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ORIGINAL ARTICLE

# Comparison of Four Risk Scores for Contemporary Isolated Coronary Artery Bypass Grafting

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**Background** EuroSCORE and the Society of Thoracic Surgeons' (STS) Score have been the most widely used risk scores for cardiac surgery. The revised EuroSCORE II and the AusSCORE, based on an Australasian population, were recently developed. We compared the prognostic utility of these four scores for mortality as well as morbidity in patients undergoing isolated coronary artery bypass grafting (CABG).

**Methods** The scores were retrospectively calculated for isolated CABG patients at Auckland City Hospital during July 2010-June 2012. Discrimination and calibration of outcomes were assessed.

**Results** 818 patients were followed for 1.6+/-0.6 years. Mortality at 30 days was 1.6% and 2.9% on follow up. Median predicted 30 day mortality (Interquartile range) for EuroSCORE I were 2.8% (1.6%, 5.2%), EuroSCORE II 1.6% (1.0%, 2.8%), STS Score 2.3% (1.3%, 4.5%) and AusSCORE 0.5% (0.2%, 1.1%). C-statistics and Hosmer-Lemeshow test p-values for these scores for 30-day mortality were Euro score I 0.675 (95%CI 0.531-0.819)/0.061, EuroSCORE II 0.642 (0.503-0.780)/0.150, STS Score 0.641 (0.507-0.775)/0.243 and AusSCORE 0.661 (0.516-0.807)/0.420.
Only EuroSCORE I and STS scores were significant for predicting mortality at follow-up (c = 0.639 and 0.666). All scores predicted composite morbidity. C-statistics were EuroSCORE I 0.678, EuroSCORE II 0.634, STS score 0.584 and AusSCORE 0.645.

**Conclusion** EuroSCORE II, STS Score and AusSCORE had slightly improved calibration but similar discrimination for 30-day mortality compared to EuroSCORE I.
Revision of risk models to fit contemporary surgical outcomes is important, but there may only be modest room for improvement in discrimination.

**Keywords** Coronary artery bypass grafting • Risk models • Cardiac surgery • EuroSCORE

## Introduction

Several operative risk scores for cardiac surgery have been developed in the last few decades including the Parsonnet Score, [1] EuroSCOREs [2,3] and Society of Thoracic Surgeon's (STS) score. [4] EuroSCORE I was developed from a European cohort of 14,781 patients having cardiac surgery during 1995 for 30-day mortality, and published as an additive model in 1999 [2] and logistic model in 2003. [3] The STS score was developed to predict operative morbidity and was derived from an American cohort of 774,881 isolated coronary artery bypass grafting

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(CABG) patients during 2002-2006 and published in 2008. [4]

Despite the early validation of EuroSCORE I in large international populations, [5,6] more recent studies found the score over-estimated operative mortality, probably because of improving operative and peri-operative management. [7,8] In Australasian populations characterised by significant ethnic diversity, the EuroSCORE I also over-estimated operative mortality. [9] The AusSCORE was published in 2009 from 11,823 patients undergoing isolated CABG during 2001-2005 from the Australasian Society of Cardiac and Thoracic Surgeon's (ASCTS) database to predict 30-day mortality. [10] To date, there are no studies assessing its external validity.

More recently as a project to revise the original EuroSCORE to fit contemporary cohorts, the EuroSCORE II was developed from an international cohort of 22,381 patients undergoing cardiac surgery during 2010 and published in 2012. [11] Studies which have assessed the external validity of this new score have reported mixed results with EuroSCORE II performing better [12–15] or similar [16,17] to EuroSCORE I.

EuroSCORE II, STS Score and AusSCORE have not been directly compared for CABG, or assessed in Australasian cohorts. In addition the comparative value of the different scores for predicting mortality beyond 30 days is uncertain. Our objective was to compare the predictive efficacy of logistic EuroSCORE I, EuroSCORE II, STS Score and AusSCORE for morbidity and mortality at 30 days and longer follow-up after isolated CABG.

# Methods

## Patient selection and data collection

Ethics approval of this study was obtained from our institution's ethics review committee. Consecutive patients undergoing isolated CABG without concomitant valve surgery at Auckland City Hospital were included from July 2010 to June 2012. Relevant clinical characteristics were collected from computerised records. Logistic EuroSCORE I, [3] EuroSCORE II, [11] STS Score [4] and AusSCORE, [10] were retrospectively calculated from all patients using available data.

The EuroSCORE II definitions were used for pre-operative characteristics, including extracardiac arteriopathy, chronic lung disease, critical pre-operative state, poor mobility and categories for renal impairment using creatinine clearance or dialysis, left ventricular ejection fraction and pulmonary hypertension. [11] Angina was graded using the Canadian Cardiovascular Society Classification (CCS) and heart failure by the New York Heart Association Functional Classification (NYHA). Hypertension was defined as prescribed medications for lowering blood pressure, any measurement of over 140/90 mmHg prior to operation and/or a previous formal diagnosis. Hypercholesterolaemia referred to total cholesterol >5.0 mmol/L, on treatment to lower cholesterol before admission and/or a previous formal diagnosis. Stroke included any previous history of a neurological deficit that persisted over 24 hours and caused by disturbance of cerebral blood supply.

Number of grafts and durations of cardiopulmonary bypass and aortic cross-clamp were collected.

Post-operatively, high-sensitivity troponin T (hs-TnT) was measured routinely at 12-24 hours. Development of new Q-waves or left bundle branch block (LBBB) on post-operative ECG or new regional wall motion abnormalities on post-operative echocardiograms were independently interpreted by two authors (TKMW and HDW). Peri-operative myocardial infarction was defined as post-operative hs-TnT > 140 ng/L [10 times 99% upper reference limit) and the ECG and/or echocardiographic criteria above, as per the universal definition. [18,19] Five other post-operative complications (stroke, renal failure, ventilation >24 hours, deep sternal wound infection and return to theatre) as defined by the Society of Thoracic Surgeon's (STS) score and their composite were determined. [4] Mortality data were checked against New Zealand's national registry up till 31 December 2012. The three pre-specified outcomes of interest were operative mortality (death in-hospital or within 30 days of operation), medium-term mortality (death during follow-up) and composite morbidity.

## Statistical analyses

SPSS (Version 17.0, SPSS Inc., Chicago, IL, USA) and Prism (Version 5, GraphPad Software, San Diego, CA, USA) were used for statistical analysis. Continuous and categorical variables are presented as mean (standard deviation) and percentages (frequency) respectively. Discriminative powers of post-operative outcomes were assessed using the area under receiver-operative characteristics curves (c-statistic) and 95% confidence interval (95%CI) reported. Calibration was assessed by the Hosmer-Lemshow goodness-of-fit test. Kaplan-Meier curves and log-rank (Mantel-Cox) test were used for longitudinal survival analysis, stratifying each risk score into quintiles. P-values less than 0.05 were deemed statistically significant and all statistical tests were two-tailed.

# Results

Table 1 presents the baseline characteristics of the study population. Mean age was 64.5+/-10.0 years and 20.2%

**Table 1 Baseline Characteristics.**

| Characteristics | Study population n = 818 |
|---|---|
| **Demographics** | |
| Age (years) | 64.5 (10.0) |
| Female | 20.5% (168) |
| **Ethnicity** | |
| New Zealand Europeans | 52.9% (433) |
| Maori/Pacific Islander | 24.7% (202) |
| Other | 22.4% (183) |
| Body mass index (kg/m$^2$) | 29.1 (5.3) |