery in 35% patients.

The common surgeries performed in the present study were appendicular perforation, small bowel perforation in 30% cases, small and large bowel obstruction in 15% cases, CBD stone/stricture (14%), GI tract malignancy and carcinoma gallbladder in 10% cases. In the study conducted by Ngulube et al.,[12] the top 4 indications for surgery were peritonitis from appendiceal rupture or visceral perforation (26%), Sigmoid Volvulus (11%), Colorectal tumours (8.8%) and Small Bowel Obstruction (8.3%).

The overall morbidity seen in the present study was 54% among which the common morbiditeies were wound infection (superficial and deep), chest infection and impaired renal function in 39%, 21% and 18% cases respectively. In a similar study done by Ngulube et al.,[10] morbidity was seen in 54% cases, the frequent complications were septic shock and superficial surgical site infection at 24.6% each followed by renal failure at 13.1% of all complications. Similarly in the study of Manoharan et al.,[8] the common complications seen were wound infection (both superficial and deep) in 14.28% and chest related morbidities in 13.63% cases. In another study by Arigela et al.,[11] common complications seen were hypotension 40%,wound infection 32.3%, impaired renal function 26.1% and chest infection in 18.4% cases.

Among the various POSSUM factors, significant respiratory history, Blood Pressure, Pulse rate, GCS, WBC count, urea, ECG, peritoneal soiling and mode of surgery were found to be statistically significant in predicting mortality with p-value <0.05. Chatterjee et al.,[12] in a similar study found significant respiratory history, Blood Pressure, GCS, Na+, K+, multiple procedures, total blood loss, malignancy and mode of surgery to be statistically significant in predicting mortality with p-value <0.05

In the present study the overall mortality was seen in 13/100 patients (13%). Majority of the

death were in emergency surgeries and sepsis was the common cause of death. In similar studies conducted by Manoharan et al.,[8] Uddin et al.,[9] Ngulube et al.,[10] and Elias et al.,[13] the overall mortality was 3.35%, 6.67%, 19.3%, and 22.4% respectively. In these studies also majority of death were seen in emergeny surgeries and most common cause of death was sepsis.

The Possum predicted morbidity calculated by linear regression analysisi in current study was 52.2% and observed morbidity was 54%. So the O:E morbidity ratio was 1.03.This finding was not statistically significant ($\chi2$= 0.06, p = 0.806). In the study by Uddin et al.,[9] O/E ratio was 1.18 and the difference in predicted risk of morbidity by POSSUM equation and observed morbidity; calculated by chi square test($\chi2$ =1.36, p=0.24,) was not statistically significant. In another study by Chatterjee et al.,[12] an observed to expected ratio of 1.001 for morbidity was found and there was no statistically significant difference between the observed and expected morbidity rates ($\chi2$ = 2.40, p = 0.792). Similarly in the study of Ngulube et al.,[10] using the POSSUM morbidity score, the observed versus expected (O: E) ratio of 0.88 was found with statistically no significant difference (p=0.970).

In a study by Sreeharsha et al.,[14] using POSSUM morbidity score, the observed to predicted ratio (O:E) 1.19 was obtained. There was no statistically significant difference between the observed and predicted morbidity rates ($\chi2$=1.594, p=0.991).

The POSSUM predicted mortality calculated by linear regression analysis in current study was 21.47% and observed mortality was 13%. The O:E mortality was 0.61 and there was no statistical significant difference between POSSUM predicted mortality and observed mortality ($\chi2$ =3.32, p=0.67).On calculating the ROC curve for POSSUM predicted mortality the area under curve was 0.896 showing that possum is a good predictor of mortality. In the study of Elias et al.,[13] the ratio between the observed and the POSSUM predicted rates of death (O: E) was 0.77 and area under ROC curve was 0.762 showing POSSUM a good predictor of death. In another study by Chatterjee et al,[12] an observed to expected ratio of 1.005 for mortaliy was found and there was no statistically significant difference between the observed and expected morbidity rates ($\chi2$= 3.54, p = 0.316). In a study by Uddin et al.,[9] ROC analyses showed POSSUM score to be good predictors mortality with area under the curve values (AUC) of 0.887.

In a study by Sreeharsha et al.,[14] the ratio between POSSUM predicted death and observed death (O: E ratio) of 0.71 was obtained. There was no statistically significant difference between the observed and predicted mortality rates ($\chi2$=1.72, p=0.974).

The sensitivity and specificity of POSSUM for predicting mortality as calculated through ROC curve in the current study was 92.30 and 83.90. Batra Pet al.,[15] reported a sensitivity of 100% and specificity of 72.29% while Elias et al.,[15] in his study found a sensitivity of 72.3% and specificity of 69.0%.

CONSLUCIONS

From this study we can say that POSSUM score is a reliable mathematical tool in predicting mortality and morbidity in our population were the patient presentation is late and there is frequent conflict between health care seekers and health care providers regarding negative outcome of patients care.

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