ECG Lead Placement: A DNP Project

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Abstract

An electrocardiogram (ECG) is a recording of the magnitude and direction of the electrical current generated during depolarization and repolarization of the heart, gathered by external electrodes placed in specific positions on the body surface. Inaccurate and/or inconsistent ECG lead placement in the perioperative setting has the potential to result in incorrect, missed, or delayed patient diagnoses and inappropriate management. The purpose of this Doctor of Nursing Practice Quality Improvement (QI) project was to assess the perceived efficacy of a standardized educational aid designed to streamline ECG lead placement and increase consistency across all disciplines in the perioperative setting. The ECG lead placement education included standard 6-lead placement and alternative placement required for varying surgical procedures and positions. This QI project utilized a pre- and post-survey design to complete a single PDSA cycle among a group of RNs who provide care to patients during the perioperative period. Invitations to participate were sent to 42 RNs via their employee email. Of these, six participated in the pre-intervention survey and four in the post-intervention survey. Results of the pre-intervention survey indicated that most of the participants did not routinely use a standardized method for ECG lead placement. After utilization of the ECG lead placement tool, participant responses showed a generalized increase in confidence levels amongst all positions. Recommendations for future projects of this caliber include following similar strategies while also identifying alternative approaches to improve participation and increase access to the ECG lead placement tool.

Keywords: ECG, lead placement, monitoring, cardiac, surgery

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Section I. Introduction

Background

The electrocardiogram (ECG) has become one of the most useful and widely used diagnostic tools in modern medicine. Despite it being one of the most important diagnostic tests used for patient care, relatively few medical professionals are confident with independent ECG facilitation and interpretation (Kashou et al., 2020). An ECG is a recording of the magnitude and direction of the electrical current generated during depolarization and repolarization of the heart, gathered by external electrodes placed on specific positions on the body surface (Medani et al., 2018). To ensure accuracy of the recording process, it is required that skin preparation be performed properly, the external electrodes be placed in a standard configuration on the body surface, and the electrocardiograph filter settings be set appropriately on the equipment. While there are multiple steps included in performing an ECG, correct chest lead placement is especially essential for obtaining an accurate ECG recording.

The American Society of Anesthesiologists (ASA) has established standards for basic anesthetic monitoring including "Every patient receiving anesthesia shall have the electrocardiogram continuously displayed from the beginning of anesthesia until preparing to leave the anesthetizing location" as an expectation of their Standard II, Section 2.3 Circulation (2020, 2.3.2 Methods). The American Association of Nurse Anesthesiology (AANA) has also included ECG monitoring in their *Standards for Nurse Anesthesia Practice* (2019). The Cardiovascular portion of Standard 9: Monitoring states that the anesthesia provider must "Monitor and evaluate circulation to maintain patient's hemodynamic status. Continuously monitor heart rate and cardiovascular status. Use invasive monitoring as appropriate" (AANA, 2019, Standard 9, Section c; Cardiovascular). Nurse anesthetists are required to continuously

monitor the patient's heart rate and rhythm while delivering intraoperative care. Changes in a patient's ECG readings could indicate major health issues that could be debilitating and, if not addressed quickly, may develop into life-threatening events.

Studies have shown that ECG recordings are often performed inaccurately, and artifact due to electrode misplacement has been identified as a primary factor (Giannetta et al., 2020). Misplacement of ECG electrodes can lead to poor reproducibility of ECG amplitude measurements and important diagnostic errors. These errors can include both falsely positive and falsely negative ischemic changes, alterations in the QRS complex and T wave morphology, and inaccurate R wave progressions/shifts. Diagnostic errors can preclude critical interventions and lead to patients receiving inappropriate care. Patients may be investigated for non-existent cardiopulmonary conditions, receive unneeded testing, and incur unnecessary expenses and anxiety (Walsh, 2018).

Many studies across the United States have addressed the concern of ECG lead placement and its effects on patient populations. In 2018, a researcher gathered 100 medical professionals in a hospital setting and performed an assessment of their ECG lead placement skills (Medani et al.). The results of the study showed that only 34% of the individuals were able to consistently place the leads in the correct position. The goals of the ASA *Standards for Basic Anesthetic Monitoring* (2020) are to encourage quality patient care and safety, and accurate ECG monitoring is crucial for the health and safety of all patients while in the perioperative setting. Mispositioning of ECG leads has become a major concern throughout healthcare, and every organization should recognize the need for interventions to correct this matter.

Organizational Needs Statement

While the partnering organization discussed in this project is a facility committed to excellence, they are not without errors or issues, and the implementation of educational interventions and improvements is always encouraged. Though no definitive data identified ECG lead placement as an issue specific to this particular organization, rising prevalence has been identified in similar settings across the nation, suggesting there is a high likelihood that these issues exist, whether recognized or not. As a facility that serves a patient population at high-risk for cardiovascular problems and abnormalities, and as an educational site for a vast number of disciplines, it is important for them to constantly strive to improve patients' experiences and outcomes.

Problem Statement

Inaccurate and/or inconsistent ECG lead placement in the perioperative setting has the potential to result in incorrect, missed, or delayed patient diagnoses. This may lead to unnecessary interventions, increased cost of care, and poor patient outcomes.

Purpose Statement

The purpose of this Doctor of Nursing Practice (DNP) project was to assess the perceived efficacy of a standardized educational aid designed to streamline ECG lead placement and increase consistency across all disciplines in the perioperative setting. The ECG lead placement education included standard 6-lead placement and alternative placement required for varying surgical procedures and positions.

Section II. Evidence

Description of Search Strategies

The information presented in this project was identified using the scholarly databases PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL), as well as the search engine Google Scholar. The literature search was driven by the following question: "For ECG lead placement, does the availability of educational material improve the placement of electrodes by healthcare providers in the perioperative setting when compared to the accuracy of lead placement by healthcare personnel who lack access to educational material or resources?". This question provided the basis for the collected information.

The main concepts employed in this literature search were electrocardiography/ECG lead placement, education, and healthcare providers (see Appendix A). For each database, when available, limitations applied included: peer-reviewed, publication between 2012-2022, and English language. For the search engine, limits of publication between 2012-2022 and English language were used. This model centered the research material on evidence that addressed whether ECG lead placement education correlated with improved patient outcomes and healthcare knowledge. While using PubMed, the initial search strategy included: ECG lead placement AND education AND healthcare providers, but only eight items were identified. While there were several suitable studies supporting the primary focus of the literature search, it was determined that it would be more beneficial if the criteria were broadened to encompass a larger pool of information. The search strategy was then adjusted to include the search terms: electrocardiography AND education AND healthcare providers. This search strategy produced 151 results, with 12 items noted as potentially pertinent. With multiple attempts required to develop an effective search strategy, CINAHL produced the lowest number of results when

compared to the other two sources. The search strategy ultimately utilized was (MM "Electrodes/ED/NU/ST") OR "ECG Lead Placement" OR (MH "Electrocardiography, Ambulatory") AND (MM "Education") OR (MH "Education, Nurse Anesthesia/ED/ST/UT") OR (MH "Education, Continuing") AND (MM "Anesthesia Nursing"). These criteria produced 17 results, but only two were useful for the topic at hand. Finally, Google Scholar was the most advantageous of the three sources, with 18 items kept for further analysis after review of 20 pages of results (See Appendix B).

Upon full text review, four randomized controlled trials (Level II), three case-controlled studies (Level VI), and one quality improvement (QI) project (Level VI) were identified as pertinent to this project and have been included in this literature synthesis (Melnyk & Fineout-Overholt, 2019). Refer to Appendix C: Literature Matrix, to view resources in more detail.

Selected Literature Synthesis

Cardiac disease currently affects approximately 12% of the population, or 26.6 million people, and continues to be the leading cause of death in the United States according to the Centers for Disease Control and Prevention (Wirt, et al., 2014). Because of the prevalence and associated morbidity and mortality amongst the general population, it brings concern that the risk of harmful cardiac events may be even higher among surgical patients. ECG recordings are a vital tool for identifying and addressing cardiac disease. To avoid issues that could arise due to improper lead placement, it should be a priority of all healthcare providers to ensure accurate lead placement for every patient. All sources analyzed in this review support that mispositioning of ECG leads has become a major concern throughout healthcare (Funk et al., 2017; Giannetta et al., 2020; Kashou et al., 2020; Medani et al., Rasmussen et al., 2019; Rehman & Rehman, 2020; 2018; Walsh, 2018; Wirt et al., 2018).

In one prospective, hospital-based pre- and post-intervention performance analysis study, 100 eligible staff members who perform ECG monitoring as part of their clinical practice were randomly selected to place sticker dots on a mannequin while their positions were recorded on a radar chart and compared to the correct precordial lead positions (Medani et al., 2018). Only 34% of the individuals were able to place the leads in the correct positions. After a training exercise on the use of ECG leads, the accuracy of lead placement increased to 83%. A similar study revealed parallel results showing a substantial increase in the accuracy of post-intervention placement, supporting the fact that proficient practical skills and knowledge were attainable through routine training and available resources (Giannetta et al., 2020).

Wirt et al. (2018) and Funk et al. (2017) performed comparable interventional research studies incorporating posters, pocket cards, and teaching provided by administrators. While these studies were done independently and the interventions were not identical, both research groups yielded very similar results. The researchers found that Registered Nurses (RNs) who participated in the interventions were not only more knowledgeable about ECG lead placement, but also placed leads correctly more frequently as well.

Three of the selected resources addressed the physical and economic burden of ECG precordial lead mispositioning (Rasmussen et al., 2019; Rehman & Rehman, 2020; Walsh, 2018). Rehman and Rehman (2020) focused on the systemic impact that these errors cause hospital wide. Researchers found that inappropriate positioning of the precordial leads can lead to significantly abnormal ECG patterns, which are then interpreted as incorrect diagnoses. As incorrect interpretations are made, practitioners may suspect the abnormal patterns represent underlying coronary artery disease, leading to additional cardiovascular consultation and testing that may be unnecessary. Simple and minor errors of precordial ECG lead placement have the

potential to cost the hospital systems and outpatient care facilities billions of dollars annually (Rehman & Rehman, 2020).

Rather than taking a systemic view, Walsh (2018) focused on individuals, centering his research on five major case studies involving inappropriate monitoring of ECG patterns. In each example, a wrongful diagnosis ensued due to the malposition of the ECG leads. These errors resulted in a change in the patient's clinical course causing them to receive unnecessary care, stress, and costs. Similar to the findings of Medani et al. (2018) and Giannetta et al. (2020), the data from these case studies highlighted the need for quality improvement and education. Walsh (2018) also focused on the specific placement of one precordial ECG lead, V1. V1 leads are used to determine the P-wave terminal force (PTF) and deep terminal negativity (DTN). These two cardiac markers are slowly gaining momentum in helping to identify patients at risk of developing atrial fibrillation and stroke. Since PTF and DTN are specific to the precordial lead V1, if this lead is misplaced it can lead to a falsely high measurement indicating the patient is at risk. Inaccurate data recorded by just one precordial lead will precipitate an incorrect diagnosis, and because of this, a patient could be placed on a variety of costly, unwarranted medications including antithrombotic agents and antiplatelet therapies, and may even be advised to undergo a cardiac catheterization.

While each source included in this review emphasized the prevalence of ECG lead misplacement, they also stressed the importance of proper training. Mistakes are made due to improper lead placement training, time restraints, and/or healthcare providers being unaware of the importance of lead placement. No matter why incorrect ECG lead placement occurs, these errors produce potential risks for missing clinically relevant ECG findings or delaying the recognition of critical clinical diagnoses (Kashou et al., 2020). Several of the identified studies

(Funk et al., 2017; Giannetta et al., 2020; Kashou et al., 2020; Medani et al., 2018; Wirt et al., 2014) assessed the impact that routine lead placement training has on medical professionals' competency and the accuracy of the ECG recordings. In each of these studies, pre- and post-test designs were used to evaluate the impact of educational classes, with the educational sessions ranging from five-hour a week classes to others being one-time classes. Not only did the results support that the interventions improved the accuracy of ECG recordings, there was also an amplification of the professionals' confidence and facilitation of appropriate interventions for the patients.

Project Framework

The methodology used for executing this project was the plan-do-study-act (PDSA) cycle. As described by the Institute for Healthcare Improvement (IHI; 2022), the PDSA cycle is a four-stage problem solving method that incorporates planning, facilitating, observing, and modifying. This methodology assesses the success of an implemented change or intervention. At the beginning of this project there was a suspected need for ECG lead placement educational resources for healthcare providers, and from this need, a plan to intervene was derived. To facilitate this intervention, the ECG lead placement resources were provided to healthcare personnel in an intensive care unit, a perioperative setting. The individuals who were provided these resources were asked to complete a pre-interventional survey and post-interventional survey that assessed their confidence in ECG lead placement and perceived efficacy of the educational material. After obtaining the results of the project, the information collected was analyzed and shared with others, along with suggestions for future implementation and interventions for those who may wish to continue or adapt this QI project.

Ethical Considerations and Protection of Human Subjects

The target population for this project was RNs who routinely care for patients undergoing surgeries or interventional procedures. The opportunity to participate was available to all providers meeting the project criteria who worked on the designated unit. There was no risk of harm or exploitation within the target population during the project implementation. All information included in the intervention aligned with current practice standards within the participating organization. This project involved no collection of personal data from participants and individual responses to surveys were kept confidential. There was no involvement of patients or collection of patient data.

In preparation for the formal approval process, the primary investigator of this project completed the following CITI modules: *Biomedical Investigators and Key Personnel* and *Responsible Conduct of Research*, as available through https://about.citiprogram.org/. Regarding the Institutional Review Board (IRB) approval process for this project, the primary investigator completed an approval process through the East Carolina University College of Nursing to evaluate the need for a full IRB review (See Appendix D). The project was determined to be QI and thus exempt from the full review process. Next, a facility approval was obtained through the research office of the participating organization in conjunction with East Carolina University and Medical Center IRB (UMCIRB). Local facility approval to collect data was obtained from a site contact person whose signature was required on the organization's approval form (See Appendix D).

Section III. Project Design

Project Setting

This QI project was conducted in the adult Cardiovascular Intensive Care Unit (CVICU) of a 950 bed, level I trauma center located in eastern North Carolina. This facility performs over 30,000 surgeries each year, with more than 1000 being cardiovascular surgeries. In this CVICU, post-operative cardiovascular surgery patients undergo their recovery before being transferred to a stepdown intermediate recovery unit prior to a planned discharge or admission into an inpatient rehabilitation facility.

Project Facilitators and Barriers

The project was conducted at a facility with a busy cardiovascular operating room (CVOR) which should have allowed for ample opportunity for participants to use the educational aid provided. Pre-existing faculty relationships with the RNs on this unit aided in the recruitment of participants and facilitated consistent use of the educational tool during the two-week data collection period. Prior to the implementation, there was not a standardized ECG lead application practice observed in this unit and application seemed to vary amongst the individual RNs. Time constraints, inability to have easy and immediate access to the educational tool when needed, and the incorporation of a new, standardized version of a practice the participants were already independently performing were all identified as potential barriers to participation in this project.

Project Population

The population involved in this QI project included RNs working in the CVICU of the participating facility. In this unit, RNs are provided ECG lead placement training upon orientation but are not required to participate in any routine/annual training, nor are they subject to any scheduled assessments to evaluate the need for repeat training. These RNs are responsible

for patients in a setting that provides immediate postoperative care of patients undergoing coronary artery bypass, aortic dissection repairs, cardiac tamponade repairs, and endovascular aneurysm repairs, as well as the implantation of left ventricular assist devices (LVADs) and intra-aortic balloon pumps (IABPs). The RNs work in collaboration with physician assistants, nurse practitioners, intensivists, respiratory therapists, physical and occupational therapists, and cardiothoracic and vascular surgeons throughout the pre- and postoperative period to provide the patient with the best possible recovery care. Immediately following these complex surgeries, patients are brought to the CVICU and these RNs assume responsibility for their care at that time.

Project Team

The project team consisted of a Student Registered Nurse Anesthetist (SRNA) as the primary investigator and author, along with two university faculty members. These faculty members ensured the project was facilitated in a way that was efficient yet educational. Both members provided an abundance of knowledge and guidance that helped to ease the transitions through the changing dynamics encompassed within this project. Serving as the project chair, the CRNA faculty member assisted with the implementation of the project within clinical practice. This faculty member also provided direction when the primary investigator needed to integrate the research identified in the literature with the data collected from the clinical practice study. The non-CRNA faculty member served as an advisor and aided in the collection of research, writing, and IRB approval. Lastly, while the primary investigator implemented the project independently, development of the project was accomplished in collaboration with three other SRNA classmates who jointly developed the educational tool, as well as the pre- and post-survey

used to gather data from participants. A representative on the unit supported data collection and signed the organizational approval form.

Methods and Implementation

The purpose of this DNP project was to assess the perceived efficacy of a standardized educational aid amongst a nonrandomized, convenience sample of CVICU RNs. The tool was designed to streamline ECG lead placement and increase consistency of lead placement across the participants involved.

This QI project utilized a pre- and post-survey design to complete a single PDSA cycle among a group of RNs who provide care to patients during the postoperative period (IHI, 2022). The planning period consisted of team meetings with the project chair and other faculty to facilitate the sharing of ideas, tools, survey information, and processes for data collection. Through a collaborative effort, the purpose and problem statements were formed with team members to guide the production and direction of the project. Furthermore, contact with the manager of the CVICU was initiated via email. Project approval was obtained through the partnering organization during the planning period.

During the implementation phase, the CVICU RNs were approached by the primary investigator, via email (See Appendix E), and asked to volunteer to participate in a DNP project exploring the usefulness of an educational ECG lead placement tool. The RNs who agreed to participate were then sent an email containing a Qualtrics link to a pre-intervention survey (See Appendix F) and a PowerPoint (PPT) presentation accompanied by a short video introducing the project (See Appendix G) and explaining how to use the tool. The tool was provided as a linked PDF file within the email and as a hard copy available in the unit's huddle room (See Appendix H). For the intervention phase, the RNs were allotted a two-week time frame to utilize the tool

when applying ECG leads. At the end of the data collection period, the participating RNs were emailed a post-intervention Qualtrics survey (See Appendix F). The primary investigator remained in contact with the RNs via a contact email and phone number.

Data Collection and Measurements

The pre- and post-intervention Qualtrics surveys completed by the CVICU RNs contained a mixture of Likert-type scale and open-ended, free response style questions designed to gather data to aid the primary investigator in better understanding the participants' perceptions of the provided tool. After the surveys were completed, the data from both the pre- and post-surveys was moved to Excel for analysis and creation of visual depictions. No patient information was recorded or maintained during this project. The project method was carried out successfully, and the surveys were delivered in Qualtrics with links sent via email. There were no changes or extensions needed for the data collection period.

Section IV. Results and Findings

The purpose of this QI project was to assess the perceived efficacy of a standardized educational aid designed to streamline ECG lead placement and increase consistency across all disciplines in the perioperative setting. The target population was CVICU RNs caring for patients undergoing cardiovascular surgery. The ECG lead placement education included standard 6-lead placement and alternative placement required for varying surgical procedures and positions. During the two weeks this project was implemented, 42 RNs were surveyed via their employee email, and of these, six participated in the pre-intervention survey and four in the post-intervention survey. After the responses were received via Qualtrics, the results were placed into an Excel spreadsheet and converted to a pictorial graph to visualize the data gathered.

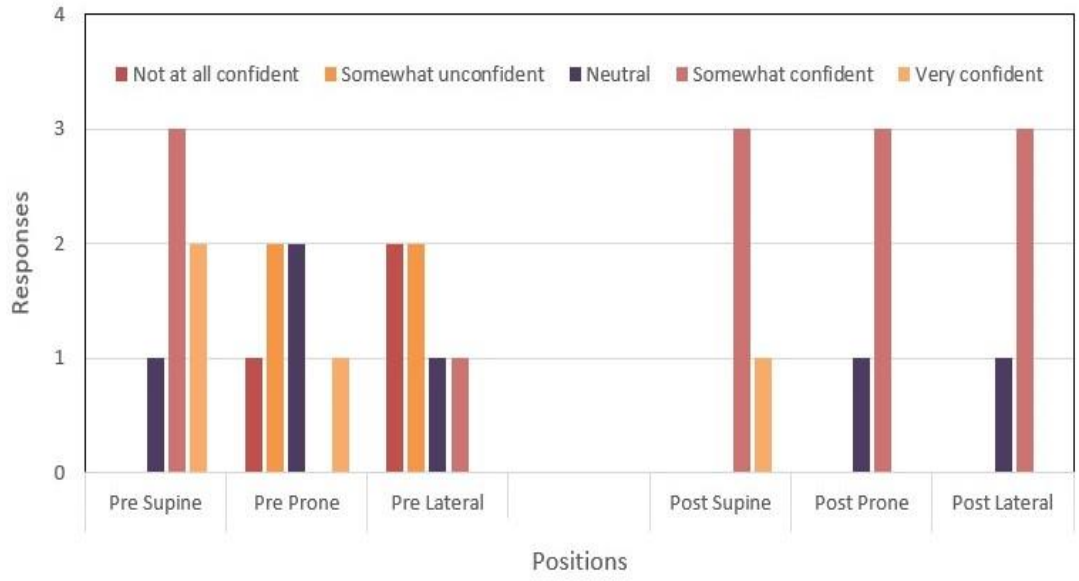
Data Presentation

To gather pre-survey data, participants were asked several questions regarding their current ECG placement practice, familiarity and confidence in identifying ECG lead locations, prior formal training, effects on quality of patient care, and any obstacles that prevent proper lead placement. Following the pre-survey and intervention, participants were provided a post-intervention survey that included questions about their use of the ECG lead placement tool, additional time needed to utilize the tool, improved quality of care, benefits of annual education, and likelihood that they would continue to use the tool in the future.

In the pre-intervention survey, several questions were asked about the RNs' current ECG monitoring practices. Figure 1 depicts responses from the participating RNs regarding their pre-survey and post-survey confidence levels when applying ECG leads in alternative positions.

Figure 1

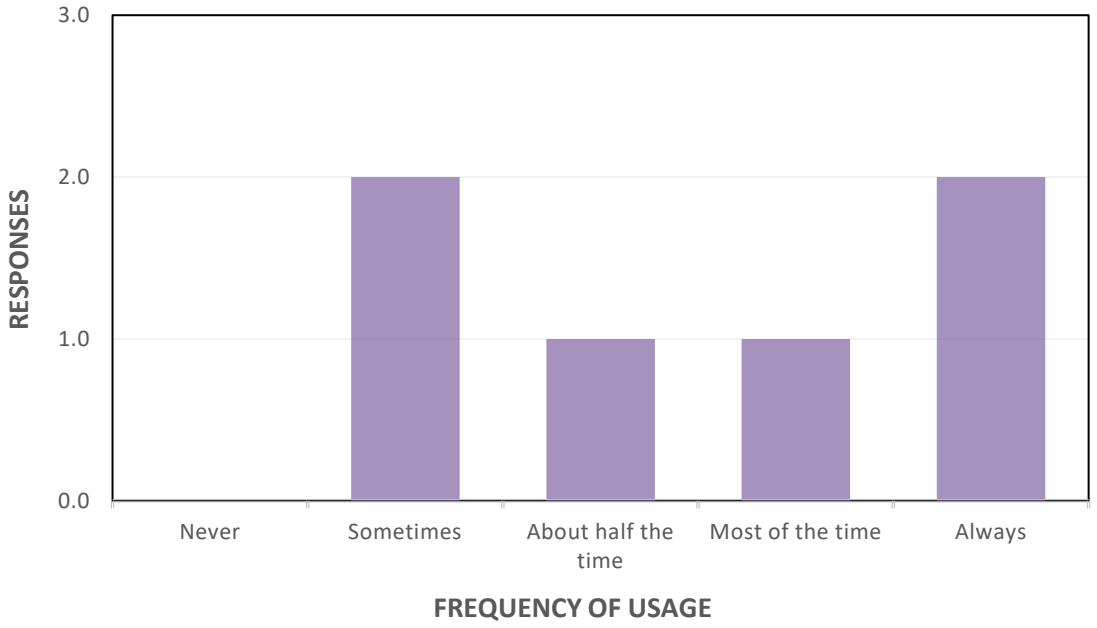
Confidence Levels of Participants (Pre n = 6; Post n = 4)



When queried about formal training in the pre-intervention survey, half of the six participants stated that they did receive formal ECG lead placement training upon entering the unit as a staff member while two nurses responded “no” and one nurse said “maybe.” The pre-intervention survey also included a question assessing how frequently the RNs on this CVICU currently use a standardized method for applying ECG leads. See Figure 2 for responses to this question.

Figure 2

Frequency of Standardized Method Usage (Pre n = 6)



When asked in the pre-intervention survey how often artifact or incorrect morphology was encountered using their current ECG lead placement practice, five RNs responded with "sometimes" and one responded with "most of the time." Adjusting ECG leads for body habitus, position, and dressings was also inquired about in the pre-intervention survey. Half of the participants responded with "sometimes" and the other half responded with "about half of the time." Most of the RNs responded with "sometimes" when asked how often they receive patients with inaccurate ECG lead placement. Before using the tool, the RNs were asked if the quality of patient care could be improved with more accurate ECG lead placement. Half of participants responded "probably yes" and the other half "definitely yes."

The post-intervention survey inquired about the participants' perceived confidence level after using the tool, the accessibility and timing required to utilize the tool, frequency of use

during the implementation period, and the likelihood of the participant continuing to use the ECG lead placement tool. There were four responses in total for the post-intervention survey. When asked how often they received artifact or inaccurate morphology after using the tool, one RN responded “most of the time,” two responded “sometimes,” and the other responded “never.”

The post-intervention survey, as did the pre-intervention survey, inquired about how often the participants adjusted the ECG lead placement for body habitus, position, and dressings now that they have used the lead placement tool. Two RNs responded with “sometimes,” one with “about half the time,” and one with “most of the time.” When participants were asked how often they used the ECG lead placement tool, one RN responded with “about half the time,” two responded with “most of the time,” and one responded with “always.” The participants were then asked the likelihood they would continue to use the tool when applying ECG leads in the future and all four participants responded with “somewhat likely.”

When asked whether the tool was easily accessible, three of the participants responded with “somewhat agree” and one responded with “strongly agree.” Following that question, the participants were asked the amount of time required to use the tool, one RN responded with “1-2 minutes” while the other three responded with “3-5 minutes.” The participants were asked if they believed the ECG lead placement tool improved the quality of care for their patients. Three participants stated that they “somewhat agree” and one stated that they “strongly agree.” When asked if they felt an annual education module would improve patient care, all four participants responded “yes.”

Analysis

It is important to note that the number of pre-intervention responses was six and the number of post-intervention responses was four, and these differences complicated the interpretation of the results and reduced the generalizability of the findings.

While the majority of the responses pertaining to the pre-intervention confidence level of lead placement in alternative positions were “somewhat confident and very confident” for the supine position, the prone and lateral position responses did not reflect such high levels of confidence. After utilizing the ECG tool, the participant responses showed a generalized increase in confidence levels amongst all positions. With the variances between the responses to the question pertaining to the formal training, it is possible that there may be some inconsistencies with ECG lead training as part of the onboarding program. Additionally, the pre-intervention survey included a question assessing how frequently the RNs on this CVICU currently use a standardized method for applying ECG leads. The results of this question indicate that most of the participants do not routinely use a standardized method for ECG lead placement.

When asked how often artifact or incorrect morphology was encountered in the pre-intervention survey, responses from the participants indicated that these issues were not a rare occurrence while using their current ECG lead placement practice. Before using the tool, the RNs were asked if the quality of patient care could be improved with more accurate ECG lead placement. Overall, the participants believed that with more accurate ECG lead placement patient care could be improved. When asked how often they received artifact or inaccurate morphology after using the ECG lead placement tool, the results indicated that there was still a concern for the frequency of inappropriate or inaccurate ECG recordings. According to the

responses, the usage of the tool was quite often among the participants and all participants said they were “somewhat likely” to continue the use of the tool.

When asked how often they performed adjustments for ECG lead placement for body habitus, position, and dressings after the usage of the lead placement tool, the results from the post-intervention survey did not change from the pre-intervention survey. The majority of the participants stated that utilization of the provided tool was easy and required less than 5 minutes and they also agreed that the usage of the tool and annual education modules would improve the quality of the care delivered to the patients.

Section V. Implications

Financial and Nonfinancial Analysis

Financial factors play a major role in the decisions regarding patient care within hospitals (Rehman & Rehman, 2020). This applies to units, departments, and generally the entire institution as a whole. As stated previously, simple and minor errors of ECG lead placement have the potential to cost hospital systems and outpatient care facilities billions of dollars annually.

There were some barriers to the usage of the tool that arose during the implementation process. These included the inability to access the ECG lead placement tool at the time of the ECG lead placement and the amount of time required to access the tool even if the participant was able to locate it. The tool was provided to the unit as a hard copy and as a PDF link so that access could be achieved through the individual's phone as well. The responses obtained from the participants indicated that the time to utilize the ECG lead placement tool was about 3 to 4 minutes. This amount of time seems minute when compared to the potential to improve patient care or even save a patient's life. Additionally, during an average shift ECG leads may need to be changed two to three times, increasing the importance of consistently and accurately placing ECG leads.

The amount of time needed to find the tool could add up quickly if it is needed several times throughout the shift. To increase the accessibility of the tool and decrease the amount of time needed to find it, a hard copy could be placed within a plastic cover in each room, on the wall, cabinet, or door, to be used as a quick reference. With this, the cost for the printing, plastic cover, employee time required to place the hard copies, and the maintenance required to keep the copies from being damaged or misplaced have to be accounted for.

Based on survey results, it was apparent that several of the participants had not received formal ECG lead placement training during the onboarding program for the CVICU. As stated by Giannetta et al. in a 2020 study, routine training and available sources lead to substantial increase in ECG lead placement accuracy and proficient practical skills. While routine training or inclusion of ECG lead placement training may improve confidence and competence when determining the accurate placement of ECG leads, this training would be accompanied by multiple costs as well. RNs and/or professional development coordinators would be required to be present during these trainings, supplies would have to be present so that the training could be performed, and the trainee would need to be compensated for their time as well. With 42 nurses on one unit, the compensation for these routine training sessions could add up.

Worldwide there is increasing pressure to improve ICU performance and quality of care in ways that will reduce costs (Gosula & Hariharan, 2020). Most critically ill patients admitted to an ICU need special therapeutic interventions, therefore leading to an increase in the associated costs. Gosula & Hariharan performed a study in 2020 that focused on the costs of an intensive care unit (ICU) stay within a hospital. The results from the study showed that in this hospital the average total cost of approximately five nights in the ICU was almost 20,000 dollars. These costs accounted for human resources, consumables, drugs, labs, and equipment. The surgery cost, if needed, was not included.

The primary surgeries performed on patients in the participating CVICU are cardiac surgery and vascular surgery. After these surgeries, the patients stay an average of 4 to 6 days, accumulating a cost of about $19,000 to $25,000, depending on the resources needed for recovery. Gosula and Hariharan found that patients who suffer from cardiac events during their stay in the ICU are more likely to have an extended length of stay and be at a higher risk of

mortality. Utilization of this tool and applying ECG leads accurately would help to diagnose cardiac events effectively, leading to immediate interventions and treatments (Rasmussen et al., 2019). This prompt treatment could reduce the cardiac damage caused and the recovery time needed after a cardiac event, thus decreasing the cost to the patient and the hospital. The usage of this ECG lead placement tool would amount to approximately $300 – $500, taking into account the cost of supplies, employee time, and other minor expenses. When equating the cost of utilizing the ECG lead placement tool on this unit to the cost of a one-night stay in an ICU that can range from approximately $1,000 to $8,000, the cost of an extra night in the ICU is much more substantial.

Implications of Project

The American Society of Anesthesiologists (ASA) has established standards for basic anesthetic monitoring, including "Every patient receiving anesthesia shall have the electrocardiogram continuously displayed from the beginning of anesthesia until preparing to leave the anesthetizing location" as an expectation of their Standard II, Section 2.3 Circulation (ASA, 2020, 2.3.2 Methods). While these patients are not receiving anesthesia once they arrive in the CVICU, ECG monitoring is important due to the length of time anesthesia was provided and the risks accompanying the cardiac surgery that was performed.

In the pre-intervention survey, participants were asked if they routinely used a standardized method for applying ECG leads. The results of this question indicated that many of the participants did not routinely use a standardized method for ECG lead placement. When performing and analyzing ECG recordings it is crucial that results can be duplicated. As stated previously, misplacement of ECG electrodes can lead to poor reproducibility of ECG amplitude measurements and important diagnostic errors (Walsh, 2018). Establishing a standardized

method of ECG lead placement could be extremely beneficial for the patient population on this cardiac unit.

Monitoring and applying ECG leads is a major part of the care expectations of the nurses on this unit. Accurate ECG lead placement could be the difference between a patient being quickly diagnosed and treated for a change in cardiac status and the patient developing irreversible damage due to delayed treatment. Application of this educational tool has the potential to positively impact nursing care, the patient population, and possibly the entire organization. As stated previously, diagnostic errors can preclude critical interventions and lead to patients inappropriately being investigated for cardiopulmonary conditions, receiving unneeded testing, and incurring unnecessary expenses and anxiety (Walsh, 2018). Not only could the tool improve unit and institutional costs by preventing unnecessary tests and decreasing unplanned hospital stays, it could even more importantly improve the outcomes for this patient population.

Sustainability

While this quality improvement project was primarily a pilot, the organization involved has the resources to both implement and add to the project's interventions. If implemented by the organization, staff suggestions should be considered. Addressing the barriers encountered by the project participants, including access and adequate time to utilize the ECG lead placement tool would be important to address when planning to implement the intervention on a larger scale. The estimated amount of money needed to perform this intervention effectively in one single ICU would be approximately $300 to $500. The unit itself could potentially afford to produce the money needed to implement the intervention and, if there were positive results, the institution could contribute to the costs and extend the project out to other units. The sustainability of this

project would mostly be impacted by the dedication of each unit to maintaining the tool in each room and ensuring the information on the tool was kept up to date with current standards. Use of the ECG lead placement tool is an intervention that could be permanent if there is appropriate incentive and proper management by the unit. Additionally the ECG tool could be placed within the electronic medical records system and be opened automatically as a pop-op when the chart is accessed or when patient assessment flowsheets are opened.

Dissemination Plan

In addition to this project paper, a poster was developed by the primary investigator for the dissemination of results. Utilizing both in person and electronic format, the project poster was presented to the nurse anesthesia program faculty and students with project participants invited to join. The final version of this paper, as well as the project poster, have been posted in The ScholarShip, the East Carolina University digital repository.

Section VI. Conclusion

Limitations

There were several limitations observed within this study, primarily the lack of data due to a low number of participant responses. Out of 42 RNs surveyed on this unit, only six responded to the pre-intervention survey and four to the post-intervention survey. These numbers make up less than 15% of the nursing staff population on this unit, which provides a poor representation to identify issues with common practices used by the CVICU RNs. Other limitations included lack of opportunity for face-to-face contact with all potential participants. The primary investigator noted that when face-to-face contact was initiated among the CVICU staff there was an increase in the number of responses. With such a large number of staff and frequent rotation through shifts, it was difficult for the primary investigator to meet and encourage each staff member to participate in the study individually.

Recommendations for Future Implementation and/or Additional Study

This quality improvement DNP project was performed to assess the perceived efficacy of an ECG lead educational tool designed to standardize ECG lead placement and increase consistency across all disciplines in the perioperative setting. The ECG lead placement education included standard 6-lead placement and alternative placement required for varying surgical procedures and positioning. Recommendations for future planning, implementation, and evaluation of another project of this caliber would include following similar strategies that were implemented within this study, while also including more incentive for the employees to participate in the project and improving access to the ECG lead placement tool. Additional support for future projects and/or reimplementation of this QI project may be better achieved by

identifying co-champions on the unit to help with recruitment, dissemination of information, and reminders to unit RNs to participate.

The single plan-do-study-act cycle, which was performed successfully, identified concepts useful in the improvement of ECG lead placement, ECG monitoring, and CVICU patient outcomes. The range of time that the project implementation was performed could be extended in future projects to allow for more face-to-face contact between the potential participants and the future investigator. Additional data should be gathered to allow assessment of the outcomes of a future project, on factors such as the number of patients with prolonged hospital stays due to undiagnosed cardiac events and unnecessary costs accrued in relation to unwarranted tests due to inappropriate ECG diagnoses. Pre- and post- intervention data should be compared to assess outcomes and associated costs to the patients and institutions.

Based on the experience of this quality improvement project, further quality improvement efforts and research projects would be beneficial in addressing the need for a standardized method of ECG lead placement. Through further research and interventional application, ECG monitoring and ECG lead placement in the perioperative setting could be made more consistent and patient outcomes improved.

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Appendix A

Literature Concepts Table

	Concept 1: ECG Lead Placement	Concept 2: Education	Concept 3: Healthcare Providers
Keywords (these are the "normal" words you would use anywhere)	ECG Lead Placement	Education	Healthcare Providers
PubMed MeSH (subject heading specific to PubMed)	EKG/ECG leads "Electrocardiography lead" {MeSH Terms}	Education "education" [MeSH Terms] "educational status" [MeSH Terms]	Healthcare Healthcare personnel "health personnel" [MeSH Terms]
CINAHL Subject Terms (Subject headings specific to CINAHL)	Electrodes ECG Lead Placement "Electrodes" "ECG Lead Placement" "Electrocardiography, Ambulatory"	Education Education for Nurse Anesthetist Continuing Education "Education" "Education, Nurse Anesthesia/ED/ST/UT" "Education, Continuing"	Nurse Anesthesia "Anesthesia Nursing"
Google Scholar	EKG OR ECG lead placement	AND Education	AND Healthcare Providers

Appendix B

Literature Search Log

Literature Search Log

Search date	Database or search engine	Search strategy	Limits applied	Number of citations found/kept	Rationale for inclusion/exclusion of items
9/7/22	PubMed	Simple: (electrocardiography) AND (education)) AND (healthcare providers) Advanced: (("electrocardiographies"[All Fields] OR "electrocardiography"[MeSH Terms] OR "electrocardiography"[All Fields]) AND ("educability"[All Fields] OR "educable"[All Fields] OR "educates"[All Fields] OR "education"[MeSH Subheading] OR "education"[All Fields] OR "educational status"[MeSH Terms] OR ("educational"[All Fields] AND "status"[All Fields]) OR "educational status"[All Fields] OR "education"[MeSH Terms] OR "education s"[All Fields] OR "educational"[All Fields] OR "educative"[All Fields] OR "educator"[All Fields] OR "educator s"[All Fields] OR "educators"[All Fields] OR "teaching"[MeSH Terms] OR "teaching"[All Fields] OR "educate"[All Fields] OR "educated"[All Fields] OR "educating"[All Fields] OR "educations"[All Fields]) AND ("health personnel"[MeSH Terms] OR ("health"[All Fields] AND "personnel"[All Fields]) OR "health personnel"[All Fields] OR ("healthcare"[All Fields] AND "providers"[All Fields]) OR "healthcare providers"[All Fields])) AND (2012:2022[pdat]) Translations	10 years (2012-2022) English	(Reviewed 10 pages of results) 151 found/12 kept	Inclusion of EKG Lead placement education Inclusion of diagnostic errors the occur due to misplacement of leads
9/7/22	CINAHL	(MM "Electrodes/ED/NU/ST") OR "EKG Lead Placement" OR (MH "Electrocardiography, Ambulatory") AND (MM "Education") OR (MH "Education, Nurse Anesthesia/ED/ST/UT") OR (MH "Education, Continuing") AND (MM "Anesthesia Nursing")	10 years (2012-2022) English	17 found/ 2 kept	Inclusion of EKG diagnostic errors due to lead misplacement Inclusion of Anesthesia Providers Inclusion of EKG Education
9/7/22	Google Scholar	(ECG Lead Placement) AND (Education) AND (Healthcare Providers)	10 years (2012-2022) English	(Reviewed 20 pages of results) 17,300 found/18 kept	Inclusion of EKG diagnostic errors due to lead misplacement Inclusion of Healthcare Providers Inclusion of EKG Education Inclusion of educational standards

Appendix C

Literature Matrix

Authors/ Year Pub	**Article Title / Journal**	**Purpose and take-home message**	**Design/Level of Evidence/ Framework**	**IV DV or Themes concepts and categories**	**Sample Size/Sample Method**	**Subject Charac.**	**Comments/critique of the article/methods GAPS**
Funk, Fennie, Stephens, May, Winkler, & Drew / 2017	Association of Implementation of Practice Standards for Electrocardiographic Monitoring with Nurses' Knowledge, Quality of Care, and Patient Outcomes: Findings From the Practical Use of the Latest Standards of Electrocardiography (PULSE) Trial / *Circulation: Cardiovascular Quality and Outcomes*	A trial was performed to test the effect of an online educational intervention.	Randomized Control Trial / Level II / N/A	Lead Placement & Training Lead Placement Inaccuracies	686 / The project population included 17 hospitals and 65 cardiac units forming 3 distinct samples	686 participated in all 3 phases of the study.	The authors found that mean test scores improved significantly in each group immediately after the intervention. Limitations: 15 months after the intervention, the mean test score gain was not sustained in one of the groups. Although the score was significantly lower than immediately postintervention, it is still significantly better than at baseline. Usefulness: The study showed a strong direct correlation with routine educational interventions and competent EKG lead placement knowledge.

Giannetta, Campagna, Muzio, Simone, Dionisi, & Muzio / 2020	Accuracy and knowledge in 12-lead ECG placement among nursing students and nurses: a web-based Italian study / *Journal of the Society of Medicines and Natural Sciences*	The study was performed to address the knowledge of ECG lead placement among professionals and showed that educational programs can lead to improved patient care.	Randomized Control Trial / Level II / N/A	General knowledge of ECG lead placement of nursing staff and students The importance of training interventions	484 / The study was a cross-sectional questionnaire-based study.	484 nurses and nursing students	The study helped to support the idea that lack of knowledge leads to an increase in lead misplacement and training interventions would improve quality of care. Strengths: The study investigated the knowledge of nursing staff and students on a large scale. Limitations: The web-based questionnaire was voluntary.
Kashou, May, DeSimone, & Noseworthy / 2020	The essential skill of ECG interpretation: How do we define and improve competency? / *British Medical and Surgical Journal*	The study showed that Medical professionals need clear, objective and universal ECG competency standards that can realistically be attained and thereafter maintained.	Case controlled study / Level VI / N/A	Assessment of ECG lead knowledge Impact of educational interventions	72 / This was an interventional study performed with pre- and post-assessments of ECG knowledge.	52 nurses and 20 ECG technologists	The study supported the idea that to solve the problem of declining ECG competency, clearly defined skill competencies for all healthcare professionals are needed. Strengths: The study clearly showed how educational interventions can positively impact the accuracy of ECG recordings.
Medani, Hensey, BAO, Caples, & Owens / 2017	Accuracy in precordial ECG lead placement: Improving performance through a peer-led educational intervention / *Journal of Electrocardiology*	Precordial ECG lead misplacement is common, and this can be successfully addressed by regular formal training incorporated into annual induction programmes of health care institutions.	Randomized Control Trial / Level II / N/A	Lead Placement & Training Lead misplacement errors	100 / The hospital staff was interviewed at one hospital.	Pre-intervention: 56 nurses, 34 doctors, 10 cardiac technicians' post-intervention: 75 nurses, 20 doctors and 5 technicians	The authors found that training and maintaining ECG performance skills will minimize lead misplacements and improve the recognition and avoidance of incorrect ECG recording, misdiagnosis and inappropriate management decisions. Limitations: Only one hospital was involved in the study. Usefulness: Establishes the importance of routine training and its direct impact on patient care.

Rasmussen, Fabricius-Bjerre, Kumarathurai, Larsen, Domínguez, Kanters, & Sajadieh / 2019	Common source of miscalculation and misclassification of P-wave negativity and P-wave terminal force in lead V1 / *Journal of Electrocardiology*	The objective of the study was to assess the influence of electrode misplacement on P-wave Terminal Force (PTF) and Deep Terminal Negativity (DTN).	Case controlled Trial without Randomization / Level VI / N/A	Lead Misplacement Alterations that are caused by ECG misplacement	29 / The study was performed on patients at the Department of Cardiology at the Copenhagen University Hospital of Bispebjerg.	29 healthy patients volunteered for the study	The authors concluded that there were significant alterations in the PTF and DTN when the ECG leads were misplaced. Limitations: The sample size included only 29 patients and the individuals were all healthy with no known heart disease. Not completely randomized. Usefulness: The study showed that with misplacement of the ECG leads there is a high chance that there will be alterations in the recording and diagnostic errors. This supports the importance of ECG Lead Placement.
Rehman & Rehman / 2020	Precordial ECG Lead Mispositioning: Its Incidence and Estimated Cost to Healthcare / *Cureus Journal of Medical Science*	The study was performed to estimate the incidence and economic burden of electrocardiogram (ECG) precordial lead mispositioning, in an effort to highlight the need for quality improvement.	Randomized Control Trial / Level II / N/A	Lead Placement & Training Lead misplacement costs to the hospital	75 / The project population included 15 units that were either ICUs or PCUs.	75 nurses were involved in the study.	The authors found that the nurses placed precordial leads with greater accuracy after the educational interventions. Limitations: The number of focus groups was limited by the time allowed for the project. Usefulness: The study showed a strong positive correlation between attitude/behavior, training interventions, and proper ECG lead Placement.
Walsh / 2018	Misplacing V1 and V2 can have clinical consequences / *The American Journal of Emergency Medicine*	The purpose of the study was to show the impact of ECG lead misplacement on the patient's course of care.	Case controlled study / Level VI / N/A	The impact of ECG lead misplacement on patient diagnosis Unnecessary costs and tests due to misdiagnosis	5 case studies / The study was performed by analyzing the effects of ECG lead placement while selecting 5 case studies to support this idea.	5 individual case studies selected	The study showed that misplacement of ECG leads can lead to patients being inappropriately investigated for cardiopulmonary conditions, receiving unneeded testing, and incurring unnecessary expenses and anxiety. Strengths: This study gave several detailed examples that showed how ECG misplacement can negatively impact patient care. Limitations: The sample was very small.

Wirt, Milbrath, & Farnsworth / 2014	Precordial Electrode Placement Accuracy by Nurses in a Large Midwestern Tertiary Care Hospital / *Journal of Continuing Education in Nursing*	This was a quality improvement project to increase the knowledge of nurses and the accuracy of electrocardiogram precordial lead placement among intensive care unit and progressive care unit staff.	QI Project / Level VI / The theory of planned behavior	Assessment of ECG lead knowledge Impact of educational interventions with educational plan	75 / The project population included 15 units that were either ICUs or PCUs	75 nurses were included in four groups in select nursing units	The study showed that the interventions were effective in increasing the accuracy of precordial lead placement. Strengths: This study included an educational plan. Limitations: The number of focus groups was limited by the time allowed for the project.

Note: 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

Approval Forms

Quality Improvement/Program Evaluation Self-Certification Tool

Purpose:
Projects that do not meet the federal definition of human research pursuant to 45 CFR 46 do not require IRB review. This tool was developed to assist in the determination of when a project falls outside of the IRB's purview.

Instructions:
Please complete the requested project information, as this document may be used for documentation that IRB review is not required. Select the appropriate answers to each question in the order they appear below. Additional questions may appear based on your answers. If you do not receive a STOP HERE message, the form may be printed as certification that the project is "not research", and does not require IRB review. The IRB will not review your responses as part of the self-certification process. For projects being done at Vidant Health, site support will be required. Please email [redacted] to obtain site support from [redacted]

Name of Project Leader:

Travis Chabo, PhD, CRNA

Project Title:

Quality Improvement DNP Project: Perioperative ECG Lead Placement

Brief description of Project/Goals:

A quick-reference perioperative guide to proper ECG lead placement, based upon accepted national guidelines, will be developed. Cardiac Intensive Care Unit care nurses at [redacted] will be asked several questions (through Qualtrics) about their perceptions of the adequacy of their current ECG lead placement resources and practice. An educational video about the use of a newly developed reference tool for proper ECG lead placement will be made available to them, and they will be asked to use the reference tool 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 proper lead placement reference and their current practice. Qualtrics survey software will be used to deliver the intervention link and gather participant perceptions prior to and post implementation of the project. No patient information will be recorded or maintained during this project.

Will the project involve testing an experimental drug, device (including medical software or assays), or biologic?

○ Yes
● No

Has the project received funding (e.g. federal, industry) to be conducted as a human subject research study?

○ Yes
● No

Is this a systematic investigation designed with the intent to contribute to generalizable knowledge (e.g. testing a hypothesis; randomization of subjects; comparison of case vs. control; observational research; comparative effectiveness research; or comparable criteria in alternative research paradigms)?

- ○ Yes
- ● No

Will the results of the project be published, presented or disseminated outside of the institution or program conducting it?

- ● Yes
- ○ No

Would the project occur regardless of whether individuals conducting it may benefit professionally from it?

- ● Yes
- ○ No

Does the project involve "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)?

- ● Yes
- ○ No

Is the project intended to improve or evaluate the practice or process within a particular institution or a specific program, and falls under well-accepted care practices/guidelines?

- ● Yes
- ○ No

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. 12/4/2022

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 [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: ECG Lead Placement: A DNP Project		
Funding Source: None		
Project Leader Name: Haley Cutler, BSN SRNA [redacted] ☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ Pharm.D. ■ R.N. ☐ Other(specify):		
Job Title: ECU SRNA/[redacted]	**Phone:** [redacted]	**Email:** [redacted]
	Primary Contact (If different from Project Leader):	
	Phone: [redacted]	**Email:** cutlerh14@students.ecu.edu

Key Personnel/ Project Team members:

Name and Degree:	Department: (Affiliation if other than [redacted]	Email:
Haley Cutler, BSN, SRNA	ECU Nurse Anesthesia Program	cutlerh14@students.ecu.edu
Travis Chabo PhD, CRNA	ECU Nurse Anesthesia Program	[redacted]

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.)	☒	☐
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 as address all of the following:
The purpose of this quality improvement project is to assess ICU nurses' perceptions of adequacy of a newly developed ECG Lead Placement guide. A quick-reference ECG Lead Placement guide, based upon accepted national guidelines, will be developed. ICU nurses [redacted] will be asked several questions (through Qualtrics) about their perceptions of the adequacy of the currently used ECG Lead Placement guide and preparedness for ECG Lead Placement. An educational video about the use of the newly developed tool 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 guide. 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 primary purpose of this DNP project will be to assess the perceived efficacy of a standardized educational aid designed to streamline ECG lead placement and increase consistency across all disciplines in the perioperative setting. The ECG lead placement education will include standard 6-lead placement and alternative placement required for varying surgical procedures and positioning.
   b) **The project 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.** ICU nurse 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 ECG Lead Placement. 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.** The intervention for this project will be a newly created informational tool focused on ECG lead placement which is based on current evidence and falls within current accepted practice standards within the facility.
   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).** Data will be gathered directly from participants through completion of Qualtrics pre- and post-surveys delivered and completed electronically through emailed links.
   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 of 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 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. Haley Cutler will be responsible for de-identification of all data prior to dissemination.

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]**perational Mgr/Leader Name:** [redacted]

[redacted] 3/1/23

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

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.

Haley Cutler — **Project Leader Signature**

2/12/23 — **Date**

----------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:** [redacted] **Date:** 3/6/2023

UMCIRB Office Staff Reviewer: [redacted] **Date:** 3/8/23

Appendix E

Emails to Participants

Initial Pre-Survey and Video Email to Participants

Dear CVICU Nurses,

Thank you for considering participating in a quality improvement project titled "Quality Improvement DNP Project: Perioperative ECG Lead Placement." The purpose of this project is to assess perioperative nurses' perceived adequacy of a newly developed reference tool for proper ECG lead placement within a Cardiovascular Intensive Care Unit.

Participation is voluntary and will involve completing a short pre-intervention survey, viewing a brief video, utilizing ECG leads in your nursing practice for two weeks (at your discretion), and completing a short post-intervention survey when the two-week implementation period is over.

Each survey and the video should take less than 2-4 minutes to complete. The surveys were created and are completed using Qualtrics® survey software. The use of ECG Lead Placement Tool 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 provide **link here.**

Following completion of the survey, view the project overview presentation video and ECG lead placement tool. Feel free to download the reference tool as a PDF for quick reference or grab a paper copy provided in the huddle room.

Presentation Video – **Link Here**

ECG Lead Placement Tool – **Link Here**

Again, thank you for your participation in our quality improvement project. I will be at [redacted] Medical Center from April 10th until April 20th if you have any questions. You may also reach out to me or Travis Chabo by email at any time.

Sincerely,

Haley Cutler, SRNA
Cutlerh14@students.ecu.edu
Travis Chabo, PhD, CRNA, Project Chair
ChaboT14@ECU.edu

Pre-Survey and Video Reminder Email to Participants

Hello CVICU Nurses,

I just wanted to send a **quick reminder** about the ongoing DNP Project on ECG Lead Placement. If you've already filled out the pre-survey and viewed the video, 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 reference tool is available as a PDF for quick reference or there are still paper copies provided in the huddle room if you haven't already received one. You may use these at your discretion. After the end of next week, I will begin sending out the post-surveys.

Links:
Pre-survey - https://ecu.az1.qualtrics.com/jfe/form/SV_b9rXzQLNHJa9fkG
Presentation Video - **Link Here**

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

Sincerely,
Haley Cutler, SRNA
ECU Nurse Anesthesia Program
Class of 2024

Post-Survey Email to Participants

Dear CVICU Nurses,

Thank you to everyone who has already completed my pre-survey and viewed the video. 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 (it's just a survey and a video). The link to the pre-survey is **here** and you can follow it up by watching the introductory PPT/video **Link Here.** The reference tool is available as a PDF for quick reference or paper copies are available for your use if you would like them, but their use is not mandatory for participation in this project.

If you've already completed the first survey, please complete the post-survey **here.**

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 nurses.

ECG Lead Placement Tool - **Link Here**

Sincerely,
Haley Cutler, SRNA
ECU Nurse Anesthesia Program
Class of 2024

Final Thank You Email to Participants

Dear CVICU nurses,

I just wanted to say thank you so much to everyone for helping me out with my DNP Project! I have collected all of the data I need to proceed with data analysis and will then 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 EKG Lead Placement Tool and found it useful, you can keep the copies that you have been provided or access the PDF via the previous email.

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

Take care,
Haley Cutler, SRNA
ECU Nurse Anesthesia Program
Class of 2024

Appendix F

RN Surveys (pre & post)

1) Pre-interventional Survey

1. Did you receive formal training on ECG lead placement as part of the onboarding process for your discipline? (For ICU nurses only)
   No/Maybe/Yes

2. How often do you follow a standardized method for applying ECG leads?
   Never/Sometimes/About half the time/Most of the time/Always

3. How confident do you feel placing ECG leads accurately in standard and alternative positions?

   a. Supine:
   Not at all confident/Somewhat unconfident/Neutral/Somewhat confident/Very confident
   b. Prone:
   Not at all confident/Somewhat unconfident/Neutral/Somewhat confident/Very confident
   c. Lateral:
   Not at all confident/Somewhat unconfident/Neutral/Somewhat confident/Very confident

4. How often do you experience artifact or incorrect morphology with your current ECG lead placement practice?
   Never/Sometimes/About half the time/Most of the time/Always

5. How often do you adjust ECG placement for body habitus, position, dressings, etc. to achieve an acceptable ECG tracing?
   Never/Sometimes/About half the time/Most of the time/Always

6. How often do you receive patients with inaccurate ECG lead placement?
   Never/Sometimes/About half the time/Most of the time/Always

7. Do you believe the quality of patient care could be improved with more accurate ECG lead placement?
   Probably not/Might or Might not/Probably yes/Definitely yes

8. What are any other obstacles to accurate ECG lead placement that you have observed?
   [free text reply]

2) Post-interventional Survey:
After using the ECG Placement tool, how confident do you now feel placing ECG leads accurately in standard and alternative positions?

a. Supine:
Not at all confident/Somewhat unconfident/Neutral/Somewhat confident/Very confident
b. Prone:
Not at all confident/Somewhat unconfident/Neutral/Somewhat confident/Very confident
c. Lateral:
Not at all confident/Somewhat unconfident/Neutral/Somewhat confident/Very confident

2. After using the ECG lead placement tool, how often do you experience artifact or inaccurate morphology?
Never/Sometimes/About half the time/Most of the time/Always

3. After using the ECG lead placement tool, how often do you adjust ECG lead placement for body habitus, position, dressings, etc. to achieve an acceptable ECG tracing?
Never, not often, sometimes/neutral, somewhat often, often

4. How likely are you to continue using the ECG placement tool when applying ECG leads in the future?
Extremely unlikely/Somewhat unlikely/Neither likely nor unlikely/Somewhat likely/Extremely likely

5. The ECG lead placement tool was easily accessible.
Strongly disagree/Somewhat disagree/Neither agree nor disagree/Somewhat agree/Strongly agree

6. How often did you use the ECG lead placement tool in your practice since receiving it?
Never/Sometimes/About half the time/Most of the time/Always

7. About how much additional time did it take to reference this tool in your daily practice?
Less than 1 minute/1-2 minutes/3-5 minutes/Greater than 5 minutes/I never used it

8. The ECG placement tool improved the quality of care I delivered my patients.
Strongly disagree/Somewhat disagree/Neither agree nor disagree/Somewhat agree/Strongly agree

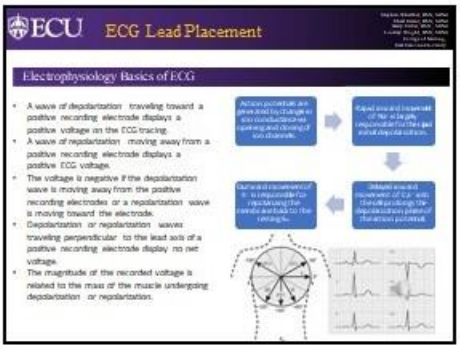
9. After using this reference tool and participating in this QI project, do you feel an annual continuing education module on ECG lead placement would improve patient care?
No/Maybe/Yes

10. Please provide any additional feedback or suggestions that haven't been addressed.
[free text reply]

Appendix G

PowerPoint

1



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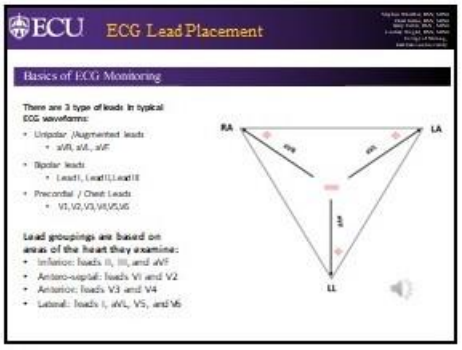

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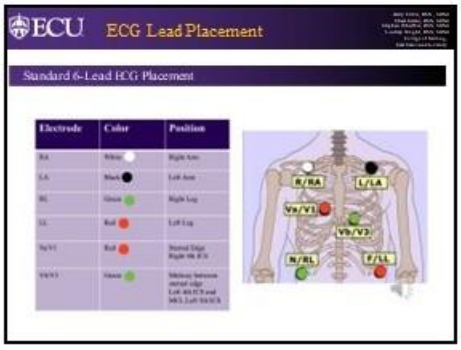

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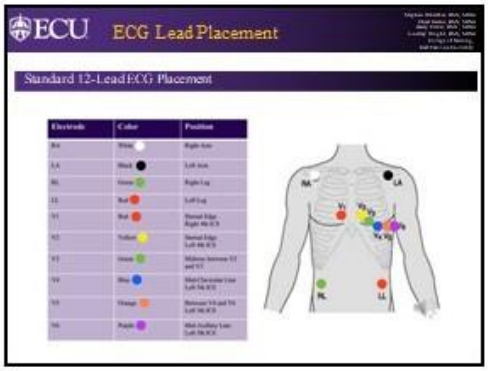
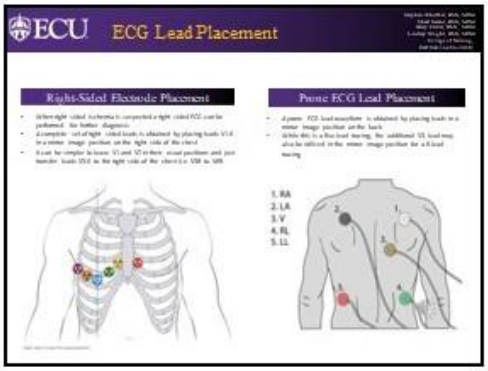
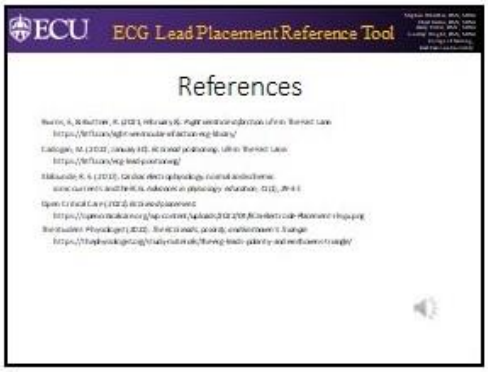

ECU
ECG Lead Placement
Standard 12-Lead ECG Placement
Electrode
Color
Position

5


ECU
ECG Lead Placement
Right-Sided Electrode Placement
Prone ECG Lead Placement
1. RA
2. LA
3. V
4. RL
5. LL

6


ECU
ECG Lead Placement Reference Tool
References

7


Thank you!

8

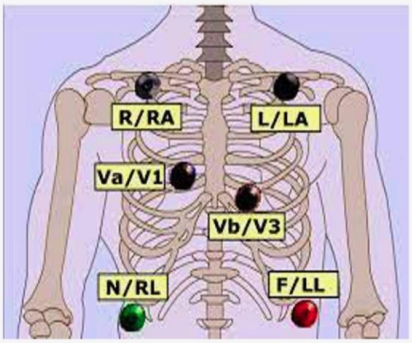
Appendix H

ECG Lead Placement Tool

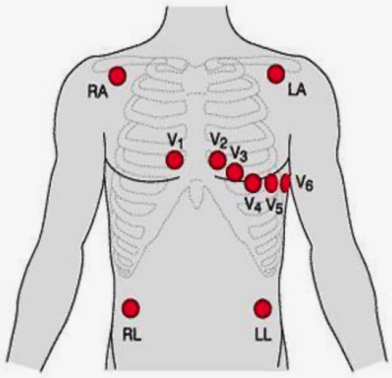
ECU ECG Lead Placement

Stephen Whedbee
Chad Greene
Haley Cutler
Lindsay Wright
College of Nursing,
East Carolina University

Electrode	Color	Position
RA	White	Right Arm
LA	Black	Left Arm
RL	Green	Right Leg
LL	Red	Left Leg
Va/V1	Red	Sternal Edge Right 4th ICS
Vb/V3	Green	Midway between sternal edge Left 4th ICS and MCL Left 5th ICS

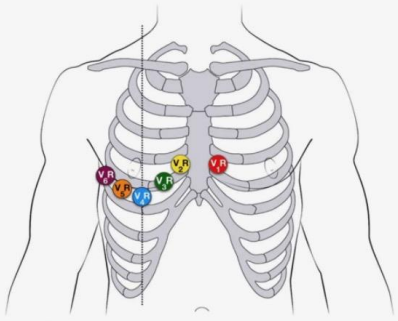


Electrode	Color	Position
RA	White	Right Arm
LA	Black	Left Arm
RL	Green	Right Leg
LL	Red	Left Leg
V1	Red	Sternal Edge Right 4th ICS
V2	Yellow	Sternal Edge Left 4th ICS
V3	Green	Midway between V2 and V4
V4	Blue	Mid-Clavicular Line Left 5th ICS
V5	Orange	Between V4 and V6 Left 5th ICS
V6	Purple	Mid-Axillary Line Left 5th ICS



Right-Sided Electrode Placement

- When right sided ischemia is suspected a right sided ECG can be performed for further diagnosis
- A complete set of right sided leads is obtained by placing leads V1-6 in a mirror image position on the right side of the chest
- It can be simpler to leave V1 and V2 in their usual positions and just transfer leads V3-6 to the right side of the chest (i.e. V3R to V6R



Right sided 12 lead ECG lead placement

Prone ECG Lead Placement

1. RA
2. LA
3. V
4. RL
5. LL