Risk-Adjusted Analysis of Patients Undergoing Laparotomy Using POSSUM and P-POSSUM Score in Queen Elizabeth Hospital, Sabah

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SUMMARY:

Background: **Scoring systems such as POSSUM and P-POSSUM have been developed to help predict mortality and morbidity in patients. The ratio of observed-to-predicted (O/P ratio) mortality and morbidity has been used as a performance indicator to compare different procedures, clinicians or hospitals. The aim of this study was to assess the predictive value of POSSUM compared with P-POSSUM in patients undergoing laparotomy in Queen Elizabeth Hospital, Sabah.**

Methods: **381 patients over the age of 12 undergoing general surgical laparotomy between 1 May 2006 and 30 April 2007 were prospectively enrolled.**

Results: **In general, POSSUM over-predicted mortality compared with P-POSSUM (O/P ratio: 0.366 versus 0.721). P-POSSUM was still poor at predicting mortality in the lowest and highest risk groups (O/P ratios: 0 and 0.438). Both systems over-predicted mortality in trauma (O/P ratios: POSSUM, 0.306; P-POSSUM, 0.459), younger patients (O/P ratios: POSSUM, 0.325; P-POSSUM, 0.622) and non-ICU patients (O/P ratios: POSSUM, 0.171; PPOSSUM, 0.421). P-POSSUM was significantly better than POSSUM in other age groups and ICU patients. In terms of morbidity, POSSUM was able to predict morbidity quite accurately with O/P ratio of 0.746 and performed equally well across the subgroup. POSSUM was poor in predicting morbidity in young patients (O/P ratio: 0.652) and non-ICU patients (O/P ratio: 0.543).**

Conclusion: **P--POSSUM is a better overall predictor of mortality in patients undergoing laparotomy in this hospital compared to POSSUM. POSSUM is fairly accurate in predicting morbidity. However, further refinement is needed to improve its predictive value in specific areas, and so increase its utility in our local setting.**

KEY WORDS:
POSSUM, P-POSSUM, laparotomy, morbidity, mortality.

INTRODUCTION:

Over the past few decades, patient outcome has been used as an indicator of patient quality of care, in both developed and developing countries.[1,5,6,10,11] Risk-adjusted analyses are crucial in order to allow comparison of outcomes between surgeons, hospitals, countries and case-mix, which could affect the outcome of a surgical procedure.[1,7]

POSSUM (Physiological and Operative Severity Score for the enumeration of Mortality and morbidity), which was developed in 1991, produced assessments for morbidity Paper (Excl title page, Incls Figs, Tables, Refs) here to download Full Paper (Excl title page, Incls Figs, Tables, Refs): MMJ.doc and mortality which did not significantly differ from observed rates.[1] The ratio of observed to predicted number of adverse outcomes (O/P ratio) has therefore been used to assess differences between surgeons, units, hospitals and countries.[7] A ratio of 1.00 would indicate average performance; greater than 1.00, worse than expected, and less than 1.00, better than expected.[7]

The original POSSUM equation over-predicted mortality in low risk patients and under-predicted it in elderly or emergency patients.[2,4,14] P-POSSUM (Portsmouth modification) was formulated to correct this.[2,9] The same variables were used but a different regression equation and constant was employed to calculate the mortality risk.[9] However, it has its own limitations, significantly under-predicting death in the elderly [13,15] as well as in emergencies.[14]

POSSUM has been found to accurately predict 30-day morbidity and mortality for a wide range of elective and emergency general surgical procedures, even though it cannot replace highly specific scoring systems for individual disease states.[1.6.7.9.10.11.12] However, when initially developed, POSSUM did not include patients undergoing surgery for trauma.[1.8]

Surgical patients often require intensive care unit (ICU) admission, and the unique characteristics of these patients have resulted in targeted systems to guide such admissions as well as predict outcome. Probably the best known and most widely used system is APACHE.[6,9] Unfortunately, its complexity and exclusion of operative factors renders APACHE less useful in the evaluation of surgical patients compared with POSSUM and PPOSSUM. [8.16.17]

Other scoring systems have also been shown to indirectly correlate with surgical outcome. For instance, post-operative mortality rises with ASA (American Society of Anesthesiologists) grade, but although simpler to use than APACHE, it again does not include operative factors other than emergent statues.[3]

The primary aim of this study was to assess the overall predictive value of POSSUM for morbidity and mortality compared with P-POSSUM in patients undergoing laparotomny

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in Queen Elizabeth Hospital (QEH), Sabah, a referral centre in a developing country. Secondary aims included evaluation of outcomes in ICU patients, emergent status and ASA grade.

MATERIALS AND METHODS:

All patients aged over 12 years undergoing elective or emergency general surgical laparotomy from 1st May 2006 to 30th April 2007 were prospectively included. Approval from the hospital director was obtained before starting this study in the absence of an ethics committee in this hospital. Data collected included demographics, surgical parameters and outcomes of patients.

Patients undergoing appendicectomy via Lanz incision, trephine defunctioning ostomies, feeding gastrostomies or mini-laparotomies were excluded. Laparoscopic procedures which were converted-to open laparotomy were included. Patients who self discharged or transferred to other hospitals after laparotomy without follow up in QEH were also excluded, as were trauma patients requiring multiple-compartment surgical intervention like additional thoracotomy or craniotomy.

The physiological components recorded were measured as close to the time of the planned laparotomy as possible. ASA grading was charted from anaesthetic notes. The operative severity component was completed after laparotomy, and any ICU admission documented. Patients were followed up for 30 days post-laparotomy to document morbidity and mortality. POSSUM and P-POSSUM score was calculated the predicted mortality and morbidity by using the regression equation respectively. Observed / Predicted (O/P ratio) for mortality and morbidity based on POSSUM and P-POSSUM was then obtained. P values were calculated and $p < 0.05$ were considered statistically significant using SPSS version 15.

RESULTS:

A total of 454 patients underwent laparotomy during the study period. Seventy three patients (16.1%) were excluded. Of the 381 patients who were eligible, 223 were male (58.5%) and 258 were female (41.5%). The median age was 50 years (range: 12-91). More than a third of patients (39.3%) developed one or more morbidity post-operatively (Table 1) with surgical site infection (SSI) being the commonest. Twenty six patients (6.8%) died postoperatively of various causes (Table 2).

Overall, P-POSSUM was a better scoring system compared to POSSUM. POSSUM generally over-predicted death almost three-fold (O/P ratio: 0.366). P-POSSUM was more predictive and stayed closer to observed mortality, but still over-predicted by a factor of 1.4 (O/P ratio: 0.721). In terms of morbidity, POSSUM in general over-predicted in all groups except in ICU admissions, where it showed good correlation (O/P ratio: 1.042) (Table 3 and 4).

Risk stratification did not improve the predictive value of POSSUM for mortality, but suggested greater predictive value for P-POSSUM in intermediate risk groups (Table 5).

Although P-POSSUM was a better predictor of mortality, POSSUM predicted morbidity fairly accurately in most of the categories studied. However, the difference in predicted and actual morbidity and mortality was only statistically significant for POSSUM in ICU patients, suggesting that both systems offer reasonable value for prognostication of patients undergoing laparotomy in this hospital.

Both POSSUM and P-POSSUM were poor predictors of mortality in trauma, despite increased crude mortality and morbidity rates in this group of patients (Tables 3 and 4).

Interestingly, while mortality for females was only slightly higher than males (8.2% and 5.8% respectively), the O/P ratio for females was twice that for males, whether POSSUM or P-POSSUM was used. This would suggest that these scoring systems are more accurate at predicting mortality in females, and that males tended to have a better than expected outcome, although this did not attain statistical significance.

The accuracy of the scoring system in predicting mortality and morbidity was increased with increasing age. ***(Male and female patients showed similar age distribution).***

Patients admitted for ICU care peri-operatively had a nine-times higher risk of death as compared to non ICU care, (19.2% as compared to 2.2% respectively) and 3 times higher likelihood of morbidity (79.8% and 24.2% respectively). However, outcomes were more accurately predicted in ICU patients than non-ICU patients; POSSUM with respect to mortality and morbidity, and P-POSSUM for mortality. This difference attained statistical significance with POSSUM.

Morbidity	Number of patients	Percentage (%)
Siperficial surgical site infection	90	23.6
Respiratory tract infection	54	14.2
Anastomotic leak	17	4.5
Septicaemia	11	2.9
Entero-cuatneous fistula	9	2.4
Respiratory failure	7	1.8
Atrial fibrillation	7	1.8
Deep surgical site infection	7	1.8
Impaired renal function	6	1.6
Deep vein thrombosis and pulmonary embolism	4	1.0
Burst abdomen	3	0.8
Intestinal obstruction	2	0.5
Acute coronary syndrome	2	0.5
Cardiac failure	1	0.3

Table 1: Post-operative morbidity.

Cause of death	Number of patients	Percentage (%)
Multi-organ dysfunction syndrome	5	19.2
Sepsis	5	19.2
Pulmonary embolism	5	19.2
Pneumonia	3	11.5
Trauma	3	11.5
Acute coronary syndrome	2	7.7
Advanced cancer	2	7.7
Aspiration pneumonitis	1	3.8
Total	26	100.0

Table 2: Causes of post-operative death.

	n mortality	Observed (Predicted)	POSSUM O/P ratio	POSSUM	P value	P-POSSUM (Predicted)	P-POSSUM O/P ratio	P value
Overall	381	6.824	18.656	0.366	0.949	9.470	0.721	0.477
Trauma	40	12.500	40.865	0.306	0.949	27.213	0.459	0.477
Non trauma	341	6.158	16.051	0.383		7.389	0.833	
Male	223	5.830	21.223	0.275	0.223	11.218	0.520	0.198
Female	158	8.228	15.033	0.547		7.003	1.175	
≤ 60 yrs	253	5.534	17.007	0.325	0.763	8.890	0.622	0.764
61 – 70 yrs	76	7.895	20.596	0.383		9.611	0.821	
> 70 yrs	52	11.538	23.842	0.484		12.087	0.955	
ICU admission	104	19.231	34.663	0.555	0.037	21.005	0.916	0.299
No ICU admission	277	2.166	12.646	0.171		5.139	0.421	
Elective	182	4.396	9.637	0.456	0.783	3.438	1.279	0.316
Emergency	199	9.045	26.905	0.336		14.986	0.603	
ASA I	76	0	9.988	0	0.161	3.409	0	0.413
ASA II	201	2.985	12.027	0.248		4.511	0.662	
ASA III	79	15.190	29.697	0.511		15.413	0.986	
ASA IV	25	32.000	63.408	0.505		48.988	0.653	
Midline incision	271	8.856	22.417	0.395	0.618	11.939	0.742	0.989
Non midline incision	110	1.818	9.389	0.275		3.388	0.520	

Table 3: Observed(O), predicted(P) mortality rates and O/P ratio of overall patients studied and patients in different subgroups.

As expected, post-operative mortality rate rose from 0% for ASA grade I to 32.0% for ASA IV. Both scoring systems failed to predict mortality in ASA I patients accurately, but POSSUM was able to predict morbidity with increasing accuracy as ASA class increased .

Another interesting finding from this study was with regard to the urgency of surgery. POSSUM over-predicts mortality in both elective and emergent cases, but for P-POSSUM, it under-predicts elective cases and over-predicts the emergency cases. POSSUM was able to predict morbidity for both groups fairly accurately with O/P ratio of 0.731 and 0.755 respectively.

In addition, mortality of those undergoing midline incisions (8.9%), was better predicted by P-POSSUM than the non-midline group (1.8%) Method of access did not appear to affect prediction of morbidity.

DISCUSSION:

The results of this study are consistent with the other published papers in that POSSUM over-predicts the number of deaths and P-POSSUM serves as a better scoring system in predicting death as a whole (Table 6).

However, the consistent theme that has emerged from our study is that the quantum increase in accuracy of P-POSSUM at predicting mortality varies, appearing to be highest on the one hand in conventionally poorer risk patients (the elderly, females, ASA class, those needing ICU), yet on the other, performing comparatively poorly in an emergent or trauma setting.

One explanation is that while trauma patients often present with more unfavorable physiological and operative parameters, thus leading to higher scores, they are otherwise young and previously healthy. Therefore, once appropriate intervention is performed, their better physiological reserve allows better recovery, and so less mortality and morbidity compared to non-trauma patients. Furthermore, trauma patients undergo damage control surgery rather than complex procedures, thus minimizing surgically-related physiological insults and perhaps contributing to the better-than-expected outcomes.

	n	Observed morbidity (%)	Predicted	O/P ratio	P value
Overall	381	39.370	52.748	0.746	0.789
Trauma	40	50.000	74.258	0.673	0.789
Non trauma	341	38.123	50.225	0.759	
Male	223	43.946	56.516	0.778	0.690
Female	158	32.911	47.429	0.694	
≤ 60 yrs	253	31.620	48.524	0.652	0.325
61 – 70 yrs	76	50.000	57.672	0.867	
> 70 yrs	52	61.538	66.101	0.931	
ICU admission	104	79.808	74.613	1.070	0.003
No ICU admission	277	24.188	44.539	0.543	
Elective	182	28.571	39.073	0.731	0.989
Emergency	199	49.246	65.255	0.755	
ASA I	76	27.316	39.143	0.698	0.310
ASA II	201	26.866	44.696	0.601	
ASA III	79	65.823	73.378	0.897	
ASA IV	25	92.000	93.648	0.982	
Midline incision	271	44.280	59.672	0.742	0.948
Non midline incision	110	27.273	37.004	0.737	

Table 4: Observed(O), predicted(P) morbidity rates and O/P ratio of overall patients studied and patients in different subgroups using POSSUM scoring system.

Score	Risk of death (%)	0 - ≤ 5	5 - ≤ 15	15 - ≤ 50	50 - ≤ 100	*P value*
POSSUM	n	88	151	105	37	
	Predicted	3.552	8.971	26.856	70.832	
	Observed	0	1.325	13.333	27.027	
	O/P ratio	0	0.148	0.496	0.382	*0.296*
P-POSSUM	n	249	73	39	20	
	Predicted	1.991	8.892	28.072	68.425	
	Observed	0	9.589	28.205	30.000	
	O/P ratio	*0*	*1.078*	*1.005*	*0.438*	*0.106*

Table 5: Observed and predicted mortality after risk stratification.

Study	Field studied	Number of patients	O/P ratio (POSSUM)	O/P ratio (P-POSSUM)
Whiteley et. al. 1996, UK[2]	General surgery	1485	0.411	1.000
Prytherch et. al. 1998, UK[4]	General surgery	10000	0.411	0.960
Yii et. al. 2002, Malaysia[5]	General surgery	605	0.581	1.271
Nicole Organ et. al. 2002, Australia[8]	ICU – general surgery	229	-	0.561
Bennett-Gueerrero et. al. 2003[10]	General surgery - UK General surgery - US	1056 1539	- -	0.974 0.268
Mohil et. al. 2004, India[11]	Emergency laparotomy	120	0.62	0.88
Brooks et. al. 2005, UK[12]	General surgery	949	0.667	1.151
This study, 2007, Malaysia	Laparotomy - overall Laparotomy - ICU Laparotomy - Emergency	381 104 199	0.366 0.555 0.336	0.721 0.916 0.603

Table 6: Comparison of result between other published studies and our study.

Female patients were more likely to die after laparotomy despite having more favorable parameters. However, although P-POSSUM was more predictive than POSSUM in this respect, a statistical significance within the P-POSSUM group between males and females could not be shown. Thus other contributors such as ward factors (bed occupancy rate, monitoring system, high dependency unit / beds etc) or staff factors (staff to patient ratio, staff experience etc) need to be explored to find the cause of the discrepancy. Perhaps the pattern of disease needs to be considered; alternatively, it could be that female patients are genetically-predisposed to fare worse. Determining this is beyond the scope of this study.

The p value for these two groups of patient showed statistical significance when POSSUM is used to predict mortality and morbidity, and this needs further evaluation to assess its validity, as the significant difference is lost when P-POSSUM is used (both scoring systems use same physiological and operative severity parameters). Perhaps a new separate regression equation for ICU patients might be required. Even though the literature shows that P-POSSUM significantly over-predicts mortality in ICU patients,8 our study suggests that PPOSSUM can be used to determine ICU admission after laparotomy, or even before laparotomy for optimization to reduce the morbidity and mortality rate. However, scoring systems were never intended to affect the decision to operate, a decision that must always remain clinical and cannot be used to prevent a patient from undergoing a potential curative procedure.[1,7]

In general ASA grading system still can be used as a rough guide on the possible morbidity and mortality of patients undergoing laparotomy and it is easily assessed by surgeon and does not require any calculation or equation. Obviously there is a huge difference between published studies (0.4% in ASA grade ≤ II and increased to 1.4 – 3.2% in ASA III and up to 7.3% in ASA grade IV)3 and our study. Patient factors (disease patterns, co-morbidities etc), environmental factors (level of hospital care, patient to ICU ratio, availability of equipment or supportive services etc) as well as staff factors (staff to patient ratio, experience of staffs multi-team approach etc) definitely need to take into consideration before the above comparison is made.

Both scoring systems predict mortality better in patients undergoing a midline incision, but almost similar O/P ratio for morbidity. The type of incision depends on the pathological condition of the patient and the access required dealing with it. Generally, simpler pathologies are dealt with non-midline incision, so operations are likely to be shorter, include less physiological stress, therefore better outcomes than predicted. Failure to obtain good access to the pathological area will lead to the surgeon struggling through the operation which could result in higher morbidity and mortality. The type of incision made should always go by the principles of laparotomy.

Although POSSUM and P-POSSUM have been validated in different countries and studies, both have their own limitations. Mistakes can occur in both data collection and analysis using POSSUM and P-POSSUM. POSSUM physiology score may change with time.[9] The operative severity score is not available until the operation has been undertaken, thus POSSUM cannot be used to prevent a patient from undergoing a potentially curative procedure.[7] The operative score has an element of subjective assessment, like the amount of blood loss and degree of peritoneal soiling. POSSUM and P-POSSUM do not take into account factors such as differences between surgeons, anaesthetists and operating time, level of peri-operative care, especially critical care services[5], the organ system operated on and duration of stay after operation which might be expected to have considerable influence on the outcome.[4,5]

Overall this study only looks at the outcome of patients who have undergone laparotomy under the care of a general surgeon. It excludes patients who have undergone urological, neurosurgical and plastic surgical procedures. Thus there may be a difference when comparison is made to the other studies. Patient presentation, disease pattern, hospital set up (wad, OT, ICU, supportive services especially radiological and blood bank services) and staffs expertise were different from other countries. Since the POSSUM and P-POSSUM were validated to predict mortality and morbidity in different regions of the world, detail analysis and study required to look into each component above for any room for correction and improvement. Hopefully by then this hospital will have outcome and quality of care comparable of that of other countries.

Conclusion:

P-POSSUM is a better overall predictor of mortality in patients undergoing laparotomy in this hospital compared to POSSUM. POSSUM is fairly accurate in predicting morbidity. However, further refinement is needed to improve its predictive value in specific areas, and so increase its utility in our local setting.

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