EUROPEAN SOCIETY OF CARDIOLOGY®

Performance of EuroSCORE in CABG and off-pump coronary artery bypass grafting: single institution experience and meta-analysis

Appendix 1: Detailed description of the statistical methods utilized

All statistical tests were two-sided, with the exception of χ^2 tests of homogeneity in the meta-analysis, which were one-sided. Apart from *Table 1*, no corrections for multiple testing were performed in this article because its purpose was not to single out one or a few results out of many.

Single institution experience

Additive and logistic EuroSCORE performances were studied in all patients and in patients undergoing CABG vs. patients submitted to OPCAB.

Performance of the models was assessed by comparing the observed and predicted mortality figures with 95% confidence intervals. In order to provide further insight, an additional grouping strategy was adopted by using a clinical risk classification generating quartiles of risk derived by logistic EuroSCORE risk prediction; also in this case, the performance of the models was assessed by comparing the observed and predicted mortality figures with 95% confidence intervals.[11]

Then, to assess the discriminatory ability of additive and logistic EuroSCORE to predict in-hospital mortality, the non-parametric area under the ROC curve was used.[12,13] It is expected to be a reliable metric because the variables are continuous and cover reasonably uniformly the range of possible values. The AUCs (generated for both additive and logistic EuroSCORE and for patients undergoing CABG and OPCAB) together with the 95% confidence intervals and standard error were computed with SPSS statistical software version 14.0 (SPSS Inc., Chicago, IL, USA) and compared using the unpaired (to compare ROC curves obtained for patients undergoing CABG and OPCAB) and paired (to compare ROC curves obtained for additive and logistic EuroSCORE) *z*-score tests based on variance estimations from the model of DeLong *et al.*[13] implemented on the University of Chicago ROC software (http://xray.bsd.uchicago.edu/krl/); *P*-values <0.05 were considered significant. Finally, calibration was formally assessed by the Hosmer–Lemeshow test.[14]

Meta-analysis

Once papers were identified by a literature search, a mandatory selection criterion for meta-analysis inclusion of each study was the presence of the assessment of discriminatory power of EuroSCORE by ROC curves reporting the figures of merit and the dispersion parameters (standard error and/or 95% CI), which were necessary for meta-analysis.[17,18] Since the purpose of this meta-analysis is to gain insight into the general discriminatory characteristics of the EuroSCORE models for the two surgical modalities, we included only the area under the curve, as opposed to construct a complete summary ROC curve. Our analysis follows the work of McClish[16] and Zhou.[17] First, the various articles were tested for homogeneity doing a χ^2 test on mortality contingency tables. Then we performed a χ^2 analysis for homogeneity using the equation

$$\chi^2_{\text{Homogeneous}} = \sum_{i=1}^{g} \frac{(\text{AUC}_i - \overline{\text{AUC}})}{\text{Var}(\text{AUC}_i)} \quad (1)$$

where AUC is the value of the AUC for paper *i*, and

$$\overline{\text{AUC}} = \frac{\sum_{i=1}^{g} \text{AUC}_i/\text{Var}(\text{AUC}_i)}{\sum_{i=1}^{g} 1/\text{Var}(\text{AUC}_i)}, \quad (2)$$

is the estimated common area among the studies.

We considered assuming that the different papers were in fact sampling a different population, which would have implied that for each study the average AUC value would be different.[18] However, all the tests for homogeneity produced very small χ^2 values, so that would not have been meaningful. (The test for homogeneity in the AUC values was done using Equation A1 and a χ^2 value of 0.86 for a *P*-value of 0.83 for OPCAB and a χ^2 value of 3.7 for a *P*-value of 0.59 for CABG was obtained.) This suggests that there is no evidence for heterogeneity; this should be interpreted, meaning that the heterogeneity between institutions is small relatively to the variability within institutions. The variance of the common AUC was also computed following McClish

$$\text{Var}(\overline{\text{AUC}}) = \frac{1}{\sum_{i=1}^{g} 1/\text{Var}(\text{AUC}_i)} \quad (3)$$

All calculations were done either with University of Chicago software, Excel (Microsoft Office Excel 2003, Microsoft Inc.) or using Mathematica (Mathematica 6, Wolfram Research Inc.).

Appendix 2

Table A1 Predicted vs. observed mortality for additive and logistic EuroSCORE by risk quartiles and surgical strategy (CABG vs. off-pump coronary artery bypass grafting)

Quartiles	*N*	Events	Observed mortality (%)	Predicted mortality by additive EuroSCORE (%)	Predicted mortality by logistic EuroSCORE (%)
All patients (*n* = 4580)					
First	1065	1	0.09 (0.03–0.38)	0.58 (0.54–0.62)	1.01 (1.00–1.02)
Second	1221	4	0.33 (0.19–0.64)	2.32 (2.28–2.35)	1.72 (1.71–1.74)
Third	1149	7	0.61 (0.41–0.99)	3.94 (3.90–3.98)	2.91 (2.88–2.93)
Fourth	1145	26	2.27 (1.86–2.84)	6.75 (6.64–6.86)	8.16 (7.80–8.52)
Total	4580	38	0.83 (0.70–1.00)	3.43 (3.36–3.50)	3.46 (3.34–3.58)
Patients stratified by surgical strategy (CABG/OPCAB)					
	CABG (*n* = 3440)				
First	859	1	0.12 (0.03–0.47)	0.58 (0.54–0.63)	1.01 (1.00–1.02)
Second	967	4	0.41 (0.24–0.80)	2.31 (2.27–2.35)	1.72 (1.70–1.74)
Third	857	4	0.47 (0.28–0.91)	3.92 (3.88–3.97)	2.88 (2.85–2.92)
Fourth	757	20	2.64 (2.10–3.42)	6.75 (6.61–6.88)	8.21 (7.74–8.68)
Total	3440	29	0.84 (0.70–1.04)	3.26 (3.18–3.34)	3.26 (3.12–3.40)
	OPCAB (*n* = 1140)				
First	206	0	0.00 (0.00–1.28)	0.57 (0.48–0.65)	1.01 (0.99–1.03)
Second	254	0	0.00 (0.00–1.04)	2.33 (2.25–2.41)	1.75 (1.71–1.78)
Third	292	3	1.03 (0.55–2.22)	3.99 (3.91–4.07)	2.97 (2.91–3.02)
Fourth	388	6	1.55 (1.01–2.60)	6.76 (6.59–6.93)	8.06 (7.51–8.62)
Total	1140	9	0.79 (0.56–1.20)	3.94 (3.80–4.09)	4.08 (3.82–4.33)

Appendix 3: Characteristics of studies reporting discriminatory performance of additive and logistic EuroSCORE in CABG and off-pump coronary artery bypass grafting included in meta-analysis

Table B1 Additive EuroSCORE

	Patients	Events	Mortality % (SE)	AUC	95% CIs (SE)
CABG					
Asimakopoulos *et al.*[21]	4654	152	3.27 (0.26)	0.760	0.72–0.80 (0.02)
Biancari *et al.*[23]	1098	5	0.46 (0.20)	0.856	0.71–1.00 (0.08)
Parolari (current study)	3440	29	0.84 (0.16)	0.808	0.72–0.89 (0.04)
Toumpoulis *et al.*[31]	3760	103	2.74 (0.27)	0.750	0.70–0.79 (0.02)
OPCAB					
Al-Ruzzeh *et al.*[20]	1907	26	1.36 (0.27)	0.750	0.64–0.85 (0.05)
Parolari (current study)	1140	9	0.79 (0.26)	0.779	0.64–0.92 (0.07)

Table B2 Logistic EuroSCORE

	Patients	Events	Mortality % (SE)	AUC	95% CIs (SE)
CABG					
Antunes *et al.*[19]	4567	44	0.96 (0.33)	0.754	0.68–0.83 (0.04)
Biancari *et al.*[23]	1098	5	0.46 (0.26)	0.856	0.67–1.00 (0.09)
Farrokhyar *et al.*[26]	1693	26	1.54 (0.41)	0.81	0.71–0.90 (0.05)
Parolari (current study)	3440	29	0.84 (0.42)	0.813	0.73–0.90 (0.04)
Toumpoulis *et al.*[31]	3760	103	2.74 (0.47)	0.75	0.71–0.80 (0.02)
OPCAB					
Farrokhyar *et al.*[26]	1657	30	1.81 (0.33)	0.79	0.71–0.88 (0.04)
Parolari (current study)	1140	9	0.79 (0.26)	0.773	0.63–0.91 (0.07)
Youn *et al.*[32]	757	10	1.32 (0.41)	0.71	0.55–0.87 (0.08)