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Accuracy of the Logistic EuroSCORE in Predicting Long-Term Survival Following Isolated Aortic Valve Replacement

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Abstract

Objective: To assess the ability of the logistic EuroSCORE to predict long-term mortality of patients undergoing isolated Surgical Aortic Valve Replacement (SAVR). **Methods:** A retrospective review of all patients undergoing SAVR between September 1999, and March 2018 was done. **Results:** 2018 patients were eligible for inclusion in the study. Patients were grouped according to risk: low (n = 506), intermediate (n = 609), and high-risk (n = 903) depending on their logistic EuroSCORE values. The 30-day mortality of the low-risk group was 0.47%. The one-, five-, 10-, 15-, and 20-year mortality was 1.66%, 4.9%, 14.9%, 24.3%, and 43.8%, respectively. Intermediate-risk group 30-day mortality was 0.66%. The one-, five-, 10-, 15-, and 20-year mortality was 3.28%, 11.9%, 32%, 54.8%, and 82.6%, respectively. The 30-day mortality of the high-risk group was 3.99%. The one-, five-, 10-, 15-, and 20-year mortality was 8.2%, 27%, 55.4%, 78.6%, and 87%, respectively. **Conclusion:** Our results confirm that the lES is accurate in predicting long-term mortality outcomes of SAVR. This real-world data provides evidence of the potential usefulness of the EuroSCORE to help the heart team and patients decide on appropriate interventions for aortic stenosis.

Keywords

Aortic Stenosis, TAVR, SAVR, Valve Disease

1. Introduction

Aortic Stenosis (AS) is the most common valvular heart disease in Europe and a frequent cause of cardiac surgery [1]. The prevalence of this condition increases

with age [1]. Estimates are 0.2% in those aged 50 to 59, and 1.3% in the 60 to 69 age-group [1]; increasing to 9.8% in octogenarians [1]. Symptom onset is associated with poor prognosis and mortality rates approach 50% at two years if left untreated [2]. Symptoms are an important determinant in the timing of surgical management. Patients usually present with dyspnoea, chest pain, and syncope [3] [4]. Severe AS is defined as the valve area less than 1 cm^2, mean gradient is more than 40 mmHg, and peak aortic jet velocity is more than 4 m/s. 3 Current guidelines recommend Aortic Valve Replacement (AVR) for symptomatic patients with severe AS and those who are asymptomatic with severe AS and left ventricular dysfunction [3] [4]. AVR is also recommended for patients with moderate AS undergoing other cardiac surgery [4].

1.1. The EuroSCORE

Risk stratification aids clinical decision-making and informed consenting of patients [3] [4]. Cardiac surgical risk can be predicted using the European System for Cardiac Operative Risk Evaluation (EuroSCORE, ES) [4] [5]. The first version developed in 1999, the additive EuroSCORE (aES), involving simple bedside calculations. In 2003, the logistic EuroSCORE (lES) was introduced as a more reliable tool, particularly for high-risk patients, *i.e.*, patients with a score greater than or equal to six points [5] [6]. The low- and intermediate-risk patients score less than three and greater or equal to three, respectively [5]. The most recent and accurate form is EuroSCORE II (ES II) [7] [8]. Nonetheless, the assessment of frailty and organ dysfunction is also imperative to estimate an individual's overall surgical risk alongside the ES [4].

The aES and lES have been validated worldwide [9]. They were additionally validated for perioperative and long-term outcomes [10]. However, studies gradually reported their poor performance [11] [12]. This could be attributed to advancements in cardiac surgery techniques and post-operative care. ES II has proved to be more accurate in predicting risks [13].

1.2. SAVR or TAVR

Surgical AVR (SAVR) is the gold standard treatment in managing aortic valve disease [14]. 80% of SAVR operations were performed on low-risk patients between 2002 and 2010 [15].

The benefit of Transcatheter AVR (TAVR) in individuals with high surgical risk is established [16]. Factors favouring TAVR include lES greater than or equal to 10%, previous cardiac surgery, or the presence of porcelain aorta [3]. TAVR patients present with lower rates of major bleeding. Yet, they have a higher risk of vascular injury and paravalvular regurgitation. SAVR and TAVR have similar in-hospital mortality [17]. The two procedures have equivalent 2-year mortality in low-risk patients [18]. The low-risk group undergoing SAVR lack major systemic comorbidities, receive a bioprosthesis, with short-term mortality of 1.7%. The Placement of Aortic Transcatheter Valves (PARTNER 1) [19] trial compared standard therapy such as balloon valvuloplasty with TAVR and re-

vealed a 20% reduction in mortality at one year in the TAVR group. Five-year mortality was 54.1% and 80.9% for TAVR and standard therapy, respectively. These results encouraged the PARTNER 2 [20] trial to compare TAVR and SAVR in intermediate-risk patients. TAVR did not show superiority, nonetheless, the American College of Cardiology/American Heart Association guidelines now recommend TAVR in those with severe AS and intermediate surgical risk [4].

Subsequently, the PARTNER 3 and Evolut Low-Risk trials initiated an excitement to perform TAVR in low-risk patients [21] [22]. PARTNER 3 reported inferiority of SAVR at one year [22]. Frailty or organ system compromise would move the patient to intermediate-risk regardless of a low-risk score [4]. The limitations of unknown long-term outcomes in TAVR remain substantial [23], while there is ample data on the long-term durability of SAVR showing a trend of near-normal life expectancy post-SAVR along with a clear improvement in quality of life for most patients [24]. The presence of a bicuspid valve [25] or small aortic annulus (<21 - 23 mm) [26] is identified as a factor favouring SAVR. It is also more desirable in low-risk patients with pure Aortic Regurgitation (AR) [27].

1.3. Objective

The aim of this study is to assess the ability of the logistic EuroSCORE to predict long-term mortality of patients undergoing isolated SAVR.

2. Methods

2.1. Patients

All patients undergoing first-time isolated SAVR, irrespective of pathology at the Blackpool Victoria Hospital between September 1999, and March 2018 were considered for inclusion in the study. Those who lacked stated lES values were excluded. Depending on their predictive lES, patients were divided into low-risk (<3), intermediate-risk (≥3), and high-risk (≥6) groups. Patient data was collected from the independently validated NICOR (National Institute for Cardiovascular Outcomes Research) database. Our hospital database was used to access patient details retrospectively.

2.2. Statistics

Categoric variables were expressed in absolute and percentage values and analysed using chi-square test. Continuous variables were analysed for normality of distribution and values were expressed in means (±standard deviation, SD) and medians. T-test or appropriate non-parametric tests were used for comparing continuous data. Statistical significance was set at p less than 0.05. The Kaplan-Meier estimator was used for survival analysis.

2.3. Patient and Public involvement

There was no patient involvement in the design and conduct of this study.

3. Results

3.1. Study Population

The starting population consisted of 2606 patients. 588 patients were excluded due to incomplete lES values. 2018 patients were eligible for inclusion in the study. Patients were allocated to different risk-groups: low-risk (n = 506), intermediate-risk (n = 609), and high-risk (n = 903). The mean age of the study population was 68.3 (median 71), 43.3% of which were female. Table 1 outlines patient demographics of the study population. Table 2 shows the different distribution of EuroSCORE variables for the three risk groups.

3.2. Mortality

30-day mortality was 42/2018 (2.1%). The one-, five-, 10-, 15-, and 20-year mortality was 101/2018 (5%), 347/2018 (17.2%), 650/2018 (32.21%) 796/2018 (39.45%), and 837/2018 (41.48%), respectively.

The mortality rates at the different time intervals for each of the three risk groups are shown in Table 3. Figures 1-4 shows the Kaplan-Meier survival curves. We demonstrate significantly higher mortality in the high-risk population at all time points following surgery. There was no significant difference in mortality between the low- and intermediate-risk groups until between one and five years post-SAVR.

4. Discussion

The results of this methodologically robust real-world analysis confirm that the lES is accurate in predicting long-term mortality outcomes of SAVR.

4.1. Principal Findings

Patients in the high-risk group died significantly earlier than the low-risk and

Table 1. Patient demographics.

Age	Mean 68.3 years (median = 71 years)		
Gender	Male 56.7%	Female 43.3%	
Chronic pulmonary disease	Yes 17.9%	No 82.1%	
Extra-cardiac arteriopathy	Yes 8.4%	No 91.6%	
Neurological dysfunction	Yes 10.0%	No 90.0%	
Previous cardiac surgery	Yes 8.3%	No 91.7%	
Creatinine > 200 μg	Yes 2.5%	No 97.5%	
LV function	Good 83%	Moderate 13%	Poor 4%
Recent MI	Yes 2.9%	No 97.1%	
Emergency surgery	Yes 1.5%	No 98.5%	

Table 2. EuroSCORE variables across three risk groups.

	Low risk	Intermediate risk	High risk	*p*
Age (years)	55.8	67.9	75.6	<0.00001
Gender (% male)	76%	57%	46%	<0.00001
COPD (% yes)	6.9%	15.6%	25.6%	<0.00001
Extra-cardiac arteriopathy (% yes)	1.0%	2.8%	16.4%	<0.00001
Neurological dysfunction (% yes)	4.7%	8.4%	12.6%	<0.00001
Previous cardiac surgery (% yes)	0%	2.6%	15.8%	<0.00001
Creatinine > 200 μg (% yes)	0%	1.2%	4.5%	Low = Inter (0.06) Inter < High (0.0002) Low < High (<0.00001)
LV function (% good, moderate, poor)	94% 6% 0%	87% 11% 2%	75% 18% 7%	<0.00001
Recent MI (% yes)	0.8%	6.1%	13.5%	<0.00001
Emergency surgery (% elective, urgent, emergency, salvage)	91% 9% 0% 0%	89% 10% 1% 0%	79% 18% 3% 0%	Low = Inter (0.1467) Inter < High (<0.00001) Low < High (<0.00001)

Table 3. Time-interval mortality rates.

	Low risk	Intermediate risk	High risk	*p*
30-day	2 (0.47%)	4 (0.66%)	36 (3.99%)	< 0.00001
1-year	7 (1.66%)	20 (3.28%)	74 (8.20%)	< 0.00001
5-year	21 (4.9%)	514 (11.9%)	203 (27%)	< 0.00001
10-year	41 (14.9%)	98 (32%)	221 (55.4%)	< 0.00001
15-year	28 (24.3%)	74 (54.8%)	110 (78.6%)	< 0.00001
20-year	7 (43.8%)	19 (82.6%)	20 (87%)	= 0.0051

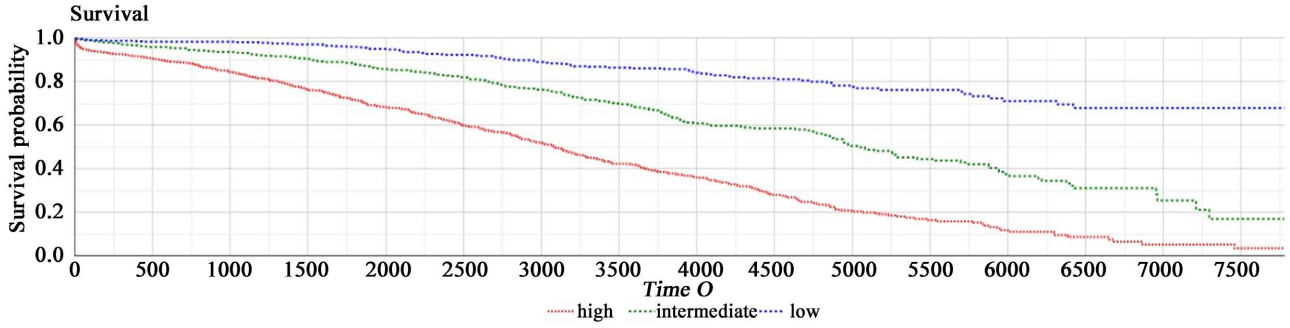

Figure 1. Kaplan-Meier curve for all risk groups, $P < 0.0001$.

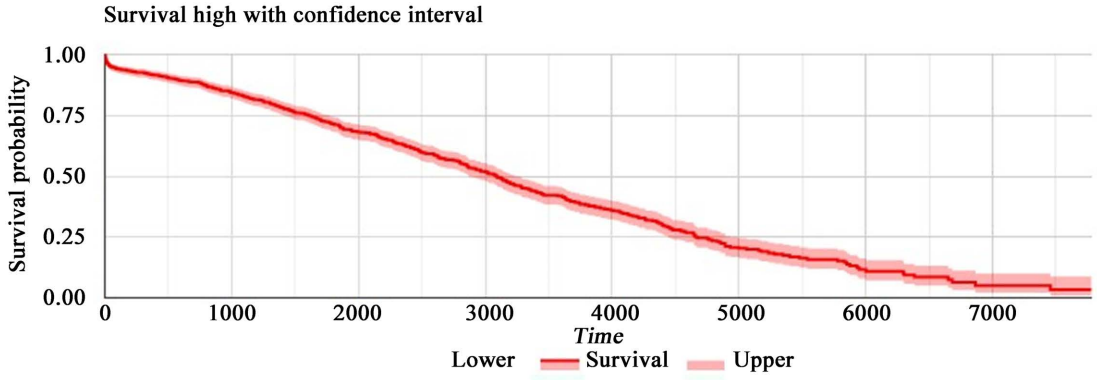

Figure 2. Median survival of 3088 days (8.5 years) in the high-risk group.

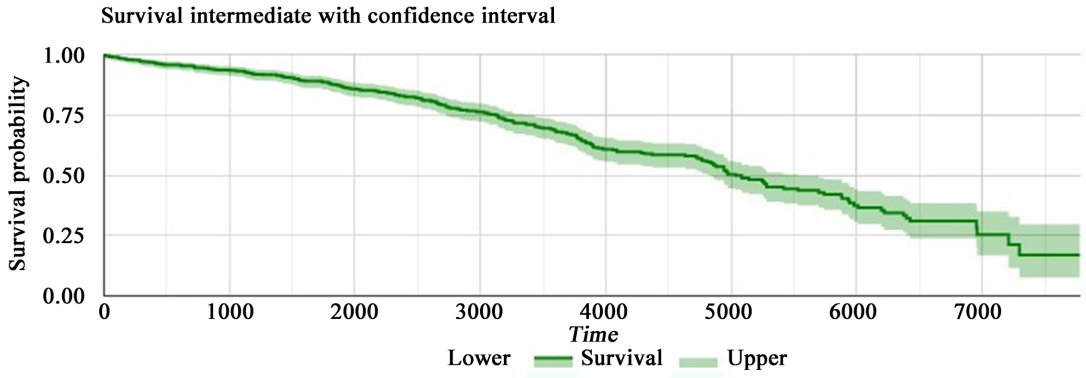

Figure 3. Median survival of 5037 days (13.8) in the intermediate-risk group.

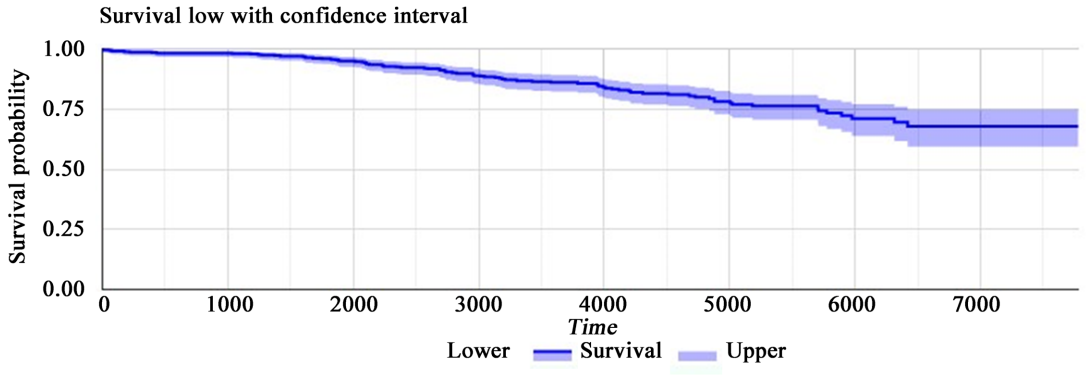

Figure 4. Median survival longer than 7500 days (more than 20 years) in the low-risk group.

intermediate-risk groups. The difference between low- and intermediate-risk groups was not statistically significant. 58.69% of our high-risk patients died within 20 years of SAVR, but this figure was decreased in intermediate- (36.78%) and low-risk (19.62%) patients. Earlier death was seen in higher scoring patient groups. We conclude that predictive lES is in fact predictive of post-operative mortality at all time points of post-SAVR.

4.2. Low-Risk Trials

The PARTNER 1 trial [19] established that TAVR is superior to medical therapy

for those ineligible for SAVR. PARTNER 2 [20] reported 30-day mortality of 3.4% versus 4%, for TAVR and SAVR, respectively. One-year mortality of TAVR patients was 11.8% in comparison to 13% for SAVR patients who were classified as being intermediate risk. Mack and colleagues [21] concluded that TAVR is an acceptable treatment strategy for this group of patients given that mortality rates were non-inferior to SAVR. The PARTNER 3 trial looked specifically at low-risk patients undergoing TAVR or SAVR. 30-day mortality in the TAVR group (0.4%) was less than in the SAVR group (0.9%). Results only became significant at one-year post-AVR mortality (1.1% and 2.4% for TAVR and SAVR, respectively).

Table 4 outlines the peri-procedural, 30-day, and one-year mortality figures of our study in addition to all three PARTNER trials. It is evident that SAVR is superior to TAVR in intermediate- and high-risk patients. A conclusion cannot be drawn for the low-risk group, necessitating data from longer-term outcomes. Of note, the TAVR-positive outcomes were demonstrated through a carefully selected group of low-risk patients with strict criteria in the PARTNER 3 trial that were followed up for no more than two years. The key question remains around the validity of these results in the real world and if these results could be applicable to all low-risk patients, outside the careful selection of these trials particularly in the context of such favourable long-term SAVR outcomes.

4.3. SAVR or TAVR

Pooled analysis of 85 retrospective cohort studies [28] reported a survival estimate of 89.7% at two years, 78.4% at five years, 57% at 10 years, 39.7% at 15 years, and 24.7% at 20 years post-SAVR. There was also a significant difference between age groups at five-year survival. Median survival was 16 years for those under 65 years of age, and 12 years and seven years in 65 to 75 and 75 to 85, respectively. This compares to our own, whole group median survival of 12.7 years. These records show that age is a strong factor in mortality post-SAVR [28].

Other studies [29] that assessed survival post-SAVR showed 80%, 55%, 32% and 21% for five, 10, 15, and 20-year survival, respectively. We report survival outcomes of 95% at one year, 83% at five years, 68% at 10 years and 58% at 20 years. Strikingly, our one-year survival (95%) is very close to the 30-day survival (95.7%) post-TAVR described by other studies [29] reiterating the non-superiority of this procedure over SAVR. Their reported outcomes for one-, and five-year

Table 4. Comparison of mortality rates between our study population and the PARTNER trials.

	PARTNER I	PARTNER II	PARTNER III	Our study			
				Overall mortality	Low-risk group	Intermediate-risk group	High-risk group
Procedural mortality	1.1%	0.99%	0.4%	0.5%	0.4%	0%	1.0%
30-day mortality	6.4%	3.4%	0.4%	0.99%	0.47%	0.66%	3.99%
One-year mortality	30.7%	11.8%	1.1%	5.0%	1.66%	3.28%	8.2%

survival are 86.9% and 46.2%, respectively [30].

There is a gap in evidence regarding outcomes of TVR in certain populations such as those with bicuspid AV, asymmetric annular calcification, and significant multivessel disease. Another component of the TAVR that needs to be explored is the durability of the heart valve. This is particularly important if younger patients with low risk undergo the procedure [15] [16] [17].

Our data raises serious concerns regarding the expansion of TAVR to all but surgically inoperable cases. We also highlight concerns regarding the expansion of findings from the PARTNER trials to the "general" aortic valve disease population. In the absence of robust, independent, long-term durability data we encourage caution with the application and expansion of TAVR and highlight the importance of a comprehensive quorate heart-team assessment of all such cases within the context of local outcome data.

Data Sharing Statement

Data available upon request.

Patient Consent

Not applicable.

Ethical Approval

Not applicable.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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