

Bedside Tool for Predicting the Risk of Postoperative Atrial Fibrillation After Cardiac Surgery: The POAF Score

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Background—Atrial fibrillation (AF) remains the most common complication after cardiac surgery. The present study aim was to derive an effective bedside tool to predict postoperative AF and its related complications.

Methods and Results—Data of 17 262 patients undergoing adult cardiac surgery were retrieved at 3 European university hospitals. A risk score for postoperative AF (POAF score) was derived and validated. In the overall series, 4561 patients (26.4%) developed postoperative AF. In the derivation cohort age, chronic obstructive pulmonary disease, emergency operation, preoperative intra-aortic balloon pump, left ventricular ejection fraction <30%, estimated glomerular filtration rate <15 mL/min per m² or dialysis, and any heart valve surgery were independent AF predictors. POAF score was calculated by summing weighting points for each independent AF predictor. According to the prediction model, the incidences of postoperative AF in the derivation cohort were 0, 11.1%; 1, 20.1%; 2, 28.7%; and ≥3, 40.9% ($P<0.001$), and in the validation cohort they were 0, 13.2%; 1, 19.5%; 2, 29.9%; and ≥3, 42.5% ($P<0.001$). Patients with a POAF score ≥3, compared with those without arrhythmia, revealed an increased risk of hospital mortality (5.5% versus 3.2%, $P=0.001$), death after the first postoperative day (5.1% versus 2.6%, $P<0.001$), cerebrovascular accident (7.8% versus 4.2%, $P<0.001$), acute kidney injury (15.1% versus 7.1%, $P<0.001$), renal replacement therapy (3.8% versus 1.4%, $P<0.001$), and length of hospital stay (mean 13.2 versus 10.2 days, $P<0.001$).

Conclusions—The POAF score is a simple, accurate bedside tool to predict postoperative AF and its related or accompanying complications. (*J Am Heart Assoc.* 2014;3:e000752 doi: 10.1161/JAHA.113.000752)

Key Words: antiarrhythmic prevention • atrial fibrillation • cardiac surgery • risk stratification

Atrial fibrillation (AF) remarkably remains the most common complication after cardiac surgery.^{1,2} Postoperative AF (POAF) carries severe clinical and economic implications, increasing early and late morbidity and mortality, and having a great impact on resource utilization.^{1–5} In

addition, the incidence of this complication has been reported to steadily increase, owing mostly to an increasing number of elderly patients with severe comorbidities.¹

In light of the importance of POAF for patient outcomes, there has been great interest in preventing this arrhythmia.^{1–10} Several studies have sought to identify patients at highest risk for the development of AF, but their number is testament to the failure to effectively prevent AF through prophylactic measures in unselected patients.^{6–10} Routine pharmacological AF prophylaxes could expose as many as 60% to 80% of patients to the side effects of antiarrhythmic drugs for which there is no indication, with unnecessary drug-related costs.^{4,11,12}

As a result, it is of utmost importance to identify patients whose risk of developing AF is very low and who should not receive routine antiarrhythmic therapy. Accordingly, efforts have been made to develop risk prediction models to identify patients most likely to develop POAF.^{4–10}

However, these models often are statistically underpowered and, because of this, inconclusive.^{6,7} In addition, they are limited by the exclusion of high-risk patients with renal and cardiac failure, as well as those undergoing complex procedures, despite the fact that these patients are those most

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affected by POAF.^{6–10} These risk models also imply complex calculations without rapid estimation for targeting patients, hampering a prompt prophylactic approach, and confounding the clinical decision making and patient counseling.^{6–10} The present study aimed to derive an efficient and reliable bedside tool to predict POAF and its related complications.

Methods

Study Population

Between July 1999 and December 2010, all consecutive patients undergoing isolated coronary artery bypass graft surgery (CABG) and valve surgery (with or without concomitant CABG) at 3 European cardiac centers (Bristol Heart Institute, UK; Varese University Hospital, and Centro Cardiologico Monzino IRCCS, Italy) were screened for this observational study. Elective, urgent, or emergency procedures were all included. Patients with a preoperative history of supraventricular arrhythmias requiring treatment were excluded to avoid overestimation of the POAF incidence. The final sample consisted of a total of 17 622 patients. Data used in this analysis were retrieved from institutional databases, which remained consistent over the study period. All data were prospectively collected, and information about demographics, comorbidities, medical and surgical history, operative details, and postoperative events during the hospital stay were registered.

The study protocol was in compliance with the local institutional review boards and received full approval; patient consent was waived.

Patient Management

Preoperative management, anesthetic, and surgical techniques were standardized for all patients and have been previously reported.^{3,13–16} Preoperative antiarrhythmic therapies were not routinely adopted; in general, β -blockers were administered on the day of surgery and restarted in the immediate postoperative period unless contraindicated for clinical reasons. At the end of surgery, patients were transferred to a dedicated intensive care unit and managed according to the unit protocol.^{3,13–16} Patients were monitored daily until discharge with continuous ECG telemetry and standard 12-lead ECG. Additional recordings were collected at clinical suspicion of AF. Amiodarone, either orally or intravenously administered, constituted the standard pharmacological treatment of POAF. In patients without successful rhythm cardioversion and with persistent AF, warfarin was administered before discharge, with the aim of achieving an international normalized ratio between 2.0 and 3.0, planning an electric cardioversion within 30 days. Symptomatic

patients or with ineffective antiarrhythmic therapy to control the ventricular rate underwent cardioversion at any time during the postoperative period.

End Point and Definitions

The primary end point of this study was to identify independent predictors of POAF, deriving an effective bedside tool to predict the arrhythmia and its related complications. Briefly, POAF was documented on the basis of a rhythm strip or 12-lead ECG as previously described.^{3,13–16} Postoperative acute kidney injury (AKI) was defined according to the RIFLE (Risk, Injury, Failure, Loss of function, and End-stage renal disease) criteria; estimated glomerular filtration rate (eGFR) was calculated with use of the Chronic Kidney Disease Epidemiology Collaboration equation.^{17,18} Cerebrovascular accidents were diagnosed on the basis of a new neurological deficit with morphological substrate confirmed by using computed tomography or nuclear magnetic resonance imaging. The decision to perform off-pump or on-pump CABG was based on individual surgeon preference.

Statistical Analysis

Clinical data were prospectively recorded and tabulated with Microsoft Excel (Microsoft Corp). Statistical analysis was computed using SPSS version 20 statistical software (IBM SPSS Inc). Fisher exact, χ^2 , Mann–Whitney, Kruskal–Wallis, and Cochran–Armitage tests were used for univariable analysis. Correlation between continuous variables was estimated by using the Spearman test. No was made attempt to replace missing values. The dataset was randomly divided into a derivation dataset (75% of patients) and a validation dataset (25% of patients).¹⁹ Multivariable analysis of data from the derivation dataset was performed using stepwise logistic regression with backward selection. The significance within the models was evaluated with the Wald test, whereas the strength of the association of variables with POAF was estimated by calculating the OR and 95% CIs. The model was calibrated using the Hosmer–Lemeshow goodness-of-fit test, as well as residual diagnostics (deviance and dfBetas). Model discrimination was evaluated by using the area under the receiver operating characteristic (ROC) curve. Only variables with a value of $P < 0.05$ in univariable analysis were included in the regression models, to avoid overfitting. Furthermore, dichotomous variables with an OR < 1.2 were excluded from the final regression analysis. Additive risk score for the prediction of POAF (POAF score) was calculated by adding weighting points for each independent risk factor. Once the predictive ability of the POAF score was tested in the validation dataset, further analyses were performed only in the overall dataset. In particular, patients in the last stratum of this additive

score (POAF score ≥ 3) were considered for further adjusted analyses. Linear regression was used for adjusted analysis of the length of in-hospital stay (LOS). Because the LOS variable was not normally distributed, the analysis was performed after it was logarithmically transformed. All tests were 2-sided with the α level set at 0.05 for statistical significance.

Results

Overall Series

Baseline and operative characteristics of enrolled patients are summarized in Table 1. The final population presented a mean age of 66.3 ± 10.6 years (range, 18 to 92 years), and 4301 (25%) were women. Patients undergoing isolated CABG accounted for 11 685 (68%) patients; isolated valve surgery, 3672 (21%); and valve surgery with concomitant CABG, 1905 (11%).

The incidence of POAF was 26.4% (4561 of 17262 patients) in the overall series, subdivided into 23% ($n=2667$), 31% ($n=1133$), and 40% ($n=761$) for isolated CABG, isolated valve surgery, and combined procedures, respectively. POAF mainly occurred within 2 days postoperatively (median 2 days). The profile for patients affected by POAF was considerably different with regard to demographics, comorbid conditions, and operative data. Patients affected by POAF in the overall series were older than those who were not affected (69.7 ± 8.9 versus 65.1 ± 10.8 years, $P < 0.0001$) and were predominantly men (72% versus 76%, $P < 0.0001$) with a lower left ventricular ejection fraction (LVEF, $53.4 \pm 12.2\%$ versus $55.5 \pm 11.3\%$, $P < 0.0001$) and eGFR (63.8 ± 23.9 versus 66.7 ± 22.1 mL/min per 1.73 m^2 , $P < 0.001$), having a more severe profile of comorbidities (additive EuroSCORE: 5.4 ± 3.1 versus 4.0 ± 2.8 , $P < 0.001$). Remarkably, preoperative drug regimen did not influence the development of AF. The use of β -blockers ($P=0.174$), calcium antagonists ($P=0.114$), angiotensin-converting enzyme inhibitors ($P=0.321$), and statins ($P=0.453$) was not associated with a decreased AF risk.

Derivation and Validation Cohorts

Results of multivariable analysis for prediction of POAF are reported in Table 2. Ninety-seven patients (0.6%) in the overall series were not included in the final regression models because of missing values of any of the covariates of interest.

Among patients in the derivation cohort, logistic regression revealed that age, emergency operation, preoperative intra-aortic balloon pump (IABP), LVEF $< 30\%$, eGFR < 15 mL/min per m^2 or dialysis, heart valve surgery, and chronic obstructive pulmonary disease were independent predictors of POAF (Hosmer–Lemeshow goodness-of-fit test: $\chi^2 [7 \text{ df}] = 4.73$, $P = 0.662$; area under the ROC curve: 0.65, 95% CI 0.64 to

0.66). POAF score for POAF was calculated (weighting factors are summarized in Table 2), and its area under the ROC curve was similar to that of the regression model (0.64, 95% CI 0.63 to 0.65). According to this risk score, the incidence of POAF in the derivation cohort was 0, 11.1% (215/1933 patients); 1, 20.1% (799/3970 patients); 2, 28.7% (1141/3982 patients); and ≥ 3 , 40.9% (1223/2992 patients) ($P < 0.001$, Figures 1 and 2).

In the validation cohort, AF incidence was 0, 13.2% (81/613 patients); 1, 19.5% (266/1363 patients); 2, 29.9% (395/1320 patients); and ≥ 3 , 42.5% (422/994 patients) ($P < 0.001$, Figure 1). The area under the ROC curve of this risk score for prediction of POAF in the validation cohort was 0.64 (95% CI 0.63 to 0.66).

In the overall series, the risk of hospital mortality ($P < 0.001$), stroke ($P < 0.001$), AKI ($P < 0.001$), renal replacement therapy (RRT, $P < 0.001$), and LOS ($P < 0.001$) increased along with the risk of AF and its occurrence. The risk of adverse events was increased in patients with POAF in all strata. However, the absolute difference in the rate of adverse events was most evident in the stratum with ≥ 3 risk factors for POAF. The POAF score was predictive also of hospital mortality (area under the ROC curve 0.73, 95% CI 0.70 to 0.76), CVA (0.71, 95% CI 0.68 to 0.73), AKI (0.67, 95% CI 0.65 to 0.68), and RRT (0.66, 95% CI 0.61 to 0.72) (Figure 3). A significant correlation was observed between POAF score and LOS ($\rho 0.32$, $P < 0.001$).

Adjusted Analysis in High-Risk Patients of the Overall Series

Analyzing the prognostic impact of POAF in the last stratum of POAF score (score ≥ 3), which included 3986 patients from the overall series, the arrhythmia was associated in univariable analysis with increased risk of hospital mortality (5.5% versus 3.2%, $P = 0.001$, for mortality after the first postoperative day: 5.1% versus 2.6%, $P < 0.001$), CVA (7.8% versus 4.2%, $P < 0.001$), AKI (15.1% versus 7.1%, $P < 0.001$), RRT (3.8% versus 1.4%, $P < 0.001$), and LOS (mean 13.2 versus 10.2 days, $P < 0.001$).

Additive EuroSCORE adjusted analysis showed that the last stratum of POAF score (score for AF ≥ 3) had the highest risk of mortality (OR 3.61, 95% CI 1.27 to 10.26). The area under the ROC curve of additive EuroSCORE for predicting hospital mortality in this stratum was 0.80 (95% CI 0.77 to 0.82). When adjusted for additive EuroSCORE, POAF was associated with an increased risk of hospital mortality (OR 1.49, 95% CI 1.08 to 2.05). Similarly, AF was an independent predictor of hospital mortality and/or CVA (OR 1.59, 95% CI 1.27 to 1.99). Because POAF usually occurs a mean of 2 to 3 days after the procedure, its impact on the hospital mortality occurring > 1 day after surgery was also evaluated. The impact of this arrhythmia was even larger in predicting hospital mortality

Table 1. Presenting Characteristics According to the Occurrence of Postoperative AF

Variables*†	Overall Population (N=17 262)			Derivation Cohort (n=12 938)		Validation Cohort (n=4324)		
	No AF (n=12 701)	AF (n=4561)	P Value	No AF (n=9515)	AF (n=3423)	No AF (n=3186)	AF (n=1138)	P Value‡
Age, y, %	65.1±10.8	69.7±8.9	<0.001	65.1±10.7	69.7±9.1	65.1±11.1	69.8±8.4	0.48
<60	28.3	13.1	<0.001	28.4	13.3	27.9	12.5	0.25
60 to 69	35.4	33.1		35.5	33.1	35.3	33.3	
70 to 79	32.5	44.1		31.3	43.6	32.1	45.8	
≥80	4.8	9.7		4.9	10.1	4.7	8.4	
Male, %	76.2	72.1	<0.001	76.3	71.7	75.6	73.1	0.85
BMI, kg/m ²	27.3±4.3	27.1±4.5	0.17	27.2±4.3	27.1±4.5	27.2±4.3	27.1±4.4	0.47
BMI >40 kg/m ² , %	0.7	1.0	0.15	0.8	1.0	0.6	1.0	0.62
Cardiac presentation, %								
Emergency	2.8	4.8	<0.001	2.8	4.7	2.5	5.3	0.94
IABP	0.7	2.0	<0.001	0.7	1.9	0.8	2.0	0.49
Previous cardiac surgery	3.7	3.7	0.91	3.5	3.9	4.1	3.1	0.62
Prior AMI	36.2	36.4	0.81	36.4	36.8	35.4	35.2	0.16
LVEF	55.5±11.3	53.4±12.2	<0.001	55.6±11.3	53.7±12.2	55.3±11.4	52.7±12.2	0.53
LVEF <30, %	3.3	5.2	<0.001	3.3	5.3	3.2	4.8	0.57
Comorbidities, %								
Hypertension	64.9	68.7	<0.001	64.8	69.1	65.2	67.4	0.94
Diabetes	20.0	21.7	0.012	19.9	21.5	20.1	22.2	0.69
COPD	5.2	8.4	<0.001	5.4	8.3	4.5	8.8	0.26
PVD	9.7	11.5	<0.001	9.8	11.8	9.4	10.7	0.25
CVD	7.3	9.1	<0.001	7.3	9.6	7.1	7.5	0.13
eGFR, mL/min per 1.73 m ²	66.8±22.0	63.9±23.8	<0.001	66.8±21.9	63.9±25.2	66.7±22.3	63.6±18.9	0.53
eGFR <15 mL/min per 1.73 m ² or dialysis, %	0.4	0.7	0.003	0.5	0.9	0.6	1.1	0.22
Additive EuroSCORE, n	4.0±2.8	5.4±3.1	<0.001	4.0±2.8	5.5±3.0	4.0±2.8	5.4±3.1	0.89
Preoperative drug regimen, %								
β-Blockers	54.8	52.9	0.17	53.7	53.7	53.0	50.3	0.16
Calcium antagonists	21.0	22.8	0.11	21.1	23.1	20.7	22.1	0.61
ACE inhibitors	38.8	40.1	0.32	38.9	38.5	38.5	40.6	0.21
Statins	57.8	58.6	0.44	57.8	58.1	57.9	59.9	0.55
Operative data								
CPB time, min	76.9±53.1	88.8±56.1	<0.001	76.8±52.4	89.4±55.8	76.9±55.1	87.0±56.9	0.55
ACC time, min	51.6±39.5	59.9±42.5	<0.001	51.6±39.6	60.3±41.8	51.4±39.3	59.0±44.5	0.44
Use of CPB, %	66.4	74.0	<0.001	66.2	74.0	67.0	74.2	0.33
Valve surgery, %	29.0	41.5	<0.001	28.9	41.7	29.1	41.1	0.88
IABP, %	1.1	2.9	<0.001	1.1	3.1	1.2	2.1	0.42
Postoperative data								
Ventilation, h	6 (4 to 11)	8.5 (5 to 17)	<0.001	6 (4 to 11)	8 (5 to 17)	6 (4 to 11)	9 (5 to 17)	0.39
ICU time, h	24 (23 to 48)	43 (23 to 72)	<0.001	24 (23 to 48)	44 (23 to 72)	25 (23 to 48)	36 (23 to 72)	0.73
CVA, %	1.7	4.5	<0.001	1.8	4.5	1.7	4.4	0.79
AKI, %	3.4	10.5	<0.001	3.4	10.5	3.5	10.4	0.94

Continued

Table 1. Continued

Variables**†	Overall Population (N=17 262)			Derivation Cohort (n=12 938)		Validation Cohort (n=4324)		
	No AF (n=12 701)	AF (n=4561)	P Value	No AF (n=9515)	AF (n=3423)	No AF (n=3186)	AF (n=1138)	P Value‡
RRT, %	0.8	2.6	<0.001	0.8	2.5	0.8	3.0	0.85
Blood transfusion, %	37.7	51.0	<0.001	37.5	51.4	38.5	49.9	0.88
Hospital outcome								
Length of stay, d	7 (6 to 8)	8 (7 to 12)	<0.001	7 (6 to 8)	8 (7 to 12)	7 (6 to 8)	8 (7 to 11)	0.86
Mortality, %	1.2	3.0	<0.001	1.1	3.2	1.3	2.4	0.77

AF indicates atrial fibrillation; BMI, body mass index; IABP, intra-aortic balloon pump; AMI, acute myocardial infarction; LVEF, left ventricular ejection fraction; COPD, chronic obstructive pulmonary disease; PVD, peripheral vascular disease; CVD, cardiovascular disease; eGFR, estimated glomerular filtration rate; ACE, angiotensin-converting enzyme; CPB, cardiopulmonary bypass; ACC, aortic cross-clamp; ICU, intensive care unit; CVA, cerebrovascular accident; AKI, acute kidney injury; RRT, renal replacement therapy.

*For continuous variables, mean±SD or median (25th to 75th percentile); for categorical variables, %.

†Other variables considered for the final model and not reported: body surface area, prior percutaneous coronary intervention, left mainstem stenosis, right coronary artery disease, left atrial diameter, dyslipidemia, basal hemoglobin, basal creatinine, creatinine values >2.0 mg/dL, angiotensin receptor blockers.

‡Test comparing the prevalence of risk factors between the entire derivation and entire validation cohorts.

occurring >1 day after surgery (OR 1.74, 95% CI 1.24 to 2.45). When adjusted for additive EuroSCORE, POAF was also associated with an increased risk of CVA (OR 1.76, 95% CI 1.34 to 2.31), AKI (OR 2.21, 95% CI 1.72 to 2.62), RRT (OR 2.68, 95% CI 1.42 to 5.08), and LOS (coefficient 0.09, 95% CI 0.07 to 0.10) in the last stratum of the POAF score.

Discussion

AF after cardiac surgery remains a vexing complication, resulting in prolonged hospital stay, and causes additional morbidity and mortality in a substantial number of patients.¹⁻¹⁰

Consequently, considerable efforts have been directed toward reduction of the risk and POAF management, mainly focusing on pharmacological agents.¹⁻¹⁰ However, a caveat with the use of the antiarrhythmic approaches is that most patients undergoing cardiac surgery do not develop POAF, and 60% to 80% of them are exposed to the costs and potential side effects of unnecessary prophylaxes.¹⁻¹⁰ On the one hand, it is critical that before such pharmacological managements are implemented in all cardiac surgery patients, the safety and effectiveness of these strategies in improving patient outcomes must be proved. On the other hand, a rapid, accurate estimation of individual

Table 2. Results of Multivariable Analysis for Prediction of Postoperative AF in the Derivation Cohort

Variables	OR (95% CI)	Coefficients	Additive Score Points
Age, y			
<60*			
60 to 69	2.04 (1.81 to 2.31)	0.715	1
70 to 79	2.93 (2.60 to 3.30)	1.076	2
≥80	3.94 (3.31 to 4.69)	1.372	3
COPD	1.33 (1.14 to 1.56)	0.286	1
eGFR <15 mL/min per 1.73 m ² or dialysis	1.90 (1.17 to 3.10)	0.643	1
Emergency	1.50 (1.19 to 1.88)	0.404	1
Preoperative IABP	1.90 (1.28 to 2.83)	0.644	1
LVEF <30%	1.45 (1.18 to 1.77)	0.369	1
Valve surgery	1.68 (1.55 to 1.83)	0.519	1
Constant		-2.032	

AF indicates atrial fibrillation; COPD, chronic obstructive pulmonary disease; eGFR, estimated glomerular filtration rate; IABP, intra-aortic balloon pump; LVEF, left ventricular ejection fraction.

*Age <60 y was the reference group.

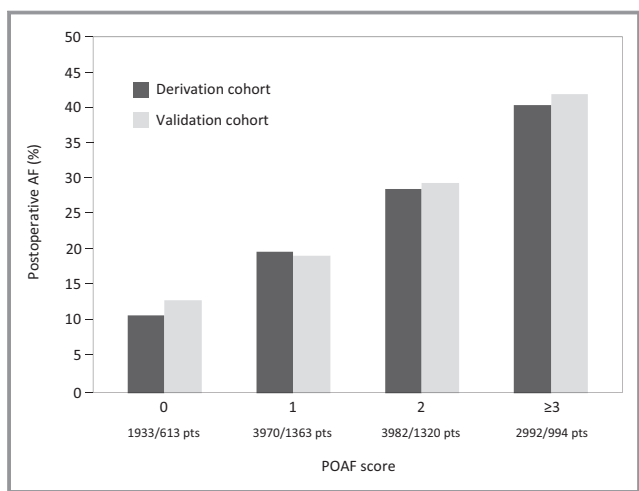


Figure 1. Incidence of postoperative atrial fibrillation (POAF) according to POAF score in the derivation and validation cohorts (both cohorts, Cochran–Armitage test: $P < 0.001$).

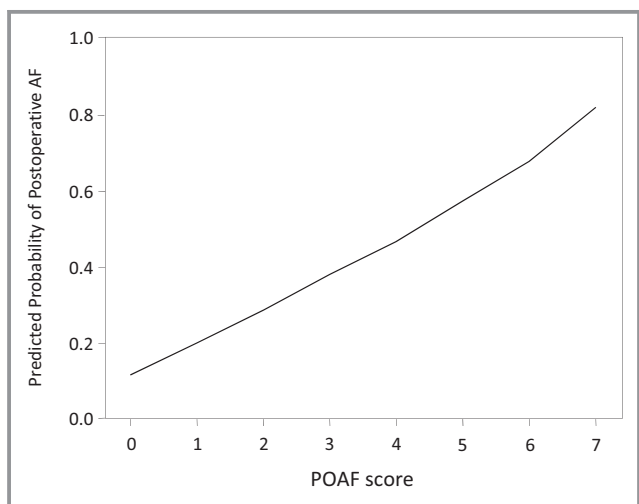


Figure 2. Correlation between postoperative atrial fibrillation (POAF) score and predicted probability of POAF occurrence.

patients' risk for POAF may facilitate correct identification of patients who are at the lowest risk of the development of AF and should not be treated with preventive strategies. In this setting, our study demonstrated that the POAF score is a simple, accurate bedside risk tool, allowing for the identification of high-risk AF patients in whom preventive antiarrhythmic therapies could be justified. The POAF score was also found to be of value in developing an easy-to-use risk scoring method for AF-related or accompanying complications, suggesting possible simultaneous preventive approaches.

Other risk prediction models have been previously proposed to identify patients most likely to develop POAF.^{4–10} Zaman et al⁶ first enrolled 326 elective isolated CABG patients and

created a model for preoperative risk stratification in patients affected by AF, demonstrating that P-wave duration > 155 ms, age, and male sex were able to predict POAF in 59% of their patient population. Amar et al⁷ reported in 1851 patients undergoing isolated CABG that 4 preoperative and postoperative variables were independently associated with AF development. Using their prediction model, 3 risk categories for AF were identified, suggesting increased AF occurrence (from 14% to 60%) with category worsening.⁷ Mathew et al⁸ performed a prospective multicenter observational study of 4657 CABG patients, obtaining a final model with 3 AF risk classes (low, medium, and high risk) based on 17 preoperative, intraoperative, and postoperative variables. More recently, Magee et al⁹ extracted 19 083 patients undergoing isolated CABG from the Society of Thoracic Surgeons Database, using perioperative risk factors to develop a predictive risk algorithm of AF development. The final model included 14 preoperative, intraoperative, and postoperative variables, which provided statistically significant coefficients and ORs.⁹

However, all of these prediction models provided controversial results, revealing important limitations, and limiting their widespread adoption in the clinical practice of AF preventive strategies.^{6–10} Some of these studies were computationally complex due to the relevant number of variables considered and underpowered due to their small sample size.^{4,6–8,10} In addition, considered risk factors of POAF such as P-wave duration, male sex, or angiotensin-converting enzyme inhibitor treatment have been demonstrated to be poorly associated with the arrhythmia, while other well-known AF predictors were surprisingly not included.^{6–10} Patients with deteriorated left ventricular function, compromised renal function, or complex operations including valve surgery were often excluded from these AF prediction models. Nevertheless, these subjects are the ones mostly affected by AF, as demonstrated in several studies, and would benefit the most from antiarrhythmic measures.^{4,6,7,9,10} On the other hand, the same risk prediction models included postoperative variables such as low cardiac output, postoperative drug treatment, and prolonged ventilation, hampering prompt prophylactic treatment, especially in the case of urgent or emergent operations.^{7–9} In fact, Magee et al⁹ included prolonged ventilation use as one of the most relevant AF predictors, limiting the possibility to adopt preventive measures before such a condition develops and postponing the usefulness of their model to the postoperative period only. However, it is well known that POAF most commonly occurs within the first 48 hours after surgery, and it remains distinctly possible that AF occurred as a consequence of the observed prolonged ventilation rather than being a cause of it, confounding the predictive value of this variable and consequently invalidating the final model. Furthermore, patients with preexistent AF were inopportunately included in the earlier mentioned

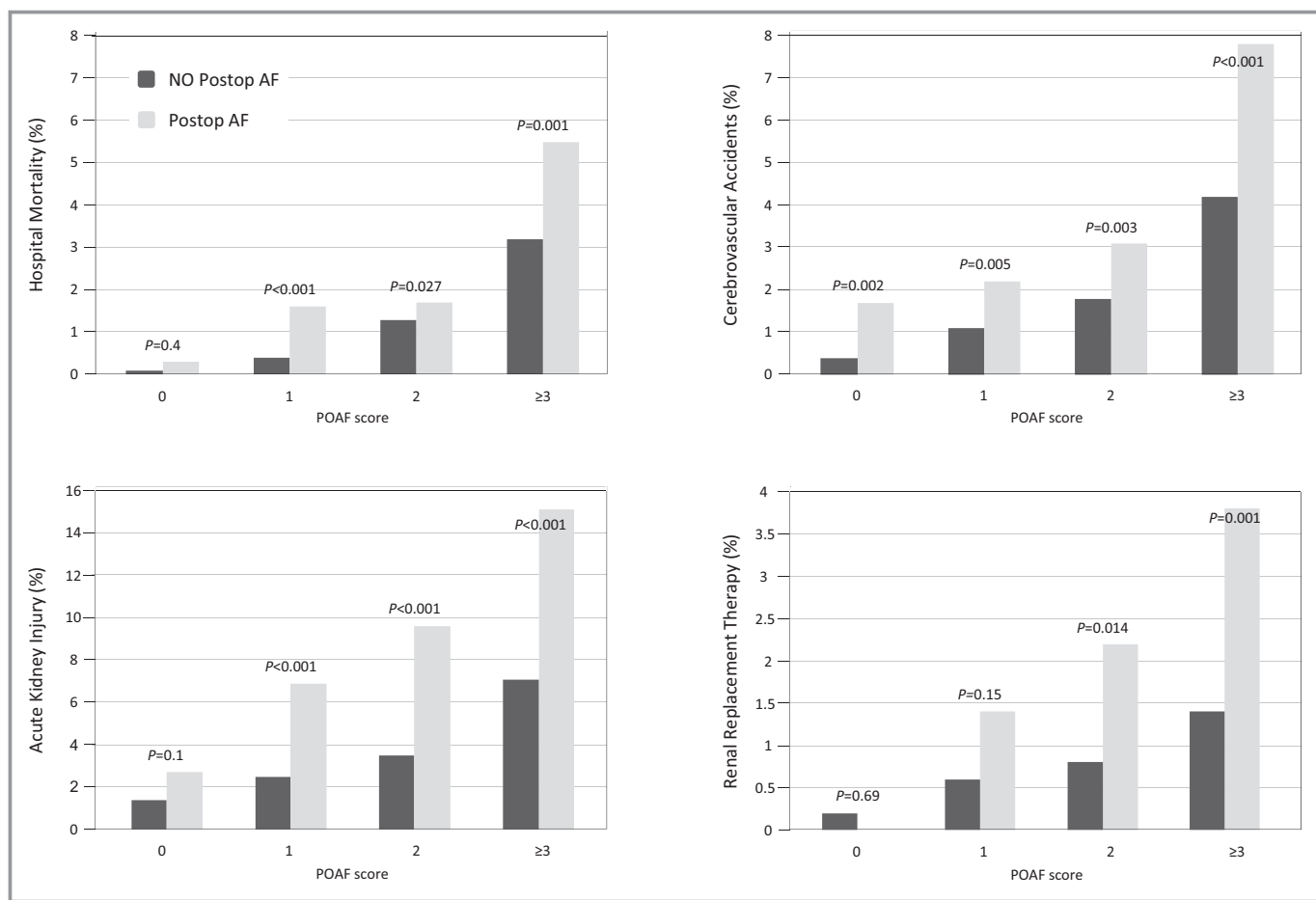


Figure 3. Postoperative complication (hospital mortality, cerebrovascular accident, acute kidney injury, and renal replacement therapy) rates according to the postoperative atrial fibrillation (POAF) score and the occurrence of POAF. *P* values are within each risk class.

prediction models, ignoring the fact that these subjects represent a specific surgical subgroup, being at higher risk for mortality and morbidity.^{7,8,10,20–23} Preexisting AF is often encountered in older patients with significant mitral valve disease and left atrial enlargement, and such patients are certainly more prone to develop AF after surgery than are those without this preexisting condition.^{19,20} In fact, both Amar et al⁷ and Mathew et al⁸ included the history of AF as a relevant risk factor in their prediction models, although patients with preexisting arrhythmia were largely affected by POAF (68% and 53%, respectively). Consonant data are obtained in the prediction model of Magee et al,⁹ with inclusion of the preoperative arrhythmia variable in the final prediction model, although patients affected by it experienced POAF in 70% of cases. In our study, patients with a preoperative history of supraventricular arrhythmias were excluded to avoid confusing the incidence of POAF with recurrence of a preexisting arrhythmic condition and because these patients have been demonstrated to benefit from extensive antiarrhythmic prophylaxis or a contemporary surgical ablation.^{22–24}

The present study has important indirect clinical implications with reference to possible AF preventive strategies, although it was not designed to specifically address the complex AF preoperative prophylaxis issue. Our aim was to identify a patient population more likely to develop AF and its related complications who may most benefit from of any preventive strategy.

The present prediction model includes variables such as COPD, valve surgery, emergency status, preoperative IABP need, advanced renal failure, and reduce LVEF, which have normally constituted exclusion criteria in several observational and randomized studies testing different AF prophylactic regimens, because the adverse drug effects registered in such patient classes.^{13,21,25,26} Low-risk patients (POAF score <3) may benefit from an extensive preoperative AF prophylaxis based on β -blockers and statins.^{13,21,25} However, high-risk patients (POAF score ≥ 3) are likely to be the most appropriate candidates for amiodarone prophylaxis, also for subjects already receiving β -blockers.^{21,25,26} Amiodarone has demonstrated a large compliance in the routine antiarrhythmic care of cardiac surgery patients, because of its low

incidence of acute complications and a large effectiveness independently from dose (high or low) or administration time (preoperative or intraoperative).^{4,21,25,26}

In addition, high-risk patients (POAF score ≥ 3) may benefit from a prolonged postoperative surveillance because of the possible occurrence of late AF episodes.^{3,27,28}

Finally, in comparison with previous prediction models, the POAF score for the first time was also tested in predicting related or accompanying complications of POAF.^{4,6–10} Having the highest AF risk as identified by POAF score ≥ 3 was strongly associated with higher hospital mortality, postoperative CVA, AKI, and RRT, suggesting a wider preventive approach based on both antiarrhythmic prophylaxes and other protective measures for AF-related morbidities. In particular, patients with a POAF score ≥ 3 and affected by POAF experienced a 2- to 4-fold increased risk of postoperative CVA compared with those in other POAF score classes. Patients with a POAF score ≥ 3 may largely benefit from antiarrhythmic prophylaxis accompanied by routine postoperative use of low-molecular-weight heparin, starting in the immediate period after surgery, especially in CABG patients as previously anticipated.²² The use of oral anticoagulation only at the onset of AF has been demonstrated to be inadequate to prevent stroke.²² Interestingly, oral anticoagulation in patients affected by POAF has been demonstrated to reduce early and late mortality associated with thromboembolic AF sequelae.^{3,5,28–30} Therefore, it should be considered in high-risk group patients (POAF score ≥ 3) immediately after cardiac surgery. In this patient class, the ligation of the left atrial appendage should also be considered.³¹

Study Limitations

Although the AF predictors were highly significant and assessed in a validation cohort, the accuracy of the present model is moderate, a result shared with other similar studies. Mahoney et al⁴ examined more than 10 000 cardiac surgery patients, investigating predictors of POAF in subjects undergoing isolated CABG and valve surgery with or without concomitant coronary surgery, and obtained 3 different models with an area under the curve of 0.67, 0.65, and 0.64, respectively. Similar results were also obtained by Thorén et al¹⁰ in a cohort of 7115 isolated CABG patients in an effort to identify patients at high risk of developing AF, and the predictive ability of their final prediction model was moderate (area under the ROC curve, 0.62). This is likely due to the complex and multifactorial nature of this arrhythmia. Furthermore, the present data were unable to clearly identify the temporal relationship between the onset of AF after surgery and the occurrence of adverse clinical events. It cannot be excluded that POAF occurred as a consequence of an observed complication rather than it being a cause of the complication.

Conclusions

The POAF score based on routinely available preoperative data is a simple, accurate bedside tool, allowing for identification of patients at high risk for POAF and in whom preventive antiarrhythmic therapies seem justified. Permitting identification of patients at high risk for AF and related or accompanying complications, the POAF score may also help to develop and update clinical and therapeutic strategies that not only would minimize the occurrence of POAF but also would result in an improvement in the otherwise dismal morbidity and mortality rates observed among patients affected by this arrhythmia.

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Disclosures

None.

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