Arch Crit Care Med. 2017 December; 3(1):e60075. doi: 10.5812/accm.60075.

Published online 2017 February 28. **Research Article**

The Role of Euro SCORE and STS Prediction Systems in Prognosis of Candidates for Surgical Pulmonary Embolectomy at a Referral Hospital

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Received 2018 January 03; **Accepted** 2018 January 23.

Abstract

Background: Pulmonary embolism (PE) is the only preventable cause of death in hospitalized patients with 15% mortality rate, which is increased to 25% among hemodynamically instable cases. The current study, regarding new concepts and techniques of risk assessment in pulmonary embolism, aimed at evaluating the role of STS score and EuroSCORE in prognosis forecast among cases of surgical embolectomy in patients with pulmonary embolism in order to suggest an acceptable way to reduce mortality rate in addition to optimum case selection for embolectomy.
Methods: Through a prospective cross-sectional study, 50 patients were recruited out of the total candidates for embolectomy at Massih Daneshvari hospital, during years 2016 and 2017. The participants were followed up for complications, morbidities, hospital stay, intensive care unit (ICU) admission and also mortality. Two scoring systems, as named before, were used and the results were compared considering the consequences of surgical embolectomy, such as hospital stay, morbidity and mortality, to finally suggest an association between the scores in each system and the outcomes.
Results: Fifty patients with pulmonary embolism, who were candidates for surgical embolectomy, entered the study. The mean age $\pm$ SD was 65.8 $\pm$ 14.1 and males made up 54.2% of the participants. The mean scores were significantly higher in patients, who died, compared with alive participants. The mean STS score was doubled in people who died while the EuroSCORE showed almost three-folded values in that group compared to survived individuals (P value $<$ 0.001 and 0.003, respectively). The APACHE II score was significantly higher in dead participants (P value = 0.04) and they spent most of their hospitalization time at the ICU (78.2% versus 15.6% of the survived group) (P value = 0.01). The survived participants had lower rate of kidney injury as well (17% versus 29%; P value = 0.009), while the overall rate of the problem was 24% in 50 participants. There was a reverse correlation between STS and EuroSCORE obtained score and the length of stay that is not too far from the fact that individuals with worse conditions usually obtain higher scores and die faster than others.
Conclusions: To sum up, with a global acceptance in addition to ease of utilization, euroSCORE is approved by the clinicians disregarding the overall controversy between the two predicting systems that were studied in terms of calibration and discrimination.

Keywords: EuroSCORE, STS Prediction, Pulmonary Embolectomy

1. Background

Pulmonary embolism (PE) is the only preventable cause of death in hospitalized patients with 15% mortality rate, which increases to 25% among hemodynamically instable cases (1-3). It kills 200 to 300 thousands a year worldwide. Hemodynamic instability and particularly hypotension are usually considered as risk factors for poor prognosis while massive embolism occurs (4, 5). There is a severity-based classification for the event, including massive (high risk), sub-massive (intermediate risk), and low risk pulmonary embolism. High risk cases have resistant hypotension and bradycardia with no peripheral heart beats while the latter group has normal right ventricle function along with stable hemodynamics. Intermediate risk holders may

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show myocardial necrosis resulting in RV dysfunction with normal blood pressure. The treatment is done regarding severity classification. The first step is usually the use of anticoagulants, which are often enough for low risk cases while surgical or catheter embolectomy is crucial for sever cases in addition to anticoagulants (6).

With highly increased risk of hemorrhagic cerebral stroke and sever bleeding, thrombosis therapy could lessen recurrent embolectomy and the risk of mortality in a large number of cases (2, 7). Studies have revealed the fact that surgical embolectomy results in very low rate of mortality (5% to 9%) and complications when compared with medications, especially during the recent decades (7, 8). It is absolutely vital for the candidates of cardiosurgery to foresee the overall risk, like its complications and mortality. This is why death and mortality risk assessment scoring systems have been essential in heart surgery. These scoring systems are fortunately revisable regarding new developments in surgical and clinical techniques.

The society of thoracic surgeons (STS) and the European system for cardiac operative risk evaluation (EuroSCORE) are two well-known important scoring systems in this regard, which evaluate different 40 and 18 clinical parameters, respectively, at three general areas. The STS score, firstly introduced in 1989, is very popular in North America to assess the risk rate after heart surgery regarding the type of operation. Europe, North America, and Asia use also the EuroSCORE, which was introduced and developed in 1995 to 1999 to do the same job although it usually overestimates the mortality rate in low risk cases while underestimates it among high risk ones. The logistically corrected version of EuroSCORE is now used due to the mentioned problem (9-11).

Rosa et al. assessed the evaluating role of both mentioned scoring systems in mortality risk in severe aortic valve stenosis (AS) among candidates for valve implementation and also Jamaati et al. studied the EuroSCORE efficacy in terms of risk assessment in candidates for CABG in Iran (12, 13).

The current study, regarding new concepts and techniques of risk assessment in pulmonary embolism, aimed at evaluating the role of STS score and EuroSCORE in prognosis forecast among cases of surgical embolectomy in patients with pulmonary embolism in order to suggest an acceptable way to reduce mortality rate in addition to optimum case selection for embolectomy.

2. Methods

Through a prospective cross-sectional study, 50 patients were recruited out of all candidates for embolectomy. In 2016 to 2017, all the participants were hospitalized waiting for surgical embolectomy when visited, and demographics and clinical in addition to paraclinic features were recorded. The participants were followed up for complications, morbidities, hospital stay, ICU admission, and also mortality. There was a questionnaire to gather the entire data before data entrance and analysis. The sample size was calculated as follows:

$$N = \frac{\left(z_{1-\frac{\alpha}{2}}\right)^2 P\left(1-P\right)}{d^2} \quad (1)$$

$Z_{1-\alpha/2} = 1.96$; P = 25%; d= 0.12

2.1. Outcome Measures

Two scoring systems, as named before, were used and the results were compared considering the consequences of surgical embolectomy, such as hospital stay, morbidity, and mortality to finally suggest an association between the scores in each system and the outcomes.

2.2. Statistics

Preoperative and postoperative information were entered in the relevant software before analysis, among which quantitative data were reported using central tendency, such as means and standard deviations while qualitative data used percentages. The normality of data distribution was checked using the Kolmogorov-Smirnoff test as well as box plots. Parametric data used t-test whilst nonparametric used the Mann-Whitney test and Pearson's chi-square and also the Fisher exact test if needed. Repeated measures analysis of variance (ANOVA) and Friedman nonparametric test were utilized to compare quantitative data in consecutive times. Two-tailed significance of 0.05 in addition to the CI = 95% and type one error (α = 0.05) were considered to achieve 0.8 study power.

2.3. Ethics

The current study scored the patients' situation before and after surgery with no decision making regarding the scores, while all the participants were enrolled in this research after getting enough information about the aims, the process and the opportunities and probable risks of participation and provided their verbal informed consent. The patients were free to quit the study whenever they decided with no penalty or excuse. It is worth repeating that no intervention or change was done regarding the scores that the patients obtained because of the descriptive character of the study. People might die due to causes other than surgical embolectomy and were not recorded as mortality cases in this study.

3. Results

Finally, 50 patients with pulmonary embolism, who were candidates for surgical embolectomy at Massih Daneshvari hospital, a university referral center for pulmonary diseases, entered the study. As observed from Table 1, the mean age ± SD was 65.8 ± 14.1 and males made up 54.2% of the participants. The patients showed some comorbidities and background diseases, such as hypertension, diabetes mellitus, respiratory and cardiac problems as well as behaviors like smoking, as illustrated in Table 1.

Table 1. Demographics and Comorbidities for Participants[a]

Variables	Value
Age, y	65.8 ± 14.1
Sex, male	25 (54.2)
Diabetes mellitus	15 (30)
High blood pressure	29 (57)
COPD	4 (7)
Family history CAD	25 (50)
Coronary artery disease	22 (43)
Obesity	32 (64)
Trauma	4 (8)
Smoking	19 (38)

[a]Values are expressed as mean ± SD or No. (%).

Tables 2 and 3 report special features of clinical outcomes and parameters like ICU/hospital stay, kidney injury, APACHE II, STS and EuroSCORE scores as well as mortality rate to facilitate finding associations between the scores of both studied systems and the mentioned absolutely important items beside values like sensitivity, specificity, and area under the curve (AUC). The findings revealed significantly higher mean scores in patients, who died compared with alive participants as far as the follow up period continued. The mean STS score was doubled in people who died while the EuroSCORE showed almost three-folded values in that group compared with survived individuals (P value < 0.001 and P value = 0.003, respectively).

The APACHE II score was significantly higher in dead participants (P value = 0.04) and they spent most of their hospitalization time at the ICU (78.2% versus 15.6% of the survived group) (P value = 0.01). The survived participants had lower rate of kidney injury as well (17% versus 29%; P value = 0.009) while the overall rate of the problem was 24% in 50 participants. The overall mortality rate was calculated as 12%.

Focusing on Table 3 and Figure 1, both studied scoring systems through the current work were similar in terms of sensitivity, specificity, and the AUC to predict prognosis including mortality among the patients with mediocre values. Furthermore, Table 4 presents the correlation coefficients for both scoring systems with hospital and ICU stay, which revealed a reverse correlation between STS and EuroSCORE obtained score and the length of stay that was not too far from the fact that individuals with worse conditions usually obtain higher scores and die faster than others. Figure 2 illustrates diagrams which compare dead and survived groups in terms of STS and EuroSCORE.

4. Discussion

The current work was a cross-sectional study that assessed the predictive role of two scoring systems, including STS and EuroSCORE, in terms of patients' prognosis after surgical embolectomy to correct pulmonary embolism among the candidates, who referred between 2016 and 2017, to a referral center for pulmonary diseases. The researchers revealed that the mean scores the patients obtained were obviously correlated with their prognosis, such as mortality. The studied scoring systems were similar in prognostic values.

In 2016, Alizadeh et al. concluded that acute pulmonary embolism could be successfully corrected surgically with 16.6% mortality rate when they studied 12 cases with a mean of 60 years old. They reported 25% postoperative rate, but no intraoperative occurrence for arrhythmia. That was in the case of fast and on time assessment when diagnosis was appropriately made (14).

One year before them, Jamaati et al. studied the impact of EuroSCORE system in prognosis detection in a group of Iranian candidates for CABG (13). They recruited 2220 patients over 18 years of age, who were candidates for CABG between 2004 and 2010 at a referral hospital in Tehran to figure out that the EuroSCORE predictive system was not appropriate to be considered a valid tool in mortality forecast at least in CABG cases (13).

Bach et al. were the other team that assessed the prognostic value of clinical scores in 30-day mortality in patients with acute pulmonary embolism (15). During their trial, they recruited more than 350 patients with pulmonary embolism to reveal more than 10% mortality rate, which was perfectly predicted with the Glasgow coma scale (GCS) beside systemic circulatory parameters, such as using mechanical ventilation, arterial pressure, and systolic blood pressure. The above researchers used the APACHE II, the GCS, which is part of APACHE II score, the euroSCORE II, and the original and simplified PE severity index (PESI) to predict 30-day mortality and compare them in this matter. The mentioned research studied nonsurgical cases, which resulted them in not using the three parameters

Table 2. The Scores and Other Studied Features for the Dead or Survived Participants

Variables	Dead	Survived	Total	Significance
STS	33.7 ± 16.7	18.6 ± 7.3	19.7 ± 12.3	< 0.001[a]
APACHE II	25.8 ± 11.4	10.3 ± 4.5	16.9 ± 9.8	0.040[a]
EuroSCORE	13.7 ± 15.3	4.8 ± 3.6	8.1 ± 7.5	0.003[a]
Hospital stay	11 ± 19.1	16.7 ± 17.9	15.8 ± 16.7	0.03[a]
ICU stay	8.6 ± 2.2	2.6 ± 2.2	6.3 ± 3.2	0.010[a]
Kidney injury, %	29	17	24	0.009[a]
Mortality, %			12	

[a]Data were significantly different between the groups of study.

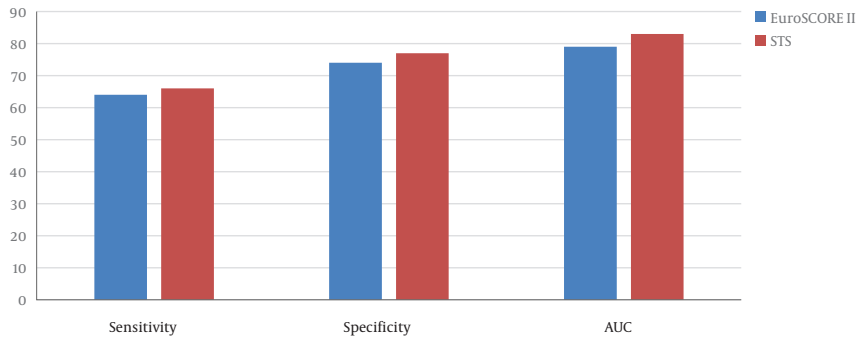

Figure 1. Comparison of sensitivity, specificity and the area under the curve for STS and euroSCORE prognosis evaluation systems

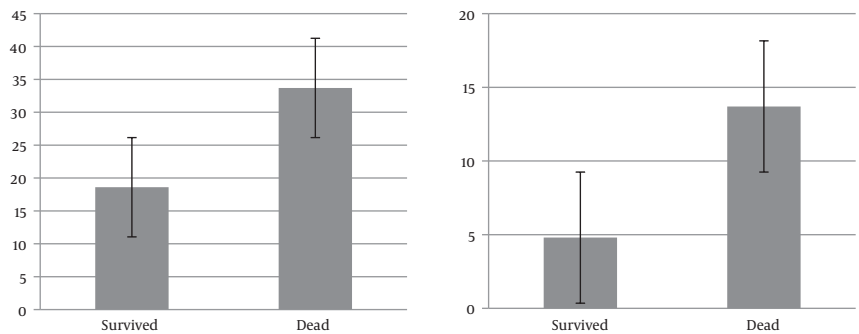

Figure 2. The error bars to compare STS and euroSCORE systems in mortality prediction after surgical pulmonary embolectomy. The right diagram belongs to euroSCORE and the left to STS scoring system.

Table 3. Some Predictive Values for the Two Scoring Systems That Were Studied in the Current Work

Variables	STS	EuroSCORE II	Significance
Sensitivity, %	66	64	
Specificity, %	77	74	
AUC	0.83	0.79	0.78

of the euroSCORE II, including urgency of surgery, risk of surgery, and necessity for surgery on thoracic aorta. Interestingly, all the scoring systems significantly differed between survivors and non-survivors with less significance for the euroSCORE II (P value = 0.0026). The GCS had the highest value of positive predictive value (PPV = 44%) while they all had similar negative predictive values (NPVs = 92% - 97%). The euroSCORE II was at a relatively modest level in terms of mortality prediction when compared with the

Table 4. The Matrix of the Variable Coefficients

Variables	STS	EuroSCORE II	Hospital Stay	ICU Stay
STS	1.0	0.60*	-0.45*	0.57*
EuroSCORE II		1.0	-0.53*	0.44*
Hospital stay			1.0	-0.51*
ICU stay				1.0

mentioned scoring systems as well. Likely, Stahli et al. found better results in calibration (16) and discrimination for ES II against LES (17), while STS was found to underestimate the mortality rate.

A mortality rate of 19% was what Vohra et al. reported in 2010 among 21 cases of pulmonary embolectomy during early outcomes at the hospital. This is less than the rate (12%) found in the current study, which could be expected regarding new concepts to keep patients more safe in recent procedures. They also reported a 5-year survival rate of just more than three-fourths (75%) for the patients, who underwent surgical embolectomy falling to around 50% when 8-year survival assessment was concerned.

Rabbani et al. tried to compare euroSCORE, euroSCORE II, and STS predictive systems in a bunch of patients, who underwent heart valve surgery in 2006 to 2013 (18). In total, 576 patients were studied during their work and half of them had pure Mitral Valve Regurgitation (MVR) beside one-fourth with pure AVR and the rest, who suffered from DVR or experienced CABG + AVR and CABG + MVR. They found that euroSCORE II had better calibration regarding the highest significance that Hosmer and Lemmeshow expressed yet it overestimated the mortality rate up to the 5th decile where switched to an underestimated prediction although it had the least difference between actual and predicted death rate as compared to additive (AES) and logistic euroSCORE (LES). Rabbani et al. finally concluded a better function for euroSCORE II in mortality prediction in isolated valve surgery, whereas, STS worked at a better level in combined valvular surgeries with CABG. Unlikely, Janikowski et al. recently raised the LES as the closest system to the actual risk of death after cardiac surgery in a Polish population (19).

Another study that assessed euroSCORE II and STS was Rosa's cohort, which focused on patients, who experienced trans-catheter aortic valve implementation (TAVI) in 2010 to 2014 (12). They evaluated the mortality rate in hospitals and in a 30-day section of time in 59 patients with mean age of 81 years. A 10% in-hospital and 13.5% 30-day mortality rate was separately calculated and the area under the curve (AVC) for STS and euroSCORE II were 0.81 and 0.77, respectively, with no significant difference between them in death prediction (P value = 0.72). However, Barili et al. believed in a limited calibration capability for STS in high-risk patients (20, 21). With more than 9000 consecutive patients, Habib et al. aimed at assessing the ability of euroSCORE in mid-term prediction of survival in cardiac surgery cases (22). They grouped their patients regarding their scores of euroSCORE and followed them for about three years after surgery. The 6-year survival was significantly correlated with lower scores at a direct even.

To sum up, with a global acceptance in addition to ease of utilization, euroSCORE sounds more approved by the clinicians disregarding the overall controversy between the two predicting systems that were studied in terms of calibration and discrimination.

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