ERAS Cardiac Society turnkey order set for prevention and management of postoperative atrial fibrillation after cardiac surgery: Proceedings from the AATS ERAS Conclave 2023

Subhasis Chatterjee, MD, Busra Cangut, MD, Amanda Rea, DNP, CRNP, AGACNP-BC, CCRN, CMC, CSC, E-AEC, Rawn Salenger, MD, Rakesh C. Arora, MD, Michael C. Grant, MD, Vicki Morton-Bailey, DNP, MSN, AGNP-BC, Sameer Hirji, MD, MPH, Daniel T. Engelman, MD, on behalf of the ERAS Cardiac Working Group

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*ERAS Cardiac Working Group: Alexander J. Gregory, MD, Kevin W. Lobdell, MD, Dawn Hui, MD, John Puskas, MD, Mario Gaudino, MD, PhD, Cheryl Crisafi, MSN, RN, CNL, V Seenu Reddy, MD, MBA

Affiliations:

1. Department of Surgery, Baylor College of Medicine, Houston, TX & Texas Heart Institute. Houston, TX

2. Icahn School of Medicine at Mount Sinai, New York, NY

3. Division of Cardiac Surgery University of Maryland St. Joseph Medical Center, Towson, MD

4. Department of Surgery, Division of Cardiac Surgery, Harrington Heart and Vascular, Institute, University Hospitals, Case Western Reserve University, Cleveland, OH

5. Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University School of Medicine. Baltimore MD

6. Providence Anesthesiology Associates, Charlotte NC

7. Division of Cardiac Surgery, Brigham and Women’s Hospital, Harvard Medical School, Boston, MA
8. Heart & Vascular Program Baystate Health, University of Massachusetts Chan Medical, School-Baystate, Springfield, MA
9. Department of Anesthesiology, Cumming School of Medicine & Libin Cardiovascular Institute, University of Calgary, Calgary, Alberta, CAN.
10. Sanger Heart & Vascular Institute, Charlotte, NC
11. University of Texas Health Science Center San Antonio, TX
13. Department of Cardiothoracic Surgery, Weill Cornell School of Medicine, New York NY.
14. TriStar Centennial Medical Center, Nashville, TN

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Abstract:

Objectives: Postoperative atrial fibrillation (POAF) is a prevalent complication following cardiac surgery and is associated with increased adverse events. Several guidelines and expert consensus documents have been published addressing the prevention and management of POAF. Our objective is to develop an order set to facilitate widespread implementation and adoption of evidence-based practices for POAF following cardiac surgery.

Methods: Subject matter experts were consulted to translate existing guidelines and literature into a sample turnkey order set (TKO) for POAF. Orders derived from consistent Class I, IIA, or equivalent recommendations across referenced guidelines and consensus manuscripts appear in the TKO in bold type. Selected orders that were inconsistently Class I or IIA, Class IIB, or supported by published evidence, were also included in italicized type.

Results: Preoperatively, it is recommended to screen patients for paroxysmal or chronic atrial fibrillation and initiate appropriate treatment based on individual risk stratification for the development of POAF. This may include the administration of beta-blockers or amiodarone, tailored to the patient’s specific risk profile. Intraoperatively, surgical interventions such as posterior pericardiotomy should be considered in select patients. Postoperatively, it is crucial to focus on electrolyte normalization, implementation strategies for rate or rhythm control, and anticoagulation management. These comprehensive measures aim to optimize patient outcomes and reduce the occurrence of POAF following cardiac surgery.

Conclusion: Despite the well-established benefits of implementing a multidisciplinary care pathway for POAF in cardiac surgery, its adoption and implementation remain inconsistent. We have developed a readily applicable order set that incorporates recommendations from existing guidelines.
Glossary of Abbreviations:

ERAS – Enhancing recovery after surgery

POAF- Postoperative atrial fibrillation

TKO - “turnkey” order set

CABG-coronary artery bypass grafting

OAC-oral anticoagulation

LAA-left atrial appendage

AF-Atrial Fibrillation

NOAC-novel oral anticoagulant
Central Message:
A standardized order set incorporating various guideline recommendations may lead to meaningful implementation of comprehensive postoperative atrial fibrillation prophylaxis and management.

Perspective Statement:
Multiple societies have published evidence-based expert consensus documents and guidelines for the prevention and management of postoperative atrial fibrillation (POAF) following cardiac surgery. Standardized adoption and implementation can be challenging. This “turnkey” order set was created by the Enhanced Recovery After Surgery (ERAS®) Cardiac Society to aid clinicians in POAF best practices.

Central Picture:
Key aspects of postoperative atrial fibrillation management across perioperative phases of care.
Introduction:

Postoperative atrial fibrillation (POAF) occurs in 20-40% of patients after cardiac surgery; the incidence is highest in combined coronary artery bypass grafting (CABG) and valve procedures, followed by isolated valve surgery, and lowest after isolated CABG. POAF has been associated with an increased risk of adverse outcomes, length of stay, and reduced late survival. Strategies to reduce the incidence of POAF may include pharmacologic management and surgical interventions. In general, current scoring systems are not accurate for the prediction of POAF after cardiac surgery; as a result, a general approach to POAF is needed for patients, rather than a targeted approach to selectively identify patients at higher risk of developing POAF. While multiple societal-based preoperative, intraoperative, and postoperative evidence-based recommendations have been published, widespread utilization and standardization of these practices is lagging. This may be in part due to a lack of awareness of “evidence-based” best practices, skepticism towards the underlying evidence supporting these practices, conflicting research findings, variations in guideline recommendations and interpretations, and paucity of granular mechanisms to facilitate bedside implementation. A systematic integration of current literature is timely and essential to develop practical, easy-to-use turnkey order sets that may be readily implemented into daily practice within the framework of cardiac enhanced recovery after surgery (ERAS).

Our primary objective was to perform a systematic analysis of published guidelines to develop a meaningful and practical order set for the prevention and management of POAF following cardiac surgery. This order set, presented at the American Association of Thoracic Surgeons (AATS) ERAS Conclave in May 2023, is part of a series created by the ERAS Cardiac Society. 

Methods:

Key subject matter experts in atrial fibrillation and cardiovascular perioperative care were consulted to review and translate existing guidelines and peer-reviewed literature into a sample turnkey order set (TKO) for the prevention and management of POAF. Table 1 provides an overview of existing Class I and IIA (or equivalent) recommendations from relevant guidelines and consensus statements. Table 2 translates the recommendations into a TKO. Orders derived from consistent Class I, IIA, or equivalent recommendations across referenced guidelines and consensus manuscripts appear in
the TKO in **bold** type. Selected orders that were inconsistently Class I or IIA, Class IIB, in these manuscripts or supported
by evidence published in other peer-reviewed journals, were also included in *italicized* type. Notably, the intent was not to
recapitulate the evidence base justifying the recommendations, since this has been done thoroughly by the guidelines and
consensus statement writing committees, which are referenced. Decisions regarding order inclusion were made based on
estimated benefit, risk, cost, implementation complexity, and generalizability. Each of these orders should be considered
based on local institutional priorities, resources, practices, and expertise.

**Comparisons across existing guidelines (Table 1)**

Given the variability in the prevention and management of POAF strategies and recommendations across different
professional societies, we a-priori elected to focus on Class I and Class IIA guidelines from the following: 1) American
Heart Association (AHA), American College of Cardiology (ACC), Heart Rhythm Society (HRS), 2) European Society of
Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS), 3) Society of Cardiovascular
Anesthesiology (SCA) and European Association of Cardiothoracic Anesthesiology (EACTA); (4) the Canadian
Cardiovascular Society (CCVC)/Canadian Heart Rhythm Society (CHRS).\(^{11-14,15}\) The various guidelines were comprised
of various selected expert panels of diverse members who represented different geographic regions, sexes, races,
ethnicities, and clinical practice settings. Specific methodological details can be found within those individual references.

Since the May 2023 ERAS Conclave at the AATS, an updated set of ACC/AHA/HRS atrial fibrillation guidelines were
published in November of 2023 which has been incorporated into these recommendations.\(^{15}\)

**Preoperative:**

After collecting the individual guidelines, several preoperative strategies consistently received strong recommendations.
Screening questions regarding any history of potential symptoms (palpitations, syncope, amongst others) of atrial
fibrillation are recommended to determine the potential of undiagnosed atrial fibrillation, and therefore, the potential
benefit of concomitant surgical ablation. Strategies to manage patients with preexisting atrial fibrillation undergoing
cardiac surgery will be discussed in a future TKO. Preoperative beta blockers are advised to be continued, including on
the morning of surgery. They are recommended particularly for patients undergoing coronary artery bypass grafting (CABG), even if they are not part of the patient’s regular medication regimen prior to surgery. Amiodarone may be utilized preoperatively to prevent POAF, particularly in patients at high-risk of POAF. This includes advanced age, valve surgery, or higher CHA2DS2-VASc score. Other patients would include those with a previous episode of atrial fibrillation or a large left atrium on echocardiography. In the Prophylactic Amiodarone for the Prevention of Arrhythmias that Begin Early After Revascularization, Valve Replacement, or Repair (PAPABEAR) trial, six days of preoperative amiodarone demonstrated a significant reduction in POAF from 30% to 16% (HR=0.52, 0.34-0.69, p<0.001). Patients with bradycardia (HR<60) should avoid routine beta blockers or amiodarone.

Intraoperative:

For patients with no history of atrial fibrillation, posterior pericardiotomy has been demonstrated to significantly reduce pericardial effusion and subsequent POAF (odds ratio 0.45, 95% confidence interval 0.32-0.64, P < 0.0001) without added morbidity risk. Posterior pericardiotomy has been issued a Class IIA (B-NR) recommendation in the most recent 2023 ACC/AHA guidelines for the prevention of POAF after cardiac surgery. Concomitant prophylactic surgical LAA closure at the time of cardiac surgery has not been shown to reduce the risk of stroke or incidence of POAF in patients without atrial fibrillation.

Postoperative:

The two primary pharmacologic strategies utilized to prevent POAF include beta blockers and amiodarone. Typically, beta blockers are started on the first postoperative day, based on an individual’s hemodynamic profile. Amiodarone may be utilized with beta blockers or as an alternative if beta blockers cannot be tolerated (ongoing need for vasoactive medications). Patients with bradycardia (HR<60) should avoid routine beta blockers or amiodarone. Amiodarone can be administered in either intravenous or oral formulation with comparable efficacy. The treatment of POAF follows a rate or rhythm control strategy with no significant difference in clinical outcomes between the two approaches. A CTSNet trial demonstrated that both strategies resulted in comparable
hospitalization durations, complications rates, and low rates of persistent AF at 60 days, indicating no demonstrated clinical advantage of one treatment approach over the other. Additional drugs commonly utilized include calcium channel blockers or less often digoxin. The role of anticoagulation is still evolving. While guidelines recommend initiation of anticoagulation for POAF, the optimal duration of paroxysmal atrial fibrillation which triggers initiation of this therapy is a subject of controversy. In addition, the use of NOACs versus warfarin is an area of controversy.

**Putting the Guidelines Together: A Turnkey Order Set**

This turnkey order set (Table 2) provides an evidence-based framework to assist bedside providers in the prevention and management of POAF. The order set may be adopted or modified according to local clinical needs and constraints. This order set is meant to facilitate programmatic implementation of evidence-based best practices to achieve effective prevention and timely management of POAF.

**Future Studies**

Current strategies to prevent POAF have limitations. There are several areas in need of further investigation, including examination of the appropriate timing, duration, and necessity for anticoagulation in POAF. The ongoing Anticoagulation for New-Onset Post-Operative Atrial Fibrillation After CABG (PACES Trial. ClinicalTrials.gov ID: NCT04045665) should complete enrollment by December 2024 and may offer important insights into the effectiveness and safety of adding anticoagulation to background antiplatelet therapy in patients who develop new-onset POAF after isolated CABG surgery aiming to balance the prevention of thromboembolic events with the risk of bleeding. A confirmatory multicenter trial to test the effect of left posterior pericardiotomy is in preparation. The current guidelines place insufficient emphasis on identification of patients that would most benefit from POAF prevention and anticoagulation. Identifying these patient populations may help tailor treatment plans, ultimately improving patient outcomes.

**Conclusion**
Existing guidelines are an important and valuable addition in our concerted efforts towards POAF prevention and management. Treatment of POAF remains variable. Utilizing these recommendations, we have developed an easily implemented TKO to facilitate the optimal management and prevention of POAF following cardiac surgery.
References:


Table 1: Comparison of Class I/IIA or equivalent recommendations for cardiac surgery - Postoperative Atrial Fibrillation Consensus and Guideline Publications.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Preoperative beta blocker</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Preoperative amiodarone to prevent POAF</td>
<td>✗</td>
<td>✗</td>
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</tr>
<tr>
<td>Beta blocker to prevent POAF</td>
<td>✗</td>
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<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Perioperative amiodarone to prevent POAF</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Nondihydropyridine calcium channel blocker when a beta blocker is unable to achieve rate control</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Amiodarone (antiarrhythmics) to treat POAF</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Antithrombotic medication for POAF to reduce thromboembolism</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Ibutilide/elective direct-current cardioversion</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Direct-current cardioversion for hemodynamic instability</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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Abbreviations: POAF - postoperative atrial fibrillation,
Table 2: POAF Turnkey Order Set

<table>
<thead>
<tr>
<th>Preoperative</th>
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<tbody>
<tr>
<td>● Screen for preoperative paroxysmal/persistent/permanent atrial fibrillation (Questions/Exam: any history of atrial fibrillation or palpitations, pulse check, ECG, etc.)</td>
</tr>
<tr>
<td>● If currently on beta-blocker, then continue the current regimen. Last dose given morning of surgery</td>
</tr>
<tr>
<td>● If beta-blocker naïve, administer metoprolol 12.5-25 mg PO x 1 preoperatively the morning of surgery (hold for HR&lt;60bpm, SBP&lt;100mHg)</td>
</tr>
<tr>
<td>● Patients at high risk of developing POAF (Age&gt; 65, Valve surgery, higher CHA2DS2-VASc score, etc.) consider amiodarone 10mg/kg PO (400mg to 800mg) daily for 6 days before and after surgery</td>
</tr>
</tbody>
</table>

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<tr>
<th>Intraoperative</th>
</tr>
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<tbody>
<tr>
<td>● Consider posterior pericardiotomy at the time of surgery</td>
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<tr>
<th>Postoperative (first 24-48 hours)</th>
</tr>
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<tbody>
<tr>
<td>● Prophylaxis:</td>
</tr>
<tr>
<td>o Diligent electrolyte normalization (K+ ≥4, Mg²⁺ ≥2)</td>
</tr>
<tr>
<td>o Administer metoprolol 12.5-25 mg PO BID starting on POD 1 (hold for HR &lt;60, SBP &lt;100) for patients not on vasoactive medications</td>
</tr>
<tr>
<td>o Or amiodarone 400 mg PO TID for 5 days, then amiodarone 200 mg PO BID for 5 days, then 200 mg PO daily. Hold if bradycardic (HR &lt;60, hold for QTc &gt;450)</td>
</tr>
<tr>
<td>o Or amiodarone 150 mg IV loading dose followed by 1 mg/min for 6 hours, then 0.5 mg/min for 18 hours. Transition to maintenance dosage.</td>
</tr>
<tr>
<td>o Amiodarone should be considered in patients unable to tolerate beta blockers; review for interactions with other medications.</td>
</tr>
<tr>
<td>● Atrial Fibrillation Rate Control Options:</td>
</tr>
<tr>
<td>o Metoprolol 5 mg IV every 3-5 minutes (total 15 mg) and/or titrate PO beta blockade</td>
</tr>
<tr>
<td>o Diltiazem 0.25 mg/kg IV bolus x1, followed by diltiazem infusion 10 mg/hr titrate to HR &lt;100, hold for HR &lt;60 or SBP &lt;100</td>
</tr>
<tr>
<td>o Digoxin 500 mcg IV x1, followed by 250 mcg IV every 8 hours x2 doses</td>
</tr>
<tr>
<td>● Atrial Fibrillation Rhythm Control Options:</td>
</tr>
<tr>
<td>o Administer IV amiodarone 150 mg IV loading dose followed by 1 mg/min for 6 hours, then 0.5 mg/min for 18 hours. Transition to amiodarone 200 mg PO BID x5 day, then 200 mg PO daily. Hold if bradycardic (HR &lt;60). Total amiodarone load of 10 g</td>
</tr>
<tr>
<td>o Direct current cardioversion (for hemodynamic instability or elective cardioversion as needed)</td>
</tr>
<tr>
<td>● Anticoagulation Options:</td>
</tr>
<tr>
<td>o Warfarin or DOAC should be used if atrial fibrillation is the predominant rhythm (or after weighing benefit of thromboembolism prevention vs risk of postoperative bleeding)</td>
</tr>
<tr>
<td>o Unfractionated heparin infusion with titration to goal aPTT (2-3x normal)</td>
</tr>
<tr>
<td>o If on dual antiplatelet therapy, strongly consider holding one medication if triple therapy bleeding risk exceeds benefit</td>
</tr>
<tr>
<td>● Apixaban 5 mg BID for non-valvular atrial fibrillation patients (or alternative DOAC)</td>
</tr>
<tr>
<td>o If patient meets 2 of the 3 criteria below, the dose may need to be reduced to 2.5 mg</td>
</tr>
<tr>
<td>o Age ≥80, weight ≤60 kg, Creatinine ≥1.5 g/dL</td>
</tr>
<tr>
<td>● Warfarin (consider the interaction with amiodarone)</td>
</tr>
<tr>
<td>o Consider heparin drip to bridge in appropriate patients</td>
</tr>
<tr>
<td>o Goal INR 2-3</td>
</tr>
<tr>
<td>● Outpatient cardiology follow-up recommended within 4-6 weeks</td>
</tr>
</tbody>
</table>

Abbreviations: DAPT - dual antiplatelet therapy, DOAC – direct oral anticoagulant; INR - international normalized ratio POAF- postoperative atrial fibrillation, Legend: Orders in Bold are Class I or IIA or equivalent in multiple sets of recommendations. Orders in italics were inconsistently Class I or IIA, Class IIB, or supported by evidence published in peer-reviewed journals.
ERAS® Cardiac Society
Turnkey Order Set for Postoperative Atrial Fibrillation

**Preoperative**
Screen for Signs of Atrial Fibrillation

**Intraoperative**
Posterior Pericardiotomy

**Postoperative**
Postoperative Beta Blocker or Amiodarone for Prophylaxis

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