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Comparison of Possum and P-Possum as Audit Tools in Patients Undergoing Emergency Laparotomy for Secondary Bacterial Peritonitis

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Abstract - Background : Though POSSUM and P-POSSUM have been proposed as accurate tools of audit, our initial experience has not been encouraging. Therefore, a prospective study was conducted to find their accuracy for predicting outcome in peritonitis patients who underwent emergency laparotomy.

Methods : 172 patients treated in single surgical unit over two years were included. Expected morbidity and mortality, computed by POSSUM and P-POSSUM equations using linear as well as exponential methods of analysis, were compared with observed outcome by observed: expected (O:E) ratios. X2-test was done to draw statistical significance; $P<0.050$ was taken as significant.

Results : POSSUM significantly over-predicted mortality with linear as well as exponential methods with O:E ratios being 0.32 ($X2=57.35$, 1 d.f. $P<0.001$) and 0.25 ($X2=111.26$, 1 d.f. $P<0.001$), respectively. P-POSSUM also significantly over-predicted mortality by linear as well as exponential methods with O:E ratios being 0.55 ($X2=11.37$, 1 d.f. $P<0.001$) and 0.27 ($X2=92.30$, 1 d.f. $P<0.001$), respectively. POSSUM significantly over-predicted morbidity by linear and exponential analysis with O:E being 0.76 ($X2=47.94$, 1 d.f. $P<0.001$) and 0.81 ($X2=23.27$, 1 d.f. $P<0.001$), respectively.

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Conclusions : Neither POSSUM nor P-POSSUM was found accurate for predicting the outcome by linear or exponential methods. Further studies are required to find their suitability for audit purposes in conditions prevailing in third world countries.

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I. Introduction

In most hospitals across the world, and especially in third world countries, surgical audit is done using crude morbidity and mortality figures. Such audits that are not based on risk-adjusted analysis have gross limitations and do not allow true assessment of quality of care. Clearly, such an exercise lacks educational punch by virtue of ignoring the problems of case-mix. The Physiological and Operative Severity Score for enUmeration of Mortality and morbidity (POSSUM) takes care of problems of case-mix and has been suggested as powerful tool of audit of general surgery patients.[1]

However, some studies suggested that conventional POSSUM may over-predict the mortality.[2-4]

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To counteract this problem the Portsmouth modification of POSSUM (P-POSSUM) was evolved,[4] and proved to be more accurate than POSSUM in predicting mortality.[3,4] One recent report from India found both of these to be reliable for predicting the outcome when correct methods of analysis were used.[5]

This prompted us to conduct a pilot study involving about 75 patients with perforation peritonitis wherein accuracy of both, POSSUM and P-POSSUM for predicting the postoperative outcome, was analysed. We found that neither POSSUM nor P-POSSUM were accurately predicting the outcome (unpublished data), even when the recommended statistical methods were used for analysis.[6]

Therefore, a larger study was undertaken to evaluate the value of POSSUM and P-POSSUM in predicting postoperative morbidity and mortality in patients with bowel perforation peritonitis in our set-up. Our working hypothesis was that neither equation, irrespective of the method of analysis, was accurate in predicting the postoperative outcome in our hands.

II. Patients And Methods

One hundred and seventy two consecutive adult patients, undergoing emergency laparotomy for non-traumatic bowel perforation peritonitis in one of the surgical units at Guru Teg Bahadur Hospital and University College of Medical Sciences were studied prospectively over two years. The physiological component of POSSUM data set was collected from parameters at admission before starting any kind of treatment intervention. The operative component was computed after laparotomy and revised if patient underwent re-laparotomy. Patients were treated as per their individual needs throughout their hospital stay. Previously given definitions[1] of postoperative complications were used while recording morbidity as yes or no. Mortality was also recorded as yes or no. Patients were *discharged* from the hospital only after satisfactory recovery. All discharged patients were followed up in surgical outpatient department for a minimum of three months for treating early postoperative complaints (mostly wound related) and recording death within this period if any. Expected mortality was calculated from POSSUM[1] and P-

POSSUM[4] equations using both linear as well as exponential methods as previously described.[6] Expected morbidity rates were calculated using POSSUM equation only as an equation of P-POSSUM for such purpose is still not available. The ratio of observed to predicted mortality and morbidity (O:E) were also calculated for each analysis separately. An O:E ratio above 1.0 indicates the risk is being under-estimated while an O:E ratio under 1.0 indicates the risk is being over-estimated.[6] Finally, X^2 test was used to find any difference between predicted and observed rates of morbidity and mortality. $P<0.050$ was accepted as significant.

III. Results

Indications for laparotomy are given in table 1. Mean (s.e.m.) age was 31.74 (2.42) and 138 (80%) were males. Mean (s.e.m.) length of hospital stay was 12.79 (0.98) days. One hundred and ninety four (194) episodes of postoperative complications were seen in 109 patients (table 2). Twenty-three patients died during the stay in the hospital. During follow-up in outpatient department there were no dropouts and deaths.

a) Mortality by POSSUM Equation

The results with linear and exponential methods of analysis are shown in table 3 and 4, respectively. Both methods significantly over-predicted the risk of death. The overall O:E ratio with linear analysis was 0.32 ($X^2=57.35$, 1 d.f, $P<0.001$). The overall O:E ratio with exponential analysis was 0.25 ($X^2=111.26$, 1 d.f, $P<0.001$).

b) Mortality by P-Possum Equation

The results of linear and exponential methods of analysis are shown in table 5 and 6, respectively. Both methods significantly over-predicted the risk of death. The overall O:E ration with linear analysis was 0.55 ($X^2=11.37$, 1 d.f, $P<0.001$). The overall O:E ratio with exponential analysis was 0.27 ($X^2=92.30$, 1 d.f, $P<0.001$).

c) Morbidity by linear and exponential analysis from POSSUM equation

These results are shown in table 7 and 8, respectively. Liner method significantly over-estimated the risk of morbidity, overall O:E being 0.76 ($X^2=47.94$, 1 d.f., $P<0.001$). Similarly, exponential analysis significantly over-predicted the risk of morbidity, with O:E being 0.81 ($X^2=23.27$, 1 d.f., $P<0.001$).

Table 9 gives the summary of above findings.

IV. Discussion

A number of risk-adjusted scoring systems have been developed to suit audit of specialty-based practices such as cardiovascular[7,8] and gastrointestinal[9-11] diseases and ICU-care.[12] One of the most widely used scoring system is APACHE II. Though ideal for intensive care patients, its application has been validated in general surgical patients also. However, some of its well known limitations namely, need for repeated measure of variables for 24 h, too many variables, failure to take into account operative aspects, need for weighing tables for individual disease states and failure to predict morbidity, do not make it a popular choice with surgeons. Therefore, to audit the quality of care across the general surgical spectrum a simple scoring system, POSSUM, was developed in 1991.[1] Following its development a number of trials proved its validity in general surgery set-up.[6,13-15] However, some authors subsequently reported that it over-predicted the outcome.[4,16] Therefore, P-POSSUM was evolved and a new equation was recommended.[4] This equation has also been modified since then for better prediction.[17]It was suggested that the over-estimation of the outcome by POSSUM is largely because of employment of linear method of analysis instead of exponential, much against the recommendations of Copeland et al.[6,18] This resulted in renewed interest in the use of POSSUM. A recent review heavily favors the use of POSSUM with proper analytical method but cautions against its use in patients with low-risk of mortality.[19]

Despite this general advocacy for use of POSSUM and P-POSSUM as the risk-scoring system for audit purpose sufficient evidence from tropical countries is lacking. This is desirable as the patients and treatment facilities in these countries tend to be quite different from those in developed countries. Patients here tend to present late, suffer from malnutrition and do not have access to world-class medical services. Our preliminary study involving 75 patients with perforation peritonitis suggested that neither POSSUM nor P-POSSUM were accurate in predicting the outcome (unpublished).

Subsequently, this larger study was undertaken. Predicted mortality rates were derived using equations of both scoring systems and linear as well as exponential methods of analysis. Since P-POSSUM equation has been not been proposed for deriving expected morbidity, it was used only for deriving expecting mortality.[4] Expected morbidity was derived using POSSUM equations with linear as well as exponential methods of analysis.

Our results show that POSSUM grossly over-predicted mortality by both linear as well as exponential method of analysis. P-POSSUM equitation also over-predicted mortality when analysed by either methods though linear analysis gave slightly better results than the other. POSSUM equation also over-predicted morbidity when analysed by either method though exponential analysis gave slightly better results than the linear method.

It is difficult to find the exact cause(s) of over-prediction in our study especially with availability of contrasting results of almost similar trial from another

government institution in Delhi.[5] Under-reporting of the in-hospital outcome and mortality beyond the period of the stay in hospital may be two important causes. However, we rule out under-reporting in our study as the consultant (SK) monitored the outcome on regular basis using strict suggested definitions. We also rule out any deaths beyond the period of stay in the hospital as we followed-up all discharged patients in outpatient department for three months postoperatively. This means that evidence is probably not sufficient to advocate the use of POSSUM or P-POSSUM in our kind of set-up. It is quite possible that a different regression equation is needed for predicting the outcome of the patients with life-threatening sepsis (such as secondary peritonitis) requiring emergency laparotomy. It is also possible that more variables are needed to generate a new 'usable' score as many a factors, known to have an impact on outcome,[4] have not been taken into account. Overall, the issue of suitability of either POSSUM or P-POSSUM in our kind of set-up requires further evidence by way of larger studies involving similar patients.

Thus, it can be summarized that both equations have not proved successful for accurate prediction of the outcome from perforation peritonitis in our hands. As suggested earlier, this may be because of many factors related to patients, treatment-practices or database. We feel that further studies are needed from third world countries addressing the suitability of either scoring system by standard analytical methods before employing the same freely for meaningful audit purposes.

Table 1 : Site of intestinal perforation (n=172)

Site of perforation	Number of patients (%)
Gastro duodenal	70 (40.6)
Jejunal	09 (5.2)
Ileal	79 (45.9)
Vermiform appendix	09 (5.2)
Colonic	05 (2.9)

Table 2 : Postoperative complications (seen in 109 patients; number of complications is larger than number of patients because some had multiple complications)

Complication	Number
Wound infection	80
Deep (intra-abdominal) infection	27
Anastomotic leak	23
Wound dehiscence	21
Chest infection	18
Septicemia	09
Others	16

Table 3 : Linear analysis of mortality predicted by POSSUM

Mortality group (%)	Patients (n)	Actual deaths (n)	Predicted deaths (n)	O:E ratio
<10	4	0	0	-
10-20	30	1	5	0.20
20-30	35	2	9	0.22
30-40	23	1	8	0.13
40-50	21	6	9	0.67
50-60	20	2	11	0.18
60-70	17	3	11	0.27
70-80	8	2	6	0.33
80-90	6	2	5	0.40
≥90	8	4	8	0.50
0-100	172	23	72	0.32

Table 4 : Exponential analysis of mortality predicted by POSSUM

Mortality group (%)	Patients (n)	Actual deaths (n)	Predicted deaths (n)	O:E ratio
0-10	4	0	0	0.00
0-100	172	23	86	0.27
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10-100	168	23	92	0.25
20-100	138	22	83	0.27
30-100	103	20	67	0.30
40-100	80	19	56	0.34
50-100	59	13	44	0.29
60-100	39	11	31	0.35
70-100	22	8	19	0.43
80-100	14	6	13	0.48
90-100	8	4	8	0.53
0-100	168+4=172	23+0=23	92+0=92	0.25

Table 5 : Linear analysis of mortality predicted by P-POSSUM

Mortality group (%)	Patients (n)	Actual deaths (n)	Predicted deaths (n)	O:E ratio
<10	60	2	3	0.67
10-20	35	4	5	0.80
20-30	29	5	7	0.71
30-40	14	1	5	0.20
40-50	11	2	5	0.40
50-60	6	3	3	1.00
60-70	3	0	2	0.00
70-80	4	1	3	0.33
80-90	7	3	6	0.50
≥90	3	2	3	0.67
0-100	172	23	42	0.55

Table 6 : Exponential analysis of mortality predicted by P-POSSUM

Mortality group (%)	Patients (n)	Actual deaths (n)	Predicted deaths (n)	O:E ratio
0-100	172	23	86	0.27
10-100	112	21	62	0.34
20-100	77	17	46	0.37
30-100	48	12	31	0.38
40-100	34	11	24	0.46
50-100	23	9	17	0.52
60-100	17	6	14	0.44
70-100	14	6	12	0.50
80-100	10	5	9	0.56
90-100	3	2	3	0.70
0-100	172	23	86	0.27

Table 7 : Linear analysis of morbidity predicted by POSSUM

Morbidity group (%)	Patients (n)	Actual morbidity (n)	Predicted morbidity (n)	O:E ratio
<10	0	0	0	-
10-20	0	0	0	-
20-30	1	0	0	0.00
30-40	2	0	1	0.00
40-50	2	1	1	1.00
50-60	5	1	3	0.33
60-70	16	8	10	0.80
70-80	33	17	25	0.68
80-90	37	21	31	0.68
≥90	76	61	72	0.85
0-100	172	109	143	0.76

Table 8 : Exponential analysis of morbidity predicted by POSSUM

Morbidity group (%)	Patients (n)	Actual morbidity (n)	Predicted morbidity (n)	O:E ratio
0-100	172	109	86	1.27
0-40	3	0	1	0.00
40-60	7	2	4	0.57
50-60	5	1	3	0.36
60-100	162	107	130	0.83
70-100	146	99	124	0.80
80-100	113	82	102	0.81
90-100	76	61	72	0.84
0-100	172	107+2=109	130+4+1=135	0.81

Table 9 : Summary findings of O:E ratios for mortality and morbidity

	POSSUM O:E ratio		P-POSSUM O:E ratio	
	Linear	Exponential	Linear	Exponential
Morbidity	0.76	0.81	-	-
Mortality	0.32	0.25	0.55	0.27

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