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Mortality rate prediction by Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM), Portsmouth POSSUM and Colorectal POSSUM and the development of new scoring systems in Chinese colorectal cancer patients

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Abstract

BACKGROUND: The aim of this study was to compare the Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM), Portsmouth POSSUM (P-POSSUM), and Colorectal POSSUM (Cr-POSSUM) for predicting surgical mortality in Chinese colorectal cancer patients and to create new scoring systems to achieve better prediction.

METHODS: Data from 903 patients undergoing surgery for colon and rectal cancers from 1992 to 2005 at Peking University Third Hospital were included in this study. POSSUM, P-POSSUM, and Cr-POSSUM were used to predict mortality. Stepwise logistic regression was used to develop the modified P-POSSUM and Cr-POSSUM. Their performances were tested by receiver operating characteristic curve, Hosmer-Lemeshow statistic, and observed:expected ratio.

RESULTS: The actual inpatient mortality was 1.0% (9 of 903). The predicted mortality of POSSUM, P-POSSUM, and Cr-POSSUM were 5.6%, 2.8%, and 4.8%, respectively, which were significantly higher than the actual mortality in our cohort. The predicted mortality of the modified P-POSSUM and Cr-POSSUM was very close to the observed mortality. Both the modified models offered better accuracy than P-POSSUM.

CONCLUSIONS: The predicted mortality of POSSUM, P-POSSUM, and Cr-POSSUM were significantly higher than the observed mortality in our patients. The modified P-POSSUM and Cr-POSSUM models provided an accurate prediction of inpatient mortality rate in colorectal cancer patients in China.

Perioperative care is the major factor that determines the success of any surgery, and perioperative mortality is one of the main issues of concern for patients and family members. How to evaluate the risk of surgery based on a patient's preoperative health status and general condition is a question that clinicians have to face every day.

The Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) was developed by Copeland et al[1] in 1991. The scoring system uses a 12-factor, 4-grade physiologic score (PS) and a 6-factor, 4-grade operative severity score (OS). It has been widely applied to predict mortality in adult inpatient sur-

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geries. Later, other researchers discovered that the mortality rate predicted by POSSUM grading was higher than the actual mortality rate[2] and much higher for the lower-risk population.[3,4] Moreover, exponential analysis was used in POSSUM, which is not a standard statistical technique to calculate the predicted mortality.[5,6]

To solve this problem, Whiteley et al[7] developed Portsmouth POSSUM (P-POSSUM) in 1996. This scoring system continued to use the risk factors and grades of POSSUM, but revised its regression equation constant and weight to predict inpatient mortality. Most researchers found that the P-POSSUM showed more accurate predictability than POSSUM.[7,8] The P-POSSUM scoring system used the linear analysis technique, which is a standard method of analysis. Analysis by this method is simple and can be applied to the individual patient as well.[5,6] However, other researchers found that P-POSSUM also had its limitations. The predicted mortality in elderly patients and in emergency surgery was less than the actual mortality, whereas the predicted mortality in low-risk groups and in elective surgery was higher than the actual mortality.[9] Thus, when surgical risk is very high or very low, application of P-POSSUM has certain limits.

In 2004, Tekkis et al[9] developed Colorectal POSSUM (Cr-POSSUM) for patients who have undergone colorectal surgery. This model incorporated the preoperative and intraoperative risk factors from the POSSUM model into a new grading system and established a new regression equation to predict inpatient mortality. Cr-POSSUM continued to use the P-POSSUM linear analysis method, but reduced the use of some of the preoperative and intraoperative risk factors. Tekkis et al experienced good results with Cr-POSSUM in colorectal surgeries.[9–11]

The perioperative mortality of colorectal carcinoma patients is relatively low, approximately .8% to 10.2%.[10–18] Therefore, few studies have been performed in this field and there is currently no specific method to predict perioperative mortality for colorectal carcinoma patients. Some researchers have used POSSUM, P-POSSUM, and Cr-POSSUM to predict the postoperative mortality of colorectal carcinoma patients. These 3 scoring systems can predict the actual mortality rate to a certain extent, but because they are developed for broad applications, their ability to predict for a specific patient population remains unsatisfactory.[16]

POSSUM, P-POSSUM, and Cr-POSSUM are all based on the study of patients in the United Kingdom. However, some researchers have indicated that these systems may be suitable for patients in other countries as well.[19–21] When comparing English and American patients, Bennett-Guerrero et al[22] found that the mortality rate predicted by the POSSUM scoring system was higher than the actual mortality rate in American patients. They suggested that this system undergo further studies in the United States.

Few studies have been performed to evaluate whether the POSSUM grading system would function well for colorectal cancer patients in China. In the study by Law et al[23] of 400 laparoscopic colorectal surgery patients in Hong Kong, the 3 POSSUM grading systems overpredicted the inpatient mortality rate. One report with a small number of samples from mainland China indicated that the mortality rate predicted by POSSUM was higher than the actual mortality rate, but the difference had no statistical significance.[24]

We analyzed the data of 903 patients who had undergone surgery for colorectal cancers from 1992 to 2005 at Peking University Third Hospital and evaluated the performance of POSSUM, P-POSSUM, and Cr-POSSUM models in predicting the perioperative mortality rate. We developed a new scoring system that would accommodate colorectal cancer patients in China.

Methods

Patient selection

All cases of colorectal cancer from April 1992 to April 2005 at Peking University Third Hospital (Beijing, China) were reviewed. A total of 903 cases were obtained during the study period. Cases included in the study were investigated according to the POSSUM physiologic and surgical scores. Preoperative data were collected at the nearest time before surgery. A total of 579 (64.1%) cases had complete data. In the 324 patients with missing data, 230 cases missed 1 parameter, 79 cases missed 2 parameters, 10 cases missed 3 parameters, and 5 cases missed 4 parameters. On average, 1.35 parameters were missing in the patients with missing data. According to Senagore et al,[11] the lost data can be replaced by normal values. All data were entered into Epidata (Version 3.02, Odense, Denmark) to establish a new database.

Selection of variables and definitions

We used inpatient mortality as the main evaluating variable for perioperative mortality. We used the POSSUM score as originally defined by Copeland et al,[1] the P-POSSUM score as defined by Whiteley et al,[8] and the Cr-POSSUM score as defined by Tekkis et al.[9] Surgical procedures were categorized according to the Office of Population Censuses and Surveys system rules.[25] Surgical procedures were classified as emergency, urgent, scheduled, or elective according to the National Confidential Enquiry into Perioperative Death classification,[26] and tumor staging was assigned according to Dukes' classification for colorectal cancer.[27]

Evaluation of the scoring system

Receiver operator characteristic curve analysis. Model discrimination refers to the ability of the model to assign a higher probability of death to patients who die than to those who do not. In our study, this was measured by the area under the receiver operator characteristic (ROC) curve,[28] or c-index. In a ROC curve, sensitivity is plotted on the Y-axis