CLINICAL AUDIT

Comparison of P-POSSUM and O-POSSUM in predicting mortality after oesophagogastric resections

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Background: P-POSSUM (Physiological and Operative Severity Score for the enumeration of Mortality and morbidity) predicts mortality and morbidity in general surgical patients providing an adjunct to surgical audit. O-POSSUM was designed specifically to predict mortality and morbidity in patients undergoing oesophagogastric surgery.
Aim: To compare P-POSSUM and O-POSSUM in predicting surgical mortality in patients undergoing elective oesophagogastric cancer resections.
Methods: Elective oesophagogastric cancer resections in a district general hospital from 1990 to 2002 were scored by P-POSSUM and O-POSSUM methods. Observed mortality rates were compared to predicted mortality rates in six risk groups for each model using the Hosmer–Lemeshow goodness-of-fit test. The power to discriminate between patients who died and those who survived was assessed using the area under the receiver–operator characteristic (ROC) curve.
Results: 313 patients underwent oesophagogastric resections. 32 died within 30 days (10.2%). P-POSSUM predicted 36 deaths ($\chi^2 = 15.19$, df = 6, p = 0.019, Hosmer–Lemeshow goodness-of-fit test), giving a standardised mortality ratio (SMR) of 0.89. O-POSSUM predicted 49 deaths ($\chi^2 = 16.51$, df = 6, p = 0.011), giving an SMR of 0.65. The area under the ROC curve was 0.68 (95% confidence interval 0.59 to 0.76) for P-POSSUM and 0.61 (95% confidence interval 0.50 to 0.72) for O-POSSUM.
Conclusion: Neither model accurately predicted the risk of postoperative death. P-POSSUM provided a better fit to observed results than O-POSSUM, which overpredicted total mortality. P-POSSUM also had superior discriminatory power.

Oesophagogastric cancers continue to be a major cause of cancer mortality. Scotland currently has one of the highest incidences of oesophageal cancers in Europe and within the UK.[1] Surgical resection continues to be the mainstay for treatment of oesophagogastric cancers. Postoperative mortality following oesophagogastric resections is significant and varies between 1.4–23%.[2 3] In the UK, mortality for oesophagogastric cancer is higher than in the rest of Europe.[4] In Scotland, patients with oesophagogastric cancers have a poor prognosis in comparison with other European countries.[1] Postoperative mortality has continued to decline over the last decade mainly due to improved case selection, specialised provision of services and multidisciplinary involvement.

Preoperative risk assessment and informed consent play a vital role in the management of oesophagogastric cancers. It is essential for both the patient and surgeon to have an assessment preoperatively of the probability of success of a major surgical procedure. This should take into account the surgeon's performance, hospital performance, physiological status of the patient, and multidisciplinary involvement including interventional radiologists. This will enable a fully informed consent to be obtained from the patient. In addition this will identify patients who are at high risk from the operative procedure. In this group, preventive measures can be instituted and postoperative complications may be predicted to enable early recognition and institution of appropriate treatment, which may result in a better outcome.

Predicting postoperative mortality and risk assessment before surgery continues to be a challenge. Over the last decade the Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (POSSUM),[5] and its modifications such as P-POSSUM[6 7] have been used in general surgery and allied specialities to predict postoperative mortality with varying degree of success. POSSUM and P-POSSUM both use a four grade, 12 factor Physiological Score and a six factor Operative Severity Score to predict operative mortality. These scoring systems, when used appropriately, can be useful in providing an estimation of postoperative mortality for an individual patient.[7]

O-POSSUM was derived to provide a dedicated scoring system to predict postoperative mortality specifically for oesophageal and gastric surgery.[8] This system was based on the methods used by POSSUM and P-POSSUM, the primary end point being in-hospital mortality. In O-POSSUM, the risk factors were selected on the basis of their clinical relevance. Operative blood loss and number of procedures, which describe structure and process of care, were excluded from multivariate analysis.

The aim of our study was to compare the predictive accuracy of P-POSSUM and O-POSSUM in patients undergoing elective oseophagogastric resections for cancer.

PATIENTS AND METHODS

Patients who underwent elective oesophagogastric resections for cancer were studied from 1990 to 2002. All patients underwent staging investigations. These included upper gastrointestinal endoscopy and biopsy, computed tomographic scan and, in some, staging laparoscopy. All patients underwent preoperative evaluation which included a chest radiograph, electrocardiogram, respiratory function tests and echocardiogram

Abbreviations: AUC, area under the receiver–operator characteristic curve; H–L, Hosmer–Lemeshow; POSSUM, Physiological and Operative Severity Score for the enumeration of Mortality and morbidity; ROC, receiver–operator characteristic; SMR, standardised mortality ratio

Table 1 Patient demographics

	Oesophagus n = 110	Stomach n = 203
Age (median, range) (years)	69 (34–91)	69 (32–92)
Sex		
Male	72 (65%)	116 (57%)
Female	38 (35%)	87 (43%)
Surgery		
Ivor/Lewis	55 (50%)	
Transhiatal	27 (25%)	
Others	28 (25%)	
Total gastrectomy		51 (25%)
Subtotal gastrectomy		37 (18%)
Partial gastrectomy		78 (38%)
Others (incl palliative GJ)		37 (18%)
Histology		
Adenocarcinoma	80 (73%)	193 (95%)
Squamous	29 (26%)	1 (1%)
Others	1 (1%)	9 (4%)

GJ, gastrojejunostomy.

if indicated. All surgical resections were performed with an intent to cure.

Crosshouse Hospital is a district general hospital in the county of Ayrshire, Scotland, with an estimated population of 220 000. Four surgeons were operating for the first half of the decade (1990 to 1995), two of whom had a special interest in the upper gastrointestinal system and performed all oesophagogastric surgery from 1996.

The data were recorded on a standard datasheet and then transferred to SPSS version 10.0 (SPSS Inc, Chicago, USA). The risk of death, R, was calculated using the P-POSSUM equation using linear analysis as follows[6]:

P-POSSUM, $\ln[R/(1-R)] = -9.065+(0.1692^*$ physiological score$) + (0.1550^*$ operative score$)$

where the physiological and operative scores were calculated as described by Copeland and colleagues.[4] Three per cent of the data was missing, and the variables corresponding to missing data were assigned a score of 1 (representing a normal result). The O-POSSUM[8] score was calculated from the physiological score, operative severity score, pathology details and mode of surgery for individual patient as described on the website (www.riskprediction.org.uk). Mortality was determined at 30 days. The demographic distribution and pattern of patients scored are shown in table 1.

The variables used for calculations of P-POSSUM and O-POSSUM are shown in table 2.[8]

Table 2 Variables used in P-POSSUM and O-POSSUM equations

Physiological score	Operative severity score
Age (years)*	Operative severity
Cardiac signs/chest radiograph	Multiple procedures†
Respiratory history/chest radiograph	Total blood loss (ml)†
Systolic blood pressure (mm Hg)	Peritoneal soiling†
Pulse (beats/min)	Presence of malignancy
Glasgow Coma Scale	Mode of surgery
Haemoglobin	
White cell count ($\times 10^{12}$/l)	
Urea (mmol/l)	
Sodium (mmol/l)	
Potassium (mmol/l)	
Electrocardiogram	

*Age was regressed independently from the Physiological and Operative severity score for the enumeration of Mortality and morbidity (POSSUM).
†Risk factors not used in scoring specific for upper gastrointestinal surgery (O-POSSUM) (used from reference 8).

Table 3 Observed and predicted deaths in risk categories as defined by the P-POSSUM score

Predicted risk	Number of patients	Predicted deaths	Observed deaths
0–10	198	9	13
>10–20	57	8	9
>20–30	29	7	5
>30–40	16	5	3
>40–50	7	3	0
50–100	6	4	2
0–100	313	36	32

The patients were stratified into six risk groups based on survival probability to allow comparison between predicted and observed deaths. This was analysed by the Hosmer–Lemeshow (H–L) goodness of fit test to assess the calibration of the model.[9] In this analysis a value of $p<0.05$ was considered to show a significant lack of fit by the model. The discrimination of the model was measured by the area under the receiver–operator characteristic (ROC) curve (AUC). A value of 0.5 represents chance performance and 1.0 represents perfect prediction. Values between 0.7–0.8 suggest reasonable discrimination and more than 0.8 suggest good discrimination.

RESULTS

A total of 313 patients were scored using the P-POSSUM and O-POSSUM equations. Thirty-two patients died within 30 days of surgery. The overall observed mortality rate was 10.2%.

The mortality rates predicted by the P-POSSUM and O-POSSUM equations compared to the observed mortality rate are shown in tables 3 and 4.

P-POSSUM predicted 36 deaths, yielding a standardised mortality ratio (SMR) of 0.89. The H–L goodness of fit test, applied to the P-POSSUM equation, indicated a significant lack of fit with the observed deaths ($\chi^2 = 15.19$, 6 df, $p = 0.019$).

O-POSSUM predicted 49 deaths, yielding an SMR of 0.65. The H–L test applied to these data indicated a lack of fit ($\chi^2 = 16.51$, 6 df, $p = 0.011$).

The ROC curve analysis applied to the P-POSSUM scores showed poor discriminatory capability for mortality, as shown in fig 1, although significantly better than chance (AUC 0.68, 95% confidence interval 0.59 to 0.76). ROC curve analysis of O-POSSUM scores (fig 2) revealed an even poorer discriminatory power for mortality (AUC 0.61, 95% confidence interval 0.50 to 0.72).

DISCUSSION

Quality assurance and risk assessment is important in an era of public choice. Surgical mortality is often seen as a surrogate of performance, to enable comparison between individual surgeons

Table 4 Observed and predicted deaths in risk categories as defined by the O-POSSUM score

Predicted risk	Number of patients	Predicted deaths	Observed deaths
0–10	125	7	8
>10–20	103	14	8
>20–30	46	11	10
>30–40	19	7	1
>40–50	10	4	2
50–100	10	6	3
0–100	313	49	32

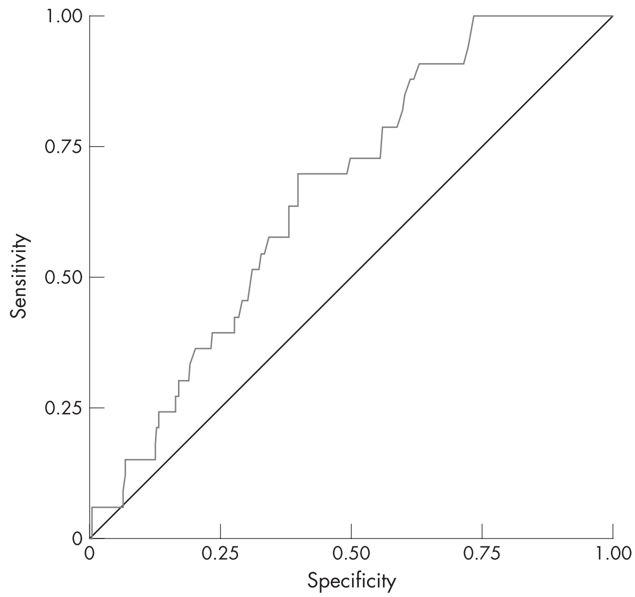

Figure 1 Receiver–operator characteristic (ROC) curve for mortality (P-POSSUM).

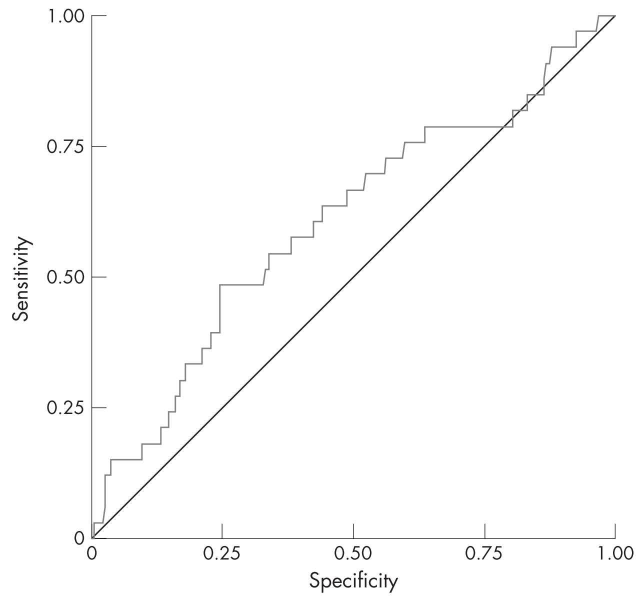

Figure 2 Receiver–operator characteristic (ROC) curve for mortality (O-POSSUM).

and hospitals. This method of comparison can be misleading due to differences in case mix.[10]

Since the introduction of POSSUM,[5] it has been possible to predict successfully postoperative mortality in patients undergoing general surgical procedures. This method and its subsequent modifications such as P-POSSUM have been applied successfully in various general surgical procedures[11–19] in the UK. More recently POSSUM has been successfully applied in populations outside the UK.[20–22] POSSUM, when applied specifically to oesophageal resections, did not predict mortality and morbidity accurately[23] and overpredicted mortality in patients with gastric cancer undergoing D2-gastrectomy.[24]

O-POSSUM was designed to provide a dedicated model for prediction of mortality after oesophagogastric resections. A recent article by Gocmen *et al* showed that O-POSSUM predicted mortality more accurately than P-POSSUM in patients undergoing resections for gastric cancer.[25]

In the present study, P-POSSUM and O-POSSUM models failed to predict postoperative mortality accurately following elective oesophagogastric cancer resections, but P-POSSUM provided better estimation of overall mortality when compared to O-POSSUM.

The failure of the O-POSSUM model in this cohort could be due to a number of factors, such as the inclusion of only elective resections for cancer, the treatment of missing data and the consideration of only 30 day mortality. The overall mortality rate during the study period is comparable to published data[26] with a decrease in mortality in the latter half of the decade. Whether this was due to improved perioperative care, provision of specialist services or improved patient selection is unclear.

As the original authors suggested, the O-POSSUM equation should be tested and applied to various different populations for the assessment of its predictive power.[8] When applied to this population, the O-POSSUM equation overpredicted the overall mortality rate.

P-POSSUM appeared to be a better fitting model, with superior discriminatory power. Predictive accuracy of both scoring systems may be limited in patients undergoing elective resections for cancer. This should be borne in mind when using these methods for comparative audit and patient information.

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