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REVIEW ARTICLE

NON-CARDIAC SURGERY IN CARDIAC PATIENTS: KEY INSIGHTS

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Abstract

The growing elderly population leads to a higher proportion of primarily non-cardiac surgeries being performed on patients with cardiac conditions. This highlights the necessity to review and update protocols for ensuring safe surgery in the patient group mentioned above. The cardiovascular complications are especially prevalent in patients with documented or asymptomatic coronary heart disease, left ventricular (LV) dysfunction, valvular heart disease (VHD) and arrhythmias, particularly when undergoing surgeries that place prolonged strain on the heart and hemodynamics. Preoperative N-terminal fragment of proBNP (NT-proBNP) measurement is the stronger predictor for postoperative complications. We should not initiate beta blockers, alpha-2 agonists, calcium channel blockers and statins, but rather continue them during the preoperative period. The risk of postoperative bleeding should not be the main reason for delaying non-cardiac surgery.

Key Words: *anesthesia management, cardiac patient , non-cardiac surgery.*

Introduction

Global estimates indicate that over 300 million major surgeries take place annually, representing approximately 5% of the world population, a figure that is steadily increasing. Around 74% of these procedures occur in countries with substantial healthcare investments (1).
Cardiovascular risk factors and conditions are common among adults undergoing non-cardiac surgery (NCS), and perioperative cardiovascular complications play a significant role in causing morbidity and mortality. The risk of perioperative complications is influenced by factors such as the presence of comorbidities, the patient's pre-surgery health status, and the urgency, scale, type, and length of the surgical procedure. Cardiovascular complications are especially prevalent in patients with documented or asymptomatic coronary heart disease, left ventricular (LV) dysfunction, valvular heart disease (VHD) and arrhythmias, particularly when undergoing

surgeries that place prolonged strain on the heart and hemodynamics (1,2). Perioperative myocardial ischemia can be result of three main mechanisms: an imbalance between oxygen supply and demand due to coronary artery stenosis, which may become flow-limiting during perioperative hemodynamic fluctuations; acute coronary syndrome (ACS) caused by stress-induced rupture or erosion of vulnerable atherosclerotic plaques, combined with the pro-inflammatory and hypercoagulable states triggered by surgery, as well as hemodynamic stress from fluid shifts and anesthesia; and increased bleeding risks during surgery, which may necessitate halting antiplatelet therapy and potentially cause stent thrombosis in patients who have had recent coronary stent placements before non-cardiac surgery (3). Left ventricular dysfunction and arrhythmias can develop for various reasons across all age groups. As the incidence of coronary artery disease (CAD), VHD, heart failure and arrhythmias rises with age, the risk of perioperative cardiovascular mortality and morbidity becomes especially concerning in adults undergoing major non-cardiac surgeries (1,3,4).

Methods and Aims

We conducted a thorough literature search to identify clinical studies, reviews and other evidence involving human subjects, published in English. The search included MEDLINE (via PubMed), EMBASE, the Cochrane Library and other relevant databases pertinent to this guidelines review, with the goal of helping healthcare professionals to determine the most effective management strategies for each patient based on their specific condition. Guidelines and their recommendations should support healthcare providers in making informed decisions in their everyday practice.

Preoperative and Operative Assessment

The American Society of Anesthesiologists (ASA) Physical Status Classification System categorizes patients based on their overall health (5). The Revised Cardiac Risk Index (RCRI) is a straightforward, validated and widely used tool for assessing the perioperative risk of major cardiac complications, using six risk factors: ischemic heart disease, cerebrovascular disease, history of HF, insulin therapy for diabetes, serum creatinine ≥2.0mg/dL, and planned high-risk procedure (intraperitoneal, intrathoracic or vascular surgery) (with one point assigned for each) (6). The RCRI provides moderate risk discrimination for cardiac events in patients undergoing non-cardiac surgery, although there is inconsistency among different risk-prediction tools in accurately identifying low-risk patients. Despite the patient's condition, another important factor is the time of surgery (6). In elective surgery, preoperative management involves optimizing medical therapy and considering revascularization through minimally invasive percutaneous coronary intervention or coronary artery bypass grafting when indicated. However, in emergency procedures, only medical management remains a viable option (7). Generally, acute procedures are associated with a higher risk of complications compared to elective procedures. Several factors influence outcomes when comparing acute or time-sensitive surgery to elective surgery, including the patient's overall condition versus the stage and progression of the acute illness. If

emergency surgery for a life-threatening condition is needed, it is believed that most of the patients would prioritize the potential benefits of the surgery over the risks. Consequently, surgery should not be delayed unless there is a legitimate reason (1,7). The patient's best interests should be prioritized when making treatment decisions, informed consent should be obtained whenever possible, and all decisions should be clearly documented (8). The optimal timing for non-cardiac surgery (NCS) should be determined through discussions within a multidisciplinary team, including an anesthesiologist, to ensure tailored and optimized anesthesia for each patient. Several prospective observational studies have investigated the ability of N-terminal fragment of proBNP (NT-proBNP) and BNP to predict major cardiovascular events following non-cardiac surgery. Brain natriuretic peptides (BNPs) and the NT-proBNP are released by the myocardium in response to stimuli like myocardial stretch and ischemia (9,10). A low ejection fraction, measured by echocardiography during rest, was found to be a significant borderline independent predictor of major cardiovascular complications occurring within 30 days following non-cardiac surgery. However, a preoperative NT-proBNP measurement was a much stronger independent predictor (11). The patients with pre-existing heart conditions are typically managed with appropriate drug therapy. The recommendations for discontinuing or maintaining treatment differ depending on the class of medication. The advice goes against starting beta-blockers, alpha-2 agonists, and calcium channel blockers therapy within 24 hours prior to non-cardiac surgery, but the chronic therapy should be continued. (Strong Recommendation; High-Quality Evidence) (12,13). ACEi/ARB blockers, as well as statins, should be continued preoperatively and postoperatively due to the minimized risk of uneventful events after non-cardiac surgery. The type of surgery, the patients' hemostasis values, and the anticipated bleeding all influence blood management during surgery. Tranexamic acid should be promptly considered for patients experiencing significant surgical bleeding (Class IIa, LOE A). The use of washed cell salvage is also recommended for surgeries where expected blood loss exceeds 500mL (Class I, LOE A) (14).

Perioperative Assessment

Both major bleeding and thrombosis (such as stroke and venous thromboembolism) are significant surgical outcomes and major contributors to mortality in non-cardiac surgery (NCS). Managing these perioperative risks is especially challenging in patients on long-term oral anticoagulation (OAC), including vitamin K antagonists (VKA) and direct oral anticoagulants (DOAC). Developing a perioperative plan for elective NCS should involve assessing patient-specific factors (e.g., age, thrombotic risk, renal function, history of bleeding), procedural factors (e.g., timing of surgery, bleeding risk) and medication characteristics (e.g., dosing, drug interactions, onset/offset) (13). In general, it is considered safe to perform surgeries with minimal bleeding risk without stopping OAC therapy for non-cardiac surgeries with higher bleeding risks; a time-based interruption ("time reversal") of OAC therapy is recommended. Procedures with higher bleeding risks, such as neuraxial anesthesia, should be conducted with a complete interruption of OAC. To achieve minimal drug effects, anticoagulants should be withheld for at

least 5 half-lives with a minimum of 3 days for factor Xa inhibitors (rivaroxaban, apixaban, edoxaban) and at least 4 days for dabigatran (or 5-6 days if creatinine clearance is <50mL/min) (15). If resuming full-dose anticoagulation in the postoperative period presents a bleeding risk greater than the risk of thromboembolic events, it may be appropriate to delay full anticoagulation until 48-72 hours post-surgery, using interim thromboprophylaxis until it is deemed safe to restart full anticoagulation (Class IIb, LOE C). The use of reduced-dose NOACs is not recommended to minimize the risk of postoperative bleeding. Recommendations go to perioperative measurement of NT proBNP/BNP, monitoring of ECG, and against use of pulmonary artery catheters (1).

Hemodynamic monitoring is essential in these patients due to their increased risk of cardiovascular instability. Continuous ECG monitoring is recommended intraoperatively, especially in patients with a history of coronary artery disease (CAD) or heart failure (HF), to detect ischemia or arrhythmias. Non-invasive blood pressure (NIBP) monitoring is standard, but in high-risk cases, invasive arterial blood pressure monitoring provides more precise hemodynamic control and facilitates blood sampling for arterial blood gas analysis and coagulation parameters. Central venous pressure (CVP) monitoring may be considered in patients with significant cardiac dysfunction, volume status uncertainty, or the ones requiring vasoactive therapy. Advanced hemodynamic monitoring, such as pulse contour analysis or esophageal Doppler, can be useful for guiding fluid management in patients with significant cardiovascular risk. Pulmonary artery catheters are not routinely recommended due to a lack of proven benefit in most of the perioperative settings. Perioperative measurement of NT-proBNP/BNP is recommended to assess cardiovascular risk and predict postoperative complications. Maintaining normovolemia and avoiding hypotension are key goals to reduce the risk of perioperative myocardial injury, with careful titration of fluids and vasopressors to balance perfusion without exacerbating bleeding risk (16).

When selecting anesthetic techniques for cardiac patients undergoing non-cardiac surgery, both general and regional anesthesia have distinct considerations. General anesthesia provides controlled airway management and stable hemodynamics but may suppress myocardial function. Regional anesthesia, such as neuraxial or peripheral nerve blocks, can attenuate the surgical stress response and offer superior postoperative analgesia, potentially benefiting patients with cardiovascular disease. However, in the patients receiving anticoagulant therapy, regional anesthesia carries an increased risk of hemorrhagic complications, including vertebral canal hematoma, which can lead to permanent neurological deficits if not promptly addressed. Therefore, the decision to employ regional anesthesia in anticoagulated patients requires careful evaluation of bleeding risks and adherence to established guidelines. For instance, the American Society of Regional Anesthesia and Pain Medicine provides evidence-based recommendations to mitigate these risks. For general anesthesia, maintaining hemodynamic stability is crucial. The choice of induction agents should prioritize minimal cardiovascular depression, while maintenance should involve anesthetics that support cardiac function and provide adequate depth

of anesthesia without compromising myocardial performance. Close intraoperative monitoring, including invasive blood pressure measurement and cardiac output assessment, is recommended to ensure optimal perioperative management (17,18). Ultimately, the choice between general and regional anesthesia should be individualized, taking into account multiple factors, including the patient's cardiac status, anticoagulation regimen, urgency and timing of surgery, overall physical status, presence of comorbidities, and the type and extent of the surgical procedure. These considerations help optimize perioperative management, balancing the risks of anesthesia-related complications with the benefits of maintaining hemodynamic stability and minimizing bleeding risks.

Postoperative Care

The postoperative period is a high-risk phase for cardiac patients recovering from non-cardiac surgery, demanding meticulous monitoring and targeted interventions to prevent complications such as myocardial infarction, arrhythmias, heart failure exacerbation and thromboembolic events. Continuous telemetry is essential for at least 48 hours in high-risk patients—particularly those with prior coronary artery disease, reduced ejection fraction, or a history of arrhythmias—to detect silent ischemia or unstable rhythms. Serial 12-lead ECGs should be performed immediately after surgery and daily for 48–72 hours in these patients, while invasive hemodynamic monitoring (e.g., arterial lines or pulse contour analysis) may be warranted in those with hemodynamic instability or cardiogenic shock (1,16,19,20).

The biomarker evaluation plays a central role in early detection of adverse events. High-sensitivity troponin levels should be measured at 24 and 48 hours postoperatively, as asymptomatic elevations often indicate perioperative myocardial injury and correlate with poor outcomes. Concurrently, serial BNP or NT-proBNP measurements help to identify subclinical heart failure, guiding judicious diuretic use and volume management. Medication optimization is equally critical: beta-blockers should be continued to avoid rebound tachycardia, with doses adjusted to maintain a heart rate of 60–80 bpm without inducing hypotension. Statins must be resumed promptly to stabilize endothelial function, while anticoagulants and antiplatelet agents (e.g., aspirin) should be restarted as soon as surgically safe, balancing thrombotic and bleeding risks (9,10).

The volume management requires a nuanced approach, prioritizing goal-directed fluid therapy using dynamic parameters like stroke volume variation to prevent both hypovolemia and overload. In patients with heart failure, cautious diuresis may be needed to avert pulmonary edema, while respiratory care,including early extubating, incentive spirometry, and opioid-sparing analgesia, reduces the risk of hypoxia-induced ischemia. Postoperative arrhythmias, particularly atrial fibrillation, are common and managed initially with rate control (beta-blockers, calcium channel blockers) or amiodarone for rhythm stabilization, with anticoagulation initiated if arrhythmias persist beyond 48 hours. Heart failure exacerbations demand prompt recognition

of signs like jugular venous distension or crackles, treated with IV diuretics, nitrates, or inotropes as needed (19,20).

Enhanced Recovery After Surgery (ERAS) protocols, emphasizing early mobilization within 24 hours improve cardiopulmonary function and reduce thromboembolic risks. Pain management should prioritize regional techniques or non-opioid analgesics (e.g., acetaminophen, NSAIDs) to minimize delirium and respiratory depression. Multidisciplinary collaboration is vital: cardiology input is mandatory for troponin-positive patients or those with hemodynamic instability, while thromboembolic prophylaxis with low-molecular-weight heparin or mechanical compression devices should continue until full mobility is restored. Prior to discharge, it should be ensured that the patients meet criteria such as stable vitals, adequate pain control and baseline functional capacity, with structured follow-up plans involving cardiac rehabilitation and medication adherence counseling. Patient education on symptom recognition (e.g., chest pain, dyspnea) and dietary modifications (e.g., sodium restriction in heart failure), further support the recovery (21-24).

Seamless coordination between surgeons, anesthesiologists, cardiologists and rehabilitation teams ensures optimal transitions from acute care to outpatient management, prioritizing both cardiac stability and surgical recovery.

Conclusion

Despite ongoing advancements in perioperative cardiovascular risk assessment and management, optimizing outcomes for cardiac patients undergoing non-cardiac surgery remains a complex challenge. A multidisciplinary, evidence-based approach incorporating NT-proBNP measurement, individualized medication management and vigilant perioperative monitoring is essential for reducing morbidity and mortality. For postoperative care, the most significant role is a vigilant, protocol-driven approach—integrating continuous monitoring, biomarker-guided therapy and ERAS principles. Further research is warranted to refine risk prediction models and develop tailored perioperative strategies for high-risk cardiovascular patients.

References:

1. Halvorsen S, Mehilli J, Cassese S, et al. ESC Scientific Document Group , 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery: Developed by the task force for cardiovascular assessment and management of patients undergoing non-cardiac surgery of the European Society of Cardiology (ESC) Endorsed by the European Society of Anaesthesiology and Intensive Care (ESAIC), European Heart Journal, Volume 43, Issue 39, 14 October 2022, Pages 3826–3924, https://doi.org/10.1093/eurheartj/ehac270.

2. Weiser TG, Regenbogen SE, Thompson KD, et al. An estimation of the global volume of surgery: a modelling strategy based on available data. Lancet 2008;372:139–144.
3. Magoon R, Makhija N, Das D. Perioperative myocardial injury and infarction following non-cardiac surgery: A review of the eclipsed epidemic. Saudi J Anaesth. 2020 Jan-Mar;14(1):91-99.
4. Weiser TG, Haynes AB, Molina G, et al. Estimate of the global volume of surgery in 2012: an assessment supporting improved health outcomes. Lancet 2015; 385:S11.
5. Heidenreich PA, Bozkurt B, Aguilar D, et al. 2022 AHA/ACC/HFSA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*. 2022; 145:e895–e1032.
6. Dhir S, Dhir A. The Global Perspective of Cardiovascular Assessment for Noncardiac Surgery: Comparisons from Around the World. J Cardiothorac Vasc Anesth. 2019 Aug; 33(8):2287-2295.
7. Duceppe E, Parlow J, MacDonald P, et al. Canadian Cardiovascular Society Guidelines on Perioperative Cardiac Risk Assessment and Management for Patients Who Undergo Noncardiac Surgery [published correction appears in Can J Cardiol. 2017 Dec;33(12):1735. doi: 10.1016/j.cjca.2017.04.002.]. *Can J Cardiol*. 2017;33(1):17-32. doi:10.1016/j.cjca.2016.09.008.
8. Bjorck M, Earnshaw J, Acosta S, et al. Editor's choice – European Society for Vascular Surgery (ESVS) 2020 Clinical Practice Guidelines on the management of acute limb ischaemia. Eur J Vasc Endovasc Surg 2020; 59:173–218.
9. Struthers A, Lang C. The potential to improve primary prevention in the future by using BNP/N-BNP as an indicator of silent 'pancardiac' target organ damage: BNP/N-BNP could become for the heart what microalbuminuria is for the kidney. Eur Heart J 2007; 28:1678-82.
10. Clerico A, Giannoni A, Vittorini S, Passino C. Thirty years of the heart as an endocrine organ: physiological role and clinical utility of cardiac natriuretic hormones. Am J Physiol Heart Circ Physiol 2011; 301:H12-20.
11. Park SJ, Choi JH, Cho SJ, et al. Comparison of transthoracic echocardiography with N-terminal pro-brain natriuretic peptide as a tool for risk stratification of patients undergoing major noncardiac surgery. Korean Circ J 2011; 41:505-11.
12. Fleisher LA, Poldermans D. Perioperative beta blockade: where do we go from here? Lancet 2008; 371:1813-4.
13. Wijeysundera DN, Bender JS, Beattie WS. Alpha-2 adrenergic agonists for the prevention of cardiac complications among patients undergoing surgery. Cochrane Database Syst Rev 2009:CD004126.
14. Grines CL, Bonow RO, Casey DE, et al. Prevention of premature discontinuation of dual antiplatelet therapy in patients with coronary artery stents: a science advisory from the

American Heart Association, American College of Cardiology, Society for Cardiovascular Angiography and Interventions, American College of Surgeons, and American Dental Association, with representation from the American College of Physicians. Circulation. 2007; 115:813–818.

15. Narouze S, Benzon HT, Provenzano D, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications (second edition): guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. Reg Anesth Pain Med. 2018; 43:225–262.
16. Kouz K, Thiele R, Michard F, Saugel B. Haemodynamic monitoring during noncardiac surgery: past, present, and future. J Clin Monit Comput. 2024 Jun;38(3):565-580. doi: 10.1007/s10877-024-01161-2. Epub 2024 Apr 30.
17. Kopp SL, Vandermeulen E, McBane RD, Perlas A, Leffert L, Horlocker T. Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy: American Society of Regional Anesthesia and Pain Medicine Evidence-Based Guidelines (fifth edition). Reg Anesth Pain Med. 2025 Jan 29:rapm-2024-105766.
18. Jamis-Holland JE, Bangalore S, Bates ER, Beckie TM, Bischoff JM, Bittl JA, Cohen MG, DiMaio JM, Don CW, Fremes SE, Gaudino MF, Goldberger ZD, Grant MC, Jaswal JB, Kurlansky PA, Mehran R, Metkus TS Jr, Nnacheta LC, Rao SV, Sellke FW, Sharma G, Yong CM, Zwischenberger BA. 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2022 Jan 18;145(3):e4-e17. doi: 10.1161/CIR.0000000000001039. Epub 2021 Dec 9. Erratum in: Circulation. 2022 Mar 15;145(11):e771.
19. Priebe H. Preoperative cardiac management of the patient for non-cardiac surgery: an individualized and evidence-based approach. British Journal of Anaesthesia, 2011; Volume 107, Issue 1, 83 – 96.
20. Thompson, A, Fleischmann, K. et al. AHA/ ACC/ ACS/ ASNC/ HRS/ SCA/ SCCT/ SCMR/ SVM Guideline for Perioperative Cardiovascular Management for Noncardiac Surgery: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. JACC. 2024 Nov, 84 (19) 1869–1969.
21. Malvindi PG, Bifulco O, Berretta P, Galeazzi M, Alfonsi J, Cefarelli M, Zingaro C, Zahedi HM, Munch C, Di Eusanio M. The Enhanced Recovery after Surgery Approach in Heart Valve Surgery: A Systematic Review of Clinical Studies. J Clin Med. 2024 May 14;13(10):2903. doi: 10.3390/jcm13102903. PMID: 38792445; PMCID: PMC11121940.
22. Salenger R, Morton-Bailey V, Grant M, Gregory A, Williams JB, Engelman DT. Cardiac Enhanced Recovery After Surgery: A Guide to Team Building and Successful Implementation. Semin Thorac Cardiovasc Surg. 2020 Summer;32(2):187-196.

23. Navas-Blanco JR, Kantola A, Whitton M, Johnson A, Shakibai N, Soto R, Muhammad S. Enhanced recovery after cardiac surgery: A literature review. Saudi J Anaesth. 2024 Apr-Jun;18(2):257-264. doi: 10.4103/sja.sja_62_24. Epub 2024 Mar 14.
24. https://erassociety.org/guidelines/ Accessed February 2025.