Perioperative Care for Patients with Cardiac Implantable Electronic Devices: A DNP Project

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Abstract

The current process used by anesthesia providers delivering perioperative care for patients with cardiac implantable electronic devices lacks standardization and creates the potential for unexecuted safety measures that should be taken to avoid potentially dangerous or lethal outcomes for these patients in relation to their device. This quality improvement project focused on the creation and evaluation of an educational resource for anesthesia providers caring for patients with these devices in the perioperative setting. The primary investigator implemented this project at two small rural hospitals by emailing the newly created *AICD/PPM Handout* and an informational PowerPoint presentation to CRNAs working at each facility. Surveys were completed prior to and after CRNAs utilized the *AICD/PPM Handout* and information from the PowerPoint presentation for a two-week period. Based on the findings obtained, participating CRNAs perceived the *AICD/PPM Handout* and education provided as potentially helpful in their future care of patients with these devices. The small sample size and short implementation period were limitations of this project. Future suggestions include repeating the project with a greater number of CRNAs or expanding to multiple larger hospitals for an increased length of time**.**

Keywords: CRNA, perioperative period, education, CIED management

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Section I. Introduction

Background

Healthcare providers frequently manage complex patients with multiple comorbidities, and an increasing number of patients are requiring pacemakers and automatic implantable cardioverter/defibrillators, devices collectively known as cardiac implanted electronic devices (CIEDs; Ellis et al., 2017). In the United States nearly 250,000 CIEDs are placed annually, and over three million Americans have one. CIEDs are used to treat and manage cardiovascular symptoms including bradycardia, heart failure, and lethal arrhythmias. The prevalence of patients with CIEDs has increased over the years and they now represent 2% of all surgical cases (Neubauer et al., 2018). Because of this increase, it is essential that anesthesia providers can safely manage surgical patients with CIEDs.

Patients with CIEDs are at increased risk of complications in the perioperative setting. Electromagnetic interference (EMI), which occurs when electrosurgery is used during surgical procedures, places patients at risk of CIED error, misinterpretations, and misfiring. The electrical current emitted from the electrosurgery, for example surgical cautery, can be misinterpreted by a patient's automatic implantable cardioverter-defibrillator (AICD) as a lethal rhythm, causing the AICD to fire inappropriately. The risk of EMI depends on the type of electrosurgery and the location of the electrosurgery in relation to the site of surgery (Gifford et al., 2017). Monopolar electrosurgery utilizes a pencil-like electrode which carries an electrical current to the target tissue; from there the electrical current is retrieved by the grounding pad that is placed on the patient. In patients with CIEDs the electrical current may pass through or over the device, leading to EMI and potentially lethal consequences. Monopolar electrosurgery is associated with the highest risk of complications from EMI, especially when used in thoracic, head, neck, and

upper extremity surgeries. There is also bipolar electrosurgery, which has a much lower risk of causing EMI but has limited ability for cutting tissue and for coagulation. Bipolar electrosurgery is recommended in surgical procedures for patients with CIEDs, especially in the thorax, upper extremities head, and neck. Other issues may arise from EMI, such as damage to the CIED, inappropriate pacing, tissue damage to areas surrounding the CIED, and myocardial injury (Navas-Blanco et al., 2021).

To prevent EMI from occuring in patients with CIEDs, perioperative intervention is typically determined by surgical location, device type (pacemaker vs. AICD), type of electrosurgery, CIED settings, and primary indication for the CIED (Gifford et al., 2017; Neubauer et al., 2018). The American Society of Anesthesiologists (ASA) Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices (ASA Task Force, 2020) and Heart Rhythm Society (HRS; Crossley et al., 2011) recommend reprogramming the CIED to asynchronous pacing for surgical sites within six inches from the CIED if there is the potential need for monopolar electrosurgery. Frequently this step is taken prior to the start of the procedure, either in the preoperative setting or the operating suite.

In 2005, the American Association of Nurse Anesthetists (AANA) Journal released an update for arrhythmia management devices and EMI that highlighted the importance of preoperative interrogation and selective magnet application for monopolar electrosurgery close to the surgical site (Mattingly, 2005). Depending on the device type and manufacturer, applying a magnet over the CIED can alter the settings of the device or stop the ability of the device to defibrillate (Gifford et al., 2017). However, in most instances, when the surgical site is greater than six inches from the patient's CIED there is no intervention necessary with the use of bipolar electrosurgery.

There is variability in perioperative CIED management based on surgical location, electrosurgery type, and device type which may contribute to a lack of consistency in caring for these patients. Institutions should be equipped with a detailed protocol, so anesthesia providers are not left to rely on clinical judgment and personal preference (Navas-Blanco et al., 2021). Due to the complexity of the care required fro patients with CIEDs in the perioperative setting, it is important for anesthesia providers to be aware of and follow current guidelines. Continued education addressing perioperative management of CIEDs has the potential to improve anesthesia providers' understanding of current practice guidelines, positively impact their practice, and ultimately prevent potential adverse events.

Organizational Needs Statement

Patient demographics for our partnering organization indicate a population with multiple comorbidities, including conditions that often require CIED placement and/or management. Anesthesia providers are primarily responsible for the perioperative care of patients with CIEDs at the partnering organization. The treatment of these patients relies heavily on the individual providers' knowledge and preferences regarding the specific management of CIEDs. Providing additional information about the perioperative care of patients with CIEDs may help prevent inconsistent management by anesthesia providers and decrease the risk of adverse events for this patient population.

The partnering organization has a policy for care of patients with CIEDs which states that, preoperatively, the anesthesia professional and the perioperative registered nurse will consult with the electrophysiology/cardiology service (EPCS) and/or primary provider managing the patient's CIED. The anesthesia professionals and the perioperative registered nurses are responsible for initiating interventions necessary for safe management for the intraoperative and

postoperative period. According to the policy and procedures, the following information should be collected preoperatively: device type and patient's dependence on the CIED, site of procedure, type of procedure, availability of a proficient provider to perform reprogramming, whether a cardioversion or defibrillation may be required during the procedure, anticipated perioperative position, the potential for EMI based on the type of electrosurgery, other potential EMI sources (i.e., nerve stimulators, lithotripsy), location of CIED generator, lead polarity, need for reprogramming, response to a magnet, presence of an alert, last pacing threshold, and procedure location. The policy includes a list of potential interventions, such as placing an armband on the patient to indicate that the pacemaker or AICD has been inactivated. The policy does not include when to reprogram the device, deactivate the device, or to apply a magnet.

Though the organization's policy specifies which members are primarily coordinating the perioperative management of CIEDs, there is little guidance for selecting the varying interventions listed. The partnering organization's anesthesia providers may benefit from education about standard practice guidelines for perioperative care of patients with CIEDs. Education and clarification of techniques regarding the appropriate use of a magnet, instances that require deactivation or reprogramming, and current recommendations by the HRS and ASA may help to provide consistent management of patients with CIEDs (Ellis et al., 2017).

Problem Statement

The current process for anesthesia providers delivering perioperative care for patients with CIEDs lacks standardization and creates the potential for unexecuted safety measures that should be taken to avoid potentially dangerous or lethal outcomes for these patients in relation to their device.

Purpose Statement

The purpose of this quality improvement project was to assess anesthesia providers' perceptions of an *AICD/PPM Handout* as an educational resource to improve perioperative CIED management patient safety.

Section II. Evidence

Description of Search Strategies

The purpose of this literature review was to identify and synthesize peer-reviewed and scholarly articles related to care of patients with CIEDs in the perioperative setting. This included the perioperative management, advisory recommendations, barriers to advised management, and potentially beneficial changes to practice. The search for information was guided by the following PICOT (which stands for problem, intervention, comparison, outcome, and time format) question: In the perioperative care of patients with cardiac implantable electronic devices (CIEDs), how does implementation of a CIED checklist influence Certified Registered Nurse Anesthetist's (CRNAs) perceptions of care for this patient population? Concepts and terms related to the PICOT question were used to guide search strategies (see Appendix A).

The literature search utilized the databases PubMed Medline and Cumulative Index to Nursing and Allied Health Literature (CINAHL), as well as the search engine Google Scholar. For the PubMed Medline database, MeSH terms included "anesthesia," "anesthetist," "anesthesiologists," "pacemaker, artificial," "defibrillators," "surgical procedures, operative," "perioperative period," "workflow," "patient safety," "disease management," "heart," "cardiac," "magnets," and "electromagnetic phenomena." The limits applied to the PubMed Medline database search included publication within the last ten years (2012-2022) and English language. This search resulted in 17 relevant articles for review. The search of the CINAHL database included key terms and subject headings such as "anesthesia," "nurse anesthetists," "defibrillators, implantable," "pacemaker, artificial," "perioperative period," and "intraoperative period." Limits applied for CINAHL included information within 20 years (2002-2020) and

English language, this resulted in eight applicable articles for review. The date range searched for CINAHL was extended due to a lack of search results. For Google Scholar, key search terms were “anesthesia,” “implantable defibrillators,” “AICD,” “artificial pacemaker,” “surgical perioperative period,” “perioperative,” “management,” and “patients.” The only limit applied to Google Scholar was information published within the last four years (2018-2022) and 18 articles were pertinent for review. Google Scholar had the most results, however, it also included numerous articles related to veterinary anesthesia care. See Appendix A for main search concepts, keywords, and database specific terms. See Appendix B for the dates of the searches, search strategies, limits applied, number of articles found, number of relevant articles kept, and exclusion rationales for articles not considered relevant. Additional sources were identified by reviewing related and referenced articles and searching professional organization websites, such as ASA and AANA.

A full text review of the pertinent articles was completed, and eight articles were selected for inclusion in this review based on being peer-reviewed, aligned with the original PICOT question, and relevant to the quality improvement project. By applying Melnyk and Fineout-Overholt’s (2019) level of evidence model, the eight articles were categorized as follows: One systematic literature review (Level I), two observational design prospective cohort studies and one case-control prospective observational study (Level IV), one retrospective cohort study (Level V), one retrospective chart review (Level VI), and two expert opinion pieces (Level VII). See Appendix C for a literature matrix with additional information.

Selected Literature Synthesis

Preoperative Preparation and Interrogation of CIEDs

Based on current recommendations by the ASA, preoperative evaluation and preparation is vital to safe perioperative CIED management (ASA Task Force, 2020; Mattingly, 2005). Preoperative evaluation includes determination of CIED manufacturer, device type, current settings, recent interrogation report, and primary indication for use (e.g., bradycardia, syncope, and successful ablation). Preoperative interrogation should be considered if the last interrogation was greater than three to six months prior or if there is reason to suggest improper function. If the CIED interrogation has not been performed within that time frame, providers such as cardiologists or electrophysiology fellows are equipped with the skills to interrogate CIEDs and should be consulted. This may lead to delays in surgical cases because cardiologists and electrophysiology fellows may not be readily available to assist with preoperative CIED interrogation.

A recent study sought to determine compliance with ASA/HRS preoperative interrogation guidelines and correlate noncompliance with adverse cardiac events (Navas-Blanco et al., 2021). The researchers found that 76% of surgical cases followed current preoperative interrogation guidelines before surgery. Elective cases that failed to preoperatively interrogate had more adverse cardiac events than cases with interrogation (19% versus 4%). This data was deemed statistically significant and provides evidence supporting the need for preoperative interrogation to reduce subsequent adverse outcomes. Barriers to performing preoperative CIED interrogation included a scarcity of qualified providers, lack of time in preoperative holding, and insufficient documentation of previous interrogation (Ellis et al., 2017; Navas-Blanco et al., 2021; Rooke et al., 2015). Due to these barriers, patients with CIEDs may have to reschedule or

delay procedures or risk CIED related adverse outcomes associated with failure to perform preoperative interrogation in accordance with guidelines.

Analysis of Perioperative CIED Intervention

Gifford et al. (2017) conducted a prospective-observational study to understand the incidence of EMI in relation to surgical location. They found incidence of EMI was highest with surgeries on the thorax, followed by head and neck, upper extremities, and abdomen. The incidence was lowest below the iliac crest. Of the 143 patients who underwent surgery below the iliac crest, none experienced EMI with either type of electrosurgery. The authors suggested from these findings that CIEDs in surgical cases below the iliac crest require no reprogramming or magnet application.

A second observational study, similar to Gifford et al.'s (2017) work, found that certain surgical cases required no preoperative intervention to prevent EMI (Neubauer et al., 2018). Both concluded that CIEDs may not require magnet application or reprogramming if the surgical site is below the umbilicus and only bipolar electrosurgery is used. Magnet application may deactivate important functions, leading to adverse outcomes such as tachycardia, and may not be considered safe for every patient with a CIED undergoing surgery. The ASA Task Force (2020) corroborates this finding, suggesting magnets should not be used indiscriminately as an intervention for perioperative CIED management. Additionally, magnet application may not always deactivate internal defibrillators which can result in unnecessary shocks triggered by EMI (Neubauer et al., 2018). Reprogramming CIEDs is considered a reliable practice but may be time consuming and may not be feasible in emergent surgical situations. Devices that are reprogrammed must be set back to original settings postoperatively. Otherwise patients may

experience severe bradycardias, tachycardia arrhythmias, or potentially undetected lethal arrhythmias in the postoperative period and after discharge.

Synthesis of Perioperative CIED Strategies

The ASA Task Force (2020) recommended when monopolar electrosurgery is used during surgeries above the umbilicus, providers should alter CIED settings to asynchronous modes and suspend defibrillation functions. However, the ASA Task Force acknowledged that not all electrosurgery poses a risk of EMI, and therefore altering CIED settings may not be necessary in every case. There is a lack of research on magnet protocols for patients with CIEDs in the perioperative setting. Gifford et al. (2017) and Neubauer et al. (2018) conducted observational studies using standardized perioperative CIED protocols, and created management protocols which categorized and sorted patients into three groups: reprogramming, magnet application, or no intervention. Both studies concluded perioperative CIED management should factor in EMI risk and surgical location. Neubauer et al. (2018) found their perioperative CIED intervention protocol resulted in no recorded EMI or adverse cardiac events. Gifford et al. (2017) additionally noted that 69% of surgeries in their sample required no intervention to the patient's CIED. It is important to note both studies were nonrandomized, which was listed as a limitation in the conclusion of each article, and the Neubauer et al. study failed to include a control group. Despite these limitations, both author groups demonstrated that surgical site and EMI risk should be considered when planning CIED perioperative management.

Anesthesia-Led CIED Management

Operative care for patients with CIEDs is a multidisciplinary task which includes anesthesia providers and EPCS, as well as registered nurses in the preoperative, operative, and postoperative areas. The current practice for perioperative care for patients with CIEDs is

influenced by manufacturer recommendations and practice guidelines from professional associations including the ASA and HRS (Ellis et al., 2017). These associations recommend a qualified provider (someone who is familiar with the patient's case and CIED settings) should advise the surgical team on perioperative care (Crossley et al., 2011; Rooke et al., 2015). Anesthesia providers are primarily responsible for perioperative CIED management as they are readily available to assist and troubleshoot problems in the operating room (OR) or preoperative holding area. Unfortunately, even though anesthesia providers are available for CIED management, most are not familiar with all device types to consistently perform CIED interrogation and troubleshooting. CIED malfunctions must be referred to EPCSs. Unfortunately, these services are not always readily available to assist in the OR. This can lead to delayed case starts, cancellations, or even failure to adhere to ASA and HRS guidelines (Ellis et al., 2017).

Navas-Blanco et al. (2018) noted a lack of compliance with ASA/HRS preoperative CIED interrogation correlated with an increase in perioperative cardiac events. According to Rooke et al. (2016), one barrier to following ASA/HRS recommendations was limited availability of providers trained in CIED interrogation and programming. EPCS and device representatives are often responsible for CIED programming, but no specialty has been assigned or asserted ownership of this task. Without prior scheduling, EPCS is often not readily available to assist OR staff with CIED related issues. This may result in OR delays, potential damage to CIEDs, and adverse cardiac events. An anesthesia-led CIED service may be beneficial in taking charge of perioperative CIED management as they are immediately available to assist and troubleshoot in the perioperative areas (Ellis et al., 2017; Rooke et al., 2015). Anesthesia providers also have an advantage over EPCS in that they are more familiar with the effects of anesthetics on the cardiac system.

University of Washington Medical Center trained a small group of anesthesiologists to interrogate, reprogram, and troubleshoot CIEDs (Rooke et al., 2015). The group was referred to as the Anesthesiology Device Service (ADS). Data was collected comparing EPCS cases and ADS cases to determine efficiency and safety. Similarly, Oregon Health and Science University sought to evaluate an anesthesia-led CIED service as a solution to reducing delays in OR start times while still maintaining patient safety (Ellis et al., 2017). Both studies included a surgical CIED management protocol that reflected the most recent ASA and HRS recommendations (Ellis et al., 2017; Rooke et al., 2015). In each study, a team of anesthesiologists received extensive training and certification in CIED interrogation, programming, and evaluation. Data was collected pre-intervention and post-intervention to assess length of delays between scheduled surgeries and actual start times, adverse events, and patient safety. Both studies concluded that anesthesia-led device teams can provide safe CIED management, which can significantly reduce delay times and operating costs. Though the findings of each study were statistically relevant, neither were randomized-controlled studies. Further investigations are needed to identify solutions, including anesthesia-led services to address the current barriers of safe perioperative care for patients with CIEDs.

Synthesis Summary

The majority of the articles reviewed in this synthesis emphasized the increasing prevalence of patients with CIEDs and the importance of following evidence-based strategies for effective and safe perioperative management. The research conducted by Navas-Blanco et al. (2021) and recommendations by the ASA task force (2020) confirmed the importance of preoperative device interrogation to minimize adverse cardiac events. Two articles found that the appropriate CIED perioperative intervention can be categorized by surgical location, type of

electrosurgery, CIED settings, and primary CIED indication (Gifford et al., 2017; Neubauer et al., 2018). Preoperative and perioperative management of CIEDs has largely been the responsibility of EPCSs, but because this service is not readily available to assist in the OR, this practice can lead to delayed case starts or even cancellations (Ellis et al., 2017). Two studies successfully demonstrated safe and efficient CIED perioperative outcomes while implementing anesthesia-led CIED management (Ellis et al., 2017; Rooke et al., 2016). Anesthesia-led perioperative CIED management may reduce current barriers to preoperative CIED interrogation and perioperative management while still adhering to ASA task force guidelines. Each article added value to understanding perioperative CIED management and the current barriers to providing safe and effective care.

As noted by Rooke et al. (2016), the limited availability of expertly trained providers to manage CIEDs is a barrier to following ASA/HRS recommendations. Equipping anesthesia providers with the knowledge and expertise to independently interrogate, manage, and troubleshoot CIEDs would benefit patients in many capacities, including having a knowledgeable provider present during the entire surgical case (Ellis et al., 2017). Other benefits would include preventing delays in surgical start times, offering preoperative and postoperative interrogation, and perioperative reprogramming of CIEDs.

Project Framework

The plan-do-study-act (PDSA) cycle is the project methodology used for this quality improvement project. This cycle is a four-step process used to assess for change following an intervention (Agency for Healthcare Research and Quality, 2022). The planning step includes developing a concise statement of your plan, an anticipated outcome, and steps to achieve your goal. The doing part in the PDSA cycle is the execution of the devised plan and documentation

of specific observations during the process. Next, the study section is an analysis of the results collected in the previous steps. Finally, the act step involves forming a conclusion and suggesting or making changes to the intervention that stimulate change and action for future interventions.

This quality improvement project began with identification of a clinical problem followed by a plan for developing an intervention. The “plan” was based on the synthesis of literature surrounding perioperative care of patients with a CIED. The plan included creating an educational handout, PowerPoint presentation, and pre- and post-educational surveys. The “do” step, the implementation of this quality improvement project, was completed by providing education and tangible resources to the anesthesia providers participating in the project. Data was gathered from the pre- and post-surveys and analyzed in the "study" portion of the PDSA. The quality improvement project concluded with the “act” phase, which included developing and sharing recommendations for future quality improvements.

Ethical Considerations and Protection of Human Subjects

This quality improvement project provided participants (anesthesia providers) with education about CIED management based on best practice guidelines from the ASA, HRS, and the partnering organization’s policies. Providing education and a handout addressing current best practice surrounding perioperative CIED management did not involve risk or harm to the anesthesia provider participants beyond their usual work stressors. To ensure ethical considerations were addressed and to prepare for the formal approval process, the project lead and all persons participating in conducting this quality improvement project completed training through the Collaborative Institutional Training Initiative Program (https://about.citiprogram.org/). This quality improvement project did not involve direct patient care or interaction.

This DNP project was deemed quality improvement, and thus exempt from full review, through a screening process set up through the East Carolina University College of Nursing and the University and Medical Center Institutional Review Board (UMCIRB). In addition, facility approval through the research office of the partnering organization, in conjunction with the UMCIRB, was obtained. Local facility approval to collect data was obtained as evidenced by a signature from the local contact personnel at the project site on the organizational approval. See project approvals in Appendix D and E.

Section III. Project Design

Project Setting

This DNP quality improvement project took place in two small rural hospitals affiliated with a level 1 trauma center and teaching medical center which has over 60 anesthesia sites. Each of these two rural hospitals has fewer than 100 beds and fewer than five ORs. The local partnering facility's project barriers included time constraints for anesthesia providers, as the partnering organization serves a population of patients with multiple comorbidities and complicated surgical and anesthetic management. The partnering organization generates a fast-paced environment which may deter providers from following time-consuming practices related to CIED management. Facilitators included having an existing hospital policy for CIED management and available equipment.

Project Population

The target population for this quality improvement project was CRNAs providing perioperative care for patients with CIEDs. The CRNAs recruited for this quality improvement project were regularly involved with precepting Student Registered Nurse Anesthetists (SRNAs). Participant-related facilitators to this project included willingness of the staff to participate in the intervention and to provide feedback. Barriers included variability in CRNA experience with CIED management, reluctance to implement current practice guidelines, and limited perioperative time to apply project recommendations.

Project Team

The project team included a primary team leader SRNA and three additional SRNAs, a project chair, an on-site contact person, a clinical contact person, the CRNA program director, and a course director. The primary team leader SRNA completed a literature search and

synthesis, implemented the quality improvement project, collected data, analyzed data, and disseminated results. Three SRNA students who also addressed the same clinical topic collaborated with the primary team leader SRNA to create the intervention, which consisted of an educational handout and PowerPoint presentation, as well as the pre- and post-intervention Qualtrics survey questionnaires. The project chair served as the clinical contact person and provided insight about the facility and topic of interest. The on-site contact person signed the letter of acknowledgement affirming data was to be collected at the intended site. The program director provided expertise about the topic of quality improvement and coordinated the site of project implementation. The course director assisted with quality improvement process execution and scholarly writing.

Methods and Measurement

This quality improvement project assessed CRNAs' perceptions of the newly created *AICD/PPM Handout* (see Appendix F) as a resource to support perioperative care for patients with CIEDs. Emails were used as the mode of communication with the participating CRNAs (see Appendix G). Participating CRNAs were emailed a link to a pre-intervention survey (see Appendix H) to be completed prior to viewing the educational PowerPoint presentation and *AICD/PPM Handout*. The pre-intervention survey assessed a variety of topics related to perioperative care of CIEDs, including knowledge of current best practice, confidence level, ability to access resources, and utilization of existing organizational CIED policy. The PowerPoint presentation included current best practices for perioperative care of patients with CIEDs, organizational policy, explanation of CIED related terms and topics, and introduction of the *AICD/PPM Handout*. The CRNAs were provided with the *AICD/PPM Handout* (as an

electronic copy attached in the initial email) to use prior to and while taking care of patients with CIEDs over a two-week period.

After the allotted time, the CRNAs were emailed a link to the post-intervention survey (see Appendix H) to assess their perceptions regarding the handout and their confidence in performing current best practice guidelines. Qualtrics survey software was used to create and deliver pre- and post-intervention surveys. Once the data was compiled in Qualtrics, results were transferred to Excel for analysis. No patient information was recorded during this quality improvement project.

Project Design and Timeline

The first phase in the PDSA cycle was to plan the quality improvement project. The topic of the quality improvement project was identified in May 2021. Following this, in the fall of 2022, a review of existing literature was conducted utilizing PubMed, CINAHL, and Google Scholar. Select articles and studies were collected, organized into a literature matrix, and synthesized for this paper. Bi-monthly, in-person meetings were conducted to collaborate with other SRNA students, the program director, and the course director. Four SRNA students with the same project topic worked together to create the *AICD/PPM Handout*, the PowerPoint presentation, and the pre- and post-survey questions, which were finalized in February 2023. This project was approved as quality improvement through the UMCIRB and partnering organization in March 2023.

The second phase of the PDSA cycle, the “do” phase, was conducted by the primary team leader in March 2023. This phase included initiating the intervention, which began with sending an email to potential participants who were identified by the clinical contact person. The email included the pre-intervention survey, educational handout, and PowerPoint presentation. The

potential participants were asked to complete the pre-intervention survey prior to viewing the PowerPoint presentation and utilizing the educational handout. The participants utilized the *AICD/PPM Handout* while caring for patients with CIEDs for a two-week period. After the two-week period, a post-intervention survey link was emailed to the potential participants. The surveys consisted of a ten question pre-intervention survey and a nine question post-intervention survey, which utilized multiple levels of measurement including ordinal, interval, and ratio.

The last parts of the PDSA cycle are the "study" and "act" phases. During the "study" phase, the data collected through the Qualtrics surveys were transferred to Excel for analysis and creation of visuals. During the "act" phase of this project, a poster was created and presented. The poster presentation displayed a synopsis of the literature synthesis, guidelines for CIED management, and the findings from the surveys within this paper. The primary team leader presented the project poster to the university's CRNA program in November of 2023. Participants of the DNP project were invited to attend the poster presentation. Finally, this paper as well as the project poster have been made available through the university's electronic repository, The ScholarShip.

Section IV. Results and Findings

Results

Data for this DNP quality improvement project was collected over a two-week period. The goal of this project was to identify the perceptions of anesthesia providers regarding CIED management in their current practice and after utilization of the *AICD/PPM Handout.* Surveys were designed to assess the impact of the DNP project intervention and distributed to the participants prior to and after completion of the intervention. The pre-intervention survey evaluated the participants' perceived competence of perioperative care of CIEDs by assessing knowledge of current best practice, confidence level, ability to access resources, and utilization of organizational policy. The post-intervention survey assessed the CRNAs' perceptions of the *AICD/PPM Handout* effectiveness in aiding their perioperative CIED management and their confidence in delivering perioperative care to patients with CIEDs that aligned with current best practice guidelines. The pre-intervention survey was completed by three CRNAs and the post-intervention survey was completed by three CRNAs. Pre- and post-intervention data were collected using Qualtrics and analyzed using Excel.

Data Presentation

Pre-Intervention Assessment. The pre-intervention survey was completed by three CRNAs. Once the pre-intervention survey was completed, the CRNAs were instructed to view the AICD/PPM PowerPoint with voice-over and the *AICD/PPM Handout*. Prior to the intervention, all three CRNAs reported not currently using a standardized approach for providing perioperative care for patients with CIEDs. When asked about how often they had trouble obtaining all necessary information on a patient's CIED, two CRNAs reported "most of the time," and one reported "sometimes." When asked if they were aware of or have used the

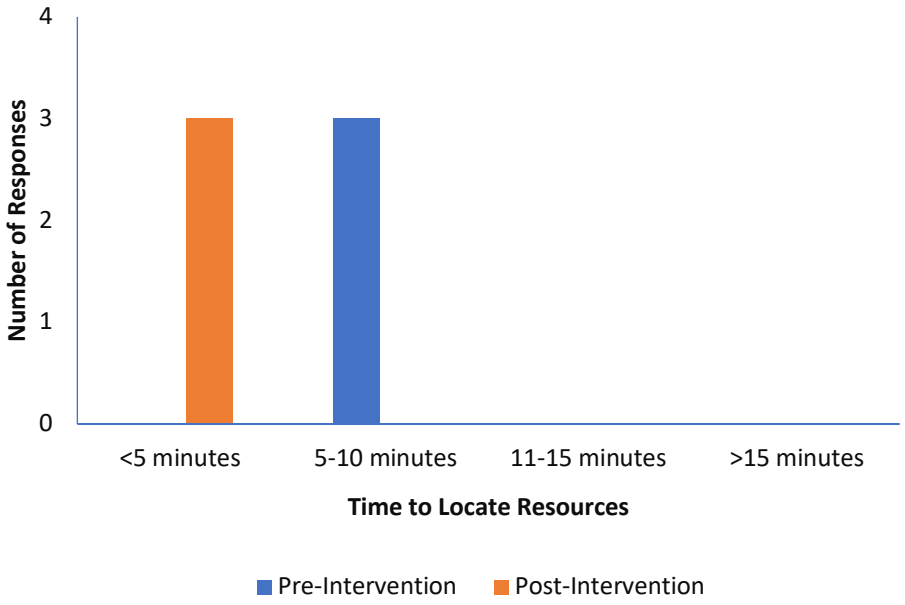
AICD/PPM policy at their place of work, all three CRNAs answered "not aware, not used." No participants reported being involved with, or knowing any colleague being involved with, a poor postoperative outcome related to inadequate management of their patient's AICD/PPM. When participants were asked if they believe additional AICD/PPM education would help prevent negative outcomes, one responded, "I believe it would be somewhat helpful," and two responded "I believe it would be extremely helpful." No CRNA participants reported experiencing an issue with the an AICD/PPM during any perioperative stage.

Post-Intervention Assessment. The post-intervention survey was available approximately two weeks after the initial email was sent. This survey was completed by three CRNAs. After the intervention, all three CRNAs reported referencing the *AICD/PPM Handout* for "0-2 procedures." Additionally, the CRNAs were asked to assess the usefulness of the *AICD/PPM Handout*; three answered "very useful." When asked if using the *AICD/PPM Handout* increased their confidence in ensuring the assessment of their patient's device was thorough, two CRNAs reported "strongly agree" and one reported "somewhat agree." When asked if using the *AICD/PPM Handout* improved their efficiency in preoperative assessment of the patient's AICD/PPM, one CRNA reported "somewhat agree," and two CRNAs reported "strongly agree." When asked the likelihood that they would use this *AICD/PPM Handout* in the future, three CRNAs reported "extremely likely."

Pre- and Post-Intervention Assessment. Multiple survey questions assessed the CRNAs' perceptions prior to and after project implementation. Three CRNAs completed the pre-intervention survey and the post-intervention survey. The CRNAs were asked to estimate the amount of time it would take them to find reference material on AICD/PPM information prior to project implementation and after project implementation (see Figure 1).

Figure 1

Amount of Time to Find Reference Material on AICD/PPM Information

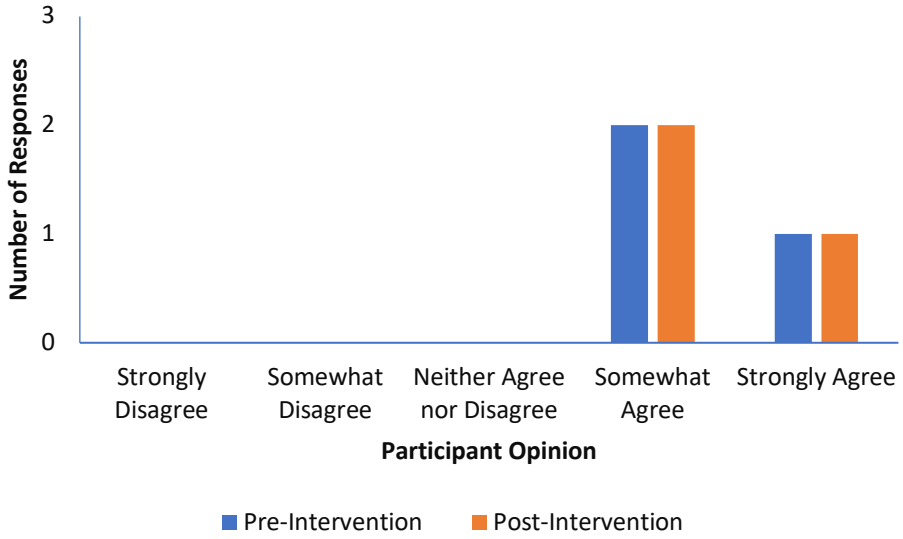


Note. Pre-Intervention n=3. Post-Intervention n=3.

Comfortability providing anesthesia to patients with an AICD/PPM was assessed pre- and post-project implementation (see Figure 2). Pre- and post-intervention, CRNAs were also asked to assess their comfortability identifying and/or managing cases that are high risk for EMI (see Figure 3). Pre-intervention, participants were asked if they were familiar with the current best practice guidelines recommended by the ASA and HRS. One participant responded with "strongly disagree," one reported "somewhat agree," and one reported "strongly agree." Post-intervention, when asked the same question, two CRNAs reported "strongly agree" and one CRNA reported "somewhat agree."

Figure 2

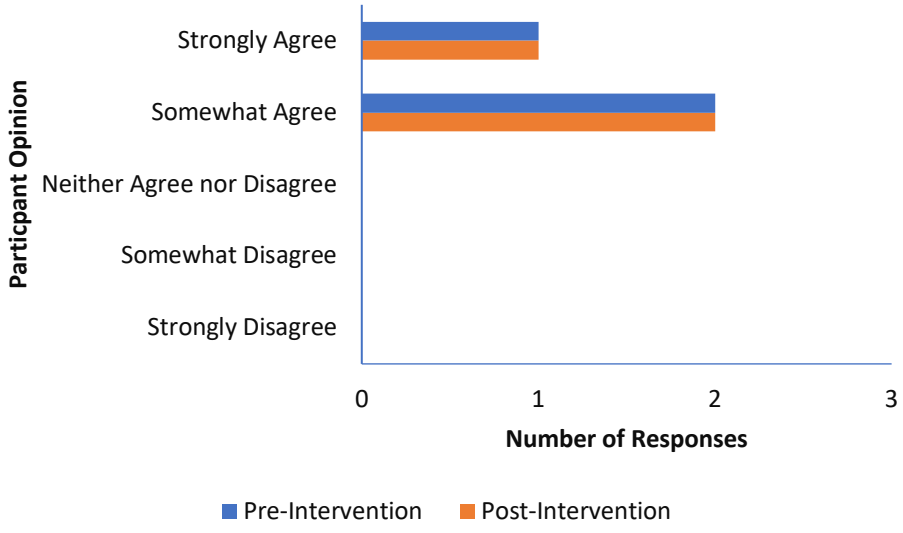
Comfortable Providing Anesthesia Care for a Patient with an AICD/PPM



Note. Pre-Intervention n=3. Post-Intervention n=3.

Figure 3

Comfortable Identifying and/or Managing Cases that are High Risk for EMI



Note. Pre-Intervention n=3. Post-Intervention n=3.

Analysis

From the data collected, multiple inferences can be made regarding CRNAs' perceptions of perioperative care of patients with CIEDs. It is important to note that none of the participating CRNAs reported using a standardized approach to caring for patients with a CIED. Additionally, all three participating CRNAs were not aware of the current AICD/PPM policy at their place of work, and therefore were not currently following their organization's policy. Pre-intervention, some CRNAs felt "strongly familiar" and "somewhat familiar" with the current practice guidelines recommended by the ASA and HRS regarding CIED perioperative management, while one strongly disagreed with being familiar with these guidelines.

Since the participating CRNAs are not using a standardized approach nor following an organization-approved policy for AICD/PPM perioperative care, this may suggest variability and lack of consistency caring for these patients. This may leave CRNAs to rely on clinical judgment and personal preference to make decisions about CIED perioperative management. However, some CRNAs reported a level of familiarity with the current best practices guidelines by the ASA and HRS, which may suggest a level of standardized approach to their current care.

After completing the intervention, two CRNAs reported being "strongly familiar" and one CRNA "somewhat familiar" with the current guidelines. This suggests a level of increased understanding of the best practice guidelines recommended by the ASA and HRS after completion of the intervention. It should also be noted that all three participating CRNAs reported they had not personally experienced a negative AICD/PPM outcome, nor do they know of a colleague who had. Still, prior to the intervention, participants replied that additional AICD/PPM education would help prevent negative outcomes. This may imply CRNAs believe

more education about CIED management may decrease the number of negative outcomes for patients with CIEDs.

Based on the data collected, CRNAs reported having trouble locating necessary information about patients' CIEDs "sometimes" to "most of the time". This may suggest a potential issue with multiple variables, ranging from lack of information within the chart to poor patient-provided history, or limited time to appropriately investigate required information. Average time spent looking for reference material for AICD/PPM management pre-intervention was reported to be five to ten minutes by all three CRNAs. After the intervention, all three participating CRNAs reported taking less than five minutes to acquire reference material for AICD/PPM care. This may suggest using a handout for AICD/PPM reference will decrease the amount of time CRNAs spend searching for required CIED information.

Participating CRNAs' comfortability providing anesthesia care for patients with AICD/PPMs did not appear to change over the course of the project implementation, nor did their comfortability identifying or managing high-risk EMI cases (see Figure 2 and Figure 3). However, post-intervention all three CRNAs reported that the *AICD/PPM Handout* was very useful and reported that they would be "extremely likely" to use the handout in the future. After completing the intervention, CRNAs at least "somewhat agreed" that their confidence in ensuring a thorough assessment of their patient's AICD/PPM increased. CRNAs also felt the *AICD/PPM Handout* improved their efficiency in perioperative assessment of the patients' AICD/PPM. It appears that the participating CRNAs view the *AICD/PPM Handout* to be useful and that the education provided will be helpful in their future care of patients with CIEDs.

Section V. Implications

Financial and Nonfinancial Analysis

Implementation of this quality improvement project could be a cost-effective endeavor for the organization. The cost of replicating the project would depend on the pay rate for employees and the estimated time to complete review of the *AICD/PPM Handout* and PowerPoint with voice-over. Primarily, four individuals created the PowerPoint with voice-over and the *AICD/PPM Handout*, with each contributing approximately five hours of time spent creating these documents. This would cost the organization approximately $1600.00 to $3000.00. The use of the Microsoft PowerPoint program was free for the individuals creating the PowerPoint with voice-over, as was the program Canva for the handout. Although Canva may require a subscription for more premium services, this handout was created with a free version. Since the PowerPoint and handouts were emailed, there was no reason to print them, so no additional cost was required for paper or ink. All communication was over email, and time to gather participants during a workday was not included. Participants were able to access the email at home or work, and no time was deducted from patient care time in the OR.

The greatest potential benefit of instituting this quality improvement project would be to prevent patient harm. The presumed patient harm would cost the hospital varying amounts depending on potential resuscitative measures and cost to replace the CIED device. It is difficult to quantify the cost for adverse events. However, damage to a CIED may require a hospital stay of approximately three days, of which cost would vary depending on the type of care required and type of CIED damaged (Nichols et al., 2016). The mean cost for repair of a PPM including a hospital stay is $19,959.00, and mean cost for a damaged AICD including hospital stay is $24,885.00. Based on these monetary estimates, preventing just one damaged CIED by

implementing this quality improvement project would save the organization approximately $17,000 - $23,400. Prevention of negative outcomes has additional nonfinancial benefits such as avoiding a negative community reputation of the organization, which could negatively impact future business.

Nonfinancial resources that added to the successful outcomes of this project included an organizational email system to allow communication between the primary project leader and CRNA participants. Participating CRNAs routinely checked emails and viewed the PowerPoint with voice-over and *AICD/PPM Handout*. CRNAs expressed optimistic attitudes regarding this quality improvement project and some CRNAs spoke with the primary project leader personally regarding the project. Based on the responses to the survey, this project provided the designated CRNAs with a resource which would be helpful in the future and provided education that could decrease potential negative outcomes related to perioperative care for patients with CIEDs. Another benefit that was observed from the survey responses was a decreased amount of time to find necessary resources related to CIED perioperative management.

Implications of Project

The aim of this DNP project was to identify the perceptions of anesthesia providers regarding CIED management in their current practice and after utilization of the *AICD/PPM Handout.* After participating in this quality improvement project, CRNAs would ideally apply the latest evidence-based practice recommendations of the ASA and HRS to their current practice. As noted previously, variability in the perioperative period for CIED management may contribute to a lack of consistency in care for these patients. This project revealed that CRNAs may not use a standardized approach to CIED management and are not aware of their organization’s policy. This aligns with the evidence presented in the literature synthesis in this

paper in which the researchers created and applied a standardized approach for perioperative CIED management after postulating a lack of consistent CIED management in current practice (Gifford et al., 2017; Neubauer et al., 2018).

As noted previously, project participants reported that additional AICD/PPM education would help prevent negative outcomes. This DNP project was designed to help standardize CIED management with an easily accessible resource and provide education on current ASA and HRS recommendations. The education provided by this DNP project addresses the perioperative management of CIEDs and has the potential to improve anesthesia providers' understanding of current practice guidelines and prevent potential adverse patient outcomes. The healthcare organization would benefit from this quality improvement project financially by decreasing patient adverse events, thereby reducing increased hospital stays and procedure costs needed to replace or repair devices in the event of an adverse event. The nursing practice of CRNAs would be improved by increasing provider knowledge and reducing potential patient harm.

Sustainability

The partnering organization can easily afford to continue using the *AICD/PPM Handout* due to the low cost of implementing its use. As described in the financial analysis section, preventing just one damaged CIED would potentially save the organization approximately $17,000 - $23,400. Distribution of the *AICD/PPM Handout* and PowerPoint could be accomplished by email, which would be free of cost. Those implementing the quality improvement intervention could assist coworkers in applying the recommendations within the *AICD/PPM Handout*. Anesthesia providers could improve their identification and management of cases that are high risk for EMI, thereby reducing adverse outcomes. Standardization of perioperative management of patients with CIEDs within the organization would comply with

the current best practice recommendation of the ASA and HRS. Factors that could reduce project sustainability include variability in CRNA experience with CIED management, limited time for anesthesia providers to find patient specific information, and inadequate perioperative time to apply project recommendations.

Dissemination Plan

The primary team leader SRNA developed a poster to disseminate the quality improvement project results. The primary team leader SRNA presented the poster to fellow SRNAs within the program, CRNA program faculty, and project participants. The final version of this paper and poster have been posted in The Scholarship, the university digital repository.

Section VI. Conclusion

Limitations

The small sample size (n=3) was limited by the number of CRNAs working at the project locations and staff willingness to participate. Smaller sample sizes have a low statistical power, prevent generalization of results, and can present higher variability. The primary team leader SRNA was present at only one of the hospital locations. The other location had no in-person contact with the primary team leader. The implementation period of two weeks limited the amount of time for participants to use the *AICD/PPM Handout*. This also decreased the likelihood of participants encountering patients that have CIEDs during the project timeframe. Another limitation of the project was the inability to link the pre- and post-intervention surveys with individual participants. This limited the ability to assess progress on an individual basis.

Recommendations for Future Implementation and/or Additional Study

If this project was to be replicated in the future, the primary researcher recommends adding an algorithm for CIED management by collaborating with cardiologists and/or electrophysiology fellows. An algorithm may be an easier way to assist in CIED management and guide provider decision-making. Decisions about the care of CIED management should be multidisciplinary and include plans for the preoperative, perioperative, and postoperative periods. Anesthesia providers are a vital part of the care for patients with CIEDs because of their comprehensive understanding of the cardiovascular effects of anesthesia. Anesthesia providers are not typically trained on reprogramming CIEDs or deciding appropriate settings on a patient specific basis, which makes the involvement of other specialties necessary for safe patient care. The algorithm development should include the expertise of other specialties to aid CRNAs in safe and effective CIED management.

Further implementation should include a larger sample size and allow for a longer period of data collection, which would require a medical organization with a greater number of CRNAs or expanding to multiple larger hospitals. Increasing the time for data collection would increase the probability of CRNAs encountering patients with a CIED. Both pre- and post-intervention surveys were anonymous, therefore the researcher could not identify if the participant completed both surveys, nor could the researcher mark their improvement. It would be valuable to assess if CRNAs' perioperative management of patients with CIEDs had improved post-intervention.

Adding a time to review the *AICD/PPM Handout* and present the PowerPoint to the staff may increase CRNA participation and encourage sustainability. The primary researcher was only onsite at one of the locations where data was collected. The researcher verbally contacted and discussed the project with three CRNAs at one rural hospital. In addition, it would be beneficial for the primary researcher to be present at each of the hospital sites. Additionally, accessibility to the *AICD/PPM Handout* could be improved by adding a link into the electronic health record for easy access.

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Appendix A

Literature Concepts Table

	Concept 1: Nurse Anesthetist	Concept 2: Pacemakers/ AICD	Concept 3: Perioperative	Concept 4: Management
Keywords	Nurse anesthetists, anesthesia, CRNA	Pacemakers, cardiac implanted electronic devices, permanent pacemakers, AICD/PPM	Perioperative, preoperative, postoperative, intraoperative, surgical	Disease management, patient safety, workflow
PubMed MeSH	Written for PubMed as "anesthesia"[MeSH Terms] OR “nurse anesthetist” [MeSH Terms] OR “anesthesiologists” [MeSH Terms]	Written for PubMed as "pacemaker, artificial"[MeSH Terms] OR “defibrillators” [MeSH Terms]	Written for PubMed as "surgical procedures, operative"[MeSH Terms] OR "perioperative period"[MeSH Terms]	Written for PubMed as "workflow"[MeSH Terms] OR "patient safety"[MeSH Terms] OR "disease management"[MeSH Terms] OR AND “heart” [MeSH Terms] OR “cardiac” [MeSh Terms] AND “magnets” [MeSH Terms] OR “electromagnetic phenomena” [MeSH Terms]
CINAHL Subject Terms	Written for CINAHL as (MH "Anesthesia") OR (“Nurse Anesthetists)	Written for CINAHL as (MH "Defibrillators, Implantable") OR (MH "Pacemaker, Artificial")	Written for CINAHL as (MH "Perioperative Period” OR “Intraoperative Period”)	

Google Scholar	“Anesthesia”	“Implantable Defibrillators” OR “AICD” OR “Artificial Pacemaker”	“Surgical Perioperative Period” OR “Perioperative”	“Management” AND “patients”

Appendix B

Literature Search Log

Search date	Database or search engine	Search strategy	Limits applied	Number of citations found/kept	Rationale for inclusion/exclusion of items
9/7/2022	PubMed	((Anesthesia) OR (Anesthesiologists) OR (nurse anesthetist)) AND ((pacemaker, artificial) OR (defibrillators)) AND ((surgical procedures, operative) OR (perioperative period)) AND ((workflow) OR (disease management) OR (patient safety)) AND ((heart) OR (cardiac)) AND (patients) AND (patients) AND ((electromagnetic phenomena) OR (magnets))	10 years English (2012-2022)	20/17	Nonsurgical Cardiac Implantable device Management, Magnetic Resonance related to nonsurgical procedures; Surgical ablation without pacemaker/ not applicable
9/13/2022	CINAHL	(MH "Anesthesia" OR "Nurse Anesthetists" OR "Anesthetists") AND ("Perioperative Care" OR "Intraoperative Period") AND (MH "Pacemaker, Artificial" OR "Defibrillators, Implantable")	20 years English (2002-2022)	10/8	Cardiovascular Disease for nonsurgical patients discussed/not applicable
9/13/2022	Google Scholar	Anesthesia AND (defibrillators OR AICD OR artificial pacemaker) AND (Perioperative OR surgical operative	4 years (2019-2022)	5 pages reviewed/20	Studies and articles related to veterinary anesthesia are not applicable

		period) AND management AND patients			

Appendix C

Literature Matrix

Year	**Author, Title, Journal**	**Purpose & Conceptual Framework or Model**	**Design and Level of Evidence** (use Melnyk)	**Setting**	**Sample**	**Tool/s and/or Intervention/s**	**Results**
2021	Navas-Blanco, J., Williams, D., & Modak, R. (2021). Analyzing the impact of preoperative interrogation of cardiac implantable electronic devices. *Annals of Cardiac Anaesthesia, 24*(4), 447-451.	Preoperative interrogation of the CIED minimizes the incidence of perioperative cardiac adverse events. The study measured the degree of compliance of providers with HRS/ASA recommendations for preoperative CIED interrogation. The study analyzed occurrence of perioperative cardiac events of patients with CIED who received preoperative interrogation versus those who did not. No conceptual framework or model used.	Retrospective, cohort study/ Level of Evidence- Level III	Hospital/ OR	Patients with CIEDs at a single center (tertiary teaching medical center) undergoing elective or emergent surgery over 3 years (2013-2016). 151 patients (power 80%). Mean age 66 yo; male 64%, female 36%; 77% elective cases, 23% emergent	Researchers used Fisher's exact test, two sample t-test, and chi-square. The researchers utilized a retrospective analysis to compare perioperative cardiac events for patients with CIED who received preoperative interrogation versus those who did not.	76% of patients had device interrogation of their device before surgery. 6% of cases had a preoperative delay due to patients CIED. Patients that did not have preoperative interrogation had more cardiac events when compared with interrogated CIED.

2020	The American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices. (2020). Practice advisory for the perioperative management of patients with cardiac implantable electronic devices: Pacemakers and implantable Cardioverter–Defibrillators 2020: An updated report by the American Society of Anesthesiologists task force on perioperative management of patients with cardiac implantable electronic devices. *Anesthesiology (Philadelphia), 132*(2), 225-252.	This advisory update addresses preoperative evaluation, preoperative preparation, intraoperative monitoring, managing potential EMI, and postoperative management. The review includes survey results of compliance with current practice guidelines No conceptual framework or model used.	Systematic literature Review/ Level of Evidence- Level I	N/A	Peer-review work with original findings from 1990-2019. Used 72 articles. The survey was based on highly experienced anesthesiologists and cardiologists but was a very small sample.	ASA-appointed task force includes 12 members including anesthesiologists, cardiologists, and two methodologists. Survey responses are based on a five-point scale and summarized based on median values.	For multiple topics surrounding perioperative care of CIED, there is inadequate research and randomized controlled trials. The review explains that there is insufficient evidence to support preoperative evaluation. This advisory update outline's expert opinion consensus regarding preoperative evaluation, preoperative preparation, intraoperative monitoring, managing potential EMI, and postoperative management.
2018	Neubauer, H., Wellmann, M., Herzog-Niescery, J., Wutzler, A., Weber, T. P., Mügge, A., & Vogelsang, H. (2018). Comparison of perioperative strategies in ICD patients: The perioperative ICD management study (PIM study). *Pacing and Clinical Electrophysiolo*	The study concluded the use of magnets, or no ICD inactivation may be safe ICD perioperative management. However, providers must still consider distance of surgical field from ICD and use of monopolar vs bipolar electrocautery. No conceptual framework or model used.	Case-Control Prospective observational study/ Level of Evidence- Level IV	Hospital/ OR	Data collection was nonconsecutive. Patients with ICD, > 18 yo, all patient's surgical field >6 inches from ICD. Exclusion criteria: patients with ICD with pacemaker dependence for bradyarrhythmia and prone surgeries.	This observational study used different ICD management strategies depending on type of electrocautery and location.	42 surgeries requiring monopolar electrosurgery above the umbilicus had their ICD reprogramed. 45 surgeries requiring bipolar electrosurgery above the navel, or monopolar electrosurgery below the umbilicus had a magnet applied over the device intraoperatively. 14 patients undergoing lower extremity surgeries using bipolar electrosurgery had no intervention. No EMI was detected in any category. Concluding

	gy, 41(11), 1536-1542.				Sample of 101 patients. Age (68 +/- 10 years on average); gender (86.1% male on average)		the strategies used in this study are safe in preventing EMI.
2017	Ellis, M. K. M., Treggiari, M. M., Robertson, J. M., Rozner, M. A., Graven, P. F., Aziz, M. F., Merkel, M. J., Kahl, E. A., Cohen, N. A., Stecker, E. C., & Schulman, P. M. (2017). Process improvement initiative for the perioperative management of patients with a cardiovascular implantable electronic device. *Anesthesia and Analgesia, 125*(1), 58-65.	This study implemented an anesthesiologist-run CIED management program that was trained to provide CIED management in the perioperative period. The researchers focused on patient safety, cost, and efficacy for care of patients with CIED perioperatively. No conceptual framework or model used.	Observational Cohort Study/ Multivariable linear regression analysis/ Level of Evidence- Level IV	Hospital/ OR	18 or older, (non-emergent, non-organ donor) First case patients for weekday procedures at Oregon Health and Science University with CIED: (preintervention) Feb 1, 2008- Aug 17, 2010; (Postintervention) Mar 4, 2012-Aug 1, 2014	Intervention: Anesthesia providers were trained to provide routine CEID management. After which a large hospital compared start times for first-case surgeries before the intervention to after the intervention. The study also looked at adverse outcomes related to patients with CIEDs. The anesthesiologists that were trained demonstrated CIED interrogations and identified CIED parameters, CIED event logs, battery status, pacing dependence, lead impedance, and pacing and sensing thresholds.	The mean difference in start time delay was 16.7 minutes. This demonstrated that anesthesia led CIED management saves time preoperatively. There were also less adverse events in the postintervention period. Concluding an anesthesia led CIED management can provide safe and efficient perioperative care for patients with CIEDs.
2017	Gifford, J., Larimer, K., Thomas, C., & May, P. (2017). ICD-ON registry for perioperative management of CIEDs: Most require no change. *Pacing and Clinical Electrophysiology, 40*(2), 128-134.	The ICD-ON protocol is safe and efficient for patients with CIEDs. The protocol factored in electrosurgery location and showed 69% of cases required no reprograming or magnet application. No conceptual framework or model used.	Observational design prospective cohort study/ Level of Evidence- Level IV	Hospital/ OR	Sample included patients with pectoral CIEDs undergoing surgery at three suburban Chicago hospitals; 331 patients; Mean age 73 years; 65% male; reprogram group (16%), magnet group (15%), no change (69%)	Depending on the electrosurgery, device, pacer dependence, and surgical location, patients were divided into three groups. Group one: patients with ICD or those who are pacemaker dependent required reprogramming for a surgical location within 6 inches of the CIED. Group 2: patients with ICDs whose surgical location was equal to or more than 6 inches from the CIED, but above the iliac crest required a magnet. Group three: all patients that did not fall into group 1 or 2	There was EMI in 45% of thoracic cases, 35% of head and neck cases, 15% of upper extremity, and 3% of abdominal cases above the iliac crest. No EMI was detected in cases below the iliac crest. Despite the EMI that was detected there were no inappropriate shocks/pacing or device reset in any other group.

						required no intervention.	
2015	Rooke, G. A., Lombaard, S. A., Van Norman, G. A., Dziersk, J., Natrajan, K. M., Larson, L. W., & Poole, J. E. (2015). Initial experience of an anesthesiology-based service for perioperative management of pacemakers and implantable cardioverter defibrillators. *Anesthesiology (Philadelphia), 123*(5), 1024-1032.	Anesthesiologists trained in advanced CIED interrogation, management, programming, troubleshooting can provide safe CIED management during surgery. Conclusion: specially trained anesthesia providers can perform CIED management but is only feasible in high volume facilities. No conceptual framework or model used.	Retrospective Chart review/ Level of Evidence-Level III	Hospital/ OR	Computer search program for pre-anesthesia notes (October 2009- June 2013); Patients undergoing surgery at University of Washington Medical Center with CIED; 662 Patients; 1025 procedures	Anesthesia providers at a large facility were provided with CIED company representees and Electrophysiology/Cardiology services. Lead Anesthesia providers passed the International Board of Heart Rhythm examiners Certification Examination for Competency in Cardiac Rhythm Device Therapy for the Physician.	In cases where restoration or asynchronous pacing for surgery, CIED management by trained CRNAs did not result in patient harm. Anesthesia providers were able to reprogram the CIED postoperatively and make minor rate changes to the devices.
2011	Crossley, G. H., Poole, J. E., Rozner, M. A., Asirvatham, S. J., Cheng, A., Chung, M. K., Ferguson, T. B., Gallagher, J. D. Gold, M. R., Hoyt, R. H., Irefin, S., Kusumoto, F. M., Moorman,	Provide an expert consensus on the management of CIED perioperatively. The authors of the article were appointed by the HRS and ASA. Each author is an expert in CIED perioperative management. The authors reviewed	Expert Opinion/ Level of Evidence-Level VII	N/A	Group of experts selected as well as a reference group of engineers and regulatory staff from CIED	Group of experts, reference group and writing committee convened in October 2009. Topics discussed: potential problems, appropriate preoperative evaluation, intraoperative	Note that recommendations are based upon available literature, however due to lack of current researched based evidence, most of this statement is based on expert experience.

	L. P., & Thompson, A. (2011). The heart rhythm society (HRS)/american society of anesthesiologists (ASA) expert consensus statement on the perioperative management of patients with implantable defibrillators, pacemakers and arrhythmia monitors: Facilities and patient management. *Heart Rhythm, 8*(7), 1114-1154. https://doi.org/10.1016/j.hrthm.2010.12.023	case reports, a large body of literature, and input from a reference group. Unfortunately, there were no randomized controlled trials to contribute to the statement. Most of the information listed is based on the experience of the writing group. No conceptual framework or model used.			manufacturers.	CIED management, and postoperative care for CIED.	
2005	Mattingly, E. (2005). AANA JOURNAL COURSE: Update for nurse anesthetists arrhythmia management devices and electromagnetic interference. *AANA Journal, 73*(2), 129-36. https://www.proquest.com/scholarly-journals/aana-journal-course-update-nurse-anesthetists/docview/222132974/se-2?accountid=10639	This journal course serves as a review for basic CIED function, EMI in the operative setting, and patient management recommendations. No conceptual framework or model used.	Expert Opinion/ Level of Evidence- Level VII	N/A	N/A	N/A	Educational course to update CIED management for anesthesia providers.

Note: Key to abbreviations: Cardiac Implantable Electronic Device (CIED), Electromagnetic Interference (EMI), Certified Registered Nurse Anesthetist (CRNA), Implantable Cardioverter Defibrillator (ICD). Key to Levels of Evidence: I: Systematic review/meta-analysis of

randomized controlled trials (RCTs); II: RCTs; III: Nonrandomized controlled trials; IV: Controlled cohort studies; V: Uncontrolled cohort studies; VI: Descriptive or qualitative study, case studies, EBP implementation and QI; VII: Expert opinion from individuals or groups. Adapted from *Evidence-based practice in nursing and healthcare: A guide to best practice* (4th ed.), by B. M. Melnyk and E. Fineout-Overholt, 2019, p. 131. Copyright 2019 by Wolters Kluwer.

Appendix D

College of Nursing/UMCIRB QI Determination

Based on your responses, the project appears to constitute QI and/or Program Evaluation and IRB review is not required because, in accordance with federal regulations, your project does not constitute research as defined under 45 CFR 46.102(d). If the project results are disseminated, they should be characterized as QI and/or Program Evaluation findings. Finally, if the project changes in any way that might affect the intent or design, please complete this self-certification again to ensure that IRB review is still not required. Click the button below to view a printable version of this form to save with your files, as it serves as documentation that IRB review is not required for this project. 11/30/2022

Appendix E

Health Research Department Letter

Center for Research and Grants [redacted]

Quality Improvement Project vs. Human Research Study Determination Form

This worksheet is a guide to help the submitter to determine if a project or study is a quality improvement (QI) project or research study, is involving human subjects or their individually identifiable information, and if IRB approval as defined by the Health and Human Services (HHS) or Food and Drug Administration (FDA) is required. (For more guidance about whether the activity meets the definition of Human Subjects Research see the IRB FAQs or the Human Subject Research Decision Chart)

Please use Microsoft Word to complete this form providing answers below. For signatures, please hand sign or convert into a PDF file and electronically sign. Once completed and signed please email the form to the [redacted] Center for Research and Grants ([redacted] CRG) at CRG.Qualit[redacted]A CRG team member will contact you with the results of their review and may request additional information to assist with their determination. The determination will be made in conjunction with the UMCIRB office.

Project Title: Perioperative Care for Patients with Cardiac Implantable Electronic Devices DNP Project		
Funding Source: None		
Project Leader Name: Leanne Burton, BSN, SRNA/ Travis Chabo, PhD, CRNA ☐ **Ed.D.** ☐ **J.D.** ☐ **M.D.** ☐ **Ph.D.** ☐ **Pharm.D.** ☒ **R.N.** ☐ **Other(specify):**		
Job Title: ECU SRNA/ECU CRNA Faculty	**Phone:** [redacted]	**Email:** chabot14@ecu.edu
	Primary Contact (If different from Project Leader):	
	Phone: [redacted]	**Email:** burtonl11@students.ecu.edu

Key Personnel/ Project Team members:

Name and Degree:	**Department:** (Affiliation if other than [redacted]	**Email:**
Leanne Burton	ECU Nurse Anesthesia Program	burtonl11@students.ecu.edu
Travis Chabo	ECU Nurse Anesthesia Program	chabot14@ecu.edu

QI/QA Assessment Checklist:

Consideration	Question	Yes	No
PURPOSE	Is the PRIMARY purpose of the project/study to: • IMPROVE care right now for the next patient? OR • IMPROVE operations outcomes, efficiency, cost, patient/staff satisfaction, etc.?	☒	☐
RATIONALE 1	The project/study falls under well-accepted care practices/guidelines or is there sufficient evidence for this mode or approach to support implementing this activity or to create practice change, based on: • literature • consensus statements, or consensus among clinician team	☒	☐
RATIONALE 2	The project/study would be carried out even if there was no possibility of publication in a journal or presentation at an academic meeting. (**Please note that answering "Yes" to this statement does not preclude publication of a quality activity.) **Of note, quality must not be published as if it is research!**	☒	☐
METHODS 1	Are the proposed methods flexible and customizable, and do they incorporate rapid evaluation, feedback and incremental changes?	☒	☐
METHODS 2	Are patients/subjects randomized into different intervention groups in order to enhance confidence in differences that might be obscured by nonrandom selection? (Control group, Randomization, Fixed protocol Methods)	☐	☒
METHODS 3	Will there be delayed or ineffective feedback of data from monitoring the implementation of changes? (For example to avoid biasing the interpretation of data)	☐	☒
METHODS 4	Is the Protocol fixed with fixed goal, methodology, population, and time period?	☐	☒
RISK	The project/study involves no more than minimal risk procedures meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.	☒	☐
PARTICIPANTS	Will the project/study only involve patients/subjects who are ordinarily seen, cared for, or work in the setting where the activity will take place?	☒	☐
FUNDING	Is the project/study funded by any of the following? • An outside organization with an interest in the results • A manufacturer with an interest in the outcome of the project relevant to its products • A non-profit foundation that typically funds research, or by internal research accounts	☐	☒

If all of the check marks are inside the shaded gray boxes, then the project/study is very likely QI and not human subject research. Projects that are not human subject research do not need review by the IRB.

In order to assess whether your project meets the definition of human subject research requiring IRB review or may qualify as a quality improvement/assurance activity, please provide the following information:

1. Project or Study Summary:

Please provide a **summary of the purpose and procedures** as well address all of the following:
The purpose of this quality improvement project is to assess Certified Registered Nurse Anesthetists' (CRNAs') perceptions of the adequacy of a newly developed *AICD/PPM Handout*. The *AICD/PPM Handout* is a quick reference tool based upon accepted national guidelines created to aid in the perioperative care of surgical patients with cardiac implantable electronic devices (CIEDs). CRNAs at [redacted] Center will be asked several questions (through Qualtrics) about their perceptions of the adequacy of their current practice and preparedness for providing perioperative care for surgical patients with CIEDs. An educational PowerPoint with voiceover about the use of the newly developed *AICD/PPM Handout* will be made available to them, and they will be asked to use the guide for two weeks. Upon completion of the two-week utilization period, they will be asked to complete a questionnaire about their perceptions of the adequacy of the *AICD/PPM Handout*. Qualtrics survey software will be used to gather participant perceptions of acceptability and adequacy of the intervention prior to and post implementation of the project. No patient information will be recorded or maintained during this project.

a) The project's primary purpose. The purpose of this quality improvement project is to assess CRNAs' perceptions of an *AICD/PPM Handout* as an educational resource to improve perioperative CIED management patient safety.

b) The project's design. The project will consist of a single Plan, Do, Study, Act cycle using a pre- and post-intervention survey design.

c) Any interaction or intervention with humans. CRNA participants will be contacted via email and asked to complete a pre-survey and then utilize an informational tool based on current evidence that aligns with practices currently accepted within the facility to support their practice regarding perioperative care for patients with CIEDs. After two weeks they will then be asked to complete a post-survey addressing their perceptions of the intervention and their own practice. The primary researcher will be available electronically, by phone, or in person to consult with participants as needed.

d) A description of the methods that will be used and if they are standard or untested. Data will be gathered directly from participants through the completion of Qualtrics pre- and post-surveys delivered and completed electronically.

e) Specify where the data will come from and your methods for obtaining this data -please specify who/where (i.e., CRG will provide you with the data, or someone from a specific department will provide you with the data, or you will pull it yourself). The intervention for this project will be a newly created informational tool focused on perioperative care for patients with CIEDs, which is based on current evidence and falls within current accepted practice standards within the facility.

f) Specify what data will be used and any dates associated with when that data was originally collected (i.e Patient Name, Diagnosis, Age, Sex), *If applicable, please attach your data collection sheet.* Aside from participant email and IP addresses, no identifiable data will be gathered. Data of interest is participant opinions and perceptions of practice and the newly developed informational tool.

g) Where will the data (paper and electronic) for your project be stored? Please specify how it will be secured to protect privacy and maintain confidentiality. For paper data, please provide physical location such as building name and room number and that it will be kept behind double lock and key. For electronic data, please provide the file path and folder name network drive where data will be stored and specify that it is secure/encrypted/password protected. If using other storage location, please provide specific details. All data will be gathered using Qualtrics survey software then transferred to Excel for analysis. The only identifying information will be email and IP addresses. Qualtrics survey software is accessed through ECU and involves multifactorial password protection. Data in Excel will be on a password protected personal laptop. Email and IP addresses will be deleted from Excel files after both surveys are completed and analysis of results begins.

h) Please specify how long data will be stored after the study is complete? (Keep in mind that data collected/generated during the course of the project that includes protected health information (PHI) should have identifiers removed at the earliest opportunity.) No PHI will be collected for this project. Data will be stored in Qualtrics and in Excel files (de-identified) until student graduation, anticipated to be spring of 2024.

i) Please specify how the collected data will be used (internal/external reports, publishing, posters, etc.) and list name(s) of person responsible for de-identification of data before dissemination. The deidentified data will be analyzed with results shared via a poster presentation to the ECU Nurse Anesthesia Program students and faculty, with participants invited to view the presentation remotely. If requested, a presentation of results to the participating department will be provided. Additionally, analysis of results will be addressed in a DNP Project Paper, completion of which is required for program graduation. This paper will be posted in the ECU digital repository, The Scholarship. Leanne Burton will be responsible for de-identification of all data prior to dissemination.

Please use this space above or **attach a** separate **summary and/or any other additional documentation describing your project**.

2. If the Primary purpose of your project is for QI, have you obtained approval from the [redacted] operational leader within your department or health system:

☐ **No** [**STOP. Please contact the appropriate operational leader for approval before proceeding.**]

☒ **Yes** [Please specify here whom and obtain their signature in the signature section below]

[redacted] **Operational Mgr/Leader Name:** DocuSigned by: [redacted] 92318B511B31494... DocuSigned by: [redacted] F5B84A9D5F5249A...

[redacted]

[redacted] 2/21/2023 | 1:26 PM EST 3/1/2023 | 9:42 AM EST

[redacted] **Operational Mgr/Leader Signature** **Date**

(Part 11 Compliant Electronic Signatures Acceptable-i.e. AdobeSign or DocuSign)

Please note:

- By submitting your proposed project/study for QI determination you are certifying that if the project/study is established to qualify as QI project, you and your Department would be comfortable with the following statement in any publications regarding this project: "This project was reviewed and determined to qualify as quality improvement by the [redacted] for Research and Grants."
- If you are submitting a Poster to Media Services, you will also need to submit this Quality Determination Form or IRB Approval to Media Services for printing.
- If the [redacted] CRG determines the activity is not human subject research, then any presentation, publication, etc. should not refer to the activity as "human subject research," "exempt research," or "expedited research."

Attestation of Understanding

My signature below indicates that I fully understand that HIPAA Privacy standards as they apply to Quality Projects involving Protected Health Information and patient medical records as outlined below.

Under HIPAA's minimum necessary provisions, [redacted] must make reasonable efforts to limit PHI to the minimum necessary to accomplish the purpose of the use, disclosure or request.

Under HIPAA, a Covered Entity (i.e. [redacted]) can disclose PHI to another CE (i.e. BSOM) for the following subset of health care operations activities of the recipient CE without needing patient consent:

- Conducting quality assessment and improvement activities
- Developing clinical guidelines
- Conducting patient safety activities as defined in applicable regulations
- Conducting population-based activities relating to improving health or reducing health care cost

Identified [redacted] healthcare data utilized in this project should not be shared outside of the CE without a fully executed data use/sharing agreement. [redacted] leadership reserves the opportunity to review all articles for dissemination/ publication for which [redacted] healthcare data has been utilized and that the content is being disseminated in the appropriate manner as a quality initiative, not resembling research in any context.

Jeanne Burton — 2/20/2023

Project Leader Signature **Date**

(Part 11 Compliant Electronic Signatures Acceptable-i.e. AdobeSign or DocuSign)

----------for [redacted] CRG Use Only----------

NHSR vs. HSR Determination:

☐ **Not Human Subject Research:** The [redacted] CRG has determined that based on the description of the project/study, approval by the IRB is not necessary. Any changes or modifications to this project may be discussed with the [redacted] CRG at that time to ensure those changes do not elevate the project to human research that would need IRB approval.

☐ **Human Subject Research:** This project/study requires review by the IRB prior to initiation. An application in the electronic IRB submission system should be submitted.

Approval Signatures:

[redacted] **CRG Reviewer:** _____ **Date:** _____

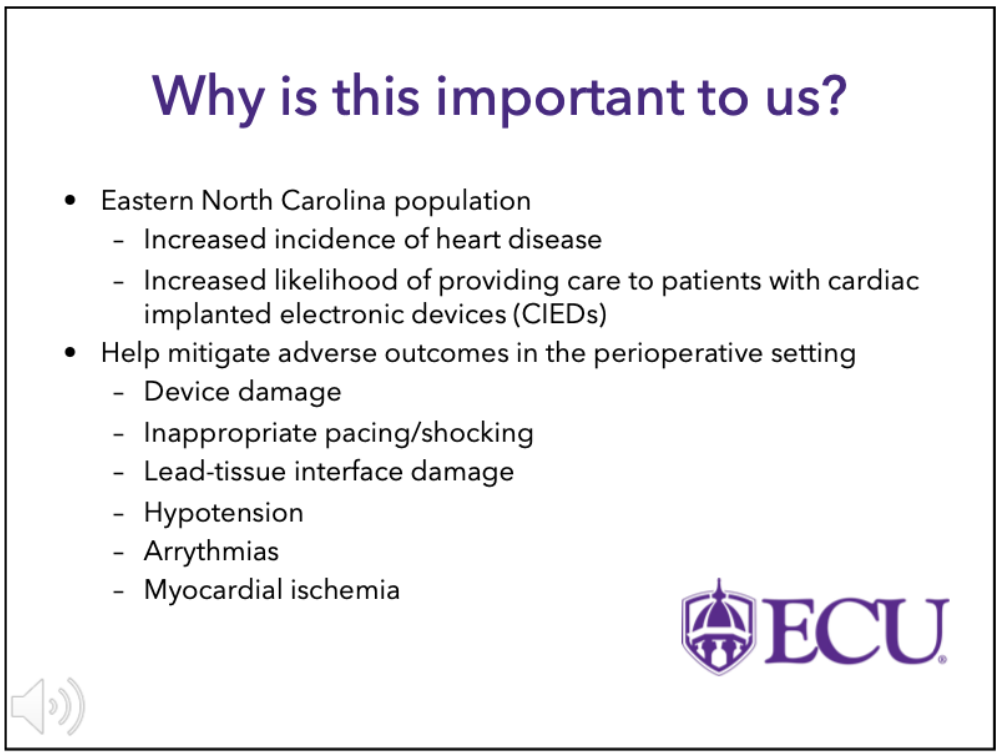
UMCIRB Office Staff Reviewer: _____ **Date:** _____

Appendix F

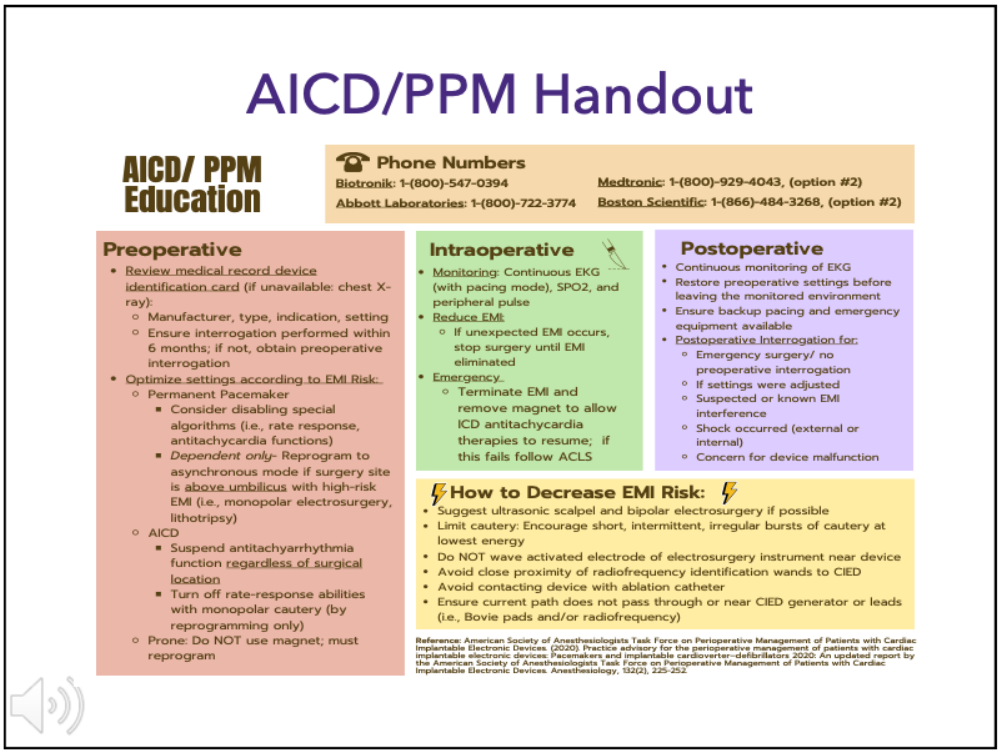
Quality Improvement Intervention


Perioperative Care of Patients with Automatic Implantable Cardioverter-Defibrillators and Permanent Pacemakers
Leanne Burton, BSN, SRNA
Caroline Flynn, BSN, SRNA
Coley Mizell, BSN, SRNA
Laura Whittington, BSN, SRNA
ECU

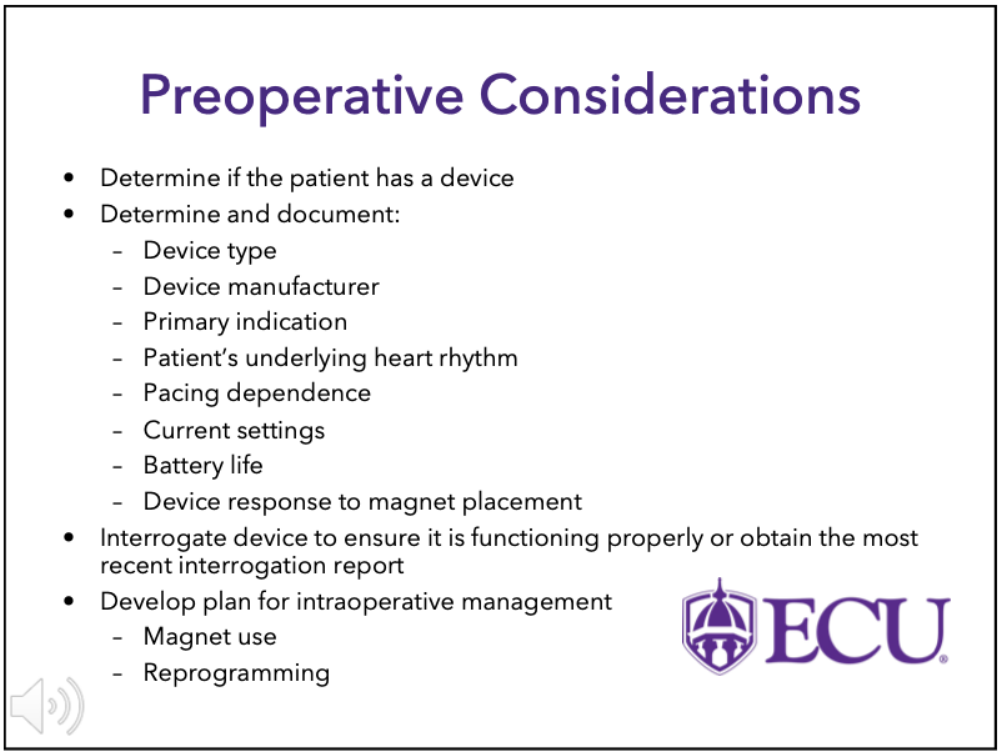
1


Why is this important to us?
Eastern North Carolina population
Increased incidence of heart disease
Increased likelihood of providing care to patients with cardiac implanted electronic devices (CIEDs)
Help mitigate adverse outcomes in the perioperative setting
Device damage
Inappropriate pacing/shocking
Lead-tissue interface damage
Hypotension
Arrythmias
Myocardial ischemia
ECU

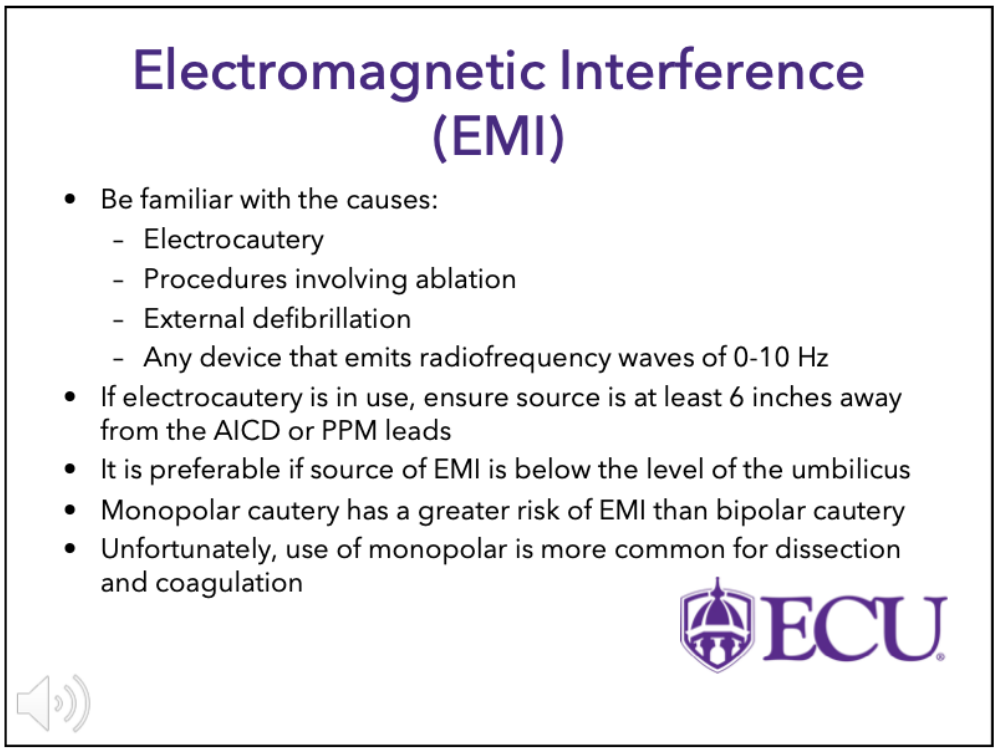
2


AICD/PPM Handout
AICD/ PPM Education
Phone Numbers
Biotronik: 1-(800)-547-0394
Abbott Laboratories: 1-(800)-722-3774
Medtronic: 1-(800)-929-4043, (option #2)
Boston Scientific: 1-(866)-484-3268, (option #2)
Preoperative
Review medical record device identification card (if unavailable: chest X-ray):
Manufacturer, type, indication, setting
Ensure interrogation performed within 6 months; if not, obtain preoperative interrogation
Optimize settings according to EMI Risk:
Permanent Pacemaker
Consider disabling special algorithms (i.e., rate response, antitachycardia functions)
Dependent only- Reprogram to asynchronous mode if surgery site is above umbilicus with high-risk EMI (i.e., monopolar electrosurgery, lithotripsy)
AICD
Suspend antitachyarrhythmia function regardless of surgical location
Turn off rate-response abilities with monopolar cautery (by reprogramming only)
Prone: Do NOT use magnet; must reprogram
Intraoperative
Monitoring: Continuous EKG (with pacing mode), SPO2, and peripheral pulse
Reduce EMI:
If unexpected EMI occurs, stop surgery until EMI eliminated
Emergency:
Terminate EMI and remove magnet to allow ICD antitachycardia therapies to resume; if this fails follow ACLS
Postoperative
Continuous monitoring of EKG
Restore preoperative settings before leaving the monitored environment
Ensure backup pacing and emergency equipment available
Postoperative Interrogation for:
Emergency surgery/ no preoperative interrogation
If settings were adjusted
Suspected or known EMI interference
Shock occurred (external or internal)
Concern for device malfunction
How to Decrease EMI Risk:
Suggest ultrasonic scalpel and bipolar electrosurgery if possible
Limit cautery: Encourage short, intermittent, irregular bursts of cautery at lowest energy
Do NOT wave activated electrode of electrosurgery instrument near device
Avoid close proximity of radiofrequency identification wands to CIED
Avoid contacting device with ablation catheter
Ensure current path does not pass through or near CIED generator or leads (i.e., Bovie pads and/or radiofrequency)
Reference: American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices. (2020). Practice advisory for the perioperative management of patients with cardiac implantable electronic devices: Pacemakers and implantable cardioverter–defibrillators 2020: An updated report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices. Anesthesiology, 132(2), 225-252.

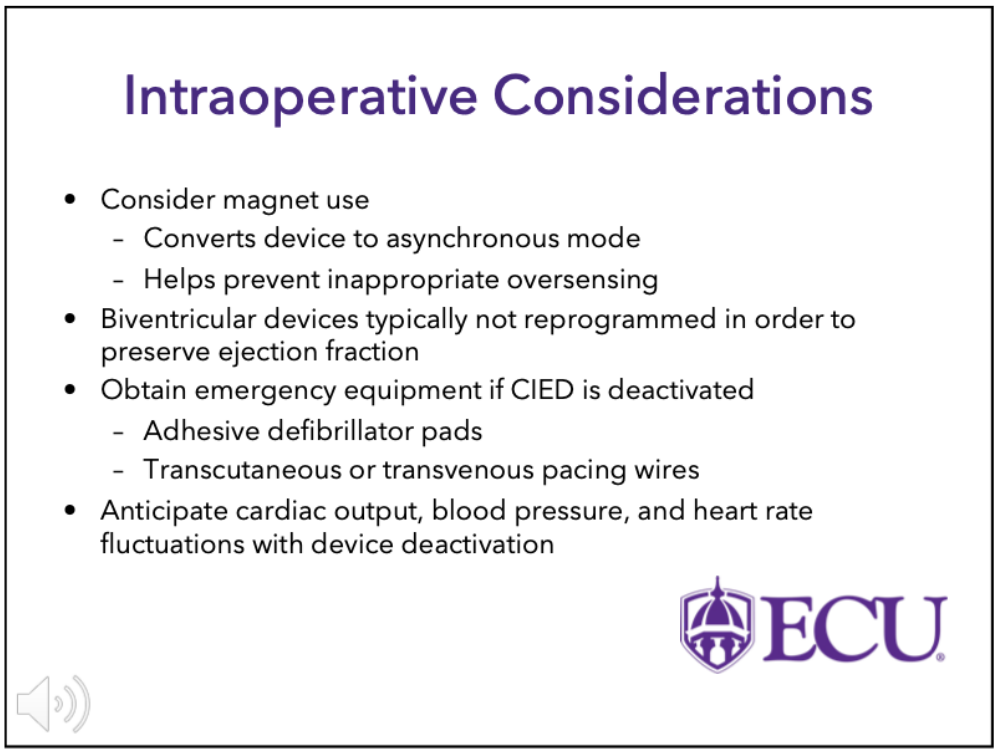
3


Preoperative Considerations
Determine if the patient has a device
Determine and document:
Device type
Device manufacturer
Primary indication
Patient's underlying heart rhythm
Pacing dependence
Current settings
Battery life
Device response to magnet placement
Interrogate device to ensure it is functioning properly or obtain the most recent interrogation report
Develop plan for intraoperative management
Magnet use
Reprogramming
ECU

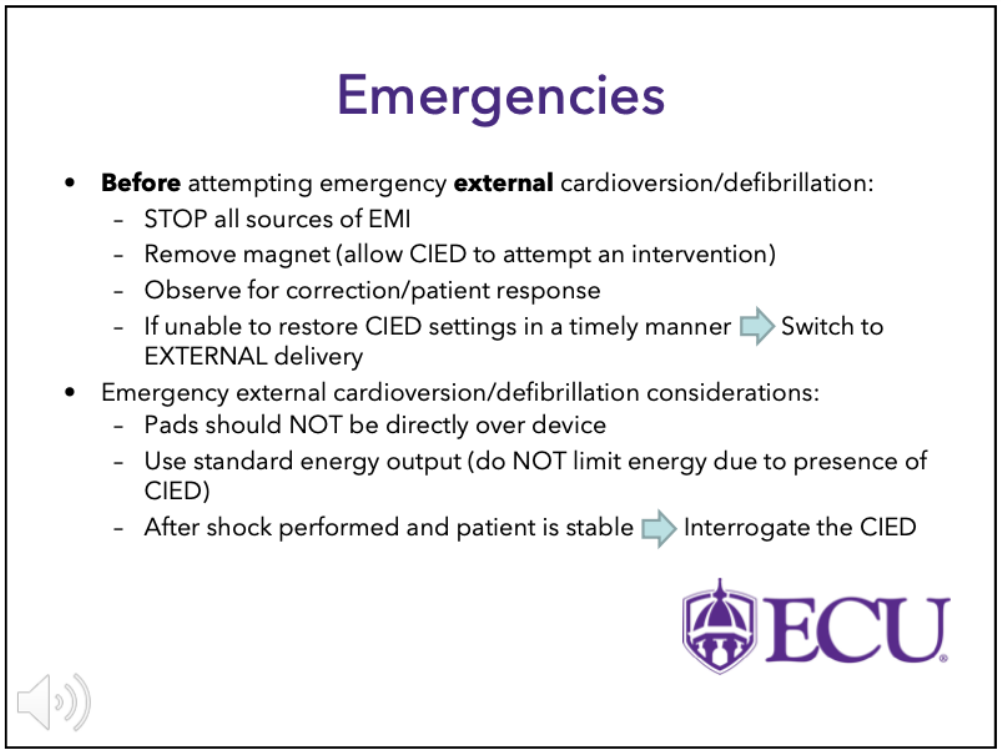
4


Electromagnetic Interference (EMI)
Be familiar with the causes:
Electrocautery
Procedures involving ablation
External defibrillation
Any device that emits radiofrequency waves of 0-10 Hz
If electrocautery is in use, ensure source is at least 6 inches away from the AICD or PPM leads
It is preferable if source of EMI is below the level of the umbilicus
Monopolar cautery has a greater risk of EMI than bipolar cautery
Unfortunately, use of monopolar is more common for dissection and coagulation
ECU

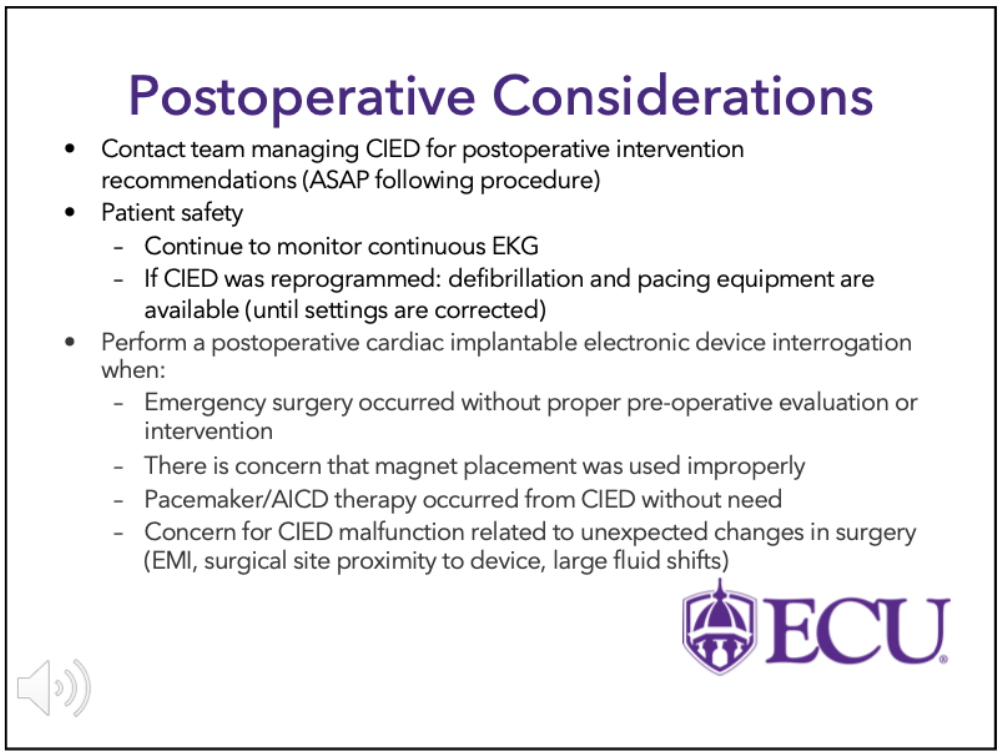
5


Intraoperative Considerations
Consider magnet use
Converts device to asynchronous mode
Helps prevent inappropriate oversensing
Biventricular devices typically not reprogrammed in order to preserve ejection fraction
Obtain emergency equipment if CIED is deactivated
Adhesive defibrillator pads
Transcutaneous or transvenous pacing wires
Anticipate cardiac output, blood pressure, and heart rate fluctuations with device deactivation
ECU

6


Emergencies
• Before attempting emergency external cardioversion/defibrillation:
– STOP all sources of EMI
– Remove magnet (allow CIED to attempt an intervention)
– Observe for correction/patient response
– If unable to restore CIED settings in a timely manner Switch to EXTERNAL delivery
• Emergency external cardioversion/defibrillation considerations:
– Pads should NOT be directly over device
– Use standard energy output (do NOT limit energy due to presence of CIED)
– After shock performed and patient is stable Interrogate the CIED
ECU

7


Postoperative Considerations
• Contact team managing CIED for postoperative intervention recommendations (ASAP following procedure)
• Patient safety
– Continue to monitor continuous EKG
– If CIED was reprogrammed: defibrillation and pacing equipment are available (until settings are corrected)
• Perform a postoperative cardiac implantable electronic device interrogation when:
– Emergency surgery occurred without proper pre-operative evaluation or intervention
– There is concern that magnet placement was used improperly
– Pacemaker/AICD therapy occurred from CIED without need
– Concern for CIED malfunction related to unexpected changes in surgery (EMI, surgical site proximity to device, large fluid shifts)
ECU

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Current Policy

- Title: "Implanted Electronic Devices, VH-PS16"
- How to access it: (Click Direct Link Here)
  - 1) [redacted]
  - 2) Under "Resources", click "Policies" to enter Policy Stat
  - 3) Search "CIED" and open first result
- What does it cover?
  - Preoperative and postoperative communication
  - Non-emergent versus emergent situations
  - High risk situations
  - Interventions to consider

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Highlights of Current Policy

- Communication
  - Anesthesia team and perioperative RN will contact team managing device for recommended intraoperative care
    - If team not available or emergency, the manufacturer of the device should be contacted
  - Information to communicate: dependence, ability for reprogramming, procedure and operative site, cardioversion/defibrillation anticipation
- If pacemaker or CIED is inactivated, an armband indicating so will be placed on the patient.
- Patient Safety:
  - EKG preoperative and postoperative continuous beat-to-beat indicator (at least pulse oximeter), pacing equipment readily available, magnet available
  - If CIED reprogrammed, continuous EKG required

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Additional Resources

- Current Guidelines
  - American Heart Association (AHA)
    - https://www.ahajournals.org/doi/10.1161/circulationaha.109.192665
  - American Nurses Association (ANA)
    - https://pubs.asahq.org/anesthesiology/article-abstract/132/2/225/108844/Practice-Advisory-for-the-Perioperative-Management/
- Recorded Lecture: Basic Management of Perioperative Pacemakers
  - By UK College of Medicine
    - https://www.youtube.com/watch?v=lqbMiNesFSE

11

References

- American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices. (2020). Practice advisory for the perioperative management of patients with cardiac implantable electronic devices: Pacemakers and implantable cardioverter-defibrillators 2020. *Anesthesiology, 132*(2), 225-252. https://doi.org/10.1097/ALN.0000000000002821
- Cronin, B., & Essandoh, M. K. (2018). Update on cardiovascular implantable electronic devices for anesthesiologists. *Journal of Cardiothoracic and Vascular Anesthesia*, *32*(4), 1871–1884. https://doi.org/10.1053/j.jvca.2017.09.007
- Feldman, J. & Stone, M. (2020). Anesthesia teams managing pacemakers and ICDs for the perioperative period: Enhanced patient safety and improved workflows. *Current Opinion in Anesthesiology, 33*(3), 441-447. https://doi.org/10.1097/ACO.0000000000000856
- Pavlovic, N., Manola, S., Vrazic, H., Vucic, M., Brusich, S., Radeljic, V., Zeljkovic, I., Matasic, R., Anic, A., Benko, I., Gavranovic, Z., & Glogoski, M. (2018). Recommendations for perioperative management of patients with cardiac implantable electronic devices. *Acta Clinica Croatica* (Tisak), *57*(2), 383. https://doi.org/10.20471/acc.2018.57.02.22

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Appendix G

Emails to Participants

Initial Pre-Survey and Video Email to Participants

Dear [redacted] CRNAs,

Thank you for considering participating in a quality improvement project titled "Perioperative Care for Patients with Cardiac Implantable Electronic Devices: A DNP Project." The purpose of this project is to assess anesthesia providers' perceptions of an a newly developed resource tool for perioperative care of patients with Automated Implantable Cardioverter Defibrillators (AICDs) and permanent pacemakers (PPMs).

Participation is voluntary and will involve completing a short pre-intervention survey, viewing a brief PowerPoint, utilizing the *AICD/PPM Handout* as a resource in your CRNA practice for two weeks (at your discretion), and completing a short post-intervention survey when the two-week implementation period is over.

Completing each survey and viewing the PowerPoint should take less than 2-4 minutes to complete. The surveys were created and are completed using Qualtrics® survey software. The use of *AICD/PPM Handout* falls within currently accepted practice in your work area. Your participation is voluntary and confidential. We will share the results of this QI study with you upon completion.

First, complete the pre-intervention survey link here.

Following completion of the survey, view the AICD/PPM PowerPoint with voiceover and the *AICD/PPM Handout.* Both documents are available as attached files in this email.

Again, thank you for your participation in our quality improvement project. I will be at [redacted] Hospital and [redacted] Hospital from June 5th until 16TH if you have any questions. You may also reach out to me or Dr. Chabo by email at any time.

Sincerely,

Leanne Burton, SRNA, burtonl11@students.ecu.edu
Dr. Travis Chabo, PhD, CRNA, chabot14@ecu.edu

Pre-Survey and Video Reminder Email to Participants

Hello [redacted] CRNAs,

I just wanted to send a quick reminder about the ongoing DNP Project on perioperative care for patients with cardiac implantable electronic devices (original email below). If you've already filled out the presurvey and viewed the PowerPoint, thank you. If you haven't had a chance to do so yet, it's not too late and would be very helpful and much appreciated. The AICD/PPM PowerPoint with voiceover and the *AICD/PPM Handout* are attached files in this email, and there are handouts located on each anesthesia workstation in the operating rooms. You may use these at your discretion. After the end of next week, I will begin sending out the post-surveys.

Link:
Pre-survey

Please let me know if you have any questions and thank you again for your participation.

Sincerely,
Leanne Burton, SRNA
ECU Nurse Anesthesia Program
Class of 2024

Post-Survey Email to Participants

Dear [redacted] CRNAs,

Thank you to everyone who has already completed my pre-survey and viewed the PowerPoint. It's now time to complete the brief post-survey.

If you have not filled out a pre-survey, I would really and truly appreciate your participation. The link to the pre-survey is here, and you can follow it up by listening to the introductory PowerPoint with voiceover. The *AICD/PPM Handout* is available for you as well, but its use is not mandatory for participation in this project.

If you've already completed the first survey, please complete the post-survey by clicking here. It should take less than 2 minutes.

If anyone has questions or issues with any of these links, please let me know. Again, thank you to everyone for your help and for being excellent preceptors. I look forward to coming back to [redacted] soon.

Sincerely,
Leanne Burton, SRNA
ECU Nurse Anesthesia Program
Class of 2024

Final Thank You Email to Participants

Dear [redacted] CRNAs,

I just wanted to say thank you so much to everyone for helping me out with my DNP Project! I have collected all the data I need to proceed with data analysis and will soon be finishing my paper. Once it's complete you all will be able to read it if you'd like. And if you liked the *AICD/PPM Handout* and found it useful, you can continue to use the copies in the operating rooms or access the online version in my previous email.

Thank you again! I hope to work with you more in the future.

Take care,
Leanne Burton, SRNA
ECU Nurse Anesthesia Program
Class of 2024

Appendix H

Pre-Intervention Survey

1. Do you currently use a standardized approach for providing perioperative care to patients with AICD/Permanent Pacemakers (PPM)?

- ○ No
- ○ Yes

2. How often do you have trouble obtaining all necessary information on a patient's AICD/PPM (such as manufacturer, type, last interrogation, etc.)?

- ○ Never
- ○ Sometimes
- ○ About half the time
- ○ Most of the time
- ○ Always

3. Have you experienced an issue with an AICD/PPM during any perioperative stage (preoperative, intraoperative, postoperative)?

- ○ No
- ○ Yes

4. If you had a question concerning AICD/PPM management, how long do you think it would take to find reference material to answer your question?

- ○ <5 minutes
- ○ 5-10 minutes
- ○ 11-15 minutes
- ○ >15 minutes

5. I feel comfortable providing anesthesia care to a patient with an AICD/PPM.

- ○ Strongly Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Strongly Agree

6. I feel comfortable identifying and/ or managing cases that are high risk for electromagnetic interference (EMI) in patients with AICD/ PPM

- ○ Strongly Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Strongly Agree

7. Are you aware of and have you used the AICD/PPM policy where you work?

- ○ Not aware, not used
- ○ Aware, not used
- ○ Aware, used

8. I am familiar with the current best practice guidelines recommended by the American Society of Anesthesiologist and the Heart Rhythm Society.

- ○ Strongly Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Strongly Agree

9. Have you or do you know of a colleague who has personally been involved in the care of a patient who had poor postoperative outcomes related to inadequate management of their AICD/PPM?

- ○ No
- ○ Yes

10. Do you believe additional AICD/PPM education would help prevent negative outcomes?

- ○ I do not believe it would be helpful
- ○ I believe it would be somewhat helpful
- ○ I belive it would be extremely helpful

Post-Intervention Survey

1. What is your perception of the usefulness of the AICD/PPM Handout for your anesthesia practice?

- ◯ Not at all useful
- ◯ Slightly useful
- ◯ Moderately useful
- ◯ Very useful
- ◯ Extremely useful

2. While participating in this quality improvement project, approximately how many procedures did you reference the AICD/PPM Handout?

- ◯ 0-2 procedures
- ◯ 3-5 procedures
- ◯ 6-8 procedures
- ◯ More than 8 procedures

3. After utilizing the AICD/PPM Handout, how long do you think it would take to find reference material to answer your question concerning AICD/PPM management?

- ◯ <5 minutes
- ◯ 5-10 minutes
- ◯ 11-15 minutes
- ◯ >15 minutes

4. After reviewing the AICD/PPM Handout, I feel comfortable providing anesthesia care for a patient with an AICD/PPM.

- ◯ Strongly Disagree
- ◯ Somewhat Disagree
- ◯ Neither Agree nor Disagree
- ◯ Somewhat Agree

5. After using the AICD/PPM Handout, I feel comfortable identifying and managing cases that are high risk for electromagnetic interference (EMI) in patients with an AICD/PPM?

- ◯ Strongly Disagree
- ◯ Somewhat Disagree
- ◯ Neither Agree nor Disagree
- ◯ Somewhat Agree
- ◯ Strongly Agree

6. Using the AICD/PPM Handout increased my confidence in ensuring the assessment of my patient's device was thorough.

- ◯ Strongly Disagree
- ◯ Somewhat Disagree
- ◯ Neither Agree nor Disagree
- ◯ Somewhat Agree
- ◯ Strongly Agree

7. I am familiar with the current best practice guidelines recommended by the American Society of Anesthesiologist and the Heart Rhythm Society.

- ◯ Strongly Disagree
- ◯ Somewhat Disagree
- ◯ Neither Agree nor Disagree
- ◯ Somewhat Agree
- ◯ Strongly Agree

8. Using the AICD/PPM Handout improved my efficiency in assessing my AICD/PPM patient in the preoperative period.

- ◯ Strongly Disagree
- ◯ Somewhat Disagree
- ◯ Neither Agree nor Disagree
- ◯ Somewhat Agree
- ◯ Strongly Agree

9. How likely are you to use this AICD/PPM Handout in the future?

- ○ Extremely unlikely
- ○ Somewhat unlikely
- ○ Neither likely nor unlikely
- ○ Somewhat likely
- ○ Extremely likely