Comparison of POSSUM and P-POSSUM for risk-adjusted audit of patients undergoing emergency laparotomy

Acil laparotomi uygulanan hastaların riske dayalı denetimi ile ilgili olarak POSSUM ve P-POSSUM skorlama sisteminin karşılaştırılması

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BACKGROUND

The Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity (POSSUM) scoring system, derived from a heterogeneous population, has been used successfully as an audit tool, but it has appeared to over-predict mortality in low-risk groups for which an alternative system, the Portsmouth predictor equation for mortality (P-POSSUM) was designed and used successfully. In this prospective study, we compared these two equations in predicting death and tested their validity in predicting morbidity and mortality in patients undergoing emergency laparotomy in a tertiary hospital.

METHODS

Eighty-two patients who underwent emergency laparotomy were included in this study. Actual morbidity and mortality rates were compared with the predicted mortality and morbidity rates using both POSSUM and P-POSSUM equations by linear regression and exponential methods of analysis.

RESULTS

POSSUM equation significantly over-predicted both morbidity and mortality when linear regression analysis was used, but predicted well when exponential analysis was used. Prediction of mortality by P-POSSUM was good using both linear and exponential analyses, and exponential method was better than linear regression analysis.

CONCLUSION

P-POSSUM is a better equation than POSSUM in predicting mortality, and exponential method is better than linear regression analysis. Both equations are useful tools for risk-adjusted surgical audit of patients undergoing emergency laparotomy.

Key Words: Audit; emergency; laparotomy; morbidity; mortality.

AMAÇ

Heterojen nüfustan elde edilen POSSUM (The Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity) skorlama sistemi, bir denetim gereci olarak başarıyla kullanılmış ancak düşük risk gruplarında, mortaliteyi olduğundan daha fazla öngörür gibi görünmüş ve bu nedenle de bu grup hastalar için alternatif olan P-POSSUM (Portsmouth predictor equation for mortality) skorlama sistemi tasarlanarak başarıyla kullanılmıştır. Bu prospektif çalışmada, üçüncü basamak bir hastanede acil laparotomi uygulanan hastalarda bu iki denklem, ölümü öngörmede karşılaştırıldı ve bunların morbidite ile mortaliteyi öngörme geçerliliği test edildi.

GEREÇ VE YÖNTEM

Bu çalışmaya acil laparotomi uygulanan 82 hasta kaydedildi. Gerçek morbidite ve mortalite oranları, lineer regresyon ve eksponansiyel analiz yöntemleri yoluyla POSSUM ve P-POSSUM denklemleri kullanılarak, öngörülen mortalite ve morbidite oranları ile karşılaştırıldı.

BULGULAR

POSSUM denklemi lineer regresyon analizi kullanıldığında mortalite ve morbidite oranını anlamlı şekilde olduğundan fazla öngördüyse de eksponansiyel analiz yöntemi kullanıldığında başarılı bir şekilde öngördü. P-POSSUM ile mortalitenin öngörülmesi, lineer regresyon ve eksponansiyel analiz yöntemi kullanıldığında iyi sonuç verdi; bununla beraber eksponansiyel analiz yöntemi lineer regresyon analizinden daha iyi sonuç verdi.

SONUÇ

P-POSSUM skorlama sistemi mortaliteyi öngörmede POSSUM skorlama sisteminden daha iyi sonuç vermektedir; eksponansiyel yöntem ise lineer regresyon analizinden daha iyidir. Her iki denklem de acil laparotomi uygulanan hastaların riske dayalı cerrahi denetimi bakımından yararlı gereçlerdir.

Anahtar Sözcükler: Denetim; acil; laparotomi; morbidite; mortalite.

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Surgical audit is not a new phenomenon. As early as 1750 BC, King Hammurabi of Babylon issued decrees for the punishment of negligent physicians, particularly surgeons.[1] The outcome of surgical intervention, whether death or uncomplicated survival, complications or long-term morbidity, is not solely dependent on the abilities of the surgeon in isolation. The patients' physiological status, the disease that requires surgical correction, the nature of the operation, and the preoperative and postoperative support services have a major effect on the ultimate outcome.[1] Crude morbidity and mortality rates are limited indicators of quality of care and can be misleading when results of emergency surgery are compared between different units and hospitals.[2-6]

The Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity[7] (POSSUM) scoring system was developed to overcome the problems of different case mix between units and has been shown to be a good predictor of morbidity and death in general, vascular and colorectal surgery.[2-4] Recent reports have cited the tendency of POSSUM to over-predict death in fit patients undergoing surgery.[8-10] In an effort to counteract the perceived shortcomings of conventional POSSUM, Whiteley et al.[10] designed a new version of POSSUM, still in the trial phase, called the Portsmouth predictor equation for mortality (P-POSSUM). The variables used in both equations are the same (12 physiological and 6 operative criteria) but the formulae used are different, as described by Copeland et al.[7] and Whiteley et al.[10]

The aim of the present study was to examine the value of POSSUM and P-POSSUM equations in predicting the mortality and morbidity in patients undergoing emergency laparotomy in a tertiary care center in a developing country and also to compare the POSSUM and P-POSSUM for risk-adjusted audit in patients undergoing emergency laparotomy.

MATERIALS AND METHODS

This prospective study included 82 patients who underwent emergency laparotomy in our hospital over a period of two years. A form was prepared and all physiological data were recorded on admission; operative findings were recorded based on the surgeons' operative notes or personal communication as and when required. Postoperative morbidity or death within 30 days of surgery were recorded as per the definitions described by Copeland et al.[7] The data was entered in Microsoft Excel (Microsoft Corporation, Redmond, Washington, USA) for analysis. POSSUM and P-POSSUM equations were used to calculate the risk of morbidity and mortality.

The data was analyzed using both exponential and linear regression analysis as described by Wijesinghe et al.[11] The ratio of observed and expected values (O:E ratio) was calculated for each analysis. A χ^2 test was used to detect any differences in expected and observed values of mortality and morbidity. Values of $p<0.05$ were accepted as significant.

RESULTS

Out of the 82 patients included in the study, 57 were males and 25 were females. The study included patients of varying ages (range: 17 to 82 years). The operative severity score was major in all cases except two, in whom it was major +. Of the 82 patients, 9 (9.1%) underwent two procedures. Fifty-nine patients had peritoneal soiling. Eight patients (9.75%) died within 30 days of surgery and 29 had significant complications (35.36%).

POSSUM: The number of deaths predicted by POSSUM when done by linear analysis was 17 and there were 9 observed deaths. The O:E ratio was 0.47 and it significantly over-predicted death (χ^2=17.5, 9 degree of freedom (df), p=0.01), as shown in Table 1, whereas the number of deaths predicted when exponential analysis was used was 12, as shown in Table 2, with an O:E ratio of 0.67; there was no significant difference between the observed and predicted values (χ^2=10.4, 9 df, p=0.14).

When linear analysis was used to predict the morbidity, the O:E ratio was 0.61 and it significantly over-predicted morbidity (χ^2=11.48, 9 df, p=0.025), as shown in Table 3, but when the same data was used in exponential analysis, the O:E ratio was 0.78, as shown in Table 4. There was no significant difference between the observed and predicted values (χ^2=11.27, 9 df, p=0.27).

P-POSSUM: P-POSSUM predicted mortality well when the linear method was used as shown in Table 5, with an O:E ratio of 0.73, and there was no significant difference between the observed and predicted values (χ^2=2.4, 9 df, p=0.82). The prediction improved when exponential analysis was used, as shown in Table 6, with an O:E ratio of 0.88, and there was no significant difference between observed and predicted deaths (χ^2=2, 9 df, p=0.95).

DISCUSSION

Surgical audit has increased in importance over the past few years, both as an educational process and as a means of assessing and improving the quality of surgical care.[7] Recognizing patients who are at risk of developing complication will contribute substantially to the better management of the patients and resource utilization. A scoring system would seem to be the best method available for assessing the risk of mortality and morbidity. In the past, various scoring systems such as ASA and APACHE II have been used to predict both mortality and morbidity in surgical patients. These existing scoring systems are either too simple or too complex and do not completely meet the expectation as being readily applicable to audit. POSSUM and P-POS-

Table 1. Comparison of observed and predicted mortality values by POSSUM using linear analysis

Predicted mortality rate (%)	No. of patients	Predicted no. of deaths*	Observed no. of deaths	O:E Ratio
0-10	16	1	0	0.
11-20	22	2	0	0.
21-30	8	1	0	0
31-40	8	1	0	0
41-50	12	2	0	0
51-60	4	1	1	1.00
61-70	6	2	3	1.50
71-80	4	2	2	1.00
81-90	4	2	2	1.00
91-100	0	0	0	0
0-100	**82**	**17**	**8**	**0.47**

* Rounded off to nearest whole number; O:E: Observed:expected.

Table 2. Comparison of observed and predicted mortality values by POSSUM using exponential analysis

Predicted mortality rate (%)	No. of patients	Predicted no. of deaths*	Observed no. of deaths	O:E Ratio
0-29	46	5	0	0
10-29	30	3	0	0.
20-29	8	1	0	0
30-100	36	10	8	0.8
40-100	28	8	8	1.00
50-100	16	8	8	1.00
60-100	14	7	7	1.00
70-100	8	6	4	0.67
80-100	4	3	2	0.67
90-100	0	0	0	0
0-100	**82**	**12**	**8**	**0.67**

* Rounded off to nearest whole number; O:E: Observed:expected.

Table 3. Comparison of observed and predicted morbidity values by POSSUM using linear analysis

Predicted morbidity rate (%)	No. of patients	Predicted no. of deaths*	Observed no. of deaths	O:E Ratio
0-10	0	0	0	0.
11-20	0	0	0	0.
21-30	4	1	0	0
31-40	8	2	0	0
41-50	6	2	0	0
51-60	8	4	2	0.5
61-70	4	2	0	0
71-80	10	5	3	0.6
81-90	16	12	10	0.83
91-100	26	22	14	0.63
0-100	**82**	**48**	**29**	**0.60**

* Rounded off to nearest whole number; O:E: Observed:expected.

Table 4. Comparison of observed and predicted morbidity values by POSSUM using exponential analysis

Predicted morbidity rate (%)	No. of patients	Predicted no. of deaths*	Observed no. of deaths	O:E Ratio
0-29	4	1	0	0
10-29	4	1	0	0.
20-29	4	1	0	0
30-69	26	6	2	0.33
40-69	18	4	2	0.5
50-69	12	4	2	0.5
60-69	4	2	0	0
70-100	52	30	27	0.9
80-100	42	28	24	0.86
90-100	26	20	14	0.7
0-100	**82**	**37**	**29**	**0.78**

* Rounded off to nearest whole number; O:E: Observed:expected.

Table 5. Comparison of observed and predicted mortality values by P-POSSUM using linear analysis

Predicted mortality rate (%)	No. of patients	Predicted no. of deaths*	Observed no. of deaths	O:E Ratio
0-10	46	2	2	1.00
10-20	20	2	1	1.00.
20-30	6	1	1	1.00
30-40	6	2	2	1.00
40-50	1	1	1	0
50-60	1	1	1	1.00
60-70	1	1	0	0
70-80	1	1	0	0
80-90	0	0	0	0
90-100	0	0	0	0
0-100	**82**	**11**	**8**	**0.73**

* Rounded off to nearest whole number; O-E: Observed:expected.

Table 6. Comparison of observed and predicted mortality values by P-POSSUM using exponential analysis

Predicted mortality rate (%)	No. of patients	Predicted no. of deaths*	Observed no. of deaths	O:E Ratio
0-29	72	4	4	1.00
10-29	26	2	2	1.00.
20-29	6	1	1	1.00
30-69	9	4	4	1.00
40-69	3	2	2	1.00
50-69	2	1	1	0
60-69	1	0	0	1.00
70-100	1	1	0	0
80-100	0	0	0	0
90-100	0	0	0	0
0-100	**82**	**9**	**8**	**0.88**

* Rounded off to nearest whole number; O:E: Observed:expected.

SUM scoring systems have been proven useful for comparative audit and have been validated in numerous studies.[1,2,7,12]

POSSUM has generally over-predicted mortality and morbidity significantly when linear method of analysis was used, and though over-prediction of mortality and morbidity was insignificant with exponential method of analysis, the O:E ratio was low and was comparable with other studies.[2,3,7,8,10,12-17] POSSUM generally over-predicts mortality, as in this study, particularly in lower-risk groups. Over-prediction results in most surgeons' appearing to perform favorably. In addition to POSSUM giving the impression of favorable performance, it may also fail to identify poor performance.

P-POSSUM was developed to avoid this over-prediction in low-risk groups and it proved to be a better predictor of mortality than POSSUM. Though a few studies have showed that when exponential method of analysis was used in P-POSSUM, the results were not good, in our study, exponential method of prediction was determined better than linear method of analysis. The present study results were comparable to the study done by Mohil et al.[18] in a referral hospital in a developing country in patients undergoing emergency laparotomies.

In this present study, we observed that POSSUM equation predicted mortality and morbidity well when exponential method was used and P-POSSUM equation demonstrated even better prediction when both exponential and linear methods of analysis were used. When linear method of analysis for mortality and morbidity was calculated using POSSUM equation, it significantly over-predicted both. It was confirmed that using an incorrect method of analysis for POSSUM gives a spurious result.[1,12,18] The POSSUM and P-POSSUM data sets provide a good tool for monitoring the quality of care provided by a particular institution and it has been confirmed in our study and a study done by Mohil et al.[18] that they can be used for emergency laparotomies. The variables required are assessed routinely in all emergency laparotomies and the calculations are simple to perform.

To conclude, the POSSUM and P-POSSUM have been extensively used in the United Kingdom and it is confirmed that they can be used in patients attending referral hospitals in a developing country and for emergency laparotomies.[19] P-POSSUM was a better predictor of mortality than POSSUM and exponential method of analysis was better than linear method of analysis in both POSSUM and P-POSSUM equations.

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