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# IMPLEMENTATION OF AMERICAN COLLEGE OF CARDIOLOGY / AMERICAN HEART ASSOCIATION CARDIOVASCULAR EVALUATION GUIDELINES FOR PATIENTS HAVING NON-CARDIAC SURGERY

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UNIVERSITY OF NORTHERN COLORADO

Greeley, Colorado

The Graduate School

IMPLEMENTATION OF AMERICAN COLLEGE OF CARDIOLOGY/  
AMERICAN HEART ASSOCIATION CARDIOVASCULAR  
EVALUATION GUIDELINES FOR PATIENTS HAVING  
NON-CARDIAC SURGERY

A Scholarly Project Submitted in Partial Fulfillment  
of the Requirements for the Degree of  
Doctor of Nursing Practice

Robert Stanley Leeper

College of Natural and Health Sciences  
School of Nursing  
Nursing Practice

August 2020

This Scholarly Project by: Robert Stanley Leeper

Entitled: *Implementation of American College of Cardiology/American Heart Association Cardiovascular Evaluation Guidelines for Patients Having Non-Cardiac Surgery*

has been approved as meeting the requirement for the Degree of Doctor of Nursing Practice in the College of Natural and Health Sciences, in the School of Nursing, Program of Nursing Practice.

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## **ABSTRACT**

Leeper, Robert S. *Implementation of American College of Cardiology/American Heart Association Cardiovascular Evaluation Guidelines for Patients Having Non-Cardiac Surgery*. Unpublished Doctor of Nursing Practice Scholarly Project, University of Northern Colorado, 2020.

Anesthesia outcomes in non-cardiac surgery are dependent upon recognition of cardiovascular disease, estimating functional capacity, the status of existing co-morbidities, and degree of end-organ disease. Anesthesia providers in a rural surgery center identified an increase in the number of patients coming to the surgery center with unstable cardiovascular conditions, resulting in delayed start-times, postponements, and cancellations. The broader objective for this anesthesia quality improvement project was greater patient access, improved quality of life, and safer delivery of anesthesia.

Anesthesia providers' cardiovascular evaluation methodology was updated by providing education for anesthesia staff including implementation of recommendations and protocols in the current American College of Cardiology/American Heart Association (Fleisher et al., 2014) guidelines. According to the guidelines, anesthesia providers could greatly reduce the number of surgical start-time delays or cancellations due to unstable cardiovascular conditions on the day of surgery. Following evidence-based guideline recommendations and cardiac assessment tools, anesthesia providers were able to minimize the probability of major adverse cardiac events. Quality anesthesia care was enhanced by pre-operative identification of active cardiac disease, estimation of functional capacity using the Duke Activity Status Index (Hlatky et al.,

1989) and a cardiac risk calculator, the Revised Cardiac Risk Index (Lee et al., 1999).

The primary objective for this anesthesia quality improvement project was greater patient access, safer anesthesia delivery, and improved quality of life. Donabedian's (1990) structure-process-outcome model provided the framework for this clinical practice quality improvement.

*Keywords:* active cardiac disease, major adverse cardiac events, functional capacity, cardiac risk stratification.

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## **DEDICATION**

I dedicate this project to all who entrust the care to a nurse anesthetist. To all of the hardworking medical professionals who willingly take on new challenges, enjoy learning, and are always treating patient with their servant's heart. And for those who are willing to tirelessly dedicate themselves to others, I respect and admire you!

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## **LIST OF ABBREVIATIONS**

A-fib	Atrial fibrillation
ACS	American College of Surgery
AHA	American Hospital Association
ASA	American Society of Anesthesiologist
DASI	Duke Activity Scale Index
EMR	Electronic Medical Record
MACE	Major adverse cardiac event
PACU	Post-Anesthesia Care Unit
RCRI	Revised Cardiac Risk Index

## **CHAPTER I**

### **BACKGROUND AND SIGNIFICANCE**

Surgery provides an opportunity for a person to alleviate disease or reduce pain and carries a variable degree of risk for increased morbidity and mortality from perioperative major adverse cardiac events. Nearly 27 million surgeries are performed each year in the United States and eight million patients (more than 30%) have coronary artery disease. Perioperative major adverse cardiac events are defined as “unintended injuries or complications caused by medical management rather than by the underlying disease leading to death, disability, or prolonged hospital stays” (Jaderling & Bellomo, 2016, p. 21).

Patients with existing cardiac disease including previous myocardial infarctions are presenting to primary care requesting non-cardiac surgery. Previous history of myocardial infarction elevates the risk of future adverse myocardial events (Padma & Sundaram, 2014). The highest risk comes from coronary artery disease, heart failure, major valvular disease, and persistent dysrhythmias. In fact, if perioperative deaths were considered a separate national incidence category, “it would rank as the third leading cause of death in the United States” (Devereaux & Sessler, 2015, p. 2258).

Using American College of Cardiology/American Heart Association (ACC/AHA; 2014) clinical practice guidelines while caring for cardiovascular patients pre-operatively has shown an advantage in the ability to modify and optimize chronic conditions before the day of surgery. Cardiovascular assessment includes past and present medical history,

physical examination, any laboratory studies, and possible cardiac ultrasound, or cardiac stress testing. Low-risk surgeries might have information collected from past and present health histories and then proceed to surgery. Medium and high-risk patients need detailed pre-anesthesia cardiovascular evaluation to determine pharmacy currency, physical stamina, or estimation of functional capacity to contribute to an understanding of the overall probability of survival.

Cardiovascular risk assessment in primary care, generally the first medical contact a patient meets, collects information specifically about family history, genetics, surgical history and personal risk factors for cardiovascular disease. Risk assessment is a well-established clinical activity taught to all who are in clinical medicine and nursing (Coviello, 2020). Risk factors are personal characteristics or disease and some patients are asymptomatic. Other patients have progressed to end-organ damage. One example would be a 42-year old male patient who rarely seeks medical attention and is requesting hernia surgery; he might state he has no medical problems and might easily be passed on by anesthesia providers to schedule for surgery unless inquiry about immediate family history has been performed. Patients seen in primary care require in-depth questioning to ferret out potential morbidity. In the above example, the patient's father at age 44 and his younger brother at age 47 died from sudden cardiac death. Both male relatives had hyperlipidemia resistant to therapy. Until anesthesia practitioners look at a thorough cardiac risk assessment as a quality preventive care, morbidity and mortality would more likely rise before going down. Clinicians who perform incomplete risk assessments personally increase the risk of patients having surgery. Performing a cardiac risk

assessment without disease identification has been considered an oversight due to lack of knowledge or the clinician's unfamiliarity with current guidelines (Coviello, 2020).

Anesthesia providers have been taught how to perform cardiovascular evaluations but after graduation and practicing for a short time, they trust their own subjective opinion to conclude whether or not a patient is healthy enough to proceed to surgery. Subjective assessments (no assessment tools) have significant limitations including poor agreement with actual quantitative measures of functional capacity (Wijeysundera et al., 2018). Inaccuracy of subjective estimates of functional capacity results in an inaccurate estimation of post-operative morbidity and mortality. Assuming patients are healthy enough for non-cardiac surgery (NCS) without obtaining objective evidence increases the potential for catastrophic outcomes (human error).

Co-morbidities associated with cardiovascular disease are hypertension, hyperlipidemia, diabetes, renal insufficiency (creatinine > 2.0 ml/dl.), atrial fibrillation, and heart failure (Fleisher et al., 2014). Patients with advanced cardiovascular co-morbidities have a higher likelihood of a perioperative major adverse cardiac event. According to Fleisher (2010), the general assumption after performing a preanesthesia evaluation is the patient will do well; however, establishing a baseline of empirical data points from a patient's chart does not ensure a satisfactory outcome.

Anesthesia quality improvement centers on minimizing patient risk especially from major adverse cardiac events. The frequency and degree of active cardiac disease, unstable angina, valvular disease, recent coronary infarction, heart failure, or stroke play a significant role in cardiac evaluation (Cohn & Fleisher, 2019; see Appendix A). Cardiovascular risk assessment requires a critical look at the combination of patient risk,

type of surgery, and anesthesia risk. The combined risk assessment is referred to as risk stratification.

### **National, Regional, and Local Statistics**

An estimated 310 million patients worldwide have major noncardiac surgery each year and a staggering 10 million people develop some type of cardiovascular complication within 30 days after surgery (Kaw et al., 2019). Perioperative major adverse cardiac events (MACE) are defined as myocardial infarctions, strokes, or death in the perioperative period and within 30 days after surgery.

Cardiovascular disease, heart disease, and stroke are the number one and number three leading cause of death in Texas accounting for 22.9% of deaths according to the Texas Department of State Health Services (2017). The first sign of heart disease frequently is sudden cardiac arrest. In Texas between 2005 and 2010, the most common risk factors of hypertension, diabetes, hyperlipidemia, and renal insufficiency increased in prevalence (Texas Department of State Health Services, 2017).

This project's rural area of Texas has a higher percentage of cardiovascular disease per capita than other parts of the state according to prevalence data for chronic diseases at the county level. In 2015, deaths due to major cardiovascular disease were 207 per 100,000 and 89.1 per 100,000 were specifically from ischemic heart disease. Many of these same individuals saw a practitioner and requested surgery. In a six-month retrospective review of 370 patients in 2018 in our rural surgery center, 16 cases (4.3 %) were not able to start on time, were rescheduled, or were cancelled because of unstable cardiovascular-related issues on the day of surgery. Patients considered not within acceptable limits at the time of surgery had hypertension, hypothyroidism, and new



onset-rapid rate atrial fibrillation. One patient was found to have not followed the surgeon's instruction to hold anticoagulants.

Another patient had a fasting blood sugar near ketoacidotic level (from department administrative report). Improving the practitioner's methodology performing cardiac evaluation, estimating exertional tolerance, and providing clear pre-operative instructions would decrease the numbers of delayed start-time and safely proceed to surgery. Determining the presence of co-morbidities, assessing functional capacity, and performing cardiac risk stratification in a consistent step-wise method is essential to improving decision-making before non-cardiac surgery.

Patients under anesthesia are insensitive to anginal pain as well as when in post anesthesia care units. The patient might have received multimodal pain therapy including opiates, blunting the sensation of chest pain (Magoon, Makhija, & Das, 2020). This type of silent myocardial ischemia associated with NCS has become prevalent enough to coin the term myocardial injury after non-cardiac surgery or MINS. Asymptomatic cardiac patients are more likely to have specific treatment delayed and even more likely to be discharged after surgery without recognizing myocardial damage occurred.

#### **2014 American College of Cardiology/ American Heart Association Cardiac Evaluation Guidelines**

An estimated 50,000 patients in the United States experience perioperative myocardial infarction and one million have some type of major cardiovascular event each year (Thoelke, Johnson, & Atwood, 2020). The 2014 ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation guidelines were developed to assist practitioners in understanding perioperative cardiac risks associated with various cardiac disease states

and best-practices for timing of cardiac evaluations, interpreting clinical data, and timing of optimizing cardiac patients before surgery (see Appendix B). The guidelines provided an evidence-based roadmap for clinicians to improve care of cardiac patients having NCS. There was as much importance placed on when to delay surgery as there was when to order additional cardiac testing or when to safely proceed to surgery. The ACC/AHA guidelines provided recommendations for performing an acceptable past and present medical history, physical examination, cardiac risk assessment with the Revised Cardiac Risk Index (RCRI; Lee et al., 1999), and estimation of functional capacity using the Duke Activity Status Index (DASI; Hlatky et al., 1989).

However, coronary artery disease is not the highest major cause of perioperative mortality. In a study using Medicare patient claims database, the risk-adjusted perioperative complication within less than 30 days after non-cardiac surgery was due to history of heart failure. The 30-day post-operative mortality was higher in patients with non-ischemic heart failure (9.3%) than ischemic heart failure (9.2%) and atrial fibrillation (6.2%) than patients with coronary artery disease (2.3%; Fleisher et al., 2014). Patients should be assessed for the presence of jugular distension, peripheral edema, a third heart sound, and rales to rule out heart failure (Fleisher et al., 2014).

The 2014 ACC/AHA (Fleisher et al., 2014) guidelines included research on atrial fibrillation, cardiac ischemia, heart failure, bundle branch block, implanted electronic devices, left ventricular ejection fraction, myocardial infarction, perioperative pain management, and volatile anesthetics. In a large population-based study of 38,047 patients, the 30-day postoperative mortality was higher in non-ischemic patients with heart failure than those with coronary artery disease (Fleisher et al., 2014). Heart failure

has a much higher degree of morbidity and mortality than coronary ischemia and could be harder to recognize.

Strong recommendations were given for echocardiogram measurement of flow rates in patients with heart failure symptoms to establish compensated or uncompensated ejection fractions. Patients with valvular disease should also have echocardiogram studies to determine the degree of valvular stenosis or regurgitation. Pre-anesthesia evaluation in patients with valvular disease should be focused upon type and severity of valvular heart disease (Fleisher et al., 2014). Using the DASI and RCRI would help providers focus on objective cardiac evaluations. Evidence in the ACC/AHA (Fleisher et al., 2014) cardiac evaluation for guidelines construction included many Class II-a or II-b evidence (expert opinion suggesting more benefit than risk) than evidence-based Class Ia or I-b level of evidence.

### **Revised Cardiac Risk Index**

Goldman et al. (1977) developed a risk assessment calculator recommended in earlier ACC/AHA (Fleisher et al., 2014) guidelines. The Cardiac Risk Index was updated by Detsky et al. (1986) and then modified by Lee et al. (1999) who developed the RCRI to predict the potential for serious cardiac complications associated with surgery (see Appendix C). Lee et al.'s Index uses five independent variables, two fewer than Goldman's original index including ischemic heart disease, heart failure, chronic renal failure (creatinine > 2.0 dl./ml.), diabetes mellitus, and cerebrovascular disease. Each of the variables is assigned one point and when totaled, a low-risk is 0 – 1, moderate-risk is 2 – 3, and high-risk is > 3. In the ACC/AHA current guidelines, the three categories are associated with a percentage risk of major adverse cardiac events: low risk < 1%

probability, intermediate risk, or high risk > 1 % probability of MACE. Lee et al.'s Risk Index has been shown to be highly accurate in identifying lower risk patients who might not benefit from further cardiac testing (Vats, Marbaniang, & Howell, 2016). Higher scores should be considered a significant risk for major adverse cardiac events.

The ACC/AHA (Fleisher et al., 2014) guidelines' step-wise algorithm for evaluation in the perioperative period could be used in protocol development or used in individual patient evaluation. In non-emergency surgery patients with significant or unstable cardiac conditions (pulse, pressure, or rhythm), the RCRI (Lee et al., 1999) could provide the anesthesia provider with an early estimate of the types of risk the patient was likely to have medical issues with that could suggest high risk of myocardial ischemia of infarction. Low cardiac risk of < 1% would not need further testing and patients with high risk > 1% probability of MACE should have functional capacity estimated.

The incidence of perioperative morbidity and mortality in patients with coronary artery disease is dependent upon the definition of myocardial ischemia. In the perioperative setting, a diagnostic electrocardiogram ST and non-ST elevation should be confirmed using cardiac biomarkers such as troponin elevation and not just the classic physical signs of angina. A large study of 15,133 patients over age 50 with non-cardiac surgery staying at least one night after surgery and using peak troponin-cTn value greater than 0.02 ng/mL occurred in 11.6% of patients. Of these patients, the 30-day mortality rate was 1.9% (95% confidence interval: 1.7 to 2.1%; Fleisher et al., 2014).

## **Duke Activity Status Index and Functional Capacity**

Being physically active is an important aspect of overall health as it helps reduce premature mortality and improves numerous risk factors for cardiovascular disease such as hypertension, diabetes, hypercholesterolemia, and stroke. Physical activity is referred to as functional capacity and is generally measured in metabolic equivalents (National Center for Health Statistics, 2019). The American Heart Association (Benjamin et al., 2019) described physical inactivity as a major independent risk factor for cardiovascular disease and stroke; patients with poor functional capacity have poor energy reserves and generally do not do well during surgery or while rehabilitating.

The DASI (Hlatky et al., 1989) provides a reliable estimate of how patients would respond to the increased stress of surgery and anesthesia and can be performed without invasive testing (see Appendix D). The DASI is a 12-question scale asking subjects about activities of daily living. The scale correlates well with peak oxygen uptake (Spearman correlation coefficient 0.80). In Hlatky et al.'s (1989) original research, an independent group of 50 subjects was asked to answer a self-administered questionnaire and take an exercise stress-test to determine functional capacity measured as peak oxygen uptake. The DASI correlated significantly ( $p < .0001$ ) with peak oxygen uptake (Spearman correlation coefficient 0.58). The DASI is a reliable and well-validated questionnaire to estimate functional capacity (Hlatky et al., 1989).

Elderly patients are more vulnerable to the stress of surgical procedures. Major adverse cardiac events in the elderly coincide with intra-operative blood pressure drops and patients taking beta-adrenergic blockers have a much slower recovery time to normal blood pressure (Lim & Lee, 2020). Many geriatric patients have at least some degree of

cardiac disease and over age 70 are at higher risk with significant physical limitations, sometimes referred to as frailty. Assessment of functional ability is vital to estimating postoperative outcome in these patients. Once functional capacity is estimated, the RCRI (Lee et al., 1999) calculator can assist with performing a cardiac risk stratification. These calculators assist in more accurate probability estimates of perioperative major adverse cardiac events—low risk ( $< 1\%$ ) from the high risk ( $> 1\%$ ; Glance et al., 2018).

In spite of the fact the DASI (Hlatky et al., 1989) has been in consistent use worldwide for over 30 years, there is still no defined index threshold that is prognostic for serious post-operative morbidity and mortality (Wijeysundera et al., 2020). A nested cohort study of 1,546 participants over 40 years of age with elevated cardiac risk having non-cardiac surgery was followed for a primary outcome of myocardial infarction within 30 days after surgery (Wijeysundera et al., 2020). Anesthesia practitioners in the pre-anesthesia clinic were responsible for subjectively estimating each patient's functional capacity based on personal routine of collecting pre-anesthesia history. Wijeysundera et al. (2020) noted less than 20% of individuals with seriously low functional capacity were being accurately assessed by the anesthesiologist. The DASI score ranges from 0—the worst functional capacity up to 58.2—excellent functional capacity (oxygen utilization). The study found a non-linear association between the DASI score at or below 34 was associated with serious cardiac outcomes (approximately 5 METs). The study provided supportive data for consistently using the DASI as an objective assessment of functional capacity rather than trusting only a personal subjective risk assessment (Wijeysundera et al., 2020).

## **American Society of Anesthesiologists Physical Status Classification**

The American Society of Anesthesiologists Physical Status (ASA-PS, 2019) classification system is a general estimation of patient's health (see Table 1). The ASA-PS is a simple subjective physical assessment with no patient outcome prediction capability.

Table 1

### *American Society of Anesthesiologists Physical Status Classification*

Classification	Description
ASA-I	Healthy individual
ASA-II	Mild to moderate disease by the surgical condition or by other pathological processes, well controlled
ASA-III	Severe disease process limiting activity but is not incapacitating
ASA-IV	Severe incapacitating disease process that is a constant threat to life
ASA-V	Moribund patient not expected to survive with or without surgery
ASA-VI	A declared brain-dead patient whose organs are being removed for donor purposes

The ASA-PS (2019) is a physical classification required of all anesthesia providers. There is a strong need for anesthesia providers to understand evidence-based cardiac evaluations and what each of the assessment tools are able to estimate so routines and habits avoid inadvertent omission of patient health conditions. The ASA-PS is not a risk assessment tool and does not provide any estimation of functional capacity.

Designation of emergency surgery includes adding an "E" after ASA class. Emergency

surgery is an independent risk factor for increased perioperative risk of cardiovascular complications regardless of initial base-line risk.

### **Statement of the Problem**

A major adverse cardiac event (MACE) is the leading cause of perioperative morbidity and mortality. The preanesthesia evaluation is the most important perioperative task to be completed before anesthesia starts. To some, evaluation might be the least favorite activity because it is not as interesting as the beat-to-beat administration of anesthesia during surgery. Many surgery centers are busy places dealing with the need to get started on time and get finished on time to make room for the next case.

Many of the efforts to identify and modify cardiac risk factors could improve outcome survival versus long-term disability or death. Risk prediction models are developed from very large datasets and provide statistical predictions about complex physical systems. Statistics often give the user some estimation of risk outcome reassurance and might even use percentage results as part of the patient's informed consent. Caution should be used when considering large population statistics and applying them to an individual patient's health risk. Cardiac evaluations have the potential to lower the incidence of a major adverse cardiac event when properly investigated through accurate history and physical exam.

Goldman et al.'s (1977) and Lee et al.'s (1999) cardiac risk research identified patients in the lower risk categories more readily. The American College of Surgeon's risk calculator's data collection was performed on patients scheduled for major surgery and RCRI research was done on patients with pre-existing cardiovascular co-morbidities having cardiac surgery accounting for why Lee et al.'s RCRI identified low risk patients



more readily than those at high risk. The benefit of having a simple to perform cardiac risk index taking only a few minutes without losing statistical strength is a significant benefit in the toolkit for getting patients safely to surgery.

Wijeyesundera et al.'s (2020) study concluded anesthesia providers were not accurate in subjectively assessing functional capacity in the pre-operative time period. There is just as good an argument for doing an in-depth history and physical on cardiac patients before surgery. Progressing through each step of the ACC/AHA (2014) cardiac evaluation algorithm is important so performing the RCRI (Lee et al., 1999) should not ever take the place of Step 1—doing a thorough history and physical on patients. Step 2 of the step-wise algorithm asks, “Is any significant or unstable cardiac condition present” so before proceeding to the next step, the history and physical need to be performed. The cardiac history, including family genetic history, is the foundation upon which the entire cardiac evaluation depends. Completing each of the steps gives medical information that is used in all of the other stages of evaluation and for understanding the probability of different intra-operative and post-operative complications to watch and prevent.

### **Project Purpose**

The purpose of this quality improvement project was to incorporate current national guideline-based recommendations for pre-anesthesia cardiac evaluation of patients having non-cardiac surgery. Adopting evaluation methodology into daily practice would elevate attention to activities performed by the anesthesia provider including careful history taking, auscultation of the heart and lungs, estimating functional capacity, administering guideline-directed medical therapies, and collaborating with the surgeon and perioperative team.

Evidenced-based anesthesia care within the surgery center would use specific clinical process and outcome indicators. Haller et al. (2019) performed a systematic literature review and identified 167 clinical outcome indicators. A final list of eight anesthesia outcome indicators were agreed upon and three of these were used in this project: perioperative myocardial infarction, death within 30 days of surgery, and stroke within 30 days of surgery as one composite indicator. These anesthesia quality outcome indicators have been validated extensively (Haller et al., 2019). Due to the very low expectation of a patient experiencing one of these outcomes, this statistic was combined into one composite score and referred to as MACE.

Anesthesia providers have been inconsistently estimating functional capacity or formally doing the risk stratification (Cohn & Fleisher, 2019). General health risk assessment of patients using the ASA (2019) status classification system was not specific and did not include estimation of functional capacity. Therefore, the ACC/AHA (Fleisher et al., 2014) guidelines recommended functional capacity be included separately from the ASA physical status in all patients before accepting an individual's readiness for the stress of non-cardiac surgery. Using the DASI (Hlatky et al., 1989) to identify high risk (0 to 4 METs) is simple and non-invasive. The RCRI (Lee et al., 1999) estimated specific cardiac risk using patient physical and metabolic attributes. The current national guideline recommends evaluating surgery-specific risks including degree of tissue disruption, blood loss, fluid shifts, and hemodynamic effects (Bierle, Raslau, Regan, Sundsted, & Mauck, 2019), when developing a cardiac patient's risk stratification.

### **Patient/Population, Intervention, Comparison, Outcome, and Time Question**

The following patient/population, intervention, comparison, outcome, and time (PICOT) question was answered in this study: Will adoption of the 2014 ACC/AHA *Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery* (Fleisher et al., 2014) in a rural surgery center improve anesthesia providers pre-anesthesia cardiac evaluation methods by consistent identification of high-risk cardiac patients using the RCRI (Lee et al., 1999) and estimation of functional capacity with the DASI (Hlatky et al., 1989) in adults aged 45 years and older, thereby minimizing the number of start-time delays, postponements, cancellations, and major adverse cardiac events compared to no change in practice over a one-month timeline?

### **Conclusion**

The risk associated with any surgery and potential benefit of performing surgery is dependent on many factors: an accurate and detailed history, identification of cardiovascular disease, and optimization of modifiable co-morbidities before the day of surgery. The patient having noncardiac surgery should receive a detailed assessment that searches for the presence of cardinal signs of cardiovascular disease. A cardiac assessment using standardized methodology to identify previous myocardial infarction, unstable angina, diabetes, uncontrolled hypertension, thyroid disease, hyperlipidemia, and renal insufficiency, rapid-rate atrial fibrillation, or valvular disease is needed.

The pre-anesthesia cardiac risk stratification process using the step-wise evaluation algorithm generally emphasizes using objective assessment tools like the RCRI (Lee et al., 1999) and the DASI (Hlatky et al., 1989). The RCRI asks about

specific cardiac physical conditions in the questionnaire including active history of coronary ischemia and history of congestive heart failure. Evidence from a Medicare claims database showed the risk of morbidity or mortality within 30 days after surgery in patients with heart failure was the highest risk with a 50 to 100% higher probability of death during non- cardiac surgery (Fleisher et al., 2014).

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **Historical Background and Significance**

Anesthesia providers historically performed very limited patient assessments before surgery. Interaction with a patient usually consisted of brief instructions “not to eat a meal before receiving chloroform,” (Frost, 2005, p. 80). The complexity of many types of surgery has increased, extending the total time under anesthesia. Longer procedures under anesthesia increase the possibility for perioperative complications including thrombus formation, metabolic changes, and depressed cardiac function. Responsibility for preparing patients for non-cardiac surgery includes having a well-developed perioperative plan with clear pre-operative instructions for patients and advanced planning for post-operative cardiac care.

In the consensus guidelines from the ACC/AHA (Fleisher et al., 2014), anesthesia providers are given a step-wise method of evaluation for patients having non-cardiac surgery. Practitioners not adopting the guidelines or performing limited or poorly executed cardiac evaluations could miss signs of coronary artery disease, valvular disease, or sub-clinical heart failure, leading to incorrect pre-operative medical management of patients.

Variability in methods of assessment or rushed timing of an assessment could inadvertently overlook serious disease. Placing a minimal priority on performing quality preanesthesia cardiac evaluations is still prevalent despite morbidity and mortality

statistics that have not improved dramatically for non-cardiac surgery. Performing quality pre-anesthesia cardiac evaluation has become so important that many researchers and guideline authors have promoted performing evaluations on all non-cardiac surgical patients 50 years of age and older and not just on patients with known cardiovascular disease (Cohn & Fleisher, 2019). Preanesthesia evaluations completed too close to the time of surgery, poorly performed, or omitted could adversely affect postoperative outcomes. Unlike patients undergoing heart surgery, cardiovascular lesions still exist after non-cardiac surgery, resulting in continued high risk of major adverse cardiac events (Bill, 2015).

A literature search was performed using the following electronic databases: PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL). The following search strategy was used for PubMed and CINAHL: peer-reviewed full-text journal articles written in the English language between 2014 to 2020 with keywords such as active cardiac disease, anesthesia risk, cardiac risk, pre-operative risk, cardiac evaluation, functional capacity, risk stratification, anesthesia mortality, anesthesia morbidity, and patient optimization. The initial topical search identified 7,462 articles. Potentially relevant articles accepted included systematic reviews, meta-analyses, clinical practice advisories, national guidelines, and observational studies. Abstracts were read and articles identified by criteria with evidence linkage to preanesthesia cardiac assessment or evaluation before non-cardiac surgery, shared decision-making, cardiac risk assessment, functional capacity estimation, or adverse anesthesia outcomes related to perioperative mortality and morbidity were included ( $N = 1,402$ ). Articles including children, or pediatric surgery, or pediatric cardiac abnormalities and patients having heart

surgery and major vascular surgery (neither are part of services at our facility) were excluded. One hundred twenty-eight articles were accepted for potential use and duplicates were excluded.

A commonly accepted thought in healthcare statistics has been mortality is a good measure of who dies but is a poor measure of who is delivering quality care. A significant gap in literature was identified regarding how often anesthesia providers performed quality care by how well cardiac evaluations were performed and the linkage to post-anesthesia outcomes (survival at 30 days postanesthesia and low morbidity). Residency programs do teach specific cardiac evaluation methodology and emphasize methods to follow in preanesthesia cardiac risk assessment before surgery. The most significant gap was after years of publishing research and national guidelines, there was still no evidence-based definition of best practices in performing a pre-anesthesia cardiac evaluation before non-cardiac surgery.

### **Pre-Anesthesia Evaluations**

Miller's (2000) *Anesthesia*, a landmark anesthesia textbook used in medical and nursing residency education as an anesthesia reference, explained the necessary elements of the preanesthesia evaluation by listing specific activities:

1. Obtain broad detailed information of a patient's physical and mental health,
2. Identify patient cardiac risk factors,
3. Assess functional capacity,
4. Practice perioperative comfort and pain management,
5. Identify risk factors for specific surgical procedures and type of anesthesia,

6. Discuss anesthetic plan in a shared decision-making process including patient and surgeon for informed consent.

Literature discussing preanesthesia cardiac evaluations with specific linkage to adverse postoperative outcome was sparse. Anesthesia residency programs teach cardiac evaluations to new medical and nurse anesthesia residents but over the years, preanesthesia evaluation national guidelines have not been totally translated into practice. In a web-based survey ( $N= 1,595$ ), actively practicing anesthesiologists were given several realistic practice scenarios involving preanesthesia evaluation of cardiac patients. Anesthesia residents who were instructed to follow the 2007 ACC/AHA (cited in Vigoda et al., 2012) guidelines were found to be in poor compliance with recommendations. Vigoda et al. (2012) concluded the 2007 ACC/AHA guidelines had been quoted over 400 times in research literature but estimated less than half of the anesthesiology residents nationwide applied the guideline step-wise algorithm consistently. In the past, therefore, residents were not performing cardiac evaluations even years after the updated ACC/AHA Guidelines were released (Vigoda et al., 2012). Following graduation and with gained experience, anesthesiologists showed resistance to using new evidence-based guidelines. The anesthesiologists believed they already knew all of what was needed to evaluate a cardiac patient. This biased assumption might provide insight into why many practitioners' continued resistance in following the 2014 ACC/AHA's (Fleisher et al., 2014) guidelines has not greatly reduced perioperative mortality.

Perioperative cardiac complications such as myocardial infarction and stroke can occur in patients with uncontrolled hypertension, coronary artery disease, and valvular disease when not recognized before the patient is administered anesthesia. Patients with



prior coronary angiography or cardiac stents should be questioned about the type of stent and the date stent(s) were placed. Patients with sustained cardiac arrhythmias such as atrial fibrillation should have the date of onset and the current heart rate documented as part of the detailed cardiac evaluation.

Anesthesia process improvement could use a pre-operative risk assessment tool to provide more objective estimation of cardiac risk. Cardiac risk is known to be elevated in patients with poor functional capacity expressed by measurement referred to as metabolic equivalents (METs). The most accepted functional capacity assessment tool is the Duke Activity Status Index (Hlatky et al., 1989). Patients who are specifically unable to exercise at  $> 4$  METs are in poor physical condition and at higher perioperative cardiac risk.

In a multicenter, international, prospective cohort study across 25 hospitals in Canada, United Kingdom, Australia, and New Zealand, Wijeyesundera et al. (2018) studied adults at least 40 years of age scheduled for major non-cardiac surgery. A physician's pre-operative subjective assessment of a patient's physical ability was compared to the results of objective markers of fitness, specifically cardiopulmonary exercise testing (CPET). The scores on the DASI indexed to serum N-terminal pro-B-type natriuretic peptide collected showed the physician's subjective preoperative risk assessment had very poor accuracy for estimating predictive risk of myocardial injury. Of the 1,401 patients enrolled in the study, 28 patients had died or had a myocardial infarction within 30 days after surgery (2%). The subjective assessment only had a 19.2% sensitivity (95% confidence interval, 14.2 – 25) and 94.7% specificity for identifying patients with very low functional capacity of 4 METs. The conclusion from

the study was clinicians should not rely on any subjective estimation of functional capacity but use the DASI for pre-operative risk evaluation (Wijeysundera et al., 2018).

Estimating functional capacity with the DASI translates to an estimation of oxygen utilization (Hlatky et al., 1989). Tang et al. (2014) studied the DASI's estimation of functional capacity, measured as peak oxygen consumption as well as related cardiac biomarkers, in stable cardiac patients. The research analyzed associations between cardiac metabolic biomarkers and the differential diagnostic value of high-sensitivity C-reactive protein (hsCRP), B-type natriuretic peptide (BNP), creatinine, fasting lipid profile, apolipoprotein-a1 and apolipoprotein-B, and the predictive value of the DASI for major adverse cardiac events. Adjusting for traditional risk factors present in all of the subjects, a positive correlation was found between lower DASI scores and a higher likelihood of coronary heart disease or peripheral arterial disease (Tang et al., 2014).

Surgeons and anesthesia clinicians might order exercise stress tests producing cardiac ischemia right before non-cardiac surgery. Wijeysundera et al. (2018) compared the non-invasive DASI (Hlatky et al., 1989) to patient performance on exercise treadmill myocardial stress perfusion imaging and concluded over 70% of patients scoring < 10 METs were unable to safely perform myocardial stress treadmill beyond stage two (7 METs). Wijeysundera et al. confirmed the DASI had a higher validity and specificity compared with a physician's estimation of functional capacity or stress testing and would be safer for the patient. Prevention of risks to cardiac patients with coronary artery disease could be achieved when using a non-treadmill assessment tool.

Visnjevac, Devari-Farid, and Lee (cited in Cohn, 2016) found a significant increase in perioperative complications and a 30-day mortality in patients with dependent

versus independent functional capacity. Visnjevac et al. assigned each level of the ASA (2019) classes into sub-groups: functionally independent, partially independent, or dependent. Outcomes had a higher likelihood of mortality in the physically dependent group. Visnjevac et al. showed functional capacity was the key element in the prediction of mortality when added to each ASA Class. Visnjevac et al. recommended increasing the ASA physical status by +1 additional level when functional capacity was decreased.

Goldman et al. (1977) proposed using a multi-factorial scoring system linked to patient co-morbid conditions to estimate cardiac risk associated with having surgery called the Cardiac Risk Index. Goldman et al. listed nine co-morbidities and ranked and gave each one a weighted value according to the increased risk of major adverse cardiac events. Lee et al. (1999) developed the RCRI for predicting perioperative cardiac risk. The RCRI is composed of one procedural and five clinical risk factors. The most serious contributory risk factor is chronic heart failure. Patients with chronic heart failure are known to be at greatly higher risk for perioperative cardiac or cerebrovascular events (stroke) and “is an independent prognostic variable for all cardiac risk assessment” tools (Lee, Tsai, Ip, & Irwin, 2019, p. 71).

The first studies reporting improved cardiac patient’s perioperative survival began recommending patients use beta-adrenergic blockers before non-cardiac surgery (Poldermans et al., 2001). Trial results appeared so beneficial that beta-blockers were recommended for all cardiac patients having non-cardiac surgery. Poldermans et al. (2001) published findings in the *European Heart Journal* from the DECREASE trials. The researchers reported the efficacy of the beta-blocker bisoprolol was statistically significant in reducing perioperative myocardial infarction. Data in the DECREASE

trials could not be replicated and administering beta-blockers close to time of anesthesia induction patient resulted in an increase in strokes (Abbott et al., 2018). Following an internal university investigation of Poldermans et al.'s data at Erasmus University Medical Center concluded data results had been falsified.

In 2008, a large randomized controlled trial titled the Peri-Operative ISchemic Evaluation (POISE-I) found perioperative beta-blockers were effective in some patients, especially those with previous heart attacks but increased mortality in other patients due to strokes (Bennett & Siegrist, 2016). The POISE-I trial enrolled 8,351 patients for non-cardiac surgery randomized to initiate oral metoprolol-ER or a placebo within two hours of induction of anesthesia (Bennett & Siegrist, 2016). Anesthesia records showed intra-operative hypotension was the likely causal event (Bennett & Siegrist, 2016). For some patients, blocking sympathomimetic hormone release from surgical stimulation with a beta-adrenergic blocker too close to induction of anesthesia resulted in prolonged hypotension, resulting in stroke, and some cases of death.

Detailed pre-anesthesia cardiac evaluations combined with proper perioperative pharmacy management reduced the occurrence of myocardial infarctions in perioperative period up to and including 30 days after surgery. The vascular events in a non-cardiac surgery patient cohort (VISION trial) recruited patients from 12 hospitals in eight countries to investigate intraoperative heart rate and systolic pressure relationship to myocardial infarction characterized as elevation of serum troponin unaccompanied by symptoms of angina or electrocardiographic evidence (Abbott et al., 2018). The VISION trial enrolled 16,079 patients, age 45 years or older, having non-cardiac surgery in a hospital setting plus staying post-surgery at least overnight. The occurrence of

myocardial infarction after non-cardiac surgery (MINS) was 7.9% and mortality rate within 30 days was 2.8% (Abbott et al., 2018). Chart audits of intraoperative vital sign recordings were done and the relationship between multiple independent variables, high versus low systolic blood pressure, high versus low heart rate, and a dependent variable of myocardial infarction were searched as outcomes. Pre-operative and intraoperative vital sign measurements were taken—the fastest heart rate and duration (HR > 100 bpm and < 55 bpm) and the highest and lowest systolic blood pressure and duration (SBP < 100 mmHg. and >160 mmHg)—to determine if myocardial infarction or death after surgery up to within 30 days after surgery existed (Abbott et al., 2018). Results of the VISION trial indicated tachycardia and hypotension were significantly associated with perioperative myocardial infarction and stroke.

Blessberger et al. (2018) published a systematic review of 88 randomized controlled trials including patients having heart surgery and non-cardiac surgery. The same medication administered to heart surgery patients was beneficial in limiting serious conduction abnormalities but increased the risk of heart attacks, stroke, and death in patients having non-cardiac surgery. The ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation guidelines now use the term perioperative to mean up to 48 hours prior to start of surgery and does not need to include the morning of surgery especially in patients naïve to beta-blockade. One of the studies on non-cardiac surgery patients cited by Blessberger et al. with 10,947 participants showed beta-blockade close to time of surgery had a high occurrence of severe hypotension (Relative effect 1.50, 95% Confidence interval 1.38 to 1.64). Both groups benefited from resuming beta-blocker medication in the post-operative period.

Kaiser et al. (2020) studied the rare event of perioperative cardiac arrest requiring cardio-pulmonary resuscitation. Intraoperative cardiac arrest had an incident rate equal to 0.03%, postoperative was 0.33%, and 30-day mortality was 1.25%. Identification of specific risk factors contributing to intra-operative cardiac arrest up to 30-days mortality was determined by age and higher ASA (2019) physical status. Using the American College of Surgeons' (2020) National Surgical Quality Improvement Project database searching between 2008 and 2012 for the risk factors responsible for intraoperative cardiac arrest, the strongest predictors were ASA physical status, age, sepsis, type of surgery, urgent and emergent cases, end-stage renal disease, and systemic inflammatory response syndrome. The most significant risk factors for 30-day mortality were ASA physical status, age, functional capacity, sepsis, and disseminated cancer (Kaiser et al., 2020).

One special patient population in the United States has been defined as frail and has only recently begun to receive additional attention. The elderly population is living longer and presently 50% of all patients having surgical procedures are over 65-years-old and 10% are those with frailty (Birkelbach et al., 2019). Frailty and functional capacity have different metabolic and physical profiles but perioperative mortality rates and threat of lasting cognitive disability after surgery have adversely impacted quality of life (Birkelbach et al., 2019). Elderly are more likely to have a history of myocardial ischemia or previous myocardial infarction and have received coronary for stent placement, atrial fibrillation, and heart failure. Elderly patients are more likely to have multi-pharmacy, increasing risks of drug interactions with anesthesia. Each of these

conditions carries significantly higher risk of perioperative complications, morbidity, and mortality.

### **Synthesis of Literature**

There is good reason to assume anesthesia residents are taught how to provide satisfactory pre-anesthesia cardiac evaluations since both anesthesiologists and nurse anesthetists are taught from Miller's (2000) *Anesthesia* textbook. The preanesthesia evaluation is the one element in anesthesia care performed a majority of the time and with the assistance of the patient, it will generally have more likelihood of accuracy. Miller's list of elements to include in a quality cardiac evaluation rely on anesthesia practitioners to be comprehensive and consistently performed. The 2014 ACC/AHA (Fleisher et al., 2014) guidelines present a step-wise approach to cardiac evaluation so practitioners have a well-validated methodology to follow.

The ACC/AHA (Fleisher et al., 2014) guidelines recommended that anesthesia providers perform auscultation of heart and lungs, identify valvular disease or pulmonary disease, use the DASI to estimate functional capacity, and use the RCRI for anesthesia risk stratification. Early patient engagement before surgery was shown to allow time for adequate evaluation, initiation of risk modification medicines, and decrease the number of patients presenting the day of surgery.

The anesthesia profession has become more cautious in reading and verifying research by attempting to replicate studies found in the literature after the falsified data found in Poldermans et al.'s (2001) DECREASE trial. The conclusions in the DECREASE trial were at first readily accepted including administration timing two hours before start of anesthesia for long-acting metoprolol and bisoprolol. The major adverse

cardiac events observed were difficult to prevent because the beta-blockade lowered cardiac output and heart rate and, in many patients, it was hard to correct with vasopressors especially in the over 65-year-old population.

Fine tuning the results of multiple trials has led to changes in practice guidelines attempting to provide quality guidance in minimizing MACE. In a large, prospectively designed, meta-analysis of randomized controlled trials, Ziff et al. (2020) investigated beta-blocker usage in patients with coronary artery disease, heart failure, or hypertension having surgery. A total of just over 1.6 million patients included from 98 meta-analyses showed beta blockers reduced mortality before coronary reperfusion but > 50% of patients required thrombolytics. Beta-blockers reduced the incidents of myocardial infarction but increased the incidence of heart failure. The key point in their study was no benefit of beta-blockers on mortality in patients having cardiac surgery and increased mortality in patients having non-cardiac surgery. In treatment of perioperative hypertension, 36 randomly controlled trials' ( $n = 260,549$ ) use of beta-blockers showed no benefit versus placebo and beta-blockers were inferior to other agents in prevention of mortality and stroke (Ziff et al., 2020).

### **Theoretical Framework**

Donabedian (2005) wrote,

[There] may never be a truly comprehensive definition of quality medical care—as it exists at the patient-practitioner level of interaction—because quality is a value judgment based upon the patient's medical history, current goals and expectations, and is variable with time. (p. 166)



Donabedian's linear theoretical model was formulated in 1966 and is known as the structure-process-outcome (SPO) theoretical model. Each of the three dimensions are inter-related and influenced by the previous dimension and are dynamic with time. The theory is a dominating framework for many types of healthcare quality improvement projects and research (see Figure 1).

Debate regarding what constitutes high quality medical and surgical care is ongoing and the methods used to determine quality perioperative care are evolving. In the practice of anesthesia care, avoiding process failures leading to catastrophic outcomes and providing each patient safe quality care are the goals.



*Figure 1.* Donabedian's structure-process-outcome model.

Donabedian's model (1990) allowed for structure, process, and outcome measurement. Process measures are actions performed that closely reflect the methods used to deliver care and outcome measures are the end-result of the delivery of care, i.e., 30-day mortality or post-operative myocardial infarction. Donabedian's emphasis on quantifying structure, process, and outcomes for evaluating quality medical care was an accepted method to assess quality improvement activities in anesthesia.

Since the 1990s, anesthesia quality care has seen significant improvement in areas such as invasive monitoring, pulse oximetry, pharmacotherapy, and chemical stress testing; as a result, morbidity and mortality have shown some improvement. Chazapis et

al. (2018) discussed how to further organize structure, process, and outcomes for anesthesia care by using relative clinical indicators. Process indicators examine and evaluate the steps in a process (how care is delivered). Anesthesia providers who apply current ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation guidelines and estimate functional capacity as part of a pre-anesthesia cardiac evaluation could organize measurable process data linked to intraoperative and postoperative outcomes.

According to Donabedian (1990), structure provides a description of the setting where care is provided and the individuals providing the care. Medical departments looking for high quality practices should be cognizant of the effect of a facility's structure, staffing, access to care, patient convenience, and safety. In addition, the organization's efficiency and cost containment could affect the capacity for care. Staff training and qualifications are included because practitioners do not all train or practice in the same manner. Structure could be analyzed and measured as resource management and could asset availability such as surgical instruments, disposables, and staffing schedules. Does the hospital have the available resources to purchase the needed materials or is the staffing adequately trained for the level of care and available for service providing quality surgical care?

Process describes methods used to direct care toward evidence-based quality care for patients and family. Variables used to measure process are clinical indicators and performance indicators (Chazapis et al., 2018). Clearly, some surgeons have more satisfactory outcomes than others. More research in the process of perioperative care involves intraoperative anesthesia and post-anesthesia care through discharge. Process is improved with use of recommendations from national guidelines and knowledge

disseminated from systematic reviews and meta-analyses. Process indicators are based upon how care is delivered such as pre-operative antibiotic prophylaxis to prevent infection (Haller et al., 2019) and pre-anesthesia cardiac evaluations to prevent perioperative adverse cardiac events.

Donabedian's (1990) model helped guide the analysis of outcomes resulting from improvement in clinical practice and determines quality care based on how well specific clinical indicators were met such as a patient's recovery, length of time until hospital discharge, or returning to normal activities of daily living. Patient satisfaction has also been used as a clinical indicator for appropriate medical care even though it is a mostly subjective outcome. The measures should be compared and contrasted to individual practitioners in one facility and one facility compared to other facilities in significant numbers to be meaningful. Consistency of measurement between clinical trials and research as well as for performance measures might provide more accurate data to determine best practices for patient outcomes. Outcomes might not be readily apparent for an extended amount of time and post-anesthesia outcomes have several time frames for different types of care. Some cardiac outcomes are measured when the patient leaves the post-anesthesia care unit, at 24 hours, and others within 30 days after surgery.

Chazapis et al. (2018) concluded in a systematic review of anesthesia quality improvement literature that in spite of the large volume of literature accumulated around the concept of anesthesia, quality is still not well-defined and clinical indicators have shown weak scientific evidence. A large number of anesthesia quality improvement articles have brought added attention to quality improvement monitoring of the anesthesia community but has not resulted in setting standards for perioperative quality.

Clinical indicators with an evidence-base varied in strength from randomized clinical trials to expert opinion. Accordingly, most of the clinical indicators with outcome measurement centered on effectiveness, safety, and efficiency of anesthesia care.

A recent method of outcome measurement is the composite outcome. Composite measures for surgical and anesthesia patients increase the power of a study and variances are detected easier. Composite outcome measures are not always useful when studying only one part of the perioperative process. Anesthesia providers are involved in many different types of perioperative activities with resulting events. Combining more than one infrequent event (mortality) or an outcome together with another outcome (morbidity) from an associated event or process might increase an event rate, allowing a clearer understanding or meaning of an outcome. Very low numbers of occurrences in mortality and morbidity used in a composite outcome data could avoid bias of frequencies so important components of the measure are not obscured (Boney, Moonsinghe, Myles, & Grocott, 2015).

### **Summary**

Donabedian's (1990) structure-process-outcome model was used as the framework for analyzing the local healthcare system's method of preanesthesia evaluation of cardiac patients before noncardiac surgery and improving practitioner's preparation of cardiac patients having surgery.

### **CHAPTER III**

#### **PROJECT DESIGN AND METHODS**

Over the past six months, a rural surgery center in Texas has had several surgical start-time delays, postponements, and cancellations of scheduled elective surgery (Hospital administrative data report, October 2019 – March 2020; Leeper, 2020). Even after patients had been assessed by a surgery nurse in the pre-anesthesia evaluation clinic (PAEC), some patients were still arriving on the morning of surgery with cardiovascular related problems such as severe hypertension, atrial fibrillation (rate over 120), or shortness of breath at rest (rate over 30 breaths/minute). These patients were delayed because they were not stable enough to progress to the operating room.

#### **Setting**

The project was conducted in a rural, hospital district-owned facility in Texas consisting of a primary care clinic, a general hospital with comprehensive medical-surgical services, an ambulatory surgery center, a satellite express-care clinic, nursing home, and an independent-living housing campus. The local population in the county is approximately 25,000. The hospital's population drawing area is approximately 100,000. The rural primary care clinic structure includes staffing with primary care physicians, nurse practitioners, registered nurses, and vocational nurses. Board-certified emergency medicine physicians and registered nurses staff the emergency department. The clinic and hospital have medical family practice residents.

The surgery center inside the general medical-surgical hospital has registered nursing staff, several with Bachelor of Science in nursing degrees. The surgery director has a Master of Science in nursing administration. Vocational nurses have been trained as scrub assistants. The hospital uses board-certified anesthesia providers. Patients come for surgery directly from the emergency department on a priority basis. The rural health clinic has 18 primary care practitioners, physicians, and advanced nurse practitioners. Physicians include three general surgeons, four obstetrical/gynecologists, and one podiatrist. All physicians are board certified in their individual specialties. Three clinic physicians have training and experience in managing complex cardiovascular disease in a primary care setting.

The surgery center has eight bed preoperative patient cubicles, three operating suites, two endoscopy rooms, and a five-bay post anesthesia care unit. The surgery center has 80 surgical and endoscopic procedures per month on average. Anesthesia machines, patient monitors, and proprietary electronic anesthesia records in the facility are state-of-the-art. Proprietary electronic anesthesia records are used for each anesthesia administration.

### **Current Process**

Examining the interpersonal aspects of the project, the pre-operative process begins with a request by the patient to be seen in a primary care setting to discuss a potential need for surgery. The patient is referred to a surgeon who has the capability and competence to diagnose surgical diseases. The surgeon collects a health assessment and provides a surgical diagnosis. The patient is given a folder in the surgeon's office with printed and written instruction for them to follow after they decide to have surgery. The

patient fills out some of the paperwork in the folder and brings the folder to the hospital registration desk and to the surgery PAEC. Each patient is given an appointment time and date to be seen by a surgery nurse to receive a pre-admission history and physical assessment. All of the patient data are entered into the electronic medical record (EMR). The day before surgery, all scheduled patient charts are reviewed including physician's history and physical, all testing when ordered, and note of potential red flags with cardiac related problems are addressed. One existing process is a change in the electronic anesthesia record template. The proprietary template was set up by the project manager, prompting anesthesia staff to always document yes or no for the presence of any of the four primary cardiac co-morbidities and whether they routinely took beta-blockers. The last dose of the beta-blockers taken is also a programmed hard-stop; it is required on the anesthesia record and on the pre-anesthesia assessment in the patient's EMR. These items have to be filled in before the system allows further charting. The system-wide networked vital sign monitoring system records the patient's vital signs into each patient's EMR. The patient arrives in the pre-operative area on the day of surgery for personal interview by the anesthesia provider.

### **Design**

Donabedian's (1990) structure-process-outcome theoretical model assisted the design of the quality improvement project. A simple and popular before and after design was used. Several structure and process steps were proposed after finishing the out of town inspection tour of a large university medical center's PAEC process. The out of town hospital had a built a large convenient one-stop PAEC. A meeting with the nursing director and admissions director at the university medical center found registration,

patient history, physical assessment, and electrocardiograms on all patients over 45-years-old were streamlined in the PAEC. When a blood type screening or any lab work was needed, the clinic nurses drew the blood and it was handed to a runner to take across the hall to the laboratory. If X-rays were needed, the patient went across the hall to radiology.

Insight from that tour led our hospital team to design a very similar floor plan and very convenient area for staff and patients. Care delivery for this project required qualified surgical nurses, anesthesia staff, and laboratory and radiology staff; all individuals had training and experience above core proficiencies. The one structural item improved locally was to facilitate more cardiovascular evaluations in the surgery center by converting a consultation room adjacent to the laboratory-radiology lobby to our pre-anesthesia evaluation clinic. A computer with hospital network connections and equipment for vital signs and cardiovascular evaluation was dedicated to the area. Analysis of structure updated the pre-operative evaluation area including a quiet and convenient location for patients to be evaluated and close proximity to laboratory, radiology, and cardiopulmonary services including a computer for electronic health records.

To gain stakeholder acceptance, the surgeons and surgery nurses were informed about the system-wide anesthesia department's plan to improve several of the surgery center processes for cardiac evaluation and how patient safety and hospital efficiency would be improved. The project used an education process model and improved anesthesia provider's skills above core proficiency in cardiac and cardiovascular evaluation. Education of current ACC/AHA (Fleisher et al., 2014) cardiovascular



evaluation guidelines using an lunchtime presentation for anesthesia practitioners was completed. Practitioners were given information about how to administer, score, and interpret the RCRI (Lee et al., 1999) and DASI (Hlatky et al., 1989) questionnaires. Both assessment tools were described in the ACC/AHA cardiac assessment guidelines (Fleischer et al., 2014). The educational material was organized to follow the step-wise evaluation algorithm. Anesthesia providers were able to build upon existing evaluation knowledge and increase confidence in the reliability and validity of the assessment tools.

The project included improvement of routine effectiveness of anesthesia practitioner's preparation of patients for surgery, assuring more patients were able to proceed to surgery without delay with a stable cardiovascular condition on the day of surgery. Patients with cardiovascular problems were seen face-to-face by an anesthesia provider to identify and evaluate the degree of active cardiac disease, functional capacity, and cardiac risk stratification. Consultation with the hospital's multidisciplinary team was utilized for benefit of patients with high cardiac risk. Implementation of guidelines led to a changed clinical behavior for anesthesiologists but also had favorable responses from patients. Earlier patient engagement with the anesthesiologists helped patients receive surgery instructions sooner and leave time for determining efficacy of any new medications needed before surgery.

### **Project Vision, Mission, and Objectives**

#### **Vision**

The vision of the quality improvement project was to improve clinical anesthesia practice behavior in performing quality cardiovascular evaluations, resulting in a

reduction in the number of start-time delays, cancellations, increased practice safety, and minimization of major adverse cardiac events.

### **Mission**

In rural communities, it has always been important to have access to quality medical, surgical, and anesthesia care. The hospital's strategic plan described a broad mission to serve individuals in our community with a medical-surgical need to provide excellent care. This quality care project promoted that mission by increasing access to quality medical and nursing care and treating all patients with respect and dignity.

### **Project Objectives**

In the past, some patients have arbitrarily been transferred from primary care to a high-volume university medical center when the physician or nurse practitioner thought they might have cardiac issues. The nearest tertiary university medical center is a distance of 130 miles. The potential inconvenience, stress on patients and their family, and time delay having to schedule and travel out of town for medical care was a significant hardship. Travel expenses, loss of time at work, shuttling back and forth for preoperative appointments, and post-operative follow-up visits were expensive and time consuming. A patient as well as the community benefit medically and economically from quality care provided in a local full-service hospital with surgical services.

This quality improvement project analyzed several structure and process steps needed to improve cardiovascular evaluations in the surgery center. The project structure required qualified nursing and anesthesia staff with training and experience above core proficiencies. The evaluation area also needed access to electronic health records, a quiet

and convenient location for patients to be evaluated, and be in close proximity to laboratory, radiology, and cardiopulmonary services.

**Objective 1.** Implemented a short educational presentation of ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation recommendations to all anesthesia providers in the rural surgery center.

**Objective 2.** Implemented the ACC/AHA (Fleisher et al., 2014) step-wise algorithm for cardiovascular evaluation five to seven days before surgery. The anesthesia providers used RCRI (Lee et al., 1999) and DASI (Hlatky et al., 1989) scores when patients were identified with one or more cardiac co-morbidities.

**Objective 3.** Evaluated the project implementation by including process outcomes and patient outcomes to determine the effectiveness of clinical activities. Anesthesia providers performed cardiac risk stratification including information from both assessment tools.

**Objective 4.** Anesthesia providers achieved improved safety and efficiency by achieving a decrease in the number of start-time delays, postponements, and cancellations the day of surgery as evidenced by EMR chart audits and from monthly administrative data.

### **Project Outline**

This quality improvement project consisted of two separate phases. An educational presentation for anesthesia providers included material updating existing knowledge and applying established guidelines learned as how and when to administer cardiac risk assessment tools. Achieving the project objectives included collecting data from the number of patients requiring cardiac risk stratification. Consultation with the

surgeon and multidisciplinary team was necessary to maintain quality care during patient optimization for surgery.

### **Provider's Education**

An in-service education presentation was given during a lunchtime meeting for anesthesia providers and included the surgery center nursing director. Copies of the complete ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation guidelines were handed out. The ACC/AHA guidelines' process and recommendations were explained to anesthesia providers. Implementation of evaluation methodology and workflow processes helped anesthesia and nurses to assist patients take the DASI (Hlatky et al., 1989). Anesthetists were shown the step-wise evaluation algorithm in the current guidelines for pre-anesthesia evaluation and the RCRI (Lee et al., 1999).

Attempting to develop quality clinical personal habits, the ACC/AHA (Fleisher et al., 2014) guidelines were available to staff nurses in a printed reference notebook kept in the PAEC and in the surgery center. Participating anesthetists implied consent to the project when they voluntarily attended the short education session. Anesthesia providers were asked to take the self-assessment but during the lunchtime meeting, they expressed a lot of resistance. In cooperation with anesthesia staff members, the education session proceeded specifically to transfer the information even without the quiz. Adjustments to routine practice were expected as a part of the project by following the step-wise evaluation algorithm and this began quickly after the education session. Providers were under no obligation to change pre-operative routines and were informed about opting-out of the project at any time merely by not scoring the DASI (Hlatky et al., 1989) or completing the RCRI (Lee et al., 1999) on their patients.

The student project manager gave a short lunchtime educational presentation. Following the meeting, an open discussion period was used for questions and answers. The education portion emphasized administration, scoring, and interpretation of the two cardiac evaluation tools in the clinical setting. Each participant was encouraged to express opinions and provide feedback on the pre-anesthesia cardiac evaluation process.

### **Pre-Anesthesia Patient Cardiac Evaluation**

Following a patient's request for surgery, the PAEC desk nurse would secure an appointment for all elective surgery/procedures. The scheduled appointment would be a minimum of five to seven days prior to the scheduled day of surgery. Patients meeting cardiovascular inclusion criteria had the project explained to them by a PAEC nursing staff or anesthetist. The nurse would read a description of the project to patients and the patient would sign and date the project consent form (see Appendix E). The patient would be offered time before signing to ask questions and be reassured all personal information would be kept confidential. The patient would take the self-administered DASI (Hlatky et al., 1989) questionnaire, which takes approximately four to five minutes to complete. Any patient needing assistance to complete the questionnaire or needing translation would be helped by the clinic nurse. The consent form was stapled together and placed in the patient's file folder in the locked anesthesia office cabinet. When the patient was seen in the pre-anesthesia evaluation clinic, the RCRI (Lee et al., 1999) was performed using the phone application software. The risk score would be written in the patient's file folder that is kept in the anesthesia department file cabinet. The process is complete when all of the step-wise algorithm actions are performed and a clear decision pathway has been achieved for the patient. Surgical pathways might include start-time

delays while pharmacotherapy is administered to optimize a condition, postponement for guideline-directed therapy or for further testing, modification of the surgery or anesthesia methods, or cancellation for transfer to a tertiary university medical center specialist.

The anesthesia provider used a cell phone application (or App) installed on their cellular phone to calculate the DASI (Hlatky et al., 1989) score. The phone App is simple to use, patient answers from the written copy are put into the blanks in the App, and results are immediately received. For patients with a DASI score of four (4) METs or less (poor functional capacity), the anesthesia staff member would meet the patient for a face-to-face interview five to seven days before surgery. The interview would be used to clarify pertinent history, see if any questions on the questionnaire were left blank by the patient, calculate RCRI (Lee et al., 1999) cardiac risk score, and complete the risk stratification. When the anesthesia provider needed to discuss a patient's health status with the surgeon, the multidisciplinary team would also agree to meet. The anesthesia provider would give the group all of the patient's details, the history, the scores on the RCRI that described the cardiac risk as  $< 1\%$  or  $> 1\%$  chance of major adverse cardiac event, and the DASI scores.

### **Instrumentation**

#### **Pre/Post Practitioner's Self-Assessment**

Anesthesia providers were offered an eight-question pre-implementation self-assessment developed by the student project manager. The clinical education material included current ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation guidelines, the RCRI (Lee et al., 1999), and the DASI (Hlatky et al., 1989). Following the initial self-assessment, the education material and discussion covered information applied clinically

including the two cardiac evaluation tools. The anesthesia provider's self-assessment was used to determine how effective the educational material had been by collecting individual practitioner's data and finding the percentage of improved knowledge (see Appendix F).

### **Revised Cardiac Risk Index**

Lee et al.'s (1999) RCRI is a multifactorial perioperative risk calculator that uses specific patient co-morbidities and surgical sites proven to be related to increased risk of major adverse cardiac events. The RCRI is considered the most accurate of all of the current cardiac risk calculators (Vats et al., 2016). The RCRI asks six questions about the presence of specific cardiac co-morbidity, history of congestive heart failure, history of transient ischemic attack or stroke, and high-risk surgery including intra-peritoneal, intra-thoracic, and infra-inguinal vascular surgery. Each response was answered yes or no. The yes answers had a value of one point. Any combination of three out of six yes answers translated to higher risk for perioperative morbidity or mortality.

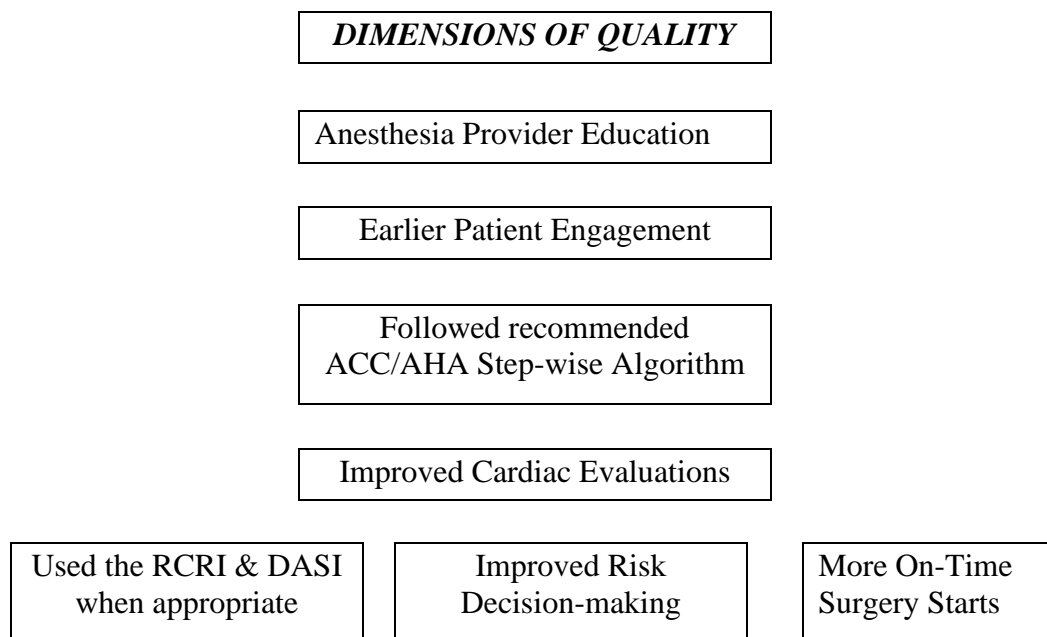
### **Duke Activity Status Index**

The original research for the DASI (Hlatky et al., 1989) compared two patient groups: one group performed physical exercise on a bicycle treadmill while having their peak oxygen uptake measured and a second group used an equal number of independent subjects completing a 12-question written self-assessment of daily physical activities. Each of the 12 questions had a weighted point value. The questions were totaled and entered into the index's formula. Values on the questionnaire correlated 4 METs or less to peak oxygen uptake with high predictive value ( $p < .0001$ ) and the written questionnaire (Spearman correlation coefficient 0.58), resulting in a standardized

assessment of functional status (Hlatky et al., 1989). The DASI was used for estimation of cardiovascular risk based upon metabolic equivalency with high validity and reliability. The summed values had three associated ranges: low risk (7-10 METs), intermediate risk (4-6 METs) and high risk (0-3 METs). Very low scores estimated elevated high cardiac risk for anesthesia. An index score of 4 METs or less carried a perioperative mortality risk approximately three times greater than patients with higher scores (Grodin, Hammadah, Fan, Hazen, & Tang, 2015).

### **Clinical Indicators**

Clinical indicators are often used in health care to assess structure, process, and outcome. Clinical indicators are capable of identifying direct linkage to causal relationships, can benefit patient safety, and can serve to provide feedback to practitioners. The dimensions of quality identified for this project were anesthesia specific and patient-centered (see Figure 2; Chazapis et al., 2018).



*Figure 2.* Improved process dimensions of quality care.



The four objectives in this project were translated into measurable clinical indicators:

1. Structural clinical indicator. The anesthesia staff needed to update and improve cardiac evaluation skills over core anesthesia competency. Therefore, anesthesia providers participated in a short educational presentation of ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation recommendations. Participants were offered a short self-assessment before and after the in-service education to help assess basic understanding.
2. Process clinical indicator (step-wise evaluation algorithm). Anesthesia providers would perform cardiovascular evaluations including consistent use of the ACC/AHA (Fleisher et al., 2014) step-wise algorithm approach for cardiac risk stratification. Anesthesia practitioners would become proficient in using RCRI (Lee et al., 1999) and the DASI Hlatky et al., 1989) scoring.
3. Timeliness clinical indicator. Pre-anesthetic cardiac evaluations are to be fully documented in the electronic medical record five to seven days before surgery. Patient delays beyond 15 minutes directly related to cardiovascular problems will be reviewed.
4. Safety and efficiency indicators (with sub-types). Anesthesia providers will observe improved patient safety and efficiency by achieving a decrease in the number of start-time delays and cancellations on the day of surgery, minimizing the incidence of major adverse cardiac events.
  - a. Delayed start-times and cancellations.

- b. Perioperative major adverse cardiovascular events (four sub-types):  
 severe hypertension, severe hypotension, acute infarction or stroke, and  
 post-operative adverse event within 30 days

### **Data Collection**

The patient data collection timetable included a 30-day retrospective EMR review from April 1 to April 30, 2020 prior to implementation and a 30-day prospective review after implementation from May 1 to May 30, 2020. The University of Northern Colorado's Institutional Review Board provided exemption for non-research status with an effective date of April 16, 2020 (see Appendix G for approval letter). Data collection aligned with the project objectives.

### **Structural Data for Anesthesia Education**

Structural data were collected to ensure qualified staff followed the step-wise cardiac evaluation algorithm. Anesthesia provider education covered current national guidelines and the administration, scoring, and interpreting of the two cardiac risk assessment instruments. A pre-education self-assessment was offered to anesthesia participants. The posttest was offered immediately after the educational session.

### **Process Data for the Patient Sample**

Process data included the patient scheduling an appointment for earlier patient engagement in the pre-anesthesia evaluation clinic at least five to seven days before the surgery. Anesthesia providers and clinic nurses were instructed not to schedule a PAEC appointment less than five days before surgery. An anesthesia provider's application of knowledge obtained from the education session included evidence of the number of each

anesthesia provider's use of the step-wise algorithm and especially calculating the RCRI (Lee et al., 1999) score and estimating functional compliance with the DASI (Hlatky et al., 1989) score. Retrospective and prospective EMR chart audits looked for the anesthetist's documentation of these two items.

### **Safety and Efficiency Process**

The anesthesia profession has made significant strides to make patient care safer with improved monitoring equipment and increased anesthesia practitioner vigilance. Anesthesia safety minimizes major adverse cardiovascular events including severe hypertension, severe hypotension, acute infarction, stroke, or death within 30 days after date of surgery. Pre-operative patient safety included giving clear patient instructions that might be a part of the causal relationship leading to or preventing major adverse cardiovascular events.

Efficiency has been improved with a better anesthesia provider evaluation process that has resulted in reduced delays and postponements. Data from hospital administrative reports and EMR anesthesia records included a search before and after implementation for decreases in the number of start-time delays, postponements, and cancellations on the day of surgery. Any patients with start-time delays, postponements, or cancellations with cardiovascular disease abnormalities were viewed for determination of a causal relationship linked to how the pre-anesthesia evaluation was performed. Patients who required an interpreter or a Spanish- or German-speaking nurse had one made available.

### **Patient Exclusion Criteria**

The project excluded patients aged 44-years-old and younger, emergency surgeries, and all obstetrical patients. Obstetric patients with significant cardiac disease

were considered very high risk and were referred to perinatal specialists at a university medical center.

### **Electronic Chart Review**

The number of medical record reviews ordinarily would total approximately 160, which were evenly distributed in a convenience sample between the three anesthesia providers and labeled A, B, and C. The anesthesia providers' cases were random but not blinded and not pre-assigned. All cases were assigned based upon surgery start-times and anesthesia provider availability. The student project manager used an electronic anesthesia records database in a proprietary anesthesia information management systems (Draeger AIMS ©) that compiled patient demographic and perioperative process data. Extraction of data from the AIMS was done with assistance of Draeger Analytics© software. A patient's height, weight, body mass index, gender, cardiac co-morbidities, and medications were organized for statistical analysis. Chapter IV presents the results of the statistical analyses.

### **Ethical Consideration**

Patient participation in this project was voluntary and consent forms were obtained following full disclosure and opportunity for participant's questions. The project was explained to each patient. Patients were told as part of the informed consent process that even if they chose not to be part of the project, the anesthetist would be taking excellent care of them and the project included only the pre-anesthesia evaluation process. Minimal risk was expected for individual patients and data collected had patient identifiers removed. If a patient wished not to participate in the project, they were told not to sign the project consent form. Patients were told they were free to withdraw at any

time by simply verbalizing a wish to do so by notifying the nurse or anesthesia provider in the surgery center.

The findings from these cardiac assessment tools were reported to the patient's surgeon before being discussed with the patient as the physician might wish to discuss further medical treatment and testing with the patient prior to the surgery. When the assessment tools were used and completed, the nurse placed the DASI (Hlatky et al., 1989) into the anesthesia department's master folder kept in the secured anesthesia department file cabinet. The project data collection worksheet was converted to digital format in an electronic thumb drive in the project manager's office. After completion of the project, only electronically stored data were kept on a thumb drive in the locked filing cabinet. Patients' identities were protected and Health Insurance Portability and Accountability Act (HIPPA) privacy regulations were followed.

Anesthesia providers in Texas are all independent practitioners and are not obligated to follow any process or methodology unless it is considered a standard of practice or included as part of the hospital or anesthesia department policy such as in medical staff bylaws. There was an obvious ethical imperative when one knew a method was proven better than another and chose to ignore the better practice. The anesthesia staff volunteered for the lunchtime educational presentation describing the ACC/AHA (Fleisher et al., 2014) cardiac evaluation guidelines and asked proper questions about the implementation. The staff began using the assessment tools after the meeting and followed the ACC/AHA step-wise evaluation algorithm in the guidelines.

## Summary

Anesthesia practice cannot be delivered in a cookbook recipe fashion. The ACC/AHA (Fleisher et al., 2014) clinical cardiac evaluation guidelines were used to help standardize professional clinical care primarily through guidelines, protocols, or algorithms. The surgery manager and anesthesia staff followed recommendations that helped nursing staff familiarize themselves with how to support project implementation. Copies of the ACC/AHA guidelines were accessible in several areas of the surgery center and pre-anesthesia clinic as a reference guide.

Patients presenting on the day of surgery without any history or symptoms suspicious of cardiac disease were placed on the surgery schedule as requested by the surgeon. Patients having a cardiovascular evaluation with high risk or symptoms potentially related to cardiac disease had their RCRI (Lee et al., 1999) and DASI (Hlatky et al., 1989) scores calculated. Scores of patients whose METs were equal or  $< 4$  were discussed with the surgeon and/or the multidisciplinary team reviewed the patient's evaluation and cardiac status before proceeding through the step-wise algorithm. Table 2 provides a summary of the project's structure, process, and outcome utilizing Donabedian's (1990) theoretical model.

Table 2

*Summary of Project*

	Current Practice	Proposed Change	Change Evaluation
Structure	Anesthesia providers without knowledge of current ACC/AHA guidelines and use of RCRI and DASI.	Educate providers on ACC/AHA guidelines and use of DASI/RCRI	Anesthesia providers increase knowledge about use of RCRI & DASI in their practice, as evidenced by increased total scores on the post-education evaluation or consistent use of cardiac assessment tools.
Process	<ul style="list-style-type: none"> <li>Anesthesia providers read each chart 2 - 5 days prior to surgery.</li> <li>American Society of Anesthesiologist's - Physical Status (ASA-PS) is currently the only health assessment classification being done.</li> </ul>	<ul style="list-style-type: none"> <li>Patients evaluated first with the Revised Cardiac Risk Index at time of Pre-Anesthesia Evaluation appointment.</li> <li>Duke Activity Status Index given to all project inclusive patients in the preanesthesia evaluation clinic (PAEC) for estimation of functional capacity.</li> </ul>	<ul style="list-style-type: none"> <li>Revised Cardiac Risk Index scored to identify high, intermediate, and low cardiac risk for all eligible patients</li> <li>Duke Activity Status Index scored for all patients to identify low functional capacity.</li> </ul>
Outcome	<ul style="list-style-type: none"> <li>Patients arriving for surgery with unstable hypertension, irregular pulse, improper anticoagulation medication cause delayed start of surgery</li> <li>Miscommunication of pre-operative medication and other instructions possible (patient).</li> </ul>	<ul style="list-style-type: none"> <li>Estimate surgery type cardiac risk of MACE. Identify active cardiac disease status before the day of surgery.</li> <li>Identify patients with Low functional capacity.</li> <li>Identify "high risk cardiac" disease requiring further evaluation before the day of surgery.</li> </ul>	<ul style="list-style-type: none"> <li>Reduced number of delayed, postponed, and cancelled cases.</li> <li>Patients cardiac situations are stable on the morning of surgery</li> <li>Minimal number, or no cases with major adverse cardiac events.</li> </ul>

**CHAPTER IV**  
**DATA RESULTS AND ANALYSIS**  
**Novel Corona Virus of 2019**

At the time the project manager was starting patient enrollment for the project, the Coronavirus-2019 (COVID-19) pandemic was becoming a problem in the United States and in the state of Texas. Most hospitals in the United States were ordered by state governors into mandatory medical resource conservation of bed space and scarce resources. Hospitals were only allowed to perform major emergency surgery. In approximately early February 2020, hospitals in the state of Texas were ordered to follow measures to protect nursing home patients and to lower risk of spreading the virus to in-hospital patients. All surgeries except emergency cases were cancelled.

Emergency surgery is itself an independent cardiac risk factor and any data collected during the current timeline would automatically have more patients with increased cardiac risk than normal. Therefore, population data collected were biased toward false positive data. Patients would have been significantly misrepresented or skewed toward elevated surgery risk by simply being an emergency case.

If the RCRI (Lee et al., 1999) was administered to patients in November, then a minimum of 18 patients was expected to need the RCRI cardiac risk estimation performed and again about four patients would have also had the DASI (Hlatky et al., 1989) functional capacity estimation. The project would have expected to find at least four patients (6.7 %) out of a volume of 60 patients with a DASI score less than or equal



to 5 METs in each of the 30-day chart review periods (retrospective and prospective). Only a few patients would have had the DASI administered during the month of April, leaving very little data to collect or compare. The number of cases each anesthesia staff member actually performed was down significantly. Table 3 shows a comparison of a normal surgery case schedule in the surgery center from November 2019 before the pandemic changed.

Table 3

*Surgery Cases Completed in November 2019*

	Total	%
Surgeries	60	100
Gender		
Male	23	38
Female	37	62
Age Range		
45-54	4	6
55-64	19	32
Not enrolled	37	62
Body Mass Index Range		
20-29	25	
30-39	20	
40-49	8	
50+	3	
Systolic B/P >180	10	
Hyperlipid	11	
Diabetes	7	
Creatine > 2.0	1	
Recent Infarction	0	
Heart Failure	1	

### Current Patient Demographics

In April 2020, a retrospective EMR chart review found 6 of 22 patients within the inclusion population of 45 years of age or older. Patients with at least one cardiac co-morbidity had their RCRI (Lee et al., 1999) calculated and functional capacity estimated using the DASI (Hlatky et al., 1989). Patient demographic information during the project timeline from April 1 to 30, 2020 is provided in Table 4.

Table 4

#### *Patient Demographics for April 2020*

	Total
Surgeries	22
Gender	
Male	5
Female	17
Age Range	
45-54	3
55-64	1
65-74	1
75+	1
Cases Excluded	16
Body Mass Index Range	
20-29	9
30-39	7
40-49	4
50+	1

In May 2020, prospective data collection began and an EMR chart review found 24 total cases and only eight patients had one or more co-morbidities in the inclusion sample. Nine of the patients in the May 2020 prospective group were emergency surgeries (see Table 5).

Table 5

*Patient Demographics for May 2020*

	Total
Surgeries	24
Gender	
Male	7
Female	17
Age Range	
45-54	3
55-64	1
65-74	1
75+	1
Cases Excluded	16
Body Mass Index Range	
20-29	10
30-39	9
40-49	4
50+	1

The chart review included a determination of the anesthesia providers following the step-wise approach to cardiac assessment on any of these patients. Anesthesia providers did apply the knowledge obtained in the education session including performing cardiac evaluations using the DASI (Hlatky et al., 1989) and the RCRI (Lee et al., 1999) in daily clinical practice. Even though the cases were significantly decreased, the number of patients having surgery that would have been included are provided in Table 6.

Table 6

*Step-Wise Evaluation of Co-Morbidity per Anesthesia Provider—April 2020*

	Anesthesia Provider			Total
	A	B	C	
Surgeries	8	5	9	22
Hypertension	3	0	0	3
H-Lipid	1	0	0	1
Diabetes	0	0	1	1
Renal Creatine	0	0	0	0
Multidiscipline	0	0	1	1
ASA-PS	8	5	9	22
RCRI	0	1	1	2
DASI	1	0	2	3
Postponed	0	0	0	0
Cancelled	1	0	0	1

Measurement of the effectiveness of updating anesthesia provider's before and after comparison of results from implementation of the ASA-PS (2019) classification, RCRI (Lee et al., 1999), and DASI (Hlatky et al., 1989) is provided in Table 7. Two of the patients had their RCRI estimated but were in the emergency case group and entered surgery on time. Three patients had the DASI functional capacity estimated, two patients were delayed for control of blood pressure (no assessment tools used), and one case was discussed among all anesthesia staff, the surgeon, and the medical intensivist. The patient was considered by anesthesia to be very high cardiac risk stratification,

moderately high surgery risk, and had five cardiac co-morbidities. The consensus opinion was this patient had untreated sub-clinical congestive heart failure. The surgery was cancelled by the multidisciplinary team and transferred to a higher level of care for surgery.

Table 7

*Evaluation of Co-Morbidity per Provider—May 2020*

	Anesthesia Provider			Total
	A	B	C	
Surgeries	8	7	9	24
Hypertension	3	0	0	3
H-Lipid	1	0	0	1
Diabetes	0	0	1	1
Renal Creatine	0	0	0	0
Multidiscipline Consultation	0	0	1	1
ASA-PS	8	7	9	24
RCRI	0	1	1	2
DASI	1	0	2	3
Postponed	0	0	0	0
Cancelled	1	0	0	1
Cardiac Testing	0	0	1	1

The implementation strategy appeared to be working well but as the number of surgeries increased, we discussed having another education session as soon as we saw

COVID positive patients dropping. As the number of surgeries rose close to normal census, we have planned to repeat the educational meeting to refresh information in the guidelines. A report of the cardiac evaluations performed was given during the meeting as feedback to all anesthesia department practitioners.

### **Analysis**

The current ACC/AHA (Fleisher et al., 2014) guidelines were presented to all staff anesthesia providers. Scores on the pre-implementation self-assessment test were not collected because the providers wanted to have more experience with the guidelines first. The providers should have achieved at least 80% correct answers. The ACC/AHA cardiovascular evaluation guidelines recommended use of cardiac risk assessment tools in performing cardiac evaluation before non-cardiac surgery such as the DASI (Hlatky et al., 1989) or the American College of Surgeon's (2020) National Surgical Quality Improvement Program risk calculator. The anesthesia department chose to use the DASI, partly for the patient's ease of self-administering the questionnaire and for the time efficiency of preparing patients for surgery. Anesthesia providers are currently using both assessment tools for patient evaluation.

Examination was done of EMRs for actual anesthesia patient outcome data from pre-operative care processes and ones with comparison data recommended by the ACC/AHA (Fleisher et al., 2014) guidelines of total number of patients seen in the PAEC continuing on to surgery without abnormal cardiac events. Anesthesia providers were beginning to follow the step-wise evaluation algorithm and performing cardiovascular evaluations as determined by the RCRI (Lee et al., 1999) score, some DASI (Hlatky et al., 1989) scores, as well as the ASA-PS (2019) classification.

The step-wise protocol guided the anesthesia provider to complete the RCRI (Lee et al., 1999) and the DASI (Hlatky et al., 1989). Anesthesia providers or surgeons have screened patients before surgery and now are not arbitrarily or unnecessarily requesting further testing such as echocardiogram, chemical stress test, or treadmill stress test in line with guidelines. The total number of patients and the numbers with positive high cardiac risk (%) with very low functional capacity scoring with  $< 4$  METs found with the DASI could not be charted but would be as soon as possible. Total patients having surgery were placed in the denominator and all patients having scored  $< 4$  METs were entered in the numerator.

### **Results of Project Objectives**

#### **Objective One**

The anesthesia staff was updated on how to improve cardiac evaluation skills over core anesthesia competency. Donabedian (1990) emphasized a need for all healthcare professionals to be evaluated on experience and expertise in performing clinical duties. An institution improves structure by having qualified anesthesia providers. Therefore, the anesthesiologists were able to assess whether patients had valvular disease or symptoms of congestive heart failure in a quiet and easily accessible location in the surgery center. The educational material assembled from recommendations in the current ACC/AHA (Fleisher et al., 2014) cardiovascular evaluation guidelines helped achieve a higher quality of patient evaluation.

**Objective Two**

Anesthesia providers are now performing cardiovascular evaluations but because the number of sample patients was too low, it could not be determined how consistent each one of the anesthesia providers was administering the assessment tools or including use of the ACC/AHA (Fleisher et al., 2014) step-wise algorithm for cardiac risk evaluations. The process ordinarily would include 60 to 80 patients and if the samples were collected over a year, the results would be very evenly distributed between the three anesthesiologists. The surgery nurses called the anesthesiologists on-call for face-to-face interviews and completed the RCRI (Lee et al., 1999) consistently when the patient had at least one co-morbid condition. This improved patient identification with heart and lung auscultation and scoring of the assessment tools but could not determine to what extent. Patients were also having fewer and fewer start-time delays and no outcome indication of MACE was reported.

**Objective Three**

Following the recommendations for early patient engagement, a pre-anesthetic cardiac evaluation was fully documented in the EMR an average of five to seven days before surgery.

**Objective Four**

Observations of chart and administrative data were performed and any reported perioperative major adverse cardiovascular events including severe hypertension, severe hypotension, or an acute infarction or stroke were investigated. Anesthesia providers observed improved efficiency. Only one patient had a delay over the 15-minute start of surgery and was directly related to cardiovascular (hypertension). The efficiency and



indirect financial savings including patient convenience by patients having only one hospital visit to the PAEC was encouraging. The new process has saved patients' time and money, and avoided excessive testing by utilizing effective planning. The anesthesia providers provided a way to avoid unexpected overnight admissions or post-operative intensive care unit admission and less opportunity of major adverse cardiac events. After initiating the project, some physicians on hospital staff started using the DASI (Hlatky et al., 1989) in their clinic offices before scheduling a patient's surgery and appropriately sent patients to a cardiologist for consultation before scheduling the surgery or coming to the pre-anesthesia clinic. None of the patients were reported to have had a post-operative adverse cardiovascular event within 30 days after surgery or an unexpected re-admission with angina, myocardial infarction, or stroke.

## **CHAPTER V**

### **DISCUSSION**

The purpose of this quality improvement project was to determine whether a positive change in anesthesia provider's cardiac evaluations could be affected using a time-dependent clinical methodology. Following the educational presentation of current ACC/AHA (Fleisher et al., 2014) cardiac evaluation guidelines, anesthesiologists began using the RCRI (Lee et al., 1999) during PAEC appointments at least five to seven days before surgery to estimate overall surgical/anesthesia risk of a major adverse cardiac event. The number of pre-anesthetic cardiac evaluations fully documented in the electronic medical record five to seven days before surgery was supposed to be included in a retrospective and prospective audit of the electronic anesthesia and medical records on pre-operative patients age 45 years and older. Due to the viral pandemic, mandatory limitations were put in place during the time of data collection and no elective surgery was performed. These patients would have had chart review for myocardial infarction, myocardial ischemia, or stroke. The project did not include intraoperative patients but would have included post-operative data collection in the post-operative time period up to within 30 days after anesthesia to identify any patients having a myocardial infarction, myocardial ischemia, or stroke.

#### **Structure-Process-Outcome Quality Improvement Model**

The quality improvement project used Donabedian's (1990) structure-process-outcome theoretical framework. The hospital, primary care clinic, and surgery center

were all built within the past three years to be state-of-the-art facilities and only one minor structural change was needed for the project. A doctor's consultation area adjacent to an outpatient services lobby was converted into the PAEC. The area has easy access for patients and makes it a convenient one-stop radiology, laboratory, and surgery department where patients complete all that is needed before surgery. Nurses have computers in the clinic for documentation in a patient's EMR and for anesthesia staff to enter patient interviews and cardiac examinations. Practitioners are able to enter additional orders into the EMR and staff can look up any past surgeries in the electronic anesthesia information management records.

The project's process focused on providing adequate educational material for anesthesia providers and for nurses caring for cardiac patients. The laboratory staff was asked to prioritize completing all lab work orders within 45 minutes so the results could be checked before the patient left the building. Since many of the patients are from out of town, staff were able to review a patient's medical record before the patient went home to avoid having to return if further work was needed and so surgeons and anesthesia providers had time to optimize a patient's condition before the day of surgery.

One potentially overlooked process involved patients with age-related memory loss or patients with anxiety about having surgery and anesthesia. Extra time before surgery is frequently needed to get clarity regarding medications patients are taking. Practitioners have pre-printed instructions for patients to take home explaining what medications to take or to hold leading up to surgery. The important part of this process is individualization of medication routines before surgery as no one rule fits all. New research in cardiac evaluation points to different types of cardiac conditions needing

different medications routinely before non-cardiac surgery. Memory issues are common in patients who have just been in the surgeon's clinic or PAEC clinic—sometimes due to a patient's age and sometimes due to anxiety. In the past, this accounted for some of the start-time delays and cancellations when patients confused medication instructions.

### **Project Successes**

Anesthesia providers are now using the RCRI (Lee et al., 1999) and the DASI (Hlatky et al., 1989) for evaluating patients more frequently. Many of the patients were below the inclusion age of 45 years old and many of them were emergency surgery; thus, no assumptions or conclusions would be applied to these results. Surgeons have independently used the DASI in their own clinic offices to estimate patient functional capacity and to help their decision-making regarding when to send patients to the PAEC for an anesthesiologist to evaluate.

Adult patients having elective non-cardiac surgery increased slightly during the prospective review during the month of April 2020. Demographic characteristics for the prospective chart review included body mass index, hypertension, diabetes, hyperlipidemia, and renal insufficiency measured as creatinine > 2.0 mg/dl. Insufficient patient data were available to compare the before and after implementation patterns for improvement in clinical evaluation methodology resulting in no further start-time delays or at least a significant reduction.

### **Enhancement, Culmination, Partnerships, Implementation, and Evaluation**

#### **Enhancement of Clinical Practice**

Before implementation of the project, anesthesiologists were familiar with various national guidelines and where to use them as a reference online for a specific patient or

condition. Each anesthesia provider used the methodology learned in residency training or one they were comfortable using. No formal protocol was put in place to guide the anesthesia providers toward a consistent best practice in cardiovascular evaluation. Until anesthesia providers noticed an increase in the number of patients with excessive out of normal range conditions such as hypertension and personal cases being delayed in starting on time, no real motivation was present to update or improve practice. Clearly, all the anesthesia providers were having a similar experience only in different degrees before implementation.

The lunchtime education session was directed at helping develop a working process to evaluate all cardiovascular disease patients and safely transition patients into surgery. Discussing each step of the step-wise algorithm with clear patient exemplars and what evidenced-based practices should look like helped anesthesiologists grasp guideline concepts and practices. During discussions with the providers before implementation, only two patients with serious conditions during the intra-operative anesthesia care and with very serious conditions on arrival in the post-anesthesia care unit were recalled from the past 8 to 12 months and with no major adverse cardiac events. The national guidelines were found to be easy to understand and easy to teach. The guidelines helped explain how to improve structure and process in the peri-anesthesia timeframe, especially the step-wise evaluation algorithm. By performing the RCRI (Lee et al., 1999) first, the anesthesiologist could subjectively see the degree of risk in the type of surgery, risk of anesthesia, and whether the patient's health would be at high risk (< 1% or > 1%).

### **Culmination of Inquiry**

The literature was clear that several authors felt a link between activities in the pre-anesthesia period and to the post-operative outcomes existed. Our experience was when our patients were seen far enough in advance of surgery and evaluated, we had fewer of them arrive with class-3 hypertension (systolic 180 & diastolic of 120). The causal analysis showed when tracking the process back five to seven days before surgery, patients who were told to continue to take medications every day until surgery except anticoagulants were much more likely to not have any delays. After the education sessions, the recommendations from the ACC/AHA (Fleisher et al., 2014) guidelines impressed upon anesthesia staff which medications to continue and not continue. The pre-anesthesia clinic nurses had a guidelines reference notebook and were including use of the assessment tools to see when to call anesthesia staff. Nurses were looking for patients with high blood pressure, dysrhythmias, previous myocardial infarction, and history of heart failure. After implementation, the patients being seen by the anesthesia provider early in the perioperative timeframe had improved start-times and no cancellations.

### **Partnerships**

The cooperation of staff and professional partnerships was conducive to identifying more patients needing a complete cardiac evaluation. As previously mentioned, partnering with surgery nurses responsible for the pre-operative history, medication reconciliations, allergies, and patient instructions was one process change that was voluntary on their part but was done more often because they saw it as their responsibility. The gatekeepers had to know what the unacceptable vital sign

measurements would be and agree to call the on-call anesthetist. At least three of four nurses were notifying anesthesia department consistently to come evaluate a patient when necessary and hoped to soon to increase the number to 100% overall improvement.

### **Project Implementation**

Donabedian (1990) indicated there is probably never a perfect quality improvement project because patients' values and beliefs are variable over time. All anesthesia providers are expected to be competent in core anesthesia proficiencies and able to safely deliver those proficiencies in the clinical setting. Cardiac evaluation is considered a core proficiency in anesthesia and has continued to be taught during residency. The consistent transfer of skills and daily clinical practice of current cardiac guidelines is the only way to safely avoid MACE. Therefore, the strategy for the quality improvement project has been to provide clinical examples of our patients for anesthesia providers to see the importance of regularly performing evaluations. Discussing cardiac patient challenges and how they could be best handled worked for this project as evidenced by the use of assessment tools by all of the anesthesia staff, albeit with much lower surgery cases. Anesthesia practitioners had to see significant value for themselves and their patients to continue improving clinical behaviors.

### **Outcome Evaluation**

Group dynamics occasionally encourage an individual to take control of a group and complicate the implementation of any project or task. If a project is not designed in a way that clearly resolves that individual's resistance to change, it risks failing. One individual could be unwilling to accept evidence-based information from randomly-controlled clinical trials or any other source and decide to take the tack of rebelling. To

enhance patient outcomes in our facility, the ACC/AHA (Fleisher et al., 2014) guidelines were presented including each step of the step-wise algorithm—a simple to use method of evaluation of risk. Following the algorithm was a non-confrontational method to allow all the anesthesia staff to participate. The educational material used included knowledge of the national guidelines and included actual patient scenarios from local hospital cases. The scenarios were on our hospital's electronic anesthesia database.

Two recent cases with no known cardiovascular co-morbidities experienced minor short-term adverse vital sign problems during anesthesia and were shown to parallel some information presented in the research literature and educational meeting. Both cases were pre-implementation and shown to have not paralleled the new protocols being recommended in the ACC/AHA (Fleisher et al., 2014) guidelines. Research from the VISION trial literature was the primary driver for the scenario presentation to help anesthesia providers see the importance of performing thorough cardiac evaluations even when no direct evidence of cardiac disease was present (Abbott et al., 2018).

### **Discussion of Practice Change**

Following Institutional Review Board project approval, the anesthesia participants began using the step-wise algorithm in most instances. As a result, several patients were identified with high cardiac risk and interventions were appropriately taken. Among recent surgery cases that had to be rescheduled following cardiac evaluation, one patient did not inform staff when questioned that he had a defibrillator-pacemaker until the morning of surgery. The pacemaker had not been recently electronically interrogated. The patient stated: “Two shocks occurred about 4 months ago, several days apart.” The patient was sent to his cardiologist for evaluation. If this patient would have had the



RCRI (Lee et al., 1999) administered, it would have shown during the five to seven day pre-anesthesia time period a way to have the patient's pacemaker interrogated before he came to the pre-operative area on the day of surgery. He would have been sent to the cardiologist on the same day.

A second patient misunderstood when the anticoagulant medicine was to be stopped. Another patient for non-emergency surgery required postponement until more information about her cardiac stent identification card was verified. Initially, the type of stent or whether it was a bare metal stent, drug-eluting stent, or the date of placement was unknown. The patient was taking long acting mono-therapy anticoagulant medication. The patient was also not sure when the stent procedure was performed. The pre-anesthesia clinic nurse called the anesthetist on call and told the patient we had to have all of that information. The patient was told stent placement caused irritation (arterial epithelial cell abrasion) and the chemical used in drug-eluting stents retarded (epithelial) healing. The surgeon was notified the patient needed to see his cardiologist. Following a visit with his cardiologist, the report returned from that office said "DO NOT stop anticoagulant, this patient will have a heart attack!" Patients with stents taking anticoagulants are often at high risk for re-thrombosis and myocardial infarction if anticoagulant is not correctly managed perioperatively. The patient had the surgery with no problems and made the follow-up appointment doing well. The pre-anesthesia evaluation clinic has changed the methods used to screen the patients and notify anesthesia staff as soon as they see a patient with significant cardiac co-morbidities or patients outside of normal vital signs.

There were some challenges for the project manager with attempting to include as much of the complex guidelines all in one project. Getting enough information disseminated to anesthesia staff on the guidelines, the two assessment tools, and the step-wise cardiac evaluation algorithm took time and persistent encouragement of nurses and anesthetist. The success will be more obvious to everyone as soon as the hospital is back handling a full surgery schedule of elective cases and identifying moderate and high-risk cardiovascular patients.

### **Strengths and Benefits**

A direct benefit from the project was the patient will be evaluated and have information about certain physical tendencies for cardiovascular disease discussed with them before surgery such as no risk factors or high, intermediate, or low functional capacity, or high cardiac risk. Some physical conditions are harder to detect and might not be known by the patient until being examined or put under the stress of surgery. Early detection of certain types of cardiovascular conditions allows the medical team to modify and hopefully improve a patient's health status prior to surgery with less potential for anesthesia complications.

The project's specific objectives focused on education (updating previous knowledge) of anesthesia providers, promoting early patient engagement, and identification of active cardiac disease. The training received in anesthesia school is sometimes thought by an individual to be all a practitioner would need to navigate through the entire length of their career. When presenting complex material of this type, individual attention has to be taken to make the education dynamic and relevant. The

decision was made to include patient scenarios from our own institution rather from a certification course or a review book.

### **Project Limitations**

The obvious limitation was the hospital being in emergency status due to the COVID-19 pandemic and limited patient admissions. Another limitation of the project was locating an evidence-based definition of quality perioperative anesthesia care and the fact that no defined standard of care has yet been established for cardiac evaluations before non-cardiac surgery. The level of evidence was more often from expert opinions in anesthesia and cardiac care professional journals. An attempt was made to include only I-A and I-B or level II-A evidence but it was not always available.

Significant limitations were present in trying to measure quality improvement based upon rarely occurring events. Quality improvement was not easily identified if the most prevalent indicator was intra-operative mortality or within 30 post-operative days since most anesthesia providers never experienced this event in their career.

A systems issue and a common limitation in many institutions, both educational and clinical, is hesitation and avoidance of reporting adverse outcomes. A managerial style producing minimal reporting of adverse outcomes or frequent near-miss (sentinel events) is treated with punitive measures rather than used as a learning or quality improvement activity. When reporting events is absent, it often establishes an even greater quality issue. The department of anesthesia in this facility in the past has had problems with this attitude. Events should be reported without favor or bias and a management-level meeting with the individual is handled professionally and used for learning. A review occurs when individuals follow current processes but have adverse

events. If the process needs to be reviewed, discarded, or improved, the opportunity to educate and improve is still preserved.

Neither assessment tool— the DASI (Hlatky et al., 1989) or the RCRI (Lee et al., 1999)—had specific predictive value for a post-operative major adverse cardiac event. These assessment tools provided estimation of future risk. The induction of anesthesia and resulting intraoperative events such as blood loss, hypothermia, and hypotension might significantly alter the conditional status of the patient following the pre-anesthesia evaluation and the resulting outcomes are not predictable for all surgeries.

Another limitation was clinical practitioners' resistance to change. Both physicians and nurses might express this attitude and if not addressed can sabotage any project. This project did not experience strong resistance in the broad sense but did have some argument when discussing what medications should be given or not given on the day of surgery. This was not unexpected and the literature and the guidelines discussed this as being common worldwide. The small educational meeting did allow each participant an opportunity to ask questions and they received examples of process methods, other key project information, and goals of the project.

The biggest limitation to the project was the inability to recruit a normal volume of patients due to the interruption in surgery services. Patients were not allowed to have elective surgeries due to the COVID-19 pandemic. This interruption lasted for months and it was impossible to collect significant amounts of data for the project.

### **Implications and Recommendations in Advanced Nursing Practice**

The implementation strategy for this project had to account for both outdated and falsified clinical trials as well as personal resistance to change. Information in the POISE

trials was in place for nearly a decade before large enough study started recognizing statistically significant differences from the results in POISE (Bennett & Siegrist, 2016). This was hard to change when healthcare providers had followed those recommendations for so long. Following the problems associated with the randomly-controlled POISE trials and the group's enthusiasm to promote the use of beta-adrenergic blockers in all types of non-cardiac and cardiac surgery patients, the 2014 ACC/AHA guidelines (Fleisher et al., 2014) were published. The guidelines used a more reserved approach to recommendations about medication usage that could be considered controversial.

The main recommendation discussed in the education meeting for implementation was beta-adrenergic blockers in patients with known myocardial ischemia or previous myocardial infarction were to be confirmed with evidence other than just an electrocardiogram, preferably with an elevated troponin. The suggestion to anesthesia providers was taking a baseline troponin level on the day of surgery in high risk myocardial disease patients was reasonable practice. Two articles from the literature review helped provide evidence to anesthesia staff who were resistant at first to the change.

The European Society of Cardiology/European Society of Anesthesiologists (cited in Kristensen et al., 2014) published their cardiac evaluation guidelines the same year as the ACC/AHA (Fleisher et al., 2014). More specific emphasis was given in the European Society of Cardiology/European Society of Anesthesiologists guidelines on even the type of beta blockers, atenolol instead of metoprolol, and when (number of days) they should be initiated before non-cardiac surgery. The articles were able to enlighten and positively change opinions of anesthesiologists, nursing staff, and a few surgeons.

An additional strategy set as an objective took into account the differences in appropriate timing for cardiac evaluations before surgery to allow time to correct conditions before anesthesia. The surgeons usually promoted scheduling pre-operative screening up to about three to four days ahead of time and anesthesia providers wanted patients to be assessed no less than five to seven days. Optimizing patients requires time to evaluate and time to treat before proceeding to surgery. Most patients could be started on guideline-directed medical protocols a week before surgery and see the results of medications and if they were efficacious or not.

The step-wise protocol for evaluating patients was the simplest part of the implementation of the project. The algorithm method was not new to most medical and nursing professionals and was generally and easily accepted. The steps were clear and the phone App for the two assessment tools made a decision much simpler and faster to make regarding a patient's health status.

### **Conclusion**

This project focused on educating anesthesia providers in the step-wise protocol for initial patient engagement, detailed history and physical, cardiac physical examination, estimation of functional capacity, and pre-operative risk stratification using recommended assessment tools. Anesthesia providers learned how to appropriately utilize the step-wise protocol, when to engage the surgeon in improving a high-risk patient's pre-operative cardiac health condition, and how to appropriately minimize perioperative morbidity.

The project was expected to provide enough foundation in cardiac evaluations to allow anesthesiologists to know which tests were best for each co-morbid disease and which

medications were safe for co-administration with anesthesia to avoid major adverse cardiac events. An exemplar was the continuation of angiotensin converting enzyme-inhibitors up to and including the morning of surgery. Regardless of which direction anesthesia providers chose to initiate, protocols should be discussed and accepted on common policy in writing as a system-wide protocol for physicians, pre-operative nurses, and anesthesia providers to promote safe continuity of care.

Quality research from numerous randomized clinical trials and meta-analysis provided evidence-based clinical data to ensure readers that following the ACC/AHA (Fleisher et al., 2014) clinical guidelines for cardiac evaluation was beneficial to healthy patient outcomes. Perioperative cardiac pharmacotherapy requires additional education to allow providers to see results of following the evidence. No clear consensus was found among providers on which medications should be held and which medications were reasonable to continue until the morning of surgery except in the professional opinion of each anesthesia provider.

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**APPENDIX A**  
**ACTIVE CARDIAC DISEASE**

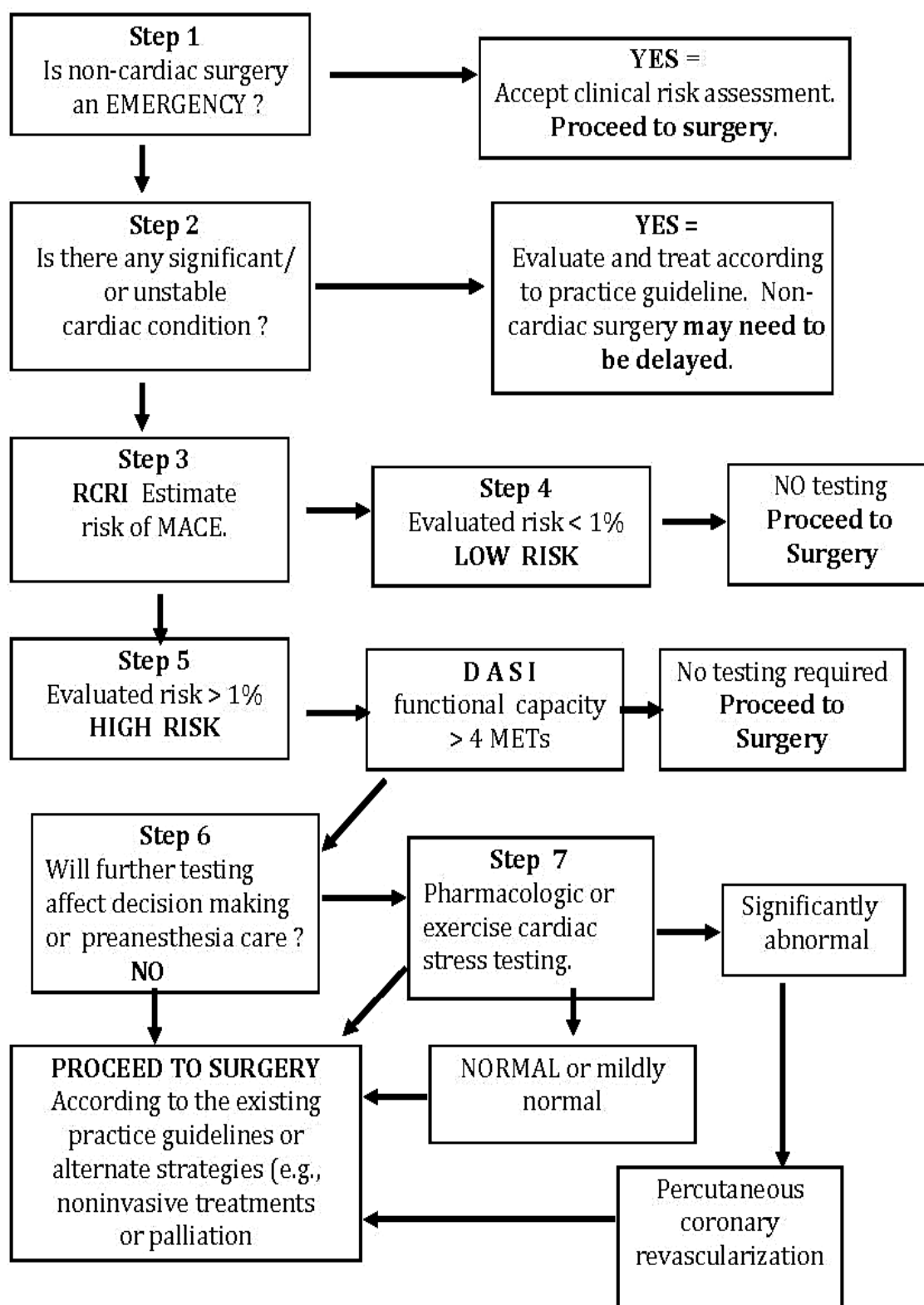


**Active Cardiac Disease**

Coronary Artery disease: Unstable Angina
Heart Failure
Valvular Heart disease: Aortic & Mitral Stenosis, Aortic & Mitral Regurgitation
Conduction Disorders: Sustained Arrhythmia – Atrial fibrillation
Pulmonary Vascular disease Pulmonary hypertension

\* Modified from subject headings: Fleisher et al., (2014)

**APPENDIX B****AMERICAN COLLEGE OF CARDIOLOGY/AMERICAN  
HEART ASSOCIATION STEP-WISE CARDIAC  
ASSESSMENT ALGORITHM FOR CORONARY  
HEART DISEASE IN NON-CARDIAC SURGERY**



**APPENDIX C**  
**REVISED CARDIAC RISK INDEX**

### Revised Cardiac Risk Index

Each risk factor is assigned one point.

- 1) History of ischemic heart disease.
- 2) History of congestive heart failure.
- 3) History of cerebrovascular disease (previous stroke, or transient attack).
- 4) Any history of diabetes (possible need for postoperative insulin).
- 5) Chronic kidney disease (creatinine > 2.0 mg/dl.).
- 6) Surgery for supra-inguinal vascular, intra-peritoneal, or intrathoracic surgery.

<b><u>Score</u></b>	<b><u>% Risk MACE</u></b>	<b><u>Range</u></b>
0	3.9%	(2.8 - 5.4%)
1	6.0%	(4.9 - 7.4%)
2	10.1%	(8.1 - 12.6%)

Adapted from *Revised Cardiac Risk Index* from Lee et al., (2006).  
Percentages for MACE Summarized risk percentages

Note: The current ACC/AHA Guideline defines major adverse cardiac events as a cardiac arrest requiring advanced cardiac life support, a myocardial infarction (electrocardiographic finding of myocardial infarction, ST-elevation of greater than 1mm in more than one contiguous lead, new bundle-branch block, or troponin greater than 3 times normal.) The 2014 ACC/AHA Guidelines modified the original opinion on Revised Cardiac Risk Index based upon new studies of over a million surgeries in the United States.

**APPENDIX D**  
**DUKE ACTIVITY STATUS INDEX**

Item	Activity	Yes	No
1	Can you take care of yourself (eating, dressing, bathing, or using the toilet)?	2.75	0 0
2	Can you walk indoors such as around your house?	1.75	0
3	Can you walk a block or two on level ground?	2.75	0
4	Can you climb a flight of stairs or walk up a hill?	5.50	0
5	Can you run a short distance?	8.00	0
6	Can you do light work around the house like dusting or washing dishes?	2.70	0
7	Can you do moderate work around the house like vacuuming, sweeping floors, or carrying in groceries?	3.50	0
8	Can you do heavy work around the house like scrubbing floors, or lifting and moving heavy furniture?	8.00	0
9	Can you do yard work like raking leaves, weeding, or pushing a power mower?	4.50	0
10	Can you have sexual relations?	5.25	0
11	Can you participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?	6.00	0
12	Can you participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?	7.50	0

**Formula:** Duke Activity Scale Index (DASI) = SUM (values for all 12 questions)

Estimated peak oxygen uptake in mL/min =  $(0.43 \times (\text{DASI sum total})) + 9.6$

Interpretation: • minimum value 0 • maximum value 58.2

\* Hlatky et al. (1989)

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**RE: Duke Activity Scale Index**

Mr. R. S. Leeper

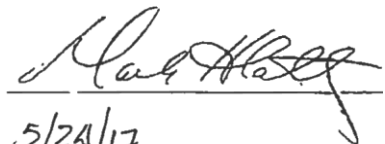
Permission is hereby granted for the academic use of the Duke Activity Scale Index for research in the Department of Anesthesia. The clinical project use is in partial fulfillment of Doctor of Nursing Practice at the University of Northern Colorado.

"Implementation of ACC/AHA Cardiovascular Evaluation Guidelines for  
Preanesthesia Evaluation of Patients having Non-cardiac Surgery."

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**RELEASE FORM**

Permission is hereby granted by the Copyright owner for use of the Duke Activity Scale Index in the manner described above.

  
5/24/17

Dr. Mark A. Hlatky, M.D.  
Professor of Cardiovascular Medicine  
Stanford Medical School



**APPENDIX E****CONSENT FORM FOR HUMAN PARTICIPATION**

## QUALITY IMPROVEMENT PROJECT CONSENT FORM FOR HUMAN PARTICIPATION

**Project Title:** *Implementation of ACC/AHA Cardiovascular Evaluation Guidelines for Patients having Non-cardiac Surgery*

**Project Manager:** Robert S. Leeper, CRNA, MSN  
email: leep6112@bears.unco.edu

**Committee Chair:** Melissa Henry, PhD, RN, FNP-C  
email: Melissa.Henry@unco.edu  
University of Northern Colorado, School of Nursing,  
Gunter Hall 3340, Greeley, CO 80639

**General Purpose:** The purpose of this Quality Improvement project is to help anesthesia providers become familiar with the 2014 ACC/AHA Guidelines for Preanesthesia Cardiac Evaluation. A self-administered 12-question survey will be used, called the Duke Activity Score Index.

**Procedure:** You will be asked by a surgery nurse to independently complete the questionnaire about daily physical activities. One of the anesthesia staff, or project student manager will review your questionnaire before surgery. He/she will also perform a pre-anesthesia interview.

**Disclosure risk:** Potential risk to participants for this project, are minimal. This project does not include medications or intra-operative anesthesia care. The information you provide in the questionnaire, and some data from your electronic medical record (including age, gender, and your blood pressure, heart rate, and exercise ability) will be used to determine readiness for surgery. The data will be reported in a non-identifiable way to protect your identity.

**Direct benefits:** A direct benefit of this project as a participant includes early identification of your physical, or functional capacity. Early detection of certain types of cardiovascular conditions if present, will allow your medical team to modify and potentially improve your health status prior to your surgery.

**Participation:** Participation in this project is voluntary. If you wish to not participate in The project, you are free to say so at any time. You may simply verbalize your wish to withdraw from the project by notifying the nurse or the anesthesia provider. Your

decision to participate or not participate will not affect you or your surgery/ procedure in any way.

**Confidentiality:** Your confidentiality will be protected. There will be no patient identifiers attached to your completed document. The completed document will be kept safe in a confidential folder in the anesthesia department file cabinet. Only the anesthesia providers and project manager will have access to the data files.

Having read the above and having had an opportunity to ask questions, please sign below if you would like to participate in this quality improvement project. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a QI project participant, please contact Nicole Morse, Office of Research, Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.

\_\_\_\_\_  
Participant Printed Name:

\_\_\_\_\_  
Signature:

Date: \_\_\_\_\_

**APPENDIX F**  
**PRACTITIONER SELF-ASSESSMENT**

### Practitioner Self-Assessment

**Project Purpose:** This is a quality improvement project to help familiarize staff with recommendations found in the current ACC/AHA Guidelines for Cardiac Evaluation and to use the Duke Activity Score Index and the Revised Cardiac Risk Index. Participation is optional. You will be asked to take a self-assessment quiz. Consent is implied when you voluntarily take the self-assessment and initial the cardiac risk assessment tool when used. You may opt-out of the project at any time.

- 1.) What is not part of an essential pre-anesthesia evaluation?
  - a.) medical review of systems
  - b.) ECG
  - c.) estimate functional capacity
- 2.) In the 2014 ACC/AHA Cardiac Evaluation Guideline how should the functional capacity determined?
  - a.) 3-minute Walk Test
  - b.) Duke Activity Scale Index
  - c.) CPET - Cardiopulmonary exercise test
- 3.) When should pre-operative testing be ordered?
  - a.) standing orders for CBC and CMP for all patients over age 50.
  - b.) results may increase probability of altering anesthesia care plan.
  - c.) ordered when it will impact a decision to proceed to surgery.
- 4.) When should surgery be delayed for hypertension ?
  - a.) 160/90    b.) 180/100    c.) systolic > 200    d.) diastolic < 110
- 5.) Revised Cardiac Risk Index score = High Risk, needing cardiac testing?
  - a.) 1    b.) 0    c.) > 2 %    d.) 3 or > 3
- 6.) What is the importance of measuring functional capacity?
  - a.) protect hospital and practitioner liability
  - b.) predict high cardiac risk of perioperative complication
  - c.) predict 30-day mortality
- 7.) Patients with RCRI score > 3 have what is Percent % probability of perioperative major adverse cardiac event, myocardial infarction, or stroke?
  - a.) 3.5 %    b.) 5.2 %    c.) 8.75 %    d.) 15%.
- 8.) Revised Cardiac Risk Index = "2," the risk of major adverse cardiac event is ?
  - a.) 14.2 %    b.) 10.1 %    c.) 5.1

**APPENDIX G**  
**INSTITUTIONAL REVIEW BOARD APPROVAL**



*Institutional Review Board*

DATE: April 16, 2020

TO: Robert Stanley Leeper, CRNA, MSN

FROM: University of Northern Colorado (UNCO) IRB

PROJECT TITLE: [1468739-1] IMPLEMENTATION OF ACC/AHA CARDIAC ASSESSMENT GUIDELINES FOR PATIENTS HAVING NON-CARDIAC SURGERY

SUBMISSION TYPE: New Project

ACTION: NOT RESEARCH

DECISION DATE: April 16, 2020

REVIEW TYPE: Administrative Review

The University of Northern Colorado IRB has reviewed your protocol and determined that your submission does not meet the federal definition of research according to CFR 45 Part 46.102.

*(f) Research means a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generalizable knowledge. Activities that meet this definition constitute research for purposes of this policy, whether or not they are conducted or supported under a program that is considered research for other purposes.*

Project activities as set forth in this submission describe an evaluation or assessment and do not require IRB oversight and approval. However, if your procedures change and/or you decide to generalize your findings, please contact the Office of Research & Sponsored Programs to further discuss if IRB approval would be needed.

If you have any questions, please contact Nicole Morse at 970-351-1910 or [nicole.morse@unco.edu](mailto:nicole.morse@unco.edu). Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.