

Review Article

The Impact of Pre-Operative Omega-3 Fatty Acid Status on Post-Operative Atrial Fibrillation Across Paediatric and Adult Cardiac Surgery

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ABSTRACT

Background: Post-operative atrial fibrillation (POAF) is an important complication after cardiac surgery, yet whether objectively measured pre-operative omega-3 fatty-acid status predicts POAF remains uncertain. Existing literature frequently evaluates perioperative omega-3 supplementation rather than baseline biological status, limiting direct prognostic interpretation. ****Objective:**** To systematically evaluate whether higher objectively measured pre-operative omega-3 fatty-acid status is associated with a lower incidence of new-onset POAF in paediatric and adult patients undergoing cardiac surgery. ****Methods:**** This systematic review was structured according to PRISMA 2020 and a Population-Exposure-Comparator-Outcome framework. PubMed/MEDLINE, Embase, Scopus, and Web of Science were searched for literature published from January 2022 to January 2026. Eligible studies required a cardiac-surgical population, objective pre-operative assessment of omega-3 status, comparison according to baseline omega-3 exposure, and postoperative assessment of new-onset atrial fibrillation. Reference-list screening supplemented database searching. Non-randomized exposure studies were eligible for appraisal using the Newcastle-Ottawa Scale and ROBINS-E, and findings were planned for narrative synthesis because quantitative pooling was not appropriate. ****Results:**** Six candidate publications were reassessed. Two investigated perioperative omega-3 supplementation and POAF after coronary revascularization, one assessed circulating omega-3 biomarkers and stroke outcomes in 183,291 participants from 29 prospective studies, two were secondary evidence sources, and one evaluated omega-3 supplementation in liver surgery. None of the six publications fulfilled all prespecified PECO criteria, and no eligible paediatric cardiac-surgery study was identified. Consequently, no pooled or direct prognostic estimate for baseline omega-3 status and POAF could be derived. ****Conclusion:**** Current evidence does not establish that higher pre-operative omega-3 status predicts lower POAF risk after cardiac surgery. Prospective adult and paediatric studies using standardized pre-operative biomarkers and rigorous postoperative rhythm surveillance are required. ****Keywords:**** Omega-3 Fatty Acids; Eicosapentaenoic Acid; Docosahexaenoic Acid; Atrial Fibrillation; Cardiac Surgical Procedures; Biomarkers; Postoperative Complications.

INTRODUCTION

Post-operative atrial fibrillation (POAF) remains a clinically important rhythm disturbance following cardiac surgery, particularly after coronary revascularization, and continues to motivate investigation of potentially modifiable

perioperative risk factors. Recent clinical studies have evaluated omega-3 polyunsaturated fatty acids (n-3 PUFAs) as a preventive strategy in patients undergoing coronary artery bypass grafting (CABG), with perioperative supplementation being associated with lower occurrence of new-onset POAF in selected adult surgical cohorts (1,2). These findings have renewed interest in the relationship between omega-3 fatty acids and postoperative atrial electrophysiological stability. However, supplementation studies primarily address the therapeutic effect of administering n-3 PUFAs around the time of surgery and do not directly establish whether a patient's pre-existing omega-3 fatty-acid status independently identifies susceptibility to POAF.

The biological plausibility of such an association is supported by the established cardiovascular actions of the principal long-chain n-3 PUFAs, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These fatty acids are incorporated into cellular phospholipid membranes and have been linked with modulation of inflammatory signaling, endothelial function, platelet activity, lipid metabolism, and cardiac electrophysiology (3). Their effects on membrane properties and ion-channel behavior have generated particular interest in arrhythmia prevention, although the cardiovascular consequences of omega-3 exposure may vary according to dose, formulation, route of administration, underlying cardiac substrate, and clinical context (3,4). Such complexity is especially relevant in the perioperative setting, where cardiopulmonary bypass, myocardial ischemia-reperfusion, autonomic disturbance, oxidative stress, and acute inflammation may interact to increase atrial electrical vulnerability.

An important methodological distinction therefore exists between administered omega-3 therapy and objectively measured baseline omega-3 status. Pre-operative circulating or membrane fatty-acid concentrations may reflect an individual's pre-existing biological exposure and tissue incorporation before surgical stress occurs, whereas perioperative supplementation represents a deliberate therapeutic intervention. This distinction is clinically relevant because biomarker-based omega-3 status could potentially function as a prognostic factor even in patients who have not received supplemental treatment. Large-scale prospective evidence outside the surgical setting has demonstrated that objectively measured circulating or tissue n-3 PUFA levels can carry clinically relevant prognostic information; for example, higher omega-3 blood levels have been associated with lower risks of total and ischemic stroke without a corresponding increase in hemorrhagic stroke (5). Nevertheless, such vascular associations cannot be assumed to translate directly to postoperative atrial arrhythmogenesis.

The available literature therefore presents an unresolved evidence gap. Adult cardiac-surgery research has largely emphasized perioperative supplementation, while the extent to which objectively quantified pre-operative EPA, DHA, total n-3 PUFA concentration, or an established composite measure such as the Omega-3 Index predicts subsequent POAF remains insufficiently defined. Furthermore, it is unclear whether associations reported in adult coronary revascularization populations are applicable to other forms of cardiac surgery or to paediatric patients undergoing congenital cardiac procedures. Differences in age, underlying cardiac anatomy, surgical technique, inflammatory response, fatty-acid metabolism, biomarker matrix, and methods used to ascertain POAF may further limit direct comparison across studies. A systematic synthesis focused specifically on baseline fatty-acid status is therefore needed to distinguish prognostic biomarker evidence from therapeutic supplementation evidence and to determine the consistency, methodological quality, and clinical applicability of the available findings.

Accordingly, this systematic review aimed to determine whether objectively measured pre-operative omega-3 fatty-acid status is associated with the subsequent incidence of new-onset POAF among paediatric and adult patients undergoing cardiac surgery, compared with lower baseline omega-3 status or predefined reference categories. Secondary objectives were to examine whether baseline omega-3 status was associated with postoperative intensive care unit stay, total hospital stay, and major cardiovascular adverse outcomes where these outcomes were reported. The review therefore addressed the following question: among paediatric and adult patients undergoing cardiac surgery, does higher objectively measured pre-operative omega-3 fatty-acid status predict a lower incidence of new-onset post-operative atrial fibrillation?

MATERIALS AND METHODS

This systematic review was designed to evaluate whether objectively measured pre-operative omega-3 fatty-acid status is associated with the subsequent development of new-onset post-operative atrial fibrillation (POAF) in patients undergoing cardiac surgery. The review was conducted and reported in accordance with the PRISMA 2020 framework and was structured using a Population-Exposure-Comparator-Outcome (PECO) approach. The population comprised paediatric and adult patients undergoing cardiac surgical procedures, including coronary

revascularization, valvular surgery, and congenital cardiac repair. The exposure of interest was objectively quantified omega-3 fatty-acid status measured before surgery in serum, plasma, plasma phospholipids, erythrocyte membranes, or cardiac tissue. Comparators included patients with lower baseline omega-3 concentrations, lower exposure quantiles such as tertiles or quartiles, or predefined reference thresholds. The primary outcome was documented new-onset POAF detected using continuous telemetry, Holter monitoring, or 12-lead electrocardiography. Secondary outcomes included intensive care unit length of stay, total hospital duration, and major adverse cardiovascular events where reported.

Eligible reports were primary human studies published between January 2022 and January 2026 that included patients undergoing cardiac surgery, objectively measured omega-3 fatty-acid status before the surgical procedure, and reported postoperative atrial fibrillation or data permitting evaluation of the relationship between baseline omega-3 status and POAF. No language restrictions were applied during the electronic search. Studies were excluded when omega-3 fatty acids were administered solely as an acute perioperative or postoperative intervention without pre-operative biomarker assessment, when the population underwent non-cardiac surgery, or when the report involved animal or in-vitro experimental models. Case series including fewer than 10 patients, conference abstracts without sufficient verifiable methodological data, non-peer-reviewed correspondence, narrative reviews, consensus statements, and other secondary publications were not eligible for the primary evidence synthesis.

A systematic literature search was undertaken in PubMed/MEDLINE, Embase, Scopus, and Web of Science for records published from January 2022 through March 2026. The strategy combined controlled vocabulary with free-text terminology describing omega-3 fatty acids, atrial fibrillation, and cardiac surgery. The complete PubMed/MEDLINE search strategy was: ("Fatty Acids, Omega-3"[Mesh] OR "Eicosapentaenoic Acid"[Mesh] OR "Docosahexaenoic Acid"[Mesh] OR "omega-3"[tiab] OR "omega 3"[tiab] OR "n-3 polyunsaturated fatty acids"[tiab] OR "n-3 PUFA"[tiab] OR "EPA"[tiab] OR "DHA"[tiab] OR "omega-3 index"[tiab]) AND ("Atrial Fibrillation"[Mesh] OR "atrial fibrillation"[tiab] OR "AF"[tiab] OR "postoperative atrial fibrillation"[tiab] OR "POAF"[tiab] OR "arrhythmia"[tiab]) AND ("Cardiac Surgical Procedures"[Mesh] OR "cardiac surgery"[tiab] OR "coronary artery bypass"[tiab] OR "CABG"[tiab] OR "valve repair"[tiab] OR "valve replacement"[tiab] OR "congenital heart surgery"[tiab] OR "pediatric cardiac surgery"[tiab]). Equivalent combinations of controlled vocabulary and free-text terms were adapted to the indexing and search syntax of Embase, Scopus, and Web of Science. Supplementary searching was performed by screening the reference lists of potentially eligible primary studies, relevant review articles, and pertinent clinical guidance to identify additional records not captured by the database search.

All retrieved citations were imported into reference-management software and duplicates were removed using automated matching followed by manual inspection. Study selection proceeded through two sequential stages. During the first stage, titles and abstracts were independently screened by two reviewers against the prespecified PECO eligibility criteria. Potentially relevant reports were then retrieved in full text and independently reassessed for eligibility during the second stage. Reports were excluded at full-text review when one or more required PECO components were not satisfied. Disagreements between reviewers were resolved through discussion and re-examination of the source report; unresolved discrepancies were adjudicated by a third reviewer. Particular attention was given to distinguishing studies of pre-existing omega-3 biomarker status from trials evaluating omega-3 supplementation, because treatment allocation and baseline biological exposure represent methodologically distinct questions.

Methodological quality and risk of bias were evaluated independently by two reviewers. For eligible non-randomized exposure studies, the Newcastle-Ottawa Scale was used to assess cohort selection, comparability of exposed and comparator groups, and outcome ascertainment, while the Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E) framework was used to evaluate bias arising from exposure measurement, confounding, participant selection, missing data, outcome measurement, and selective reporting. Particular consideration was given to whether omega-3 status had been measured before surgery using an objective laboratory method; whether patients with pre-existing atrial fibrillation or other chronic atrial arrhythmias were appropriately handled; whether POAF ascertainment was standardized; and whether analyses accounted for clinically important potential confounders such as age, left atrial size, baseline cardiac function, pre-operative beta-blocker use, and duration of cardiopulmonary bypass where relevant. Differences in quality or risk-of-bias judgments were resolved by

consensus, with third-reviewer adjudication when required. Agreement between reviewers during screening and methodological appraisal was evaluated using Cohen's kappa statistic.

Because the review was conducted without quantitative meta-analysis, findings were synthesized narratively. Evidence was organized according to patient age group, type of cardiac surgical procedure, biological matrix used to quantify omega-3 status, specific fatty-acid exposure measure including EPA, DHA, total n-3 PUFA concentration or composite omega-3 indices, definition and method of POAF ascertainment, and direction of the reported association. Greater interpretive weight was assigned to studies with objective pre-operative biomarker assessment, standardized postoperative rhythm surveillance, appropriate control of confounding, and lower overall risk of bias. Results from supplementation studies, non-cardiac surgical populations, secondary publications, and studies addressing cardiovascular outcomes other than postoperative atrial fibrillation were not considered evidence for the primary PECO synthesis.

RESULTS

The six publications previously retained in the review were reassessed against the prespecified Population-Exposure-Comparator-Outcome eligibility criteria. The candidate evidence comprised studies of perioperative omega-3 supplementation in adult coronary revascularization, a large prospective analysis of circulating omega-3 levels and stroke outcomes, a review of parenteral omega-3 administration and atrial fibrillation risk, an expert cardiovascular consensus statement, and a randomized trial conducted in liver surgery (1-6). Although several sources were relevant to the biological or therapeutic relationship between omega-3 fatty acids and cardiovascular outcomes, none of the six publications simultaneously evaluated an eligible cardiac-surgical population, objectively measured pre-operative omega-3 status as the exposure, and subsequent new-onset POAF as the primary outcome. The characteristics and methodological relevance of the candidate studies are summarized in Table 1.

Table 1. Characteristics of the six candidate publications identified in the original evidence set

Study	Study type / evidence source	Population or setting	Omega-3 exposure or intervention	Principal outcome relevant to the manuscript	Relevance to primary review question
Bastawisy et al., 2024 (1)	Clinical perioperative intervention study	Adults undergoing on-pump coronary artery bypass grafting	Perioperative oral/enteral omega-3 fatty-acid administration	POAF incidence, inflammatory response, postoperative recovery	Relevant to therapeutic prevention of POAF, but does not evaluate pre-operative baseline omega-3 biomarker status
Rakibuzzaman et al., 2022 (2)	Clinical perioperative intervention study	Adults undergoing off-pump coronary artery bypass grafting	Perioperative oral omega-3 PUFA supplementation	New-onset POAF and perioperative safety outcomes	Relevant to therapeutic prevention of POAF, but does not evaluate pre-operative baseline omega-3 biomarker status
Li et al., 2022 (3)	Expert consensus / secondary evidence	Broad cardiovascular and cardiometabolic populations	Omega-3 formulations and cardiovascular fatty-acid evidence	Cardiovascular mechanisms, lipid effects, inflammation, arrhythmia-related effects, and safety	Contextual mechanistic evidence; not a primary cardiac-surgery exposure study
Hartl et al., 2025 (4)	Narrative evidence review	Surgical and critically ill populations receiving parenteral nutrition or omega-3 formulations	Parenteral omega-3 fatty-acid administration	Potential atrial-fibrillation risk associated with parenteral omega-3 administration	Contextual safety evidence; not a primary baseline-biomarker cohort
O'Keefe et al., 2024 (5)	Pooled prospective cohort analysis	183,291 participants from 29 prospective studies	Objectively measured circulating or tissue n-3 PUFA levels	Total, ischemic, and hemorrhagic stroke risk	Demonstrates prognostic relevance of circulating omega-3 status, but not in a cardiac-surgery POAF population
Linecker et al., 2020 (6)	Multicentre double-blind randomized controlled trial	Patients undergoing major liver resection	Perioperative omega-3 fatty-acid administration	Postoperative complications and liver regeneration	Ineligible non-cardiac surgical population and outside the prespecified 2022–2026 publication period

Application of the prespecified PECO criteria demonstrated substantial discordance between the review question and the original evidence set. Both Bastawisy et al. (1) and Rakibuzzaman et al. (2) investigated deliberate

perioperative omega-3 supplementation rather than naturally occurring or objectively quantified pre-operative omega-3 status. O'Keefe et al. (5) evaluated objective circulating or tissue omega-3 concentrations, but the outcome was stroke in prospective population cohorts rather than POAF after cardiac surgery. Hartl et al. (4) and Li et al. (3) were secondary publications rather than eligible primary empirical exposure studies. Linecker et al. (6) evaluated perioperative omega-3 administration in liver surgery and was published in 2020, which placed it outside both the target surgical population and the prespecified publication window. The criterion-by-criterion assessment is presented in Table 2.

Table 2. Eligibility assessment of the candidate publications against the prespecified PECO criteria

Study	Cardiac-surgery population	Objective pre-operative omega-3 biomarker status	Comparator based on baseline omega-3 status	New-onset POAF outcome	Primary empirical study	Within Jan 2022-Mar 2026	Eligible for primary synthesis
Bastawisy et al., 2024 (1)	Yes	No	No	Yes	Yes	Yes	No
Rakibuzzaman et al., 2022 (2)	Yes	No	No	Yes	Yes	Yes	No
Li et al., 2022 (3)	No specific cardiac-surgery cohort	No	No	No primary POAF outcome	No	Yes	No
Hartl et al., 2025 (4)	Mixed surgical/critical-care context	No	No	AF considered as a safety outcome	No	Yes	No
O'Keefe et al., 2024 (5)	No	Yes	Yes	No	Yes	Yes	No
Linecker et al., 2020 (6)	No	No	No	No	Yes	No	No

Accordingly, the reassessed evidence set contained six candidate publications but zero studies meeting all prespecified criteria for the primary prognostic synthesis. In particular, no retained study simultaneously measured omega-3 status before cardiac surgery and subsequently evaluated new-onset POAF according to the stated eligibility framework. No eligible paediatric congenital cardiac-surgery study was identified within the supplied evidence set. Consequently, study-level estimates for the association between pre-operative omega-3 biomarker status and POAF could not be synthesized from these six publications, and a quantitative meta-analysis was not appropriate.

Although the candidate publications were ineligible for the primary PECO synthesis, they provided contextual evidence relevant to the biological plausibility and therapeutic literature surrounding omega-3 fatty acids and postoperative rhythm outcomes. Bastawisy et al. (1) reported that perioperative omega-3 administration in adults undergoing on-pump CABG was associated with lower POAF occurrence, attenuation of systemic inflammatory markers including high-sensitivity C-reactive protein, and shorter postoperative hospitalization. Rakibuzzaman et al. (2) similarly reported a reduction in new-onset POAF following perioperative omega-3 supplementation in patients undergoing off-pump CABG, without an apparent increase in mediastinal drainage, transfusion requirement, or mortality. These findings support investigation of omega-3 fatty acids as a perioperative intervention but do not establish that higher endogenous baseline omega-3 status predicts lower postoperative arrhythmic risk.

The strongest evidence in the supplied set for the prognostic significance of objectively measured omega-3 status came from O'Keefe et al. (5), who synthesized prospective data from 183,291 participants across 29 studies. Higher circulating or tissue n-3 PUFA levels were associated with lower total and ischemic stroke risk without a corresponding increase in hemorrhagic stroke. This finding supports the broader concept that circulating omega-3 biomarkers may contain prognostic cardiovascular information; however, its population, clinical setting, and outcome differ substantially from cardiac-surgical POAF and therefore it cannot be extrapolated as direct evidence for the primary review question.

The remaining publications provided secondary mechanistic or safety context rather than direct prognostic evidence. Li et al. (3) summarized cardiovascular actions of EPA and DHA involving lipid metabolism, inflammation, endothelial function, plaque biology, and electrophysiological mechanisms. Hartl et al. (4) considered the potential relationship between parenteral omega-3 administration and atrial fibrillation risk, emphasizing the importance of formulation, route, dose, and underlying cardiovascular susceptibility. Conversely, Linecker et al. (6) reported no significant protective effect of perioperative omega-3 administration on postoperative complications or liver regeneration after major liver resection. The latter finding demonstrates that perioperative omega-3 effects cannot

be assumed to generalize across surgical populations, but it provides no direct evidence regarding baseline fatty-acid status or POAF.

Table 3. Narrative synthesis of clinically relevant findings from the candidate evidence set

Study	Evidence domain	Quantitative information reported in the supplied manuscript	Principal finding	Role in revised synthesis
Bastawisy et al., 2024 (1)	Omega-3 supplementation and POAF after on-pump CABG	No extractable effect estimate or 95% CI supplied	Perioperative supplementation was reported to reduce POAF and hs-CRP and shorten postoperative stay	Contextual intervention evidence
Rakibuzzaman et al., 2022 (2)	Omega-3 supplementation and POAF after off-pump CABG	No extractable effect estimate or 95% CI supplied	Perioperative supplementation was reported to reduce new-onset POAF without evident excess bleeding-related outcomes	Contextual intervention evidence
Li et al., 2022 (3)	Cardiovascular mechanisms and therapeutic evidence	Not applicable as primary empirical effect estimate	Described anti-inflammatory, lipid-modulating, vascular, and anti-arrhythmic actions of EPA/DHA	Mechanistic/contextual evidence
Hartl et al., 2025 (4)	Parenteral omega-3 and AF safety	Not applicable as primary empirical effect estimate	Highlighted potential dose- and route-dependent electrophysiological effects	Safety/contextual evidence
O'Keefe et al., 2024 (5)	Baseline omega-3 biomarkers and vascular prognosis	183,291 participants from 29 prospective studies	Higher baseline n-3 PUFA levels were associated with lower total and ischemic stroke risk without higher hemorrhagic stroke risk	Prognostic biomarker evidence outside cardiac surgery
Linecker et al., 2020 (6)	Perioperative omega-3 in non-cardiac surgery	No extractable effect estimate or 95% CI supplied	Omega-3 supplementation did not significantly improve postoperative complications or liver regeneration	Contextual non-cardiac intervention evidence

Because no study in the supplied evidence set satisfied the complete primary PECO, a formal study-level risk-of-bias synthesis using the Newcastle–Ottawa Scale or ROBINS-E was not applied to a primary eligible cohort. Similarly, pooled effect estimates, heterogeneity statistics, subgroup analyses, sensitivity analyses, and publication-bias assessments were not appropriate. The available evidence therefore supports biological plausibility and therapeutic interest in omega-3 fatty acids but does not currently provide a direct systematic evidence base from which to estimate the prognostic association between objectively measured pre-operative omega-3 status and new-onset POAF after cardiac surgery.

DISCUSSION

The principal finding of this systematic review is that the currently identified literature does not provide direct evidence sufficient to answer whether objectively measured pre-operative omega-3 fatty-acid status predicts new-onset post-operative atrial fibrillation following cardiac surgery. Of the six candidate publications initially considered, none fulfilled all prespecified PECO domains simultaneously. Two studies involved adult coronary revascularization and reported POAF outcomes, but both evaluated perioperative omega-3 supplementation rather than naturally occurring pre-operative biomarker status (1,2). Conversely, the largest study incorporating objectively measured circulating or tissue omega-3 concentrations included 183,291 participants from 29 prospective cohorts but evaluated stroke rather than POAF after cardiac surgery (5). The remaining publications consisted of secondary cardiovascular or nutritional evidence and a non-cardiac surgical trial (3,4,6). Accordingly, the available evidence supports biological plausibility and therapeutic interest in omega-3 fatty acids but does not establish a prognostic relationship between baseline omega-3 status and POAF.

The distinction between omega-3 supplementation and baseline omega-3 status is fundamental to interpretation. Bastawisy et al. and Rakibuzzaman et al. reported lower occurrence of POAF among adults receiving perioperative omega-3 supplementation during on-pump and off-pump coronary revascularization, respectively (1,2). These findings are clinically relevant because they suggest that manipulation of omega-3 exposure around surgery may influence postoperative electrophysiological vulnerability. However, an intervention effect cannot be interpreted as evidence that patients entering surgery with naturally higher circulating or membrane concentrations are intrinsically at lower risk of POAF. Supplementation studies involve treatment allocation, dose, timing, formulation, adherence, and perioperative exposure, whereas prognostic biomarker studies examine pre-existing biological variation. Conflating these approaches risks converting therapeutic evidence into an unsupported prognostic conclusion.

Mechanistic and broader cardiovascular evidence nevertheless provides a reasonable biological basis for investigating this association prospectively. Long-chain n-3 PUFAs, particularly eicosapentaenoic acid and docosahexaenoic acid, have been implicated in modulation of inflammatory signaling, membrane characteristics, endothelial function, platelet activity, lipid metabolism, and cardiac electrophysiology (3). Hartl et al. further emphasized that electrophysiological effects may depend on formulation, dose, route of administration, and underlying cardiovascular susceptibility, demonstrating that omega-3 exposure cannot be considered biologically uniform across clinical contexts (4). Such mechanisms are relevant to cardiac surgery because postoperative arrhythmogenesis occurs within a complex environment involving myocardial ischemia-reperfusion, systemic inflammation, autonomic disturbance, and acute changes in atrial electrophysiological stability. Nevertheless, these mechanisms remain supportive rather than confirmatory evidence for a baseline biomarker-POAF association.

The prospective analysis by O'Keefe et al. provides the strongest evidence within the supplied literature that objectively measured omega-3 status may have prognostic cardiovascular relevance (5). Across 183,291 participants from 29 prospective studies, higher circulating or tissue n-3 PUFA levels were associated with lower risks of total and ischemic stroke without a corresponding increase in hemorrhagic stroke. This observation supports the concept that biological omega-3 measurements may capture clinically meaningful cardiovascular risk information. However, stroke risk in general prospective populations differs substantially from postoperative atrial arrhythmogenesis following cardiac surgery in terms of population, temporal relationship, causal pathways, perioperative stressors, and outcome ascertainment. Extrapolation of this association to POAF would therefore exceed the evidence.

The evidence gap is particularly pronounced in paediatric cardiac surgery. Although the review question included both paediatric and adult populations, none of the six candidate publications provided eligible evidence from children undergoing congenital cardiac procedures. This absence is clinically important because developmental differences in myocardial physiology, congenital anatomy, inflammatory response, nutritional status, fatty-acid metabolism, and surgical complexity may preclude direct extrapolation from adult coronary-revascularization cohorts. The current literature therefore does not support age-specific recommendations regarding pre-operative omega-3 assessment in paediatric cardiac surgery.

The findings also caution against assuming that omega-3-associated benefits are transferable across surgical settings. Linecker et al. evaluated perioperative omega-3 supplementation during major liver resection and reported no significant improvement in postoperative complications or liver regeneration (6). Although this trial does not directly inform POAF risk, it illustrates the context dependence of perioperative omega-3 effects and reinforces the need to distinguish cardiac electrophysiological outcomes from generalized assumptions of surgical organ protection. Similarly, the heterogeneous intervention, cardiovascular, nutritional, and non-cardiac evidence represented among the candidate publications explains why quantitative pooling would have been methodologically inappropriate.

This review has several limitations that arise directly from its evidence base and selection framework. Most importantly, none of the six candidate publications met the complete PECO criteria, preventing estimation of a direct association between pre-operative omega-3 status and POAF. The evidence set was also dominated by adult data and contained no eligible paediatric cardiac-surgery cohort. Considerable conceptual heterogeneity existed between biomarker assessment and therapeutic supplementation, while the relevant publications varied in clinical context and outcome definition. In addition, one initially considered study was published outside the prespecified search period and involved non-cardiac surgery (6), while two candidate sources represented secondary rather than primary empirical evidence (3,4). These issues substantially restrict the certainty and generalizability of any inference concerning baseline omega-3 status.

The principal clinical implication is therefore not that routine omega-3 biomarker screening should currently be implemented before cardiac surgery, but that the biomarker hypothesis warrants direct prospective evaluation. Before pre-operative fatty-acid profiling can be considered a clinically useful risk-stratification strategy, studies must establish whether omega-3 indices provide prognostic information independently of established determinants of POAF and whether their measurement meaningfully improves perioperative risk classification.

Intervention evidence may remain relevant to a separate therapeutic question, but it should not substitute for direct prognostic validation.

Future research should prioritize prospective adult and paediatric cardiac-surgery cohorts in which omega-3 status is measured before surgery using standardized biological matrices, preferably erythrocyte-based or other validated long-term fatty-acid indices. Investigators should prespecify POAF definitions and monitoring duration, use continuous postoperative rhythm surveillance where feasible, and report both absolute event frequencies and adjusted association estimates with confidence intervals. Models should account for established clinical confounders, including age, atrial dimensions, ventricular function, pre-existing rhythm history, beta-blocker use, surgical procedure, and cardiopulmonary-bypass exposure where applicable. Multicentre recruitment would improve generalizability, while prespecified analyses by adult versus paediatric population and surgical subtype would clarify effect modification. Ultimately, adequately powered prospective studies are required to determine whether pre-operative omega-3 status is merely biologically plausible or represents an independently useful biomarker of POAF susceptibility.

CONCLUSION

The currently available evidence does not establish that higher objectively measured pre-operative omega-3 fatty-acid status is associated with a lower incidence of new-onset post-operative atrial fibrillation after cardiac surgery, because none of the six candidate publications fulfilled all prespecified population, exposure, comparator, and outcome criteria. Existing adult coronary-revascularization studies primarily address perioperative omega-3 supplementation rather than baseline biomarker status, while broader biomarker evidence concerns cardiovascular outcomes outside the cardiac-surgical POAF setting. Routine pre-operative omega-3 screening therefore cannot presently be recommended for POAF risk stratification on the basis of this evidence set. Prospective, adequately powered adult and paediatric cardiac-surgery studies using standardized pre-operative omega-3 measurements and rigorous postoperative rhythm surveillance are required to determine whether omega-3 status provides independent and clinically useful prognostic information.

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