Background: The indications for surgical treatment of patients with head and neck cancer can be limited by the risk of perioperative complications. Prediction of outcome is important in disease stratification and the subsequent decision-making process.

Objective: To assess the value of the APACHE II (Acute Physiology and Chronic Health Evaluation II) score, POSSUM (Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity), and ASA (American Society of Anesthesiologists) classification in the prediction of complications in patients with oral or oropharyngeal cancer.

Methods: Five hundred thirty patients with oral or oropharyngeal carcinomas who underwent surgical treatment were evaluated using ASA, POSSUM, and APACHE II scores. The outcome measure was morbidity within 30 days. Logistic regression and receiver operating characteristic curve analyses were used to estimate the predictive ability of the scoring systems.

Results: The overall complication rate was 58.9%. Most of the patients had local complications. The mortality was 2.6%. The results showed that APACHE II (relative risk, 1.09; \( P = .001 \)) and POSSUM (relative risk, 1.09; \( P < .001 \)) equally predicted perioperative complications and were superior to the ASA system (relative risk, 0.98; \( P = .89 \)) (area under the curve, 0.65 for APACHE II, 0.68 for POSSUM, and 0.56 for ASA).

Conclusions: The POSSUM and APACHE II scores were useful in predicting perioperative morbidity for patients with oral or oropharyngeal cancer, serving as objective methods to assist the surgeon in classifying patients into risk groups with different probabilities of perioperative complications. The poorer results achieved with the ASA classification are possibly because this system is primarily based on subjective clinical judgments.

Arch Otolaryngol Head Neck Surg. 2003;129:739-745
the most appropriate score in the establishment of operative risk. Also, improvements in anesthetic and surgical techniques, including microvascular reconstruction, have allowed the implementation of radical oncological procedures for treating advanced head and neck cancer. However, the curative intent can be limited by the hazard of perioperative complications, which increase the length of hospital stay and require diagnostic and therapeutic procedures, adding to treatment costs. There is no specific scoring system to predict morbidity or mortality in patients with head and neck cancer.

The objective of this study was to compare the APACHE II, POSSUM, and ASA scoring systems in the prediction of perioperative complications in patients undergoing curative surgical treatment for oral or oropharyngeal cancer.

**METHODS**

Five hundred thirty medical records of patients with squamous cell carcinoma of the oral cavity or oropharynx admitted to the Centro de Tratamento e Pesquisa Hospital do Cancer A. C. Camargo from January 1, 1990, to December 31, 1997, were reviewed. The following criteria were used for inclusion in the study: a histologically confirmed diagnosis, absence of previous oncological treatment for the primary tumor, no distant metastasis, and surgical treatment (exclusive or as part of a multidisciplinary approach) with a curative purpose.

The APACHE II classification (a revised version of the prototype APACHE system) includes 12 physiological measures (temperature, mean arterial pressure, heart rate, respiratory rate, oxygenation, arterial pH, serum sodium, serum potassium, serum creatinine, hematocrit, white blood cell count, and Glasgow Coma Scale score); age; and severe chronic health problems. The physiological score is determined by the worst value (eg, the lowest hematocrit or the highest respiratory rate) found during the initial 24 hours after intensive care unit admission. In our study, we also applied APACHE II to patients not referred to the intensive care unit, based on the findings of the first postoperative 24-hour period (Table 1).

The POSSUM was developed through multivariate discriminant analysis to obtain a method of risk assessment. This 12-factor, 4-grade physiological score includes the following: age; cardiac status; pulse rate; systolic blood pressure; respiratory status; Glasgow Coma Scale score; serum concentrations of urea, potassium, and sodium; hemoglobin concentration; white blood cell count; and findings on electrocardiography. It is subsequently combined with a 6-factor operative score that adjusts for the type of surgical procedure and includes the type and number of procedures, volume of blood loss, perioperative contamination, presence and extent of malignancy, and timing of the operation. In this study, the operative extent was defined as minor (partial glossectomy and other intraoral resections without neck dissection), moderate (any surgical procedure with microvascular reconstruction). For both indexes, if an item was not present, it was recorded as not applicable.

Morbidity was defined as any complication occurring within the first 30 postoperative days. Local complications were those that arose on the surgical wound without systemic repercussions. Systemic complications were defined as those that affected the whole body, including pneumonia, sepsis, respiratory failure, cerebral vascular accident, acute myocardial infarction, massive bleeding requiring reoperation, and operative death. Any death within 30 days of operation was classified as an operative death.

The statistical analysis included Spearman rank correlation coefficient, 1-way analysis of variance (with the Tukey HSD [Honestly Significantly Different] test for multiple comparisons), and χ² and Fisher exact tests. Logistic regression analysis was applied to estimate the predictive ability of the ASA, APACHE II, and POSSUM scoring systems in assessing perioperative morbidity. The dependent variable was the postoperative course (uncomplicated or complicated), and the independent variables were the ASA classification and APACHE II and POSSUM scores. The significance of the independent variable in each model was tested with G statistics, which (according to the hypothesis that B1 is equal to zero) follow a χ² distribution.

The second step in the statistical analysis compared the predictive ability among the scores using receiver operating characteristic (ROC) curve analysis. The area under the ROC curve indicates the probability of concordance between the predicted probability of postoperative complications and the actual postoperative state, and has been described as the best “index of detectability.” The area ranges from 0.50 for chance performance to 1.00 for perfect prediction. Each area ± SD referring to a predictive model was estimated and compared with each other using the method proposed by Metz et al. Data were considered statistically significant at P < .05.
senting with an APACHE II score higher than 10 (5.3%) compared with subjects with an APACHE II score of 10 or lower (1.8%) \( (P = .052) \). A statistically significant difference between the operative mortality was also noted between patients with POSSUM scores higher than 24 (3.7%) vs 24 or lower (0.6%) \( (P = .04) \).

The correlation between the ASA classification and the length of hospitalization was weak \( (r = 0.14; P = .002) \). The APACHE II showed a weak positive correlation with the length of hospitalization \( (r = 0.22) \), while the POSSUM showed a modest positive correlation \( (r = 0.41) \) \( (P < .001 \) for both) \( \text{(Figure 1)} \).

The results of the logistic regression analysis showed a significant relationship between the risk of complications and the predictive score of each index, as indicated by the \( G \) statistics: ASA, 6.18 \( (P = .01) \); APACHE II, 32.98 \( (P < .001) \); and POSSUM, 39.82 \( (P < .001) \) \( \text{(Table 6)} \). The positivity of the logistic regression coefficient of all scores revealed that the risk increases along with the scores. The results showed that APACHE II (rela-
Mortality and Morbidity. Probably not changed, with a significant number of unhealthy surgical procedures. The acceptable level of risk has probably not changed, with a significant number of unhealthy patients still undergoing extensive surgical procedures. Therefore, the role of the preoperative evaluation in the planning and management of anesthesia, surgery, and postoperative care continues to be a relevant issue. Several scoring systems can calculate the risk of death, but unfortunately they are inclined to ignore morbidity.

The ROC curve analysis demonstrated that the POSSUM index (area under the ROC curve, 0.68) had a statistically significant better prognostic capacity than ASA classification (area under the ROC curve, 0.56) (P = .89) (area under the curve, 0.65 for APACHE II, 0.68 for POSSUM, and 0.56 for ASA).

The APACHE II score (area under the ROC curve, 0.65) also showed a better prognostic ability than ASA classification (area under the ROC curve, 0.56) (P = .001) and POSSUM (relative risk, 1.09; P = .019) equally predicted perioperative complications and were superior to the ASA system (relative risk, 0.98; P = .89) (area under the curve, 0.65 for APACHE II, 0.68 for POSSUM, and 0.56 for ASA).

Any surgical procedure should be routinely preceded by a satisfactory preoperative assessment with the main objective of reducing risks. Improvements in methods and equipment and the development of new drugs have decreased the risks associated with anesthesiological and surgical procedures. The acceptable level of risk has probably not changed, with a significant number of unhealthy patients still undergoing extensive surgical procedures. Therefore, the role of the preoperative evaluation in the planning and management of anesthesia, surgery, and postoperative care continues to be a relevant issue. Several scoring systems can calculate the risk of death, but unfortunately they are inclined to ignore morbidity.

Table 2. POSSUM Score

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>≤60</td>
<td>61-70</td>
<td>≥71</td>
<td>NA</td>
</tr>
<tr>
<td>Cardiac signs</td>
<td>No failure</td>
<td>Diuretic, digoxin, antianimal, or hypertensive therapy</td>
<td>Peripheral edema; warfarin sodium therapy</td>
<td>Raised jugular venous pressure</td>
</tr>
<tr>
<td>Chest radiograph (heart)</td>
<td>NA</td>
<td>NA</td>
<td>≥171</td>
<td>≤89</td>
</tr>
<tr>
<td>Respiratory history</td>
<td>No dyspnea</td>
<td>Dyspnea on exertion</td>
<td>Limiting dyspnea (1 flight)</td>
<td>Cardiomegaly</td>
</tr>
<tr>
<td>Mean systolic blood pressure, mm Hg</td>
<td>110-130</td>
<td>131-170</td>
<td>10-120</td>
<td>≥121</td>
</tr>
<tr>
<td>Pulse, beats/min</td>
<td>50-80</td>
<td>81-100</td>
<td>101-120</td>
<td>≥121</td>
</tr>
<tr>
<td>Glasgow coma score</td>
<td>15</td>
<td>12-14</td>
<td>11-12</td>
<td>=9</td>
</tr>
<tr>
<td>Hemoglobin, g/dL</td>
<td>13.0-16.0</td>
<td>11.5-12.9</td>
<td>10.0-11.4</td>
<td>≤8</td>
</tr>
<tr>
<td>White blood cell count, ×10⁹/L</td>
<td>4.0-10.0</td>
<td>10.1-20.0</td>
<td>10-13</td>
<td>≤8</td>
</tr>
<tr>
<td>Serum urea, mg/dL</td>
<td>≥21</td>
<td>22-28</td>
<td>29-41</td>
<td>≥42</td>
</tr>
<tr>
<td>Serum sodium, mEq/L</td>
<td>≥136</td>
<td>131-135</td>
<td>126-130</td>
<td>≥125</td>
</tr>
<tr>
<td>Serum potassium, mEq/L</td>
<td>3.5-5.0</td>
<td>3.2-3.4</td>
<td>2.9-3.1</td>
<td>≤8</td>
</tr>
<tr>
<td>Electrocardiogram</td>
<td>Normal</td>
<td>NA</td>
<td>≥20.1</td>
<td>NA</td>
</tr>
<tr>
<td>Operative severity</td>
<td>Minor</td>
<td>Moderate</td>
<td>Major</td>
<td>Major plus</td>
</tr>
<tr>
<td>Multiple procedures</td>
<td>1</td>
<td>NA</td>
<td>2</td>
<td>≥2</td>
</tr>
<tr>
<td>Total blood loss, mL</td>
<td>≤100</td>
<td>101-500</td>
<td>501-999</td>
<td>≥1000</td>
</tr>
<tr>
<td>Peritoneal soiling</td>
<td>None</td>
<td>Minor (serous fluid)</td>
<td>Local pus</td>
<td>Free-bowel content, pus, or blood</td>
</tr>
<tr>
<td>Presence of malignancy</td>
<td>None</td>
<td>Elective</td>
<td>Primary only</td>
<td>Nodal metastases</td>
</tr>
<tr>
<td>Mode of surgery</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Emergency (immediate surgery &lt;2 h needed)</td>
</tr>
</tbody>
</table>

Abbreviations: COPD, chronic obstructive pulmonary disease; NA, not applicable; POSSUM, Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity.

SI conversion factor: To convert urea to millimoles per liter, multiply by 0.357.
The ASA classification system is concisely defined using simplistic terms. This fact paradoxically may have contributed to its extensive and worldwide application, but it is recognized that the use of the system in clinical practice is subject to large variation among assessors.21,23

The APACHE II system has been described as flexible, with good prognostic capacity and with no significant differences in the prediction of outcomes between elective and emergency surgery or between benign and malignant disease, and it is able to predict increasing levels of complications (minor, major, and death).1 However, its weaknesses are that it ignores conditions such as the nutritional status of the patient, cardiac findings such as acute ischemic electrocardiographic alterations, presence of severe arrhythmias, or a history of recent myocardial infarction, which would increase the operative risk.24,25

The POSSUM system has been recommended as an accurate method in evaluating the outcome of surgical patients and allowing direct comparisons, despite distinct patterns of referral and populations.4 It has the benefit of being simple and includes variables that are easy to collect. It considers the physiological condition of the patient at admission and the severity of the surgical procedure to predict the rates of morbidity and mortality.

The POSSUM index aims to draw attention to differences in surgical care and outcome. The inclusion of operative factors adjusts for dependencies on surgical procedure, but adjustments for differences among surgeons, anesthetists, and operating time are lacking.26 The large acceptance and precision in recording a score demands that all the data be promptly accessible from the patient’s regular assessment. The POSSUM uses complex data, but all the physiological information is available from a routine preoperative evaluation, and the operative data are included in an ordinary operative note.10 Scores that require nonroutine information may be of value in patients who are prone to be at higher risk from surgery, but they are not appropriate for broad use.10

The accurate measurement of outcomes in surgical patients is a challenge, requiring variables that should be easily quantifiable preoperatively and intraoperatively.27 Some scores are accurate in assessing the risk of morbidity and mortality in particular patients, and the APACHE II is probably the most extensively used and recognized.22 This index is good for intensive care unit patients but has the disadvantages of requiring 24 hours of surveillance28 and not taking into account the extent of the surgical procedure. The POSSUM has the advantages of inclusion of operative complexity, extent of malignant spread, and correction for comorbidities.4

The effect of comorbidities on the prognosis of patients with oral or oropharyngeal cancer has already been demonstrated.29,31 It is well-known that comorbidities con-
tribute to a higher incidence of perioperative complications in this group of patients,\textsuperscript{11,12} which is subsequently related to a worse prognosis.\textsuperscript{20} This study demonstrated a good performance of APACHE II and POSSUM scores in the prediction of perioperative complications in patients with oral or oropharyngeal carcinomas. However, current scoring systems for the assessment of surgical risk of complications and death are not completely satisfactory for these patients, who usually have cardiac, pulmonary, and hepatic disorders. Therefore, the development of a new scoring system for patients with head and neck cancer, comprising perioperative and operative factors, should be included as an essential part of clinical outcomes research.

Accepted for publication December 4, 2002.

This study was presented at the annual meeting of the American Head and Neck Society, Boca Raton, Fla, May 11, 2002.

Corresponding author: Luiz Paulo Kowalski, MD, PhD, Hospital Cancer Registry and Department of Head and Neck Surgery and Otorhinolaryngology, Centro de Tratamento e Pesquisa Hospital do Câncer A. C. Camargo, R. Professor Antônio Pudente, 211, CEP 01509-010, São Paulo-SP, Brazil (e-mail: lp_kowalski@uol.com.br).

Table 6. Comparison of the Results of the Logistic Regression Analysis Between the ASA, APACHE II, and POSSUM Models

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>β0 (Intercept)</th>
<th>β1 (Independent Variable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA</td>
<td>−0.44 (0.36)</td>
<td>0.391 (0.16)</td>
</tr>
<tr>
<td>APACHE II</td>
<td>−0.64 (0.20)</td>
<td>0.131 (0.02)</td>
</tr>
<tr>
<td>POSSUM</td>
<td>−2.58 (0.53)</td>
<td>0.113 (0.02)</td>
</tr>
</tbody>
</table>

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; ASA, American Society of Anesthesiologists; POSSUM, Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity.

Figure 1. A, Scatterplot of length of hospitalization and American Society of Anesthesiologists classification. B, Scatterplot of length of hospitalization and APACHE (Acute Physiology and Chronic Health Evaluation) II score. C, Scatterplot of length of hospitalization and POSSUM (Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity) score.

Figure 2. Receiver operating characteristic curves for the American Society of Anesthesiologists (ASA), APACHE (Acute Physiology and Chronic Health Evaluation) II, and POSSUM (Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity) indexes.

Table 6. Comparison of the Results of the Logistic Regression Analysis Between the ASA, APACHE II, and POSSUM Models


