A Validation Study for POSSUM and EuroSCORE as a Predictor of Mortality After Selective Cardiac Surgery

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ABSTRAK

Tujuan: *menilai sistem skoring* physiological and operative severity score for the enumeration of mortality *(POSSUM) dan membandingkannya dengan skor* European system for cardiac operative risk evaluation *(EuroSCORE) pada pasien yang menjalani pembedahan jantung di dua rumah sakit yang terletak di daerah barat daya Iran.* ***Metode:*** *pada penelitian retrospektif ini, sebanyak 1420 pasien yang datang ke pusat kesehatan untuk menjalani pembedahan jantung elektif sejak tahun 2007 hingga 2012 dihitung skornya dengan menggunakan sistem skoring POSSUM dan EuroSCORE.* ***Hasil:*** *tingkat mortalitas keseluruhan ditemukan sebanyak 0.87%. Di antara seluruh faktor risiko yang ada, riwayat diabetes, kebiasaan merokok, penyakit saluran pernapasan, dan infark miokardium ternyata memengaruhi tingkat mortalitas secara bermakna. Meskipun demikian, dari faktor-faktor risiko tersebut, hanya kadar hemoglobin (OR: 1,43, IK95%:0,59–4,57. p=0,004) yang secara bermakna berkorelasi dengan tingkat morbiditas. Akurasi prediktif pada persamaan mortalitas adalah 74,5%. Akurasi prediktif batas bawah untuk persamaan mortalitas didapatkan sebesar 67,8% bila menggunakan EuroSCORE.* ***Kesimpulan:*** *meskipun didapatkan hasil yang bermakna secara statistik, namun kedua metode ini tidak pernah ditujukan untuk memengaruhi keputusan pembedahan dan keputusan ini harus didasarkan pada keahlian klinis karena masih diperlukan pengumpulan data standar dan stratifikasi risiko pembedahan agar sistem skoring seperti POSSUM dapat dipakai secara prospektif. Bila dianalisis dengan tepat, POSSUM merupakan prediktor yang baik untuk memperkirakan mortalitas pada pasien yang menjalani pembedahan jantung.*

Kata kunci: *pembedahan jantung, physiological and operative severity score for the enumeration of mortality (POSSUM), European system for cardiac operative risk evaluation (EuroSCORE).*

ABSTRACT

Aim: *to assess physiological and operative severity score for the enumeration of mortality (POSSUM) scoring system and compare it with European system for cardiac operative risk evaluation (EuroSCORE) scores in patients who underwent cardiac surgery from two hospitals in the southwestern region of Iran.* ***Methods:*** *in this retrospective study, total of all 1420 patients who were admitted for elective cardiac surgery at our centers, from 2007 to 2012, were scored using the POSSUM and EuroSCORE systems.* ***Results:*** *the overall mortality rate was 0.87%. Among the risk factors, history of diabetes, smoking, respiratory disease, and myocardial infarction, were significantly affect the mortality rate. Therefore, of these risk factors, only the hemoglobin was significantly*

correlated with the morbidity rate. The predictive accuracy of mortality equations was 74.5%. The lower predictive accuracy of mortality equations was 67.8% was observed using EuroSCORE. ***Conclusion:*** *although results are statistically significant, but the analysis have never intended to affect the decision to operate, and this decision must be based on clinical expertise, because of the need to standardize data collection and stratify the risks involved in operations, scoring systems such as POSSUM should be used prospectively. However, if analyzed correctly, POSSUM is a good predictor of mortality in patients undergoing cardiac surgery.*

Key words: *cardiac surgery, physiological and operative severity score for the enumeration of mortality (POSSUM), European system for cardiac operative risk evaluation (EuroSCORE).*

INTRODUCTION

The number of surgical interventions is likely to increase because of the aging population and the increasing number of patients with congenital heart disease.[1] Although data about the patient's care and outcome, which present as overall mortality rate, are somewhat easy to derive, but the quality of care is difficult to determine. The Continuous Improvement in Cardiac Surgery Program (CICSP) national database was developed in 1987, in which this quality of care improvement appears to have positively affected short-term and longer-term cardiac surgical outcomes.[2] Recently, epidemiologic evidence of preoperative independent risk factors of one of the following outcomes after adult cardiac surgery including death, stroke, renal failure and/or length of stay, showed that risk estimates of these outcomes may be improved by the inclusion of innovative risk factors.[3]

Many scoring systems have been introduced, to assess the risk of mortality to a lesser extent morbidity or are preferably suited to special types of surgical procedure such as cardiovascular surgeries,[4-7] or gastrointestinal[8,9] diseases. Risk assessment in a simple form, may allow consideration of a change in plan to reduce individual's risk such as a more limited operation, modification of the planned anesthetic technique or preoperative hemodynamics optimization. Therefore, in a more complex format, risk is assessed to allow suitable targeting of therapeutic options and decision-making about treatment choices so a suitable balance of risks, often between the possible side effects and dangers of surgery and the potential success of treatment, can be made.[10]

Many scoring systems for severity of illness were reported and widely known, but one of the most widely used scoring systems is the Acute Physiology and Chronic Health Evaluation (APACHE) scoring system.[11] This system, along with other general scoring systems, can only be used after an operation, and therefore any risk assessment ability within these scores can only be applied to postoperative care. The scoring system that has been precisely designed for surgical patients is the Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM) score.[12,13] Though POSSUM scoring was also inaccurate in laparoscopic surgery[14,15], but was suggested that may work better in gastrointestinal surgery[16,17], and vascular surgery.[18]

The European system for cardiac operative risk evaluation (EuroSCORE) system is a large, unrivalled in the completeness, and up-to-date database. This scoring system is also a method of calculating predicted operative mortality and a risk evaluation scoring system for patients undergoing cardiac surgery. It is taken from a cross-section of nearly 19030 consecutive patients from 128 hospitals in eight European countries.[19]

We aimed to assess the POSSUM scoring system in two different types of hospital across the southwestern region of Iran. In addition, we are comparing POSSUM with EuroSCORE scoring systems and examining the impact of physiological score manipulation, by preoperative resuscitative measures, on mortality rate after cardiac surgery.

METHODS

In this retrospective study, 1420 patients who were admitted for elective cardiac surgery at Golestan and Naft grand hospitals, Ahvaz, Iran, from 2007 to 2012, was scored using the POSSUM system. This study was approved by Naft Grand Hospital ethics committee and informed consent was obtained from all patients.

POSSUM Scoring

All patients were scored before operation (using the physiological score) and at Intensive care unit (using the operative severity score) based on the protocol explained formerly.[13] The physiological score reflects the indices of surgery rather than admission.

EuroSCORE System

The data collection and entry of all patients and quality checks have been done using multiple regressions analysis based on the risk factors associated with postoperative mortality.[19]

Data Collection

Data was obtained on patient characteristics and details of the mode and timing of presentation, the relevant investigations, and treatment received were also recorded. The information collected regarding the cardiac operation included: type of operation, degree of urgency, method of myocardial protection, bypass time, and cross-clamp time. Intensive care notes were reviewed to find out time to extubation and length of stay in the intensive care unit. We also recorded patient age, gender, measures of preoperative risk mortality (at any point during a hospital stay), and admission to the intensive care unit (ICU).

Statistical Analysis

Categorical data are summarized as absolute values (percentage), while continuous data are presented as mean (95% confidence intervals). Characteristics of patients with differing POSSUM scores were compared using of chi-square test, or analysis of variance, depending on the distribution and nature of the data. Using outcome (dead/alive or complicated/uncomplicated) as a dichotomous dependent variable, we have derived multiple logistic regression equations for both mortality. Multiple regression analysis was performed to assess associating preoperative (age, gender, BMI, smoking, economics, and POSSUM score) and other evidence-based factors (POSSUM score, operative time, preoperative and postoperative hematocrit, and immediate postoperative temperature). Secondly, Receiver Operating Characteristic (ROC) analyses were conducted to identify a more accurate cut-off point that could help identify the probability of the tools. ROC curves were created by plotting the range of sensitivity and specificity pairs for each error rate, with case status as the classifier variable. A global assessment of the performance of the test is given by the area under the ROC curve (AUC). That is, AUC provides an estimate of the accuracy of the diagnostic test in discriminating between various tests. All analysis was done using SPSS 16.0. A value of $P<0.05$ was considered significant.

RESULTS

Demographic characteristics of the study group are shown in **Table 1**. The overall mortality rate was 0.87%. Eight significant risk factors determined, which those OR and p-values were analyzed by logistic regression. Among the risk factors, history of diabetes (OR: 5.19, 95% CI: 1.47–18.32, p=0.01), smoking (OR: 6.10, 95% CI: 1.78–20.89, p=0.004), respiratory disease (OR: 4.38, 95% CI: 1.22–15.66, p<0.001), and myocardial infarction (MI) (OR: 6.17, 95% CI: 1.85–20.54, p=0.003), and history of diabetes significantly affected the mortality rate.

The range of physiological scores obtained is shown in **Figure 1** and operative severity scores can be observed in **Figure 2**. Logistic regression analysis yielded statistically significant equations for mortality. In mortality, this was In R/1 -R= -7.99 + (0.06 x physiological score) + (0.14 x operative severity score) (P <0.01). The predictive accuracy of these equations was assessed by the determination of the receiver operating characteristic curves (ROC curves), by determining classification matrices for different levels of predicted mortality (**Figure 3**). Predictive accuracy of morbidity equation and mortality equation was 96.1% and 74.5%, respectively (**Figure 3**). The lower predictive

Table 1. Patient characteristics

Characteristics	n (%)
Age (Year), mean ± SD	56.69 ± 10.08
Age categories	
- <50	302 (21.6%)
- 50.1-60	673 (48.0%)
- 60.1-70	320 (22.8%)
- >70	106 (7.6%)
Sex	
- Female	321 (22.6%)
- male	1099 (77.4%)
BMI	
- Under weight	22 (1.7%)
- Normal	319 (23.9%)
- Overweight	619 (46.5%)
- Obese	372 (27.9%)
Smoking	
- non-smoker	970 (68.3%)
- current smoker	450 (31.7%)
History of diabetes	
- No	904 (68.3%)
- Yes	516 (68.3%)
History of hypertension	
- No	494 (34.8%)
- Yes	926 (65.2%)
History of MI	
- No	885 (62.3%)
- Yes	535 (37.7%)
Type of Aesthesia	
- GA	356 (25.1%)
- GA with Epidural	1063 (74.9%)

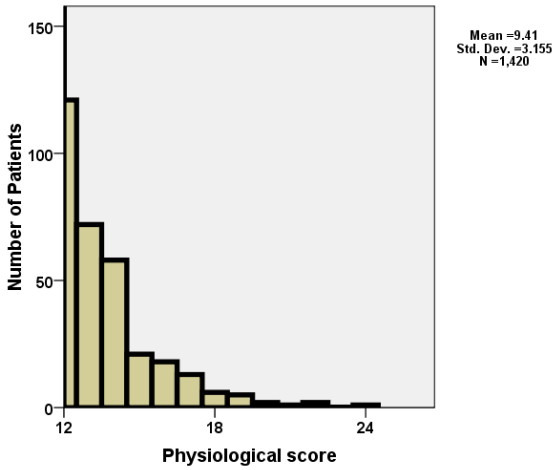

Figure 1. Distribution of patients according to physiological score

accuracy of mortality equation was 92% and 67.8% was observed using EuroSCORE, respectively (**Figure 4**).

DISCUSSION

Reliable evaluation of quality of care following anesthesia and surgeries is of the greatest importance for health service providers and patients. The quality of care can be assessed from three interrelated components including structure, process, and outcomes.[21] The surgical-related structural measures include the physical plant, the equipment and supplies, the members of the surgical team and their qualifications,

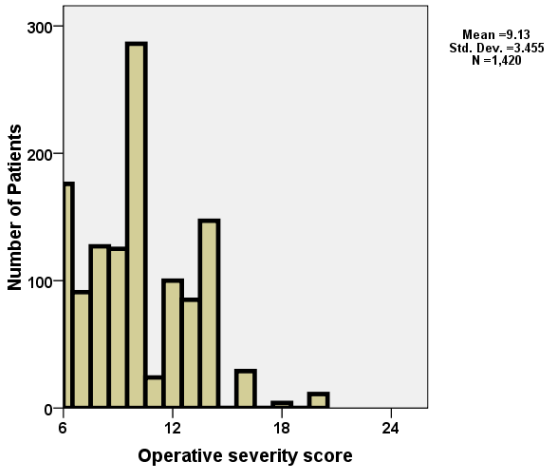

Figure 2. Distribution of patients according to operative severity score

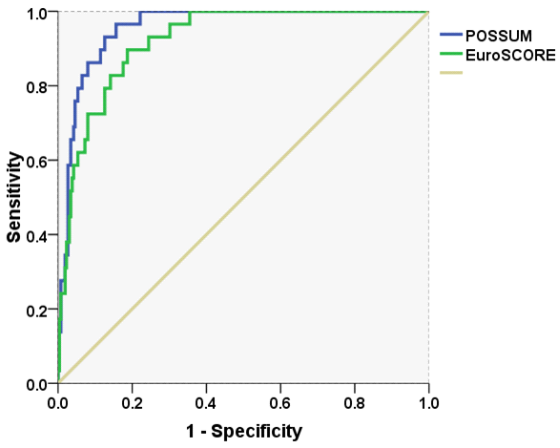

Figure 3. Receiver operating characteristic curve for mortality (AUC = 96.1% and 92% for POSSUM and EuroSCORE, respectively)

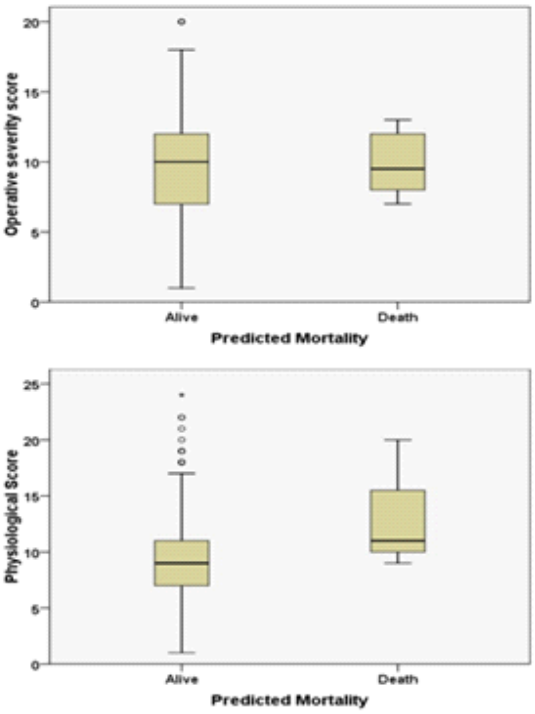

Figure 4. Mortality stratification (bottom images) according to physiology and operative severity scores within boxes, boxes and error bars represent mean, standard deviation and range respectively ($p< 0.05$)

and provider volume.[22] Postoperative mortality is defined either as in hospital mortality, 30-day mortality.[23] A group of former studies showed that POSSUM is one of the most accurate scoring systems in patients undergoing surgical treatments.[24-27]

Brunelli et al, applied POSSUM to a population of 250 lung resection candidates to assess its capability to predict postoperative complications, and claimed that this scoring system can be appropriately used as a tool of surgical audit in lung resection operations.[28] Tekkis et al, compared crude and risk-adjusted operative mortality rates among four surgeons and 505 consecutive patients undergoing major gastrointestinal surgery, using the POSSUM scoring systems and assess their applicability for patients scored retrospectively. They reported that this scoring system seems to provide the best choice for analyzing operative mortality rates for individual surgeons.[16] Brunelli et al, used POSSUM in 801 candidates for thoracic procedures to assess the performance of our thoracic surgery unit during two successive periods of activity, and showed that POSSUM can be reliably applied as an instrument of internal comparative audit in a thoracic surgery unit.[29] Yii and Ng, conducted a prospective study on 605 general surgical patients who were operated on under regional or general anesthesia, to validate POSSUM application in a surgical practice with a different population and level of resources, and showed that this scoring system may serve as a useful comparative audit tool for surgical practice.[12] Isbister and Al-Sanea, examined the use of POSSUM in colorectal practice in 145 patients referred for primary management of an histologically proven rectal cancer, and reported that POSSUM failed to predict outcomes accurately in patients undergoing surgery for rectal cancer and also over-predicted mortality but to a lesser extent. They claimed that patient's 'wellness' and the previously identified inability of this scoring system to accurately predict death in low-risk populations may explain their findings.[30] Shuhaiber et al, tested the validity of the POSSUM in predicting outcome of patients undergoing abdominal aortic aneurysm repair, and reported that outcome risk equations of this scoring system, is thus valid in predicting mortality for all cases and emergency abdominal aortic aneurysm repairs.[31] Griffiths et al used Possum and introduced two new variables including radiotherapy and previous surgery to the operative site, and thus tested their association with outcome.[32] Tekkis et al, recorded POSSUM variables for 1017 patients undergoing major elective or emergency colorectal surgery, and claimed there is a lack of calibration of this scoring systems at the extremes of age and high emergency workload, which has important implication in clinical practice, and suggested recalibration or remodeling of POSSUM in colorectal surgery.[33] Gu et al, evaluated the applicability of POSSUM in predicting the mortality of the 141 patients undergoing hip joint arthroplasty, and reported that this scoring system can predict the mortality accurately in such patients.[34] Otsuka et al applied POSSUM in 123 patients who had gastrectomies for gastric cancer at the age of 75 or above, and reported that this scoring system over-predicted the mortality of patients who underwent gastrectomy, but after

creating a modified equation using data from retrospective analysis, a modified POSSUM was found to predict the prospective mortality rate accurately.[35] Recently, Wang et al conducted the first systematic review of the predictive value of POSSUM in patients undergoing pancreatic surgery. They reported that this scoring system over-predicted postoperative mortality and failed to offer significant predictive value for mortality in pancreatic surgery.[36]

Using POSSUM scoring system may help us to obtain a numerical estimate of the health status of an individual patient before operation, allowing us to adjust the type and duration of operation and determine rationally individualized postoperative monitoring and treatment to decrease mortality in cardiac surgery, especially in elderly patients.

CONCLUSION

Although results of statistical modeling and analysis have never intended to affect the decision to operate, and this decision must be based on clinical expertise, but because of the need to standardize data collection and stratify the risks involved in operations, scoring systems such as POSSUM should be used prospectively. It must also be remembered the POSSUM scoring while predicting 30 day outcomes does not provide any indication of the prognosis. If analyzed correctly POSSUM is a reliable predictor of mortality in patients undergoing cardiac surgery.

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