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Comparison of Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity (POSSUM) and its Portsmouth Modification (P-POSSUM) as a tool for prediction of mortality and morbidity in patients undergoing emergency laparotomy

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Abstract

Introduction

In the recent era, patient's surgical outcome has been used as an indicator of patient's quality of care. A number of scoring systems have been developed to predict the risk of peri-operative morbidity and mortality. Aim of this study was to access and compare POSSUM (Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity) and its Portsmouth modification (P-POSSUM) equation for predicting morbidity and mortality in patients undergoing emergency laprotomy.

Material And Methods

This prospective, observational study was conducted in SMS Hospital, Jaipur from March 2015 to May 2016. Patients, who underwent emergency laprotomy, were included. All patients were scored depending on their physiological parameters at the time of admission. An operative severity score was calculated based on intraoperative findings and final expected mortality and morbidity rate was calculated. This was compared with observed mortality and morbidity. Patients were followed up for 30 days following the surgery. The risk of morbidity and mortality was calculated using POSSUM and P- POSSUM equations.

Results

In this study, 75 patients (50%) developed complications and 19 patients (12.6%) expired (observed death). POSSUM equation for mortality estimated 37 deaths with linear method of analysis and 20 deaths with exponential method of analysis. P-POSSUM equation for mortality estimated 19 deaths with linear method of analysis and 20 deaths with exponential method of analysis.

Conclusion

Exponential method of analysis for POSSUM and linear method of analysis for P-POSSUM scoring system are valid in predicting death of patients undergoing emergency laprotomy.

Introduction

In the recent era, patient's surgical outcome has been used as an indicator of patient's quality of care. Risk adjusted analysis are crucial in order to allow comparison of outcomes between surgeons, hospitals and countries, which would affect the outcome of a surgical procedure. A number of scoring systems have been developed to predict the risk of peri-operative morbidity and mortality with varying degree of accuracy. [1, 2]

Probably the best known and the most widely used scoring system is the American Society of

Anesthesiologists Physical Status score (ASA-PS), but it does not describe individual patient risk and not includes operative factors. [2, 3]

To overcome these issues, Copeland et al. developed a risk adjusted POSSUM (Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity) scoring system. It is used as a method for normalizing patient's data so that direct comparison of patient outcome could be made despite varying pattern of referral and demographic characteristic. POSSUM scoring system accurately predicts 30 days mortality and morbidity. It is easy and rapid to use and widely applied both in the elective as well as in emergency surgeries. [4]

The original POSSUM equation over-predicted mortality in low risk patient and under-predicted it in elderly and emergency patients. In an effort to counteract the shortcoming of POSSUM, Whiteley et al, developed Portsmouth modification (P-POSSUM) which is incorporating the same variable and grading system, but a different equation, which provide a better fit to observed mortality rate, which is an important and objective measure of outcome. [5, 6]

Aim of this study was to access and compare POSSUM and its Portsmouth modification (P-POSSUM) equation for predicting morbidity and mortality in patients undergoing emergency laprotomy and try to analyses the cause for low outcome in high risk group.

Material And Methods

This hospital based validation analytic type of prospective, observational study was conducted in department of surgery, SMS Medical College and Hospital, Jaipur from March 2015 to May 2016. Patients, who underwent emergency laprotomy, were included with a sample size of 150. Patients younger than 12 years, trauma patients underwent laprotomy and patients who are self-discharged or transferred to other hospital after laprotomy without follow up were excluded.

All patients were scored depending on their physiological parameters at the time of admission. An operative severity score was calculated based on intraoperative findings recorded by the operating surgeon and final expected mortality and morbidity rate was calculated. This was compared with observed mortality and morbidity. Patients were followed up for 30 days following the surgical procedure. Informed written consent was taken and this study was approved by ethical committee of our hospital.

The risk of morbidity and mortality was calculated using following POSSUM and P- POSSUM equations.

POSSUM equation:

1) $\text{Log } R_1 / 1\text{-}R_1 = -7.04 + (0.13 \times PS) + (0.16 \times OSS)$
2) $\text{Log } R_2 / 1\text{-}R_2 = -5.91 + (0.16 \times PS) + (0.19 \times OSS)$

R_1 = Risk of Mortality R_2 = Risk of Morbidity

P- POSSUM equation for mortality:

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

R= Risk of Mortality, PS=Physiological score, OSS= Operative severity score

Postoperative morbidity and mortality in the hospital was recorded and statistical analysis was done.

Statistical analysis

The expected mortality and morbidity rate was obtained using linear and exponential regression analysis and the O: E ratio was calculated. Chi square test was applied to note any significant difference between the predicted death rate and actual outcome. P value < 0.05 was considered statistically significant.

Results

In present study, a total of 150 patients underwent emergency laprotomy during study period of one year. The mean age of patients was 34.74 years and majority of

patients were in age group of 30-40 years. Male to female ratio was 4.35:1 (122 males and 28 females).

The most common indication of emergency laprotomy was peptic perforation (36.7%) and least common was rectal perforation (0.6%). Overall mortality rate was 12.6% (19 patients). Gut gangrene (57.14%) was the most common cause of mortality followed by obstructed hernia (28.5%). (Table 1)

After emergency laprotomy, post-operative complications were observed during hospital stay and 30 days of follow-up. In this study, 75 patients (50%) developed complications and 19 patients (12.6%) expired. Wound site infection was the most common complication (30.6%). (Table 2)

In our study, 19 patients were expired (observed death). POSSUM equation for mortality with linear method of analysis estimated 37 deaths with O:E ratio of 0.52 (χ^2 =14.3, *df*=7, p=0.04). POSSUM score significantly over predicted death by linear analysis. Whereas number of deaths estimated when exponential method of analysis was used was 20 with O: E ratio of 0.95; there was no significant difference between observed and estimated values (χ^2=0.029, *df*=1, p=0.864). (Table 3 & 4)

P-POSSUM predicted mortality well in both linear as well in exponential method of analysis. By linear analysis method, it predict 19 deaths with O:E ratio of 1 (χ^2=5.03, *df*=6, p=0.539). When exponential method of analysis used, it predict 20 deaths, with an O:E of 0.95 (χ^2=0.029, *df*=1, p=0.864). There was no significant difference between observed and predicted deaths by both linear and exponential method. (Table 5 & 6)

POSSUM equation for morbidity with linear method of analysis estimated 103 patients with complications with O:E ratio of 0.72 (χ^2 = 18.61, d.f. 9, p = 0.02). POSSUM over predict morbidity by linear analysis. With exponential method of analysis it predicted 67 patients with complications with O:E ratio of 1.11 (χ^2 = 0.86, d.f. 1, p = 0.35) with no significant difference in observed and predicted morbidity.

Discussion

In recent era, where the patient's safety and proper management is of foremost important, hence it is necessary to assess the expected outcome of the performed procedure. Recognizing patients who are at high risk of mortality would prompt us to explain the prognosis to relatives and help us in the better management of patient. In a set up like ours, where the patients undergo emergency laprotomy for diverse etiologies, these patient's nutritional status, co morbid conditions, availability of limited resources, post-operative supportive care play important role in the quality of care of patients. An ideal scoring system should be applicable to both elective and emergency surgeries and that allow predicting both morbidity and mortality.

Scoring system such as POSSUM and P-POSSUM has been validated all around the globe and has been used successfully as a tool for surgical audit. The ratio of observed to predicted mortality and morbidity has been used as a performance indicator to compare different procedure, clinician and hospitals.

The POSSUM scoring system is based on 12 preoperative physiological factors and 6 operative factors. Each factor is scored with 4 graded score values which exponentially increasing from 1 to 8 (1, 2, 4, 8) dependent upon grading. The sum of individual scores was used to predict 30 days' postoperative morbidity and mortality after deriving equations from logistic regression analysis. [3, 4] The physiological variables are those apparent at the time of surgery and include age, cardiac history, respiratory

history, blood pressure, pulse rate, Glasgow coma score, hemoglobin level, white cell count, urea concentration, Na^+ level, K^+ level and electrocardiography. The operative variables include operative severity, multiple procedures, total blood loss, peritoneal contamination, presence of malignancy and timing of surgery. Highest score being given to the most deranged values.

The POSSUM mortality equation was found to over predict deaths. This over prediction was greatest amongst low risk patients. To counteract this shortcoming of POSSUM, Whiteley et al[5], devised the Portsmouth predictor equation for mortality (P-POSSUM), which incorporates the same variable as POSSUM, but uses a different calculation formula, which provides a better fit to the observed mortality rate. P-POSSUM use linear analysis while POSSUM uses exponential analysis. [7]

Yadav K et al[8] studied the evaluation of POSSUM and P-POSSUM as a tool for prediction of surgical outcomes in the Indian population. They concluded that POSSUM and P-POSSUM to be good and valid indices for use in risk prediction of mortality and morbidity respectively in Indian population. Also they are better predictors in high risk groups than in low risk groups.

Kumar S [9] compared POSSUM and P-POSSUM in 172 cases over period of two years and found out that POSSUM over predicted mortality and morbidity by linear and exponential analysis.

In our study, the observed mortality was 12.6%, which is in close resemblance to average mortality in various studies (6%-19%). (6, 8) The low mortality rates may be attributed to low symptom – operation interval and to the fact that maximum number of patients was of upper gastrointestinal perforation with relatively low mortality rates.

In this study, POSSUM equation clearly over predicted mortality (O:E ratio of 0.52) when linear method of analysis was used, but the mortality calculated by exponential method of analysis was similar to the actual rate (O: E ratio of 0.95). It implies that if incorrect method of analysis is used, it gives false reports. The P-POSSUM equation predicted similar mortality rates (O:E ratio of 1) when correct linear method of analysis was used, but to the contrary it also predicted similar deaths (O: E ratio of 0.95) when exponential method of analysis was used which can be explained because of small sample size. Our results show that, when correct method of analysis is used the scoring systems are valid in this group of patients in our hospital setup.

Kumar P et al [10] compared POSSUM and P-POSSUM for risk adjusted audit of 82 patients undergoing emergency laprotomy. The observed mortality was 9 and predicted death by POSSUM and P-POSSUM were 17 and 9 respectively. They concluded that P-POSSUM is a better equation than POSSUM in predicting mortality, and exponential method is better than linear method.

In the study of Thirunavukkarasu S et al [11] , 50 patients were underwent emergency laprotomy. Five patients (10%) were expired and 29 patients (58%) experienced some form of morbidity. The P-POSSUM score was found to be an accurate predictor of mortality (p-value 0.997), but the POSSUM score was not found to be an accurate predictor of morbidity (p-value 0.0403), proving not to be as accurate, because post-operative factors playing a major role in morbidity determination.

Vishwani A et al [13] studied the efficacy of the POSSUM in predicting morbidity and mortality in 89 patients of peritonitis undergoing laprotomy and found out that the POSSUM score is reasonably good predictor of mortality

(O:E = 0.6) and morbidity (O:E = 0.7) using exponential and linear analysis respectively.

In our study, the POSSUM equation for morbidity over predicted complications (O:E ratio of 0.72) by linear method of analysis and near similar number of complications occurred (O:E ratio of 1.1), when exponential method of analysis was used.

The present study shows morbidity of 50%, which is comparable to study of Vishwani A et al[13] (48.3%) and Kumar S et al[9] (50%). Surgical site wound infection was most frequent complication in our patients (30.6%), followed by chest infection, urinary infection, wound dehiscence, septicemia, deranged renal function and anastomotic leak. These complications can be occur due to gross peritoneal contamination, raised diaphragm, upper abdominal incisions, depressed immune function and presence of co-morbid conditions like anemia, diabetes, hypoproteinemia and chronic obstructive airway disease. [14]

On analysis of risk factors, we found positive rate of increment with all risk factors studied. Various factors like decrease in immunity resulting from malignancy, ischemia and impaired hemostasis resulting from blood loss, uremia resulting in decrease healing rates, impaired immunity, leukocytosis correlating with degree of inflammation, toxemia, hyponatremia resulting in impaired physiological response could be attributed to the effect of these factors on postoperative mortality rates.

Therefore adequate and prompt correction can definitely be expected to cause a decrease in adverse outcome rates.

Conclusion

Exponential method of analysis for POSSUM and linear method of analysis for P-POSSUM scoring system are valid in predicting death of patients undergoing emergency laprotomy in a set up like ours. POSSUM equation of morbidity, estimated complications comparable to observed rates when exponential method of analysis is used. If this finding is validated on the larger data set it may be possible to use POSSUM scoring system to improve the emergency services.

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Table 1: Indications for Emergency Laprotomy (On Basis of Final Diagnosis)

Diagnosis (n=150)	Number of cases n (%)	Mortality n (%)
Peptic Perforation	55 (36.7%)	6 (10.9%)
Small intestine Perforation	33 (22%)	4 (12.1%)
Intestinal obstruction	21 (14%)	2 (9.5%)
Appendicular pathology	14 (9.3%)	0 (0%)
Obstructed hernia (incisional/inguinal/diaphragmatic)	7 (4.7%)	2 (28.5%)
Gut gangrene	7 (4.7%)	4 (57.14%)
Ceacal perforation	6 (4%)	0 (0%)
Ruptured liver abscess	4 (2.7%)	0 (0%)
Jejunal perforation	2 (1.3%)	1 (50%)
Rectal perforation	1 (0.6%)	0 (0%)

Table 2: Post-operative complications

Complications	Number of patients (n) (%)
Wound infection/SSI	46 (30.6%)
Chest Infection	38 (25.3%)
Pyrexia of unknown origin (PUO)	29 (19.3%)
Urinary tract infection (UTI)	26 (17.3%)
Hypotension requiring inotrope supports	26 (17.3%)
Superficial wound dehiscence	23 (15.3%)
Septicemia	17 (11.3%)
Respiratory failure requiring ventilator	15 (10%)
Impaired renal function	12 (8%)
Anastomotic leak	9 (6%)
Deep wound dehiscence	7 (4.6%)
Hemorrhage-wound/deep	4 (2.6%)
Deep infection/abscess formation	3 (2%)
Cardiac Failure	2 (1.3%)
DVT	1 (0.6%)

Table 3: Linear Analysis For Possum

Mortality group (%)	Number of patients (n=150)	Actual deaths (n=19)	Predicted* (n=37)	O:E (0.52)
< 10	32	0	2	0.00
10-19	43	2	6	0.33
20-29	32	1	8	0.12
30-39	7	1	2	0.50
40-49	19	5	9	0.55
50-59	7	3	4	0.75
60-69	8	5	5	1.00
70-79	2	2	1	2.00
80-89	0	0	0	0.00
> 90	0	0	0	0.00

$\chi^2 = 14.3$, $df = 7$, $p = 0.04$, * rounded to nearest value

Table 4: Exponential Analysis For Possum

Mortality group (%)	Number of patients (n=150)	Actual deaths (n=19)	Predicted* (n=20)	O:E (0.95)
0-39	114	4	6	0.66
10-39	82	4	8	0.50
20-39	7	1	2	0.50
40-100	36	15	14	1.07
50-100	17	10	9	1.11
60-100	10	7	6	1.16
70-100	2	2	1	2.00
80-100	0	0	0	0.00
90-100	0	0	0	0.00

χ^2 = 0.029, *df*= 1, p = 0.864, * rounded to nearest value

Table 5: Linear Analysis For P-Possum

Mortality group (%)	Number of patients (n=150)	Actual deaths (n=19)	Predicted* (n=19)	O:E (1.00)
< 10	94	4	5	0.8
10-19	24	3	4	0.75
20-29	18	5	4	1.25
30-39	9	5	3	1.66
40-49	2	0	1	0.00
50-59	1	0	1	0.00
60-69	2	2	1	2.00
70-79	0	0	0	0.00
80-89	0	0	0	0.00
> 90	0	0	0	0.00

χ^2 = 5.03, *df* = 6, p = 0.539, * rounded to nearest value

Table 6: Exponential Analysis For P-Possum

Mortality group (%)	Number of patients (n=150)	Actual deaths (n=19)	Predicted* (n=20)	O:E (0.95)
0-9	118	7	12	0.58
10-19	24	3	2	1.50
20-49	29	10	6	1.66
30-49	11	5	3	1.66
40-49	1	0	1	0.00
50-100	3	2	2	1.00
60-100	2	2	1	2.00
70-100	0	0	0	0.00
80-100	0	0	0	0.00
90-100	0	0	0	0.00

χ^2 = 0.029, df = 1, p = 0.864, * rounded to nearest value.