

Scoring system for predicting the Post-Operative Atrial Fibrillation (POAF) in post-cardiac surgery: a literature review



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ABSTRACT

Background: Coronary artery bypass grafting (CABG) is still one of the optimal treatment options for revascularization in coronary heart disease. Despite Atrial Fibrillation being the most common arrhythmia after CABG, there's still no agreement on which risk assessment to predict the incidence of Post Operative Atrial Fibrillation (POAF). Some studies have shown that the findings of Atrial fibrillation after CABG are associated with increased hemodynamic disturbances, thromboembolic manifestations, readmission to the Intensive Care Unit (ICU), increased length of stay, organ failure, and death. This study aims to analyze the scoring system used for predicting the incidence of POAF in cardiac surgery.

Methods: This study used "POAF" AND "Scoring system," AND "CABG" AND "Atrial Fibrillation" as keywords to explore the literature from PubMed, Google Scholar, ProQuest, and Clinical Key. Search engines were searched for relevant papers from the last 15 years.

Result: CHA2DS2-VASc score has a sensitivity of 74.2%, a specificity of 44.7% and can identify patients who are predicted to have a high risk of experiencing POAF by 49.4%. The CHA2DS2-VASc score can be used as an independent predictor for predicting POAF. HATCH score cut-off point exceeding 1 was linked to AF prediction, yielding a sensitivity of 42% and specificity of 70%. POAF Score, the scoring system anticipates an increased likelihood of POAF development (58.5%). A score of 1 corresponds to a 30.1% probability of POAF occurrence and is a practical point for commencing preventive therapy.

Conclusion: Despite the various scoring systems used to predict postoperative atrial fibrillation, including the CHA2DS2-VASc score, HATCH score and Mariscalco. POAF Score demonstrated a validated ability to predict POAF.

Keywords: POAF, Scoring system, Atrial Fibrillation, CABG.

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INTRODUCTION

Coronary artery bypass surgery is still an option in revascularization in coronary heart disease. However, some complications still cannot be eliminated, including postoperative atrial fibrillation, also called Postoperative Atrial Fibrillation (POAF).^{1,2} The occurrence of abnormal heart rhythm after surgery (POAF) in patients who receive blood vessel grafts to treat blocked arteries or CABG is as much as 30%, where POAF itself is a complication that can cause morbidity both in the short and long term, with an event time ranging from 2 – 3 days after surgery.^{3,4} POAF can cause hemodynamic disturbances, thromboembolic manifestations, readmission to the Intensive Care Unit (ICU), increased length of stay, organ failure, and death.⁷ For this reason, predicting patients with a

high risk of POAF is one of the important things in preventing POAF.^{5,6}

According to a research paper by Mariscalco G et al., regarding the predictors that cause POAF in all open heart surgery operations, whether it be coronary, valvular, or both, is proven that several factors trigger POAF, namely age, COPD, eGFR <15 mL/min/1.73m², history of dialysis, emergency surgery, preoperative Intra-Aortic Balloon Counter Pump (IABP), EF <30%, and valve surgery.⁷ In that study, it was said that the POAF score represents a straightforward and precise bedside instrument that detects individuals with a high chance of developing AF. After heart surgery, patients often develop an irregular heartbeat, leading to more health problems and a higher risk of death. The Mariscalco POAF score is a validated tool that can estimate the likelihood of this complication.^{7,8}

Despite the various scoring systems being developed to predict the incidence of POAF, there's no agreement on which risk assessment is used to indicate atrial fibrillation that occurs post-CABG operation. This study expects it; we could compare the scoring system based on reviewing the literature and finding the best way possible to predict patients with high risk developing Atrial fibrillation postoperatively and reduce the risk of hemodynamic disturbances, thromboembolic manifestations, readmission to the Intensive Care Unit (ICU), increased length of stay, organ failure, and death.⁹⁻¹¹

Based on those mentioned above, this study aims to analyze the various literature for scoring systems used to predict the incidence of POAF in cardiac surgery.

METHODS

This article was conducted by analysis and synthesis from various references. The author uses “POAF” AND “Scoring system,” AND “CABG” AND “Atrial Fibrillation” as keywords to explore the literature from PubMed, Google Scholar, ProQuest, and Clinical Key. The related papers published in the last fifteen years were included, and non-full-text papers were excluded. These papers were analyzed subsequently to answer the aim of this study.

RESULTS

We obtained a total of six articles that met our review criteria. Up to six journals were extracted from PubMed, Google Scholar, ProQuest, and Clinical Key. According to our review method considerations, many articles excluded by the year of publication criteria are out of date. The results are shown in [Table 1](#).

Coronary Heart Disease

The constriction of the coronary arteries characterizes coronary heart disease (CHD). This condition may arise from the thickening and diminished flexibility of the walls of these arteries (arteriosclerosis). If severe enough, it will cause reduced blood flow to the myocardium. In the early stages, this disease will only reduce the coronary blood flow reserve (increased normal blood flow following increased oxygen demand in the myocardium). Still, in later stages, CHD can reduce blood flow within the coronary arteries, even during rest periods. In the most severe stages, atherosclerosis in coronary heart disease (CHD) can potentially obstruct blood circulation within the coronary arteries.^{12,13} Coronary heart disease can be divided into Stable Coronary Artery Disease (Stable Angina), Unstable Angina, and Acute Coronary Syndrome. Handling individuals diagnosed with coronary heart disease is lifestyle modification and control of risk factors, pharmacological management, and revascularization through percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG).¹

Coronary Artery Bypass Graft (CABG)

Coronary artery bypass surgery, also known as Coronary Artery Bypass Graft (CABG), is an open-heart surgery in which blood vessels are transplanted from the aorta to the coronary arteries to improve blood flow to the heart that was previously obstructed due to coronary artery disease.⁵ The three most common diagnoses of complications that can occur after CABG surgery are postoperative infection, congestive heart failure, and chest discomfort.¹⁶⁻¹⁸

Atrial Fibrillation

Atrial Fibrillation is an episode with irregular R-R intervals, and no P waves are seen for at least 10 seconds. Atrial fibrillation is a supraventricular arrhythmia with electrocardiographic characteristics in low-amplitude oscillatory movements accompanied by irregular ventricular rhythms.^{2,3}

Post Operative Atrial Fibrillation (POAF)

Postoperative atrial fibrillation (POAF) is estimated to occur in 20-40% of cardiac operations, where the onset of POAF appears within 2-4 days after surgery, with intermittent episodes and sometimes goes away on its own. However, the occurrence of POAF has consequences, namely hemodynamic instability, increased incidence of stroke, lengthened ICU stay and overall care. How POAF happens is still unclear, but it is related to inflammation and activation of the sympathetic and ischemic systems of the heart, thus triggering atrial fibrillation.^{2,3,7}

POAF Scoring System

At present, no risk assessment method that is universally agreed upon exists to forecast AFCS. Several models have been created and validated to predict the occurrence of Atrial Fibrillation following cardiac surgery, such as the Mariscalco POAF Score and HATCH score. In addition, the CHA2DS2-VASc score, originally conceived to estimate the likelihood of blood clots in people with atrial fibrillation, was validated prospectively and retrospectively to predict POAF.^{2,7}

The CHA2DS2-VASc scoring system is frequently utilized to evaluate the chance

of neurological impairment resulting from embolism in individuals with atrial fibrillation. Surprisingly, several features of this score correlate with heart conditions involving the structure and postoperative atrial fibrillation (POAF). Therefore, the use of the CHA2DS2-VASc score can also be used to determine cardiac structural abnormalities and atrial fibrillation that might occur after surgery (POAF).^{11,14,15}

Based on the research conducted by Kashani RG et al., the CHA2DS2-VASc score has a sensitivity of 74.2% and a specificity of 44.7%. It can identify patients who are predicted to have a high risk of experiencing POAF by 49.4%. The CHA2DS2-VASc score can be used as an independent predictor for predicting POAF. Compared to those with a score below 2, people with a score of 2 have a significantly higher chance of experiencing POAF.¹¹

In addition, atrial fibrillation can easily appear and become perpetuated in patients with high HATCH scores. Chronic Obstructive Pulmonary Disease (COPD) constitutes a distinctive element within the HATCH score. Atrial Fibrillation and COPD frequently occur together, making managing both conditions more intricate. In a recent study, it has been argued that the HATCH, the probability of developing atrial fibrillation with various coexisting diseases, can be estimated by score. The useful predicting factors of progression from paroxysmal to persistent as a HATCH score (hypertension <1 point>, age>75 years <1 point>, transient ischemic attack [TIA] or stroke < 2 points>, chronic obstructive pulmonary disease [COPD] <1point>, and heart failure <2points>) in AF patients who participated in the Euro Heart Survey. The useful predicting factors of progression from paroxysmal to persistent as a HATCH score (hypertension <1point>, age>75 years <1point>, transient ischemic attack [TIA] or stroke <2points>, chronic obstructive pulmonary disease [COPD] <1point>, and heart failure <2points>) in AF patients who participated in the Euro Heart Survey. The useful predicting factors of progression from paroxysmal to persistent as a HATCH score (hypertension <1point>, age >75 years <1 point>, transient ischemic attack [TIA]

Table 1. Detailed six articles that met our review criteria

Article	Design	Objective	Population	Results	Limitation
Chen L et al. ³	Retrospective Cohort	To create and confirm a straightforward scoring method for assessing the likelihood of POAF after isolated CABG, utilizing readily accessible clinical data.	Successive individuals undergoing isolated CABG surgery at Beijing Anzhen Hospital, the Capital Medical University (Beijing, China) from April 1, 2014 to September 30, 2015.	Both the derivation and validation groups had a 27.3% rate of POAF. The risk of POAF was higher for those 65 years or older or with a history of hypertension, heart failure, or myocardial infarction. These factors were used to assign points and create a risk score, where a score of 3 or more meant a high probability of POAF. In the derivation group, 41.1% of those with a score of 3 or more had POAF, while 78.5% of those with a lower score did not. The validation group showed similar results, with 44.3% and 80.8%, respectively, for the same score.	<ol style="list-style-type: none"> 1. External validation is necessary for confirming the reliability of this risk score. 2. The study's retrospective design could introduce information bias and other variables that might confound the results. 3. The study's focus on a single center might restrict the broad applicability of our conclusions.
Burgos LM et al. ²	Retrospective cohort	To explore the effectiveness of CHADS2 and CHA2DS2-VASc scores as tools for evaluating the risk of new-onset atrial fibrillation following cardiac surgery.	Sequential patients who received heart surgery at the writer's institution from January 2008 to December 2011	84 (30%) of the patients experienced atrial fibrillation after heart surgery, typically around 2 days following the procedure. The CHADS2 and CHA2DS2-VASc scores in separate analyses showed significant predictive value for post-operative atrial fibrillation. When the CHADS2 and CHA2DS2-VASc scores were at least 2, the Kaplan-Meier analysis demonstrated an increased incidence of atrial fibrillation after surgery compared to scores below 2. Moreover, using the CHA2DS2-VASc scores, patients with CHADS2 scores of 0 or 1 could be further categorized into two groups with varying rates of postoperative atrial fibrillation, using a cutoff value of 2.	<ol style="list-style-type: none"> 1. POAF could vary among patients who undergo CABG and valve procedures, potentially introducing bias in the results due to the scoring system's application to a diverse patient group. 2. A continuous monitoring system was not employed to observe patients for 30 days after heart surgery. 3. The potential exists for an underestimation of POAF frequency in this study, which might introduce a bias to the results and lessen the apparent connection between CHADS2 and CHA2DS2-VASc scores and POAF.
Kashani RG et al. ¹¹	Retrospective cohort	To assess the effectiveness of the CHA2DS2-VASc scoring system in foreseeing the likelihood of new-onset POAF among patients undergoing cardiac surgery	Patients who received cardiac surgery at Ronald Reagan Medical Center at the University of California, Los Angeles, from January 2008 – May 2004.	POAF was observed in 380 out of 2,385 patients. The mean CHA2DS2-VASc scores for individuals with and without postoperative atrial fibrillation (POAF) were 3.6±1.7 and 2.8±1.7, respectively. Multivariate analysis determined that as a patient's CHA2DS2-VASc score increased from 0 to 9, the likelihood of encountering POAF rose from 8.2% to 42.3%. With each incremental point in the score, the possibility of developing POAF increased. Compared to low-risk patients, those in the high-risk category were 5.21 times more prone to developing POAF.	<ol style="list-style-type: none"> 1. This report represents our findings are based on observations from a single academic medical center. 2. The incidence of POAF observed in this study is lower than the rates in existing literature.

Article	Design	Objective	Population	Results	Limitation
Mariscalco et al. ⁷	Retrospective Cohort	To develop a practical and dependable bedside tool for predicting the occurrence of POAF and its associated complications.	Every patient who underwent isolated coronary artery bypass graft surgery (CABG) and valve surgery (with or without concomitant CABG) at three cardiac centers in Europe (Bristol Heart Institute, UK; Varese University Hospital, and Centro Cardiologico Monzino IRCCS, Italy) from July 1999 to December 2010.	Four thousand five hundred sixty-one patients experienced postoperative atrial fibrillation (AF). The following factors were found to be independently associated with AF in the group that was derived: age, any heart valve surgery, emergency operation, preoperative intra-aortic balloon pump, left ventricular ejection fraction <30%, chronic obstructive pulmonary disease, and estimated glomerular filtration rate <15 mL/min per m ² or dialysis. The POAF score was determined by adding weighted points corresponding to these independent AF predictors. According to the predictive model, the postoperative AF incidences in the derivation cohort were: 0, 11.1%; 1, 20.1%; 2, 28.7%; ≥3, 40.9% and in the validation cohort they were 0, 13.2%; 1, 19.5%; 2, 29.9%; and ≥3, 42.5%. In contrast to those without the arrhythmia, individuals with a POAF score of 3 or higher exhibited a heightened likelihood of in-hospital mortality, postoperative mortality after the first day, cerebrovascular events, acute kidney injury, need for renal replacement therapy, and longer hospital stays.	<ol style="list-style-type: none"> The precision of the current model is moderate, a result consistent with other studies of a similar nature. The present data in this study could not identify the temporal relationship between the occurrence of adverse clinical events and the onset of AF after surgery.
Selvi M. et al. ¹⁴	Retrospective study	To explore the correlation between the HATCH score and the occurrence of atrial fibrillation (AF) following coronary artery bypass graft (CABG) surgery.	Patients who had elective CABG surgery at the Department of Cardiovascular Surgery in Adnan Menderes University Hospital from January 2011 to December 2015.	<p>The median age of patients diagnosed with atrial fibrillation (AF) was significantly greater when compared to the median age of the group without AF. Patients who experienced AF following CABG surgery had substantially higher HATCH scores than those in the non-AF group. After conducting multivariate logistic regression analysis, The HATCH score was identified as an independent predictor of atrial fibrillation following coronary artery bypass graft (CABG) surgery. Receiver operating characteristics curve analysis determined that a HATCH score cut-off point exceeding 1 was linked to AF prediction, yielding a sensitivity of 42% and specificity of 70%. Patients with elevated preoperative HATCH scores might have a heightened risk of developing AF after undergoing CABG surgery.</p>	<ol style="list-style-type: none"> The identification of POAF following discharge from the intensive coronary unit was based on patient symptoms or daily ECG recordings. Certain brief or asymptomatic AF instances might not have been detected during this timeframe. This led to their categorization in the alternate group due to the lack of ongoing continuous ECG monitoring. This study utilized a retrospective design and presented findings based on the experience of a single medical center.

Article	Design	Objective	Population	Results	Limitation
Suenari K et al. ¹⁵	Retrospective study	To employ the HATCH scoring system to assess the likelihood of atrial fibrillation (AF) development in patients with different underlying health conditions.	This study used the "Taiwan National Health Insurance Research Database" from January 1, 2000 to December 31, 2001. The study concentrated on individuals aged above 20 years who had no prior record of cardiac arrhythmias.	Six hundred seventy-eight hundred four individuals aged over 20 years, without any past cardiac arrhythmia history, were involved in calculating the HATCH score. Over the follow-up period, 9,174 patients developed new-onset AF. The occurrence rate increased from 0.8 per 1000 patient-years in those with a HATCH score of 0 to 57.3 per 1000 patient-years in individuals with a HATCH score of 7. The HATCH score exhibited utility in effectively estimating and categorizing the risk of new-onset AF.	3. The identification of atrial fibrillation relied on diagnostic codes recorded by the attending physicians responsible for patient care, and external verification was not conducted. 4. The study exclusively included Taiwanese patients. Thus, the applicability of the findings to other populations remains uncertain.

Table 2. The CHA₂DS₂-VASc Score¹

Risk factor	Score
Congestive heart failure/LV dysfunction	1
Hypertension	1
Age > 75	2
Diabetes mellitus	1
Stroke/TIA/thromboembolism	2
Vascular disease*	1
Age 65-74	1
sex category (ie, female sex)	1
Maximum score	9

Note: *Prior myocardial infarction; peripheral artery disease; aortic plaque.

Abbreviations: LV, left ventricular; TIA, transient ischemic attack.

Table 3. The HATCH Score⁵

Variables	Point
Ejection fraction ≤ 40	2
Transischemic attack/stroke	2
Age > 75	1
Hypertension	1
Chronic obstructive pulmonary disease	1

or stroke <2points>, chronic obstructive pulmonary disease [COPD] <1point>, and heart failure <2points>) in AF patients who participated in the Euro Heart Survey. The useful predicting factors of progression from paroxysmal to persistent as a HATCH score (hypertension <1 point>, age>75 years <1point>, transient ischemic attack [TIA] or stroke <2points>, chronic obstructive pulmonary disease [COPD] <1point>, and heart failure <2points>) in AF patients who participated in the Euro Heart Survey.^{1,8}

De Vos and colleagues found that the HATCH score, which includes hypertension (1 point), age over 75 (1 point), history of TIA or stroke (2 points), COPD (1 point), and heart failure (2 points), can help predict who will go from having occasional to constant AF among the patients in the Euro Heart Survey.⁵

The sole scoring system developed and verified for forecasting postoperative Atrial Fibrillation in individuals undergoing coronary artery bypass graft (CABG) or valve surgical procedures is the Mariscalco POAF score. This system employs seven factors identified through a multivariable analysis. The scoring system known as the POAF Score was established by Mariscalco and colleagues in 2013. This system operates under the assumption that the primary complication following open heart surgery is post-operative atrial

fibrillation (POAF), which has economic and clinical implications, increased morbidity and mortality in the long and short periods, and considerable impact on the use of medical devices and materials.⁷

Previously, there have been several studies that tried to identify patients at high risk of atrial fibrillation, but in these studies, many failed to find an effective analytical system for finding solutions to POAF, such as prophylactic drugs. However, the use of preventive medications in preventing atrial fibrillation has unwanted side effects with quite a large percentage, namely 60% - 80% with inappropriate indications.^{3,19}

The POAF Score study was conducted from July 1999 to December 2010 with a sample of all patients who underwent isolated coronary artery bypass graft surgery (CABG) and valve surgery (with or without CABG surgery) conducted at three European cardiac care facilities, which are: Bristol Heart Institute, Varese University Hospital, and Centro Cardiologico Monzino IRCCS and is considered an observational study. From this study, an instrument was obtained, namely the POAF Score (Table 4), which concluded that if the patient's score was ≥ 3, it could be said that these patients have a high risk of developing POAF and can be recommended for the use of preoperative drugs to prevent POAF.^{2,3,7} According to the research carried out by

Table 4. The POAF Score⁷

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	

Hung and colleagues in 2021 regarding the POAF Score, the scoring system anticipates an increased likelihood of POAF development (58.5%). A score of 1 corresponds to a 30.1% probability of POAF occurrence and serves as a practical point for commencing preventive therapy (Figure 2).¹⁰

POAF Risk Factor

Several risk factors can affect the incidence of POAF, including age, chronic obstructive pulmonary disease (COPD), cardiac function (ejection fraction), and kidney function (eGFR). A study conducted by Seo EJ et al. stated that age is a risk factor for POAF. On the other hand, another study conducted by Selvi et al. found that patients who experienced POAF were patients aged 68.7 ± 8.8 years.^{14,20} Not only that, according to Stefano PL et al., in patients with older age, degenerative processes and hypertension occur in the arteries, which then causes structural changes in the atria, increasing the incidence of POAF.²¹

Based on research conducted by Seo EJ et al., coronary heart disease has many comorbidities, one of which is referred to as Chronic Obstructive Pulmonary Disease (COPD). In COPD, a decrease in lung function is found, resulting in hypercapnia and an increase in pulmonary artery systolic pressure, a predictor of atrial fibrillation. This increases the incidence of atrial fibrillation by 1.8 times in patients with FEV1 60% -80% compared with FEV1 > 80%.^{20,22}

Decreased cardiac function, as described by a low ejection fraction, increases the incidence of POAF, usually

followed by diastolic dysfunction and large left atrial volume. In research undertaken by Pieri M et al., it was found that patients with an ejection fraction of less than 40% had a higher incidence of POAF.²³ Patients with renal failure have eGFR < 15 mL/min/1.73 m². eGFR is an estimate of the amount of blood filtered each minute. In a study conducted by Zaman AG et al., an increase in creatinine > 125 µmol/L preoperatively would increase the incidence of POAF by 1.4 times, and an increase in creatinine > 125 µmol/L postoperatively would increase the incidence of POAF by 2.33 times.^{24,25}

Although this study has a very good implementation for diagnosing atrial fibrillation post-operatively to reduce morbidity, the limitation of this study is the risk of selection bias in selecting the articles, and the study design means there's no comparison for the significance difference for multiple scoring systems. We suggest future studies to do a more comparative study between the scoring systems.

CONCLUSION

Diverse models have been developed and validated to predict the occurrence of atrial fibrillation after cardiac surgery, including the POAF and HATCH scores. Among these two, the POAF score is used as a singular scoring framework established and verified for predicting postoperative Atrial Fibrillation, specifically in patients undergoing CABG or valve surgery. The POAF score is an uncomplicated and precise tool that can be used at the bedside, enabling the ease of identifying patients prone to AF risk.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

ETHICAL CONSIDERATIONS

This review of published literature did not require an ethical review. In addition, this study has following COPE and ICMJE guidelines regarding the publication ethics protocol.

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AUTHORS CONTRIBUTION

Rahajeng Arianggarini Puspitasari was primarily responsible for writing the manuscript and co-coordinated study design, data analysis, data interpretation and data collection. Yan Efrata Sembiring contributed to data analysis, interpretation, critical revision of the article for intellectual purposes and final approval. Joan Angelina Sembiring contributed to providing the article's material, expertise and writing for important intellectual content. All authors have reviewed and approved the final version of the manuscript for submission.

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