Applicability of the Most Commonly Used Risk Scores for Patients Undergoing Isolated Coronary Artery Bypass Grafting in Algeria

Follow this and additional works at: https://www.j-saudi-heart.com/jsha

Part of the Cardiology Commons

This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 4.0 License.

Recommended Citation
BOUKHMIS, Abdelkader; NOUAR, Mohamed El-Amin; and GUERCHANI, Mohamed Karim (2022) "Applicability of the Most Commonly Used Risk Scores for Patients Undergoing Isolated Coronary Artery Bypass Grafting in Algeria," Journal of the Saudi Heart Association: Vol. 34 : Iss. 1 , Article 5. Available at: https://doi.org/10.37616/2212-5043.1297

This Original Article is brought to you for free and open access by Journal of the Saudi Heart Association. It has been accepted for inclusion in Journal of the Saudi Heart Association by an authorized editor of Journal of the Saudi Heart Association.
Applicability of the commonly used risk scores for coronary bypass surgery in Algeria

Abdelkader Boukhmis a,⁎, Mohamed El-Amin Nouara a, Mohamed Karim Guerchani b

a Department of Cardiac Surgery, Mustapha Bacha University Hospital Center, Algiers, Algeria
b Department of Epidemiology, Mustapha Bacha University Hospital Center, Algiers, Algeria

Abstract

Objectives: The applicability of European system for cardiac operative risk evaluation II (EuroSCORE II) and the Society of Thoracic Surgeons Predicted Risk Of Mortality (STS-PROM) as well as the initial logistic Parsonnet risk score, who have been developed from European and American datasets, is questionable outside these regions. We aimed to assess the performance of these three risk scores for patients undergoing isolated coronary artery bypass grafting (CABG) in Algeria.

Methods: Between June 2014 and June 2016, data from 235 consecutive patients, who underwent isolated CABG at a reference center in Algiers, were prospectively collected and scored according to the EuroSCORE II, STS-PROM and the Parsonnet score. Their discriminative power was evaluated by the area under the receiver operating characteristic curve (AUC) while their calibration was tested by the Hosmer–Lemeshow goodness-of-fit test.

Results: The mean patient age was 59.08 years and 18.3% were female. The mortality at 30 days was 3.40%. The mortality expected by EuroSCORE II, STS-PROM and by Parsonnet risk score was: 1.33%, 0.78% and 3.35%, respectively. Discriminatory ability was fair for the Parsonnet risk score, good for the STS PROM and excellent for EuroSCORE II (AUCs = 0.737, 0.788, and 0.892, respectively). Regarding calibration, EuroSCORE II and STS-PROM under estimated observed mortality (Hosmer–Lemeshow test: P < 0.001 for both scores), while the Parsonnet risk score was well calibrated (Hosmer–Lemeshow test: p = 0.395).

Conclusions: EuroSCORE II and STS-PROM had excellent and good discriminating power, respectively, but both underestimated the risk of 30 days mortality following isolated CABG at a reference center in Algiers. The Parsonnet risk score was well calibrated but was moderately discriminating. The development of a local risk score or the recalibration of recent international risk scores is necessary.

Keywords: Coronary artery bypass grafting, Decision-making, Hospital mortality, Risk prediction

1. Introduction

Accurate scoring models for predicting the risk of operative mortality and morbidity are essential for surgical decision making, informed patient consent and healthcare management. When validated in a local population, these risk scores can be used as a benchmark for the assessment of the quality of cardiac surgical services [1]. Although all these score systems are based on patient derived data such as age, gender and co-morbidities, they differ by their design and by the number of clinical and biological parameters used, which necessarily results in a difference in their estimation and in their validation. Selection of appropriate score systems among those commonly used, or the development of a loco-regional risk score, has become an absolute necessity.

Currently, more than 20 models of risk stratification have been developed to predict short-term morbidity and mortality after cardiac surgery. The pioneer in this field was the Parsonnet risk score, which was described in 1989 [2]. This useful score has been rapidly adopted by several cardiac surgery teams,
and other authors have confirmed its predictive value on hospital mortality and morbidity [3]. The modified 2000 Bernstein-Parsonnet algorithm, which is a simplified model [4], showed a good correlation between predicted and observed mortality in patients undergoing CABG (on and off pump).

The European System for Cardiac Operative Risk Evaluation (EuroSCORE), in its initial additive version [5] was developed between 1995 and 1999, and has gained wide acceptance in Europe, North America and Asia. This additive model of EuroSCORE was followed by a logistic version which was developed in 2003 to improve its tendency to underestimate the risk in high-risk patients [6]. After losing its calibration, this score was updated in 2011 and was called EuroSCORE II, which is currently one of the most commonly used scores in the world [1].

In 2008, the American Society of Thoracic Surgeons developed its own logistic model, which has been called the Society of Thoracic Surgeons Predicted Risk Of Mortality (STS-PROM) [7–9]. This risk stratification model is widely used in North America and received a stronger recommendation than that of EuroSCORE II, by the 2018 European Society of Cardiology and the European Association of Cardio-Thoracic Surgery guidelines on myocardial revascularization, to calculate the risk of mortality following CABG surgery [10].

The need to update regularly these risk scoring systems, within the populations on which they were originated, require external validation for other populations, before certifying their applicability, predictability, and accuracy beyond the European and American boundaries [11].

Given the absence of a loco-regional score, we aimed to assess the performance of the Euroscore II; the STS-PROM, and the Parsonnet risk score, for patients undergoing isolated CABG in Algeria.

2. Methods

2.1. Type of the study

This is a monocentric, prospective and observational study. After obtaining approval from the Ethics Committee, we prospectively enrolled, between June 2014 and June 2016, 235 consecutive patients undergoing isolated CABG at a reference center in Algiers. Data acquisition was done from patient records, and the calculation of EuroSCORE II, STS-PROM and the initial logistic Parsonnet risk score has been done on their respective website (Parsonnet risk score: https://sfar.org/scores/parsonnet.php, EuroSCOREII: http://www.euroscore.org/calc.html, STS-PROM: https://riskcalc.sts.org/stswebriskcalc/calculate). No patient was excluded from analysis due to missing data. The outcome of interest was the operative mortality which includes all in-hospital deaths and deaths occurring within 30 days of the procedure.

All procedures performed in this study involving human participants were in accordance with the ethical standards of the Faculty of Medicine of Algiers and with the 1964 Helsinki declaration and its later amendments.

The study was approved in 2014 by the institutional review board of the Faculty of Medicine of Algiers.

Written and informed consent for coronary artery bypass surgery was obtained from all participants.

2.2. Inclusion and exclusion criteria

We included all consecutive patients who underwent isolated CABG (with or without the use of cardiopulmonary bypass) between June 2014 and June 2016.

Exclusion criteria: Association to another cardiac surgical procedure.

2.3. Statistical analysis

Statistical analyses were performed with SPSS version 19.0 (SPSS Inc., Chicago, Illinois). Continuous variables were expressed as mean and standard deviation, and categorical variables were expressed as percentages. A P value of less than 0.05 was considered significant.

The risk models performances were evaluated in terms of discrimination and calibration.

The discriminating power of these three risk scores (statistical accuracy) was tested by calculating the areas under the receiver operating characteristic curve (AUC), which assessed how well the model
could discriminate between survivors and non-survivors. The AUC value ranges from 0.5 (no ability to discriminate) to 1.0 (full ability to discriminate). The discriminating power of the model is considered reasonable when the AUC is greater than 0.7 and strong when the AUC exceeds 0.8. AUCs were compared using the method proposed by DeLong’s test.

Calibration (statistical precision) represents the agreement between observed and predicted outcome. It was tested, for these risk scores, by the Hosmer–Lemeshow goodness-of-fit statistics, which performs a $\chi^2$ test comparing the observed and expected data, which have been previously divided into deciles of risk. A well-calibrated model gives a P value greater than 0.05.

3. Results

All 235 patients undergoing isolated CABG, between June 2014 and June 2016 were prospectively studied. The mean patients age was $59.1 \pm 9.6$ (37–82), and 18.3% were female. In this cohort, 68.1% of patients had hypertension, 61.7% had diabetes mellitus, 23.4% presented extracardiac arteriopathy, and 25.5% have had a myocardial infarction within the past 03 months. A left ven- tricular ejection fraction (LVEF) $\geq 50\%$ was noted in 29.4% (n = 69) of patients. Most of the patients (60%, n = 141) had three-vessel diseases and 21.3% (n = 50) of them had left main disease. Bilateral internal thoracic artery grafting was performed in 59.6% (n = 140) of patients and the mean of the distal anastomoses was $2.4 \pm 0.8$/patient (1–5) (Table 1).

3.1. Overall mortality

There were 8 deaths observed, giving an overall observed mortality at 30 days of 3.40%. Predicted mortality rate for the EuroSCORE II, STS-PROM, and Parsonnet risk score were 1.33% $+/−0.95\%$, 0.78% $+/−0.96\%$, and 3.35% $+/−2.44\%$, respectively (Fig. 1).

3.2. Discrimination

EuroSCORE II achieved a strong discrimination with an AUC = 0.893 (95% Confidence Interval: 0.798–0.987), followed by STS-PROM (AUC = 0.788. 95% Confidence Interval: 0.617–0.959) then by Parsonnet risk score (AUC = 0.737. 95% Confidence Interval: 0.520–0.953), whose discrimination was fair (Fig. 2).

Table 1. Clinical and operative baseline characteristics of CABG patients.

| Risk factors                  | Patients (N = 235) |
|-------------------------------|--------------------|
| Male sex. % (N)               | 81.7 (192)         |
| Age (Year)                    | 59.1 ± 9.6 (37–82) |
| Hypertension. % (N)           | 68.1 (160)         |
| Diabetes mellitus % (N)       | 61.7 (145)         |
| Previous smoker. % (N)        | 59.1 (139)         |
| Hyperlipidemia. % (N)         | 57.9 (136)         |
| BMI $\geq 30$ kg/m²            | 27.7 ± 3.8 (19–38) |
| Previous Myocardial Infarction. % (N) | 75.3 (177) |
| Myocardial Infarction <3 months. % (N) | 25.5 (60) |
| Previous stroke. % (N)        | 5.1 (12)           |
| Extracardiac arteriopathy % (N) | 23.4 (55)         |
| Chronic lung disease % (N)    | 4.7 (11)           |
| Creatinine clearance ml/mn    | 93.8 ± 28.1 (33–190) |
| Stable angina % (N)           | 83.8 (197)         |
| Unstable angina % (N)         | 16.2 (38)          |
| NYHA class I % (N)            | 43 (101)           |
| NYHA class II % (N)           | 53.6 (126)         |
| NYHA class III % (N)          | 3.4 (8)            |
| LVEF % (N)                    | 55.4 ± 12 (24–80)  |
| Pulmonary artery systolic pressure (mmHg) | 26.5 ± 7.3 (15–60) |
| Left main disease % (N)       | 21.3 (50)          |
| Three-vessel disease % (N)    | 60 (141)           |
| Number of distal anastomoses  | 2.4 ± 0.8 (1–5)    |
| BITA grafting % (N)           | 59.6 (140)         |
| CPB time (minute)             | 84 ± 33.6 (25–166) |
| Aortic cross-clamp time (minute) | 63.6 ± 24.7 (15–110) |

Abbreviations: BITA: Bilateral internal thoracic artery. BMI: Body-Mass Index, CPB: Cardiopulmonary bypass, LVEF: Left Ventricle Ejection Fraction, NYHA: New York Heart Association.

The comparison between the discriminating powers, using the De Long’s test for two receiver operating characteristic curves, showed that the EuroSCORE II outperformed significantly the STS-PROM (0.893 versus 0.788. 95% Confidence Interval: 0.004–0.204, P = 0.041).

3.3. Calibration

EuroSCORE II and STS-PROM achieved bad calibrations and underestimated the observed mortality (Hosmer–Lemeshow statistic was: 37.96, $p' < 0.0001$ and 72.14, $p' = 0.0001$, respectively), while the Parsonnet risk score was well calibrated (Hosmer–Lemeshow statistic: 8.40, $p = 0.395$). The observed/expected ratio of operative mortality was 2.55, 4.36, and 1.01, respectively.

The details of the three risk scores performances are shown in Table 2.

Calibration curve plots (Fig. 3) showed that all scores had a relatively linear relationship between predicted and observed mortality. While the Parsonnet risk score had good calibration regardless of the patient’s risk profile, the STS-PROM underestimated mortality for all patient’s risk profiles, and
Fig. 1. Distribution of mortality rates estimated by EuroSCORE II, STS PROM and Parsonnet score. The red line indicates the average observed mortality.

Fig. 2. Receiver operating characteristics (ROC) curves of the three scoring models for patients undergoing CABG in Algiers. The area under the curve ROC (AUC) of EuroSCORE II was 0.893 (95% CI: 0.798–0.987), of STS-PROM was 0.788 (95% CI: 0.617–0.959), and of Parsonnet score was 0.737 (95% CI: 0.520–0.953).
the EuroSCORE II only underestimated it for patients whose expected mortality was greater than 2%.

4. Discussion

The main conclusions of this prospective monocentric study, concerning patients undergoing isolated CABG at a reference center in Algiers, are:

- EuroSCORE II and STS-PROM, which are the most widely used risk scoring systems worldwide, had excellent and good discrimination, respectively, but both underestimated the risk of 30 days mortality.
- The initial logistic Parsonnet risk score had fair discrimination but perfect calibration.

The excellent and good discriminating power of EuroSCORE II and STS PROM, compared to the fair accuracy of Parsonnet risk score, means that the design of these two models and the greater number of variables they contain make them more accurate in identifying patients at high, intermediate or low risk of mortality. However, the lack of precision of these two recent risk scores, reflecting the current and efficient European and united states health systems, in estimating the mortality of Algerian CABG-patients; is due to the higher than expected mortality rate in our cohort which was closer to that expected by Parsonnet risk score.

A calibration failure can be explained by differences in the patients risk profile, but also by a deficiency in the quality of care, which depends closely on socio-economic conditions, surgical technique and quality of postoperative care, or by a poor design of the predictive model.

Compared with EuroSCORE II database patients, our cohort included many more patients with

---

Table 2. Predictive performances of the three risk scores for patients undergoing isolated CABG in Algeria.

| Risk Score            | Observed mortality | Predicted mortality | AUC (95% Confidence interval) | Hosmer–Lemeshow test (P value) | Observed mortality/Predicted mortality |
|-----------------------|--------------------|---------------------|-------------------------------|-------------------------------|---------------------------------------|
| EuroSCORE II          | 3.40%              | 1.33% ± 0.95%       | 0.893 (0.798–0.987)           | p<0.0001                      | 2.55                                  |
| STS-PROM              | 3.40%              | 0.78% ± 0.96%       | 0.798. (0.617–0.959)          | p<0.0001                      | 4.36                                  |
| Parsonnet risk score  | 3.40%              | 3.35% ± 2.44%       | 0.737. (0.520–0.953)          | P = 0.395                     | 1.01                                  |

Abbreviations: AUC: area under the receiver operator characteristics curve; CI: confidence interval.

---

Fig. 3. Calibration plots for the three risk scoring models. The diagonal line represents the perfect calibration line. (Blue) for Parsonnet score. (Red) for EuroSCORE II. (Green) for STS-PROM.
these risk scores, which were established on Malaysia [13]. However, in developing countries, certain surgeons certainly in modern equipments added to the learning curve of cardiac surgery center in across the country. The lack of still not available in our center or in any other center significantly reduce CABG morbidity and mortality, are mechanical circulatory supports, which can significantly reduce the risk in European populations, was not applicable for estimating operative mortality following CABG. This is due not only to ethnic and epidemiological factors, but also to differences in the quality of control of cardiovascular diseases risk factors and in the quality of intra-hospital care, which necessarily lead to different outcomes.

Thus in a Brazilian retrospective cohort study of 1,065 patients, 2000 Bernstein-Parsonnet score and EuroSCORE I showed good discriminatory power, but underestimated the in-hospital mortality. This result was in contradiction with what has been observed, during the same period, when applying these two scores in developed countries [14]. Furthermore, in a more recent cohort of 5,222 Brazilian patients, including 60% of patients who benefited from a CABG, the regional score overperformed the STS-PROM and the EuroSCORE II, which also greatly underestimated the observed mortality [15]. The calibration curves of the EuroSCORE II and STS-PROM of this Brazilian cohort are in perfect adequacy with those generated by our study.

The same conclusion was made for EuroSCORE II in India [16], and Turkey [17]. Even the logistics EuroSCORE, who is known for its overestimation of the risk in European populations, was not applicable in an Iranian study including 2220 CABG procedures [18].

Concerning the predictive performances over time of these scoring systems, it has been noted that Parsonnet risk score, STS-PROM, and EuroSCORE have experienced a progressive loss of their calibration, even in the populations where they have been established. Indeed, these models overestimated the risk as the results of cardiac surgery have substantially improved with a sustained reduction of risk-adjusted mortality [1]. In addition, EuroSCORE II has been criticized since its publication. Its innate tendency to underestimate observed mortality was considered "acceptable" by authors of the original publication, although its calibration was controversial, since the value of the goodness-of-fit test was near the failure in the original internal validation (p = 0.0505) [1]. This has led to validation concerns of EuroSCORE II in countries that participated in its development, such as Canada [19] and the United Kingdom [20] where this model was poorly calibrated and failed the Hosmer-Lemeshow test in cohorts of isolated CABG patients (P = 0.002, P < 0.001, respectively).

Since international scores are not applicable in all countries, some national scores have emerged, and were validated on their respective populations, such as...
as the Chinese [12], or the Australian System for Cardiac Operative Risk Evaluation [21] or the São Paulo risk Score for Brazil [15].

5. Limitations

The major limitations of this study are the small sample size and the single-centre design, which may affect the generalizability of results to the entire country. Our relatively low annual volume of CABG procedures may have affected the prediction precision of EuroSCORE II and STS-PROM which also showed good accuracy. A multicentre study conducted over a longer period will make it possible to collect a larger sample size of patients in order to improve the power of the study and to validate or not the applicability of these universal tools of risk scoring at the country scale.

6. Conclusions

EuroSCORE II and STS-PROM had good discriminating power, but both underestimated the risk of 30 days mortality following isolated CABG at a reference center in Algiers. The Parsonnet risk score was well calibrated but was moderately discriminating. The development of a local risk score or the recalibration of recent international risk scores is necessary to better assess the risk.

Author contribution

Conception and design of Study: AB, MEAN. Literature review; Acquisition of data; Research investigation and analysis; Drafting of manuscript; Data preparation and presentation; Research coordination and management: AB. Analysis and interpretation of data; Data collection: MKG. Revising and editing the manuscript critically for important intellectual contents: AB, MEAN, MKG. Supervision of the research; Funding for the research: MEAN.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

None declared.

References

[1] Nashef SAM, Roques F, Sharples LD, Nilsson J, Smith C, Goldston AR, et al. EuroSCORE II. Eur J Cardio Thorac Surg April 2012;41(Issue 4):734–45. https://doi.org/10.1093/ejcts/ezs043.
[2] Parsonnet V, Dean D, Bernstein AD. A method of uniform stratification of risk for evaluating the results of surgery in acquired adult heart disease. Circulation 1989 Jun; 79(6 Pt 2):13–12. PMID: 2720942. (There is no DOI for this article).
[3] Nashef SAM, Carey F, Silcock MM, Oomen PK, Levy RD, Jones MT. Risk stratification for open heart surgery: trial of the Parsonnet system in a British hospital. Br Med J 1992;305: 1066–7. https://doi.org/10.1136/bmj.305.6861.1066.
[4] Bernstein AD, Parsonnet V. Bedside estimation of risk as an aid for decision-making in cardiac surgery. Ann Thorac Surg 2000 Mar;69(3):823–8. https://doi.org/10.1016/S0003-4975(99)01424-1.
[5] Nashef SA, Roques F, Michel P, Gauducheau E, Lemeshow S, Salamon R, et al. European system for cardiac operative risk evaluation (EuroSCORE). Eur J Cardio Thorac Surg 1999 Jul;16(1):9–13. https://doi.org/10.1016/S1010-7940(99)00134-7.
[6] Roques F, Michel P, Goldstone AR, Nashef SA. The logistic EuroSCORE. Eur Heart J 2003 May;24(9):881–2. https://doi.org/10.1016/S0195-668X(02)00796-6.
[7] Shahian DM, O’Brien SM, Filardo G, Peterson ED, Edwards FH, Anderson RP, et al. Society of thoracic surgeons quality measurement task force. The society of thoracic surgeons 2008 cardiac surgery risk models: part 1—coronary artery bypass grafting surgery. Ann Thorac Surg 2009 Jul;88(1 Suppl): S2–22. https://doi.org/10.1016/j.athoracsur.2009.05.053.
[8] O’Brien SM, Shahian DM, Filardo G, Peterson ED, Edwards FH, Anderson RP, et al. The society of thoracic surgeons 2008 cardiac surgery risk models: part 2—isolated valve surgery. Ann Thorac Surg 2009;88:S52eS542. https://doi.org/10.1016/j.athoracsur.2009.05.056.
[9] Shahian DM, O’Brien SM, Filardo G, Peterson ED, Edwards FH, Anderson RP, et al. The society of thoracic surgeons 2008 cardiac surgery risk models: part 3—valve plus coronary artery bypass grafting surgery. Ann Thorac Surg 2009;88:S55eS56. https://doi.org/10.1016/j.athoracsur.2009.05.055. S54.
[10] Neumann FJ, Sousa-Uva M, Alhsson A, Alfonso F, Banning AP, Benedetto U, et al. 2018 ESC/EACTS Guidelines on myocardial revascularization. Eur Heart J 07 January 2019; 40(2):87–165. https://doi.org/10.1093/eurheartj/ehy394.
[11] Ivanov J, Tu JV, Naylor CD. Ready-made, recalibrated, or remodeled? Issues in the use of risk indexes for assessing mortality after coronary artery bypass graft surgery. Circulation 1999;99:2089–104. https://doi.org/10.1161/01.CIR.99.16.2089.
[12] Ma X, Wang Y, Shan L, Cang Z, Gu C, Qu N, et al. Validation of SinoSCORE for isolated CABG operation in east China. Sci Rep 2017;7:16806. https://doi.org/10.1038/s41598-017-16925-x.
[13] Musa AF, Cheong XP, Dillon J, Bin Nordin R. Validation of EuroSCORE II in patients undergoing coronary artery bypass grafting (CABG) surgery at the National Heart Institute, Kuala Lumpur: a retrospective review. F1000Research 2 May. 2018;7:534. https://doi.org/10.12688/f1000research.14760.2.
[14] Garforollo SB, Machado DP, Rodrigues CG, Bordim Jr O, Kalil RAK, Portal VL. Applicability of two international risk scoring at cardiac surgery in a reference center in Brazil. Arq Bras Cardioi 2014 Jun;102(6):539–48. https://doi.org/10.5935/ abc.20140064.
[15] Mejia OAV, Borgomoni GB, Zubeeli JP, Dallan LRP, Pomerantzfeff PMA, Oliveira MAP, et al. Validation and quality measurements for STS, EuroSCORE II and a regional risk model in Brazilian patients. PLoS One 2020;15(9): e0238737. https://doi.org/10.1371/journal.pone.0238737.
[16] Pillai BS, Baloria KA, Selot N. Validation of the European System for Cardiac Operative Risk Evaluation-II model in an urban Indian population and comparison with three other risk scoring systems. Ann Card Anaesth 2015;18:335–42. https://doi.org/10.4103/0971-9784.159803.
[17] Kunt AG, Kurtcephe M, Hidiroglu M, Cetin L, Kucuker A, Bakuy V, et al. Comparison of original EuroSCORE, EuroSCORE II and STS risk models in a Turkish cardiac surgical cohort. Interact Cardiovasc Thorac Surg 2013;16:625–9. https://doi.org/10.1093/icvts/ivt022.

[18] Jamaati H, Najafi A, Kahe F, Karimi Z, Ahmadi Z, Bolursaz M, et al. Assessment of the EuroSCORE risk scoring system for patients undergoing coronary artery bypass graft surgery in a group of Iranian patients. Indian J Crit Care Med 2015;19:576–9. https://doi.org/10.4103/0972-5229.167033.

[19] Kieser TM, Rose MS, Head SJ. Comparison of logistic EuroSCORE and EuroSCORE II in predicting operative mortality of 1125 total arterial operations. Eur J CardioThorac Surg 2016;50:509–18. https://doi.org/10.1093/ejcts/ezw072.

[20] Grant SW, Hickey GL, Dimarakis I, Trivedi U, Bryan A, Treasure T, et al. How does EuroSCORE II perform in UK cardiac surgery; an analysis of 23 740 patients from the society for cardiothoracic surgery in great britain and Ireland national database. Heart 2012;98:1568–72. https://doi.org/10.1136/heartjnl-2012-302483.

[21] Reid C, Billah B, Dinh D, Smith J, Skillington P, Yiu M, et al. An Australian risk prediction model for 30-day mortality after isolated coronary artery bypass: the AusSCORE. J Thorac Cardiovasc Surg 2009;138:904–10. https://doi.org/10.1016/j.jtcvs.2009.03.020.