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Implementing Computerized ST-Segment Analysis Utilizing 5-Lead ECG Cables during the Perioperative Period for Myocardial Ischemia Detection in Patients at Risk for Cardiovascular Disease

Lauren Robertson

IMPLEMENTING COMPUTERIZED ST-SEGMENT ANALYSIS UTILIZING 5-LEAD ECG CABLES DURING THE PERIOPERATIVE PERIOD FOR MYOCARDIAL ISCHEMIA DETECTION IN PATIENTS AT RISK FOR CARDIOVASCULAR DISEASE

by

Lauren Robertson

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ABSTRACT

IMPLEMENTING COMPUTERIZED ST-SEGMENT ANALYSIS UTILIZING 5-LEAD ECG CABLES DURING THE PERIOPERATIVE PERIOD FOR MYOCARDIAL ISCHEMIA DETECTION IN PATIENTS AT RISK FOR CARDIOVASCULAR DISEASE

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Cardiovascular disease (CVD) is one of the leading causes of death in the United States (U.S.) annually (Centers for Disease Control and Prevention, 2011). Mississippi has a disproportionately higher percentage of citizens likely to have CVD (Mississippi State Department of Health [MSDH], n.d.). The numerous stressors related to surgery are alone enough to increase the demand of the heart and lead to ischemia of the myocardium. Surgical stressors combined with preexisting CVD can exponentially increase the risk of ischemia. It is estimated that over a third of all surgical patients have ischemic heart disease. Puelacher et al. (2015) reported 40% of deaths after noncardiac surgery are attributable to cardiovascular (CV) complications and myocardial ischemia/infarction in particular. The most specific and gold standard of monitoring for such ischemia is the ST-segment on the electrocardiogram (ECG).

An informal survey of anesthesia providers at several hospitals in Mississippi revealed that they did not place 5-lead ECG cables on patients at risk for CVD the majority of the time. A quality improvement (QI) educational project was prepared from the most recent literature and presented to anesthesia providers at a Southeastern hospital (N=12). The pre-survey percentage of 5-lead versus 3-lead ECG cables was determined and compared with the reported percentage of use after the presentation. The percentage of 5-lead ECG cable use before the intervention was 8.1% and post intervention was 30.5%, an obvious increase. The main barrier reported by anesthesia providers was not having the 5-lead ECG cables readily available. The most important factor for choosing to use the 5-lead ECG was a patient history of CVD. By updating the anesthesia providers on the most recent literature and guidelines by numerous professional organizations, the primary goal to increase the utilization of 5-lead ECG cables was met.

ACKNOWLEDGMENTS

I would like to express my deep gratitude to Dr. Marjorie Geisz-Everson for her patient guidance, useful critiques, and words of encouragement during the planning and development of this doctoral project. My sincere thanks are also extended to the other members of my committee, Dr. Michong Rayborn and Dr. Luis Irizarry, as well as the staff at the facility where the project was implemented.

DEDICATION

I dedicate this project to my family. To my husband, Ryan, my favorite person in the world. Your love and support and presence has been the only way that I have made it through this journey. To my loving parents, Marion and Betty Boyd, and my mother and father-in-law, Susan and the late Ronnie Robertson, for never faltering in their love and support.

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LIST OF ABBREVIATIONS

AACN	American Association of Critical Care Nurses
AANA	American Association of Nurse Anesthetists
ACC	American College of Cardiology
AHA	American Heart Association
ASA	American Society of Anesthesiologists
BBB	Bundle Branch Block
BMI	Body Mass Index
BPM	Beats Per Minute
CAD	Coronary Artery Disease
CHF	Congestive Heart Failure
CRNA	Certified Registered Nurse Anesthetist
CV	Cardiovascular
CVD	Cardiovascular Disease
CVP	Central Venous Pressure
DBP	Diastolic Blood Pressure
DM	Diabetes Mellitus
DNP	Doctorate of Nursing Practice
EBP	Evidence Based Practice
ECG	Electrocardiogram
HOTN	Hypotension
HR	Heart Rate

HTN	Hypertension
IRB	Institutional Review Board
MAP	Mean Arterial Pressure
MI	Myocardial Infarction
MINS	Myocardial Injury After Noncardiac Surgery
PACU	Post Anesthesia Care Unit
POISE	Perioperative Ischaemic Evaluation
QI	Quality Improvement
RN	Registered Nurse
SBP	Systolic Blood Pressure
SOB	Shortness of Breath
US	United States

CHAPTER I – SUMMARY OF THE EVIDENCE

Introduction

Cardiovascular disease (CVD) is the leading cause of death in the United States (U.S.) totaling almost 1 million deaths annually (Centers for Disease Control and Prevention, 2011). Therefore, the need for constant analysis, diagnosis, and methods of prevention and treatment of cardiac dysfunction perioperatively are of utmost importance to the anesthesia provider (World Health, 2009). The American Association of Nurse Anesthetists (AANA, 2013) and American Society of Anesthesiologists (ASA, 2010) issue standards of care for anesthesia providers. One of those standards is monitoring of circulation which consists, at minimum, of the following: continuous electrocardiography for assessing rate and rhythm, blood pressure at least every five minutes, and evaluation of circulatory function as evidenced by a pulse oximeter (American Association of Nurse Anesthetists [AANA], 2013; American Society of Anesthesiologists [ASA], 2010). Each of the components of circulation monitoring is vigorously assessed by the anesthetist and scrutinized for any evidence of irregularities. The purpose of this doctoral project was to promote a practice change to use continuous electrocardiogram (ECG) monitoring of the ST-segment in high-risk patients undergoing anesthesia in order to thoroughly assess for changes that would indicate myocardial ischemia.

In 1908, the first ECG was introduced in the U.S. at Mt. Sinai Hospital, New York (Burnett, 1985). In its primitive design, the ECG could only be used to assess for dysrhythmias. It was not until years later that the increasingly sophisticated design of ECGs enabled clinicians to assess for myocardial ischemia and/or infarction. While under anesthesia, continuous monitoring of the patient's ECG for rhythm, rate and for some, ST segment analysis, is necessary (Nagelhout & Plaus, 2014).

Problem Statement/Needs Assessment

The leading cause of death in the state of Mississippi is CVD (41%), and Mississippi has the highest rate mortality from CVD in the nation (Mississippi State Department of Health [MSDH], n.d.). Based on a national survey completed in 2007-2008, "49.7%, or an estimated 107.3 million U.S. adults aged ≥20 years, have at least one of the following three preventable CVD risk factors: uncontrolled hypertension (HTN), uncontrolled high cholesterol, or smoking" (Centers for Disease Control and Prevention [CDC], 2011, p. 1251). CVD is the cause of one out of every three deaths in the U.S. annually (CDC, 2011). One person dies due to CVD and coronary heart disease leading to an acute coronary event every minute (American Heart Association [AHA], 2011).

It is estimated that one-third of all surgical patients annually in the U.S. have ischemic heart disease (Hines & Marschall, 2012). Unfortunately, the ischemic heart disease is often unnoticed until sudden cardiac arrest or an acute myocardial infarction (MI) occurs (Hines & Marschall, 2012). The authors suggested the best form of monitoring patients perioperatively for myocardial ischemia is continuous ECG monitoring with ST segment analysis. Both the AANA and the American Association of Critical Care Nurses (AACN) recommends utilization of 5-lead ECG cables for continuous monitoring of ST-segment in patients who are at a high risk for myocardial ischemia ("AACN," n.d.; Hewer, Drew, Karp, & Stotts, 1997).

Several informal interviews of staff Certified Registered Nurse Anesthetists (CRNAs) and anesthesiologists at more than one hospital in Mississippi revealed that these anesthesia providers used the ECG leads that were connected to the machine at the time of induction, regardless of CVD risk factors. Only a few admitted to changing the ECG cables connected to the monitor from 3 to 5-lead ECG cables in order to perform ST-segment analysis despite multiple risk factors for CVD. Some of these facilities did not have any 5-lead ECGs available for perioperative use.

Clinical Question

Will anesthesia providers who are provided evidence related to the benefits of 5-lead ECGs for detecting perioperative myocardial ischemia through ST-segment surveillance be willing to make a practice change and increase utilization of 5-lead ECGs for continuous ST-segment analysis in their plan of care for patients who have risk factors for CVD?

Puelacher et al. (2015) reported 40% of all deaths after noncardiac surgery are attributable to cardiovascular (CV) complications and myocardial ischemia/infarction in particular. Another noteworthy statistic from Puelacher et al. (2015) stated 20% of vascular surgical patients experience ST depression perioperatively. Incorporating ST-segment analysis in the surgical candidates at risk for CVD is recommended by many professional societies (Nagelhout & Plaus, 2014). With over 25% of surgical candidates having risks factors for CVD, they are more likely to experience myocardial ischemia perioperatively and the risk of infarction increases threefold (Nagelhout and Plaus, 2014).

The American College of Cardiology (ACC) and American Heart Association (AHA) practice guidelines recommend perioperative and postoperative computerized ST-segment analysis in patients with at least one risk factor (HTN, heart failure, cardiomyopathy, smoking history, male gender, elevated cholesterol levels, advanced age, etc.) for CVD due to the usefulness of detecting myocardial ischemia (ACC/AHA, 2007). Additionally, no increased risk is associated to the patient using 5-lead ECG cables, and it is low-cost, noninvasive, and may lead to reduce morbidity when detecting ischemia early (AANA, 2013; Nagelhout & Plaus, 2014).

Purpose of the Project

The primary goal of this project was to promote increased utilization of 5-lead ECG cables for computerized ST-segment analysis for patients at risk for CVD by anesthesia providers. Providing the facility's anesthesia providers with current, evidence-based statistics and severity of postoperative morbidity and mortality from unrecognized or untreated myocardial ischemia was the method in which to promote the goal. The literature suggests that in the presence of risk factors for CVD, documented or not, practitioners should exercise their clinical judgment and choose the ECG configuration that allows for more judicious monitoring (Nagelhout & Plaus, 2014). The 5-lead ECG configuration is preferred over the 3-lead ECG configuration due to the ability of the former to view a more accurate assessment of the myocardium and to reduce the likelihood of unrecognized myocardial ischemia as evidenced by T-wave and/or ST-segment inversion (Mark & Nussmeier, 2005; Nagelhout & Plaus, 2014; Ryan, Rodseth, & Biccard, 2011; The Vascular events In noncardiac Surgery patients cOhort evaluatioN (VISION) Writing Group, on behalf of The Vascular events In noncardiac Surgery patients cOhort evaluatioN (VISION) Investigators, 2014). A thorough assessment of all feasible patient data will possibly lead to improved outcomes in anesthesia (Nagelhout & Plaus, 2014).

A secondary goal of this study was to improve the postoperative outcomes of patients by reducing the likelihood of unrecognized and therefor untreated myocardial ischemia leading to myocardial injury/infarction after noncardiac surgery. Annually worldwide, it is estimated that almost 10% of patients suffer from myocardial injury after noncardiac surgery (MINS) and 10% of those patients will die from complications within 30 days (The Vascular events In noncardiac Surgery patients cOhort evaluatioN (VISION) Writing Group, on behalf of The Vascular events In noncardiac Surgery patients cOhort evaluatioN (VISION) Investigators, 2014).

Review of the Literature

An analysis of the literature revealed the risk factors for CVD, incidence and consequences of postoperative cardiac complications due to perioperative myocardial ischemia, methods of proper monitoring for myocardial ischemia and patient selection for such monitoring, and barriers to the application/usage of 5-lead ECG monitoring for ST-segment analysis. The search engines CINHAL, PubMed, and MedLine were utilized and the terms cardiac monitoring, anesthesia, perioperative monitoring, ST-segment depression, cardiovascular risk factors, and electrocardiogram were used interchangeably with results itemized within the last 5 years. The search terms cardiac monitoring, perioperative, anesthesia, and cardiovascular monitoring, in various combinations, resulted in the most articles totaling 272. Eight articles were selected for this doctoral project after being reviewed and can be found in Appendix A. For the purposes of this doctoral project, in conjunction with the scholarly articles, several academic books are utilized for the literature review.

Risk Factors for Cardiovascular Disease

CVD is the leading cause of death in the U.S. and is disproportionally higher in Mississippi (Centers for Disease Control and Prevention, National Center for Health Statistics [CDC], 2015). Poldermans et al. (2010) stated that patient factors prior to surgery are the main determinant of CV complications perioperatively and postoperatively. CVD risk factors consist of nonmodifiable factors such as family history, race, and age and modifiable factors such as HTN, high cholesterol, smoking, excessive alcohol intake, poor diet, obesity, sedentary lifestyle, and diabetes mellitus (World Heart Federation, n.d.). The standardized definitions of the risk factors are as follows: HTN is a systolic blood pressure (SBP) ≥ 140 mmHg or a diastolic blood pressure (DBP) ≥ 90 mmHg; obesity is a body mass index (BMI) ≥ 30 kg/m2; diabetes mellitus (DM) is a fasting blood glucose level ≥ 126 mg/dL; high cholesterol is a total cholesterol level ≥ 200 mg/dL (Romero, Romero, Shlay, Ogden, & Dabelea, 2012).

Preoperative Screening for Cardiovascular Disease

An essential component of an anesthesia provider's job responsibilities is to conduct a thorough preoperative assessment of patients undergoing anesthesia. Objective and subjective data are collected in the preoperative interview in an attempt to customize the anesthetic plan to provide the safest care possible. Nagelhout and Plaus (2014) discuss assessing the presence of existing cardiac pathophysiology, extent of the disease and its treatment, coexisting comorbidities and type of surgical procedure during preoperative evaluation. The use of 5-lead ECG cables for perioperative ST-segment monitoring should be selected based on patient CV risk factors, current CVD states, treatment regimen and compliance, and the type of surgery performed (Abbott et al., 2016; Guarracino, Baldassarri, & Priebe, 2015; Poldermans et al., 2010; Puelacher et al., 2015; Vincent et al., 2015).

As previously mentioned, Abbott et al., (2016) found significant correlation ($P < 0.01$) between perioperative myocardial infarction/injury after noncardiac surgery and a preoperative heart rate >96 beats per minute (BPM) and suggested more studies be conducted to determine if reducing the preoperative heart rate will reduce these events. Of interest is a case study reported by Singh, Shah, and Trikha (2012) regarding perioperative myocardial ischemia as evidenced by ST-segment depression in an otherwise healthy male in the absence of all other CV risk factors. The authors attributed the ST-segment depression to be a mismatch of supply and demand of the heart despite a mean arterial pressure (MAP) indicating adequate perfusion.

Perioperative Monitoring for Myocardial Ischemia

Monitoring of the ST-segment continuously throughout the perioperative period is fundamental to assess for myocardial ischemia (Abbott et al., 2016; Mark & Nussmeier, 2005; Poldermans et al., 2010; Puelacher et al., 2015). The physical stressors of surgery by themselves are enough to precipitate myocardial ischemia through an imbalance of supply and demand and are exacerbated by HTN, hypotension (HOTN) and hypoxia (Abbott et al., 2016). Also of importance is the cause of the myocardial ischemia. Unlike the more ‘traditional’ MIs that are caused by ruptured plaque or embolus, the perioperative physiologic stress of the surgery and the anesthetic combined with CVD causes a mismatch between supply and demand for the myocardium (Abbott et al., 2016; Puelacher et al., 2015). Preexisting CVD, the physiologic stress of surgery as well as the degree of risk of surgery put the patient at a greater risk for myocardial ischemia perioperatively (Abbott et al., 2016; Poldermans et al., 2010; Vincent et al., 2015). In one study, tachycardia was found to be the most important causative factor of perioperative ischemia and the authors suggested that further research is needed to determine the relationship of tachycardia treatment preoperatively and its correlation with improved postoperative outcomes (Abbott et al., 2016).

Poldermans et al. (2015) concluded not only surgical type factors but physiologic responses to surgery are influences on the degree of risk for myocardial ischemia. Surgical procedures that carry the highest risk of perioperative and postoperative myocardial injury are major thoracic, abdominal and vascular procedures (ACC/AHA, 2007). The ACC and AHA (2007) also mention the severity of myocardial stress is directly proportional with increased age.

Anesthesia textbooks delineate several methods utilized to monitor for perioperative myocardial ischemia and dysfunction. The incidence of perioperative myocardial ischemia as evidenced by ST-segment depression is 20% to 80% in patients with documented CAD; therefore, proper lead selection is imperative to prevent adverse outcomes postoperatively (Nagelhout & Plaus, 2014). Hensley Jr., Martin, and Gravlee (2013) discussed the benefits of utilizing a five-lead ECG cable in all patients with known or suspected CVD and list advantages of this configuration, one of which being a more accurate view of the entire heart, excluding the posterior wall. The authors stated that V5 lead is the single most important lead in detecting myocardial ischemia and 90% of the ischemia is detected by leads II and V5 in combination (Hensley Jr. et al., 2013).

Myocardial Injury After Non-Cardiac Surgery

Postoperative myocardial injury is a major cause of postoperative CV complications and a leading cause of morbidity and mortality (Abbott et al., 2016; Poldermans et al., 2010; Puelacher et al., 2015; Ryan, Rodseth, Biccard, 2011; van Waes et al., 2013; The Vascular events In noncardiac Surgery patients cOhort evaluatioN [VISION] Writing Group, on behalf of The Vascular events In noncardiac Surgery patients cOhort evaluatioN [VISION] Investigators, 2014; and Singh, Shah, & Trikha, 2012). When converting the statistical likelihood of perioperative and postoperative cardiac complications to the number of patients undergoing surgery annually, over 10 million will experience perioperative myocardial injury and of those, 1 million will die from directly attributed complications (Ryan, Rodseth, & Biccard, 2011). Abbott et al. (2016) reviewed medical records of over 15,000 patients undergoing non-cardiac surgery and found that an increased heart rate, >96 BPM, was a major association with CV complications. The VISION study (2014) was a large, international, prospective cohort study that assessed serial troponin levels after surgery and determined the prevalence of myocardial injury after non-cardiac surgery (MINS) to be 8%.

Postoperative Myocardial Complications

Perioperative myocardial ischemia is major risk factor for adverse postoperative outcomes and is associated with substantial mortality and morbidity and occurs in almost 10% of patients undergoing noncardiac surgery (Abbott et al., 2016; Guarracino et al., 2015; Mark & Nussmeier, 2005; Poldermans et al., 2010; Puelacher et al., 2015; Ryan, Rodseth, & Biccard, 2011; Van Waes et al., 2013; Vincent et al., 2015; VISION Writing Group, 2014). One group proclaimed the leading cause of death after noncardiac surgery is perioperative myocardial ischemia (Landesberg, Beattie, Mosseri, Jaffe, & Alpert, 2009). Van Waes et al. (2013) found that 0.6% of the patients in their study were diagnosed with postoperative MI. The POISE trial, a landmark study, was conducted over a period of 5 years. The focus was on noncardiac surgical patients and found the incidence of the following: postoperative cardiac complications at a rate of 3.5%, perioperative mortality from CV death at 1.6%, and the incidence of non-fatal myocardial infarction was 4.4% (Poise Study Group, et al., 2008).

Hemodynamic surgical stressors and individual patient factors influence perioperative and postoperative cardiac complications (Vincent et al., 2015). Lee et al. (1999) developed an index for determining which patients would be at higher risk for postoperative cardiac complications and found six independent predictors of equal importance: high-risk surgery, history of ischemic heart disease, history of congestive heart failure (CHF), history of cerebrovascular disease, insulin treatment preoperatively, and serum creatinine >2.0 mg/dL preoperatively. The scores are then totaled and give the clinician a statistical representation of the severity of cardiac risk in order to form the best anesthetic plan (Lee et al., 1999).

Conclusion

Postoperative myocardial injury is one of the leading complications in patients after noncardiac surgery (Abbott et al., 2016; Guarracino et al., 2015; Mark, Nussmeier, 2005; Poldermans et al., 2010; Puelacher et al., 2015; Ryan, Rodseth, & Biccard, 2011; Van Waes et al., 2013; Vincent et al., 2015; VISION Writing Group, 2014). Due to the increasing number of surgical cases performed annually in conjunction with an aging population, CVD is increasingly prevalent in surgical patients. The pathophysiology of

CVD places patients at an increased risk of developing perioperative and postoperative myocardial ischemia/infarction. If unrecognized and, therefore, untreated, severe life-threatening myocardial dysfunction could result. Additional clinical data in the perioperative period such as continuous ST-segment monitoring is recommended for patients with diagnosed CVD or those who have several risk factors that place them at increased risk for postoperative cardiac complications (Lee et al., 1999).

Theoretical Framework

The purpose of the theoretical framework is to guide doctoral projects by providing a framework and a logical order of events (Butts & King, 2015). The nursing theory chosen to guide this DNP project is the Nursing Intellectual Capital Theory. One of the concepts of this particular theory is that of continued professional development, which was the basis for the intervention planned in this DNP project. The theory selected expounds on all of the facets needed to achieve the intended practice change: nursing intellectual capital, nursing performance, organizational performance, nursing human capital, nursing structural capital, employer support for nurses continuing professional development, and nursing staffing (Covell & Sidani, 2013). The following table provides the Nursing Intellectual Capital Theory concepts and an example of how this doctoral project utilized the concepts.

Table 1

Nursing Intellectual Capitol Theory Concepts and Their Application for DNP Research

Nursing Intellectual Capital Theory	Intended Application for Doctoral Project
"*Nursing intellectual capital* is nursing knowledge that is translated into nursing and organizational performance" (Covell & Sidani, 2013).	By synthesizing the latest evidence-based practices regarding perioperative monitoring for ST-segment changes, the aim was to increase the utilization of 5-

	lead ECGs for patients with known or suspected CVD in an attempt to decrease adverse outcomes from misdiagnosed myocardial ischemia whilst under anesthesia.
"*Nursing performance* leads to improvements in patient outcomes associated with quality of patient care such as reduction in adverse events, such as hospital-acquired infections, patient falls, and medication errors. *Organizational performance* leads to improvement in organizational outcomes, such as the cost-related outcomes associated with the recruitment and retention of knowledgeable and experienced registered nurses including (e.g. lower orientation hours, registered nurse turnover, vacancy, higher recruitment and retention statistics)" (Covell & Sidani, 2013).	By advocating for judicious use of 5-lead ECGs for ST-segment analysis and providing supporting evidence as to the clinical and organizational benefits, the aim was to decrease adverse events from unrecognized myocardial ischemia from more traditional 3-lead ECG usage.
"*Nursing human capital* is the knowledge, skills and experience of registered nurses" (McGillis & Hall, 2003). "For registered nurses, this is reflected in: • Academic preparation • Specialty certification status • Hours of continued education attended • Professional experience • Unit tenure • Clinical specialty experience" (Covell & Sidani, 2013).	The method of this doctoral project was to implement a practice change among anesthesia providers at a level 2,500+ bed hospital to increase the usage of 5-lead ECGs intra-operatively for ST-segment monitoring.
"*Nursing structural capital* is the structural resources that contain nursing knowledge and are used to support registered nurses in the application of their knowledge and skills in the delivery of patient care. It is operationalized in: • Availability of practice guidelines, care maps, and protocols • Information technology for diagnostic purposes (e.g. glucometers, telemetry)	Several risk factors were listed as a warning of potential CVD that could be present but undiagnosed from subjective reporting of chest pain and SOB to a history of familial CVD, smoking, diabetes mellitus, etc.

• Portable computerized devices used for acquiring evidence-based information (e.g. laptops, iPads, personal digital assistants)" (Covell & Sidani, 2013).	
"*Employer support for nurses' continuing professional development* is the investment by the organization in the knowledge and skill development of registered nurses through continuing professional development activities. It is captured in the following strategies: • Financial assistance from the organization for registered nurses to attend continuing professional development activities • Paid and unpaid time off for registered nurses to learn, such as study leaves • Availability of replacement staff for registered nurses when away from the unit to learn • Availability of clinical educators or consultants to assist registered nurses with clinical decision-making and knowledge and skill development" (Covell & Sidani, 2013).	N/A
"*Nurse staffing* is the supply and the mix of registered nurses who possess the knowledge, skills and experience to competently meet the care needs of patients on the unit" (American Nurses Association, 2002). "It is operationalized into: • Hours per patient per day • Skill mix • Registered nurse-to-patient ratio" (Covell & Sidani, 2013).	This facility currently employs over 50 CRNAs who are licensed and certified to provide anesthesia care for the patients undergoing anesthesia services.

Doctorate of Nursing Practice Essentials

All eight Doctorate of Nursing Practice (DNP) essentials were met by this doctoral project and are listed in Appendix B. The essentials that this project focused on was Essential II, III, IV, and VI. Essential II: Systems Thinking, Healthcare Organizations, and the Advanced Practice Nurse Leader, guides nurses with a DNP to examine organizational policies in an attempt to improve upon them (Zaccagnini & White, 2014). The aim of this project was to increase 5-lead ECG cable utilization in which anesthesia providers implement ST-segment monitoring in patients at a high risk for CVD in an attempt to promptly recognize myocardial ischemia and intervene to prevent further myocardial damage.

Essential III: Clinical Scholarship and Evidence-Based Practice, involves DNP nurses performing research, interpreting results and implementing evidence-based practices (Zaccagnini & White, 2014). A review of literature found that continuous ST-segment analysis is best practice for monitoring of myocardial perfusion changes, which if ischemia goes undetected, can be detrimental. The evidence-based practice (EBP) suggestions were presented to anesthesia providers to advocate for improvement.

Essential IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Healthcare aims to guide the DNP nurse to evaluate and disseminate specific elements for the selection and use of specific patient care technologies. By educating anesthesia providers on the specificity and sensitivity of ECG lead choices for ST-segment monitoring, patient care was optimized through technology. An outcome was possibly detecting myocardial ischemia, which if unrecognized, could lead to a MI and other sequelae.

Essential VI: Interprofessional Collaboration for Improving Patient and Population Health will be met by collaborating with anesthesia providers so that ST-segment monitoring was be incorporated as a standard of care for patients undergoing anesthesia who were determined to be at risk for CVD.

Summary

An increasing number of patients are undergoing surgery each year and due to advanced age or having multiple risk factors for CVD, these patients are at an increased risk of perioperative myocardial ischemia (Guarracino, Baldassarri, & Priebe, 2015). One of the most detrimental effects of myocardial ischemia is infarction from unrecognized and untreated ischemia, which can be life threatening to the patient and place an unnecessary and preventable financial burden on organizational healthcare expenditure for treatment of postoperative cardiac complications (Singh, Shah, & Trikha, 2012). This project aimed to increase utilization of 5-lead ECG cables among anesthesia providers at a particular healthcare facility through the dissemination of the results of an extensive literature review of computerized ST-segment analysis, postoperative complications, and technology utilization best practice.

CHAPTER II - METHODOLOGY

Overview

The purpose of this doctoral project was to increase the usage of perioperative computerized ST-segment analysis with 5-lead ECG cable systems in order to promptly diagnose and treat myocardial ischemia to prevent myocardial injury. The literature review reiterated the importance of preoperative screening of patients for risk factors of CVD, the prevalence of perioperative/postoperative myocardial injury, and best practice methods of analyzing ST-segment. By increasing the usage of 5-lead ECG cables for continuous ST-segment monitoring, improving patient outcomes postoperatively fulfills the secondary goal of this doctoral project.

Target Population

The subjects/participants for this doctoral project were CRNAs and anesthesiologists employed at a 512-inpatient bed medical facility in the Southeastern U.S. This facility offers surgical services for the following specialties: cardiothoracic, vascular, neurosurgery, orthopedics, trauma, general, obstetrics, ear/nose/throat, ophthalmic, and reconstructive. Those eligible for participation included licensed and certified anesthesia providers at this facility. They also had to be employed either full-time or part-time at the time of the intervention. There was no random selection among the population. Non-eligible employees included Registered Nurses (RN), surgical technicians, anesthesia technicians, surgeons, anesthesia assistants and any other employee of the facility not directly administering anesthesia services to surgical patients.

Design-Ethical Considerations - Protection of Human Subjects (IRB)

Institutional Review Board (IRB) approval was obtained from the facility's Nursing Research Council (Appendix C) and The University of Southern Mississippi (Appendix D). University IRB addendum approval was granted after adjustments were made to the project per recommendations by the facility research committee and the letter is found in Appendix E. A letter of support was provided by the chair of the anesthesia department at the facility where the project was implemented and is found in Appendix F. The author of the doctoral project, the committee chair, and committee members had completed the required CITI Common Course training. All participants were anonymous and all data from obtained for this project will be shredded and/or deleted 6 months after graduation requirements are complete.

Anonymity was maintained during the doctoral project by allowing the participants to elect whether or not to participate (Patten, 2014). The completion of the questionnaire allowed participants to give informed consent to partake in the project. There were no perceivable physiologic or psychological threats or inconveniences associated with the QI educational project. Potential benefits included increased safety for the surgical patient in the perioperative period via more thorough monitoring, earlier recognition and treatment of myocardial ischemia therefore prospective decreased financial burden on the facility in treating postoperative myocardial injury.

Design

A quality improvement (QI) educational project was delivered to the anesthesia providers at a convenient location in the facility during operational hours. Information on evidence-based practice was compiled from data found in the literature review, scholastic anesthesia textbooks, and guidelines from professional organizations. Anesthesia providers in attendance were first asked to complete a questionnaire (Appendix G) regarding the frequency in which they chose 5-lead ECG cables to implement computerized ST-segment analysis, their selection criteria for applying 5-lead ECGs, and common barriers to ST-segment monitoring. The participants were informed that by filling out the questionnaire, they provided informed consent to participate in the doctoral project. The descriptive statistics of the pre-survey questionnaire were determined at a later time.

The participants in the project were then shown a detailed, QI educational presentation that summarized the literature review findings and the current recommendations for 5-lead ECG placement for ST-segment analysis. Permission was granted by the AHA to utilize a reference tool for determining the status of CV health as determined by the presence and degree of multiple risk factors and can be found in Appendix H. Participants were informed where the tool could be located if they decided to use it to facilitate their decision of using computerized ST-segment analysis. A cause-and-effect diagram was also included in the presentation and is located in Appendix I. Data collection took place over a 2-week period and determined whether the anesthesia providers increased their usage of computerized ST-segment analysis in the time since the original QI project was presented. Descriptive statistics were again used and compared to the original results to determine the effectiveness of the QI educational project.

Assumptions

An assumption of this project was that intraoperative monitoring needed to be improved upon. The willingness of the anesthesia providers to participate in the project was another assumption. A final assumption was that the anesthesia providers were not up to date on the most recent literature regarding MINS.

Resource Requirements

A location for the intervention was needed as well as anesthesia staff to attend. Physical resources were used such as paper and ink for the questionnaires, a data collection box for the data collection period, and paper and ink for the data collection records. The availability of equipment, such as 3-lead and 5-lead ECG cables was also a resource as well as the monitoring devices in the operating rooms, the iPad for the presentation, and the data collection box.

Summary

Increasing the use of 5-lead ECG cables for perioperative computerized ST-segment analysis required many physical resources and several operating rooms worth of equipment, as well as time from the participants. However, the equipment was preexisting and readily available in the operating rooms and anesthesia workroom. The anesthesia providers who participated were already present at the facility on the day of the intervention. The benefit to the patient and facility justifies applying 5-lead ECG cables in the event that myocardial ischemia is present. After the implementation of the doctoral project and the 2-week data collection, descriptive statistics were used to determine if anesthesia providers at a Southeastern U.S. hospital had increased the usage of 5-lead ECG cables in the perioperative period for computerized ST-segment analysis in patients at risk for CVD.

CHAPTER III - RESULTS

Overview

A questionnaire was given to anesthesia providers in the healthcare facility. Following the questionnaire, a 10-minute presentation was made via iPad to each individual provider. After the completion of the presentation, anesthesia providers were apprised of the data collection box in the post anesthesia care unit (PACU) and how to submit tallies of ECG cable usage. They were then asked to immediately, and for the next 2 weeks, place a data collection record that pertained to the type of ECG cable utilized for each anesthetic delivered in the data collection box after they took their patient to PACU. Upon completion of the 2-week data collection period, data collection records were taken up and stored in a safe location for data analysis.

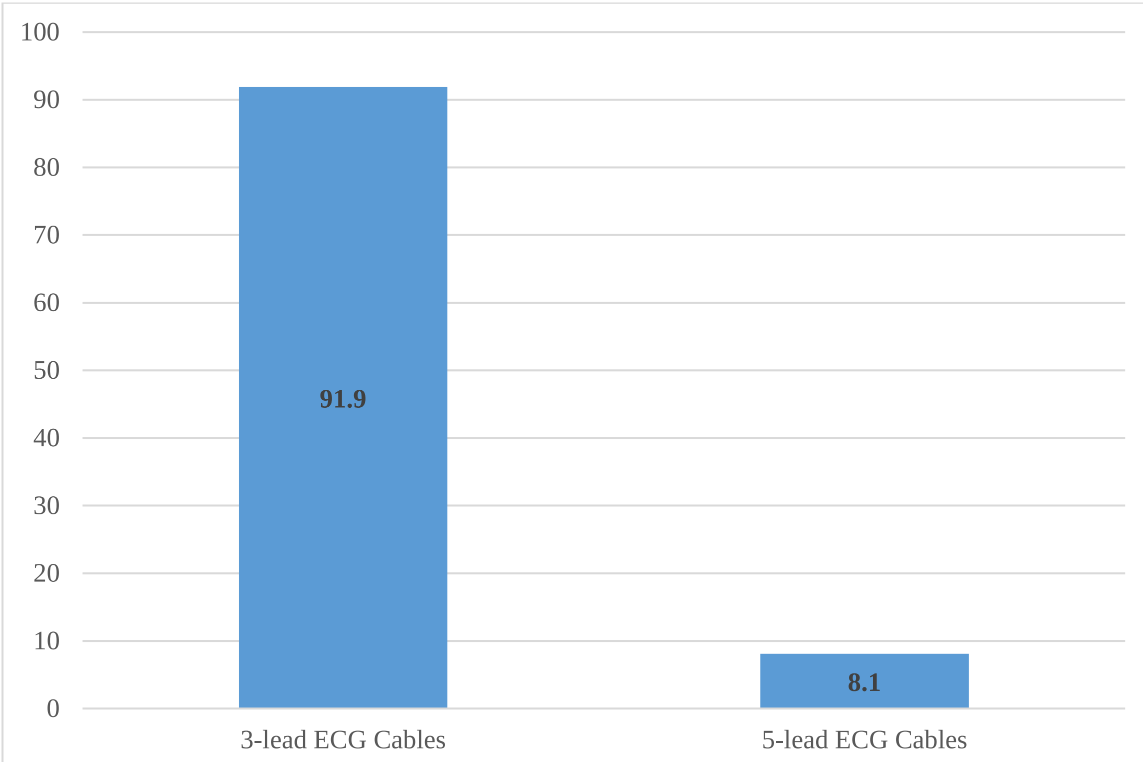
Statistical Analysis

Initial Questionnaire Results

Twelve anesthesia providers filled out the questionnaires and participated in the presentation. The initial question asked the percentage of cases where the anesthesia provider used 3-lead ECG cables and the percentage of 5-lead ECG cables. The responses were as follows in Table 2.

Table 2

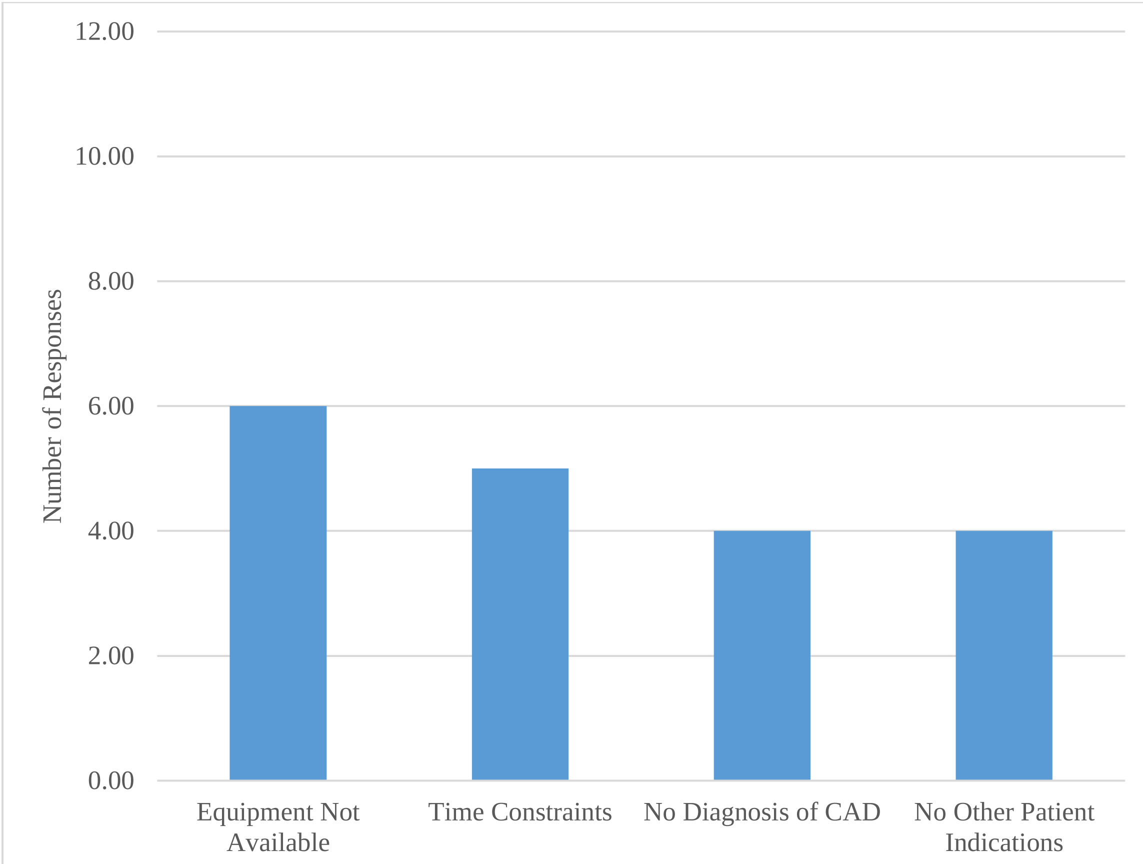
Pre-survey Comparison of 3-Lead Versus 5-Lead ECG Cables Utilization for Computerized ST-Segment Monitoring in the Perioperative Period



The mean was determined from the analysis of the questionnaire. It is noted that anesthesia providers prior to the presentation utilized 3-lead ECG cables in 91.9% of anesthetics delivered and 5-lead ECG cables in only 8.1% of the anesthetics delivered. To further assess the rationale for the choice of leads used, Question 2 asked the anesthesia providers to rank the barriers to the use of 5-lead ECG cables over 3-lead ECG cables listed in order of the most likely reason (1 = most important). Table 3 displays the results of Question 2.

Table 3

Barriers to the Utilization of 5-Lead ECG Cables

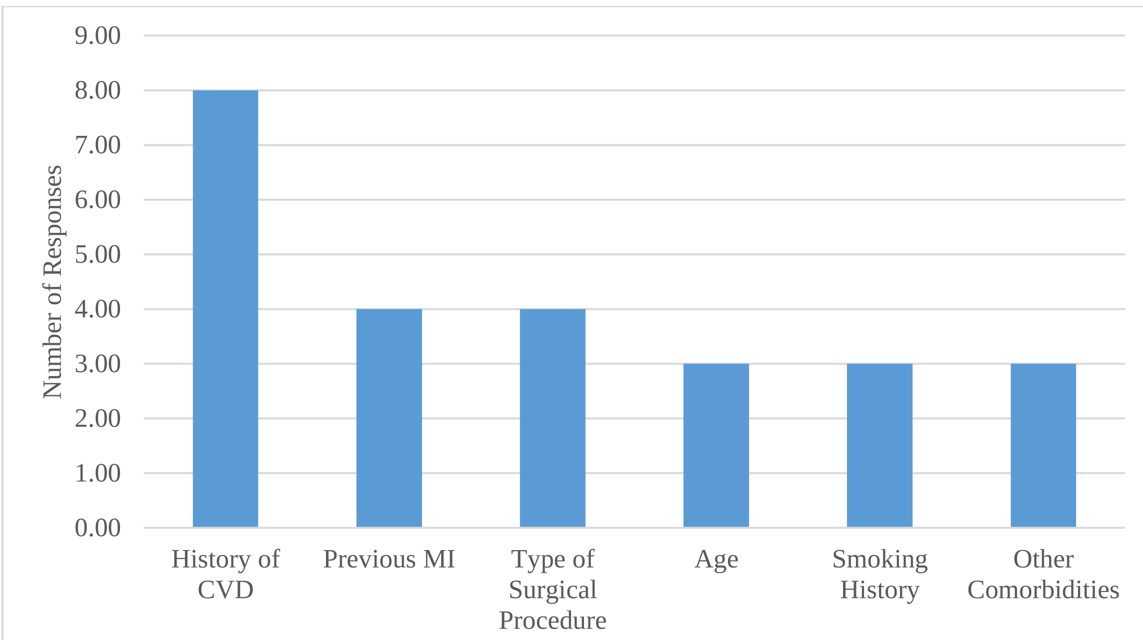


Descriptive statistics were used to find the mode of the responses related to the barriers of using 5-lead ECG cables. The most frequent and leading barrier of using 5-lead ECG cables was equipment (5-lead ECG cables) not being available with 6 out of 12 responses. The second most important barrier was determined to be not enough time for applying the 5-lead ECG cables with 5 out of 12 responses. The third barrier ranked in order was an impasse of the patient having no diagnosis of CAD and no patient indications for application of 5-lead ECG cables. A third barrier that also ranked number 4 was the lack of patient indicators for needing a 5-lead ECG with 4 out of 12 responses.

The third and final question of the questionnaire asked the anesthesia providers which patient factors determined their usage of 5-lead ECG cables in the perioperative period. Being that 2 anesthesia providers reported a 100% utilization of 3-lead ECG cables, they did not respond to Question 3. The remaining responses were recorded and the most important factors received the most responses. Table 4 displays the results.

Table 4

Factors That Determine the Utilization of 5-Lead ECG Cables in the Perioperative Period



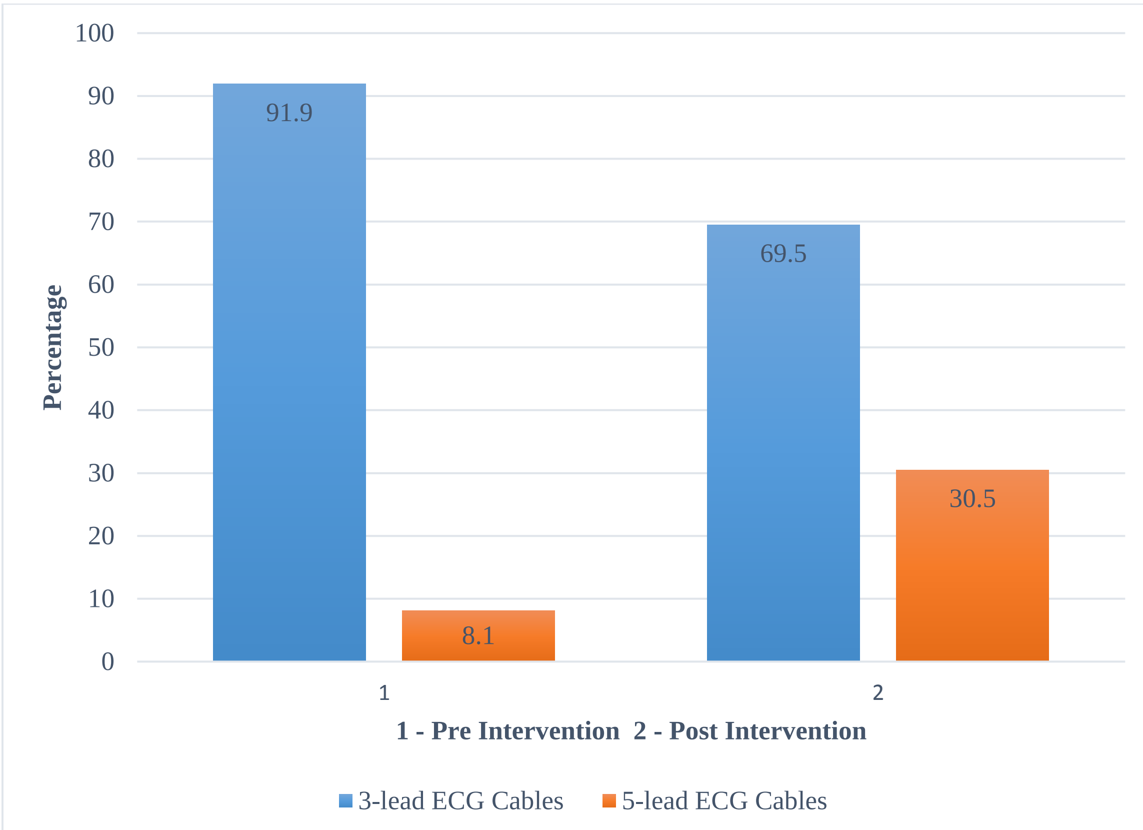
The most important factor to determine the participant's usage of 5-lead ECG cables was a history of CVD (8 out of 9 responses). The second most important determinant was found to be a patient history of a previous MI (4 out of 9 responses) as well as the type of surgical procedure (4 out of 7 responses). Age was a draw for third place (3 out of 9 responses) with smoking history (both 3 out of 7 responses) and other comorbidities (3 out of 9 responses). Lastly, one anesthesia provider reported in the comment section having a 5-lead ECG cable already hooked up and attached to the monitoring computer being the rationale for use.

Two-Week Data Collection Results

At the conclusion of the 2-week data collection period, the data collection box was retrieved and the records were taken to a secure location for data analysis. There were 82 total records submitted in the data collection box: 57 records (69.5%) that conveyed 3-lead ECG cables usage and 25 records (30.5%) for 5-lead ECG cable utilization. The increase in utilization of 5-lead ECG cables increased from 8.1% to 30.5%, a variance of 21.8% as shown in Table 5.

Table 5

Comparison of Pre and Post Intervention Percentage of 3-Lead and 5-Lead ECG Cable Utilization



Summary

Anesthesia providers at this facility increased the utilization of 5-lead ECG cables in the perioperative period for computerized ST-segment analysis. The increase in utilization of 5-lead ECG cables for ST-segment analysis accomplished the primary goal of the doctoral project. The discussion of results and implications for practice are examined in the next chapter.

CHAPTER IV – DISCUSSION

Recommendations

Although the percentage of 5-lead ECG usage remained lower than expected, the increased use after the intervention substantiates that the project was a success. By reflecting on the data from the pre-survey questions, it was clear that the major barrier to using 5-lead ECG cables for ST-segment monitoring is the availability of such equipment. If all operating rooms were supplied with 5-lead ECG cables, perhaps the rate of their usage would increase. Time constraints in the operating room are a reality and trying to find equipment while keeping up with the workflow can put the anesthesia provider at a risk of delaying productivity. By replacing 3-lead ECG cables with 5-lead ECG cables, the equipment would be more readily available and more likely to be utilized.

Implications for Future Practice

Similar quality improvement educational projects would be beneficial regarding the topic of intraoperative ST-segment analysis. Perhaps a larger sample size, a department policy, or removing 3-lead ECG cables entirely from the operating rooms would lead to the dramatic increase in ST-segment monitoring. Reaching out to more anesthesia providers to present the data over several days perhaps would have led to a more department wide increase in ST-segment monitoring. Future studies that look at the long term impact of MINS at this facility or similar facilities would be able to assess the long term goal of decreasing complications and reducing the financial burden of treating preventable morbidities.

Conclusion

Ryan, Rodseth and Biccard (2011) suggested from the analysis of the POISE trial that the leading complication after surgery were cardiac complications. After the intervention, utilization of 5-lead ECG cables increased from 8.1% to 30.5% of surgical cases. Future studies can be done to examine the barriers to 5-lead ECG cable utilization or the rate of postoperative CV complications at individual facilities. The creation of a department wide policy regarding criteria for 5-lead ECG cables is also a future possibility. All of the interventions having the same goal in mind, to reduce the risk of MINS and lead to improved healthcare outcomes for the nation's citizens.

APPENDIX A – Literature Review

	Myocardial Ischemia Prevalence associated with Noncardiac Surgery	Preoperative Screening for CVD	Intra-operative Monitoring for Myocardial Ischemia	Post-operative Complica-tions due to Myocardial Ischemia
Abbott, T., Ackland, G. L., Archbold, R. A., Wragg, A., Kam, E., Ahmad, T., Khan, A. W., Niebrzegow-ska, E., Rodseth, R. N., Devereaux, P. J., Pearse, R. M., (2016)	Out of a total of 15 087 patients in the VISION study, 1197 (7.9%) sustained MINS.	A preoperative heart rate >96 BPM is associated with myocardial injury after surgery including MI, increased risk of MINS, and mortality. The association of these factors is not decreased even when taking other factors into consideration. A linear relationship between heart rate >96 BPM and postop complications of the heart is proposed using a multivariable fractional polynomial analysis.	No specific mention of 5-lead ECG versus 3-lead ECG was mentioned. However, with the causal relationship between heart rate and postoperative myocardial damage, it is imperative to increase the potency of intraoperative monitoring with ST segment analysis in order to ensure proper oxygenation of the myocardium. ST segment or T wave changes is one of the criteria that are present for the diagnosis of myocardial infarction in the presence of elevated troponin >0.04 ng/ml^{-1}. The other factors listed are new or presumed new Q waves, left bundle branch block (BBB) on the ECG, or new or presumed new regional wall motion abnormality on echocardiogram.	Elevated heart rate (HR) in the preoperative period >96 BPM was associated with MINS, MI and mortality within 30 days after surgery.

Guarracino, Baldassarri, & Priebe, (2015)		Perioperative MI is found to be predicted by a combination of patient factors: type of surgery, patient physical status, ASA classification, age, etc.		Perioperative cardiovascular (CV) complications are the strongest predictors of morbidity and mortality after major non-cardiac surgery.
Mark, J.B., & Nussmeier, N.A., (2005)			The primary responsibility of the anesthetist is prompt detection/recognition of myocardial ischemia. Multiple lead combinations can be used to detect perioperative myocardial ischemia. V_5 has a sensitivity of 75% of ischemic changes but combining II, V_4 and V_5 increased the sensitivity to 96%.	
Poldermans et al., (2010)	Due to the lack of systemized data at a European level, the Netherlands data is used as a reference. Lee et al. studied 4,315 patients undergoing elective major non-cardiac procedures throughout	The Perioperative Ischaemic Evaluation (POISE) trial observed that perioperative mortality occurred in 226 patients (2.7%), of whom 133 (1.6%) suffered CV death, non-fatal MI was	ST-segment monitoring was mentioned as being the method for assessing ST-segment for ischemic changes. Lead V_5 has the best sensitivity (75%) of diagnosing myocardial ischemia. A 90% sensitivity exists by combining leads V_5 and V_4. Further combined leads II,	The longer the length of time a myocardial myocytes experience directly correlates with the degree of myocardial damage. Therefore, any change in ST segment occurring should prompt

	1989-1994. 92 patients (2.1%) suffered major cardiac complications.	observed in another 367 (4.4%) subjects.	V_4, and V_5 and gained a sensitivity of 96%. In another study of similarity, they found by combining two or more precordial leads increased ECG sensitivity of detecting ST segment depression and subsequent MI to >95%. When ST-segment changes are observed perioperatively, the anesthesia provider should assume myocardial ischemia.	the clinician to intervene in order to prevent postoperative complications to prevent postoperative complications.
Puelacher et al., (2015)	1-10% of postoperative mortality affects patients after noncardiac surgery. Up to 40% of those deaths are attributable to cardiovascular complications, including perioperative MI. An odds ratio of 10 (95% confidence interval [CI] 7.8-12.9) for death and a composite of cardiovascular complications at 30 days is	The "Lee" risk score, or the Revised Cardiac Risk Score, is the most commonly used to identify high-risk cardiac patients. The risk calculator provided by the American College of Surgeons National Surgical Quality Improvement Program is recommended by current guidelines. Further	20% of vascular surgery patients have been noted to have ST segment deviations that reflect myocardial ischemia. Plaque rupture would result in possible ST elevation and decreased mean arterial pressure such as frequently occurs in HOTN during surgery is reflected by ST segment depression. In the VISION study, 35% of patients were noted to have ST segment depression suggesting that ECG monitoring might not be sufficient	30-day mortality is increased almost 10-fold from postoperative myocardial injury.

	experienced by patients up to 30 days postopera-tively.	cardiac biomarker, B-type natriuretic peptide and cardiac troponin can further increase the risks assessment sensitivity.	enough. There was no mention as to whether 3-lead ECGs versus 5-lead ECGs were utilized.	
Ryan, L, Rodseth, R.N., & Biccard, B.M., (2011)	Analysis of POISE Trial-postoperative MI has a 5% incidence in patients >45 years of age, with cardiovascular risk factors, following noncardiac surgery. This makes postoperative MI the most common postoperative cardiac complication.		The majority of perioperative MIs result in ST depression rather than ST elevation due to fundamental pathophysiologic differences in etiology.	Mortality rate of 10% of the world's population that undergo non-cardiac surgery.
Singh, Shah, & Trikha, (2012)	A postoperative MI rate is 0.6% in patients without a previous diagnosis of coronary artery disease (CAD). The authors attribute this to the supply-	The patient in the case study had no previous diagnosis of CAD and no subjective symptoms that would elude to such a concern by the anesthetist.	The standard monitoring of ECG in the operating room consisted of ST segment monitoring with a 5-lead ECG. The ST depression was present at a BP and HR that would normally not lead to treatment as the MAP was greater	With prompt recognition and pharmacologic intervention, the myocardial ischemia was corrected and no postoperative elevations in troponin were

	demand mismatch that is brought on from the physiologic stressors experienced perioperatively.		than 60 mmHg, suggesting sufficient perfusion to end-organs.	present. The prompt recognition and treatment was crucial in preventing cardiac damage and the postoperative troponin levels were negative.
Van Waes et al., (2013)	Sample size of 2216 patients undergoing noncardiac surgery. Troponin I was elevated at least once in 315 patients (19.4%); 14 (4.4%) showed ST-segment depression (≥1 mm), and 15 (4.8%) showed minimal ST-segment depression (<1 mm) or repolarization changes. MI diagnosed in 10 patients (0.6%).	Troponin I, age, sex, emergency surgery, and renal failure were the preoperative variables assessed during this study.	ST segment analysis was included with all patients in the study. Ten of the 315 (3.2%) patients with elevated troponin levels had ECG changes that suggested myocardial ischemia. ST-elevation was evident in one (0.3%) and depression (≥1mm) evident in 14 (4.4%) and ST depression (<1mm) was evident in 15 (4.8%).	Perioperative CV events are the leading cause of morbidity and mortality after non-cardiac surgery.
The Vascular events In noncardiac Surgery patients cOhort evaluatioN	This study that looked at 15 065 patients, 1200 (8.0%) suffered MINS.	Twelve independent risk factors of MINS were identified in this study: ≥75 yoa, cardiovascula	34.9% (95% CI, 31.9-38.0) of patients with MINS had an ischemic ECG finding, of which T-wave inversion (23.3%, 95% CI, 20.7-26.1)	MINS was common (8.0%),1 in 10 patients will die from MINS within 30-days of

(VISION) Writing Group, on behalf of The Vascular events In noncardiac Surgery patients cOhort evaluatioN (VISION) Investigators, (2014)		r risk factors such as renal insufficiency and DM, known CV disease, and surgical factors such as urgent/ emergent surgery.	and ST depression (16.4%, 95% CI, 14.1-18.9) were the most common.	noncardiac surgery.
Vincent et al., (2015)			The article reviews all forms of hemodynamic monitoring devices: basic monitoring, arterial pressure, central venous pressure (CVP), cardiac output monitoring, Doppler echocardiography, pulmonary artery catheter, pulse contour analysis, applied Fick principle and dye dilution, bioimpedance and bioreactance. Proper preoperative assessment can help the clinician determine the best method to assess the CV status intraoperatively.	Up to 80% of postoperative deaths occur in the high-risk patients that undergo surgical procedures. Heart dysfunction remains a leading cause of postoperative complications and poor-outcomes.

APPENDIX B – DNP Essentials

I. Nursing Science and Theory: Scientific Underpinnings for Practice
   - *By utilizing the concept of safety and the nursing theory of Nursing Intellectual Capital to guide in the development of the problem identified and the reasons for intervention*
   - *Examine barriers to change in anesthesia practice*

II. Systems Thinking, Healthcare Organizations, and the Advanced Practice Nurse Leader
   - *Improved outcomes through safer monitoring, no additional expenses required by the organization, and attempted to facilitate an organization-wide practice change*
   - *Demonstrated leadership skills in attempting to improve patient outcomes*

III. Clinical Scholarship and Evidence-Based Practice
   - *By questioning the reliability of 3-lead ECGs in monitoring for ST-segment changes and seeking out evidence to the contrary in an attempt to show the efficacy of 5-lead ECGs; disseminated evidence from a variety of articles and professional publications*
   - *Developed a QI educational presentation in an attempt to elucidate the improvement of intraoperative ECG monitoring through the utilization of 5-lead ECG versus 3-lead*

IV. Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care
   - *Used 5-lead ECGs as more effective method for monitoring the electrocardiogram intraoperatively for evidence of myocardial ischemia/dysfunction*
   - *Used multiple electronic databases to allocate the latest and most applicable evidence-based practice for the utilization of 5-lead ECGs monitors as well as statistics that reflect the severity of intraoperative myocardial ischemia*
   - *Properly utilized technology available to the anesthetist to detect adverse events (myocardial ischemia) earlier to reduce the morbidity/mortality from sequelae*

V. Healthcare Policy for Advocacy in Health Care
   - *Exemplified the professionalism and knowledge of advanced practice registered nurses through implementing practice changes that follow the clues of ways to improve patient safety*
   - *Complied with the Institute of Medicine's 2011 report by being active partners in the transformation of healthcare*
   - *Validated APRN practicing at their full scope through evidence that nursing improves patient safety and outcomes as well as healthcare cost attenuation*
   - *Used improved safety standards to impress upon congressional leaders the legitimacy of nurse anesthetists in an attempt to promote full practice legislation*

VI. Interprofessional Collaboration for Improving Patient and Population Health
   - *Led the development of an interprofessional practice change to improve that safety and outcomes of surgical patients*

- *Potential incorporation into standard of care at this organization; reiterated the low technological, low cost approach to improvement of care*

VII. Clinical Prevention and Population Health for Improving the Nation's Health
- *Prompt recognition and treatment of ST-segment changes intraoperatively to reduce the risk of myocardial infarction postoperatively*
- *Improve the health outcomes for patients at the organization in which the practice change is being promoted with eventual reduction of national/worldwide postoperative morbidity and mortality from postoperative cardiac dysfunction attributable to intraoperative myocardial ischemia*

VIII. Traditional Advanced Practice Roles for the DNP
- *Incorporate technical skills and assessment techniques*
- *Publish findings in peer reviewed journals to exemplify the practice change and the interprofessional collaboration*

APPENDIX C – Nursing Research Committee Approval Letter

[redacted]

TO: Lauren Robertson
FROM: Research Committee
RE: Proposed project/study entitled: Implementing Computerized ST-Segment Analysis with 5-Lead ECG Cables During the Perioperative Period for Myocardial Ischemia Detection in Patients at Risk for Cardiovascular Disease

On July 11, 2017 your research project/study proposal was approved by the Nurse Practice Council to be conducted within Patient Care S[redacted]e free to proceed with your project/study within the following guidelines:

1. You are required to complete an online non-employee orientation that is administered though our Education Department (601-288-2677).
2. A *Non-Employee Confidentiality and Nondisclosure Agreement* must be signed during the online orientation process.
3. Any modifications to this approved study must be re-routed to the Research Committee. All activity on this project must stop until you are notified by the Research Committee Chair of Committee's decision regarding proposed changes
4. Data Collection Period: July 2017
5. Inform Research Chair when data collection is initiated and when completed (via e-mail)
6. Provide results of study to committee (may provide presentation or written documentation of findings)

Sincerely,

[redacted]

I, ____, have reviewed the above guidelines and agree to comply with the terms of this *Research Proposal Letter of Agreement.*

Signature:____ Da te:___________

Facility/School/Other Association: ____

1

APPENDIX D – USM IRB Approval Letter

THE UNIVERSITY OF
SOUTHERN MISSISSIPPI.

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.5997 | Fax: 601.266.4377 | www.usm.edu/research/institutional.review.board

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: CH17051802
PROJECT TITLE: Implementing Computerized ST-Segment Analysis in the Perioperative Period for Myocardial Ischemia Detection in Patients at Risk for Cardiovascular Disease
PROJECT TYPE: Change to a Previously Approved Project
RESEARCHER(S): Lauren Boyd Robertson
COLLEGE/DIVISION: College of Nursing
DEPARTMENT: Advanced Practice
FUNDING AGENCY/SPONSOR: N/A
IRB COMMITTEE ACTION: Exempt Review Approval
PERIOD OF APPROVAL: 05/26/2017 to 05/25/2018
Lawrence A. Hosman, Ph.D.
Institutional Review Board

APPENDIX E – USM IRB Addendum Approval Letter

THE UNIVERSITY OF
SOUTHERN MISSISSIPPI.

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.5997 | Fax: 601.266.4377 | www.usm.edu/research/institutional.review.board

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- The risks to subjects are reasonable in relation to the anticipated benefits.
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- Informed consent is adequate and appropriately documented.
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- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
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  Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: CH17051802
PROJECT TITLE: Implementing Computerized ST-Segment Analysis in the Perioperative Period for Myocardial Ischemia Detection in Patients at Risk for Cardiovascular Disease
PROJECT TYPE: Change to a Previously Approved Project
RESEARCHER(S): Lauren Boyd Robertson
COLLEGE/DIVISION: College of Nursing
DEPARTMENT: Advanced Practice
FUNDING AGENCY/SPONSOR: N/A
IRB COMMITTEE ACTION: Exempt Review Approval
PERIOD OF APPROVAL: 05/26/2017 to 05/25/2018
Lawrence A. Hosman, Ph.D.
Institutional Review Board

APPENDIX F – Letter of Support

[redacted]

RE: Lauren Robertson Request for Letter of Support

I am the Chief Anesthesiologist [redacted]ffering this letter of support of the SRNA doctoral student, Lauren Robertson, in her capstone project titled Implementing Computerized ST-Segment Analysis in the Perioperative Period for Myocardial Ischemia Detection in High Risk Patients.

I understand that Lauren Robertson is a doctoral student in the nurse anesthesia program at The University of Southern Mississippi who is planning to graduate in December of 2017. This letter of support will be included in The University of Southern Mississippi IRB application. I understand that open participation will be presented to anesthesia providers practicing at this facility. There is no compensation for their participation.

I understand the planned dates for her research are from May, 2017 to August, 2017 after USM IRB approval is received. Her committee chair contact information is Dr. Marjorie Geisz-Everson at marjoria.geiszeverson@usm.edu and at (601) 266-5462.

I understand that participation is completely anonymous and voluntary. If anesthesia providers at this facility choose to not participate or withdraw from the study at any time, there will be no penalty.

I am looking forward to hearing the results of the research and impact on clinical practice.

Sincerely,

[redacted]

APPENDIX G – Questionnaire

Lauren Robertson RN, BSN, SRNA

Thank you for participating in this project.

Type of Meeting: **Quality Improvement Education Project**

Question 1: What percentage of anesthesia cases do you utilize 3-lead and 5-lead ECG cables for computerized ST-segment monitoring in the perioperative period in patients at risk for cardiovascular disease?	○ 3-lead _______% ○ 5-lead _______%	Comments:
Question 2: What are some of the barriers to the use of 5-lead ECG cables over 3-lead ECG cables? Please *RANK* in order of the most likely reason (1 = most important).	___ Equipment (5-lead ECG cables) not available ___ Patient does not have a diagnosis of CAD ___ Not enough time for applying 5-lead ECG cables ___ No patient indications for 5-lead ECG cables ___ Other: _________________	Comments:
Question 3: What factors determine your usage of 5-lead ECG cables in the perioperative period? Please *RANK* in order of the most likely reason (1 = most important).	___ Age ___ Smoking history ___ Previous MI ___ CV history ___ Other comorbidities ___ Type of surgical procedure ___ Other: _________________	Comments:

APPENDIX H – AHA Permission Letter

American Heart Association | American Stroke Association.

life is why™

National Center
7272 Greenville Avenue | Dallas, Texas 75231
www.heart.org

Inv #12438-LROBERTSON

January 10, 2017

PRINT COPYRIGHT USE AGREEMENT

Lauren Robertson
The University of Southern Mississippi
205 Comanche Drive
Hattiesburg, MS 39402

Dear Mrs. Robertson:

Amount Due: **$50.00 U.S. Funds (WAIVED)** (This is a fee for service, not a charitable contribution). Our tax id number is 13-5613797. **Please consider this letter an invoice.**

Approval of this request is contingent upon receipt of a $50.00 U.S. Funds (WAIVED) processing fee and a signed copy of this Agreement (including Exhibit A.) Please send a check (drawn on a U.S. Bank or an International money order) payable to the American Heart Association with a copy of this Agreement **(including Exhibit A)** to P.O. Box 841750, Dallas TX, 75284-1750. The conditions of this copyright use agreement are listed below and the specifics of the material to be used are set out on Exhibit 'A' to this Agreement. An AHA credit card form will be provided upon request.

1. A credit line must be prominently placed on the page in which the American Heart Association materials appear as shown in Exhibit A.

2. This Agreement shall not be assigned or transferred to an undisclosed third-party without the prior written consent of the AHA. Further, the Requestor represents and affirms that they are requesting the material listed in Exhibit A for their own use and not as an agent or representative of an undisclosed third-party.

"Building healthier lives, free of cardiovascular diseases and stroke."

life is why™ es por la vida™ 全為生命™

3. Original artwork cannot be supplied, and the requestor agrees to reprint the material exactly as originally published. The American Heart Association (AHA) logo and AHA Service Marks may only be used as they appear on the materials requested. Obvious typographical errors may be corrected and typography may be altered to conform to the proposed publication. No other deletions, alterations, or other changes may be made without the prior written consent of the AHA.

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Upon receipt of payment and the signed agreement, permission will be granted on your original request. **Your cancelled check or credit card statement will be your receipt.**

Signature of Requestor ____________________

Printed Name Lauren B. Robertson

Date 4/28/2017

EXHIBIT A

Publication Name—*Circulation.2011;123:e18-e209*

Specifically:
Page e28, Table 2-1 – Definitions of Poor, Intermediate, and Ideal Cardiovascular Health for Each Metric in the AHA 2020 Goals

Citation/Credit Line:

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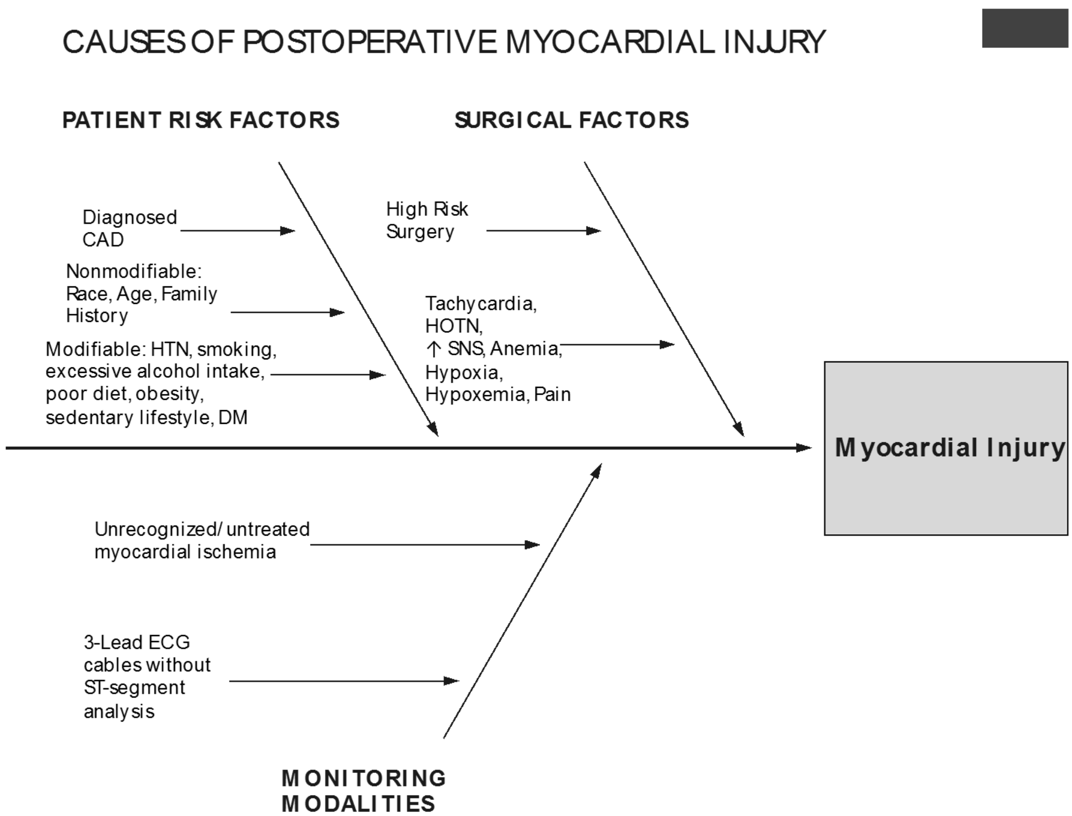
Circulation.2011;123:e18-e209

For use in:

a print only version of a student doctoral capstone project. The project will not be published to the general public or published outside of the University program. If the requestor/student decides at a later date to publish the material, the request must be submitted to the AHA for review/approval.

APPENDIX I – Cause and Effect Diagram



REFERENCES

Abbott, T., Ackland, G. L., Archbold, R. A., Wragg, A., Kam, E., Ahmad, T., ... Devereaux, P. J. (2016, May 13). Preoperative heart rate and myocardial injury after non-cardiac surgery: results of a predefined secondary analysis of the VISION study. *British Journal of Anaesthesia*, *117 (2*), 172-181. http://dx.doi.org/10.1093/bja/aew182

ACC/AHA. (2007, October 22). 2007 Guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation, 116, e418-e500. http://dx.doi.org/10.1161/CIRCULATIONAHA.107.185699

American Association of Nurse Anesthetists (2013). Standards for nurse anesthesia practice. Retrieved from https://www.aana.com/resources2/professionalpractice/Documents/PPM%20Standards%20for%20Nurse%20Anesthesia%20Practice.pdf

American Heart Association. (2011, February 1). Heart disease and stroke statistics - 2011 update. *Circulation*, *4*, e18-e209. http://dx.doi.org/10.1161/CIR.0b013e3182009701

American Society of Anesthesiologists. (2010). Basic standards for preanesthetic care. Retrieved from www.asahq.org/~/media/.../asahq/.../standards.../basic-standards-for-preanesthesia-care...

Burnett, J. (1985). The origins of the electrocardiograph as a clinical instrument. *Med Hist Suppl*, 5, 53-76. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2557409/

Butts, J. B., & Rich, K. L. (2015). Philosophies and Theories for Advanced Nursing Practice (2 ed.). Burlington, MA: Jones & Bartlett Learning.

Centers for Disease Control and Prevention. (2011). Million hearts: strategies to reduce the prevalence of leading cardiovascular disease risk factors - United States, 2011. *Morbidity and Mortality Weekly Report*, *60*, 1248-1251. Retrieved from http://web.b.ebscohost.com.lynx.lib.usm.edu/ehost/detail/detail?vid=7&sid=7f55b8d3-c984-4a52-9083-89a9dea909c2%40sessionmgr120&hid=116&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#AN=104696121&db=c8h

Centers for Disease Control and Prevention, National Center for Health Statistics. (2015). Underlying cause of death 1999-2015. Retrieved from https://wonder.cdc.gov/controller/datarequest/D132;jsessionid=CCC1D22FCAF9B188F9EDB4AEA3DC3D6C

Covell, C. L., & Sidani, S. (2013, May 2013). Nursing intellectual capital theory: Implications for research and practice. *The Online Journal of Issues in Nursing*, 18 2013. http://dx.doi.org/10.3912/OJIN.Vol18No02Man02

Guarracino, F., Baldassarri, R., & Priebe, H. J. (2015, February). Revised ESC/ESA guidelines on non-cardiac surgery: Cardiovascular assessment and management. Implications for preoperative clinical evaluation. *Minerva Anestesiologica, 81 (2*), 226-233. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/25384693

Hensley Jr., F. A., Martin, D. E., & Gravlee, G. P. (2013). *A practical approach to cardiac anesthesia* (5 ed.). Philadelphia, PA: Lippincott Willams & Wilkins.

Hewer, I., Drew, B., Karp, K., & Stotts, N. (1997, August). The utilization of automated ST segment analysis in the determination of myocardial ischemia. *Journal of the American Association of Nurse Anesthetists, 65,* 351-356. Retrieved from https://www.aana.com/newsandjournal/Documents/utilization_0897_p351.pdf

Hines, R. L., & Marschall, K. E. (2012). *Stoelting's anesthesia and co-existing disease* (6 ed.). Philadelphia, PA: Elsevier Saunders.

Landesberg, G., Beattie, W. S., Mosseri, M., Jaffe, A. S., & Alpert, J. S. (2009). Perioperative myocardial infarction. *Circulation*, *119*, 2936-2944.

Lee, T. H., Marcantonio, E. R., Mangione, C. M., Thomas, E. J., Polanczyk, C. A., Cook, E. F., ... Goldman, L. (1999, September 7). Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation, 100* (10), 1043-1049. https://www.ncbi.nlm.nih.gov/pubmed/10477528

Mark, J. B., & Nussmeier, N. A., (2005). Multimodal detection of perioperative myocardial ischemia. *Texas Heart Institute Journal*, *32*. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1351814/

McGillis Hall, L. (2003). Nursing intellectual capital: A theoretical approach for analyzing nursing productivity. *Nursing Economics*, *2,* 14-19.

Mississippi State Department of Health. (n.d.). Heart disease and stroke prevention and control. Retrieved from http://msdh.ms.gov/msdhsite/_static/resources/1670.pdf

Nagelhout, J. J., & Plaus, K. L. (2014). *Nurse Anesthesia* (5 ed.). St. Louis, MO: Elsevier Saunders.

Patten, M. L. (2014). *Understanding research methods* (9ed.). Glendale, CA: Pyrczak Publishing.

POISE Study Group, Devereaux, P.J., Yang, H., Yusuf, S., GUyatt, G., Leslie, K., Villar, J.C., Xavier, D., Chrolavicius, S., Pogue, J., Pais, P., Lui, L., Xu, S., Malaga, G., Avezum, A., Chan, M., Montori, V.M., Jacka, M., & Choi, P. (2008, May 31). Effects of extended-release metoprolol succinate in patients undergoing non-cardiac surgery (POISE trial): A randomized controlled trial. *Lancet*, *9627*, 1839-47. http://dx.doi.org/10.1016/S0140-6736(08)60601-7

Poldermans, D., Bax, J. J., Boersma, E., De Hert, S., Eeckhout, E., Fowkes, G., ... Vermassen, F. (2010). Guidelines for pre-operative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery: The task force for preoperative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery of the European Society of Cardiology (ESC) and endorsed by the European Society of Anaesthesiology (ESA). *European Journal of Anaesthesiology*, *27*, 92-137. Retrieved from http://journals.lww.com/ejanaesthesiology/Citation/2010/02000/Guidelines_for_pre_operative_cardiac_risk.2.aspx

Puelacher, C., Lurati-Buse, G., Singeisen, H., Dang, M., Cuculi, F., & Mueller, C. (2015, November). Perioperative myocardial infarction/injury after noncardiac surgery. *Swiss Medical Weekly*. http://dx.doi.org/10.4414/smw.2015.14219

Romero, C. X., Romero, T. E., Shlay, J. C., Ogden, L. G., & Dabelea, D. (2012). Changing trends in the prevalence and disparities of obesity and other cardiovascular disease risk factors in three racial/ethnic groups of USA adults. *Advances in Preventive Medicine*, 1-8. http://dx.doi.org/ 10.1155/2012/172423

Ryan, L., Rodseth, R.N., Biccard, B.M. (2011, November 9). Peri-operative myocardial infarction: Time for therapeutic trials. *Anaesthesia*, *66*, 1083-1087. http://dx.doi.org/10.1111/j.1365-2044.2011.06984.x

Singh, P. M., Shah, D., & Trikha, A. (2012). Recurrent intraoperative silent ST depression responding to phenylephrine. *Journal of Anaesthesiology Clinical Pharmacology*, *28*, 510-513. http://dx.doi.org/10.4103/0970-9185.101944

The Vascular events In noncardiac Surgery patients cOhort evaluatioN (VISION) Writing Group, on behalf of The Vascular events In noncardiac Surgery patients cOhort evaluatioN (VISION) Investigators. (2014). Myocardial injury after noncardiac surgery: a large, international, prospective cohort study establishing diagnostic criteria, characteristics, predictors, and 30-day outcomes. *Anesthesiology*, *120*, 564-578. http://dx.doi.org/10.1097/ALN.0000000000000113

Van Waes, J. A., Nathoe, H. M., De Graaff, J. C., Kemperman, H., De Borst, G. J., Peelen, L. M., & Van Klei, W. A. (2013). Myocardial injury after noncardiac surgery and its association with short-term mortality. *Circulation*, *127*, 2264-2271. http://dx.doi.org/10.1161/CIRCULATIONAHA.113.002128

Vincent, J., Pelosi, P., Pearse, R., Payen, D., Perel, A., Hoeft, A., ... Rhodes, A. (2015). Perioperative cardiovascular monitoring of high-risk patients: A consensus of 12. *Critical Care*, *19 (224)*. http://dx.doi.org/10.1186/s13054-015-0932-7

World Health Organisation (2009). *Global health risks: Mortality and burden of disease attributable to selected major risks*. Retrieved from http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf

World Heart Federation. (n.d.). Cardiovascular disease risk factors. Retrieved from http://www.world-heart-federation.org/cardiovascular-health/cardiovascular-disease-risk-factors/

Zaccagnini, M. E., & White, K. W. (2014). *The Doctor of Nursing Practice Essentials* (2 ed.). Burlington, MA: Jones & Bartlett Learning.