# Meta-analysis on the Performance of the EuroSCORE II and the Society of Thoracic Surgeons Scores in Patients Undergoing Aortic Valve Replacement

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***Objective:*** **To evaluate the performance of the EuroSCORE II (ESII) and the Society of Thoracic Surgeons (STS) scores in surgical (SAVR) or transcatheter aortic valve replacement (TAVR).**

***Design:*** **Systematic review of the literature and meta-analysis.**

***Setting:*** **University hospitals.**

***Participants:*** **Studies reporting data on the performance of ESII and STS scores in patients undergoing SAVR or TAVR.**

***Interventions:*** **SAVR or TAVR.**

***Measurements and Main Results:*** **Ten studies validated these scores in 13,856 patients who underwent either TAVR or SAVR. Operative mortality was 5.9% (SAVR 3.1%; TAVR 9.6%). ESII-expected mortality was 5.1% (O/E ratio: 1.15, SAVR, O/E ratio 0.94; TAVR, O/E ratio 1.23) and STS-expected mortality was 6.3% (O/E ratio: 0.94, SAVR, O/E ratio 0.84; TAVR, O/E ratio 1.13). The area under the ROC curve for ESII was 0.70 and for STS was 0.70 (SAVR patients: 0.73 for ESII and 0.75 for STS; TAVR patients; 0.66 for ESII and 0.63 for STS). The difference between observed/expected mortality was not significant for ESII (Peto's OR 0.99, $p = 0.88$) and was significant for STS (Peto's OR 0.86, $p = 0.008$). ESII (Peto's OR 1.35, $p < 0.00001$) and STS (Peto's OR 1.23, $p < 0.00001$) significantly underestimated the mortality risk in TAVR patients. The STS (Peto's OR 0.74, $p < 0.0001$) and, to a lesser extent, the ESII (Peto's OR 0.86, $p = 0.0.04$) overestimated the mortality risk in SAVR patients.**

***Conclusions:*** **The ESII and STS scores have good O/E ratios for either TAVR or SAVR patients, but both scores significantly underpredicted the risk of TAVR patients. ESII seemed to be accurate in predicting the risk of SAVR patients.**



***KEY WORDS: aortic valve, replacement, statistics, meta-analysis, EuroSCORE II, STS score***

RISK SCORING METHODS increasingly have been used for prediction of postoperative mortality and morbidity in patients undergoing cardiac surgery.[1] These methods are valuable research tools and can be used to evaluate hospital performance. Indeed, in the era of less-invasive treatment methods, the estimation of individual patient risk is of importance in assisting the clinical decision-making process. In fact, conventional cardiac surgery procedures can be withheld in very-high-risk patients in favor of percutaneous coronary intervention or transcatheter valve procedures. The assumption to obtain these practical benefits is that the risk scoring method is easy to use and accurate. In the present meta-analysis, the authors investigated the performance of EuroSCORE II (ESII)[2] and the Society of Thoracic Surgeons (STS)[3,4] scoring methods in patients undergoing surgical aortic valve replacement (SAVR) or transcatheter aortic valve replacement (TAVR).

## METHODS

A literature review was performed through PubMed, Scopus, Science Direct and Google for any study published since 2011 and evaluating the performance of the ESII score and the STS score in the same population of patients undergoing SAVR or TAVR. The word employed in the search was "EuroSCORE II". Reference lists of obtained articles were searched as well. This study was not financially supported.

### Inclusion Criteria

Prospective and retrospective observational studies published in English, Spanish, or Italian, reporting on the outcome of patients undergoing SAVR or TAVR, were considered for this study. Studies including aortic valve replacement with coronary revascularization were included in the present analysis. Only studies reporting on the estimated mean of both the ESII and the STS scores and reporting results of c-statistics; that is, area under the ROC curve and its 95% confidence interval, were considered for the present analysis. This criterion was chosen in order to evaluate the performance of both risk scoring methods in the same patient population.

### Exclusion Criteria

Data reported only in abstracts were not included in this analysis. Studies not reporting on in-hospital or 30-day mortality were not included in this study. The authors excluded from this analysis those studies reporting on major concomitant procedure other than coronary revascularization. Studies including fewer than 100 patients were excluded. Since the transformation of median to mean is not reliable, the authors excluded from the analysis those studies not reporting on the mean and standard deviation of the ESII and the STS scores. Missing standard deviation values were replaced with the mean of the other available values.

### Data Collection

These investigators identified the articles potentially dealing with this topic, abstracted data from all eligible studies using a standardized Excel file, retrieved data on study design, study size, patient demographics, types of intervention, and outcome. Data were retrieved only from the articles, and no attempt to get missing data from the authors was made. The authors applied the guidelines for Meta-analysis of Observational Studies in Epidemiology (MOOSE).[5] The main outcome end-point of this study was in-hospital or 30-day mortality and, from that point, was defined as operative mortality.

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## Statistical Analysis

Statistical analysis was performed using Open Meta-analyst.[6] The difference between the numbers of observed and of predicted deaths estimated by the mean values of the ESII and the STS risk scores was evaluated by the Peto's odds ratio method with fixed-effect method. The area under the receiver operating curve of the ESII and the STS scores were pooled using the random-effects method. The observed/expected ratios were calculated dividing the pooled proportion of observed mortality by the mean values of the ESII and the STS scores. Comparisons were performed by random-effects meta-regression. A $p < 0.05$ was considered statistically significant.

# RESULTS

A literature search was performed on March 16, 2014 and yielded 138 articles of which 10[7–16] reported on data of interest and fulfilled the inclusion criteria of the present study (Fig 1). No prospective study was available for this analysis.

Table 1 summarizes the main characteristics of these studies. These studies included 13,856 patients with 577 operative deaths. SVAR was performed in 11,791 patients and TAVR in 2,065 patients. The pooled operative mortality rate was 5.9% (95% CI 4.6-7.2%, $I^2$ 93%), and its arcsine transformed proportion was 6.0% (95% CI 4.3-7.9%, $I^2$ 94%). Pooled operative mortality after AVR with or without CABG was 3.1% (95% CI 2.1-4.1% $I^2$ 89%) and after TAVR was 9.6% (95% CI 7.9-11.4%, $I^2$ 45%) ($p < 0.0001$) (Table 2).

## EuroSCORE II Score Versus Society of Thoracic Surgeons Score

The expected mortality estimated by the ESII was 5.1% (95% CI 4.0-6.2, $I^2$ 89%, O/E ratio: 1.15), and the expected mortality estimated by the STS was 6.3% (95% CI 4.5-7.5, $I^2$ 90%, O/E ratio: 0.94). The observed/expected (O/E) operative mortality ratio for SAVR according to the ESII score was 0.94 and according to the STS score was 0.84. The O/E ratio for TAVR according to the ESII score was 1.23 and according to the STS score was 1.13. Figure 2 summarizes the O/E ratio according to predicted mortality rates and shows the marked heterogeneity of results in the retrieved studies. Meta-regression showed that both the ESII score ($p < 0.0001$) and the STS score ($p < 0.0001$) significantly correlated with the observed operative mortality.

The pooled area under the ROC curve for ESII was 0.70 (95% CI 0.66-0.74, $I^2$ 71%) and for the STS score was 0.70 (95% CI 0.66-0.74, $I^2$ 70%). The area under the ROC curves of the STS score was significantly larger in patients who underwent SAVR than in those who underwent TAVR ($p < 0.0001$)

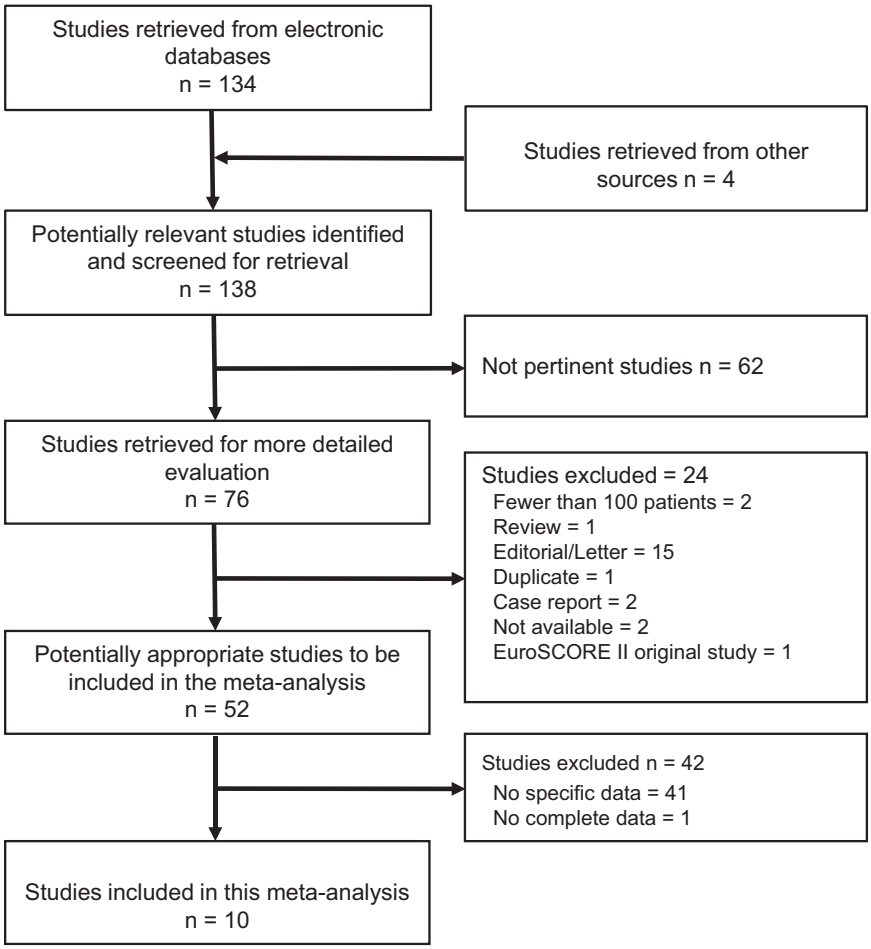


**Fig 1. Literature search flow chart.**