IDENTIFYING KNOWLEDGE GAPS AND ATTITUDE BARRIERS AMONGST CERTIFIED REGISTERED NURSE ANESTHETISTS TO IMPROVE UTILIZATION OF OPIOID-SPARING ANESTHESIA TECHNIQUES IN CARDIAC SURGERY

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Abstract

Background: Opioids have been a mainstay in cardiac anesthesia for many years with providers often administering up to twenty milliliters of fentanyl per case. With the existence of the opioid crisis and enhanced recovery after surgery (ERAS) protocols leading to improved patient outcomes, opioid-sparing anesthesia (OSA) techniques should be utilized more often within cardiac surgeries. **Purpose:** Discovering knowledge gaps and attitude biases of Certified Registered Nurse Anesthetists (CRNAs) will improve the provider's awareness of OSA techniques in cardiac surgery and increase the provider's utilization of OSA techniques within their practice. **Methods:** Certified Registered Nurse Anesthetists were provided a descriptive, cross-sectional electronic survey. Based on the findings, an educational intervention was provided. After a month, a post-intervention survey was completed electronically. **Results:** Sixty-eight percent of respondents believed OSA techniques in any surgical patient effectively reduced intraoperative pain. Sixty-eight percent believed OSA techniques should be included in cardiac surgery programs. Regional anesthetic techniques were the only knowledge gap discovered with respondents expressing the desire to have regional blocks incorporated into their cardiac program. Surprisingly, no biases were found. **Recommendations and Conclusion:** Future projects should be completed at facilities that do not have a pre-existing ERAS cardiac program. This will allow for a more robust project. Certified Registered Nurse Anesthetists are eager to learn about cardiac surgery OSA techniques and incorporate those methods within their practice.

Key Words: “opioid-free anesthesia” and “cardiac surgery”, “awake cardiac surgery”, “opioid-sparing anesthesia in cardiac surgery”

Background and Significance

Opioids have been used to treat pain during surgery for many years. After German pharmacist Friedrich Wilhelm Adam Sertürner isolated morphine from opium in 1805, morphine eventually became a standard component of anesthesia. By the last half of the nineteenth century, its use as a pre-anesthetic agent shortened induction time and reduced overall anesthetic requirements. As a result, high-dose morphine anesthesia became commonplace in the early 1960s. Morphine was used in valvular heart surgery despite incomplete amnesia, histamine release with significant vasodilation, and postoperative respiratory depression. These expected but untoward side effects led to studies of high-dose fentanyl in animals and, later, patients undergoing valvular surgeries. High-dose fentanyl demonstrated improvements over morphine because of its lack of histamine release and histamine-mediated vasodilation. Doses of fentanyl in valvular and coronary artery bypass operations increased from 50 micrograms during an entire case to 50-100 micrograms per kilogram by the 1980s. Eventually, opioids became a mainstay in every anesthetic as an analgesic and to reduce the sympathetic response to direct laryngoscopy (Stanley, 2014).

While opioid administration has become a cornerstone in anesthesia, its misuse through over-prescribing has led to other problematic issues: opioid addiction and death from an unintentional opioid overdose. From 1999 to 2017, there were greater than 13,000 unintentional opioid-related overdose deaths in North Carolina alone. Should the current trend continue, North Carolina could see as many as 2,400 deaths from unintentional opioid overdoses annually (Jones et al., 2020). While anesthesia providers have not exclusively contributed to the current opioid crisis, they can help counteract the epidemic by reducing the number of opioids given and administering non-opioid alternatives within their anesthetics. One approach that has shown success in opioid reduction is Enhanced Recovery After Surgery (ERAS). Enhanced Recovery After Surgery is a multimodal, multidisciplinary approach that uses published evidence to improve patient outcomes while keeping costs low (Ljungqvist et al., 2017). Bariatric, general, and orthopedic surgeries all have successful ERAS protocols documented through research, but an area where research evidence is lacking is cardiac surgery. In the practice of anesthesia where high-dose opioid has been a mainstay for years, cardiac surgery is the next logical step for instituting ERAS protocols.

Opioid-sparing anesthesia (OSA) techniques in cardiac surgery have been developed, described, and implemented. Ketamine, lidocaine, and dexmedetomidine infusions in conjunction with regional and neuraxial blocks have facilitated fast-track and ultrafast-track cardiac surgery programs, both on and off cardiopulmonary bypass (Chanowski et al., 2019; Kumar et al., 2018; Noiseux et al., 2008). A “fast-track” or “ultrafast-track” approach in cardiac surgery involves a perioperative process that promotes rapid progression from preoperative preparation through surgery to hospital discharge. Fast-track protocols permit early extubation following uncomplicated cardiac surgery by administering a low-dose, opioid-based general anesthetic and/or having a time-directed extubation protocol (within six hours of anesthesia end) (Goeddel et al., 2018). This “fast track” leads to reduced postoperative ventilation time, intensive care unit (ICU) length of stay (LOS), and hospital LOS (Desai & Hwang, 2020). An ultrafast-track technique typically involves extubation in the operating room. Opioid-sparing anesthesia techniques, along with regional and neuraxial blocks, have also aided in drastically reducing opioid use in the postoperative period (Guinot et al., 2019; Roediger et al., 2006). Marrying these successful techniques within an enhanced recovery after cardiac surgery (ERACS) program would improve clinical outcomes and reduce the burden of the opioid crisis.

While OSA techniques in cardiac surgery are a logical next step, roadblocks exist which prevent their application, including a lack of knowledge and prejudiced attitudes against the various OSA techniques. Bridging knowledge gaps and uncovering biased attitudes that may impede the implementation of and adherence to OSA techniques in cardiac surgery led this author to a level one trauma center where a new ERACS program was recently developed.

Purpose

This project aims to discover knowledge gaps and biases toward OSA techniques in cardiac surgery. It is hypothesized that discovering biased attitudes and bridging knowledge gaps will improve Certified Registered Nurse Anesthetists' (CRNAs) understanding and promote the utilization of OSA techniques in their cardiac surgery practice.

Review of Current Evidence

Search Strategy

A literature search for all English-language, peer-reviewed studies evaluating opioid-free anesthesia and cardiac surgery was completed within the following databases: CINAHL Complete, Google Scholar, ProQuest Central, and PubMed. Keywords "opioid-free anesthesia" and "cardiac surgery", "awake cardiac surgery", "opioid-sparing anesthesia in cardiac surgery", and "fast-tracking cardiac surgery" were utilized.

Opioid-sparing techniques in cardiac surgery

Evaluations of OSA applications in cardiac surgery included case reports, literature reviews, and prospective randomized clinical trials. Trials included on and off cardiopulmonary bypass techniques and various opioid-free and regional anesthesia techniques (Chanowski et al., 2019; Noiseux et al., 2008). Most research studies were randomized controlled trials comparing groups who received an opioid-free treatment regimen to those who did not. These studies evaluated not only postoperative visual analog scale (VAS) scores but ventilator durations, lengths of stay in the intensive care unit, and use of rescue opioid analgesics as well (Chakravarthy, 2014; Guinot et al., 2019; Kumar et al., 2018; Roediger et al., 2006). Despite the variety of techniques described in the literature, some common themes emerged.

Regional and neuraxial techniques

First, regional blocks for cardiac surgery patients are especially useful in limiting or eliminating opioid requirements in intraoperative and postoperative periods. Contemporary research has shown a correlation between the use of regional blocks with decreased duration of postoperative ventilatory support, improved VAS scores, and reduced rescue analgesia requirements postoperatively (Chanowski et al., 2019; Jack et al., 2020; Kumar et al., 2018; Liu et al., 2019). The regional anesthesia techniques used included bilateral pectoralis nerve blocks, placement of continuous infusion via erector spinae plane catheters, and parasternal intercostal nerve blocks. These methods effectively prevent nociceptive transmission from the midline sternotomy incision, the primary and most significant source of pain following cardiac surgery. By eliminating this painful stimulus, fast and ultrafast tracking is possible following open-heart surgery. Benefits include speedier extubation times, shortened intensive care unit stays, and more brief overall hospital lengths of stay. The utilization of continuous incisional infusion has also been associated with pneumonia prevention in the postoperative period, a complication linked to increased morbidity and mortality following cardiac surgery (Amour et al., 2019).

Improvements in ultrasound-guided regional anesthesia techniques and the broader utilization of minimally invasive surgical approaches have further advanced the ability to fast-track cardiac surgery patients. Because of its simplicity and perceived low risk of complications, the use of fascial plane blocks for patients undergoing thoracotomy or sternotomy has expanded

(Kelava et al., 2020). Pectoralis I (PECS I) injections block medial and lateral pectoral nerves, and the Pectoralis II (PECS II) blocks the lateral cutaneous branches of the intercostal nerves at thoracic spinal nerves two through six [T2-T6], providing analgesia to the upper anterolateral chest wall. Serratus anterior plane (SAP) blocks anesthetize the lateral cutaneous branches of intercostal nerves at T3-T9 and provide analgesia to the lateral chest wall. Pectointercostal fascial and transverse thoracic muscle plane (PIF/TTMP) injections block the anterior cutaneous branches of the intercostal nerves, providing analgesia to the anterior or parasternal chest wall. Erector spinae plane (ESP) techniques anesthetize the spinal nerves' dorsal and ventral rami and provide analgesia to the anterior, lateral, and posterior chest wall (Kelava et al., 2020).

Additionally, neuraxial anesthesia in cardiac surgery is possible and has been used successfully (Liu et al., 2019; Noiseux et al., 2008). Thoracic epidural analgesia has long been considered the gold standard in thoracic surgery, leading to improved postoperative pain control and pulmonary performance while decreasing the incidence of post-thoracotomy pain syndrome (Kelsheimer et al., 2019). Thoracic epidural anesthesia provides pain relief from the median sternotomy incision by blocking spinal nerves. Since the cardiac accelerator nerve fibers arise from T1 to T4, this type of analgesia also blunts the sympathetic response to surgery, improving overall recovery from cardiac surgery by substantially reducing the magnitude of endogenous catecholamines released (Nagelhout & Plaus, 2014).

The use of thoracic epidural anesthesia in cardiac surgery is controversial as these patients require systemic heparization for cardiopulmonary bypass. Systemic heparinization while having an epidural in place can increase the risk of epidural hematoma. In the event an epidural hematoma occurs and is not diagnosed promptly, the patient may develop irreversible paralysis below the hematoma site. Despite the risk of irreversible paralysis, research demonstrates the threat of epidural hematoma is exceptionally low. Patients undergoing cardiac surgery should not be denied thoracic epidurals as the benefits of exceptional pain control and patient satisfaction coupled with decreased ventilator dependence and intensive care unit stays outweigh the risk of developing an epidural hematoma (Chakravarthy, 2014; Liu et al., 2019; Noiseux et al., 2008; Roediger et al., 2006).

Multimodal agents

The use of non-opioid medications during and after cardiac surgery without regional or neuraxial anesthesia can significantly reduce the number of rescue analgesics required in the postoperative period as well as the duration of ventilatory support and the lengths of stay in intensive care units (Grant et al., 2020; Guinot et al., 2019; Kremer & Griffis, 2018; Roediger et al., 2006). Combinations of non-opioid medications have included induction boluses of intravenous dexmedetomidine, ketamine, lidocaine, and propofol with lidocaine, followed by propofol infusions through the conclusion of surgery. Postoperative analgesics have included intravenous acetaminophen, oral tramadol, and non-steroidal anti-inflammatory medications. These combinations allow multiple receptor sites to be either stimulated or blocked, depending on the mechanism of action of the particular drug. This technique provides more comprehensive pain relief than opioids alone (Markham et al., 2019; McConnell et al., 2018).

Knowledge gaps

The literature search disclosed numerous knowledge gaps. First, there was little research on opioid-free anesthesia in cardiac surgery and patient outcomes. Furthermore, many articles were reports from a single cardiothoracic surgeon about his work with opioid-free anesthesia techniques. Little research was published after 2015. This gap in time prevented the use of most of his research as it was completed greater than five years ago and was limited to his practice alone.

Conceptual Framework/Theoretical Model

Evidence-based practice model

The Academic Center for Evidence-Based Practice (ACE) created the ACE Star Model as an interdisciplinary approach to transfer knowledge into nursing and healthcare practice to improve patient quality of care (Indra, 2018). The ACE Star Model uses five points in transforming knowledge into practice: Discovery, Evidence Summary, Translation, Integration, and Evaluation.

Discovery is the finding of new knowledge and is represented by the research process (Indra, 2018). A literature search was performed to discover the latest research on OSA techniques in cardiac surgery. A pre-intervention survey was sent to participating CRNAs as part of the research process. The next step is the development of evidence summaries following a thorough literature review (Indra, 2018). This stage involved taking the body of evidence describing OSA techniques in cardiac surgery and developing an educational intervention for CRNAs based on identified knowledge gaps and biases discovered through the completion of an electronic survey. The third step in the ACE Star Model, translation, is built on the knowledge generated during the Evidence Summary and involves the development of clinical guidelines, protocols, or procedures (Bliss-Holtz, 2009). The educational intervention describing OSA techniques in cardiac surgery is expected to expand the CRNAs' knowledge of OSA techniques and encourage the incorporation of OSA techniques into their practice. This knowledge expansion and adoption of OSA techniques segue into the fourth-star point, Integration. The final step involves Quality Assurance (QA) and Performance Improvement (PI) processes; the former is utilized to monitor for expected outcomes and the latter should the results fall short of expectations (Bliss-Holtz, 2009). In this project, the evaluation of knowledge gained and if that new knowledge created change to the CRNA's practice will be monitored (QA).

Theoretical Framework

The theoretical framework used for this project is the change theory of nursing (see Figure 1). Kurt Lewin, a social scientist, developed the change theory. Lewin has been touted as the father of social psychology, and his philosophy has three major concepts: driving forces, restraining forces, and equilibrium. Lewin surmised that if one could recognize and comprehend the forces that support, resist, or are indifferent to change, one can discern the rationale for those behaviors and create an environment that will aid change (Spear, 2016). By applying the change theory framework to this project, CRNAs would be identified who 1) embrace change, 2) resist change, and 3) are indifferent to change. This application would aid in discovering how receptive the targeted group would be to learning about OSA techniques in cardiac surgery. Utilizing the change theory would ascertain whether CRNAs would implement these techniques more readily into their cardiac surgery anesthesia practice.

Methods

Permissions

Written permission to use the trauma center's anesthesia department as the project site was received in February 2021. Official approval for the use of the project site was received on March 29, 2021. The project was submitted to the University of North Carolina Greensboro's Institutional Review Board (IRB) on April 16, 2021. The submission was reviewed on May 10, 2021, with IRB approval deemed not required. Project IRB documentation was sent to the project site's IRB analyst for review. After completing the site's required Quality Assessment and Quality Improvement (QA/QI) checklist, a determination letter was received on June 3, 2021, stating that IRB approval would not be required.

Project design and data collection

This project used a descriptive, cross-sectional survey sent out electronically through the University of North Carolina Greensboro's Qualtrics system. Informational flyers containing a Quick Response (QR) code were placed in central locations within the anesthesia department. The electronic mail (e-mail) included a brief introduction and contact information with a hyperlink and QR code to the survey. A project information sheet was sent as an attachment. The survey assessed the knowledge and attitudes of CRNAs specific to OSA techniques in cardiac surgery.

The survey was sent out to thirty-three CRNAs on June 1, 2021, requesting those who chose to participate to complete the online survey within four weeks. The principal investigator reviewed all results after July 14, 2021. Based on the survey results, an educational intervention was planned to address knowledge gaps and describe techniques currently utilized in the medical center's ERACS program.

The educational intervention was provided to all anesthesia providers who wished to attend, including those who completed the electronic survey. The intervention was held on Friday, September 3, 2021, from 0700 to 0745 during the anesthesia department's monthly meeting. Four weeks after the educational intervention (October 3, 2021), another electronic survey was sent out to all CRNAs who participated in the educational intervention. The post-intervention survey would determine if attending the session improved their knowledge and attitudes regarding OSA techniques in cardiac surgery and encouraged them to increase the use of OSA techniques more frequently in their cardiac surgery anesthesia practice.

Sample

This project's participants included the CRNAs who work at a level 1 trauma center in Raleigh, North Carolina. Anesthesiologists, anesthesiologist assistants, anesthesia residents, student registered nurse anesthetists, and medical students were excluded from participation.

Setting

The project site has twenty-three operating rooms, excluding obstetric, electrophysiology, interventional radiology, magnetic resonance imaging, and gastrointestinal departments. The site performed 725 cardiac surgeries in 2020, averaging 56-71 cases per month and 2-4 cases per day. Six hundred thirty-six cases had been completed as of November 5, 2021. Opioid-sparing anesthesia techniques in cardiac surgery were unfamiliar to clinicians in this department before the advent of their ERACS program. The chief CRNA believed providing an educational intervention to his staff would help the CRNA staff better appreciate the importance of OSA techniques in cardiac surgery.

Implementation plan

The significant barriers to success are those CRNAs who resist change, as described in Lewin’s change theory of nursing. Opioids have been a cornerstone of cardiac anesthesia since its advent in the 1960s (Stanley, 2014). The established history of opioid use in cardiac anesthesia may make it challenging for many anesthesia providers to accept OSA techniques in cardiac surgery. However, opioids have been misused through over-prescribing and have contributed to opioid addictions, overdoses, and deaths (Jones et al., 2020). Therefore, it is imperative to discover knowledge and attitudes regarding OSA techniques in cardiac surgery. Bridging knowledge gaps and biases may lead to buy-in and increase the likelihood of CRNAs incorporating OSA techniques within their cardiac anesthesia practices.

Measurement methods/tools/instruments

A modified version of Velasco's interview guide (2019) was used in this project's electronic survey to identify CRNAs' knowledge and attitudes regarding OSA techniques in cardiac surgery. The survey collected demographic information regarding gender, age, ethnicity, and years of experience as a CRNA (see Tables 1-4). The survey further provided information about what the respondent knew and felt about general and cardiac surgery OSA techniques. The survey also collected respondents' positive and negative experiences with OSA techniques.

Data analysis

Open-ended questions were asked about positive and negative factors that influenced CRNAs' willingness to utilize OSA techniques in their clinical practice in general and specifically in cardiac surgery. The final open-ended question asked for any professional experiences shaping their beliefs or affecting the implementation of OSA techniques in cardiac surgery.

Themes were identified from the pre-intervention results, indicating a need for focused education on the perceived deleterious effects of dexmedetomidine and ketamine in cardiac surgery patients. Emphasis in the educational intervention was placed on the direction in which current research is leading cardiac surgery programs.

Following the educational intervention, a survey was sent to participants to evaluate the knowledge gained by the CRNAs and determine if they believed the intervention increased their ability to implement OSA techniques into their cardiac surgery anesthesia practice.

Results

A total of twenty-two CRNAs responded to the pre-intervention survey for a response rate of 66.7%. Most were female (63.4%), Caucasian (81.8%), between 30 and 39 years of age, and with

1-2 years of experience. Sixty-eight percent believed OSA techniques were effective in reducing intraoperative pain. Fifty-five percent of the respondents worked with ERACS protocols before August 2020. Sixty-eight percent of the participants believed OSA techniques should be included in cardiac surgery programs.

Seventeen CRNAs responded to the post-educational intervention survey for a response rate of 77.3%. Seventy-one percent of respondents strongly agreed that their knowledge of OSA techniques in cardiac surgery improved following the education intervention. However, most CRNAs surveyed neither agreed nor disagreed or somewhat disagreed that changes were made to their clinical practice following the educational intervention (52.9% and 58.8%, respectively). These CRNAs commented that many OSA techniques were utilized within the ERACS program, excluding regional blocks, but that those techniques learned during the education intervention furthered their understanding of and knowledge to support OSA techniques in cardiac surgery.

Discussion

High-dose opioids have been utilized in cardiac surgery since the 1960s (Stanley, 2014). However, fast- and ultrafast-tracking of cardiac patients have been made possible using neuraxial and regional blocks and OSA techniques (Chanowski et al., 2019; Grant et al., 2020; Guinot et al., 2019; Jack et al., 2020; Kremer & Griffis, 2018; Kumar et al., 2018; Liu et al., 2019; Noiseux et al., 2008; Roediger et al., 2006). With the advent of ERAS protocols and their success in bariatric, general, and orthopedic cases (Ljungqvist et al., 2017), the inclusion of OSA techniques in cardiac surgery is a natural progression.

This project aimed to identify knowledge gaps and biases against OSA techniques in cardiac surgery. Many participants were already aware of non-opioid pharmacological adjuncts in cardiac surgery. This project introduced various regional anesthetic techniques to participants through an educational intervention, prompting new knowledge acquisition. As a result of the educational intervention, CRNAs expressed an increased interest in applying regional anesthetic techniques in cardiac anesthesia at the project site. Additionally, participants expressed reduced reluctance to include dexmedetomidine and ketamine as components of OSA techniques in cardiac surgery.

Since high-dose fentanyl has been a vital part of cardiac surgery for so long, it was anticipated that biases would exist against OSA techniques in cardiac surgery settings. Surprisingly, twenty of twenty-two respondents answered “definitely yes” or “probably yes” when asked if OSA techniques should be included in cardiac surgery programs. These responses may reflect the newly developed ERACS program at the project site. As the degree of increased knowledge and acceptance is dependent on the education existing prior to the intervention, a more robust project would have been completed if the intervention had been implemented before August 2020.

Several limitations were identified during the course of the project. Certified Registered Nurse Anesthetists were the target audience. However, they are not the only anesthesia providers available. Including anesthesiologists, anesthesiologist assistants, and student registered nurse anesthetists would allow for more robust sample sizes and subsequent data pools. Additionally, more open-ended questions in the pre-survey would have allowed respondents the opportunity to express their opinions instead of limiting their responses to a Likert scale. Expanding the open-ended questions may have permitted the discovery of more knowledge gaps or biases that were not identified in the initial survey.

Conclusion

While OSA techniques, including regional and neuraxial anesthesia, have been remarkably successful in bariatric, orthopedic, laparoscopic general, and other chest wall surgeries (i.e., mastectomies), cardiac surgery should be the next arena where further research is focused. Cardiac surgery patients experience immense physical and emotional stress during all three stages of surgery: preoperative, intraoperative, and postoperative. They experience significant fear and anxiety, knowing their underlying cardiac disease and comorbidities can increase their risk of death during and after their surgery. If educating this patient population about a new technique eliminating their pain and assisting them through faster and potentially safer recovery, then we as anesthesia providers owe it to these patients to deliver this type of care in the form of OSA and all it entails: regional and neuraxial techniques and non-opioid medications.

Further research on the feasibility of OSA techniques and cardiac surgery should include a careful psychological assessment to ascertain a patient’s suitability. Additional research is needed to determine neuraxial anesthetic techniques risk, particularly concerning intraoperative heparinization and epidural hematomas. While the threat is 2% in some studies (Roediger et al., 2006), there has not been enough research to support this statistic. Most anesthesia providers will not consider a thoracic epidural because of this hazard, so more research is needed to determine the true risk and reassure anesthesia providers.

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Appendix A

Theoretical Framework: Lewin's Change Theory

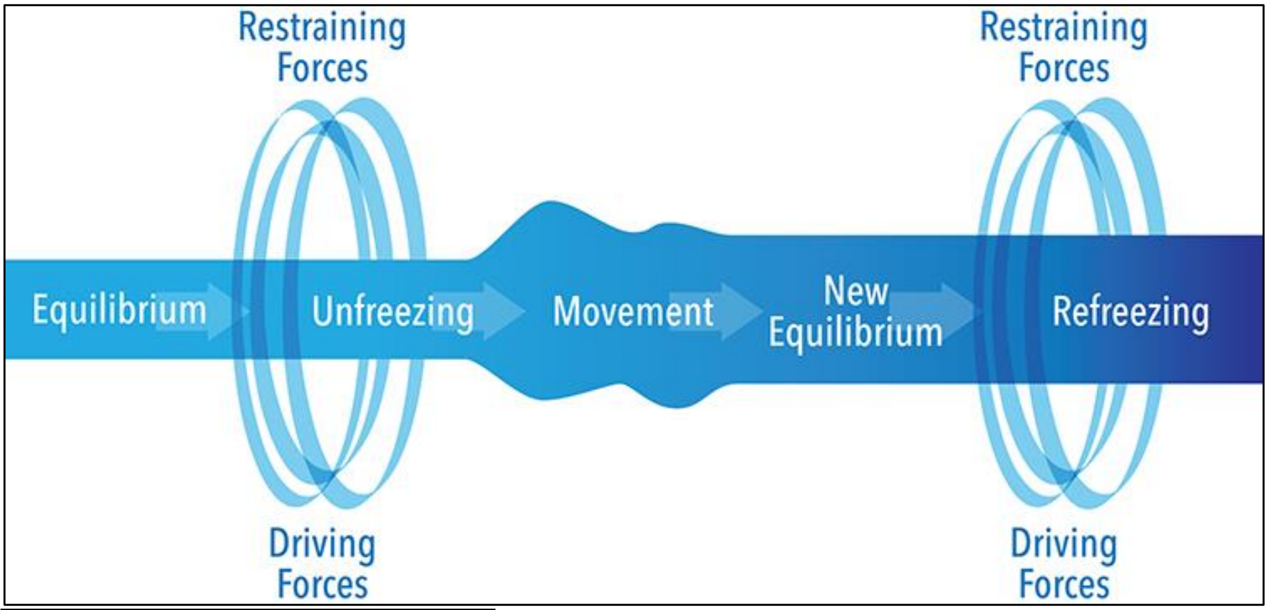

Figure 1 Lewin's Change Theory

Appendix B

Demographics: Gender

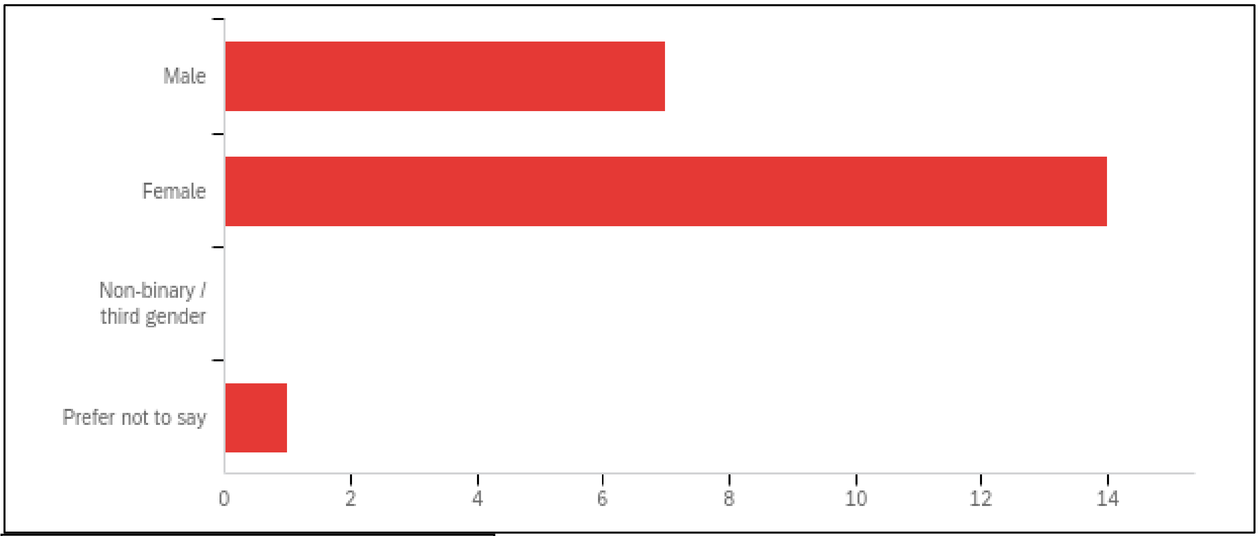

Table 1 Demographics: Gender

Appendix C

Demographics: Age

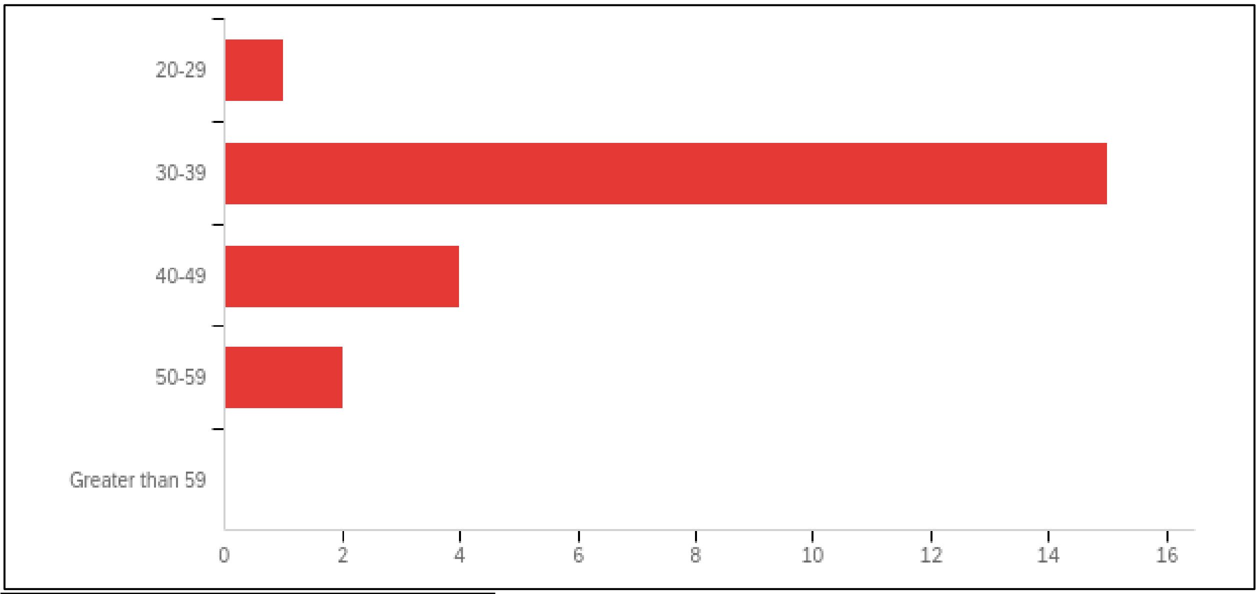

Table 2 Demographics: Age

Appendix D

Demographics: Ethnicity

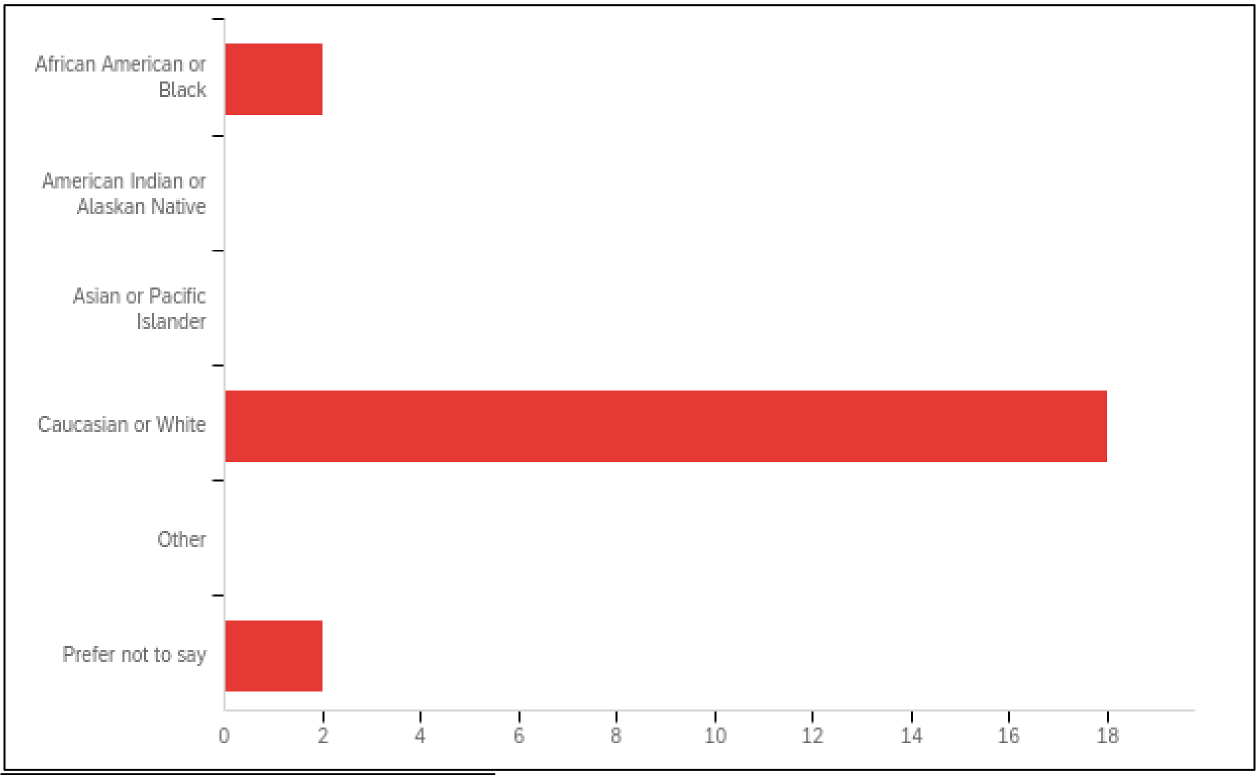

Table 3 Demographics: Ethnicity

Appendix E

Demographics: Years of Experience

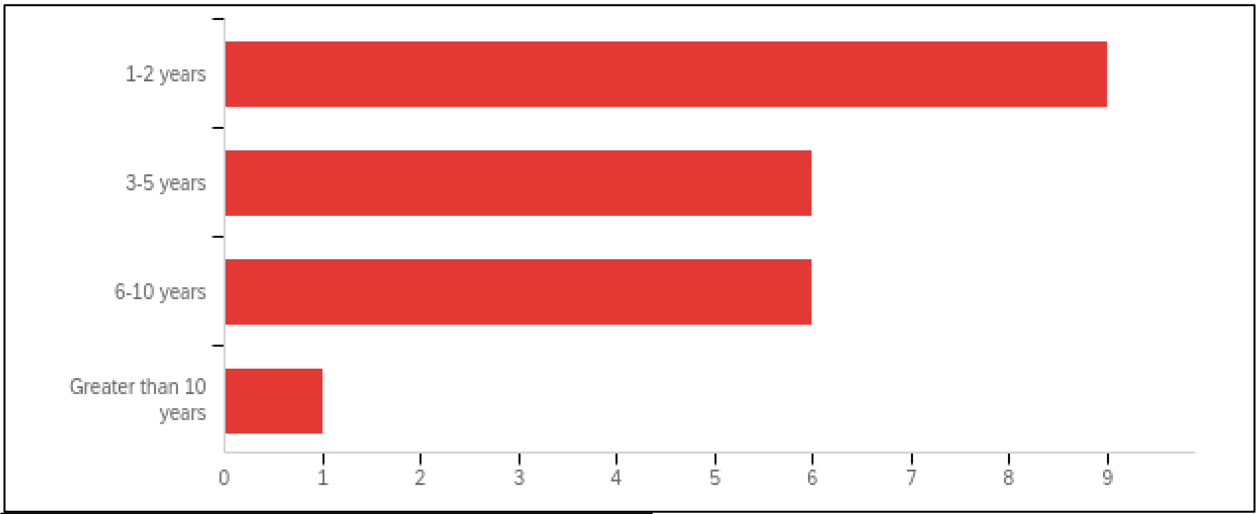

Table 4 Demographics: Years of Experience

Appendix F

Pre-survey tool

Opioid-sparing Anesthesia and Cardiac Surgery | Pre-Survey

Start of Block: Demographics

Q1 Please indicate your gender

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)

Q2 What is your age?

- ○ 20-29 (1)
- ○ 30-39 (2)
- ○ 40-49 (3)
- ○ 50-59 (4)
- ○ Greater than 59 (5)

Q3 What is your ethnicity?

- African American or Black (1)
- American Indian or Alaskan Native (2)
- Asian or Pacific Islander (3)
- Caucasian or White (4)
- Other (5)
- Prefer not to say (6)

Q4 How long have you been a CRNA?

- 1-2 years (1)
- 3-5 years (2)
- 6-10 years (3)
- Greater than 10 years (4)

Q5 Do you feel opioid-sparing anesthesia techniques in any surgical patient are effective in reducing intraoperative pain?

- Definitely yes (1)
- Probably yes (2)
- Might or might not (3)
- Probably not (4)
- Definitely not (5)

Q6 Thinking about what you **know and understand** of opioid-sparing anesthesia, please identify positive factors that influences you to utilize it within your clinical practice.

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Q7 Thinking about what you **know and understand** of opioid-sparing anesthesia, please identify negative factors that influences you to utilize it within your clinical practice.

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Q8 Prior to August 2020, had you worked with Enhanced Recovery After Cardiac Surgery (ERACS) protocols before?

- ○ Definitely yes (1)
- ○ Probably yes (2)
- ○ Might or might not (3)
- ○ Probably not (4)
- ○ Definitely not (5)

Q9 Do you believe opioid-sparing anesthesia should be included in cardiac surgery programs?

○ Definitely yes (1)

○ Probably yes (2)

○ Might or might not (3)

○ Probably not (4)

○ Definitely not (5)

Q10 Thinking about your experience in opioid-sparing anesthesia in cardiac surgery, please identify positive aspects in your clinical practice.

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Q11 Thinking about your experience in opioid-sparing anesthesia in cardiac surgery, please identify negative aspects in your clinical practice.

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Q12 Tell me about any professional experiences you may have encountered that would shape your beliefs or affect your implementation of opioid-sparing anesthesia techniques in cardiac surgery.

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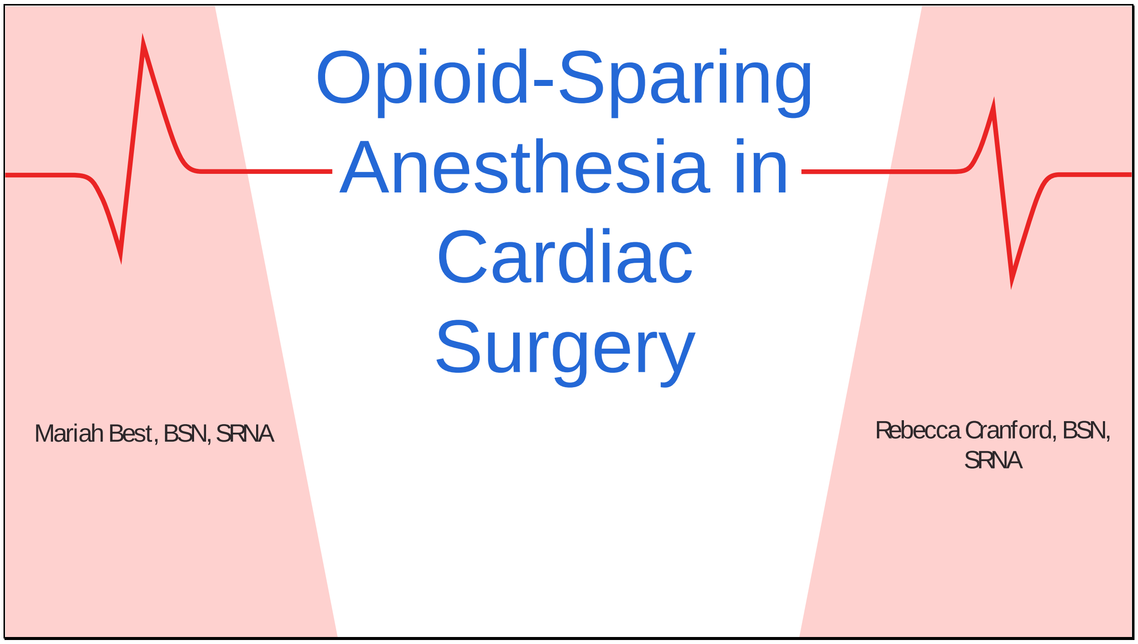
End of Block: Demographics

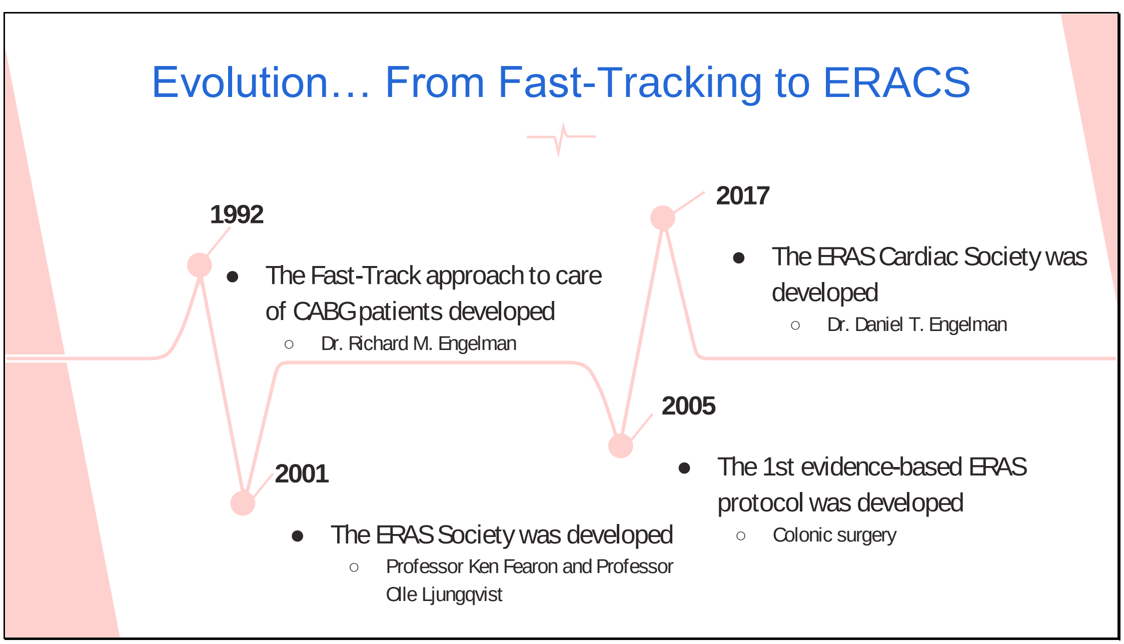
Appendix G

Educational intervention tool

Slide 1



Slide 2



Slide 3

Current Trends: Pharmacological Agents

Acetaminophen

- Opioid sparing
- Decreased postoperative delirium
- Antiemetic properties

Gabapentin

- Opioid sparing
- Decreased development of chronic pain postoperatively

Lidocaine

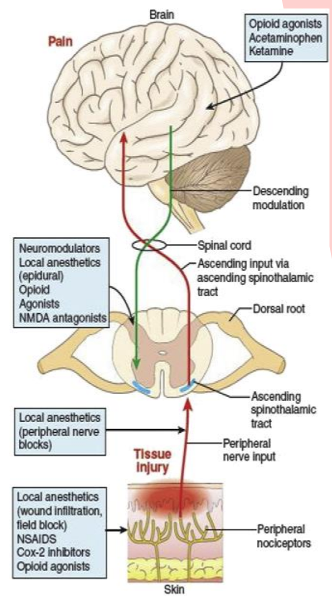
- Opioid sparing
- Early extubation
- Faster return of bowel function

Dexmedetomidine

- Opioid sparing
- Decreased postoperative delirium
- Early extubation
- Cardioprotective

Ketamine

- Opioid sparing
- Antihyperalgesia
- Improved hemodynamics
- Decreased respiratory depression
- Decreased postoperative delirium



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Slide 4

Current Trends: Regional Techniques

Erector Spinae Plane (ESP)

- Blocks spinal nerve dorsal and ventral rami
- Analgesia ALCW and posterior CW

Serratus Anterior Plane (SAP)

- Blocks lateral cutaneous branches of intercostal nerves apprx T3-T9
- Analgesia to LCW

Pectointercostal Fascial (PIF)

- Blocks anterior cutaneous branches of intercostal nerves
- Analgesia to parasternal CW

Pectoral I (PECS I)

- Blocks median and lateral pectoral nerves
- Analgesia to upper ALCW

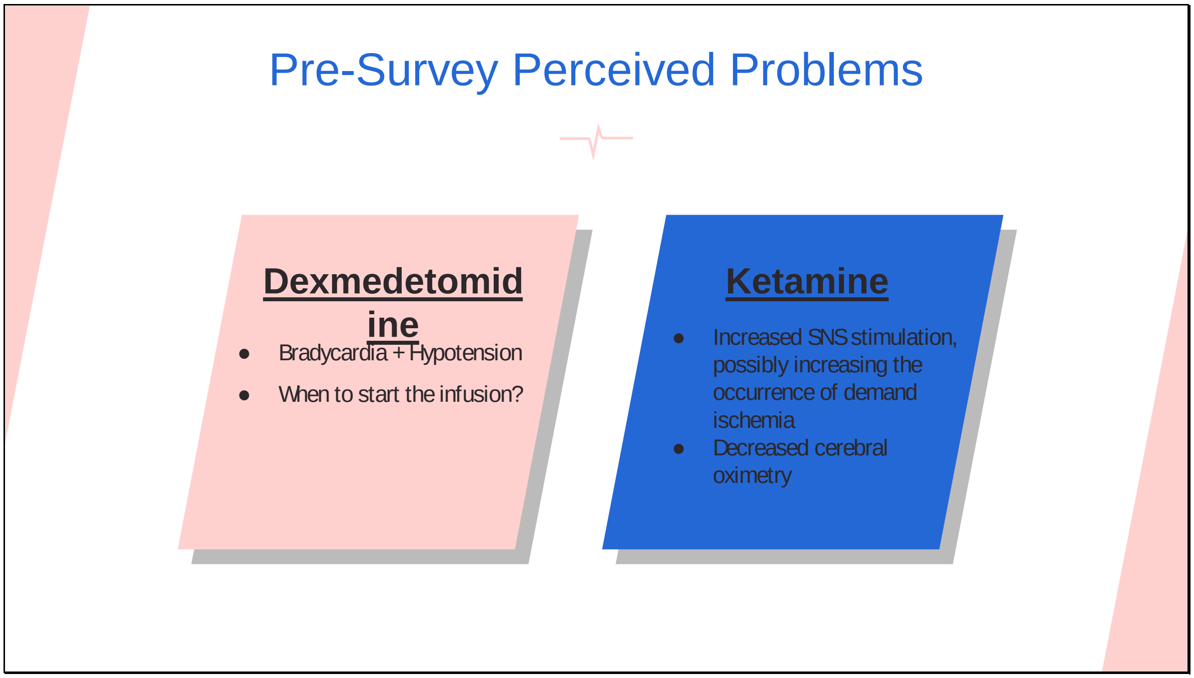
Pectoral II (PECS II)

- Blocks lateral cutaneous branches of intercostal nerves apprx T2-T6
- Analgesia to upper ALCW

Transverse Thoracic Muscle Plane (TTMP)

- Blocks anterior cutaneous branches of intercostal nerves
- Analgesia to parasternal CW

Slide 5



Slide 6

Slide 7

Slide 8

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Slide 10

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Appendix H

Post-survey tool

Opioid-sparing Anesthesia and Cardiac Surgery | Post-Survey

Start of Block: Default Question Block

Q1 Following the educational intervention held on September 3, 2021, I believe my knowledge on opioid-sparing techniques in cardiac surgery improved.

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

Q2 Following the educational intervention held on September 3, 2021, I made changes to my clinical practice to support opioid-sparing techniques in cardiac surgery.

- ○ Strongly agree (7)
- ○ Somewhat agree (8)
- ○ Neither agree nor disagree (9)
- ○ Somewhat disagree (10)
- ○ Strongly disagree (11)

Q3 If you did not make changes to your clinical practice to support opioid-sparing techniques in cardiac surgery, what were the barriers that prevented you from changing?

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End of Block: Default Question Block