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Postoperative Atrial Fibrillation after Cardiac Surgery: A Review of Risk Factors, Clinical Outcomes, and Management Strategies

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Abstract

Postoperative atrial fibrillation (POAF) is the most common arrhythmia following cardiac surgery and is associated with increased morbidity, prolonged hospitalization, and higher long-term risks of stroke, heart failure, and mortality. Once considered a transient and benign condition, POAF is now recognized as a clinically significant complication with lasting prognostic implications. This narrative review summarizes the current evidence on the epidemiology, risk factors, pathophysiology, clinical consequences, and management strategies of POAF. It highlights both pharmacological and non-pharmacological preventive measures, including beta-blockers, amiodarone, and posterior pericardiotomy, while also examining the ongoing controversy surrounding anticoagulation therapy in the postoperative setting. Current guideline recommendations for anticoagulation remain inconsistent, largely due to limited high-quality evidence and the absence of validated risk stratification tools tailored to surgical patients. Future research should focus on refining predictive models such as the CHA_2DS_2-VASc score and generating robust randomized data to inform treatment decisions, especially concerning anticoagulation. Recognizing POAF as a marker of long-term cardiovascular risk is essential to improving outcomes and guiding individualized postoperative care.

Introduction

Postoperative atrial fibrillation (POAF) is the most common type of arrhythmia after any cardiac surgery [1]. The arrhythmia usually manifests itself two to three days after surgery. Researchers previously accepted POAF as a benign and transient phenomenon, often because they perceived it as reversible. Although prospective randomized trials have shown that most patients return to normal sinus rhythm within 60 days after CABG [2], recent research suggests that patients who develop POAF after cardiac surgery have an increased risk of other complications, such as stroke, and a higher risk of mortality [3], [4]. Although the arrhythmia often resolves on its own and clinicians usually discharge many patients in sinus rhythm, multiple studies show that patients who experience POAF have a significantly higher risk of recurrent atrial fibrillation during long-term follow-up compared to those who remain in sinus rhythm after surgery [5], [1], [6]. Postoperative atrial fibrillation significantly increases the overall economic burden associated with cardiac surgery [7], [8]. The clinical importance of POAF is not only due to the arrhythmic episode itself, but also to its association with increased short- and long-term complications, such as more extended hospital stays, stroke, myocardial infarction, heart failure, and increased mortality [9], [10], [11], [12].

Effective prevention and treatment of postoperative atrial fibrillation are crucial for improving patient outcomes, promoting faster recovery, and reducing healthcare costs. Although clinical guidelines from major societies such as the American Heart Association, the European Society of Cardiology, and the American College of Cardiology provide general recommendations, essential uncertainties remain, particularly regarding the optimal choice, timing, and duration of antiarrhythmic therapy, as well as strategies for preventing recurrence and stroke. Current recommendations regarding anticoagulation in POAF are based on limited and inconsistent evidence, making clinical decision-making challenging due to the balance between thromboembolic risks and bleeding complications [13], [14], [15]. Early identification of patients at high risk for new-onset POAF after cardiac surgery is crucial to guide perioperative management and improve overall clinical outcomes.

In this review, we aim to provide an up-to-date

overview of POAF in patients undergoing cardiac surgery, summarizing the available literature on its epidemiology, risk factors, clinical consequences, prevention strategies, and management challenges.

Materials and Methods

This article is a narrative review of the current literature on postoperative atrial fibrillation following cardiac surgery. We conducted a comprehensive literature search using PubMed, MEDLINE, Google Scholar, and PubMed Central (PMC) to identify relevant studies published from 2000 to March 2025.

The search strategy included the following terms:

("Postoperative atrial fibrillation" OR "POAF") AND ("cardiac surgery" OR "CABG" OR "valve surgery") AND ("incidence" OR "risk factors" OR "complications" OR "stroke" OR "anticoagulation" OR "management").

We included only English-language articles with full-text availability. Eligible sources comprised original clinical studies (prospective, retrospective, cohort, and case-control), randomized controlled trials (RCTs), systematic reviews, meta-analyses, expert consensus documents, and significant international guidelines from societies such as the European Society of Cardiology (ESC), the American College of Cardiology/American Heart Association (ACC/AHA), and the American Association for Thoracic Surgery (AATS). Articles were screened for relevance based on titles and abstracts, followed by full-text evaluation. Studies were selected if they addressed at least one of the following domains:

- Epidemiology and prevalence of POAF;
- Pathophysiology and risk factors;
- Clinical course and long-term outcomes;
- Prevention strategies and pharmacological management;
- Anticoagulation therapy and guideline recommendations.

We excluded studies that focused exclusively on non-cardiac surgery, pediatric populations, non-AF arrhythmias, or atrial fibrillation unrelated to surgery. In total, over 150 abstracts were screened, and approximately 56 full-text articles, including both recent and landmark studies, were included in the final synthesis.

We thematically synthesized the data into the following sections: (1) Epidemiology and Risk Factors, (2) Pathophysiology, (3) Clinical Outcomes and Prognosis, (4) Treatment Strategies, and (5) Anticoagulation and Guideline Recommendations.

Although we did not conduct a formal risk-of-bias assessment due to the narrative nature of this review, we prioritized high-quality studies, including extensive cohort studies and randomized controlled trials. We synthesized the literature thematically to provide a comprehensive review of POAF in the context of cardiac surgery.

Epidemiology and prevalence

Postoperative atrial fibrillation (POAF), as a prevalent complication after cardiac surgery, occurs with an incidence of 20-60% [12], [3]. The risk of developing POAF varies significantly by procedure. Isolated coronary artery bypass grafting (CABG) is associated with a relatively lower incidence, typically ranging from 17% to 30%. In contrast, valve surgeries tend to have higher rates, ranging from 38% to 64%, while aortic procedures are associated with an incidence of around 30%. The highest occurrence—reaching up to 62%—is observed in patients undergoing combined CABG and valve surgery [16], [12], [17]. Moreover, the incidence is expected to increase over time, as the cardiac surgery population continues to age and atrial fibrillation becomes more prevalent with advancing age in the general population. The incidence of POAF following heart transplantation is relatively low—around 4%—primarily because the transplanted heart is denervated. Similarly, POAF is far less common in non-cardiac surgeries, with an incidence of just 3%, compared to rates typically seen in cardiac and thoracic procedures [16]. This variation underscores the importance of individualized risk assessment and targeted preventive measures across various cardiac surgery groups.

Risk factors and pathophysiology

Knowledge of risk factors that increase the risk of POAF will lead to improved care for patients after cardiac surgery. On the other hand, because the etiology of POAF is incompletely understood, predicting the occurrence of POAF remains a challenge.

Although some patients develop atrial fibrillation (AF) after cardiac surgery without any obvious predisposing factors, most patients have at least one clinical predictor. Qureshi et al. (2021) divided the risk factors for POAF into three groups: (1) those related to preexisting atrial substrate changes occurring before surgery; (2) those associated with intraoperative stress and technique; and (3) postoperative factors that occur in the days or weeks after surgery [18].

In their literature review, Qureshi et al. (2021) categorized preoperative risk factors for POAF into cardiovascular and non-cardiovascular groups. The cardiovascular factors include left atrial enlargement, left ventricular dysfunction, valvular heart disease, coronary artery disease, and prior history of atrial fibrillation—all of which contribute to structural and electrical remodeling that predisposes patients to

arrhythmia [18]. The non-cardiovascular group includes demographic characteristics of patients and their comorbidities that are independently associated with the incidence of POAF: age, gender, obesity, diabetes mellitus, lung disease, kidney disease, hypertension, anemia, previous AF, and structural changes of the heart. These risk factors have been consistently identified in numerous studies, underscoring their value in assessing a patient's risk prior to surgery [19], [16], [20].

Intraoperative risk factors for POAF include the type of cardiac surgery, use of an intra-aortic balloon pump (IABP), graft type in bypass procedures, volume and composition of cardioplegia, and other procedural variables. Cardiac surgery itself can serve as a potent trigger for the development of POAF by inducing atrial structural and electrical remodeling through surgical trauma and inflammation, thereby increasing the likelihood of postoperative arrhythmogenesis. Among these intraoperative contributors, the duration of cardiopulmonary bypass (CPB) has been identified as a particularly significant risk factor for adverse outcomes. In a meta-analysis by Seo et al. (2021), although several intraoperative variables were assessed—including use of an IABP, graft type, and transfusion—only prolonged CPB time showed a statistically significant association with an increased incidence of POAF ($p = 0.017$). To further elucidate the impact of CPB, the authors explicitly analyzed data from a subset of 4445 patients with documented CPB use. POAF occurred in 34.1% of patients undergoing on-pump CABG, compared with 28.7% of those undergoing off-pump CABG, a statistically significant difference ($\chi^2 = 9.39$, $p = 0.002$) [21]. These findings suggest a role for systemic inflammation in the pathophysiological mechanisms of POAF and reinforce the role of atrial stress induced by CPB. These data indicate that minimizing CPB exposure may reduce the incidence of POAF. However, in a more recent systematic review and meta-analysis, Gdey et al. (2023) found that the use of IABP was significantly associated with the development of POAF, suggesting that mechanical support may pose an additional arrhythmogenic risk in selected patient populations [20].

While the development of POAF involves multiple mechanisms, several postoperative factors—such as low potassium or magnesium levels, use of inotropic agents, reoperation, acute kidney injury, and pericarditis—have been recognized as potential triggers during the early recovery period [1], [21], [22].

Understanding the pathophysiology of POAF is crucial for the prevention, treatment, and follow-up of patients with POAF. Despite extensive research to date, the exact pathophysiology of POAF remains undetermined. Several studies have highlighted a range of pathophysiological mechanisms involved in the development of postoperative atrial fibrillation, including systemic inflammation, heightened sympathetic nervous system activity, oxidative stress, myocardial ischemia, and disturbances in electrolyte balance [23]. Following cardiac surgery, patients commonly enter a hypercoagulable state while also facing an elevated risk of bleeding. Postoperative sympathetic activation, characterized by increased catecholamine release and elevated heart rate, can enhance arrhythmogenic potential. Additionally, perioperative fluid administration—mainly when resulting in hypervolemia—may lead to atrial stretching, a known trigger for POAF [18]. Myocardial ischemia is also a key contributor to the development of POAF. Pokorney et al. (2022) linked blockage in the atrial branches of the coronary arteries to the onset of atrial fibrillation, even in nonsurgical settings [24]. Some studies suggest the role of inflammatory markers in the development of POAF (CRP, interleukins). However, this mechanism is not yet well defined [25], [26].

Complications and Prognostic Outcomes

Despite the use of increasingly modern antiarrhythmics, the rate of POAF remains almost unchanged today, which is further evidence of its multifactorial etiology. Many studies suggest that postoperative atrial fibrillation is not just a transient perioperative arrhythmia—it is a clinically significant entity associated with a higher incidence of major perioperative and long-term complications.

Caldonazo et al. (2021), in a large meta-analysis, demonstrated that POAF is independently associated with increased risks of perioperative mortality, stroke, myocardial infarction, and acute renal failure, as well as prolonged intensive care unit and hospital stays [3]. Suero et al. (2024) corroborated these findings by reporting that POAF is linked to higher rates of early postoperative complications and contributes to long-term adverse outcomes, including elevated risks of readmission for heart failure and progression to chronic atrial fibrillation [27]. Similarly, a multicenter observational study by LaPar et al. (2014) found that POAF significantly increases hospital readmission rates, thereby prolonging overall hospitalization and increasing healthcare costs [28]. Rezk et al. (2022), in a retrospective study of over 6,000 patients undergoing CABG and/or valve surgery, found that the clinical course of POAF—remarkably whether sinus rhythm was restored spontaneously, pharmacologically, or through electrical cardioversion—was associated with differential long-term outcomes. Sustained atrial fibrillation at discharge and AF requiring electrical cardioversion were both independently linked to an increased risk of heart failure hospitalization. However, they were not associated with higher long-term mortality or thromboembolic complications [29].

Regarding long-term prognosis, multiple large-scale studies have shown that POAF confers elevated cardiovascular risk. In a cohort of over 7,000 patients undergoing isolated CABG, Thorén et al. (2020) found

that POAF was independently associated with increased long-term risks of recurrent AF, ischemic stroke, heart failure, and mortality. Notably, the incidence of AF remained significantly elevated even a decade after surgery, suggesting a lasting arrhythmogenic substrate [30].

Eikelboom et al. (2020) confirmed a strong association between POAF and long-term mortality through a systematic review and meta-analysis of 32 studies. Their findings revealed a 25% increased hazard of death in patients with POAF, reinforcing its prognostic value [10]. Additionally, Almassi et al. (2019) found, in a five-year follow-up of the ROOBY-FS trial, that while adjusted mortality did not significantly differ between groups, first-year healthcare costs were substantially higher among patients with POAF, reflecting a significant early burden [11].

In an updated meta-analysis, Caldonazo et al. (2021) demonstrated that POAF was significantly associated with increased risks of persistent AF, late stroke, and long-term mortality [3]. More recently, Kawczynski et al. (2025) further clarified the long-term implications of POAF. After adjusting for age, cardiovascular comorbidities, and type of surgery, early POAF remained significantly associated with late mortality. Interestingly, the same analysis did not identify a statistically significant association with late stroke after accounting for these variables. These findings suggest that POAF is an independent risk marker for long-term mortality, but its relationship with stroke may be more complex and influenced by other factors [31].

Together, these findings highlight that POAF is not a benign or self-limiting arrhythmia, but rather a marker of long-term cardiovascular vulnerability that warrants close follow-up and potentially intensified preventive strategies beyond hospital discharge.

Treatment and Prevention of Postoperative Atrial Fibrillation

The management of postoperative atrial fibrillation aims to reduce symptom burden, shorten hospital stay, prevent thromboembolic complications, and minimize recurrence. Clinicians generally divide treatment strategies into preventive measures and therapeutic interventions, including rate control, rhythm control, and anticoagulation. Given the multifactorial nature of POAF, a multimodal approach tailored to individual risk is recommended.

Prophylactic strategies are essential in high-risk patients undergoing cardiac surgery. The updated Cochrane review by Arsenault et al. (2013), encompassing 118 studies and over 17,000 patients, also concluded that multiple interventions—both pharmacological (e.g., beta-blockers, amiodarone, sotalol, magnesium) and non-pharmacological (e.g., atrial pacing, posterior pericardiotomy)—significantly reduce the incidence of POAF. These interventions were also associated with reduced hospital stays and treatment costs, though the effect on postoperative stroke did not reach statistical significance [32].

According to international guidelines (ACC/AHA/ACCP/HRS, 2023; European Society of Cardiology, 2024), beta blockers remain the cornerstone of pharmacological prophylaxis in the preoperative period, with numerous studies confirming their effectiveness in reducing the occurrence of POAF [14], [15], [33], [34], [35], [36], [37].

Clinicians commonly use amiodarone for both the prevention and treatment of atrial fibrillation. Evidence from randomized controlled trials, including the PAPABEAR study, and meta-analyses such as the Cochrane review, supports the efficacy of amiodarone in preventing postoperative atrial fibrillation [38], [27].

There is limited data available on the effectiveness of other antiarrhythmic drugs in preventing POAF. Calcium-channel blockers, particularly non-dihydropyridines, may offer some benefit, while magnesium has shown inconsistent results across trials and meta-analyses. Similarly, colchicine has demonstrated potential in specific studies such as the COPPS substudy. However, larger trials, such as END-AF, failed to confirm its efficacy, highlighting the need for further high-quality research. Current international guidelines do not recommend the routine use of statins, glucocorticoids, or polyunsaturated fatty acids for POAF prevention, as evidence supporting their anti-inflammatory and electrophysiological benefits remains insufficient. Optimizing electrolyte balance, particularly concerning potassium and magnesium, is also crucial [1].

Among the non-pharmacological preventive measures, posterior pericardiotomy (PP) has emerged as one of the most effective surgical strategies for reducing the incidence of postoperative atrial fibrillation. This technique facilitates continuous drainage of pericardial fluid, thereby decreasing local inflammation and atrial wall stress—two key contributors to atrial arrhythmogenesis. A 2023 systematic review and meta-analysis of 25 randomized controlled trials confirmed a significant reduction in POAF incidence among patients undergoing CABG or valve surgery who received PP [39]. Similarly, a meta-analysis by Hu et al. (2016), which included ten randomized controlled trials encompassing 1,648 patients, demonstrated that the incidence of POAF was markedly lower in the PP group (10.6%) compared to the control group (24.9%). The authors reported a 45% relative risk reduction with PP (RR 0.45, 95% CI: 0.31–0.64; OR 0.36, 95% CI: 0.23–0.56; $p < 0.00001$), reinforcing its role as a safe and effective intervention in patients undergoing CABG. Despite some heterogeneity, sensitivity analyses confirmed the consistency of these findings. Collectively, the evidence strongly supports the inclusion of PP as a prophylactic measure in appropriately selected patients undergoing cardiac surgery [40].

Randomized controlled trials demonstrate that bi-atrial pacing most effectively reduces the incidence of POAF after CABG, compared to no pacing or single-site atrial pacing. Specifically, bi-atrial pacing achieves a greater reduction in POAF incidence (OR 0.34; 95% CI 0.21–0.55) without increasing postoperative bleeding, infection, or mortality, making it the most favorable strategy among pacing modalities [41].

Surgical Ablation and Left Atrial Appendage Occlusion (LAAO) are Class I recommendations in patients with preexisting atrial fibrillation undergoing cardiac surgery. However, surgical LAAO in patients without AF has not shown a benefit and may even increase the incidence of POAF, so it is not currently recommended for prophylactic use [27].

Although substantial evidence supports the effectiveness of prophylactic therapies for POAF, many cardiac surgery centers still do not widely adopt these strategies in routine clinical practice [42].The limited adoption stems from factors such as perceived insufficient evidence, the complexity of specific drug regimens, and concerns about potential risks. Therefore, clinicians should prioritize preventive strategies, including antiarrhythmic drugs, for patients identified as being at high risk for POAF, where the benefits are more likely to outweigh the risks.

The management of POAF remains variable and depends on the patient's condition. Two main approaches are employed: rate control and rhythm control, both of which have shown comparable efficacy in hemodynamically stable patients. A prospective randomized pilot study by Lee et al. demonstrated that both rate-control and rhythm-control strategies yielded similar outcomes in patients with POAF after cardiac surgery, with no significant differences in time to sinus rhythm restoration or relapse rates. Most patients regained sinus rhythm within two months, regardless of the strategy used, although the antiarrhythmic group had a slightly shorter hospital stay [43]. The CTSN randomized trial by Gillinov et al. found no significant differences between rate and rhythm control in terms of hospital stay, mortality, or serious adverse events. However, rhythm control was associated with a slightly higher rate of sinus rhythm at 60 days [2]. Similarly, Bruggmann et al. observed the widespread use of rhythm control (mostly with amiodarone), despite guideline support for both strategies, and highlighted inconsistencies in drug dosing and anticoagulation practices, underscoring the need for standardized protocols [44]. In a retrospective study, Samuels et al. showed that amiodarone combined with early cardioversion restored sinus rhythm in 90% of POAF patients within 48 hours and reduced length of stay compared to non-amiodarone therapies [45].

Prevention of stroke

Another proposed approach for the management of POAF and prevention of stroke risk is anticoagulant therapy, for which the results in different studies are controversial, and the recommendations are unclear. Although anticoagulation is essential to reduce the risk of stroke in patients with atrial fibrillation, its use in cases of provoked or "secondary" atrial fibrillation after cardiac surgery remains debated due to concerns about increased bleeding [46].

Data from a large Danish cohort comparing POAF after coronary artery bypass grafting with nonsurgical non-valvular atrial fibrillation (NVAF) found that patients with POAF had a significantly lower risk of thromboembolism than those with NVAF (adjusted HR 0.67), and were less frequently anticoagulated (8.4% vs. 42.9%). Despite the lower risk, patients with POAF who did receive anticoagulation experienced a reduction in thromboembolic events (adjusted HR 0.55), indicating a possible benefit in selected individuals [47]. However, other large-scale data challenge the routine use of anticoagulation in this setting. In an analysis of over 38,000 CABG patients with POAF, anticoagulation was associated with increased all-cause mortality (HR 1.16) and a significantly higher risk of major bleeding (HR 1.60), without a corresponding reduction in ischemic stroke, regardless of CHA_2DS_2-VASc score [46]. Furthermore, a retrospective study by Schulman et al. (2015) examining early postoperative stroke risk concluded that warfarin had a limited preventive effect in POAF, with most strokes occurring early postoperatively when bleeding risk is highest and anticoagulation is least effective [48]. A systematic review and meta-analysis by Neves et al. (2021) further supports the complexity of anticoagulation decisions in POAF. Their analysis of over 200,000 cardiac surgery patients showed that oral anticoagulation was associated with a lower risk of thromboembolic events (OR 0.68; 95% CI, 0.47–0.96), but this benefit came at the cost of significantly increased bleeding risk (OR 4.30; 95% CI, 3.69–5.02). Mortality, however, was not significantly reduced, underscoring the need for individualized treatment decisions and highlighting the lack of randomized controlled trial data in this setting [49].

Anticoagulation Recommendations in Current Guidelines

The latest 2024 European Society of Cardiology recommendations show minimal variation from the previous 2020 recommendations. They continue to support the use of oral anticoagulant therapy to prevent the risk of stroke after the occurrence of POAF in non-cardiac surgery and cardiac surgery (class of recommendation IIa, level of evidence B), taking into account the specifics of the patient [13], [14]. In this direction, the current American recommendations from 2023 recommend anticoagulant therapy in patients who develop POAF for a minimum of 60 days, unless complications occur (class of recommendation IIa, level of evidence B-NR) [15]. Other guidelines, such as the Canadian

Cardiovascular Society, recommend anticoagulation therapy for POAF lasting > 72 hours for 6 weeks (low quality evidence) [50]. There are also guidelines, such as those from the American Society of Thoracic Surgery, that recommend anticoagulation therapy based on risk factors, regardless of the duration of the arrhythmia. However, for stroke risk assessments, such as the CHA2DS2-VASc score, more studies are needed to validate the score in the post-surgical setting [51]. Although most guidelines support oral anticoagulation therapy if the risk of thromboembolic events (assessed by the CHA2DS2-VASc score) outweighs the risk of bleeding (evaluated by the HAS-BLED score), it is essential to note that these recommendations are based on low-quality evidence. The risk scores have not been validated in surgical patients. Due to the lack of solid evidence on the role of OAC in patients with POAF, researchers need to conduct future studies to answer several key questions: Should anticoagulant therapy be limited to high-risk patients with POAF, or should it be included in all patients with POAF? What is the long-term risk-benefit ratio for patients on OAC, and is it appropriate to discontinue OAC in these patients with POAF? For these reasons, the views on the use of anticoagulant therapy in POAF differ significantly among physicians.

Regarding the CHA2DS2-VASc score, most studies have focused on using the CHA2DS2-VASc score to predict POAF and show promising results in predicting POAF after cardiac surgery. It may help identify patients at increased risk for developing POAF [52], [53]. Several studies have shown that POAF does not influence the relationship between the CHA2DS2-VASc score and stroke occurrence. In contrast, others have shown that the CHA2DS2-VASc score can be used to predict the risk of stroke and major cardiovascular events, independently of the occurrence of POAF [54], [55], [56]. Therefore, the question remains: Is a stroke risk score such as CHA2DS2-VASc an adequate risk score for patients after cardiac surgery?

Conclusion

Postoperative atrial fibrillation (POAF) remains a prevalent and clinically significant complication following cardiac surgery, contributing to increased morbidity, prolonged hospitalization, higher healthcare costs, and adverse long-term outcomes such as stroke, heart failure, and mortality. Although often transient, POAF is not a benign arrhythmia and warrants careful consideration in both the acute and chronic postoperative period. Risk stratification based on clinical and procedural factors is essential for guiding targeted preventive strategies. Pharmacological and non-pharmacological interventions—especially beta-blockers, amiodarone, and posterior pericardiotomy—have shown efficacy in reducing the incidence of POAF. At the same time, rhythm and rate control remain valid treatment strategies in hemodynamically stable patients. The role of anticoagulation in POAF continues to be debated due to conflicting evidence on its benefits and risks, underscoring the need for individualized treatment based on thromboembolic and bleeding risk. Future research should focus on refining predictive tools such as the CHA_2DS_2-VASc score in the postoperative setting and establishing high-quality randomized trials to guide anticoagulation decisions in this unique patient population.

Future Directions for Clinical Research

Future studies should prioritize large-scale, randomized controlled trials to determine the optimal duration and patient selection for anticoagulation in POAF, and to validate risk stratification tools such as the CHA_2DS_2-VASc score in the postoperative cardiac surgery population. Additionally, further investigation into the pathophysiological mechanisms of POAF may help develop targeted prevention and treatment strategies.

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