Evaluation of O-POSSUM vs ASA and APACHE II scores in patients undergoing oesophageal surgery

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Abstract

Background and aims: Risk and prognostic scores quantify the patient’s risk of death or complication according to the severity of his illness. The aim of this study was to evaluate the predictive accuracy of O-POSSUM vs ASA and APACHE II models on patients undergoing oesophageal surgery.

Material and method: In this observational retrospective study 55 patients were enrolled who had undergone surgical interventions of excision and reconstruction of the oesophagus for neoplastic oesophageal stenosis, in the Surgical Clinics (I and II) of the Clinical County Emergency Hospital Mures, between January 2011 and January 2014. By using patients file records after extracting the data we calculated the predictive mortality, according to the prognostic scores O-POSSUM, ASA and APACHE II and we analyzed its correlations with the postoperative evolution. We evaluated the discriminatory power of the three scores using the ROC (receiver-operating characteristic) curves. According to the cut-off value corresponding to each score, we compared the Kaplan Meier survival curves during the hospitalization period.

Results: ROC curves analysis revealed that O-POSSUM had a better discriminatory power for mortality compared to the other two scores: AUC = 0.73 for O-POSSUM, AUC = 0.57 for APACHE II and AUC = 0.64 for ASA (p < 0.001). The cut-off value was statistically significant only in case of O-POSSUM, as it derives from the statistical analysis of the survival curves (p = 0.035).

Conclusion: O-POSSUM predicts mortality more accurately compared to ASA or APACHE II in patients undergoing oesophageal surgery.

Keywords: O-POSSUM, ASA, APACHE II, oesophageal surgery

Introduction

Surgical interventions for the removal and reconstruction of the oesophagus represent the “corner stone” in the elective treatment of esophageal stenosis. Most patients with oesophageal cancer apply for surgery in an advanced stage of disease. Curative surgery requires considerable resources in the operating theatre and in the critical care unit and is associated with important postoperative morbidity and mortality. Respiratory complications occur the most frequently and are responsible for the majority of the postoperative deaths [1].

Therefore, preoperative surgical risk assessment is a crucial part of the modern surgical practice. Risk and prognostic scores quantify the patient’s risk of death or complication according to the severity of his illness. This will allow a surgeon to anticipate the adverse events following the surgery and to facilitate the informed consent process and surgical decision making. Various surgical risk prediction models have been developed to objectively quantify the postoperative morbidity and mortality. Some of the common risk
prediction models in surgery are APACHE II (Acute Physiology and Chronic Health Evaluation) [2], POSSUM (Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity) [3] and ASA (The American Society of Anesthesiologist’s) physical status classification [4].

The simplest and most used scoring system is the ASA score, based on the assessment of the patients’ physical status. The ASA score was initiated in the beginning of the 1940’s, and since then only minor changes have been added despite major progress in anesthesiology and surgery.

The APACHE II score is a standard tool for the assessment of the degree of disease severity in ICU ranging between 0-71 points. Higher values are related to higher severity and mortality levels. This score is defined by 3 components: the acute physiological score involving 12 parameters, age score and chronic illnesses score. Each parameter has a coefficient ranging 0-4, according to the severity of abnormal findings. The APACHE II score cannot be directly converted to a percent risk of mortality. In order to calculate a mortality risk, the patient’s indication for ICU admission must be accounted for.

The POSSUM model for predicting post-operative mortality was developed in 1991 using cohorts of general surgical patients, but has been used in clinical practice only in the last decade. It is based on a combination of physiological parameters, operative variables and age of the patients. Each of these factors is given a weighted value and the predicted risk of morbidity or death is calculated by a logarithmic formula. The POSSUM scoring system was particularly developed as an audit tool to compare postoperative outcome in general surgery, but it would appear that the POSSUM model increasingly overestimates mortality particularly in those who were at low risk [5]. Possible reasons for this are the increasing use of minimally invasive operative techniques and the better peri-operative care. In 1996 a new variant of POSSUM was developed: P-POSSUM [5]. It used the same set of variables as POSSUM but has a different logistic regression equation. Both POSSUM and P-POSSUM scoring systems use a 12 factor physiological score and a 6 factor operative severity score [6].

Attempts have been made to modify the POSSUM scoring system for specific surgical procedures. For example: V-POSSUM [7] for vascular, RAAA-POSSUM [8] for ruptured abdominal aortic aneurysm, CR-POSSUM [9] for colorectal surgery and O-POSSUM [10] for oesophageal and upper gastrointestinal surgery. In O-POSSUM, the operative severity score is modified to exclude operative blood loss, number of procedures and peritoneal soiling. Age was regressed independently from POSSUM.

**Objective**

The aim of this study was to evaluate the predictive accuracy of O-POSSUM vs ASA and APACHE II scores in our case series of patients undergoing oesophageal surgery. In our setting, the O-POSSUM score is not utilized as a routine, but still holds a great potential for evaluating the risk severity associated with oesophageal surgery.

**Material and method**

The study was observational and retrospective. The Institutional Review Board approval was obtained before enrolling the patients (n = 55). Our including criteria were: adult patients who had undergone surgical interventions of removal and reconstruction of the oesophagus, in the Surgical Clinics No. I and II of the Clinical County Emergency Hospital Mures, between January 2011 and January 2014 and were admitted postoperatively in ICU.

The following data were collected from the patients’ files: age, diagnostic, length of postoperative stay in ICU, the ASA score - as it appeared in the patient pre-anesthetic informed consent, the physiological and the disease-related variables necessary for calculating APACHE II score on the first day of ICU admittance, the preoperative physiological parameters and operative variables necessary for calculating O-POSSUM score and outcome of the patient at their ICU discharge.

The data were collected from patients’ files and were processed using Microsoft Excel and SPSS statistics version 22 (IBM, New York, USA).

We calculated the predictive mortality, according to the prognostic scores O-POSSUM, ASA and APACHE II and we correlated it with the postoperative evolution. We evaluated the discriminatory power of the three scores using the ROC (receiver-operating characteristic) curves. According to the cut-off value corresponding to each score, we compared the Kaplan Meier survival curves during hospitalization period.

**Results**

The present study enrolled a number of 55 patients (47 males and 8 females) diagnosed with neoplastic oesophageal stenosis. Patients’ age ranged 40-80 years, and the average was 61.32 ± 6.95 years. The median range of hospitalization was 17 (2, 51) days.

At the day of surgical intervention, values for O-POSSUM, APACHE II and ASA prognostic score systems were as they are presented in Table 1.

Neoplastic stenosis was located most frequently at the lower third of the oesophagus (39.29%).
Table 1. The average values of the preoperative prognostic scores

<table>
<thead>
<tr>
<th>O-POSSUM</th>
<th>APACHE II</th>
<th>ASA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>24.77</td>
<td>15.57</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>6.809</td>
<td>5.095</td>
</tr>
<tr>
<td>Minimum</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Maximum</td>
<td>43</td>
<td>32</td>
</tr>
</tbody>
</table>

Using the Cox regression model, the site of tumor was not a predictor of mortality (p = 0.195, hazard ratio = 0.47) as presented in Table 2.

Table 2. Tumor site as a predictor of mortality

<table>
<thead>
<tr>
<th>Cox regression model for tumor site as a predictor of mortality</th>
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<tbody>
<tr>
<td>Tumor Site</td>
</tr>
<tr>
<td>------------</td>
</tr>
<tr>
<td>O-POSSUM</td>
</tr>
<tr>
<td>APACHE II</td>
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<tr>
<td>ASA</td>
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A number of 20 patients died after surgery (36.36%). We noticed that the highest mortality was in patients with neoplastic stenosis located in the intermediate and lower third of the esophagus (Figure 1). Surgical mortality is often seen as a surrogate of performance, to enable comparison between individual surgeons and hospitals. This method of comparison can be misleading due to differences in the case mix [11].

Fig. 1. Deaths according to tumor location

We evaluated the discriminatory power for mortality of the three scores using the ROC (receiver-operating characteristic) curves (Figures 2, 3, 4).

ROC curves analysis revealed that O-POSSUM had a better discriminatory power for mortality as compared to the other two scores: AUC = 0.73 for O-POSSUM, AUC = 0.57 for APACHE II and AUC = 0.64 for ASA (p < 0.001).
According to the cut-off value corresponding to each score, we compared the Kaplan Meier survival curves during the hospitalization period. The cut-off value was established in order to gain an optimal ratio between specificity and sensitivity, our target being the highest specificity (Figures 5, 6, 7).

The cut-off value was statistically significant only in the case of O-POSSUM, as it derives from the statistical analysis of survival curves (p = 0.035).

If we change the cut-off values of the APACHE II score, in order to increase specificity, the prognostic power of this score will be superior to O-POSSUM’s (p = 0.014 vs p = 0.035) (Figure 8).
Discussions

O-POSSUM predicts mortality more accurately than ASA or APACHE II in patients undergoing oesophageal surgery. But, in the case of patients with multiple associated comorbidities, the APACHE II score has a superior statistical significance compared to the POSSUM score.

The ASA score is easy to use but it is not very precise and it does not consider surgical insult in predicting postoperative outcome. Its main advantage consists of its simplicity, but it is also its major limitation. The ASA score does not make a difference either between the illnesses of different systems nor the different abnormalities in the same system and does not rank asymptomatic patients (eg., patients with severe coronary disease). Values of the ASA score cannot guide preoperative management of the patients, because it does not make a difference in the preoperative approach for an asthmatic patient to a patient with severe renal impairment or metastatic tumors [12]. The ASA score has no capacity to delimit or to add the risk imposed by multiple diseases. The evaluation of ASA score reflects only the patient’s physical condition, with no respect to the magnitude of the surgical insult [13].

The APACHE scoring system is quite complex and time consuming. Moreover, all the parameters are not always easily obtainable, particularly outside the intensive care setting. Therefore, missing values in the data are a potential source of error in the APACHE scoring system [14]. The APACHE II score is mainly useful for monitoring patients’ evolution in ICU but it is also accurate in predicting perioperative complications in the surgical patients [15, 16].

The POSSUM scoring system is an intermediate score between ASA and APACHE regarding its objectivity and its simplicity. O-POSSUM was designed to provide a dedicated model for prediction of mortality after oesophago-gastric resections.

According to our study, the O-POSSUM score system has the best discriminatory capacity in the assessment of postoperative mortality (AUC = 0.73 for O-POSSUM, AUC = 0.57 for APACHE II and AUC = 0.64 for ASA), but it could not identify patients with a higher risk for in-hospital mortality. For patients presenting multiple comorbidities, the APACHE II score is more accurate and it has a superior statistic significance than the O-POSSUM score.

The high mortality is explained by the pressure to operate due to rejected patients or deferred from other hospitals, sometimes patients exceeding the indications for surgery.

There were four studies of O-POSSUM on postoperative mortality in patients undergoing resection for gastro-oesophageal cancer [17-20]. Out of these four studies, three were oesophageal studies and one gastro-oesophageal study. In all of them, O-POSSUM appeared to have poor predictive accuracy and showed significant lack of goodness of fit.

However, a deficiency in the current POSSUM models is that they are not based on a good understanding of the patho-physiological process that results in morbidity and mortality following cancer surgery. Recently it has become clear that the systemic inflammatory response, as evidenced by an inflammation based prognostic score (Glasgow Prognostic Score), is strongly associated with long term survival of both inoperable [21] and operable [22] cancer patients. Given that the GPS is much simpler (two factors) compared with physiological POSSUM (12 factors) further work is required to compare its value in predicting morbidity and mortality following cancer surgery.

These risk assessment tools have been used to allow for the comparative audit of surgical mortality although they fail to address the prediction of morbidity and mortality in individual patients.

As a retrospective study this has several limitations. Of these the most important are the relative small number of subjects included (55 patients) and the existence of bias in collecting the necessary data from patients files that may adversely impact the reliability of the results.

Conclusions

Our results showed that O-POSSUM predicts mortality more accurately than the ASA or the APACHE II scores in patients undergoing oesophageal surgery.

In patients with multiple comorbidities, the APACHE II score has increased statistical significance.

Conflict of interest

Nothing to declare

References

Evaluarea scorurilor O-POSSUM vs ASA şi APACHE II la pacienții supuși chirurgiei esofagiene

Rezumat

Obiectiv: Scorurile de risc și prognostic cuantifică riscul de deces sau complicație a pacientului pe baza severității bolilor. Obiectivul acestui studiu a constat în evaluarea acurateței predictive a scorurilor O-POSSUM vs ASA și APACHE II la pacienții supuși chirurgiei esofagiene.

Material și metodă: În acest studiu observațional, retrospectiv au fost înrolați 55 de pacienți care au necesitat intervenții chirurgicale de rezecție și reconstrucție esofagiană pentru stenoze de etiologie neoplazică în Cliniciile Chirurgie I și II ale Spitalului Clinic Județean de Urgență Târgu Mureș în perioada 2011-2014. Am calculat mortalitatea predictivă potrivit scorurilor de prognostic O-POSSUM, ASA și APACHE II și am comparat curbele de supraviețuire Kaplan Meier pe perioada internării. Evaluarea capacității discriminatorii a celor trei scoruri s-a realizat utilizând curbele ROC (receiver-operating characteristic). În funcție de valoarea de cut-off aferentă fiecărui scor, am comparat curbele de supraviețuire Kaplan Meier pe perioada internării.

Rezultate: Analiza curbelor ROC a arătat o mai bună capacitate discriminatoare a celor trei scoruri pentru O-POSSUM (AUC = 0,73 pentru O-POSSUM, AUC = 0,57 pentru APACHE II și AUC = 0,64 pentru ASA) (p < 0,001). Valoarea de cut-off a fost semnificativă statistic numai pentru O-POSSUM, informație derivată din analiza curbelor de supraviețuire (p = 0.035). Concluzii: Scorul O-POSSUM a prezentat cea mai bună capacitate de discriminare în prediccția mortalității la pacienții supuși chirurgiei esofagiene.

Cuvinte cheie: O-POSSUM, ASA, APACHE II, chirurgie esofagiană.