NCBI Bookshelf. A service of the National Library of Medicine, National Institutes of Health.

StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-.

Anesthetic Management For Enhanced Recovery After Cardiac Surgery (ERACS)

Authors

Iwan P. Sofjan[1]; Amy McCutchan[2].

Affiliations

[1] Westchester Medical Center and New York Medical College
[2] Indiana University School of Medicine

Last Update: June 11, 2022.

Continuing Education Activity

Since the advent of the Enhanced Recovery After Surgery (ERAS) initiative, enhanced recovery protocols exist for many surgical specialties. Many studies have shown the benefits of the ERAS-based approach in improving outcomes, minimizing complications, and reducing costs. Similar protocols were developed to potentially reap these benefits for patients undergoing cardiac surgery and are now known as the Enhanced Recovery After Cardiac Surgery (ERACS). This activity reviews the ERACS guidelines released by the ERAS cardiac society to help the management by an interprofessional team.

Objectives:

- Review the Enhanced Recovery After Cardiac Surgery (ERACS) preoperative, intraoperative, and postoperative guidelines.
- Describe the types of peripheral and neuraxial nerve blocks that can be used for pain control in cardiac surgery.
- Identify the cardiovascular risk in using non-steroidal anti-inflammatory medications such as celecoxib.
- Outline the medications that can be incorporated by the interprofessional team in ERACS based protocols.

Access free multiple choice questions on this topic.

Introduction

Enhanced Recovery After Surgery (ERAS) is a protocol-based multidisciplinary initiative designed to improve various outcomes. ERAS-based protocols typically cover the preoperative, intraoperative, and postoperative periods. They have led to many benefits, such as decreasing hospital length of stay, complications, readmission rates, and costs.[1]

ERAS guidelines have been around for over a decade and exist in many surgical specialties, but recently they have come to the forefront in cardiac surgery. In 2019, the ERAS Cardiac Society (ERAS CS) released its first consensus expert review guidelines for patients undergoing cardiac surgery. This is commonly referred to as the Enhanced Recovery After Cardiac Surgery (ERACS) guidelines.[2] This article will discuss the main categories of the ERACS guidelines and findings from other studies that address ERAS-based strategies in cardiac surgery.

Function

The main goal of the ERACS guidelines is to facilitate the widespread adoption of ERAS-based protocols within cardiac surgery. In building an ERACS program, Noss et al. recommend identifying target events of particular interest, such as complications or length of stay. After ascertaining the events of interest, he advocates for identifying the

incidence of these events and developing a standardized, evidence-based care pathway. Finally, data must be gathered to assess the efficacy of the implemented pathway.[3]

For example, Fleming et al. implemented an ERACS protocol for elective coronary artery bypass grafting (CABG) and valve surgery. The protocol included ERAS-based strategies such as reducing preoperative fasting, minimizing long-acting opioids, early enteral feeding, and early mobilization. After its implementation, the length of stay was no different from that prior to its implementation. They found a statistically significant decrease in several complications such as infection, renal injury, myocardial infarction, respiratory failure, and death.[4]

Issues of Concern

Preoperative Considerations

Glucose control is important throughout the perioperative period. Early preoperative intervention can improve outcomes. Unfortunately, hyperglycemia is common in cardiac surgical patients, with almost 1 in 4 patients have elevated hemoglobin A1c (Hb A1c) and 1 in 10 with undiagnosed diabetes. Elevated Hb A1c is associated with deep sternal wound infection, ischemic events, and mortality. Whenever possible, Hb A1c level should be below 6.5%.[2][5]

Lower preoperative albumin is associated with prolonged mechanical ventilation, acute kidney injury (AKI), infection, prolonged hospital length of stay, and death. Whenever possible, maximizing nutritional status with preoperative nutritional supplementation before surgery (ideally for 7 to 10 days) is paramount, especially in malnourished patients.[2] In addition, similar to other ERAS guidelines, allowing clear liquids up to 2-4 hours before general anesthesia is generally safe and is not associated with an increased risk of aspiration.[2] Clear liquid carbohydrate loading 2 hours before surgery can reduce insulin resistance and decrease possible inotropic support, which might occur in the post-bypass period.[6][7]

When possible, increasing preoperative patient engagement and functional capacity should be emphasized. Improving patient engagement through education and counseling has been shown to improve outcomes.[2] A preoperative exercise regimen is associated with patients having less perioperative insulin resistance and sympathetic over-reactivity, a reduction in complications, and shorter length-of-stays along with faster recoveries.[2]

The preoperative clinic should emphasize the cessation of both alcohol and tobacco. These should be stopped at least one month before surgery. Alcohol and smoking tobacco are associated with various complications such as infection, respiratory issues, slower wound healing, bleeding, and metabolic dysfunction.[2]

Intraoperative Considerations

The most important surgical site infection in cardiac surgery is the deep sternal wound infection (DSWI). DSWI occurs in about 1 to 4% of cardiac surgery, leading to increased morbidity, mortality, and cost. *Staphylococcus aureus (S. aureus)* is the most common bacteria involved, with the majority likely originating from preoperative colonization as up to 30% of cardiac surgery patients are carriers. The ERACS guidelines recommend preoperative intranasal *S. aureus* therapy, skin preparation (including chest clipping), intraoperative antibiotics that cover *S. aureus,* and regular postoperative wound and dressing care.[2][8]

Many studies have shown that adequate glycemic control improves outcomes. In cardiac surgery, maintaining a glucose level below 180 mg/dL leads to significantly fewer sternal wound infections. This can be most efficiently accomplished with an insulin infusion. Of note, tight glucose control (i.e., 80-110 mg/dL) is not recommended as this may lead to hypoglycemia.[2][8]

Pain is a significant issue in cardiac surgery and is typically treated with high-dose opioids, which have many side effects. The ERACS guidelines recommend a multimodal opioid-sparing approach to achieve adequate pain control. Medications used for this multimodal approach include acetaminophen, gabapentin (or pregabalin), tramadol, and

dexmedetomidine. All of these medications are associated with lower opioid requirements in patients.[2] Opioids and benzodiazepines are generally acceptable but should be minimized if possible. Other medications that have proven beneficial for analgesia but need further research in cardiac surgery include ketamine, lidocaine, magnesium, and steroids.[3] Of note, non-steroidal anti-inflammatory drugs (NSAIDs), such as celecoxib, should not be used in cardiac surgery. Though commonly used in non-cardiac ERAS protocols, NSAIDs are associated with increased thromboembolic cardiovascular risk.[2]

In addition to medications, various neuraxial and peripheral nerve blocks can be utilized in cardiac surgery. With the use of intraoperative high-dose heparin, neuraxial anesthesia (thoracic epidural and intrathecal opioids) and paravertebral blocks remain controversial. However, studies have shown benefits from using these measures in reducing cardiopulmonary complications.[9][10] Alternatively, various peripheral nerve blocks can be done to reduce chest wall pain and are gaining popularity. In general, these peripheral nerve blocks target branches of the intercostal nerves, which innervate the lateral and anterior chest walls. These blocks include pectoralis nerve blocks (PECS I and II), serratus anterior plane blocks (SAP), erector spinae plane blocks (ESP), transversus thoracic muscle plane blocks (TTMP), pectointercostal-fascial blocks (PIF), and intercostal nerve blocks.[3][11] Of note, the TTMP targets the plane between the intercostal and transverse thoracic muscles, where the left and right internal mammary arteries (LIMA and RIMA) are located. As such, the TTMP block may either inadvertently damage the LIMA or RIMA or lead to local anesthetic spillage to the adjacent mediastinal cavities after LIMA or RIMA dissection. Therefore, in cases where the LIMA or RIMA is harvested, a more superficial block such as the PIF block is likely a safer approach.[11][12]

Normothermia should be maintained after cardiopulmonary bypass and during the initial intensive care period. Hyperthermia (core temperature above 37.9 degrees Celsius) has been associated with cognitive dysfunction, infection, and renal injury.[2] Persistent hypothermia (core temperature below 36 degrees Celsius) can lead to bleeding, infection, longer hospital stay, and mortality.[2][13]

Bleeding is common in cardiac surgery, and various blood product conservation guidelines exist to minimize unnecessary transfusions. The ERACS guidelines recommend developing a blood product transfusion protocol based on the existing guidelines.[2] One of the guidelines, published by the Society of Cardiovascular Anesthesiologists (SCA), recommends using thromboelastography (TEG) or rotational thromboelastometry (ROTEM) when determining the need for blood product transfusions such as fresh-frozen plasma, platelets, and cryoprecipitate. TEG or ROTEM have been found in various transfusion studies to be superior to the conventional coagulation tests.[14] In addition, the ERACS guidelines also recommend using antifibrinolytics such as epsilon aminocaproic acid or tranexamic acid for any cardiac surgery requiring cardiopulmonary bypass. Both of these antifibrinolytics are associated with less blood product transfusion, major hemorrhage, and cardiac tamponade.[2]

Sternotomy closure is typically done with wire cerclage, which has been the standard of care for decades. However, several newer rigid plate fixation devices are currently available and have been suggested to reduce side-by-side sternal movement during healing and are associated with improved bone healing, decreased pain, improved upper body function, and less mediastinitis. Though data and adoption are still limited, a rigid fixation plate device should be considered in high-risk patients. Some high-risk factors include a history of obesity, diabetes, chronic obstructive pulmonary disease, and radiated chest wall.[2][8]

Postoperative Considerations

Minimizing mechanical ventilation and intubation reduces morbidity, mortality, and cost. Several studies in cardiac surgery have shown that early extubation (within 6 hours of ICU admission) is safe and decreases cost and the length of stays in the ICU and hospital.[2] Further studies are needed to determine whether early extubation reduces morbidity and mortality.

Goal-directed fluid therapy has been shown to reduce complications and length of stay in cardiac surgery. Quantitative measures (such as cardiac index, mixed venous oxygen saturation, urine output, lactate, etc.) should be used whenever

available to guide fluid management to achieve euvolemia.[2][15]

Acute kidney injury (AKI) is fairly common and very costly in cardiac surgery. Identifying patients at high risk for AKI can be difficult. Still, recently some urinary biomarkers (tissue inhibitor of metalloproteinases-2 and insulin-like growth factor-binding protein 7) can predict AKI early after cardiopulmonary bypass. Using these biomarkers may lead to early AKI risk stratification, early renoprotective intervention, and AKI reduction in cardiac surgery.[2][16][17]

Delirium occurs fairly often in cardiac surgery patients (up to 50% in some studies) and can lead to decreased long-term cognitive recovery and increased mortality and readmission. Regular delirium monitoring and early treatment should be routinely done, with nonpharmacologic treatment as the first-line intervention.[2] Whenever possible, the use of long-acting medications that may contribute to delirium (e.g., sedatives, opioids, anxiolytics, etc.) should be minimized.

Both deep venous thrombosis (DVT) and pulmonary embolism (PE) are likely preventable complications after cardiac surgery. Patients should have mechanical thromboprophylaxis until they are mobile. As soon as there is surgical hemostasis, chemical thromboprophylaxis should be initiated, ideally from postoperative day one until discharge.[2]

Chest tube clogging is fairly common after cardiac surgery and may lead to pericardial effusion, hemothorax, and atrial fibrillation. One method of unclogging a chest tube is by stripping (or milking), which unfortunately does not work effectively and may be harmful. Another unclogging method includes using a smaller tube to suction the chest tube, which typically involves breaking the chest tube sterility and can lead to infection or iatrogenically cause internal damage. The ERACS guidelines do not recommend either stripping or suctioning that involves breaking the sterile field.[2] Alternatively, newer chest tubes that include active chest tube clearance methods may be used, as it has shown some promise in reducing chest tube-related complications.[2]

Clinical Significance

Cardiac surgery presents a complicated yet promising target for enhanced recovery strategies. The typically high level of patient comorbidities and the complexity of cardiac surgery requires high costs while consuming significant resources.[3] Despite these challenges, there are common modifiable risk factors and feasible interventions to help, as discussed by the ERACS guidelines. Hopefully, the ERACS guidelines can be the foundation for many cardiac surgery programs when implementing ERACS-based protocols.

Other Issues

In addition to the above considerations, several other common perioperative factors have shown some beneficial effects in cardiac surgery. These factors include investigation of preoperative anemia, higher cardiopulmonary bypass flow to ensure adequate renal perfusion, lung protective strategies for mechanical ventilation, postoperative nausea and vomiting prophylaxis, early postoperative enteral feeding, and early physical rehabilitation.[2][3]

Enhancing Healthcare Team Outcomes

There are many challenges in implementing multifaceted enhanced recovery strategies such as ERACS. Cardiac surgical care will always involve a multidisciplinary team effort starting from the initial diagnosis to the eventual post-surgical recovery. As such, having standardized preoperative, intraoperative, and postoperative protocols for all the team members is crucial in implementing a successful ERACS program. In addition, ERACS is still relatively new, and it will be a while before data from large-scale randomized trials are available. It is important to gather as much data as possible for all the relevant events and interventions before and after the ERACS implementation to assess the efficacy.[3] [Level 2]

Review Questions

- Access free multiple choice questions on this topic.
- Comment on this article.

References

1. Ljungqvist O, Scott M, Fearon KC. Enhanced Recovery After Surgery: A Review. JAMA Surg. 2017 Mar 01;152(3):292-298. [PubMed: 28097305]
2. Engelman DT, Ben Ali W, Williams JB, Perrault LP, Reddy VS, Arora RC, Roselli EE, Khoynezhad A, Gerdisch M, Levy JH, Lobdell K, Fletcher N, Kirsch M, Nelson G, Engelman RM, Gregory AJ, Boyle EM. Guidelines for Perioperative Care in Cardiac Surgery: Enhanced Recovery After Surgery Society Recommendations. JAMA Surg. 2019 Aug 01;154(8):755-766. [PubMed: 31054241]
3. Noss C, Prusinkiewicz C, Nelson G, Patel PA, Augoustides JG, Gregory AJ. Enhanced Recovery for Cardiac Surgery. J Cardiothorac Vasc Anesth. 2018 Dec;32(6):2760-2770. [PubMed: 29503121]
4. Fleming IO, Garratt C, Guha R, Desai J, Chaubey S, Wang Y, Leonard S, Kunst G. Aggregation of Marginal Gains in Cardiac Surgery: Feasibility of a Perioperative Care Bundle for Enhanced Recovery in Cardiac Surgical Patients. J Cardiothorac Vasc Anesth. 2016 Jun;30(3):665-70. [PubMed: 27321791]
5. Halkos ME, Puskas JD, Lattouf OM, Kilgo P, Kerendi F, Song HK, Guyton RA, Thourani VH. Elevated preoperative hemoglobin A1c level is predictive of adverse events after coronary artery bypass surgery. J Thorac Cardiovasc Surg. 2008 Sep;136(3):631-40. [PubMed: 18805264]
6. Ljungqvist O. Modulating postoperative insulin resistance by preoperative carbohydrate loading. Best Pract Res Clin Anaesthesiol. 2009 Dec;23(4):401-9. [PubMed: 20108579]
7. Breuer JP, von Dossow V, von Heymann C, Griesbach M, von Schickfus M, Mackh E, Hacker C, Elgeti U, Konertz W, Wernecke KD, Spies CD. Preoperative oral carbohydrate administration to ASA III-IV patients undergoing elective cardiac surgery. Anesth Analg. 2006 Nov;103(5):1099-108. [PubMed: 17056939]
8. Lazar HL, Salm TV, Engelman R, Orgill D, Gordon S. Prevention and management of sternal wound infections. J Thorac Cardiovasc Surg. 2016 Oct;152(4):962-72. [PubMed: 27555340]
9. Caruso TJ, Lawrence K, Tsui BCH. Regional anesthesia for cardiac surgery. Curr Opin Anaesthesiol. 2019 Oct;32(5):674-682. [PubMed: 31356362]
10. Guay J, Kopp S. Epidural analgesia for adults undergoing cardiac surgery with or without cardiopulmonary bypass. Cochrane Database Syst Rev. 2019 Mar 01;3:CD006715. [PMC free article: PMC6396869] [PubMed: 30821845]
11. Kelava M, Alfirevic A, Bustamante S, Hargrave J, Marciniak D. Regional Anesthesia in Cardiac Surgery: An Overview of Fascial Plane Chest Wall Blocks. Anesth Analg. 2020 Jul;131(1):127-135. [PubMed: 32032103]
12. Sepolvere G, Tognù A, Tedesco M, Coppolino F, Cristiano L. Avoiding the Internal Mammary Artery During Parasternal Blocks: Ultrasound Identification and Technique Considerations. J Cardiothorac Vasc Anesth. 2021 Jun;35(6):1594-1602. [PubMed: 33293216]
13. Karalapillai D, Story D, Hart GK, Bailey M, Pilcher D, Cooper DJ, Bellomo R. Postoperative hypothermia and patient outcomes after elective cardiac surgery. Anaesthesia. 2011 Sep;66(9):780-4. [PubMed: 21692761]
14. Raphael J, Mazer CD, Subramani S, Schroeder A, Abdalla M, Ferreira R, Roman PE, Patel N, Welsby I, Greilich PE, Harvey R, Ranucci M, Heller LB, Boer C, Wilkey A, Hill SE, Nuttall GA, Palvadi RR, Patel PA, Wilkey B, Gaitan B, Hill SS, Kwak J, Klick J, Bollen BA, Shore-Lesserson L, Abernathy J, Schwann N, Lau WT. Society of Cardiovascular Anesthesiologists Clinical Practice Improvement Advisory for Management of Perioperative Bleeding and Hemostasis in Cardiac Surgery Patients. Anesth Analg. 2019 Nov;129(5):1209-1221. [PubMed: 31613811]
15. Aya HD, Cecconi M, Hamilton M, Rhodes A. Goal-directed therapy in cardiac surgery: a systematic review and meta-analysis. Br J Anaesth. 2013 Apr;110(4):510-7. [PubMed: 23447502]
16. Mayer T, Bolliger D, Scholz M, Reuthebuch O, Gregor M, Meier P, Grapow M, Seeberger MD, Fassl J. Urine Biomarkers of Tubular Renal Cell Damage for the Prediction of Acute Kidney Injury After Cardiac Surgery-A

Pilot Study. J Cardiothorac Vasc Anesth. 2017 Dec;31(6):2072-2079. [PubMed: 28803769]

17. Meersch M, Schmidt C, Hoffmeier A, Van Aken H, Wempe C, Gerss J, Zarbock A. Prevention of cardiac surgery-associated AKI by implementing the KDIGO guidelines in high risk patients identified by biomarkers: the PrevAKI randomized controlled trial. Intensive Care Med. 2017 Nov;43(11):1551-1561. [PMC free article: PMC5633630] [PubMed: 28110412]

Bookshelf ID: NBK572107 PMID: 34283473