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Society of Thoracic Surgeons Risk Scores Performance in Patients with Left Main Coronary Artery Disease Undergoing Revascularization in the EXCEL trial

Running title: **STS-scores in LMCAD Revascularization**

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ABSTRACT

AIMS: Accurate risk prediction in patients undergoing revascularization is essential. We aimed to assess the predictive performance of Society for Thoracic Surgeons (STS) risk models in patients with left main coronary artery disease (LMCAD) undergoing coronary artery bypass grafting (CABG) or percutaneous coronary intervention with everolimus-eluting stents (PCI-EES).

METHODS AND RESULTS: The predictive performance of STS risk models for perioperative mortality, stroke and renal failure were evaluated for their discriminative ability (C statistic) and calibration (Hosmer-Lemeshow goodness-of-fit-test; χ^2 and *p*-values) among patients with LMCAD undergoing PCI-EES (n=935) and CABG (n=923) from the randomized EXCEL trial. STS risk scores, in CABG patients, showed good discrimination for 30-day mortality and average discrimination for stroke (C statistics 0.730 and 0.629 respectively) with average calibration. For PCI, STS risk scores had no discrimination for mortality (C statistic 0.507), yet good discrimination (C statistic 0.751) and calibration for stroke. The predictive performance for renal failure was good for CABG (C statistic 0.82), yet poor for PCI (C statistic 0.59).

CONCLUSIONS: In selected patients with LMCAD from the EXCEL trial, STS risk models showed good predictive performance for CABG yet lacked predictive performance for PCI for perioperative mortality and renal failure. The STS stroke risk model was surprisingly more discriminating in PCI

compared to CABG EXCEL patients. Improved and procedure-specific risk-prediction instruments are needed to accurately estimate adverse events after LMCAD revascularization by CABG and PCI.

Keywords: Drug-eluting stent; death; stroke; clinical trials; risk stratification; other techniques

CONDENSED ABSTRACT

Accurate risk prediction in patients undergoing revascularization is essential. The current study assessed the predictive performance of STS risk models for peri-procedural mortality, stroke and renal failure in patients with left main coronary artery disease from the EXCEL trial treated with CABG or PCI. STS risk models showed good predictive performance for CABG, yet non-predictive for PCI regarding perioperative mortality and renal failure. The STS stroke model was surprisingly more discriminating in PCI compared to CABG. Improved and procedure-specific risk-prediction instruments are needed to accurately forecast clinical outcomes after LMCAD revascularization by CABG and PCI.

ABBREVIATIONS

C statistic = concordance statistic

CAB = coronary artery bypass

CABG = coronary artery bypass grafting

CAD = coronary artery disease

EACTS = European Society for Cardio-Thoracic Surgery

EES = everolimus-eluting stent

ESC = European Society of Cardiology

EXCEL = Evaluation of XIENCE versus Coronary Artery Bypass Grafting for Effectiveness of Left Main Revascularization

LMCAD = left main coronary artery disease

O/E = observed/expected

OR = odds ratio

PCI = percutaneous coronary intervention

PROM = predicted risk of mortality

STEMI = ST-elevated myocardial infarction

STS = Society of Thoracic Surgeons

WHO = World Health Organization

INTRODUCTION

Accurate preoperative risk assessment is essential to decide between percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG) surgery in patients with advanced coronary artery disease (CAD). This is particularly true now as PCI is increasingly accepted as a suitable alternative to CABG in selected patients with multivessel and left main coronary artery disease (LMCAD) (1-8). Moreover, it is unclear how risk score calculators perform in selected patients with isolated LMCAD undergoing revascularization in the current era.

The randomized EXCEL (Evaluation of XIENCE versus Coronary Artery Bypass Grafting for Effectiveness of Left Main Revascularization) trial showed that PCI with everolimus-eluting stents (EES) was non-inferior to CABG in patients with LMCAD and simple or moderate anatomic coronary complexity in terms of death, large myocardial infarction, or stroke at an intermediate follow-up time of 3 years. PCI patients had fewer major adverse events in the peri-procedural period compared with CABG yet had a higher 3-year rate of ischemia-driven repeat revascularization (9). Patients at low risk of surgical complications may thus have a more favourable risk-benefit profile after CABG.

Multiple risk-stratification tools have been developed to predict perioperative outcomes after CABG, (10-13). These predictive models can guide cardiothoracic surgeons and cardiologists during heart team meetings to select the optimal treatment and predict their clinical outcomes as recommended by the ESC/EACTS 2018 Guidelines on myocardial revascularization (6, 14).

It is unclear, however, whether the accuracy of isolated “CABG-only” STS risk models will remain as robust when applied in specific patient sub-cohorts (e.g., LMCAD EXCEL patients) treated with CABG or alternatively with PCI. We therefore sought to investigate the predictive performance of STS risk scores in patients that underwent CABG for LMCAD in the randomized EXCEL trial. We also examined the utility of STS risk models in PCI-treated subjects to determine if these models enable identifying those patients best managed by one or the other revascularization-modality.

METHODS

Study design. The design and results of the EXCEL study have been previously reported (9, 15). In brief, the EXCEL trial was a multicentre randomized trial that compared CABG to PCI with everolimus-eluting stents (XIENCE, Abbott Vascular, Santa Clara, California) in patients with LMCAD. The trial was approved by local ethics committees of all participating sites and is registered at ClinicalTrials.gov (NCT01205776). The EXCEL trial randomized 1905 patients with LMCAD and a low or intermediate SYNTAX score (≤32, site-determined) to undergo CABG (n=957) or PCI with EES (n=948). Of the 957 patients randomized to CABG, 930 underwent revascularization, with CABG being the primary procedure in 923 patients (as-treated). Of the 948 patients randomized to PCI, 942 underwent revascularization and of those, 935 patients underwent PCI as the primary procedure (as-treated). The current study included the as-treated randomized patients (CABG n=923 and PCI n=935) to assess whether 30-day clinical outcomes could be accurately predicted by the STS predicted risk of mortality (PROM), stroke, and renal failure risk models. STS risk scores were calculated by by implementing the STS CABG risk models as per the specifications described by Shahian *et al.*(11), and the accuracy of implementation was confirmed by robust cross-checking with the "online STS Adult Cardiac Surgery Risk Calculator" for "isolated CAB" (16). The definitions of death, stroke and renal failure used by the EXCEL trial are consistent with the definitions used by the STS adult cardiac surgery database.

Study endpoints. The primary endpoint was the predictive performance of the STS PROM and stroke risk scores in the as-treated LMCAD population that underwent CABG or PCI. The secondary endpoints was the predictive performance for the STS renal failure risk score in the CABG and PCI cohorts.

Statistical analysis. Continuous variables were expressed as mean ± standard deviation (SD), and discrete variables were expressed as percentage with frequency, unless otherwise stated. An unpaired *t* test was used to compare mean outcomes, and the Wilcoxon 2-sample test was used to compare median outcomes. Overall observed-to-expected (O/E) ratios were visualized by bar plots. The χ^2 test was used to calculate *p* values and 95% confidence intervals (CI) on the difference in observed to expected proportions (O/E-ratios) between treatment groups. An O/E ratio of >1 indicated under-prediction of the clinical outcome by the STS risk score.

Each treatment group was split into quintiles based on the mean predicted STS risk scores, ranking subgroups from lowest predicted risk scores to highest predicted risk scores. The PROM, stroke, and renal STS models were evaluated for their discriminating ability using the area under the receiver operator curve according to the "concordance" (C statistics) methodology. A C statistic outcome of 1.0 indicates perfect discriminative power, whereas 0.5 indicates no discriminative ability (17). Risk model calibration competence was assessed using the Hosmer-Lemeshow goodness-of-fit test to examine the observed versus expected outcomes for all quintiles.. Specifically for the Hosmer-Lemeshow goodness-of-fit test, a 2-sided p value of ≤ 0.05 indicated a statistically significant difference between observed and expected values, therefore, a p value >0.05 indicates better predictive performance. For all other statistical tests, a $p<0.05$ was considered to be statistically significant. Statistical analyses were performed with SAS version 9.4 (SAS Institute, Cary, North Carolina).

RESULTS

Baseline and procedural characteristics. Baseline characteristics between the as-treated CABG and PCI groups were similar except for modest differences in New York Heart Association class I, and distal left main stenosis anatomy (Table 1). Off-pump CABG was performed in 29.4% of the procedures, and bilateral internal thoracic arteries were used in 22.4%. Mean post-procedural in-hospital stay was 8.3 ± 7.8 days for CABG and 2.2 ± 2.9 days for PCI ($p<0.0001$, Supplemental Table 1).

STS PROM risk scores. The mean expected 30-day STS PROM scores were similar for patients who underwent CABG (0.85% ± 0.76%) versus PCI (0.90% ± 0.89%, $p=0.21$). Observed 30-day mortality rates were also similar between CABG (n=10, 1.1%) and PCI (n=9; 1.0%) ($p=0.83$). This resulted in comparable O/E ratios (1.27 vs 1.07, respectively, $p=0.32$, Figure 1, Supplemental Table 1-3). The STS PROM C statistic for CABG was 0.73 (Figure 2A) and 0.51 for PCI (Figure 2B). The Hosmer-

Lemeshow goodness-of-fit tests was 10.21 (p=0.25) for CABG and 8.81 (p=0.36) for PCI (Figure 2C and 2D, respectively).

STS stroke risk scores. The mean expected 30-day STS stroke scores were 0.76% ± 0.54% for CABG versus 0.77% ± 0.61% for PCI patients (p=0.86). Stroke occurred in 1.3% (n=12) after CABG versus 0.6% (n=6) after PCI (p=0.12). Consequently, stroke O/E ratios were 1.70 for CABG and 0.83 for PCI (p=0.045, Figure 1, Supplemental Table 2-4). The C statistic for the STS stroke risk score was 0.63 for CABG compared with 0.75 for PCI (Figure 3A and 3B). The Hosmer-Lemeshow goodness-of-fit tests was 7.21 (p=0.51) for CABG and 6.13 (p=0.63) for PCI (Figure 3C and 3D, respectively).

STS renal failure risk scores. No differences were found between the mean expected 30-day STS renal failure scores in the CABG cohort (1.95% ± 2.13%) and PCI cohort (1.95% ± 2.35%, p=0.96). Observed renal failure rates, at 30-days, were 2.6% in patients that underwent CABG (n=24) and 0.6% in patients that underwent PCI (n=6) (p<0.001). Subsequently, renal O/E ratios were 1.34 for CABG and 0.33 for PCI (p=0.42, Figure 1, Supplemental Table 3-5). The C statistic was 0.82 for CABG and 0.59 for PCI (Figure 4A and 4B, respectively), and the Hosmer-Lemeshow goodness-of-fit test was 14.73 (p=0.065) for CABG (Figure 4C) and 11.98 (p=0.15) for PCI (Figure 4D).

DISCUSSION

For patients with LMCAD undergoing revascularization in the EXCEL trial, the perioperative STS PROM risk model for CABG patients showed good predictive performance based on the C statistic and was well calibrated according to the Hosmer-Lemeshow goodness-of-fit test, with modest under prediction of mortality among high-risk patients. Conversely, the STS PROM risk model was non-predictive after PCI with EES (C statistic 0.507; comparable to “flipping a coin”). In particular, perioperative mortality was overestimated by the STS PROM in the highest PCI risk quintile (9); however, the number of very high risk patients was limited in EXCEL, potentially reducing precision of the STS predictive ability in higher risk groups (18). The predictive ability for stroke was reasonably good for both PCI and CABG. Finally, the predictive performance of STS renal failure risk scores was good in the CABG cohort, but poor in the PCI group. As the number of more complex patients with coronary artery disease that are discussed during heart team meetings increases, it is importance to be able to accurately predict ability the risk of adverse events after CABG or PCI. Therefore, evaluating the predictive performance of the STS risk score calculator provides valuable insights into perioperative risk assessment in the contemporaneous revascularization era.

The STS isolated CABG risk models were developed and validated for short-term outcomes (in-hospital or 30-day mortality and other major morbidity) based on a large, national-scale and all-inclusive isolated CABG surgery patient population derived from the STS adult cardiac surgery database over a period of time (1 to 3 years) (11). It is therefore not surprising that STS risk models predicted outcomes less accurately in patients undergoing PCI with EES compared with those undergoing CABG. During structured heart team meetings, clinicians should combine the results from the STS and other risk scores with clinical judgement and contemporaneous guidelines to determine the optimal patient-tailored and evidence-based revascularization decision (6, 14). Besides, it is important to account for the expected increased short-term risk of surgical intervention versus potential differential long-term outcomes of available treatment options.

In the current study, stroke within 30-days occurred less often after PCI compared to CABG. This finding is in line with a prior large-scale meta-analysis reporting a significantly lower 30-day rate of stroke after PCI compared with CABG in LMCAD (odds ratio (OR) 0.36 (95% CI 0.16-0.82, p=0.007) (8, 19). Nonetheless, it was surprising that the STS risk model underestimated the risk of stroke at 30-days in patients that underwent CABG (O/E 1.70). The STS stroke risk model was developed and validated in an all-inclusive (LMCAD and non-LMCAD) patient population without including LMCAD as a predictor variable of perioperative stroke. Risk models developed in specific sub-cohorts (e.g., LMCAD only) can differ appreciably from models based on overall patient populations. In the EXCEL trial, the PCI cohort had a lower 30-day stroke rate (n=6, 0.6%) compared with CABG (n=12, 1.3%; odds ratio 0.5, 95% CI [0.19-1.33], P=0.15) (9). The risk of developing stroke is influenced by multiple underlying causes, in both CABG or PCI cohorts, such as (i) on versus off-pump, (ii) usage of side-biting aorta clamp, (iii) single versus double antiplatelet therapy, (iv) single versus bilateral internal thoracic arteries use, (v) post-procedural atrial fibrillation and (vi) femoral versus the radial artery percutaneous access (19, 20). STS risk models are solely based on demographic and preoperative CABG patient factors and comorbidity. Therefore, a different way of modelling is warranted to take into account all peri-procedural factors influencing the risk of stroke.

Renal failure is a well-known and imperative complication after cardiopulmonary bypass and the excess use of contrast-agents during PCI (21) increases the risk of mortality and morbidity (22). A subgroup analysis of patients with versus without chronic kidney disease from the EXCEL trial, showed that PCI compared with CABG, was associated with lower rates of acute renal failure in patients with (2.3% vs. 7.6%; OR: 0.28; 95% CI [0.09-0.87]) versus without chronic kidney disease (0.3% vs. 1.3%; OR: 0.20; 95% CI: [0.04-0.90]) (23). Nonetheless, no treatment-interaction was identified (*p* for interaction=0.71). It is important to adequately predict the risk of renal failure after revascularization to personalize treatment strategies in individual patients. The predictive performance of the STS renal failure risk model was excellent in CABG cohort, however performed poorly in the PCI cohort.

To date, no risk model has focused exclusively on predicting perioperative outcomes in patients with LMCAD. The CABG-specific STS risk model did not include LMCAD as a predictor of the risk for mortality, stroke, renal failure, and reoperation. Rather, it only included LMCAD-specific coefficients for “prolonged ventilation” and “any composite adverse outcome” (11). The SYNTAX score II did take LMCAD into account by grading the presence of a ≥50% left main with the highest possible weighting factor, but this risk score was developed and validated for predicting long-term (4-year) mortality in patients with complex coronary artery disease (13). To more accurately determine perioperative clinical outcomes for LMCAD patients, risk models specifically and separately derived in the LMCAD-CABG and LMCAD-PCI patient populations will likely prove to be more discriminating.

Limitations. In the current study, the predicted STS risk scores were computed based on the 2008 STS risk models. The STS Adult Cardiac Surgery Risk models were recently updated using a more recent patient population and considered a larger number of predictive variables (24). Since not all variables that were used in the updated STS models were collected in the EXCEL trial, it was not possible to evaluate the predictive performance of the 2018 STS CABG risk models in the EXCEL trial population.

Furthermore, the EXCEL trial excluded patients with high site-determined SYNTAX scores; therefore, the results of this study cannot be generalized to such patients (SYNTAX score ≥33).

CONCLUSIONS

In selected patients with LMCAD from the EXCEL trial, STS risk models showed good predictive performance for CABG yet were non-predictive for PCI regarding perioperative mortality and renal failure. The predictive ability for stroke was reasonably good for both PCI and CABG. Derivation and validation of treatment and cohort specific risk models are warranted to optimally predict perioperative clinical outcomes in patients with LMCAD requiring revascularization, keeping in mind the between-treatment differences emerging beyond 30-days.

IMPACT ON DAILY PRACTICE

In selected patients with LMCAD from the EXCEL trial, STS risk models showed good predictive performance for CABG yet lacked predictive ability for PCI for perioperative mortality and renal failure. The predictive ability for stroke was reasonably good for both PCI and CABG. Derivation and validation of an treatment and cohort specific risk models are warranted to optimally predict perioperative clinical outcomes of CABG and PCI in patients with LMCAD to better guide clinical decision support and to choose the best revascularization treatment.

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CONFLICT OF INTEREST

Dr. Stone has served as a consultant to Matrizyme, Miracor, Neovasc, V-wave, Shockwave, Valfix, TherOx, Reva, Vascular Dynamics, Robocath, HeartFlow, Gore, Ablative Solutions, Abiomed and Ancora; has received speaker honoraria from Amaranth and Terumo; holds equity/options in Ancora, Cagent, Qool Therapeutics, Aria, Caliber, MedFocus family of funds, Biostar family of funds, Applied Therapeutics and SpectraWAVE; has served as a director for SpectraWAVE; and his employer, Columbia University, receives royalties for sale of the MitraClip from Abbott. Dr. Serruys reports to receive personal fees from Abbot, Biosensors, Medtronic, Micell Technologies, Qualimed, Sinomedical Technologies, St Jude Medical, Stentys, Svelte, Philips/Volcano, Xeltis outside the submitted work. Dr. Sabik reports to receive personal fees from Medtronic, Edwards, and Sorin, and he sits in the advisory board of Medtronic Cardiac Surgery. Dr. Puskas reports to work as consultant of Medtronic. Dr. Kappetein and dr. Head report to work as employees of Medtronic, outside the submitted work. Dr. Thuijs, Dr. Habib, Dr. Taggart and Zixuan Zhang declare no competing interests.

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FIGURE LEGENDS

Figure 1. Observed-to-expected (O/E) ratios for 30-day all-cause mortality, 30-day stroke, and 30-day renal failure after coronary artery bypass grafting (CABG; n=923) and percutaneous coronary intervention (PCI; n=935).

Figure 2. Representation of STS PROM score performance by C statistic (panel A and B) and Hosmer-Lemeshow goodness-of-fit tests (panel C and D) for coronary artery bypass grafting (CABG) and percutaneous coronary intervention with everolimus-eluting stents (PCI-EES). Panel C and D represent groups ordered by quintiles from the lowest predicted risk scores to highest predicted risk scores.

Figure 3. Representation of STS stroke risk score performance by C statistic (panel A and B) and Hosmer-Lemeshow goodness-of-fit tests (panel C and D) for coronary artery bypass grafting (CABG) and percutaneous coronary intervention with everolimus-eluting stents (PCI-EES). Panel C and D represent groups ordered by quintiles from the lowest predicted risk scores to highest predicted risk scores.

Figure 4. Representation of STS renal failure risk score performance by C statistic (panel A and B) and Hosmer-Lemeshow goodness-of-fit teste (panel C and D) for coronary artery bypass grafting (CABG) and percutaneous coronary intervention with everolimus-eluting stents (PCI-EES). Panel C and D represent groups ordered by quintiles from the lowest predicted risk scores to highest predicted risk scores.

Table 1. Baseline Clinical and Angiographic Characteristics

Characteristics	CABG (n = 923)	PCI (n = 935)
Age (years)	65.9 ± 9.5	66.0 ± 9.6
Female sex	22.1% (204/923)	23.9% (223/933)
Coronary artery disease risk factors		
Hypertension	73.7% (680/923)	74.2% (694/933)
Hyperlipidaemia	68.9% (635/921)	70.8% (661/934)
Diabetes mellitus	27.7% (256/923)	30.2% (282/933)
Medically-treated	25.7% (237/923)	27.0% (252/933)
Recent smoker	20.4% (187/915)	23.7% (220/930)
Family history of premature coronary artery disease	65.0% (506/779)	67.1% (521/777)
Preoperative risk factors		
Peripheral vascular disease	9.0% (83/919)	10.3% (96/932)
Prior transient ischemic attack or stroke	7.3% (67/923)	5.5% (51/934)
Creatinine clearance (ml/min)	89.1 ± 32.1 (908/923)	90.0 ± 32.6 (922/935)
Renal Insufficiency[c]	15.1% (137/908)	17.4% (160/922)
Dialysis	0.3% (3/923)	0.2% (2/933)
Chronic obstructive pulmonary disease	8.4% (77/921)	6.9% (64/934)
History of carotid artery disease	8.5% (78/919)	7.9% (74/931)
History of anaemi[a]	8.8% (81/921)	10.6% (99/931)
Body mass index (kg/m^2)	28.5 ± 5.0	28.8 ± 4.9
Congestive heart failure		

NYHA class I[b]	0.7% (6/920)	1.7% (16/933)
NYHA class II	3.7% (34/920)	2.4% (22/933)
NYHA class III	1.7% (16/920)	2.8% (26/933)
NYHA class IV	0.2% (2/920)	0.1% (1/933)
Critical preoperative state[d]	2.0 (18/922)	1.1% (10/933)
Recent myocardial infarction[e]	14.8% (136/920)	15.0% (140/931)
STEMI	1.4% (14/917)	1.4% (13/928)
Non-STEMI	12.9% (118/917)	13.3% (123/928)
Coronary dominance, site assessed		
Right	89.9% (816/908)	89.2% (814/913)
Left	10.1% (92/908)	10.8% (99/913)
LM stenosis location, site assessed		
Ostial	36.1% (333/923)	32.9% (308/933)
Mid	18.6% (172/923)	20.3% (190/933)
Distal[f]	51.9% (479/923)	59.1% (553/933)
Bifurcation[f]	31.9% (294/923)	37.8% (353/933)
Left main diameter stenosis, site assessed		
0 to <50%	0.4% (4/921)	0.3% (3/933)
≥50 to <70%	16.8% (155/921)	16.7% (156/933)
≥70%	82.7% (762/921)	83.0% (774/933)
SYNTAX score, site assessed	20.5 ± 6.2	20.7 ± 6.2
Low (≤22)	61.7% (569/922)	59.0% (551/934)
Intermediate (23-32)	38.3% (353/922)	41.0% (383/934)
High (≥33)	0% (0)	0% (0)
Left ventricular ejection fraction, site assessed	57.4 ± 9.0	57.0 ± 9.6

Values are % (n/N) or mean ± standard deviation. [a]World Health Organization (WHO) criteria: Haematocrit (Ht) at initial presentation: <13 g/dL (male) and <12 g/dL (female). [b]NYHA Class I: *p*=0.03. [c]Renal Insufficiency was defined as a creatinine clearance of <60 ml/min according to the Cockcroft-Gault equation, [d]critical preoperative state: Ventricular tachycardia, ventricular fibrillation, or aborted sudden death; preoperative cardiac massage; preoperative ventilation before anaesthetic room; preoperative inotropes or IABP; preoperative acute renal failure (anuria or oliguria <10 mL/h). [e]myocardial infarction within 7 days of randomization; [f]left main stenosis lesion: Distal (*p*=0.001) and bifurcation (*p*=0.008). All other *p* values are non-significant.

Abbreviations used: CABG: coronary artery bypass grafting, PCI: percutaneous coronary intervention, NYHA: New York Heart Associations, STEMI: ST-elevation myocardial infarction.

Figure 1. Observed-to-expected (O/E) ratios for 30-day all-cause mortality, 30-day stroke, and 30-day renal failure after coronary artery bypass grafting (CABG; n=923) and percutaneous coronary intervention (PCI; n=935).

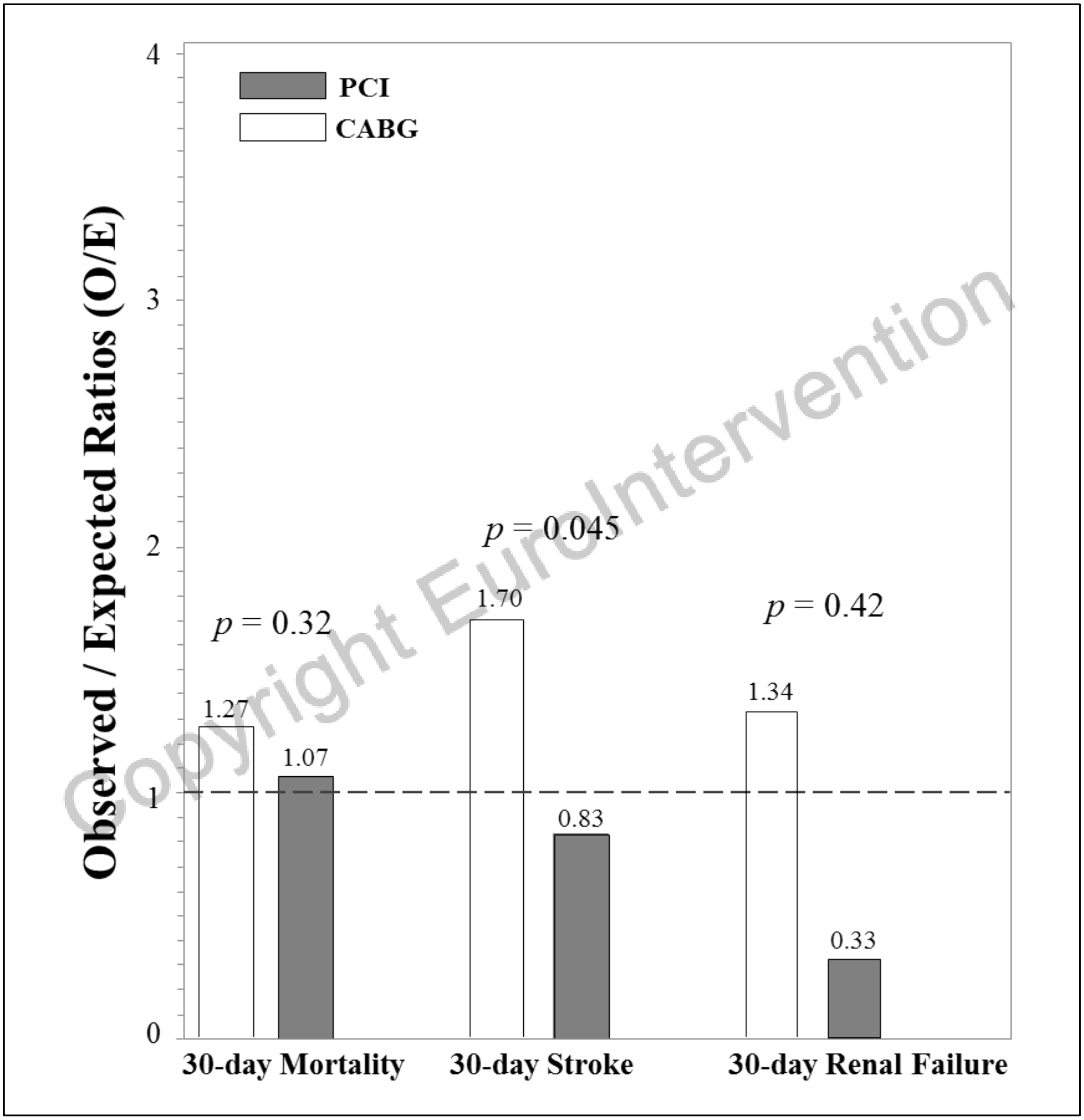


Figure 2. Representation of STS PROM score performance by C statistic (panel A and B) and Hosmer-Lemeshow goodness-of-fit tests (panel C and D) for coronary artery bypass grafting (CABG) and percutaneous coronary intervention with everolimus-eluting stents (PCI-EES).

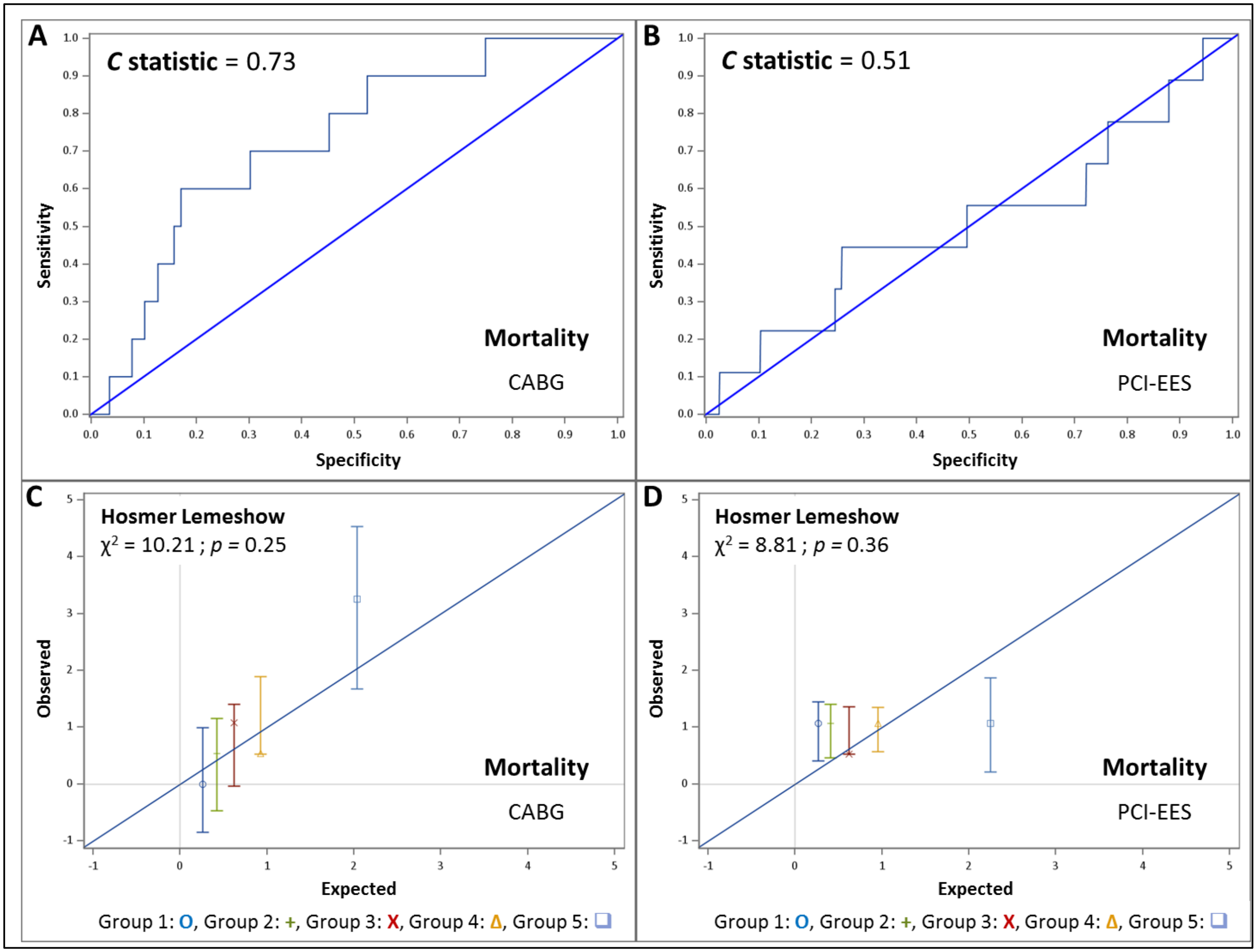


Figure 3. Representation of STS stroke risk score performance by C statistic (panel A and B) and Hosmer-Lemeshow goodness-of-fit tests (panel C and D) for coronary artery bypass grafting (CABG) and percutaneous coronary intervention with everolimus-eluting stents (PCI-EES).

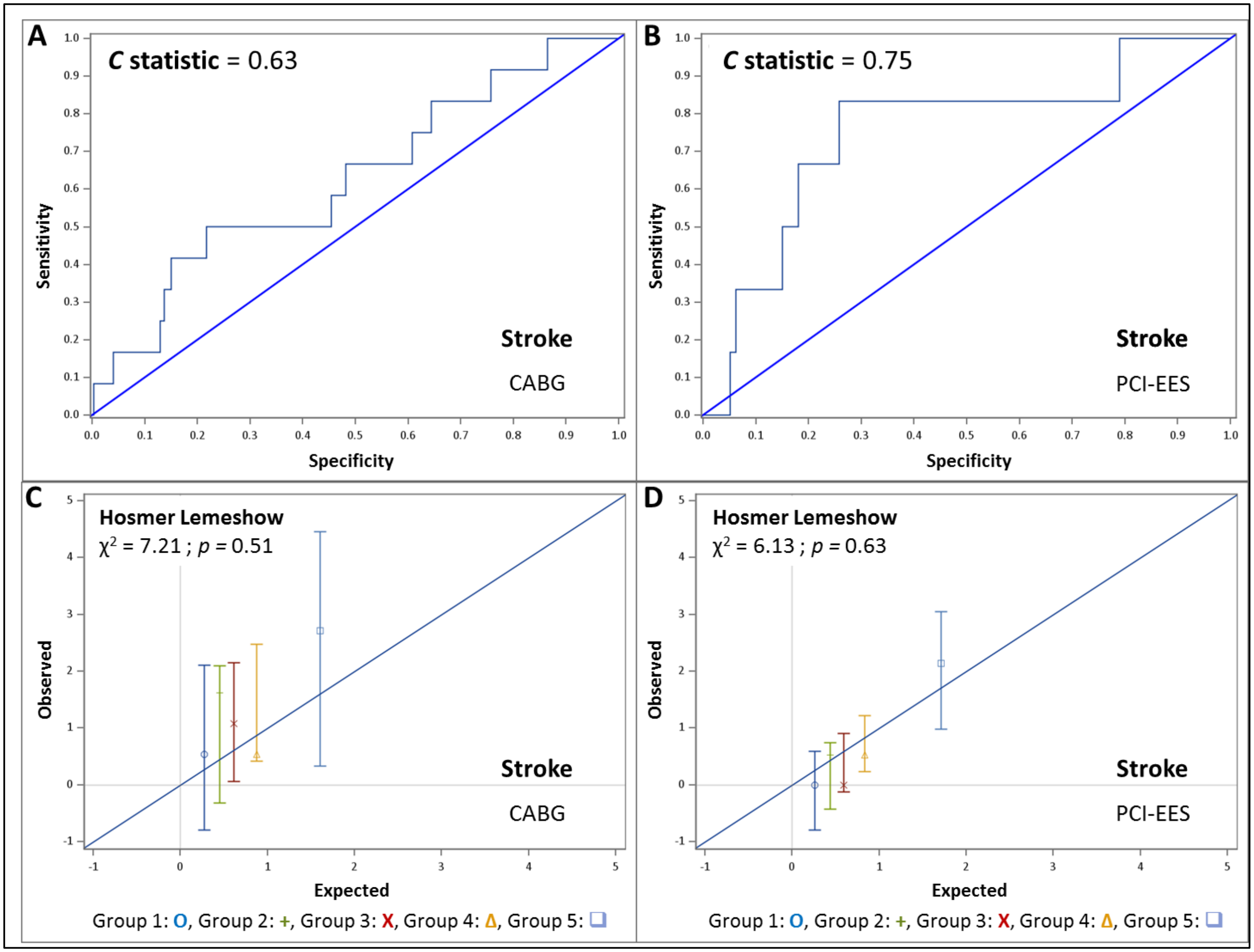
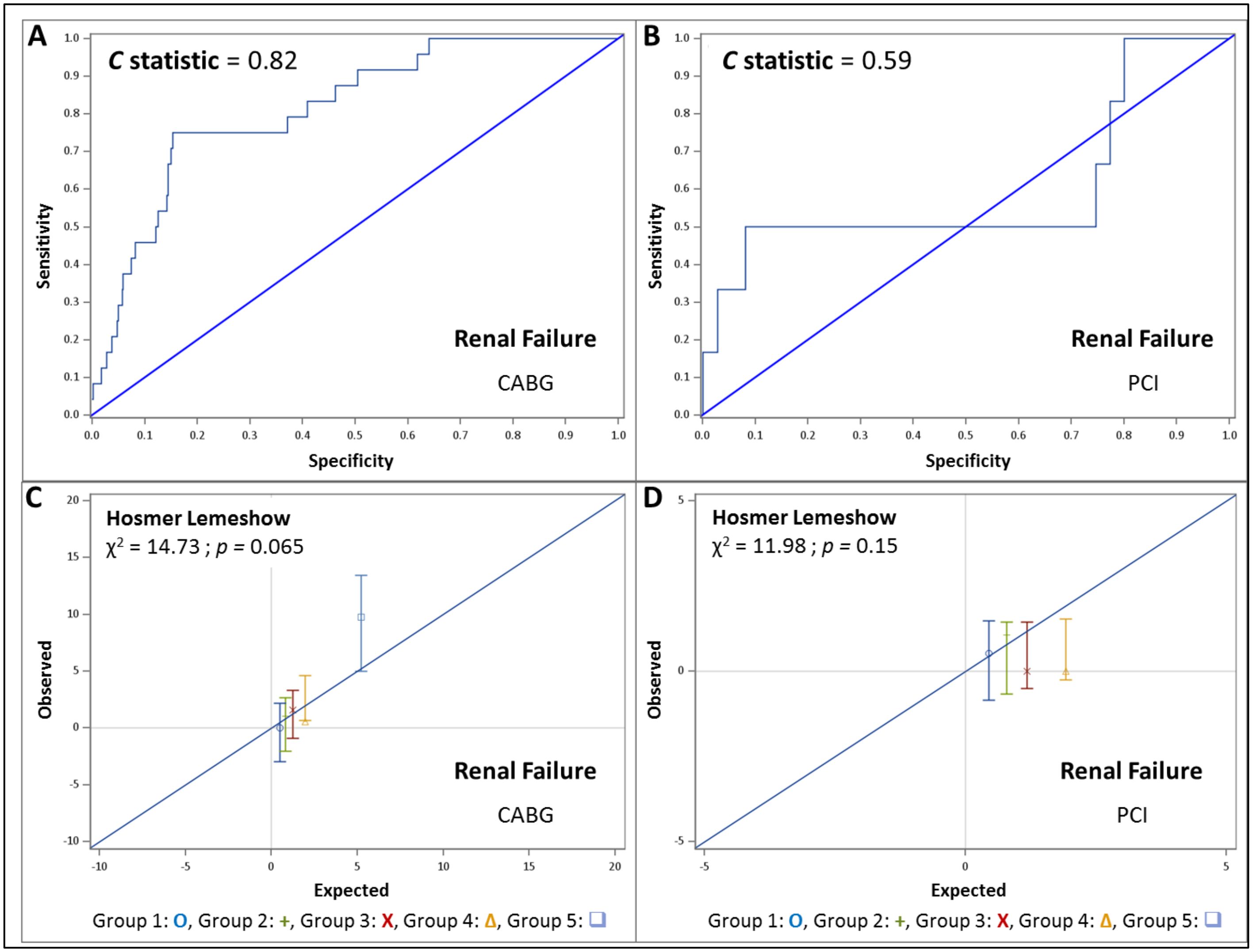


Figure 4. Representation of STS renal failure risk score performance by C statistic (panel A and B) and Hosmer-Lemeshow goodness-of-fit teste (panel C and D) for coronary artery bypass grafting (CABG) and percutaneous coronary intervention with everolimus-eluting stents (PCI-EES).



SUPPLEMENTAL MATERIAL

Supplemental Table 1. Procedural Characteristics

Characteristics	**CABG (n = 923)**	**PCI (n = 935)**	***p* Value**
Time from randomization to first procedure, days	6.7 ± 14.3	3.3 ± 5.3	<0.0001
Arterial access site[a]			
Femoral	—	72.9% (744/1021)	—
Radial	—	26.9% (275/1021)	—
Brachial	—	0.2% (2/1021)	—
Number of vessels treated			
Left main	—	100.0%	—
Left anterior descending	98.8% (907/918)	28.3% (265/925)	<0.0001
Circumflex artery	88.2% (810/918)	16.6% (155/925)	<0.0001
Right coronary artery	37.8 (347/918)	26.7% (250/925)	<0.0001
Number of stents implanted per patient	—	2.4 ± 1.5	—
Total stent length per patient (mm)	—	49.1 ± 35.6	—
On-pump bypass duration (min)	83.5 ± 45.0	—	—
Cross clamp duration	54.9 ± 27.3	—	—
Number of conduits used per patient	2.6 ± 0.8		
Arterial conduits	1.4 ± 0.6	—	—
Venous conduits	1.2 ± 0.9	—	—
Off-pump CABG	29.4% (271/923)	—	—
Bilateral internal thoracic artery	23.5% (217/923)	—	—

Any radial artery used	6.0% (55/923)	—	—
Length of hospital stay (days)	8.3 ± 7.8	2.2 ± 2.9	<0.0001

Values are % (n/N) or mean ± standard deviation. [a]All procedures, including index and planned staged (1021 procedures in 935 PCI patients with one or more procedures). CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention.

Supplemental Table 2. STS expected risk-scores for mortality, stroke and renal failure based on demographic and baseline characteristics.

Variables	Entire population	*p* Value	Quintiles					*p* Value
			1	2	3	4	5	
Mortality								
CABG	0.85±0.76	0.21	0.26±0.04	0.42±0.05	0.62±0.07	0.93±0.12	2.03±0.95	<0.0001
PCI	0.90±0.89		0.27±0.05	0.41±0.05	0.62±0.08	0.95±0.14	2.25±1.17	<0.0001
Stroke								
CABG	0.76±0.54	0.86	0.27±0.07	0.45±0.05	0.62±0.05	0.88±0.10	1.60±0.60	<0.0001
PCI	0.77±0.61		0.26±0.07	0.44±0.04	0.60±0.05	0.83±0.09	1.71±0.74	<0.0001
Renal Failure								
CABG	1.95±2.13	0.96	0.48±0.11	0.83±0.11	1.26±0.16	1.97±0.28	5.20±2.85	<0.0001
PCI	1.95±2.35		0.45±0.11	0.79±0.09	1.18±0.14	1.92±0.33	5.41±3.39	<0.0001

Values are mean ± SD. For mortality and stroke primary endpoints, data were available for 923 CABG patients and 935 PCI patients. For secondary endpoints, LOS was available for 922 CABG patients and 935 PCI patients. Scores represent predicted 30-day percentage rate unless otherwise noted. CABG = coronary artery bypass grafting, PCI = percutaneous coronary intervention, LOS = length of in-hospital stay.

Supplemental Table 3. STS mean predicted risk of mortality, observed mortality percentages, and the observed/expected mortality ratios for the as-treated CABG versus PCI patients

	Coronary Artery Bypass Grafting				Percutaneous Coronary Intervention			
	n	**Expected**	**Observed**	**O/E**	**n**	**Expected**	**Observed**	**O/E**
Entire population	923	0.85	1.07	1.27	935	0.90	0.96	1.07
Quintile1	184	0.26	0	0	187	0.27	1.07	3.97
Quintile 2	185	0.42	0.54	1.28	187	0.41	1.07	2.60
Quintile 3	185	0.62	1.08	1.74	187	0.62	0.53	0.85
Quintile 4	185	0.93	0.54	0.58	187	0.95	1.07	1.12
Quintile 5	187	2.03	3.26	1.60	187	2.25	1.07	0.48

O/E = observed-to-expected ratio.

Supplemental Table 4. STS mean predicted risk of stroke, observed stroke percentages, and the observed/expected stroke ratios for the as-treated CABG versus PCI patients

	Coronary Artery Bypass Grafting				Percutaneous Coronary Intervention			
	n	**Expected**	**Observed**	**O/E**	**n**	**Expected**	**Observed**	**O/E**
Entire population	923	0.76	1.30	1.70	935	0.77	0.64	0.83
Quintile1	184	0.27	0.54	1.99	187	0.26	0	0
Quintile 2	185	0.45	1.62	3.62	187	0.44	0.53	1.20
Quintile 3	185	0.62	1.08	1.75	187	0.60	0	0
Quintile 4	185	0.88	0.54	0.62	187	0.83	0.53	0.64
Quintile 5	187	1.60	2.72	1.70	187	1.71	2.14	1.25

O/E = observed-to-expected ratio.

Supplemental Table 5. STS mean predicted risk of renal failure, observed renal failure percentages, and the observed/expected renal failure ratios for the as-treated CABG versus PCI patients.

	Coronary Artery Bypass Grafting				Percutaneous Coronary Intervention			
	n	Expected	Observed	O/E	n	Expected	Observed	O/E
Entire population	923	1.95	2.60	1.34	935	1.95	0.64	0.33
Quintile1	184	0.48	0	0	187	0.45	0.53	1.18
Quintile 2	185	0.83	1.08	1.30	187	0.79	1.07	1.35
Quintile 3	185	1.26	1.62	1.29	187	1.18	0	0
Quintile 4	185	1.97	0.54	0.27	187	1.92	0	0
Quintile 5	184	5.20	9.78	1.88	187	5.41	1.60	0.30

O/E = observed-to-expected ratio. Data on LOS was unavailable for one patient who underwent CABG.