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Evaluation of CR-POSSUM, Original ACPGBI and New ACPGBI Scoring Systems for Colorectal Cancer Surgery

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Rezumat

Evaluare a scorurilor CR-POSSUM, ACPGBI original și noul ACPGBI în chirurgia cancerului rectal

Scop: De a compara scorul Colorectal Physiological and Operative Score for enUmeration of Mortality and Morbidity (Cr-POSSUM) cu scorul original al Asociației de Coloproctologie a Marii Britanii și Irlandei (ACPGBI) și cu noul scor ACPGBI în ceea ce privește capacitatea acestora de a estima mortalitatea după intervenția chirurgicală pentru cancer colorectal.
Metode: Am calculat restrospectiv scorurile Cr-POSSUM, ACPBGI original și noul ACPGBI a 105 pacienți ce au suferit intervenții pentru neoplasm colorectal. Datele au fost obținute din fișele pacienților și din protocoalele operatorii. Mortalitatea a fost definită ca moartea în primele 30 de zile după operație. Scorurile au fost validate prin evaluarea calibrării lor și a capacității de discriminare. Calibrarea a fost estimată cu ajutorul testului Hosmer-Lemeshow și al curbelor de calibrare. Capacitatea discriminativă a modelelor a fost evaluată prin analiză tip curbă ROC.
Rezultate: Rata mortalității observate a fost de 4,8 %. Riscurile globale de moarte estimate prin Cr-POSSUM, ACPGBI original și noul ACPGBI au fost 9.92%, 7.35%, respectiv 4.20%. Ariile de sub curbă pentru cele 3 scoruri au fost, în aceeași ordine, 0,792, 0,844 și 0,801.
Concluzii: Scorurile Cr-POSSUM, ACPGBI original și noul ACPGBI prezintă acuratețe în determinarea ratelor de mortalitatea și estimarea riscului de deces la anumiți pacienți. Scorurile ACPGBI original și nou au oferit rezultate ușor superioare celor obținute prin scorul Cr-POSSUM.

Cuvinte cheie: cancer colorectal, Cr–POSSUM, ACPGBI original, noul ACPGBI, mortalitate

Abstract

Purpose: To compare the Colorectal Physiological and Operative Score for enUmeration of Mortality and Morbidity (Cr-POSSUM) with the original Association of Coloproctology of Great Britain and Ireland (ACPGBI) and new ACPGBI scoring systems for their ability to predict mortality after colorectal cancer surgery.
Methods: We retrospectively calculated the Cr-POSSUM, original ACPBGI and new ACPGBI scores of 105 patients who underwent colorectal cancer surgery. Data were obtained from patients' medical records and operative notes. Mortality was defined as death within 30 days of surgery. Scores were validated by assessing their calibration and discrimination. Calibration was assessed using the Hosmer-Lemeshow test and corresponding calibration curves. The discriminative capability of the models was evaluated using receiver operating characteristic (ROC) curve analysis.
Results: The observed mortality rate was 4.8 %. The overall estimated risks of death of the Cr-POSSUM, original ACPGBI, and new ACPGBI scores were 9.92%, 7.35% and 4.20%, respectively. The results of areas under the curve (AUC) for Cr-POSSUM, original ACPGBI and new

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ACPGBI scores were 0.792, 0.844 and 0.801 respectively.
Conclusions: The Cr-POSSUM, original ACPGBI and new ACPGBI scoring sytems are accurate in determining mortality rates and for predicting the risks of death in individual patients. The new and original ACPGBI scoring systems performed slightly better than the Cr-POSSUM scoring system.

Key words: colorectal cancer, Cr-POSSUM, original ACPGBI, new ACPGBI, mortality

Introduction

Operative mortality rate is a common measure of outcome and can be used to compare quality of health care. Simple comparisons of operative mortality rates between departments of surgery may be misleading, however, because these comparisons do not consider the physiological condition of the patient at the time of surgery, the severity of surgery, or the age and general health of the patient (1). Many scoring systems have been developed to predict patient risks of complications and mortality. One such scoring system is the Physiological and Operative Score for enUmeration of Mortality and Morbidity (POSSUM), which combines 12 physiological factors and six factors associated with operative severity score to calculate risks of mortality and morbidity and to objectively and accurately stratify patients under-going surgical procedures (1,2).

Since the introduction of the original POSSUM system, several reports have demonstrated that this system tends to overestimate mortality in low risk patients (3,4,5). This led to the development of the Portsmouth-POSSUM (P-POSSUM) system (6), which was shown to predict mortality risk better than the original model (3). However, the P-POSSUM was found to predict higher mortality rates in young patients and lower mortality rates in elderly emergency patients. The Cr-POSSUM scoring system was therefore developed, based on 6 of the 12 original physiological parameters and 4 of the operative variables, and found to have better calibration and discrimination than the other POSSUM systems (7).

Since all of the POSSUM models have limitations, the Association of Coloproctology of Great Britain and Ireland (ACPGBI) designed a new scoring system in 2003, called the ACPGBI scoring system, from a study that included 8,077 patients. The ACPGBI utilizes multifactorial logistic analysis to adjust multiple risk factors and can be used easily for patients undergoing colorectal surgery. Although there have been few reports to date of its use in the literature, the original ACPGBI scoring system was found to be more sensitive than the POSSUM model (8,9,10).

In 2010, the original ACPGBI scoring system was revised to include age, ASA grade, cancer stage, operative urgency, and operation type, resulting in a new ACPGBI scoring system (11). We have compared the predictive accuracy of the Cr-POSSUM, original ACPGBI and new ACPGBI scoring systems in patients undergoing colorectal surgery.

Methods

We retrospectively evaluated all patients who underwent surgery for colorectal cancer in a three year period in the Department of General Surgery of the Trabzon Numune Training and Research Hospital, Trabzon, Turkey. Patients were excluded if data were missing or if they did not undergo resection. Physiological and operative parameters were collected from medical records and operative notes. Mortality was defined as death within 30 days of colorectal surgery. A form was created for each patient, containing the Cr-POSSUM, original ACPGBI, and new ACPGBI scoring parameters. Scores for individual patients were calculated from the web page, www.riskprediction.org.uk.

The ability of each scoring system to predict mortality was analysed by measures of calibration and discrimination. Model calibration was assessed using the Hosmer and Lemeshow's goodness-of-fit test, on which a $p > 0.05$ indicates that the model is performing well for perfect prediction. Analysis confidence intervals were chosen at 95 percent (12).

Model discrimination was assessed using the area under the receiver operator characteristics (ROC) curve to evaluate how well the model distinguished patients who died from those who did not. The statistics represent the concordance between predicted probabilities and observed outcomes for all possible pairs of patients with different outcome status. ROC curves were constructed for each scoring system, and the sensitivity and specificity of each was analysed. The area under the curve (AUC) is used as an index of model discrimination; it ranges from 0.5 for pure chance to 0.99 for perfect prediction. Values ranging from 0.7 to 0.8 represent reasonable discrimination, and values higher than 0.8 represent good discrimination (12,13).

All statistical analyses were performed using SPSS for Windows and Microsoft Excel 2010.

Results

Of the 110 patients who underwent surgical resection of colorectal cancer in our department, five were excluded due to lack of data. Thus, 105 patients (65 men and 40 women), of mean ± SD age 65.95 ± 4.47 years (range, 38-94 years) were included in the study. The demographic and clinical characteristics of these patients, and the types of colorectal resection performed are shown in *Table 1*. The distribution of the patients according to predicted risk of mortality rate for the Cr-POSSUM, original ACPGBI, and new ACPGBI scoring systems are shown in *Table 2*.

Five patients (4.8%) died, either in the hospital or within 30 days after surgery. The causes of death in electively operated patients were acute myocardial infarction in two patients, cerebrovascular disease in two patients and one patient died in the acutely operated group due to sepsis. The

Table 1. *Patient demographics and type of surgery*

	Number	%
Age		
≥ 60	71	67.6
< 60	34	32.4
Sex		
Male	65	61.9
Female	40	38.1
Mode of operation		
Emergency	17	16.2
Elective	88	83.8
Procedure		
Low anterior resection	30	28.5
Abdominoperineal resection	20	19.0
Anterior resection	11	10.4
Hartmann's procedure	8	7.6
Right hemicolectomy	20	19.0
Left hemicolectomy	12	11.4
Subtotal colectomy	4	3.8
Dukes stage		
A-B	44	41.9
C	48	45.7
D	13	12.4

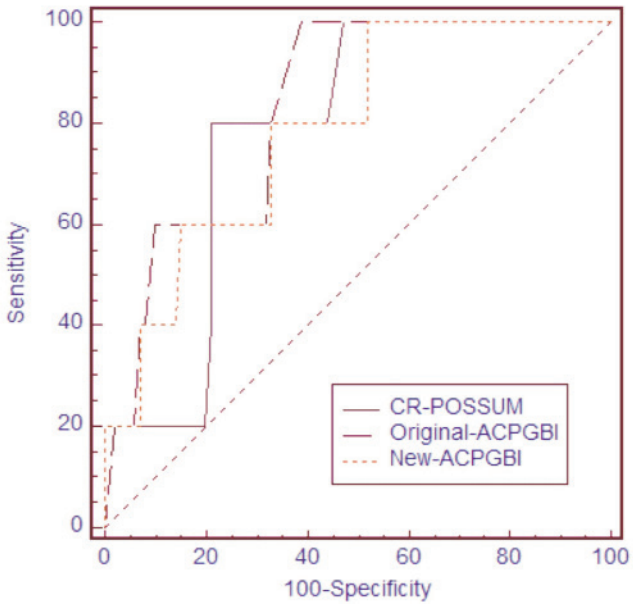

Figure 1. *ROCs for all three scoring systems*

mean predicted mortality rates based on the Cr-POSSUM, original ACPGBI and new ACPGBI scoring systems were 9.92%, 7.35% and 4.20%, respectively. The Cr-POSSUM model showed a good fit with data, giving good Hosmer-Lemeshow statistics (HL χ^2=12.54; 6 d.f.; p=0.052). For both the original (HL χ^2= 8.29; 6 d.f.; p=0.218) and new (HL χ^2= 9.92; 6 d.f.; p=0.128) ACPGBI scoring system, there was no significant difference between the predicted and observed numbers of deaths (*Table 3*). The discrimatory power of the Cr-POSSUM, orginal ACPGBI and new ACPGBI score systems in predicting death as an outcome measure was analyzed using receiver operating characteristic curves. The AUCs for the Cr-POSSUM, original ACPGBI, and new ACPGBI scoring systems were 0.792 (95% confidence interval (CI) 0.648-0.932), 0.844 (95% CI 0.712 -0.967), and 0.801 (95% CI 0.628- 0.961), respectively (*Table 4, Figs. 1, 2*).

Table 2. *The distribution of patients according to predicted risk of mortality rate*

		CR-POSSUM	Original ACPGBI-CRC	New ACPGBI-CRC
Predicted Risk of Mortality Rate, %		No of Patients	No of Patients	No of Patients
<5	57	55	77	
5-15	25	37	22	
>15	23	13	6	
Total	105	105	105	

Table 3. *Hosmer and Lemeshow's results*

Number	CR-POSSUM Mortality	Original ACPGBI-CRC Mortality	New ACPGBI-CRC Predicted 30-day Mortality
105	9.92	7.35	4.20
	(7.519-12.330)	(6.132-9.525)	(3.357-6.635)
	p=0.052*	p=0.218*	p=0.128*

*: Hosmer and Lemeshow's test p>0,05 indicates that the model is performing well for perfect prediction

Table 4. *Performance of the Cr-POSSUM, original ACPGBI and new ACPGBI scoring systems according to ROC analysis*

	CR-POSSUM Mortality	Original ACPGBI-CRC Mortality	New ACPGBI-CRC Predicted 30-day Mortality
ROC-AUC (%95 CI)	0.792±0.072 (0.648-0.932) p=0.028	0.844±0.070 (0.712 – 0.967) p=0.010	0.801±0.089 (0.628 – 0.961) p=0.024

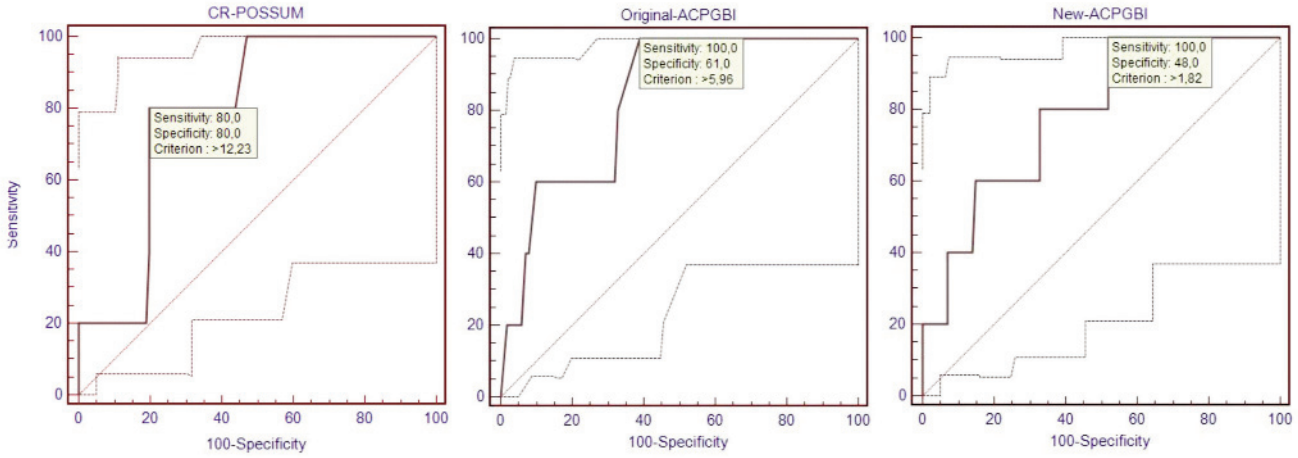

Figure 2. *ROCs for performance of the Cr-POSSUM, original ACPGBI and new ACPGBI scoring systems*

Discussion

Modern health care systems have been sought to ensure the standardization of treatment, including the use of scoring systems to evaluate surgical outcomes across different specialities. Colorectal cancer most frequently occurs in older individuals, many of whom have other systemic diseases. Since it is important to know the risk of mortality of a surgical procedure, several scoring systems have been developed to provide more objective comparisons for quality of care. These score systems can identify high risk patients, who may require additional care during surgery or the postoperative period (14-16).

One of the first scoring systems developed to predict outcomes after surgery was POSSUM (2). Due to the limitations of the original POSSUM system, several modifications were developed, including the P-POSSUM and Cr-POSSUM scoring systems (6,7). Comparisons of these three scoring systems showed that Cr-POSSUM was a better predictor of mortality than the other POSSUM systems (17-19). Despite the superiority of the Cr-POSSUM system, specifically for colorectal cancer surgery, it requires a relatively large amount of data, which may not be easy or practical to gather preoperatively. This led to the development of a new scoring system, the original ACPGBI scoring system, which was found to have better calibration and discrimination than the POSSUM systems (8-10). This led to the further development of the new ACPGBI scoring system (11), although only a few studies to date have assessed this system. We compared the Cr-POSSUM, original ACPGBI, and new ACPGBI scoring systems by assessing calibration and discrimination in patients who underwent surgery for colorectal cancer.

The original ACPGBI scoring system was formulated based on 8,077 patients with colorectal cancer. This scoring system predicted a postoperative mortality rate of 5.98%, whereas the actual postoperative mortality rate was 7.5%. This scoring system was therefore regarded as an accurate and validated model, providing risk adjusted outcomes for patients undergoing surgery for colorectal cancer (9).

A comparison of the three POSSUM systems and the original ACPGBI scoring systems showed that POSSUM over-predicted mortality whereas P-POSSUM underpredicted mortality for patients undergoing colorectal cancer surgery (10). Cr-POSSUM was more accurate than the other POSSUM variants, whereas the original ACPGBI score predicted overall mortality most accurately (10).

A retrospective comparison of the P-POSSUM and CR-POSSUM scoring systems in 120 patients who underwent colorectal cancer resection found that the P-POSSUM system underpredicted mortality by 25%, although the difference was not significant (p=0.06) (16). The observed to expected ratio for the CR-POSSUM scoring system was 1.11, with no difference between the observed and predicted values (p=0.19). These findings suggested that, although both scoring systems were accurate in predicting mortality after colorectal cancer surgery, the CR-POSSUM scoring system was more accurate (16).

Another retrospective study compared the accuracy of the POSSUM, P-POSSUM, and Cr-POSSUM scores in predicting mortality in 304 patients undergoing surgery for colorectal cancer (17). The observed to expected ratios for these three scoring systems were 3.37, 1.59, and 1.25, respectively, suggesting that the CR-POSSUM system was superior to the POSSUM and P-POSSUM scoring systems, both of which over-predict mortality.

Similarly, the accuracy of the POSSUM, P-POSSUM, and Cr-POSSUM scores in predicting mortality was retrospectively assessed in 734 patients undergoing colorectal resection, as well as in subgroups of patients undergoing surgery for malignancy (n=386), IBD (n=113), diverticulitis (n=91) and other indications, including trauma, endometriosis, volvulus or ischemia (n=144) (8). The predictive value of these scoring systems was also assessed relative to the setting of surgery, acute or elective settings; and, in patients undergoing surgery for malignancy,

these scores were compared with original ACPGBI scores. All three POSSUM scoring systems were significant predictors for outcome after surgery, both in the total patient cohort and in the 4 subgroups of patients, with no differences in AUCs for the different POSSUM scoring systems. The P-POSSUM and CR-POSSUM systems predicted significantly worse outcomes in patients undergoing elective surgery for carcinoma than for diverticulitis. In contrast, the CR-POSSUM was a better predictor of mortality in patients undergoing acute surgery for divertisulitis than for other indications. The ACPGBI scoring system had a larger AUC for malignancy than any of the POSSUM scores, indicating that it was superior in patients undergoing elective resection for malignancy (8).

The Cr-POSSUM and original ACPGBI scoring systems were also compared in elderly patients undergoing colorectal cancer surgery (20). Although the observed mortality rate was 1.6%, the Cr-POSSUM and original ACPGBI scoring systems predicted mortality rates of 11.2% and 5.4%, respectively. Although these scoring systems were not well validated in Japanese patients, the original ACPGBI model was superior to Cr-POSSUM in predicting mortality following surgery for colorectal cancer (20).

A recent study retrospectively compared the P-POSSUM, Cr-POSSUM, original ACPGBI and new ACPGBI models in 423 patients undergoing resection for colorectal cancer (21). The observed to expected ratios for these four scoring systems were 0.87, 0.63, 0.58, and 1.05, respectively. Moreover, the revised ACPGBI model performed well in patients undergoing both elective and emergency surgery, with observed to expected ratios of 1.06 and 0.91, respectively. These findings indicated that the revised ACPGBI scoring system was simple to construct and was a more accurate predictor of operative mortality after potentially curative resection for colorectal cancer than the other three scoring systems (21).

Taken together, these previous studies showed that both the Cr-POSSUM and original ACPGBI scoring systems were good predictors of mortality after colorectal surgery, with the latter being slightly more accurate. The observed mortality rate among our patients was 4.8%, whereas the Cr-POSSUM, original ACPGBI and new ACPGBI scoring systems estimated overall risks of death of 9.92%, 7.35%, and 4.20%, respectively, with AUCs of 0.792, 0.844 and 0.801 respectively. While the original ACPGBI and Cr-POSSUM scoring systems overestimated the mortality rate, the new ACPGBI underestimated the mortality rate in our patients. Although the original ACPGBI was found to have better calibration and discrimination than the Cr-POSSUM and new ACPGBI scoring systems, all three demonstrated good calibration ability with no statistically significant differences in the observed and expected number of deaths.

In conclusion, these results demonstrate that the Cr-POSSUM, original ACPGBI and new ACPGBI scoring systems can be used to calculate predicted mortality rates and are accurate in predicting the risk of death for individual patients. The original ACPGBI scoring system was the most accurate of the three in predicting mortality after colorectal cancer surgery. The new ACPGBI scoring system was both practical and useful in clinical practice and easily applied to patients undergoing colorectal cancer resection.

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