Validation of a New Classification Method of Postoperative Complications in Patients Undergoing Coronary Artery Surgery

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Objective: **The authors aimed to validate the European Multicenter Study on Coronary Artery Bypass Grafting (E-CABG) classification of postoperative complications in patients undergoing coronary artery bypass grafting (CABG).**

Design: **Retrospective, observational study.**

Setting: **University hospital.**

Participants: **A total of 2,764 patients with severe coronary artery disease. Complete baseline, operative, and postoperative data were available for patients who underwent isolated CABG.**

Interventions: **Isolated CABG.**

Measurements and Main Results: **The E-CABG complication classification was used to stratify the severity and prognostic impact of adverse postoperative events. Primary outcome endpoints were 30-day, 90-day, and long-term all-cause mortality. The secondary outcome endpoints was the length of intensive care unit stay. Both the E-CABG complication grades and additive score were predictive of 30-day (area under the receiver operating characteristics curve 0.866, 95% confidence interval [CI] 0.829-0.903; and 0.876; 95% CI 0.844-0.908, respectively) and 90-day (area under the receiver operating characteristics curve 0.850, 95% CI 0.812-0.887; and 0.863, 95% CI 0.829-0.897, respectively) all-cause mortality. The complication grades were independent predictors of increased mortality at actuarial (log-rank: $p < 0.0001$) and adjusted analysis ($p < 0.0001$; grade 1: hazard ratio [HR] 1.757, 95% CI 1.111-2.778; grade 2: HR 2.704, 95% CI 1.664-4.394; grade 3: HR 5.081, 95% CI 3.148-8.201). When patients who died within 30 days were excluded from the analysis, this grading method still was associated with late mortality ($p < 0.0001$). The grading method ($p < 0.0001$) and the additive score (rho, 0.514; $p < 0.0001$) were predictive of the length of intensive care unit stay.**

Conclusions: **The E-CABG postoperative complication classification seems to be a promising tool for stratifying the severity and prognostic impact of postoperative complications in patients undergoing cardiac surgery.**

KEY WORDS: coronary artery bypass grafting, cardiac surgery, complication, classification

ADULT CARDIAC SURGERY is associated with significant postoperative mortality and morbidity. Moreover, a number of postoperative complications are rather common and may compromise the recovery of patients undergoing cardiac surgery.[1,2] Such complications also increase the burden of resource use[1,2] and may affect late survival.[3–7] Few grading methods for complications after major surgery have been developed to assess the quality of surgical treatment.[8,9] However, these grading systems are not applicable to patients undergoing cardiac surgery, and therefore a specific grading method for these patients is needed. The European Multicenter Study on Coronary Artery Bypass Grafting (E-CABG) investigators recently proposed a classification of postoperative complications as a part of their study protocol.[10] The study presented here was designed to assess the ability of the E-CABG complication classification to predict early and long-term mortality and length of intensive care unit stay of patients undergoing isolated coronary artery bypass grafting (CABG).

METHODS

Patient Population and Data Collection

This study included 2,764 consecutive patients who underwent isolated CABG from June 2006 to December 2013 at the Oulu University Hospital, Finland. The study included elective, urgent, and emergency surgeries performed with either the off-pump or on-pump technique. Patient characteristics and operative data are summarized in Table 1. Definition criteria of baseline characteristics are according to the EuroSCORE criteria.[11]

Complete preoperative, intraoperative, and postoperative data were available for all patients and were obtained from the institutional electronic cardiac surgery database that collected baseline and operative data and data on immediate

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Table 1. Baseline and Operative Characteristics and In-Hospital Deaths of the Study Population and Subgroups According to the E-CABG Grading

	Overall Series (n = 2,764)	Grade 0 (n = 514)	Grade 1 (n = 1,425)	Grade 2 (n = 466)	Grade 3 (n = 359)	p Value
Age (yr)	67.0 ± 9.1	63.3 ± 8.4	67.1 ± 8.9	69.6 ± 9.4	68.1 ± 8.7	<0.001
Female	582 (21.1)	60 (11.7)	289 (20.3)	151 (32.4)	82 (22.8)	<0.001
Pulmonary disease	274 (9.9)	48 (9.3)	126 (8.8)	52 (11.2)	48 (13.4)	0.05
Diabetes	788 (28.5)	120 (23.3)	381 (26.7)	176 (37.8)	111 (30.9)	<0.001
Hypertension	1547 (56.0)	269 (52.3)	794 (55.7)	280 (60.1)	204 (56.8)	0.11
Stroke	95 (3.4)	10 (1.9)	46 (3.2)	20 (4.3)	19 (3.4)	0.04
Neurologic dysfunction	50 (1.8)	1 (0.2)	32 (2.2)	8 (1.7)	9 (2.5)	0.02
Extracardiac arteriopathy	265 (9.6)	33 (6.4)	117 (8.2)	59 (12.7)	56 (15.6)	<0.001
eGFR (mL/min/1.73 m^2)	86.1 ± 25.2	92.3 ± 20.8	87.0 ± 23.1	81.2 ± 29.4	79.9 ± 30.2	<0.001
Dialysis	22 (0.8)	1 (0.2)	8 (0.6)	3 (0.6)	10 (2.8)	<0.001
Atrial fibrillation	282 (10.2)	7 (1.4)	159 (11.2)	64 (13.7)	52 (14.5)	<0.001
Recent myocardial infarction	1,319 (47.7)	144 (28.0)	652 (45.8)	307 (65.9)	216 (60.2)	<0.001
Previous PCI	201 (7.3)	34 (6.6)	94 (6.6)	41 (8.8)	32 (8.9)	0.23
Previous cardiac surgery	46 (1.7)	6 (1.2)	17 (1.2)	11 (2.4)	12 (3.3)	0.02
Unstable angina requiring nitrate at OR arrival	364 (13.2)	13 (2.5)	141 (9.9)	110 (23.6)	100 (27.9)	<0.0001
Left ventricular ejection fraction						<0.001
30%-50%	612 (22.1)	81 (16.2)	284 (20.8)	131 (29.2)	116 (33.7)	
<30%	87 (3.1)	4 (0.4)	39 (2.9)	28 (6.3)	16 (4.7)	
Critical preoperative status	217 (7.9)	12 (2.3)	81 (5.7)	62 (13.3)	62 (17.3)	<0.001
Operative data						
Type of surgery						<0.001
Elective	1,260 (45.6)	340 (66.1)	688 (48.3)	115 (24.7)	117 (32.6)	
Urgent	1,306 (47.3)	173 (33.7)	677 (47.5)	289 (62.0)	167 (46.5)	
Emergency	197 (7.1)	1 (0.2)	60 (4.2)	62 (13.3)	75 (20.9)	
Mammary artery graft	2,642 (95.6)	508 (98.8)	1385 (97.2)	432 (92.7)	317 (88.3)	<0.001
Potent antiplatelets within 5 days	512 (18.5)	37 (7.2)	242 (17.0)	139 (29.8)	94 (26.2)	<0.001
Off-pump coronary surgery	1,510 (54.6)	311 (60.5)	789 (55.4)	230 (49.4)	180 (50.1)	0.01
Number of distal anastomoses	4.0 ± 1.1	4.0 ± 1.1	3.9 ± 1.1	4.0 ± 1.1	3.8 ± 1.0	0.07
In-hospital death	67 (2.4)	0 (0.0)	6 (0.4)	8 (1.7)	53 (14.8)	<0.001

NOTE. Continuous variables are reported as mean and standard deviation. Categorical variables are reported as counts and percentages. Definition criteria are according to EuroSCORE II.

Abbreviations: E-CABG, European Multicenter Study on Coronary Artery Bypass Grafting; eGFR, estimated glomerular filtration rate; PCI, percutaneous coronary intervention; OR, operating room.

adverse postoperative events. These data were collected by 2 research nurses and 3 colleagues. The senior author (F.B.) checked all the data throughout the study period. In 2014 and 2015, this database was checked again by 2 researchers (E.M. K. and M.A.M.). Twenty-eight patients without data on serum levels of creatinine still were included in this analysis because in most of the cases they died immediately after surgery and their postoperative creatinine level was not checked. The number of transfused blood products, such as red blood cells, platelets, and solvent/detergent-treated plasma (Octaplas; Octapharma AG, Lachen, Switzerland), was retrieved from a prospective electronic hospital registry that collected data on any transfusion of blood products. These blood products were administered intraoperatively and throughout the in-hospital stay. Data on the amount of postoperative blood losses were retrieved from a prospective electronic registry of the institution's intensive care unit. Glomerular filtration rate was estimated using the Modification of Diet in Renal Disease (MDRD) formula.[12] Clinical variables were defined according to the EuroSCORE II definition criteria.[12] Data on patients' deaths were retrieved from Statistics Finland (Tilastokeskus), which collects the certificates of death of all inhabitants of Finland. The data for this study were provided up to December 31, 2013. The authors assumed that there were no missing data on immediate and late deaths of this study population.

Operative Techniques

Intermittent anterograde and retrograde blood cardioplegia with potassium and magnesium at temperatures ranging from 10° to 16°C was delivered during on-pump CABG. Epiaortic ultrasound were performed according to the surgeon's preference. The ascending aorta was not clamped in case of atherosclerotic lesion involving the lateral and/or anterior wall of the ascending aorta. Proximal anastomoses were sutured to the ascending aorta during side clamping or cross-clamping when it was considered safe. An Octopus stabilizer (Medtronic, Minneapolis, MN) and intracoronary shunts were used routinely in patients who underwent off-pump CABG.

E-CABG Postoperative Complication Classification Method

E-CABG is a European multicenter study currently recruiting patients undergoing isolated CABG. The protocol of this