Validation of risk assessment scoring systems for an audit of elective surgery for gastrointestinal cancer in elderly patients: An audit

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KEYWORDS
POSSUM score; Portsmouth-POSSUM; Elderly patient; Risk assessment; Gastrointestinal cancer

Abstract The goal of this study was to validate the usefulness of risk assessment scoring systems for a surgical audit in elective digestive surgery for elderly patients. The validated scoring systems used were the Physiological and Operative Severity Score for enUmeration of Mortality and morbidity (POSSUM) and the Portsmouth predictor equation for mortality (P-POSSUM). This study involved 153 consecutive patients aged 75 years and older who underwent elective gastric or colorectal surgery between July 2004 and June 2006. A retrospective analysis was performed on data collected prior to each surgery. The predicted mortality and morbidity risks were calculated using each of the scoring systems and were used to obtain the observed/predicted (O/E) mortality and morbidity ratios. New logistic regression equations for morbidity and mortality were then calculated using the scores from the POSSUM system and applied retrospectively. The O/E ratio for morbidity obtained from POSSUM score was 0.23. The O/E ratios for mortality from the POSSUM score and the P-POSSUM were 0.15 and 0.38, respectively. Utilizing the new equations using scores from the POSSUM, the O/E ratio increased to 0.88. Both the POSSUM and P-POSSUM over-predicted the morbidity and mortality in elective gastrointestinal surgery for malignant tumors in elderly patients. However, if a surgical unit makes appropriate calculations using its own patient series and updates these equations, the POSSUM system can be useful in the risk assessment for surgery in elderly patients.

Introduction

Since the geriatric population in most developed countries is progressively increasing, the majority of patients admitted to hospitals are elderly. Furthermore, the increased life span and recent progress in perioperative management...
and operative techniques mean that surgeons have had to expand operative indications to include geriatric patients. Preoperative risk assessment is of primary importance in planning surgical treatment in these patients, because they often have cardiovascular diseases, metabolic disorders, or age-related respiratory problems in addition to the functional disorder of the diseased organ.\(^1,2\)

Recently, several scoring systems have been developed for evaluating the risk associated with surgery. The Physiological and Operative Severity Score for enUmeration of Mortality and morbidity (POSSUM) scoring system, reported by Copeland et al.,\(^3\) is one of the best-known scoring systems and consists of a physiological score and an operative severity score. However, since some reports cited a tendency of the POSSUM score to over-predict death in fit patients in several surgical areas,\(^4,5\) Whiteley et al.\(^6\) devised a new version, the Portsmouth predictor equation for mortality (P-POSSUM) system.

The POSSUM model was originally developed for quality assessment purposes in general surgical units. In order to implement it for specific subgroups of patients, its performance within such subgroups needs to be evaluated. This study estimated the usefulness of the POSSUM and P-POSSUM as risk prediction systems in surgery for gastrointestinal cancer in elderly patients.

**Patients and methods**

**Patients**

This study involved 153 consecutive patients (81 men and 72 women) aged over 75 years who underwent elective surgery for the gastric or colorectal malignant tumors between July 2004 and June 2006 in our Department of Surgery. The average age was 80.2 years and the age range was 75–96 years. Eighty-six patients were in the seventh decade of life, 56 in the eighth, and 11 in the ninth. Eighty-one patients had gastric cancer, 1 had a gastric stromal tumor, and 71 had colon or rectal cancer. Each patient underwent an operation for a curative resection of the cancer with lymphadenectomy. Final stagings of cancer classified based on the UICC TNM classification (6th edition, 2002) were as follows: for gastric cancer, IA in 10 patients, IB in 15 patients, II in 20 patients, IIIA in 31 patients, IIIB in 5 patients; for colorectal cancer, I in 4 patients, II in 18 patients, IIIA in 5 patients, IIIB in 11 patients, IIIC in 15 patients. Types of surgery performed are summarized in Table 1. The extent of a lymphadenectomy for the gastric cancer was classified as D1 or D2, according to the Japanese Gastric Cancer Association classification.\(^7\)

**Methods**

We recorded the preoperative morbidity in each patient. The performance status and the American Society of Anesthesiologists (ASA) score were also recorded prospectively. The postoperative complications were recorded retrospectively.

The POSSUM and P-POSSUM scores were calculated prospectively according to previously described criteria. A correlation between the physiological scores for the POSSUM and P-POSSUM and ASA score was examined. All correlations were examined statistically by using Pearson’s correlation test. Thereafter, the morbidity risk was calculated using the POSSUM and the mortality risk was calculated using both the POSSUM and P-POSSUM (for general surgery), the POSSUM and P-POSSUM data were analyzed as described by Wijesinghe et al.\(^8\) The observed/expected complications and deaths ratio (O/E ratio) was calculated for each analysis, as described in other reports.\(^8,9\) A chi-square test was used to detect differences between predicted and observed rates of morbidity and mortality. New logistic regression equations for morbidity and mortality rates, calculated using the physiological score and operative severity score for the POSSUM system, were developed using the data for our patient series and then were applied retrospectively.

**Results**

**Preoperative condition**

Regarding preoperative morbidity, 50 patients (32.7%) had hypertension, 19 patients (12.4%) had diabetes mellitus, 17 patients (11.1%) ischemic heart diseases, 4 patients (2.6%) had a pacemaker implantation for arrhythmia, 10 patients (6.5%) had respiratory diseases including asthma and emphysema, 7 patients (4.6%) had past histories of cerebral infarction, and 4 patients (2.6%) had chronic renal failure. Forty-six patients (29.3%) had no morbidity. Performance status was rated 0 in 13 patients, 1 in 62 patients, 2 in 61 patients, 3 in 15 patients, and 4 in 2 patients, with a median value of 2. The median ASA score was 2, with a range from 1 to 4.

**POSSUM scores**

The mean value of the physiological score was 25.0 with a standard deviation of 5.2 in all patients. The mean value of the operative score was 15.2 with a standard deviation of 4.7.
Postoperative complications

In 130 patients, the postoperative course was uneventful, while 23 patients had postoperative complications. Of these 23, 6 died during the same admission as the operation within 30 days after surgery. Postoperative complications included pneumonia (12 patients), renal failure (4 patients), leakage of the gastrointestinal anastomosis and the intraperitoneal abscess (10 patients), intraperitoneal bleeding (2 patient), and gastroenteritis caused by methicillin-resistant *Staphylococcus aureus* (4 patients). The morbidity rate was 15.0% (23/153) and the mortality rate 3.9% (6/153).

Correlation between ASA score and POSSUM physiological score

As is shown in Fig. 1, a statistically significant ($P < 0.001$) positive correlation was observed between the ASA score and POSSUM physiological score. In patients with ASA score 1 the POSSUM physiological score was 22.3 ± 2.9 (mean ± SD), while those in patients with ASA score 2 and 3 were 24.8 ± 4.5 and 32.7 ± 4.6, respectively.

Prediction of morbidity

As shown in Table 2, the O/E ratio obtained for the POSSUM score was 0.23. A chi-square test showed no significant difference in morbidity and the number predicted using the POSSUM system ($P = 0.002$).

Prediction of mortality

As shown in Table 3, the O/E ratio for the POSSUM score was 0.15, while those for the P-POSSUM obtained using a linear analysis was 0.38. Chi-square tests showed significant differences between the observed and predicted numbers using the POSSUM system ($P = 0.86$) and P-POSSUM system ($P = 0.726$).

![Graph](image)

**Figure 1** A statistically significant positive correlation was observed between ASA score and POSSUM physiological score.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Prediction of the morbidity: POSSUM</th>
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<tbody>
<tr>
<td>Predicted morbidity rate (%)</td>
<td>No. of patients</td>
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<tr>
<td>0–29</td>
<td>1</td>
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<tr>
<td>30–49</td>
<td>36</td>
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<td>50–69</td>
<td>46</td>
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<td>70–89</td>
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<td>90–100</td>
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<td>0–100</td>
<td>153</td>
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<th>Table 3</th>
<th>Prediction of the mortality</th>
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<tr>
<td>Predicted mortality rate (%)</td>
<td>No. of patients</td>
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<tr>
<td>POSSUM</td>
<td></td>
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<tr>
<td>0–&lt;10</td>
<td>33</td>
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<tr>
<td>10–&lt;20</td>
<td>51</td>
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<td>20–&lt;40</td>
<td>39</td>
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<tr>
<td>40–100</td>
<td>30</td>
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<td>0–100</td>
<td>153</td>
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<tr>
<th>P-POSSUM</th>
<th>Mean predicted risk (%)</th>
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<tr>
<td>0–&lt;5</td>
<td>68</td>
</tr>
<tr>
<td>5–&lt;30</td>
<td>74</td>
</tr>
<tr>
<td>30–100</td>
<td>11</td>
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<tr>
<td>0–100</td>
<td>153</td>
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Derivation of equations predicting morbidity and mortality by logistic regression using our data set

We used a logistic regression analysis of our data to obtain new equations predicting hospital morbidity including mortality for the POSSUM systems. For the POSSUM system, the new equation was: $\log\left(\frac{R}{1-R}\right) = -15.158 + 0.295 \times PS + 0.331 \times OS$, where $R$ denotes the morbidity risk.

The original equations were: POSSUM: $\log\left(\frac{R}{1-R}\right) = 7.04 + 0.13 \times PS + 0.16 \times OS$; P-POSSUM: $\log\left(\frac{R}{1-R}\right) = -9.065 + 0.1692 \times PS + 0.1550 \times OS$, where PS denotes the physiological score, and OS denotes the operative severity score.

The frequency tables of three risk bands using the new equations are shown in Table 4. For the POSSUM calculated by using the new equation the O/E ratio was 0.88.

Discussion

The geriatric population is increasing worldwide, with the over-65 age group increasing at the swiftest rate. Within this over-65 age group, population aged 85 years and older is growing at the fastest rate. Currently, one in 4 surgical patients is over 65, and 50% of people over 65 will have an operation during the remainder of their lifetime.³
The impact of age upon the organ morphology and function has been thoroughly investigated. The heart, kidney, liver, lung, and brain lose mass with age. Therefore, the morbidity and mortality risks associated with surgical treatments generally increase with age, although some reports have found no effect of aging alone on operative risk. If the postoperative course is complicated, then organ functional disability occurs faster and recovery takes longer. A precise risk assessment is therefore of primary importance in planning surgical treatment for elderly patients. However, no definite criteria have yet been established for risk assessment for surgery in the elderly.

Recently, several scoring systems for assessing risk associated with surgery have been developed. In risk assessment, systems may be required to include not only the preoperative condition of the patient, but also the complexity of the surgical procedure. The well-known POSSUM scoring system consists of the physiological score (including age, cardiopulmonary signs, the Glasgow coma scale, and some laboratory tests) and the operative severity score. POSSUM is the newer Portsmouth predictor equation for perioperative mortality and was developed to correct the mortality rate using the same score but a different equation. In this study, we applied these scoring systems to our series of elderly patients who had undergone elective gastrointestinal surgery, with the aim of determining whether the systems were useful for evaluating the risk of surgery for digestive tract cancer in elderly patients.

The results showed that neither of the systems was sufficiently precise to predict the morbidity and mortality in our series of patients, as the O/E ratios were not high enough. Both systems tended to over-predict both the morbidity and mortality score. In our series of patients, the morbidity rate was 15.0% (23/153) and the mortality rate was 3.9% (6/153). Recently, it was reported that perioperative mortality for general surgery in the elderly has decreased to 5%. If the postoperative course is complicated, then organ functional disability occurs faster and recovery takes longer. A precise risk assessment is therefore of primary importance in planning surgical treatment for elderly patients. However, no definite criteria have yet been established for risk assessment for surgery in the elderly.

In this study, new equations derived using the data from the POSSUM system proved to be useful tools in risk assessment for the elderly. A better understanding and use of perioperative monitoring, earlier intervention, earlier restoration of mobility and return to usual activity, and neuroleptic anaesthesia have all contributed to lower rates of surgical mortality in the elderly. Thus, preoperative management based on this scoring system in addition to the recognition of precise individual risk may thus help reduce the mortality and morbidity rates in elective surgery for the elderly. However, the small number of patients investigated in this study means that further studies are required.

In conclusion, both the POSSUM and P-POSSUM scores over-predicted the morbidity and mortality in elective gastrointestinal surgery for malignant tumors in elderly patients. However, if a surgical unit can accurately calculate equations using its own patient series while also performing updates for these equations, then the POSSUM system is expected to be useful in the risk assessment for surgery among the elderly.
Conflict of interest
None.

Funding
None.

Ethical approval
Ethical approval was given by a committee of Kagawa University.

References