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An Educational Intervention on the Role of Perioperative Troponin Monitoring in Adult Patients Undergoing Noncardiac Surgery

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**An Educational Intervention on the Role of Perioperative Troponin Monitoring in Adult
Patients Undergoing Noncardiac Surgery**

A DNP Project Presented to the Faculty of the
Nicole Wertheim College of Nursing and Health Sciences

Florida International University

In partial fulfillment of the requirements for the degree of
Doctor of Nursing Practice

By

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Date: _____

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ABSTRACT

Background: Myocardial injury after noncardiac surgery is considered a common perioperative complication associated with increased morbidity and mortality following surgery. Patients who sustain MINS are predominantly asymptomatic and do not meet the conventional definition and diagnostic criteria for myocardial infarction (MI). This presents a challenge in identifying patients with MINS without proper surveillance and monitoring in place.

Objectives: The purpose of this study is to improve anesthesia provider knowledge on the value of perioperative troponin monitoring in identifying myocardial injury after noncardiac surgery. A literature review including primary research studies addresses the PICO question: “In patients older than 45 years of age with cardiovascular risk factors, does routine perioperative troponin monitoring vs. monitoring traditional subjective symptoms indicative of postoperative myocardial ischemia improve identification of myocardial injury after noncardiac surgery?” The literature review is used to provide the educational framework to improve provider knowledge. The overall objective is to increase awareness with the intention of improving healthcare outcomes for surgical patients.

Methodology: The primary methodology of the proposed project is to administer an online educational intervention to providers which focuses on the benefits of perioperative troponin monitoring in the early identification of MINS. Pre- and post-assessment surveys will be used to measure improvement of provider knowledge before and after the intervention.

Results: Overall, there was an improvement in provider knowledge following the education intervention. Additionally, the likelihood of utilizing perioperative troponin monitoring increased among providers.

Conclusions: Currently, troponin monitoring is not standard practice in high-risk patients undergoing major noncardiac surgery. The educational intervention provided was effective in improving anesthesia provider knowledge of MINS and the likelihood of utilizing perioperative troponin monitoring. Increasing awareness of myocardial injury after noncardiac surgery and the role of serial troponin monitoring can reduce mortality and improve postoperative outcomes.

Keywords: myocardial injury, noncardiac surgery, postoperative troponin elevations, cardiac enzymes, postoperative mortality

Introduction

Description of the Problem

The United States population continues to shift towards an older demographic and an increasing number of patients are presenting for surgery with cardiovascular risk factors. Coronary heart disease is currently the number one cause of death worldwide and is frequently seen in patients presenting for noncardiac surgery. This presents a major concern when currently one-third of major perioperative complications are attributed to cardiovascular events.¹ Extensive research has been conducted on the incidence of myocardial injury after non-cardiac surgery (MINS), unfortunately myocardial infarction (MI) and MINS still account for significant morbidity and mortality in the 30 days following noncardiac surgery.¹ MINS is often an unrecognized asymptomatic event which may be detected early through appropriate monitoring. Early detection can lead to better outcomes; thus, importance of monitoring postoperative troponin levels is gaining widespread recognition.

Over 300 million patients have surgery annually and perioperative death is the third leading cause of death in the United States.² Myocardial injury after noncardiac surgery is considered a common perioperative complication present in up to 25% of patients healing from noncardiac surgery and is associated with both short and long-term implications.³ MINS is associated with increased morbidity, longer hospitalization, and in-hospital mortality, posing a significant burden to the healthcare system.⁴ Cardiovascular complications currently account for approximately 25% of 30-day hospital readmissions following surgery in patients who sustain perioperative myocardial ischemia.⁴ In-hospital cardiovascular complications following noncardiac surgery are associated with a 155% increase in adjusted expenditure compared with noncardiac surgical admissions with minor complications.⁵ Proper screening and early

intervention are essential to reducing overall healthcare costs. It is imperative to implement appropriate perioperative monitoring to improve surgical outcomes and reduce costs associated with postoperative complications.

The American College of Cardiology (ACC) and American Heart Association (AHA) published a clinical practice guideline on the perioperative evaluation and management of patient's undergoing noncardiac surgery. This guideline consists of evidence-based proposals to systematically improve cardiovascular health in perioperative patients having surgery.⁶ A preoperative assessment is of vital importance in identifying those patients with a greater likelihood of cardiovascular events so surgical and anesthetic management may be tailored to optimize patient outcomes. Algorithms have been established to assist with perioperative risk stratification. Assessment of functional capacity using metabolic equivalents (METS) and the existence of cardiovascular risk factors using the revised cardiac risk index (RCRI) are commonly employed when evaluating patients and determining the need for further testing prior to surgery.² Nevertheless, despite satisfactory preoperative risk stratification, patients still present with MI and myocardial injury after surgery.⁷

The ACC/AHA recommendations currently question the usefulness of standard perioperative troponin measurements, even in those patients deemed high-risk. This is attributed to the lack of a specified management strategy for MINS.⁶ Measurement of troponin levels is advised only when signs or symptoms indicative of myocardial ischemia or MI are present.⁶ Unfortunately, given the "silent ischemia" experienced by a large percentage of patients with MINS, routine postoperative troponin screening is the only reliable way to detect myocardial injury after noncardiac surgery.³ Recently, a growing body of evidence-based research is challenging current guidelines, advocating for the use of perioperative troponin monitoring.

Background and Pathophysiology

MINS is described as myocardial injury due to ischemia in the postoperative period unrelated to a non-cardiac cause, such as sepsis or pulmonary embolism, and is strongly associated with 30-day mortality.^{8,9,10} Patients who sustain MINS are predominantly asymptomatic and do not meet the conventional definition and diagnostic criteria for myocardial infarction (MI).⁸ This presents a challenge in identifying patients with MINS despite its common occurrence in the postoperative period. 80% of patients with MINS may go unrecognized without proper surveillance and monitoring in place.⁸

The pathophysiology of MINS in surgical patients describes a non-ST-elevation type ischemia attributable to a prolonged imbalance between myocardial oxygen supply and demand.¹¹ This differs from classic ST-elevation MI (STEMI) related to an atherosclerotic event and plaque rupture and is more likely to randomly occur during the weeks following surgery.^{1,7} Patients undergoing surgery have an elevated stress response and are prone to acute blood loss, pain, hemodynamic instability, and hypercoagulability in the perioperative period, leaving them vulnerable to ischemic events.¹ These factors are thought to account for MINS and its common presentation within the first three days after surgery.^{1,3} Patients at higher risk of MINS include those ≥ 45 years of age with cardiovascular risk factors and those ≥ 65 years of age.³ Additionally, atrial fibrillation, diabetes, hypertension, congestive heart failure (CHF), peripheral vascular disease, renal insufficiency, and urgent or emergency surgery have been identified as independent predictors of MINS.

Purpose of the Study

The purpose of this study is to assess anesthesia provider knowledge on myocardial injury after noncardiac surgery and the role of perioperative troponin monitoring. An

educational intervention will be provided to certified registered nurse anesthetists as part of a quality improvement project. The goal is to improve provider knowledge and the likelihood of utilizing serial troponin monitoring in individuals considered high risk for myocardial injury after noncardiac surgery. An increased understanding of the role of perioperative troponin monitoring in high-risk adult patients undergoing noncardiac surgery may help in the early identification of MINS and potentially reduce the risk of cardiovascular events following surgery. The overall objective is to increase awareness with the intention of improving healthcare outcomes for surgical patients.

Literature Review

Purpose of the Literature Review

Perioperative evaluation of cardiac biomarkers such as troponin and natriuretic peptides strongly predict the occurrence of major adverse cardiovascular events (MACE) after surgery including death, non-fatal cardiac arrest, congestive heart failure (CHF), and stroke.² Elevated troponin levels in the postoperative period have been indicated as the most compelling predictor of 30-day mortality after surgery and is associated with higher 30-day rates of MACE.¹² Identifying those patients at high risk for cardiovascular injury in the perioperative period and careful monitoring of perioperative cardiac biomarkers is crucial in providing early intervention and preventing death and disability.

The purpose of the literature review is to identify available evidence and evaluate research findings on the value of perioperative troponin monitoring in identifying myocardial injury after noncardiac surgery. The literature review includes primary research studies answering the PICO question: “In patients older than 45 years of age with cardiovascular risk factors, does routine perioperative troponin monitoring vs. monitoring traditional subjective

symptoms indicative of postoperative myocardial ischemia improve identification of myocardial injury after noncardiac surgery?” The results obtained from the literature review will be used to formulate an educational intervention to improve anesthesia provider knowledge on myocardial injury after noncardiac surgery and the role of perioperative troponin monitoring.

Methodology

Information Sources and Search Strategy

An online database search utilizing MEDLINE (ProQuest), Excerpta Medica Database (EMBASE), and Cumulative Index of Nursing and Allied Health Literature (CINAHL) was performed in pursuit of primary research studies. The terms used in the search were as follows: *perioperative OR postoperative, troponin OR cardiac enzyme OR biomarker, myocardial ischemia OR myocardial injury OR cardiac complications*. The search was limited to those studies published since 2015 available in the English language. Studies were further filtered to include only adults > 18 years of age. The MEDLINE database yielded 227 results, the CINAHL database resulted in 84 articles, and the EMBASE database produced 285 articles. A total of 596 articles resulted from all 3 searches. After removal of duplicates, 367 articles were left to be appraised.

Study Selection and Screening Method

The titles and abstracts of the remaining 367 articles were screened in relation to the preliminary PICO question. The following inclusion criteria were applied:

1. Studies involving the specific monitoring of perioperative troponin levels
2. Studies that focused on the identification of myocardial injury after noncardiac surgery and any subsequent outcomes

The following exclusion criteria were applied:

1. Research reports that did not address primary research (e.g. opinion articles, editorials, literature reviews)
2. Research reports involving cardiac surgery or procedures
3. Research reports involving assessment of other biomarkers (e.g. BNP)
4. Research reports focused on the prevention and/or treatment of MINS
5. Research reports solely focused on morbidity and mortality following MINS

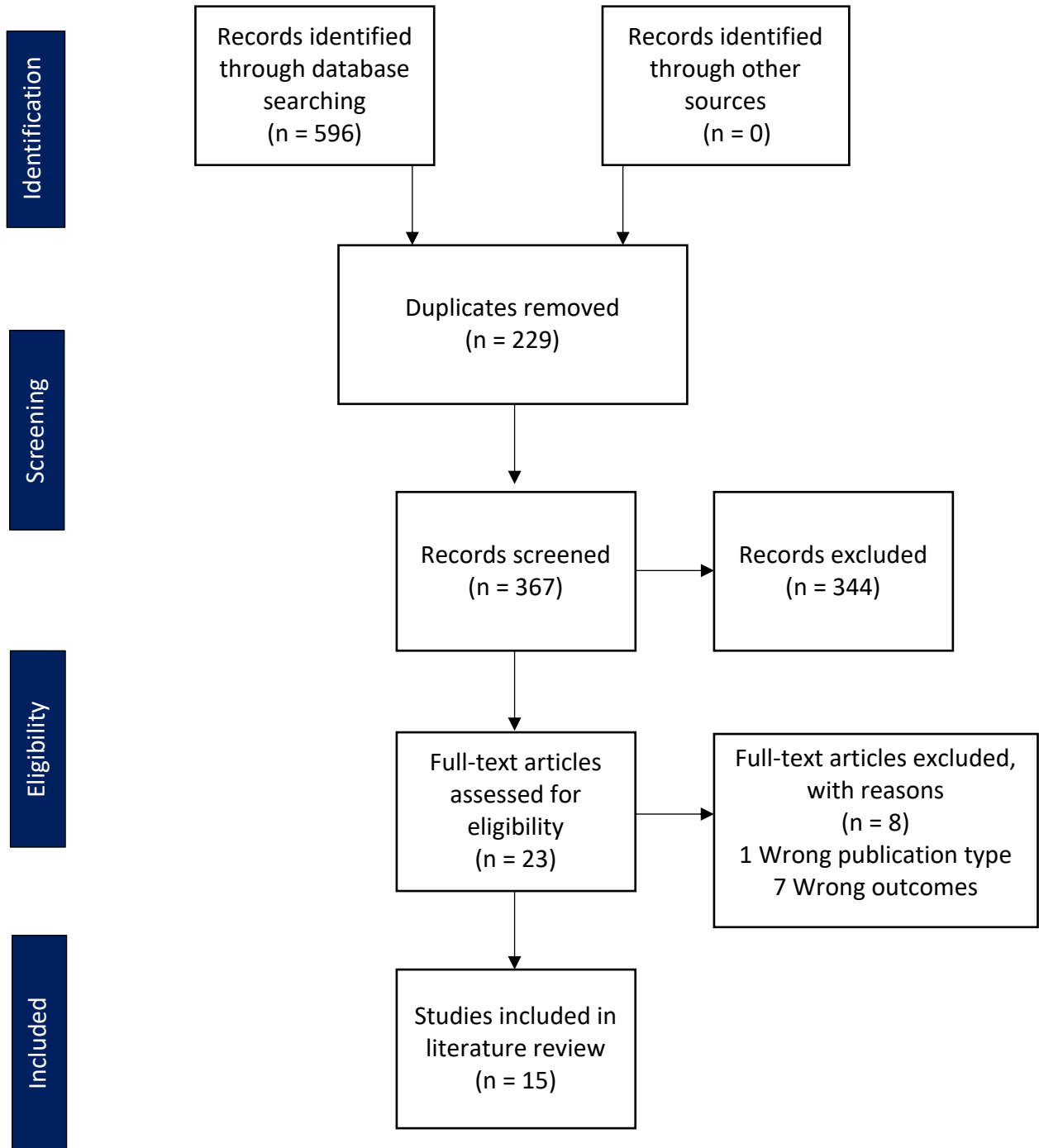
Out of 367 articles a total of 23 articles were found to be relevant and underwent a full-text screening process. Of these 23 articles, 8 articles were excluded. 1 article was excluded for being an editorial, 4 articles were excluded because they focused on long-term outcomes and adverse events associated with MINS, 1 article was excluded because it focused on the medical management of MINS, and 2 articles were excluded because they did not specify how many patients with MINS presented with clinical symptoms. Fifteen studies met the eligibility requirements and were included in literature review. A PRISMA flow diagram is shown in Figure 1 that provides a visual representation of the literature review screening process.

Data Collection and Analysis

The selected studies were evaluated using the John Hopkin's Nursing Evidence-based Practice process to determine the strength and quality of research. According to John Hopkin's strength of research evidence rating scheme, level I evidence comprising of evidence obtained from an experimental study, randomized controlled trial, or systematic review of randomized controlled trials, with or without meta-analysis, is considered the strongest level of evidence.¹³ Level II evidence includes evidence obtained from a quasi-experimental study or a systematic review which includes quasi-experimental studies, with or without meta-analysis.¹³ Level III evidence obtained from a quantitative non-experimental study (e.g., observational cohort study),

qualitative study, or a systematic review consisting of either, is considered the lowest level of evidence.¹³

Figure 1. PRISMA Flow Diagram



Research evidence is further evaluated and determined to be of high quality, good quality, or low-quality evidence. “High” quality evidence contains consistent and generalizable results, a sufficient sample size, adequate control, definitive conclusions, and consistent recommendations based on a thorough literature review established from scientific evidence.¹ “Good” quality evidence contains reasonably consistent results, a sufficient sample, some degree of control, fairly definitive conclusions, and reasonably consistent recommendations based on a fairly comprehensive literature review.¹³ “Low” quality evidence contains little evidence with inconsistent results, an insufficient sample size, and lacks any definitive conclusions.¹³

The selected studies were also evaluated for relevant information consistent with the purposes of the literature review and stated PICO question. The information obtained and evaluated from each observational cohort study included: (1) the study design and method, (2) sample size and characteristics, (3) sample setting, (4) troponin measurement tool and abnormal threshold value, (5) results of the study, (6) associated risk factors for MINS, (7) limitations of the study, and (8) study conclusions. A matrix table was created to summarize the characteristics and findings from each study, and an evidence rating was assigned to each study based on John Hopkin’s research evidence appraisal tool.

Results

Study Characteristics

The selected observational cohort studies had a combined total of 38,758 patients undergoing noncardiac surgery and troponin surveillance. All studies were published between 2015 and 2020, reflecting the most current evidence available. All studies were published in English but were representative of a large, international group of countries from North America, South America, Europe, Africa, Asia, and Australia. The majority of the studies focused on adults older

than 45 years of age. Troponin elevation was measured in the context of a diverse array of noncardiac surgeries including orthopedic, vascular, major abdominal, spinal, thoracic, head and neck procedures.

Definitions and Findings of Outcomes

There were three main outcomes evaluated for this literature review: the prevalence of MINS, the incidence of perioperative MI, and patient risk factors associated with MINS. MINS is characterized as an elevated postoperative troponin level with at least one value above the 99th percentile upper reference limit resulting from myocardial ischemia without the requirement of an ischemic feature (e.g. chest pain or significant ECG changes), and occurs within 30 days of surgery.¹⁴ According to the Fourth Universal Definition of Myocardial Infarction, acute MI is defined as acute myocardial injury with clinical evidence of myocardial ischemia including the detection of at least one elevated troponin value above the 99th percentile upper reference limit with at least one of the following characteristics: symptoms of myocardial ischemia (e.g. chest pain), new ischemic ECG changes, development of pathological Q waves, imaging evidence of new loss of viable myocardium or new regional wall motion abnormality consistent with ischemic etiology, or identification of a coronary thrombus by angiography or autopsy.¹⁵ The selected studies focus on the use of perioperative troponin monitoring to identify prognostically significant elevated troponin levels indicative of myocardial injury. Depending on the type of troponin assay used, manufacturer-derived 99th percentile cutoffs were applied to classify troponin results as positive or negative.

Prevalence of MINS. Based on this analysis, MINS was identified in 15-25% of patients undergoing noncardiac surgery in 8 out of 15 studies.^{10,14,16-21} Five studies had an incidence of 5-15% and two studies identified MINS in 29-46% of patients.²²⁻²⁶ Duceppe et al and Thomas et al

conducted studies in patients undergoing vascular surgery (primarily endovascular aortic repair, open abdominal aortic aneurysm repair, and open lower limb perfusion) and reported higher rates of troponin elevation compared to other studies.^{26,28} Three additional studies focused on vascular surgery and reported troponin elevations in 15-25.5% of their patients, with many of these patients not experiencing clinical ischemic symptoms or ECG changes.^{14,19-20} Coetzee and colleagues reported the lowest incidence of MINS at 4.9% in their study of 301 patients undergoing noncardiac surgery including intraabdominal, thoracic, joint replacement, major orthopedic, and vascular surgery.²² Gorgun and colleagues reported a similar incidence of MINS at 5%, but the study focused on patients having major colorectal surgery.²⁴ Coetzee et al and Gorgun et al were the only two studies that reported an incidence of MINS less than 10%.

Perioperative MI. The incidence of MI according to the Fourth Universal Definition of Myocardial Infarction is less common, although still significant. Bass et al and Huang et al reported a 5.5% incidence of MI in patients with elevated troponin who underwent orthopedic and abdominal surgery.^{24,26} In a study performed by Brown and colleagues, MI was diagnosed in 11% of patients with MINS who had undergone either orthopedic or vascular surgery, of which 70% had no ischemic symptoms. Ekeloef et al reported a similar occurrence of MI in 11.2% of patients diagnosed with MINS who had undergone major emergency abdominal surgery, and none of these patients had any ischemic subjective symptoms. Devereaux et al conducted a study representing a large sample size of over 21,000 patients which showed a higher incidence of MI, reporting a frequency of 21.7% in patients diagnosed with MINS who primarily underwent orthopedic and major general surgery.¹⁰ Additionally, 68% of these patients did not experience any ischemic symptoms.¹⁰ Puelacher and colleagues reported a 29% incidence of MI in patients with myocardial injury in a large cohort study involving a diverse group of surgeries including

orthopedic, vascular, thoracic, visceral, urologic, spinal, and trauma surgery.²⁷ 82% of patients with myocardial injury in this study did not exhibit any ischemic symptoms and chest pain was present in only 6% of these patients.²⁷ Biccard and colleagues observed patients specifically undergoing vascular surgery and revealed a significant occurrence of MI, accounting for 42% of patients who developed MINS.¹⁴ 74% of patients diagnosed with MINS in this study exhibited no clinical symptoms of ischemia.¹⁴ Grobber et al reported MI in 24% of carotid endarterectomy patients exhibiting elevated troponin levels, with 75% of diagnosed MIs having no clinical symptoms.¹⁹ Duceppe et al reported similar results in patients who underwent endovascular aortic repair (EVAR), with 23.1% of patients with MINS meeting the clinical definition of MI. It is worth noting, Puelacher and colleagues found mortality to be comparable in patients with MINS who did not fulfill any other criteria for acute MI versus those who had at least one additional criterion.²⁷

Patient Risk Factors Associated with MINS. A number of risk factors have been implicated in the development of myocardial injury after noncardiac surgery. Advancing age and the presence of comorbidities such as cardiovascular disease, diabetes, and decreased renal function pose the greatest risk for the development of MINS.

Age group. Age is considered a significant risk factor for MINS with older patients > 65 years of age more likely to have elevated postoperative troponin levels.^{10,14,16-21,23,24,26-28} Bass et al conducted a study on patients undergoing orthopedic surgery revealing an increased risk for postoperative myocardial ischemia of 3.5-fold per decade of life.²³ A multivariate analysis performed in 4 other studies on all significant variables identified as predictors of MINS through univariate analysis revealed a similar correlation between increasing age and myocardial injury.^{17,24,26,28} Additionally, Gorgun and colleagues

identified both age and elevated troponin concentrations as independent risk factors for mortality following noncardiac surgery.²⁴

Cardiovascular. Coronary artery disease (CAD), chronic heart failure (CHF), previous history of MI, and atrial fibrillation have also been indicated as risk factors for the development of MINS.^{14,16,18,20-21,25,27} In 5 studies, at least 30% of patients diagnosed with MINS had CAD.^{14,24-27} Additionally, those with coronary artery disease are much more likely to sustain myocardial infarction after surgery. Brown et al found 81% of those diagnosed with postoperative MI to have a history of CAD.¹⁶ Duceppe and colleagues also revealed MINS to be strongly associated with CHF, with CHF being present in 46.2% of EVAR patients who sustained myocardial injury.²⁶ According to Biccard et al and Puelacher et al, chronic heart failure and atrial fibrillation were both independent risk factors for MINS, with P-values of 0.002 or less.^{14,27}

Diabetes. Silent ischemia is known to occur with increased frequency in diabetic patients and is thought to be due to cardiac autonomic neuropathy.²⁹ Therefore, identifying myocardial injury in these patients can be challenging without objective data. After performing a multivariate analysis, Bass et al found that diabetes was an important predictor of postoperative myocardial ischemia.²³ According to this analysis, the odds of sustaining myocardial injury increased 2.2-fold in patients with diabetes. Additionally, MINS was found to be significantly associated with diabetes mellitus in three other studies, with P-values of 0.002 or less.^{18,21,27}

Renal function. Myocardial ischemia is a major cause of death in in patients with chronic kidney disease (CKD) and CAD is also highly prevalent in this population.³⁰ Therefore, CKD is considered a significant risk factor for MINS. According to Duceppe

and colleagues, 45.5% of patients who sustained myocardial injury after undergoing endovascular aortic repair had an eGFR < 60 mL/min, whereas only 27% of patients without myocardial injury had an eGFR < 60 mL/min.²⁵ Gorgun et al. found a GFR < 45 mL/min in 32.4% of patients with troponin elevation following carotid endarterectomy compared to 11.6% of patients without troponin elevation.²⁴ Brown and colleagues also reported a higher incidence of CKD in patients who sustained myocardial infarction following vascular and orthopedic surgery, and was present in 23% of those with MI.¹⁶

Risk of Bias

Selection bias was an issue due to incomplete and inconsistent data collection. In a retrospective study conducted by Duceppe and colleagues, data was collected on patients with at least one postoperative troponin level within three days after surgery.²⁶ MINS could have been missed in those patients who only had a single troponin level drawn compared to those who had serial troponin measurements done. Likewise, Coetzee and colleagues performed a prospective observational study where only 10% of patients had a second troponin level drawn within 72 hours of surgery.²² Monitoring serial troponins provides a trend of rising and falling values, further increasing the probability of identifying myocardial injury. Five studies measured only one troponin value or failed to measure serial troponins consistently. This could have resulted in underestimating the incidence of myocardial injury after surgery. Furthermore, routine ECGs were not performed in all patients with troponin elevation which could have also underestimated the occurrence of perioperative MI.

Information bias refers to outcomes being misclassified or measured with error. A lack of baseline troponin levels could have contributed to information bias. Baseline troponin levels were not measured in 9 out of 15 studies, and 2 other studies did not measure baseline troponin

levels in all patients. Thus, those patients with chronically elevated troponin levels could have been misclassified as having MINS in the postoperative period. Baseline preoperative troponin values help differentiate chronically elevated levels from acute myocardial damage and give a more accurate identification of MINS.²⁷⁻²⁸

Reporting bias was another concern. Devereaux et al admitted to using arbitrary criteria for prognostically important troponin elevation.¹⁰ Puelacher et al also used arbitrary delta values to define myocardial injury.²⁷ Without standardized thresholds, it is difficult to accurately identify clinically significant myocardial injury.

Discussion

Summary of the Evidence

The asymptomatic nature of MINS is of clinical importance. It is important to identify those individuals at risk for myocardial injury after noncardiac surgery so proper surveillance measures may be implemented. Troponin elevations are a prognostic tool capable of identifying patients with poor functional reserve who are at high risk for mortality due to underlying comorbidities.²⁴ All of the studies, with the exception of two, identified MINS in at least 10% of patients following surgery. Patients who primarily underwent vascular surgery showed the highest incidence of MINS with up to 42% of those diagnosed with MINS meeting the universal definition for perioperative MI.^{14,26,28} The majority of these patients were asymptomatic and otherwise would not have been identified without routine perioperative troponin monitoring.

Age is considered a significant risk factor for MINS. Individuals > 65 years of age have an increased risk of both postoperative myocardial injury and death following noncardiac surgery. Older individuals are also more likely to have comorbidities associated with diminished cardiac reserve. Therefore, older individuals are more likely to benefit from routine perioperative

troponin monitoring. Other significant risk factors include CAD, CHF, history of previous MI, atrial fibrillation, diabetes, and chronic kidney disease.

Considering the high incidence of MINS in patients undergoing vascular surgery, it is possible CAD is underdiagnosed in patients with peripheral vascular disease. Szczeklik et al found CAD was not more prevalent in patients with critical limb ischemia (CLI) who sustained myocardial injury compared to those who did not.²⁰ This indicates the presence of CAD may be underestimated in CLI patients.²⁰ It would be prudent to treat these patients as if they have CAD, whether or not they have been officially diagnosed, and institute troponin monitoring.

Limitations

The limitations to this literature review must be acknowledged. This review included observational cohort studies and thus were not classified as the highest level of evidence. All of the studies had defined inclusion and exclusion criteria, but such criteria were not consistent among studies. Most of the studies included in this review were prospective in nature which allowed for a more complete study design; however, four studies were classified as retrospective. There is limited control over data collection in retrospective studies and data may be incomplete, inaccurate, or inconsistently measured between subjects.³¹ This was certainly the case when Duceppe et al. conducted a retrospective study where baseline troponin levels were not drawn, serial troponin levels were not measured, and four different troponin assays were used. Additionally, this review did not take into consideration intraoperative factors such as anesthetic technique, intraoperative blood pressure or heart rate, blood loss, and transfusion events. Such factors can also affect the incidence of MINS and may have affected the results in this review.

Cost Analysis

It is important to consider the feasibility of perioperative troponin monitoring in terms of the cost associated with it. While the cost of troponin monitoring itself is relatively inexpensive, follow-up diagnostic tests and consultations in patients with elevated troponin must also be considered. Buse et al reported an incremental cost of \$112.18 CAD per screened patient with an incremental cost per case of MINS detected ranging between \$1134 CAD and \$2138 CAD.⁹ Given the high incidence of MINS and poor prognosis of these patients, the cost associated with postoperative complications would be far greater without timely identification. Mantha and colleagues reported troponin surveillance to have an incremental cost-effectiveness ratio of \$12,641 per quality-adjusted life year (QALY) in patients presenting for open abdominal aortic surgery, considering it a cost-effective measure when interpreted with a threshold value of \$50,000/QALY.³² The threshold of \$50,000/QALY is often used for commonly funded interventions and is frequently applied in decision analytic cost-effectiveness models related to cardiovascular medicine.³² While both studies mentioned have their limitations, they both support the role of perioperative troponin monitoring as a cost-effective measure.

Recommendations for Practice

Early identification of myocardial injury through routine troponin surveillance allows appropriate interventions to take place, potentially reducing morbidity and mortality following noncardiac surgery. Currently, troponin monitoring is not standard practice in high-risk patients undergoing major noncardiac surgery. This is attributed to the lack of a specified management strategy for MINS. Although there is no definitive treatment for MINS, there is promising research suggesting the use of anticoagulants in the acute as well as long-term setting may prevent major complications in patients who have sustained MINS.³³ According to George et al, the 30-day mortality rate was 11.7% in patients diagnosed with MINS compared to 2.5% of

patients who did not have MINS.¹⁸ Mortality was reduced to 6.7% of patients with MINS who received aspirin postoperatively.¹⁸ Furthermore, a large, international, randomized-controlled study testing the efficacy of an oral direct thrombin inhibitor in patients diagnosed with MINS, found that dabigatran reduced major vascular complications following surgery with no increased risk of major bleeding.³⁴

HMG-CoA reductase inhibitors, also known as statins, have also been correlated with positive outcomes. In a study performed by Park and colleagues, a statin prescription at discharge was found to be associated with improved mortality after MINS, with significant reductions in 1-year and overall mortality in patients receiving statin therapy.³⁵ The pleiotropic effects of statins make them an attractive option in preventing perioperative cardiovascular complications as they exert anti-inflammatory properties, increase nitric oxide bioavailability, and promote plaque stabilization.³⁶ As more research continues to be conducted on management strategies for MINS, cardiac consultation in patients who have sustained MINS should be strongly considered so that appropriate individualized therapy may be implemented. Given the evidence suggesting that available treatments may reduce morbidity and mortality in patients diagnosed with MINS, it would be prudent to routinely measure troponin levels on postoperative days 1-3 in patients ≥ 65 years old and/or with known risk factors such as CAD or diabetes. Routine monitoring prevents missing an opportunity to provide beneficial intervention to high-risk individuals.

Recommendations for Future Research

Despite the heterogeneity in performed studies, extensive research has determined routine troponin monitoring to be an effective method in identifying MINS in otherwise asymptomatic patients. Furthermore, elevated troponin levels have been found to be strongly associated with

increased morbidity and mortality following surgery. If any further research focuses on the value of troponin levels in the identification of MINS, it should aim to more accurately assess troponin elevations through consistent measurement of baseline troponin values and serial troponin levels through postoperative day 3.

More importantly, more research should be conducted on management strategies for MINS as this would provide the most benefit to patients and would further justify the value of perioperative troponin monitoring. Ideally, such research would comprise of randomized controlled trials to determine the true efficacy of proposed treatments. More studies focusing on the cost-effectiveness of troponin monitoring and any subsequent treatments should also be performed to gain a better understanding of the cost-benefit.

Methodology

Setting and Participants

To successfully achieve the goals of this quality improvement project, a series of actions will be conducted that involve a specific group of study participants receiving an educational intervention on perioperative troponin monitoring. The main setting of this quality improvement project will take place at Memorial Regional Hospital in Hollywood, Florida. Primary participants include all certified registered nurse anesthetists (CRNAs) employed with Envision Physician Services. The participants will be recruited voluntarily, and the anticipated sample size will be between 5-15 participants.

Description of Approach and Project Procedures

The primary methodology of the proposed project is to administer an online educational intervention to providers which focuses on the benefits of perioperative troponin monitoring in the early identification of MINS. Participants will initially complete an online preassessment test

that gauges current knowledge and perceptions on perioperative troponin monitoring and MINS. Participants will then watch a ten minute online educational module about myocardial injury after noncardiac surgery and the role of perioperative troponin monitoring. Provider education is important in bridging gaps in knowledge and is necessary to improve the quality of patient care delivered and subsequent healthcare outcomes. The presentation will offer insight into the background and pathophysiology of MINS, risk factors most associated with MINS, and the role of perioperative troponin monitoring in identifying MINS. The final phase will involve an online post-assessment test to evaluate knowledge gained and any changes in perception regarding perioperative troponin monitoring.

The information obtained in the post-assessment survey will provide greater feedback regarding the impact of the educational intervention and will determine how to best move forward in expanding perioperative troponin monitoring in the identification of MINS. The pre/post-testing provides relevant information regarding the effectiveness of the educational intervention and seeks to promote the increased utilization of perioperative troponin monitoring in high-risk patients undergoing noncardiac surgery. Results will also demonstrate if further provider education is needed and if the program would be beneficial to other providers.

Protection of Human Subjects

For this study, the recruitment population will include certified registered nurse anesthetists employed with Envision Physician Services who work at Memorial Regional Hospital in Hollywood, Florida. This population is important because they directly provide care to high-risk patients undergoing noncardiac surgery and thus would benefit from the education provided as a means to improve patient outcomes following surgery. Recruitment will be conducted via email invitation to all certified registered nurse anesthetists. Participation is

voluntary and there is no penalty if participants decide to withdraw from the QI project. There are no perceived risks to the study as it only requires the time spent by each participant in the education intervention.

Data Collection

The primary instruments of data collection will include a pre-assessment and post-assessment questionnaire to determine the effects of the education intervention. Both assessments will be conducted using surveys consisting of approximately 10 questions focusing on knowledge and practice using Qualtrics. In this manner, the pretest will gauge knowledge and current perspectives on the educational material while the posttest survey will determine if the participants gained knowledge from the intervention and will apply their knowledge to the practice environment. The instrument reliability and validity will be measured in accordance with the intervention provided and its effectiveness for the participants. The data collected will be confidential and no subject identifiers will be recorded during any component of the study.

Data Management and Analysis Plan

The co-investigator for this project will be the DNP student who will be responsible for administering the survey. To evaluate the responses provided on the pretest and posttest, Excel software will be used to determine if participants received any knowledge and potentially modify their practice in response to the educational tool. Each question will be measured, and the responses recorded to identify the knowledge base before and after the intervention as well as the practical applications of the intervention. Through statistical analysis, the study results will identify patterns which will be used to determine the effectiveness of educational intervention and its impact on clinician practice. The co-investigator will store the collected data in a password protected laptop computer.

Results

Pre-Test Participant Demographics

The pretest demographics are shown in Table 1 below.

Table 1.

Pre-Test Participant Demographics

Demographics	N (%)
Total Participants	10 (100%)
Gender	
Male	1 (10%)
Female	9 (90%)
Age	
18 – 30 yr	0 (0%)
31 – 40 yr	5 (50%)
41 – 50 yr	1 (10%)
51 – 60 yr	2 (20%)
> 60 yr	1 (10%)
Prefer Not to Say	1 (10%)
Ethnicity	
Hispanic	0 (0%)
Caucasian	7 (70%)
African American	2 (20%)
Asian/Pacific-Islander	0 (0%)
Other	1 (10%)
Education	
Masters	7 (70%)
Doctorate	3 (30%)
Years of CRNA Practice	
0 – 2 yr	2 (20%)
2 – 5 yr	3 (30%)
5 – 10 yr	1 (10%)
10 – 20 yr	4 (40%)
> 20 yr	0 (0%)

There were 10 participants in the pretest demographics, but only 8 completed the study in its entirety. Most of the participants were female (n=9, 90%), as opposed to male (n=1, 10%). Half of the participants were between the ages of 31 – 40 years old (n=5, 50%), and the remaining participants were as follows: 41 – 50 years old (n=1, 10%), 51 – 60 years old (n=2, 20%), and greater than 60 years old (n=1, 10%). One participant declined to answer and there were no participants less than 30 years of age. The following ethnicities were represented: Caucasian (n=7, 70%), African American (n=2, 20%), and other (n=1, 10%). There were no participants of Hispanic or Asian/Pacific-Islander descent. Information was obtained about the participant's level of education, and it was found that the majority had a masters degree (n=7, 70%) and only a few had a doctorate degree (n=3, 30%). Participants were also questioned about their years of practice as a certified registered anesthetist (CRNA) and a mix of experience was found: 0 – 2 years (n=2, 20%), 2 – 5 years (n=3, 30%), 5 – 10 years (n=1, 10%), and 10 – 20 years (n=4, 40%).

Prior to beginning the pretest, study participants were also asked about any previous education regarding MINS and perioperative troponin monitoring. Many participants declined having any training in the past year about MINS (n=4, 40%). Of the remaining participants, two claimed having one training in the past year (20%), one claimed having two trainings in the past year (10%), and three participants did not know or remember how many trainings they attended (30%). The participants who received prior training about MINS were then asked if they received any information not related to perioperative troponin monitoring. Two participants claim they only received information related to troponin monitoring in their training (33.33%). The remaining claim that the content had a little information not related to troponin monitoring

(n=2, 33.33%) or some information related to troponin monitoring (n=1, 16.67%), and one participant did not answer (16.67%).

Pre-Test Knowledge About MINS

10 participants completed the pretest evaluating their current knowledge and perceptions about MINS and perioperative troponin monitoring. More than half of the participants (60%) did not know MINS most commonly presents within 3 days of surgery. Additionally, the vast majority (80%) were not aware that up to 80% of patients with MINS may go unrecognized without proper surveillance and monitoring in place. However, 100% of the participants knew that a diagnosis of MINS does not require the presence of an ischemic feature such as chest pain or ECG changes. Many participants (70%) also knew how the pathophysiology of MINS differs from classic ST-elevation MI.

Knowledge about patient risks factors was lacking. Only 20% of participants knew that diabetes, chronic kidney disease, and age > 65 years old were considered significant risk factors for MINS and did consider smoking to be a significant risk factor. On the other hand, 100% of participants were aware that blood loss, hemodynamic instability, and hypercoagulability are commonly associated events in the perioperative period which predispose patients to myocardial ischemia.

Knowledge about possible treatment options for MINS was mixed. Two participants (20%) believed there were no treatment options available for MINS. 30% of participants incorrectly identified ACE inhibitors as a treatment option for MINS, but 70% of participants correctly identified oral direct thrombin inhibitors as a treatment option and 30% of participants correctly identified HMG-CoA reductase inhibitors as a treatment option. Despite those that did not identify HMG-CoA reductase inhibitors as a treatment option, 100% of participants

understood the mechanisms by which this class of drugs could be beneficial in preventing cardiovascular complications after a diagnosis of MINS.

Pre-Test Knowledge and Perspective of Perioperative Troponin Monitoring

60% of participants were aware troponin monitoring is not standard practice in high-risk patients undergoing noncardiac surgery. Given the nature of the question provided, these participants acknowledged MINS as a common event, perceived troponin monitoring to be reliable in detecting MINS, and believed there was evidence correlating elevated troponin levels with increased morbidity and mortality following surgery. However, the remaining 40% of the participants either believed routine troponin monitoring was not a reliable way to detect myocardial injury after noncardiac surgery (n=3, 30%) or believed there was no evidence suggesting elevated troponin levels are associated with increased morbidity and mortality following surgery (n=1, 10%).

As expected, most participants were indifferent or were unlikely to utilize serial troponin monitoring in high-risk patients undergoing noncardiac surgery. Only one participant (10%) was somewhat likely to utilize perioperative troponin monitoring. The majority were unlikely to employ serial troponin monitoring with 40% of participants somewhat unlikely and 20% of participants extremely unlikely to monitor troponin levels after surgery. The remaining 30% of participants were neither likely nor unlikely to institute troponin monitoring.

Post-Test Participant Demographics

The posttest demographics are shown in Table 2 below.

Table 2.

Post-Test Participant Demographics

Demographics	N (%)
Total Participants	8 (100%)

Gender	
Male	0 (0%)
Female	8 (100%)
Age	
18 – 30 yr	0 (0%)
31 – 40 yr	4 (50%)
41 – 50 yr	0 (0%)
51 – 60 yr	2 (25%)
> 60 yr	1 (12.5%)
Prefer Not to Say	1 (12.5%)
Ethnicity	
Hispanic	0 (0%)
Caucasian	5 (62.5%)
African American	2 (25%)
Asian/Pacific-Islander	0 (0%)
Other	1 (12.5%)
Education	
Masters	6 (75%)
Doctorate	2 (25%)
Years of CRNA Practice	
0 – 2 yr	1 (12.5%)
2 – 5 yr	3 (37.5%)
5 – 10 yr	1 (12.5%)
10 – 20 yr	3 (37.5%)
> 20 yr	0 (0%)

There were 8 participants in the posttest demographics and all 8 actually completed the study. 100% of the participants were female; no males completed the study.

Half of the participants were between the ages of 31 – 40 years old (n=4, 50%) and the remaining participants were as follows: 51 – 60 years old (n=2, 25%) and greater than 60 years old (n=1, 12.5%). One participant declined to answer; there were no participants less than 30 years of age or between the ages of 41-50 years old. The following ethnicities were represented:

Caucasian (n=5, 62.5%), African American (n=2, 25%), and other (n=1, 12.5%). No participants of Hispanic or Asian/Pacific-Islander descent participated. Information was obtained about the participant's level of education; the majority had a masters degree (n=6, 75%) and only a couple had a doctorate degree (n=2, 25%). As far as years of practice as a certified registered nurse anesthetist (CRNA): 0 – 2 years (n=1, 12.5%), 2 – 5 years (n=3, 37.5%), 5 – 10 years (n=1, 12.5%), and 10 – 20 years (n=3, 37.5%). Of note, although fewer people completed the posttest, the distribution of the sample was similar across both tests.

Post-Test Knowledge About MINS

8 participants completed the posttest evaluating their knowledge and perceptions about MINS and perioperative troponin monitoring after receiving the intervention. Half the participants (n=4, 50%) still did not know MINS most commonly presents within 3 days following surgery. Half of the participants (n=4, 50%) also did not know MINS may go unrecognized in up to 80% of patients without proper surveillance and monitoring in place. Following the intervention, less participants (87.5%) knew MINS does not require the presence of an ischemic feature such as chest pain or EKG changes, and one participant (12.5%) unexpectedly believed MINS to often not be asymptomatic despite the educational content provided. However, a greater number of participants (87.5%) knew how the pathophysiology of MINS differed from class ST-elevation MI.

Knowledge of patient risk factors increased significantly. Nearly all the participants (87.5%) correctly identified patient risk factors for MINS as opposed to only 12.5% prior to the intervention. Conversely, knowledge of perioperative risk factors such as blood loss, hemodynamic instability, and hypercoagulability unexpectedly decreased from 100% to 75% of participants.

Increase in knowledge about the possible treatment options for MINS was insignificant. Only 25% of participants could correctly identify the two possible treatment options following the intervention. 5 participants (62.5%) could only partially identify treatment options for MINS, similar to pretest results. Knowledge of HMG-CoA reductase inhibitors as a viable treatment option did increase from 37.7% to 75%. However, knowledge of direct thrombin inhibitors as a treatment option declined from 75% to 50%, 25% of participants incorrectly identified ACE inhibitors as a treatment option, and one participant (12.5%) believed there were no treatment options available despite education provided. Cognition of the mechanisms by which HMG-CoA reductase inhibitors could prevent cardiovascular complications following a diagnosis of MINS also decreased from 100% to 87.5% of participants.

Table 3.***Difference in Pre- and Post-Test Responses (Knowledge About MINS)***

CORRECT RESPONSES	PRE-TEST	POST-TEST	DIFFERENCE
MYOCARDIAL INJURY AFTER NON-CARDIAC SURGERY MOST COMMONLY PRESENTS WITHIN 3 DAYS FOLLOWING SURGERY.	37.5%	50%	12.5%
UP TO 80% OF PATIENTS WITH MINS MAY GO UNRECOGNIZED WITHOUT PROPER SURVEILLANCE AND MONITORING IN PLACE.	12.5%	37.5%	25%
WHICH OF THE FOLLOWING IS NOT ASSOCIATED WITH MINS? IT REQUIRES THE PRESENCE OF AN ISCHEMIC FEATURE SUCH AS CHEST PAIN OR EKG CHANGES.	100%	87.5%	-12.5%
WHICH OF THE FOLLOWING IS NOT CONSIDERED A SIGNIFICANT RISK FACTOR FOR MINS? SMOKING.	12.5%	87.5%	75%
HOW DOES THE PATHOPHYSIOLOGY OF MINS DIFFER FROM CLASSIC ST-ELEVATION MI? MINS IS USUALLY ATTRIBUTABLE TO A PROLONGED IMBALANCE BETWEEN MYOCARDIAL OXYGEN DEMAND AND SUPPLY.	62.5%	87.5%	25%
WHICH OF THE FOLLOWING COMMONLY ASSOCIATED EVENTS IN THE PERIOPERATIVE PERIOD PREDISPOSE PATIENTS TO MYOCARDIAL ISCHEMIA? ALL OF THE ABOVE: BLOOD LOSS, HEMODYNAMIC INSTABILITY, AND HYPERCOAGULABILITY.	100%	75%	-25%

POSSIBLE TREATMENT OPTIONS FOR MINS INCLUDE? DIRECT THROMBIN INHIBITORS AND HMG-COA REDUCTASE INHIBITORS.	12.5%	25%	12.5%
WHAT MAKES STATINS AN ATTRACTIVE OPTION IN PREVENTING CARDIOVASCULAR COMPLICATIONS AFTER A DIAGNOSIS OF MINS? ALL OF THE ABOVE: ANTIINFLAMMATORY PROPERTIES, NITRIC OXIDE BIOAVAILABILITY, AND PLAQUE STABILIZATION.	100%	87.5%	-12.5%

Post-Test Knowledge and Perspective of Perioperative Troponin Monitoring

As expected, a greater number of participants (75%) were aware troponin monitoring is not standard practice in high-risk patients undergoing noncardiac surgery. Given the nature of the question provided, these participants acknowledged MINS as a common event, perceived troponin monitoring to be reliable in detecting MINS, and believed there was evidence correlating elevated troponin levels with increased morbidity and mortality following surgery. The remaining 25% of the participants either believed routine troponin monitoring was not a reliable way to detect MINS (n=1, 12.5%) or that MINS was not common event following surgery (n=1, 12.5%) despite the education provided.

Table 4.

Difference in Pre- and Post-Test (Knowledge of Perioperative Troponin Monitoring)

CORRECT RESPONSE	PRE-TEST	POST-TEST	DIFFERENCE
CURRENTLY, TROPONIN MONITORING IS NOT STANDARD PRACTICE IN HIGH-RISK PATIENTS UNDERGOING NONCARDIAC SURGERY.	50%	75%	25%
INCORRECT RESPONSE			
THERE IS NO EVIDENCE SUGGESTING ELEVATED TROPONIN LEVELS ARE ASSOCIATED WITH INCREASED MORBIDITY AND MORTALITY AFTER SURGERY.	12.5%	0%	-12.5%
ROUTINE TROPONIN MONITORING IS NOT A RELIABLE WAY TO DETECT	37.5%	12.5%	-25%

MYOCARDIAL INJURY AFTER NONCARDIAC SURGERY. MINS IS NOT A COMMON EVENT BECAUSE SURGERY DOES NOT IMPOSE STRESS ON THE BODY, THEREFORE, IS DOES NOT LEAVE THE PATIENT VULNERABLE TO ISCHEMIC EVENTS.	0%	12.5%	12.5%
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According to the data, there was a positive change in perspective regarding perioperative troponin monitoring following the intervention. Two participants (25%) were somewhat likely to utilize serial troponin monitoring in high-risk patients undergoing noncardiac surgery, as opposed to no participants prior to the intervention. However, 62.5% of participants exhibited no change in perspective and one participant (12.5%) exhibited a negative change in perspective. Overall, 50% of participants were still either somewhat unlikely (n=3, 37.5%) or extremely unlikely (n=1, 12.5%) to employ perioperative troponin monitoring, an improvement from 62.5% before educational intervention. Two participants (25%) remained indifferent and were neither likely nor unlikely to utilize troponin monitoring.

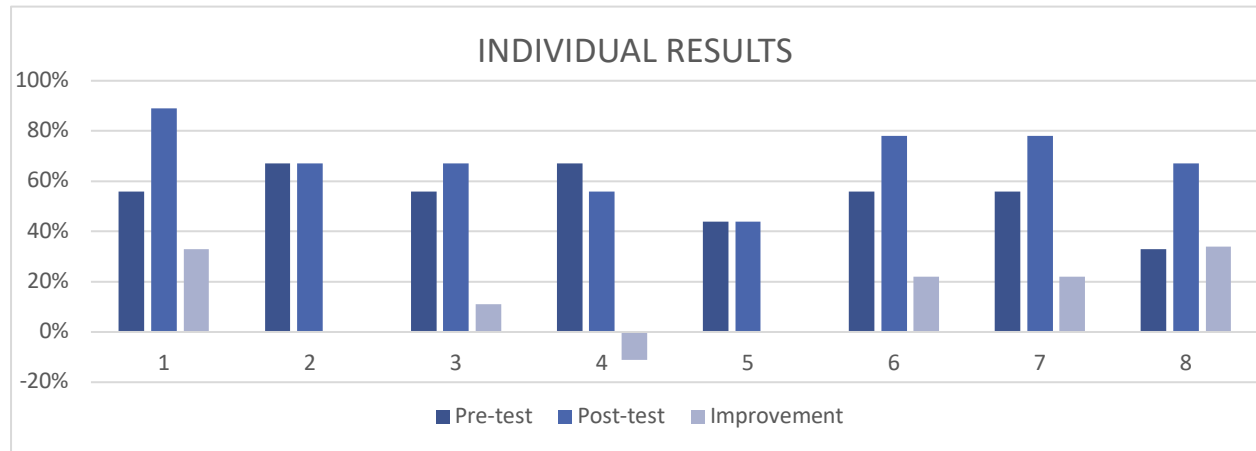
Table 5.

Difference in Pre- and Post-Test (Perspective of Perioperative Troponin Monitoring)

HOW LIKELY ARE YOU TO UTILIZE SERIAL TROPONIN MONITORING IN HIGH-RISK PATIENTS UNDERGOING NONCARDIAC SURGERY?	PRE-TEST	POST-TEST	DIFFERENCE
EXTREMELY LIKELY	0%	0%	0%
SOMEWHAT LIKELY	0%	25%	25%
NEITHER LIKELY NOR UNLIKELY	37.5%	25%	-12.5%
SOMEWHAT UNLIKELY	50%	37.5%	-12.5%
EXTREMELY UNLIKELY	12.5%	12.5%	0%

Summary of Data

Overall, the results show there was a gain in knowledge between pre- and post-test assessments.



In general, pre-test assessments show an average score of 54% compared to an average score of 68% on post-test assessments. The overall average improvement between pre- and post-test assessments was 14%. Only 5 out of the 8 participants (62.5%) who completed the study showed an improvement in knowledge following the intervention with an average increase of 24.4% between pre- and post-assessment scores. The remaining participants either had no change in knowledge (n=2, 25%) or had a decrease in knowledge (n=1, 12.5%) despite the education provided.

Out of the participants who showed improvement in knowledge between pre- and post-test assessments (n=5), one participant (20%) was more likely to utilize perioperative troponin monitoring following the intervention. Two participants (40%) remained somewhat unlikely to employ troponin monitoring, one participant (20%) remained neither likely or unlikely to employ troponin monitoring, and one participant (20%) was less likely to employ troponin monitoring after the intervention, despite improvement in knowledge.

Discussion

Limitations

Limitations of the QI project include a small sample size. The survey was deployed to all certified registered nurse anesthetists at Memorial Regional Hospital via email, but many chose not to participate in the study. A larger sample size would have increased the strength and reliability of the study. The delivery method of the study could have also limited the results as it was done entirely online. Not all participants are self-directed learners, and it is possible that participants may have completed the study in an environment not conducive to learning. A more controlled, in-person setting could have yielded more accurate results.

Future Implications for Advanced Nursing Practice

Early identification of myocardial injury through routine troponin surveillance allows appropriate interventions to take place, potentially reducing morbidity and mortality following noncardiac surgery. Currently, troponin monitoring is not standard practice in high-risk patients undergoing major noncardiac surgery. The outcomes of this study are important in determining strategies available to participants that will improve knowledge and potentially change practice to improve patient outcomes in high-risk patients undergoing noncardiac surgery. According to the data collected, the educational intervention provided was effective in increasing anesthesia provider knowledge on perioperative troponin monitoring and MINS. Furthermore, there was an increase in the likelihood of utilizing perioperative troponin monitoring in high-risk patients. The results of this study can be applied to a wider audience of certified registered nurse anesthetists. As research continues to be conducted on management strategies for MINS, increasing awareness of myocardial injury after noncardiac surgery and the role of serial troponin monitoring can reduce mortality and improve postoperative outcomes.

Conclusion

MINS is a commonly unrecognized event following noncardiac surgery due to its asymptomatic presentation. Without routine troponin monitoring in place, the majority of patients with myocardial injury after noncardiac surgery would be missed. This has serious consequences as MINS is associated with increased morbidity and mortality within 30 days of surgery, resulting in significant utilization of healthcare resources. As patient demographics continue to shift towards an aging population with an increasing number of comorbidities, it would be prudent to monitor troponin levels in the perioperative period. Currently, troponin monitoring is not standard practice in high-risk patients undergoing noncardiac surgery and there is a lack of knowledge among certified registered nurse anesthetists regarding the value of troponin monitoring in identifying MINS. Educational intervention can effectively increase provider knowledge and the likelihood of utilizing perioperative troponin monitoring in high-risk patients. Overall, increased awareness can help prevent cardiovascular events after surgery and improve healthcare outcomes in surgical patients.

Appendix A: IRB Exemption

Office of Research Integrity
Research Compliance, MARC 414

MEMORANDUM

To: Dr. Yasmine Campbell
CC: Araceli Plancarte
From: Elizabeth Juhasz, Ph.D., IRB Coordinator *EJ*
Date: April 7, 2021
Protocol Title: "An Educational Intervention on the Role of Perioperative Troponin Monitoring in Adult Patients Undergoing Noncardiac Surgery: A Quality Improvement Project"

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the **Exempt Review** process.

IRB Protocol Exemption #: IRB-21-0129 **IRB Exemption Date:** 04/07/21
TOPAZ Reference #: 110193

As a requirement of IRB Exemption you are required to:

- 1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
- 2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
- 3) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at <http://research.fiu.edu/irb>.

EJ



3501 Johnson Street, Hollywood, FL 33021
Phone (954) 265-1857 | E-mail: irb@mhs.net
FWA# 00003898 | IRB Registration # 00003075

May 26, 2021

Daniel Brady, DNP
3501 JOHNSON STREET
DEPARTMENT OF ANESTHESIA
MEMORIAL REGIONAL HOSPITAL
HOLLYWOOD FL 33021

IRB Project#: MHS.2021.055

Project Title: "An Educational Intervention on the Role of Perioperative Troponin Monitoring in Adult Patients Undergoing Noncardiac Surgery: A Quality Improvement Project"

Submission Type: Human Subjects Research Application – Initial Review (Reference# 007366)

Dear Investigator:

The Memorial Healthcare System Institutional Review Board (IRB) has reviewed the proposed activity referenced above and determined that it is **exempt** from the requirement for IRB oversight as outlined in 45 CFR 46.101 or 21 CFR 56.104. Additional details regarding this determination are provided starting on page 2 of this letter. Please review each page carefully.

Any amendments that substantially change the design of this activity must be submitted to the IRB for review prior to implementation as they may change the exemption determination.

Sincerely,

A handwritten signature in black ink that reads 'Luke Fiedorowicz'.

Luke Fiedorowicz, Ph.D.
IRB Director
Memorial Healthcare System



3501 Johnson Street, Hollywood, FL 33021
 Phone (954) 265-1857 | E-mail: irb@mhs.net
 FWA# 00003898 | IRB Registration # 00003075

EXEMPTION CATEGORY

Educational Activity; Anonymous Survey (No PHIs collected).

This exemption determination applies only to the project described in the application referenced above. Any changes to the project (including scope, objectives, methodology, or publication plan) may affect the determination. It is the responsibility of the Principal Investigator (PI) to submit any changes to the project to the MHS IRB for review prior to implementation.

SUBMISSION ATTACHMENTS

The following attachments were reviewed with this submission:

Submission Components			
Form Name	Version	Outcome	
Pre-Review Corrections Form	Version 1.0	Approved	
Initial Review	Version 1.0	Approved	
Non-Human Subject Research Determination	Version 1.1	Approved	
Study Document			
Title	Version #	Version Date	Outcome
Survey	Version 1.1	05/12/2021	Acknowledged
FIU IRB Exemption Letter	Version 1.0	05/12/2021	Acknowledged
Recruitment Letter	Version 1.0	05/12/2021	Acknowledged
Study Consent Form			
Title	Version #	Version Date	Outcome
QI Project Informed Consent	Version 1.0	05/19/2021	Acknowledged
Consent to Participate in a Quality Improvement Project	Version 1.0	05/12/2021	Acknowledged

The latest submission packet can be downloaded from the MHS IRB System (irb.mhs.net). The Principal Investigator is responsible for keeping records of all IRB correspondence, including outcome letters and IRB stamped documents.

HIPAA AUTHORIZATION

HIPAA Authorization: N/A - Anonymous Survey; No PHIs collected.

PHI's Approved for Access/Collection: None

CONFLICTING IRB MEMBERS

The following IRB members did not participate in this decision due to Conflict of Interests: **None**.

Thank you for complying with the Memorial Healthcare System Institutional Review Board policies

Appendix B: QI Project Consent

CONSENT TO PARTICIPATE IN A QUALITY IMPROVEMENT PROJECT
“An Educational Intervention on the Role of Perioperative Troponin Monitoring in Adult Patients Undergoing Noncardiac Surgery.”

INTRODUCTION

You are being asked to participate in a quality improvement project. The goal of this project is to improve anesthesia provider knowledge on the use of perioperative troponin monitoring in identifying myocardial injury after noncardiac surgery (MINS), as well as improve recognition of associated risk factors that predispose patients to the development of MINS. The overall objective of the program is to increase the quality of healthcare delivery and improve healthcare outcomes for surgical patients undergoing noncardiac surgery.

Your participation will require approximately 20 minutes of your time. You will be asked to complete a pre-test questionnaire, which is expected to take approximately 5 minutes. You will then be asked to view a short 10-minute educational presentation online. After watching the video, you will be asked to complete the post-test questionnaire, which should take approximately 5 minutes.

There are no foreseeable risks for participating in this project. The records of this project will be kept private and will be protected to the fullest extent provided by law. If in any sort of report we might publish, we will not include any information that will make it possible to identify you as a participant. Records will be stored securely, and only the project team will have access to the records.

There is no cost or payment to you for receiving the health education and/or for participating in this project. Your participation in this project is completely voluntary. You are free to participate in the project or withdraw your consent at any point during the project.

If you have any questions about the purpose, procedures, or any other issues relating to this quality improvement project, you may contact Araceli Plancarte at 561-809-5105/aplan021@fiu.edu or Dr. Jorge Valdes at 305-348-7729/jvalde@fiu.edu.

By clicking the button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

Pre-test and Post-test

QUESTIONNAIRE

- 1. Myocardial injury after noncardiac surgery most commonly presents within _____ following noncardiac surgery.**
 - a. 6 hours
 - b. 3 days
 - c. 5 days
 - d. 10 days

- 2. Up to ____ of patients with MINS may go unrecognized without proper surveillance and monitoring in place.**
 - a. 2%
 - b. 5%
 - c. 25%
 - d. 80%

- 3. Which of the following is NOT associated with MINS?**
 - a. Elevated troponin values
 - b. Increased 30-day mortality
 - c. It requires the presence of an ischemic feature such as chest pain or EKG changes
 - d. It is often asymptomatic

- 4. Which of the following is NOT considered a significant risk factor for MINS?**
 - a. Smoking
 - b. Diabetes
 - c. Chronic kidney disease

d. Age > 65 years

5. How does the pathophysiology of MINS differ from classic ST-elevation MI?

a. MINS is usually attributable to a prolonged imbalance between myocardial oxygen supply and demand

b. MINS is usually related to an atherosclerotic event or plaque rupture

c. MINS usually occurs more than 30 days following surgery

d. There is no difference, they are exactly the same

6. Which of the following commonly associated events in the perioperative period predispose patients to myocardial ischemia?

a. Blood loss

b. Hemodynamic instability

c. Hypercoagulability

d. All of the above

7. Which of the following is TRUE?

a. There is no evidence suggesting elevated troponin levels are associated with increased morbidity and mortality following surgery

b. Currently troponin monitoring is not standard practice in high-risk patients undergoing major noncardiac surgery

c. Routine troponin monitoring is not a reliable way to detect myocardial injury after noncardiac surgery

d. MINS is not a common event because surgery does not impose stress on the body, therefore, it does not leave patients vulnerable to ischemic events

- 8. Select all that apply: Possible treatment options for MINS include**
- a. Oral direct thrombin inhibitors
 - b. ACE inhibitors
 - c. HMG-CoA reductase inhibitors
 - d. None of the above
- 9. What makes statins an attractive option in preventing cardiovascular complications after a diagnosis of MINS?**
- a. It exerts anti-inflammatory properties
 - b. It increases nitric oxide bioavailability
 - c. It promotes plaque stabilization
 - d. All of the above
- 10. How likely are you to utilize serial troponin monitoring in high-risk patients undergoing noncardiac surgery?**
- a. Highly likely
 - b. Somewhat likely
 - c. Unlikely
 - d. Highly unlikely

Appendix D: Table 1. Overview of Literature Review Results

Author(s) And Pub Year	Design/ Method	Subject Selection/ Final Sample Size and Setting	Measurement Tool/ Abnormal Threshold	Results	Risk Factors	Limitations	Level of Quality	Conclusions
Bass et al. (2015)	-Ancillary prospective observational study to ongoing RCT. - Multi-center study - Samples obtained on postop day 2	394 hip or knee arthroplasty patients > 65 years old.	- hsTnT from Meso Scale Discovery (MSD) >14 ng/dL	13.5% of patients had MINS. 0.77% identified clinically as having MI.	-↑ age - Diabetes *Based on multivariate analysis	-Small sample size -No baseline troponin and troponin levels only measured once -ECG not routinely performed for elevated troponin	Level III Grade B	Patients at high risk for ischemia, such as diabetics and the elderly, may benefit from postoperative troponin surveillance.
Biccard et al. (2018)	-Prospective observational cohort study -Multi-center, international study -Troponin measured 6 and 12 hours postop and post op days 1-3.	-502 patients > 45 years old taken from VISION study who underwent vascular surgery between August 2007-January 2011	-Roche 4 th generation Elecsys TnT assay >0.03 ng/mL	-19% of patients developed MINS. 74% were asymptomatic. 42% fulfilled universal definition of MI. -12.5% mortality rate in MINS patients within 30 days of surgery.	-↑ age -Atrial fibrillation -CHF -CAD -Renal dysfunction -Higher mean preoperative heart rate	-No baseline troponin	Level III Grade B	Troponin surveillance detects MINS in approximately 20% of patients having vascular surgery and MINS is independently associated with 30-day mortality.

Brown et al. (2017)	<p>-Ancillary prospective observational study to the VINO Trial (a double-blinded, randomized RCT) -Single-center study -Troponin measured before surgery, at the end of surgery, and postoperative days 1-3 or until discharge.</p>	<p>-605 patients predominantly undergoing vascular and orthopedic surgery. -Mean age of 65 ± 11</p>	<p>-Roche Elecsys 2010 hsc-TnT (men: ≥14.5 ng/dL, women: ≥ 10 ng/dL, or >50% postoperative hscTnT rise from baseline) -Siemen Dimension RxL cTnI (0.07 ug/L) -Both assays were used to compare detection rates</p>	<p>-22.2% of patients had MINS. 11% of patients were diagnosed with MI of which 70% had no symptoms. -6-month mortality was increased 3 to 5-fold when patients experienced a postoperative hscTnT increase. -hs-cTnT increased detection of postoperative myocardial injury when compared to cTnI.</p>	<p>-CAD -Kidney disease -Heart failure -Previous MI -History of CABG/PCI</p>	<p>-Single center study -Absolute or relative change metrics are arbitrary.</p>	<p>Level III Grade B</p>	<p>hscTnT assay improves incidence rate of diagnosed perioperative MI compared to cTnI assay by about a 2-fold increase.</p>
Coetzee et al. (2018)	<p>-Prospective observational single-center cohort study -Troponin analyzed within 24 hours after surgery. 10% of patients had 2nd level drawn within 72 hours after surgery.</p>	<p>-301 patients ≥ 45 years old undergoing intrabdominal, noncardiac thoracic, joint replacement, major orthopedic, and vascular surgery. - Groote Schuur Hospital in South Africa from November 2014 to February 2016</p>	<p>-Roche 5th generation hs-cTnT assay ≥33 ng/L</p>	<p>Incidence of MINS was 4.9%</p>	<p>There was inadequate data to perform multivariate regression analysis to investigate associations between risk factors and MINS.</p>	<p>-Single center study -Small sample size -No baseline troponin -Not all patients had 2nd level drawn (MINS may have been missed)</p>	<p>Level III Grade B</p>	<p>Data suggests postoperative troponin surveillance is necessary in elevated risk noncardiac surgical patients in South Africa.</p>

Devereaux et al. (2017)	<p>-Prospective observational cohort study</p> <p>-International, multi-center study</p> <p>-Troponin was measured 6-12 hours postoperatively and on days 1,2, and 3 after surgery.</p> <p>-ECG for ↑ troponin</p> <p>- 30 day follow-up</p>	<p>-Over 21,000 patients ≥ 45 years old undergoing noncardiac surgery (primarily orthopedic and major general) from October 2008-November 2013</p>	<p>-Roche 5th generation Elecsys hsTnT assay</p> <p>≥14 ng/dL</p>	<p>-18% of patients had MINS. 21.7% of MINS patients were diagnosed with MI of whom 68% of patients did not experience any ischemic symptoms.</p> <p>-↑ cardiovascular complications within 30 days of surgery with hsTnT ≥ 20 ng/dL.</p>	<p>-Not specified</p>	<p>-Baseline troponin done in only 40.4% of patients</p> <p>-Arbitrary criteria for prognostically important hsTnT elevation.</p>	<p>Level III Grade B</p>	<p>Data supports that MINS does not require the presence of an ischemic feature and elevated postoperative troponin levels with and without an ischemic feature were both associated with increased risk of 30-day mortality.</p>
Duceppe et al. (2019)	<p>-Retrospective observational cohort study</p> <p>-Data collected from medical records from patients with at least one postoperative troponin level within 3 days after surgery</p>	<p>267 patients ≥18 years old undergoing EVAR in two tertiary care centers in Canada and Poland.</p>	<p>-Ultra-sensitivity troponin I Vidas ≥19 ng/L</p> <p>-non-high sensitivity troponin I Vidas ≥0.01 ug/L</p> <p>-hsTnT ≥20 ng/L</p> <p>-non-hsTnT ≥0.03 ng/mL</p>	<p>-Myocardial injury occurred in 29.2% of patients of which 23.1% met the Universal Definition of MI.</p> <p>-The majority of patients with MI did not experience ischemic symptoms or ECG changes.</p>	<p>-↑ age</p> <p>-RCRI score ≥ 3</p> <p>-ASA 4 status</p> <p>-Duration of surgery</p> <p>- Perioperative drop in hemoglobin</p> <p>*Based on multivariate analysis</p>	<p>-Retrospective study</p> <p>-No baseline troponin</p> <p>-Serial troponin measurements not done</p> <p>-Different types of troponin assays used</p>	<p>Level III Grade B</p>	<p>Majority of patients with myocardial injury do not experience any symptoms and thus would be missed without routine troponin monitoring.</p>

Ekeloef et al. (2020)	<p>-Retrospective single center observational cohort study -Data collected from medical records. -Troponin was measured daily on postoperative days 1-3 as part of standard protocol in hospital. -ECG if ≥ 45 ng/L</p>	<p>401 patients ≥ 18 years old who underwent major emergency abdominal surgery in Zeeland University Hospital between February 2017 and January 2019.</p>	<p>-Siemens Healthcare Dimension Vista cTnI assay ≥ 45 ng/L</p>	<p>-24.4% of patients had MINS within 3rd postoperative day. -11.2% of MINS had an in-hospital MI and none of these patients had any ischemic subjective symptoms</p>	<p>-*\uparrow age -RCRI score ≥ 2 -HTN -Previous MI *Confirmed by multivariate analysis</p>	<p>-Retrospective study -Single center study -No baseline troponin</p>	<p>Level III Grade B</p>	<p>Monitoring troponin levels after major emergency abdominal surgery can identify patients at high risk of postoperative mortality and could potentially improve risk stratification after surgery.</p>
George et al. (2018)	<p>-Prospective single center observational cohort study -Troponin measured at 12 and 24 hours after surgery, and 48 hours postoperatively if clinically indicated -ECG performed -30 day follow-up</p>	<p>-1075 patients ≥ 45 years old with at least one comorbidity (diabetes, HTN, CAD, CVA, PVD) and ≥ 65 years old w/ or w/o comorbidities. Chronic renal failure excluded. - Elective noncardiac surgery - Amerita Institute of Medical Sciences in India 2015-2016.</p>	<p>-ARCHITECT stat hs-TnI assay (Abbott) ≥ 0.03 ng/dL</p>	<p>-MINS was diagnosed in 17.5% of patients. 67% of these patients did not have ECG changes. -11.7% of patients with MINS expired compared to 2.5% of patients without MINS -Mortality was reduced in patients who received postoperative aspirin.</p>	<p>-\uparrow age -*Diabetes -*CAD -History of CVA -*Peripheral nerve block anesthesia *Confirmed by multivariate analysis</p>	<p>-No baseline troponin -Single center study</p>	<p>Level III Grade B</p>	<p>Use of standard criteria for MI alone would have missed the diagnosis of prognostically relevant myocardial injury in 67% of patients. This supports the need to implement a screening protocol for MINS.</p>

Gorgun et al. (2016)	-Prospective observational cohort study -Troponin measured within 24 and 48 hours after surgery - ECG if troponin > 0.01 ng/mL -Follow-up at 30 days and 1 year	-1020 patients > 45 years old undergoing major colorectal surgery. -Single tertiary institution from March 2015 to January 2016.	-Roche 4 th generation troponin T assay > 0.01 ng/mL	-5% of patients had MINS with only 16% exhibiting symptoms -6% of MINS patients were diagnosed with MI -20% of MINS patients expired within 1 year with 70% of mortalities occurring in troponin concentrations ≥ 0.03 ng/mL	-↑ age -Male -CAD -Diabetes -Renal insufficiency -ASA 4 status -Cancer	-Single center study -No baseline troponin	Level III Grade B	Troponin elevation may not only be an indicator of cardiac or vascular complications, but rather an indicator for all-cause mortality. It can identify patients with poor functional reserve who are at high mortality risk due to underlying medical comorbidities.
Grobben et al. (2016)	-Retrospective observational cohort study -Data obtained from medical records -All patients had routine troponin levels drawn on postoperative days 1,2, and 3 -30 day and 1 year follow-up	225 patients ≥ 60 years old undergoing CEA performed under general anesthesia. Patients undergoing CEA combined with cardiac surgery were excluded. Tertiary referral center between January 2011 and December 2013.	-3 rd generation AccuTnI assay > 60 ng/L	-15% had ↑ postoperative troponin -NSTEMI diagnosed in 24% of patients with troponin elevation -75% of diagnosed MIs were silent -MACE occurred in 29% of patients with elevated troponin vs. 6% without	- ↑ age -Renal failure -Stroke as clinical indication of CEA -Type of closure	-Retrospective study -Single center study -No baseline troponin	Level III Grade B	Troponin elevation after CEA occurred in 1 in 6 patients and troponin elevation was associated with higher incidence of major adverse cardiovascular events.

Huang et al. (2018)	<p>-Retrospective observational cohort study -Data obtained from medical records -Troponin levels were not routinely performed for all patients, only for patients who had identified risk factors, intraoperative events, or symptoms and events after surgery.</p>	<p>-285 patients ≥ 65 years old undergoing abdominal surgery longer than 2 hours. -National Center of Gerontology in Beijing, China between January 2016 and March 2017.</p>	<p>-Roche electro-chemiluminescent troponin I assay ≥ 0.04 ng/mL</p>	<p>-12.6% with troponin elevation -0.7% of total patient diagnosed with MI</p>	<p>-CAD -Infection before surgery -blood loss > 800 mL -non-venous maintain -non-laparoscopic surgery *Confirmed by multivariate analysis</p>	<p>-Retrospective study -Single center study -Troponin levels not routinely collected for all patients</p>	<p>Level III Grade B</p>	<p>Myocardial injury is common in elderly patients undergoing abdominal surgery. Troponin elevation in elderly patients, especially within the first 7 days after surgery may aid in the risk stratification and prognostic assessment.</p>
Puelacher et al. (2018)	<p>-Prospective observational cohort study -Troponin measured before surgery and on postop days 1 and 2 -ECG for elevated troponin levels</p>	<p>-2018 patients undergoing noncardiac surgery (visceral, orthopedic, trauma, vascular, urologic, spinal, and thoracic) ≥ than 65 years old or ≥ 45 years old with history of CAD, PAD, or stroke. -University Hospital in Basel, Switzerland in October 2014.</p>	<p>-Roche Elecsys hsTnT assay ≥14 ng/L increase above preoperative levels</p>	<p>-13.4% of patients had MINS and 82% of these patients did not show any ischemic symptoms and chest pain was only present in 6% -29% of patients with MINS fulfilled criteria for MI -30 day mortality ↑ 6-fold with MINS.</p>	<p>-↑ age -CAD -Previous MI -CHF -Atrial fibrillation -Valvular heart disease -PAD -Diabetes -HTN -↑ RCRI score -nonelective surgery</p>	<p>-Single center -Arbitrary delta values used to define myocardial injury</p>	<p>Level III Grade B</p>	<p>MINS is common after noncardiac surgery and is associated with substantial short- and long-term mortality. Mortality is comparable in patients with MINS not fulfilling any other additional criteria required for spontaneous AMI versus those with at least 1 additional criterion.</p>

Szczeklik et al. (2017)	<p>-Prospective observational cohort study</p> <p>-ECG and troponin on admission</p> <p>-Additional troponin levels measured 3-6 hours after surgery and following morning.</p> <p>-ECG repeated for elevated troponin.</p>	<p>-239 patients ≥45 years old undergoing endovascular revascularization.</p> <p>-Single center study at Jagiellonian University Hospital in Krakow, Poland between the years of 2013-2015.</p>	<p>-Roche Elecsys hsTnT assay ≥ 14 ng/dL</p>	<p>-Myocardial injury in 25.5% of patients.</p> <p>Only 14.8% of these patients had any clinical symptoms or ECG changes.</p> <p>-50% of all patients who died in 1st year had myocardial injury</p>	<p>-↑ age</p> <p>-CHF</p> <p>-beta blocker use</p> <p>- ↑ WBC (infection?)</p> <p>-↓ eGFR</p> <p>-↓ Hgb</p> <p>-↑ baseline CRP, BNP, and hsTnT</p>	<p>-Single center</p> <p>-a priori specified thresholds</p>	<p>Level III Grade B</p>	<p>Almost 25% of critical limb ischemia patients have MINS after endovascular treatment.</p> <p>Routine troponin monitoring is necessary in these patients, as opposed to symptom-initiated troponin surveillance due to only a minority of patients experiencing clinical symptoms.</p>
Thomas et al. (2016)	<p>-Prospective observational ancillary study to an RCT.</p> <p>-Troponin samples were drawn for all patients preoperatively and at 6, 12, 24, and 48 hours postop.</p>	<p>-85 patients undergoing major vascular surgery such as open AAA repair, open lower limb perfusion, or EVAR.</p> <p>-Mean age: 74</p>	<p>-Roche hsTnT assay ≥ 14 ng/L</p>	<p>-46% of patients had significant troponin elevation</p> <p>-5% of patients were diagnosed with MI characterized by chest pain or ECG changes</p>	<p>-↑ age</p> <p>-ASA 3 or 4</p> <p>-intra-abdominal vascular surgery</p>	<p>-Small sample size</p> <p>-Mandatory ECG monitoring was not performed for all patients with elevated troponin</p>	<p>Level III Grade B</p>	<p>-High incidence of myocardial injury in vascular patients undergoing surgery.</p> <p>-A preoperative hsTnT may be useful so that each patient has a reference point to calculate any meaningful increase, that way an acute event can be distinguished from a chronic, stable elevation.</p>

van Waes et al. (2016)	-Prospective observational cohort study -Troponin was measured daily on the first 3 days after surgery. - 1 year follow-up	-3,224 patients aged ≥ 60 yrs of age undergoing intermediate to high-risk noncardiac surgery (intrabdominal, intrathoracic, suprainguinal vascular surgery, and emergency surgery) - University Medical Center in Utrecht, The Netherlands between January 2011 and December 2012.	-3 rd generation AccuTnI assay > 0.06 ug/L	-22% of patients had MINS -MI occurred in 14% of patients with MINS -26% of patients with MINS died within 1 year of surgery compared to 13% of patients without MINS.	-↑ age -Previous MI -Heart failure -Renal failure -PVD -↑ ASA Status -Emergency surgery	-No baseline troponin	Level III Grade B	Myocardial injury as detected by routine troponin measurements is associated with 1-year mortality.
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Appendix E: QI Educational Module

An Educational Intervention
on the Role of Perioperative
Troponin Monitoring in
Adult Patients Undergoing
Noncardiac Surgery

By: Araceli Plancarte, RN
Jorge Valdes, DNP, CRNA, APRN

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- Understand the background and pathophysiology of myocardial injury after noncardiac surgery (MINS)
- Identify risk factors most commonly associated with MINS
- Acknowledge the role of perioperative troponin monitoring in identifying MINS

Objectives

Background of Problem

Myocardial injury after noncardiac surgery (MINS) is described as myocardial injury due to ischemia in the postoperative period unrelated to a noncardiac cause, such as sepsis or pulmonary embolism.

MINS is a common perioperative complication present in up to 25% of patients healing from noncardiac surgery and is associated with both long-term and short-term implications.

MINS is associated with increased morbidity, longer hospitalization, and 30-day mortality.

The asymptomatic nature of MINS presents a challenge in identifying patients despite its common occurrence.

80% of patients with MINS may go unrecognized without proper surveillance and monitoring in place.

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Pathophysiology

Patients who sustain MINS are predominantly asymptomatic and do not meet the conventional criteria for myocardial infarction (MI).

Describes a non-ST elevation type of ischemia attributable to a prolonged imbalance between myocardial oxygen supply and demand.

Differs from classic ST-elevation MI which is more likely to be due to an atherosclerotic event and plaque rupture.



Patients undergoing surgery have an elevated stress response and are prone to acute blood loss, pain, hemodynamic instability, and hypercoagulability in the perioperative period, leaving them vulnerable to ischemic events.

These factors are thought to account for MINS and its common presentation within the first three days after surgery.

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Who is at risk for MINS?


- Age is considered a significant risk factor with older patients > 65 years of age at greatest risk
- History of CAD, CHF, previous history of MI, and atrial fibrillation
- Diabetics have a 2.2-fold increased risk of sustaining myocardial injury
- Patients with chronic kidney disease and eGFR < 60 mL/min
- High incidence of MINS in patients undergoing vascular and urgent/emergent surgery compared to other types of noncardiac surgery


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Role of Perioperative Troponin Monitoring

- Perioperative evaluation of cardiac biomarkers such as troponin strongly predict the occurrence of major adverse cardiovascular events (MACE) after surgery.
- Elevated troponin levels in the postoperative period have been indicated as the most compelling predictor of 30-day mortality after surgery and is associated with higher 30-day rates of MACE.
- Identifying those patients at high risk for cardiovascular injury in the perioperative period and careful monitoring of perioperative cardiac biomarkers is crucial in providing early intervention and preventing death and disability.




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Current Practice

- The ACC/AHA recommendations currently question the usefulness of standard perioperative troponin measurements, even in those patients deemed high-risk.
- This is attributed to the lack of a specified management strategy for MINS.
- Currently, measurement of troponin levels is advised only when signs or symptoms indicative of myocardial ischemia or MI are present.
- Unfortunately, MINS is often ASYMPTOMATIC.
- Routine postoperative troponin screening is the only reliable way to detect MINS.



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Recommendations for Practice


A growing body of evidence-based research is challenging current guidelines, advocating for the use of perioperative troponin monitoring.

Anticoagulants and HMG-CoA reductase inhibitors have been associated with reduced morbidity and mortality in patients with MINS.

Given the evidence suggesting that available treatments may reduce morbidity and mortality in patients diagnosed with MINS, it would be prudent to routinely measure troponin levels on postoperative days 1-3 in patients ≥ 65 years old and/or with known risk factors such as CAD or diabetes.

As more research continues to be conducted on management strategies for MINS, cardiac consultation in patients who have sustained MINS should be strongly considered so appropriate individualized therapy may be implemented.

Routine monitoring prevents a missed opportunity to provide beneficial intervention to high-risk individuals.



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While the cost of troponin monitoring is relatively inexpensive, follow-up diagnostic tests and consultations in patients with elevated troponin must also be considered.

However, given the high incidence of MINS and the poor prognosis of these patients, the cost associated with postoperative complications would be far greater without timely identification.

Mantha and colleagues reported troponin surveillance to have an incremental cost-effectiveness ratio of \$12,641 per quality-adjusted life year (QALY), considering it a cost-effective measure when interpreted against a threshold value of \$50,000/QALY.

COST ANALYSIS





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Summary

- MINS is a common event following major noncardiac surgery, which often goes unrecognized due to its asymptomatic presentation.
- MINS is associated with increased morbidity and mortality within 30 days of surgery, resulting in significant utilization of healthcare resources.
- Routine postoperative troponin monitoring is the only reliable way to detect myocardial injury after noncardiac surgery but is currently not standard practice.
- Defined management strategies for MINS continue to be researched, providing support for the usefulness of troponin surveillance.
- Early identification of myocardial injury through routine troponin surveillance allows appropriate interventions to take place, potentially reducing morbidity and mortality following noncardiac surgery.



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