TRANSLATION OF A VASCULAR-SPECIFIC CARDIAC RISK STRATIFICATION TOOL INTO PRACTICE FOR PATIENTS UNDERGOING OPEN ABDOMINAL AORTIC ANEURYSM REPAIR

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Abstract

Background: Postoperative myocardial infarction (MI) is a common complication after open aortic abdominal aneurysm (OAAA) repair. Perioperative cardiac risk stratification informs clinicians and patients of individualized risks of surgery. The Vascular Quality Initiative Cardiac Risk Index (VQI CRI) is a validated, vascular procedure-specific risk stratification tool to calculate the probability of in-hospital postoperative MI.

Local Problem: The leadership within the Division of Vascular Surgery at a large academic medical center in the Mid-Atlantic region identified a need for more accurate cardiac risk stratification among patients undergoing OAAA repair and supported the implementation of the OAAA VQI CRI risk stratification tool. The purpose of this project was to implement and evaluate the tool's usability and its effect on provider clinical decision-making.

Interventions: Patients undergoing non-emergent infrarenal OAAA repair that met VQI CRI inclusion criteria were prospectively risk stratified by Vascular Surgery providers over a 14-week period. The usability of the tool and the effect on clinical decision-making was determined using the System Usability Scale (SUS) and Provider Decision Process Assessment Instrument (PDPA). Compliance data and the mean postoperative MI risk score were collected.

Results: Providers rated the VQI CRI tool's mobile application as an acceptable interface and rated the tool's usability to be excellent (SUS $\mu = 87.5$). Providers had low degree of conflict with the clinical decision to operate after using the VQI CRI tool (PDPA $\mu = 16.5$).

Conclusion: This project provides initial support regarding the feasibility of implementing a standardized cardiac risk stratification tool for OAAA repair in the Department of Vascular Surgery. This project may serve as a basis for more rigorous evaluation and implementation of vascular procedure-specific risk stratification in the future.

Translation Of A Vascular-Specific Cardiac Risk Stratification Tool Into Practice For Patients Undergoing Open Abdominal Aortic Aneurysm Repair

Approximately 200 million non-cardiac surgery procedures occur worldwide each year; of those, seven million people experience a major cardiac complication and one million people experience death within one year of surgery (Weiser et al., 2008). Vascular surgery is categorized as a non-cardiac surgery. The American College of Cardiology/ American Heart Association (ACC/AHA) clinical practice guideline originally published in 1996 and most recently revised in 2007, provides a framework for clinical decision-making and evaluating cardiac risk for patients undergoing non-cardiac surgery (Fleisher et al., 2007). The guideline recognizes that every surgery has different surgical specific risks and categorizes open vascular surgery as a high-risk procedure. The ACC/AHA guideline recommends that physicians use their judgment to correctly assess perioperative surgical risks and the need for further cardiovascular evaluation and work up in patients undergoing vascular surgery (Fleisher et al., 2007).

The prevalence of comorbidities in patients undergoing vascular surgery is high. The most common comorbidities include coronary artery disease (CAD), heart failure, diabetes mellitus (DM), peripheral artery disease (PAD), obesity, and chronic obstructive pulmonary disease (COPD) (Back et al., 2003; Bertges et al., 2016). Due to the severity of the surgery and the patients' medical comorbidities, risk prediction models, especially assessment of cardiac risk, are widely used to estimate the likelihood of adverse outcomes. The ACC/AHA guideline for non-cardiac surgery emphasizes the use of perioperative cardiac risk stratification and highly recommends the use of the Revised Cardiac Risk Index (RCRI) (Fleisher et al., 2007). The RCRI is a multivariable predictive index, derived from a heterogeneous population of patients undergoing a variety of non-cardiac surgical procedures (Lee et al., 1999). However, only a

small portion of the sample, 21%, included patients undergoing vascular procedures (Lee et al., 1999). This raises questions about the generalizability of this model to accurately predict cardiac events in vascular surgery patients, specifically those patients undergoing open abdominal aortic aneurysm (OAAA) repair. Vascular surgery patients who suffer perioperative or postoperative myocardial infarction (MI) have an increased short and long-term mortality compared to those who do not experience MI (Redfern, Rodseth, & Biccard, 2011; Simons et al., 2013). Due to the known risk factors for postoperative MI in vascular surgery patients coupled with the fact that MI leads to increased mortality, it is imperative to perform an accurate cardiac risk assessment.

The Vascular Quality Initiative Cardiac Risk Index (VQI CRI) for OAAA repair is a validated tool to predict the risk of postoperative MI after vascular surgery (Bertges et al., 2016). The tool is a multivariable predictive index, comprised of 11 variables associated with increased risk for postoperative MI: age, race, body mass index, creatinine, stress test results, prior vascular procedure, history of heart failure, history of COPD, planned proximal clamp position, and planned level of distal anastomosis (Bertges et al., 2016). The VQI CRI tool calculates the probability of in-hospital postoperative MI as a percentage.

A large academic medical center within the Mid-Atlantic region reported an increase in adverse events specifically postoperative MI among patients undergoing OAAA repair. Prior to the implementation of this project, this hospital used the RCRI tool or expert cardiology opinion for cardiac risk stratification. The leadership within the Division of Vascular Surgery identified a need for more accurate cardiac risk stratification among patients undergoing OAAA repair and supported the implementation of the OAAA VQI CRI risk stratification tool in the preoperative setting.

The purpose of this DNP project was to implement and evaluate the utility of the OAAA VQI CRI tool for patients undergoing OAAA repair at an academic medical center in the Mid-Atlantic region. The anticipated outcomes of this DNP project are 1) facilitation of the use of standardized cardiac risk stratification tool in vascular surgery for OAAA repair and 2) improved provider comfort with clinical decision-making.

Theoretical Framework

The adoption and implementation of this project followed the principles outlined by Roger's Diffusion of Innovation Theory (1983). The Diffusion of Innovation Theory was developed to describe the concepts that facilitate the adoption of new ideas into practice change. Diffusion is the "process by which an *innovation* is *communicated* through certain *channels* over *time* among the members of a *social system*" (Rogers, 1983, p. 5). Through the definition of diffusion, Rogers identifies four main elements in the diffusion of innovation; innovation (the new idea), communication channels (how the message travels from person to person), time, and social system (the interrelated units engaged in problem solving to accomplish a common goal). These elements are the precursors of the Innovation-Decision Process model proposed by Rogers. The Innovation-Decision Process is made up of five stages; knowledge, persuasion, decision, implementation, and confirmation (Rogers, 1983).

Each stage in the Innovation-Decision Process follows one another in a time-ordered manner; however, the amount of time it takes each individual to reach each step varies depending on their level of innovativeness. Rogers classifies individuals on the basis of their innovativeness; individuals are classified as early adopters or late adopters. Early adopters consist of the innovator (2.5% of social system), early adaptors (13.5% of social system), and early majority (34% of social system). The late adopters consist of the late majority (34% of social system) and

the laggards (16% of social system). Early adopters tend to hold leadership positions and have an established communication network within the social system compared to late adopters. It is important to be able to identify early adopters in order to target communication and build momentum for an innovation, as the attitudes of early adopters are important in the process of adoption.

The Innovation-Decision Process starts with knowledge; the individual develops knowledge of an innovation and then seeks information about the specific innovation. The aim of this stage is to learn about how and why an innovation works. The persuasion stage starts when the individual's understanding and perceptions towards the innovation contribute towards an emotional response either in support or opposition of the innovation, leading to the decision stage. In the decision stage, the individual either adopts or rejects the innovation. If the individual adopts the innovation, the implementation stage begins. The implementation stage is where the innovation is translated into practice. Reinvention of the innovation can take place during this stage, if the innovation needs to be modified to fit the process of adoption within a specific social system. The last stage is the confirmation stage; during this stage the individual looks for support from the social system to confirm their decision. Depending on the support for the innovation and the attitude of the individual either continued adoption, late adoption, or discontinuation occurs during this stage. Each stage involves utilization of communication channels.

The Diffusion of Innovation Theory provided structure and guidance for practice change during this DNP project. It guided the adoption of the OAAA VQI CRI tool (the innovation) by the change agent (DNP student). It also guided how the change agent influenced others (early adopters and late adopter) in the social system (vascular surgery service) to use the innovation in

practice. Lastly the Diffusion of Innovation Theory speaks to sustainability and helped guide the decision process to either continue or discontinue adoption of the innovation based on the perceptions of the social system after implementation.

Literature Review

The need for appropriate and accurate cardiac risk stratification in the vascular surgery population specifically patients undergoing OAAA repair is imperative and is the focus of this literature review. A literature search using CINAHL, PubMed, and Science Direct was conducted using the following keywords: *vascular surgery, non-cardiac surgery, risk stratification, open AAA repair, postoperative MI, Revised Cardiac Risk Index,* and *VQI CRI.*

The literature review began broadly with a review of the long and short-term effects of postoperative MI in vascular surgery patients followed by the evidence regarding the use of the RCRI tool and its associated limitations within the vascular surgery population. Finally, the review concluded with the current evidence regarding the use of the OAAA VQI CRI tool for cardiac risk stratification.

Effects of Postoperative MI in Vascular Surgery Patients

Cardiac complications account for 15% of all perioperative complications after elective OAAA repair (Schermerhorn & Cronenwett, 2005). Of those cardiac complications, 2-8% are defined as MI (Schermerhorn & Cronenwett, 2005). A number of studies have shown that postoperative MI increases short term and long-term mortality in non-cardiac surgery patients, specifically patients undergoing vascular surgery.

Analysis of evidence. Van Waes et al. (2013) examined the relationship between postoperative MI and 30-day mortality in 2,216 patients who underwent non-cardiac surgery. The sample included 331 patients who underwent vascular non-cardiac surgery. They found that

cardiac troponin 1 (cTn1) elevation was an independent predictor of 30-day mortality. Van Waes et al. demonstrated that the risk of death was dependent on the degree of cTn1 elevation.

Kim et al. (2002) evaluated the association between postoperative cTn1 levels and six-month mortality in 229 patients who underwent vascular surgery. They found that patients with postoperative peak cTn1 levels equivalent with MI had significantly higher levels of mortality compared to patients with cTn1 levels below the diagnostic threshold. Mortality was 21% and 6% respectively. Kim et al. also demonstrated that patients with postoperative MI had a four-fold increase in mortality risk compared with patients with cTn1 levels below the diagnostic threshold (OR, 4.2; 95% CI [1.4-12.4]). Similarly to Van Waes et al. (2013), Kim et al. concluded that there was a dose-dependent relationship between cTn1 concentrations and six-month mortality, meaning the higher the cTn1 concentration the higher the six-month mortality.

McFalls et al. (2008) examined the postoperative outcomes of 377 vascular surgery patients who had cTn1 levels greater than 0.1mg/L, corresponding with postoperative MI. They found that one-year mortality following vascular surgery was significantly higher in patients with MI (20%) than in patients with cTn1 levels below the diagnostic threshold (4.7%) ($p< 0.001$).

Simons et al. (2013) conducted a multi-center cohort study evaluating the association between postoperative cTn1 elevation and long-term mortality in 16,363 vascular surgery patients. Long- term mortality was defined as five years. They found that postoperative MI was a significant independent predictor of death during the first five years postoperatively compared to patients who did not experience postoperative myocardial ischemia ($p<0.0001$).

Synthesis of evidence. Every study defined MI by using the universal definition of MI; peak cTn1 level above the 99th percentile of the upper reference limit (Thygesen et al., 2012). However, Simons et al. (2013) does not specifically list the value point definition of MI, rather

they list their data in a categorical fashion: no ischemia, troponin elevation only, or MI. Simons et al. conducted a multicenter study, therefore reference values were not the same at each institution. The consistent definition of MI strengthens the results and validity of the evidence.

All studies examined included patients who underwent a surgical procedure that was classified as non-cardiac surgery. However, three of the four studies specifically examined patients who underwent vascular non-cardiac surgery. Each study examined mortality risk at different subset of postoperative time- 30 days, 6 months, 1 year, and 5 years. The results of the studies were consistent among all studies and timeframes; patients who experienced postoperative MI experience higher rates of mortality. The evidence shows that postoperative MI and postoperative cTn1 level was independently associated with increased mortality. Due to the serious implications of postoperative MI following vascular surgery, improved strategies to identify patients who are at risk are needed.

Current Cardiac Risk Stratification Utilized in Vascular Surgery

When considering a patient for surgery, a pre-operative clinical evaluation is essential to reduce postoperative cardiac complications. Risk predictive models can help guide providers' clinical decision-making and help patients understand their mortality risk. Many different cardiac risk stratification tools have been developed. The RCRI is the most commonly used risk stratification tool in non-cardiac surgery (Lee et al., 1999). However, the literature has shown that the RCRI has several limitations in predicting cardiac risk in the non-cardiac vascular surgery population.

Analysis of evidence. A systematic review of 24 studies by Ford, Beattie, & Wijeysundera (2010) evaluated the ability of the RCRI to predict cardiac complications and mortality after non-cardiac surgery. The sample consisted of 792,740 patients from 24 studies.

Ford et al. found that the RCRI demonstated moderate performance at discriminating between low and high risk patients when used in a mixed heterogenous sample of non-cardiac surgeries (AUC 0.77). However, Ford et al. found that when the RCRI was used on a homogenous sample of vascular non-cardiac surgeries, the RCRI performance was poor at discriminating between low and high risk patients (AUC 0.65). They concluded that the data does not support the use of the RCRI to predict all-cause mortality in noncardiac surgery populations (AUC 0.62).

Gupta et al. (2011) developed their own cardiac risk calculator for patients undergoing non-cardiac surgery and compared its accuracy to the RCRI scale. The sample was statified into two categories, non-cardiac surgery and aortic/non-cardiac vascular surgery, to further look at the accuracy of the two scales. Gupta et al. found that when the new risk model was applied specifically to patients who underwent aortic/non-cardiac vascular surgeries, the C statistic of the model was 0.746, which indicates strong discrimination. When the RCRI was applied to that same sample, the C statistic was 0.591, indicating poor discrimination. Gutpa et al. concluded that RCRI lacks discrimination and predictive ability in the vascular surgery population.

Bertges et al. (2010) conducted a prospective multi-center cohort study comparing the accuracy of the RCRI with the Vascular Surgery Group of New England Cardiac Risk Index (VSG-CRI) to predict cardiac complications. The sample consisted of 10,081 vascular patients of which 1,110 underwent OAAA repair. Bertges et al. found that RCRI underestimated the risk of cardiac complications in patients undergoing OAAA repair across all levels of risk- low, intermediate, and high. They also reported that in high risk patients the RCRI underestimated the cardiac risk for OAAA repair by threefold (predicted risk 11%, actual event rate 36.7%).

Gualandro et al. (2017) conducted a retrospective analysis comparing the performance of the RCRI to the VSG-CRI in predicting major cardiac events in patients undergoing arterial

vascular surgery. The sample consisted of 954 patients who underwent arterial vascular surgery, 107 of which underwent OAAA repair. Gualandro et al. found that RCRI and VSG-CRI both underestimated the rate of major cardiac events (AUC 0.58, 0.63 respectively). They also reported that of the patients who underwent OAAA repair, 15% experienced cardiac events and 9.3% experienced MI.

Bryce et al. (2012) conducted a prospective multi-center cohort study comparing five validated preoperative risk stratification scoring systems for patients undergoing OAAA repair and examined their ability to predict mortality and adverse cardiac events. The RCRI was one of the examined scoring systems. Statistical analysis of the RCRI scale revealed low accuracy in predicting cardiac death, major adverse cardiac outcomes and mortality (AUC 0.525, 0.596, 0.578 respectively). Bryce et al. found that the RCRI scale had poor sensitivity and specificity for all outcome measures- cardiac death (60%, 68%), major adverse cardiac outcomes (63%, 38%) and mortality (45%, 68%).

Synthesis of evidence. The current evidence does not support the use of the RCRI to predict cardiac complications and/ or major adverse cardiac events in the vascular surgery population, especially in patients undergoing OAAA repair. Major adverse cardiac events and cardiac complications were defined differently in each study, however, every study included MI and CHF within their definition. Byrce et al. (2012) used the most comprehensive definition of major adverse cardiac events, which included MI, cerebrovascular disease, CHF, chronic renal failure, COPD, white cell count, and prothrombin time. Due to this broad definition overestimation of actual events could have occurred. Overall, the literature finds that RCRI lacks discrimination and predictive ability in the vascular surgery population (Bryce et al., 2012; Ford et al., 2010; Gualandro et al., 2017; Gupta et al., 2011; Moses et al., 2017).

Proposed Use of the VQI CRI Tool

Analysis of evidence. The Vascular Quality Initiative (VQI) group recognized the need for an improved risk stratification tool, particularly one that was specific to vascular surgery. Bertges et al. (2016) developed and validated the VQI CRI tool to predict postoperative MI after vascular surgery, specifically in carotid endarterectomy (CEA), infrainguinal bypass (INFRA), suprainguinal bypass (SUPRA), endovascular aneurysm repair (EVAR) and OAAA repair. Risk models for each procedure were developed and then internal and external validations of the models were completed. The sample consisted of 88,791 patients from over 350 hospitals in the United States and Canada. Inconsistent discrimination was noted when the all-procedures model was applied to individual procedure cohorts. Given this, procedure-specific models were developed. The sample consisted of 6,242 patients who underwent OAAA repair. Variables significantly associated with risk for postoperative MI in OAAA repair were identified as age, creatinine greater than 1.8mg/dL or dialysis, prior vascular procedure, and BMI greater than 30.3. The OAAA VQI CRI showed adequate discrimination (AUC 0.72) and excellent calibration (Hosmer-Lemeshow goodness of fit test, P=1). The OAAA VQI CRI is applicable to patients who undergo non-emergent open infrarenal AAA repair. The OAAA VQI CRI does not apply to and is not validated in patients with ruptured aortic aneurysms. The VQI CRI interactive algorithm can be accessed via a website or a free smart phone application for IOS and Andriod devices through QxCalculate (see Appendix C).

Synthesis of evidence. The accuracy of the OAAA VQI CRI tool is comparable with the accuracy of the risk prediction calculator developed by Gutpa el at. (2011). However, Gupta et al. applied the tool to all vascular surgeries without specification of the different vascular procedures. Bertges et al. (2016) showed that an all-procedure model for vascular surgery had

inconsistent discrimination and decreased accuracy when applied to specific vascular procedures. In order to increase accuracy and discrimination a procedure specific model is preferred. Bertges et al. (2016) is the largest study of vascular patients used to validate a cardiac risk prediction tool in the literature to date. It is currently the most valid and reliable tool available. The only limitation of this tool is that it is new and has not been widely used or implemented into practice.

Methods

Description of Project, Sample, and Setting

The focus of the project was to translate evidence into practice. The stakeholders and champions for this project included the Division of Vascular Surgery, specifically the lead nurse practitioner and an attending physician who was the Director of Quality. The project end users are the medical providers (Physicians, Nurse Practitioners, and Physician Assistants) from the Division of Vascular Surgery at a large academic medical center in the Mid-Atlantic region.

The OAAA VQI CRI tool was utilized for all adult patients who were undergoing elective OAAA repair during the 14-week implementation period (see Appendix A). Patients with thoracic or thoracoabdominal aortic aneurysm repair, AAA rupture or who needed emergency surgery for any other reason were excluded from this project. When an appropriate patient was identified, providers accessed the OAAA VQI CRI tool algorithm through either the website or free smart phone application from QxCalculate (see Appendix C). Both the website and free smart phone application were endorsed and validated for appropriate scoring by the VQI group (Bertges et al., 2016).

The DNP student worked with the site coordinator to make a user-friendly template note in EPIC (the medical center's electronic health system) that aided the providers in filling out the OAAA VQI CRI tool. The EPIC note template was also used for documentation of the

"probability of in-hospital postoperative myocardial infarction" which is the generated outcome of the OAAA VQI CRI tool. A copy of the EPIC template used can be seen in Appendix D. Taking into account the average number of elective OAAA repairs seen at this medical center during a similar 14-week period the previous year, the OAAA VQI CRI tool was projected to be completed approximately 12 times.

After completion of the OAAA VQI CRI tool, the provider was asked to complete the System Usability Scale (SUS) to measure the usability of the tool (see Appendix E) and the Provider Decision Process Assessment Instrument (PDPA) to measure the providers' degree of comfort with a medical decision, in this case predicting risk of postoperative MI (see Appendix G). The projected sample size for this project taking into account the number of providers trained to use the tool and projected number of uses was approximately six. Therefore, it was projected that six providers would fill out both the SUS and PDPA instruments (n= 6).

Procedures and Timeline

Implementation of the OAAA VQI CRI tool into practice took place over a 14-week period, however certain aspects of the project were planned prior to that period to maximize the success of the project. The implementation period was limited to 14-weeks due to the confines of the DNP project timeline. Prior to implementation the DNP student leader worked with the champions to identify and recruit a group of end users, along with creating the EPIC template note for documentation. Due to the procedure-specific information needed to complete the OAAA VQI CRI tool, the end users must be surgeons or non-surgeons who are privy to surgical planning information. End users for this project were the Vascular Surgery fellows, Vascular Surgery Nurse Practitioners and Vascular Surgery Physician Assistants.

During the first week of implementation, the end users received an educational email from the project leader on the significance of the problem, the importance of the VQI CRI tool, when to use the tool, and how to document the results within the EPIC template. The end user education also included an interactive training session where providers practiced filling out and using the OAAA VQI CRI tool and using the EPIC note template. The project leader and champions signed off each end user as competent once they independently and correctly filled out the OAAA VQI CRI tool using a standard practice patient. All providers also received a badge backer information card, which highlighted how to access the VQI CRI tool and how to document the results in EPIC, along with the contact information for the project leader for troubleshooting. The purpose of the end user education was to ensure all technology was working appropriately and to ensure all users were educated and comfortable with the proper use and documentation of the OAAA VQI CRI tool.

The implementation period began during week one and continued through week fourteen. During this time, approved providers used the OAAA VQI CRI in all patients who meet inclusion criteria and documented the use of the tool using the EPIC template. The project leader met with the champions and end users weekly for scheduled meeting and intermittently as needed to monitor the implementation process and answer any questions. During the scheduled weekly meeting, the project leader performed chart audits to determine compliance rates. The project leader provided ongoing feedback and education over the course of the implementation period. The end users who used the OAAA VQI CRI tool during the implementation period were asked to complete the SUS survey on usability and the PDPA survey on clinical decision-making following completion of OAAA VQI CRI use. Both surveys were sent to providers electronically. After completion of the 14-week implementation period, data collection and

analysis occurred. A detailed timeline of the implementation process and data collection is outlined in Table 2.

Data Collection

Data collection included compliance, VQI CRI postoperative MI risk scores, and SUS and PDPA survey results.

Compliance. The OAAA VQI CRI compliance was assessed weekly by retrospective chart review. Compliance was defined as documentation of the OAAA VQI CRI risk score in the designated EPIC template note. Compliance data was collected as categorical data- compliant versus noncompliant. Compliance was further broken down into two categories- compliant-done correctly and compliant-done incorrectly. Each time the tool was used the DNP student independently calculated the VQI CRI risk score for inter-rater reliability. Examples of compliant data-done incorrectly would be any result that differs from the DNP student. Overall compliance was determined by measuring the total number of patients in which the OAAA VQI CRI tool was actually used compared to the total number of patients eligible for risk stratification via the OAAA VQI CRI tool.

Vascular quality initiative cardiac risk index (VQI CRI) postoperative MI risk score. VQI CRI postoperative MI risk scores were collected for all patients who met criteria for risk stratification via the OAAA VQI CRI tool, regardless of compliance. Individual item response for the OAAA VQI CRI tool was not recorded, only calculated risk score. No identifying patient specific information was collected.

SUS and PDPA survey results. After competition of the OAAA VQI CRI tool, the project leader electronically distributed the SUS and PDPA surveys to the appropriate provider. The surveys were administered through the online survey service called SurveyMonkey. Survey participation was voluntary and anonymous. In an effort to reduce bias, both surveys were

constructed so that each provider can only complete them once. The project leader transcribed all the survey results into a Microsoft Excel spreadsheet for data analysis purposes.

Tools/ Instruments

Open aortic abdominal aneurysm vascular quality initiative cardiac risk index (OAA VQI CRI). The OAAA VQI CRI tool was used in the perioperative period to determine the probability of postoperative MI. The OAAA VQI CRI is a multivariable predictive index, comprised of 11 variables associated with increased risk for postoperative MI (see Appendix A). The tool yields the risk of postoperative MI as a percentage. As discussed in the literature review, OAAA VQI CRI is a validated tool. Permission to use the OAAA VQI CRI was granted by Dr. Daniel Bertges and the VQI Group (see Appendix B).

System usability scale (SUS). The SUS was used to measure the usability of the OAAA VQI CRI tool (see Appendix E). The SUS is comprised of 10 questions, which are scored using a 5-point Likert scale. The Likert scale ranges from strongly disagree to strongly agree. The odd numbered questions access the positive qualities of the system/tool and the even numbered questions assess the negative qualities of the system/tool (Bangor, Kortum, & Miller, 2008). The SUS is scored using a standard formula to make the direction of all responses consistent. The scoring formula can be seen in Appendix F. The SUS yields a single overall score. The overall score represents a composite measure of the overall usability of the system/tool being studied (Bangor et al., 2008). Individual item responses are not meaningful on their own. Final overall scores can range from 0 to 100, where a higher score indicates better usability.

The SUS is the most commonly used and researched tool to measure usability (Brooke, 2013). Bangor et al. (2008) found that the SUS is a reliable tool, meaning it is a consistent measure of usability (Cronbach alpha = 0.911). The SUS is also a valid tool. The SUS has been

validated in a wide range of technologies and interfaces including cellular phones, web-based interfaces, and non web-based interfaces (Bangor et al., 2008). Additionally, the SUS has proven to remain valid even when used with small samples sizes (Sauro, 2011). The SUS is a nonproprietary tool; meaning permission for academic use is not needed (Bangor et al., 2008).

Provider decision process assessment instrument (PDPA). The PDPA instrument was used to measure providers' degree of comfort with a clinical decision (Dolan, 1999). The PDPA instrument is comprised of 12 questions, which are answered using a 5-point Likert scale. The Likert scale ranges from strongly agree to strongly disagree (see Appendix G). A summary score is calculated by adding the responses from each question together after reversing the scoring for questions 1, 2, 4, 5, and 6 to ensure the direction of all answers are the same (see Appendix H). Summary PDPA scores can range from 12 to 60. Lower summary scores indicate lower degree of conflict with the clinical decision that was made, therefore, indicated greater comfort with the decision (Dolan, 1999).

Dolan (1999) found that PDPA exhibited internal consistency and was a reliable tool (Cronbach's alpha = 0.878). Additionally, Dolan tested the construct validity of the PDPA by hypothesizing that there would be a negative correlation between decision conflict and a decision maker's satisfaction with the decision. Dolan tested this hypothesis using Spearman's correlation coefficient and found that there was a strong negative correlation between the two satisfaction items and the decisional conflict score (Spearman's correlation = -0.53 to -0.67). Thus, showing that the PDPA instrument is a valid tool to measure a providers' degree of comfort with a clinical treatment decision. Permission to use the PDPA instrument was granted by Dr. James Dolan (see Appendix I).

Data Analysis

Data analysis took place at the end of the implementation period after all surveys were collected. All data- compliance, VQI CRI postoperative MI risk scores, SUS results, and PDPA results- were analyzed using descriptive statistics (N, M, SD, %). All descriptive analyses were performed using Microsoft Excel.

Compliance data was analyzed for the duration of the implementation period as a whole. The data and results from the SUS survey were analyzed using the standard SUS methodology and standard formula (see Appendix F). After using the standard formula, the total scores were analyzed. The total score was interpreted using ranges and descriptions recommended by the survey developer, which are as follows: Not Acceptable (0-64), Acceptable (65-84), and Excellent (85-100) (Bangor et al., 2008). The data and results from the PDPA survey were analyzed using the standard PDPA instrument methodology (see Appendix H). Lower scores indicate lower degree of conflict with clinical decision and thus greater comfort with clinical decision.

Protection of Human Subjects

All data collected during this project was stored in a password-protected computer. Only the DNP student had access to the data. No individual patient-specific information was collected for this project. All surveys were collected in a confidential and anonymous manner from clinicians. To protect human subjects during implementation of this project, a University of Maryland Baltimore Institutional Review Board (IRB) for Non-Human Subjects Research (NHSR) query was performed and approved (see Appendix K).

Sustainability

The confirmation stage of Roger's Diffusion of Innovation Theory deals with sustainability of the innovation, in this case the OAAA VQI CRI tool. During this stage, clinicians' expressed

their perceptions of the tool's usability and effect on clinical decision-making by filling out the SUS and PDPA surveys. The results of the surveys indicate the support for the tool.

Results

During the 14-week implementation period, there were four opportunities to implement change through implementation of the OAAA VQI CRI tool on eligible patients. Eligible patients underwent elective infrarenal OAAA repair (see Figure 1). Of those four opportunities, providers were noncompliant with implementation twice (N=2/4, 50%) and compliant with implementation twice (N=2/4, 50%). When the OAAA VQI CRI tool was implemented, it was implemented properly, meaning the tool was filled out correctly yielding the appropriate risk score.

The noncompliant cases were discussed with the Vascular Surgery team for identification of barriers to implementation. Identified barriers to implementation were identified as miscommunication between team members and gaps in knowledge. The first incidence of noncompliance involved miscommunication between team members as to who was going to fill out the tool. The patient was appropriately identified in this case however no one followed up on the utilization of the tool. The second noncompliant case involved a knowledge gap due to a change in practice during implementation. The practice change included increasing the management duties and responsibility of the surgical residents, which included risk stratification. The surgical residents were not originally identified as end users and did not receive education on the tool. Once the practice change was identified, the surgical residents were educated to the same standards as the original end users.

The SUS and PDPA surveys were sent to the providers who properly filled out the OAAA VQI CRI tool. The SUS survey was completed 100% of the time (N= 2). The mean SUS

score was 87.5 (μ=87.5, SD= 3.54). The SUS scores ranged from 85 to 90, which is an acceptable range. The PDPA survey was completed 100% of the time (N=2). The mean PDPA score was 16.5 (μ= 16.5, SD= 2.12). The PDPA scores ranged from 15-18. The demographics of the providers who were surveyed (both SUS and PDPA) included one nurse practitioner with five years of vascular surgery experience and one physician assistant with two years of vascular surgery experience.

The OAAA VQI CRI tool yields the probability of postoperative MI. Postoperative MI risk scores were collected for all eligible patients during the implementation period (N=4). The mean postoperative MI risk score was 7.83% (μ= 7.83%, Median = 8.1%, SD= 3.65%). The postoperative MI risk scores ranged from 3.4% to 11.7%.

Discussion

This translation of evidence into practice project provides initial support regarding the feasibility of implementing a standardized cardiac risk stratification tool for OAAA repair in the Department of Vascular Surgery. However, more data is needed to determine if the VQI CRI tool improved provider comfort with clinical decision-making.

Usability is a measure in which a process or tool can be described within the context of its intended outcome. Usability, as indicated by the SUS, directly effects the translation of evidence into practice. The SUS provides a single reference score of the provider's view of the tool's usability. This includes the tool itself and the interface with which it was used (smartphone application). The SUS scores ranged from 85 to 90, with a mean score of 87.5. According to Bangor et al. (2008) acceptability ranges and adjective ratings, the OAAA VQI CRI tool scored in the acceptable range with an adjective rating of excellent. This means that the providers found the tool and its interface's usability to be excellent and acceptable. Utilization of smartphone

applications in the medical arena is increasing in popularity and allows medical tools to be readily available to providers at anytime (Ventola, 2014). Point of care tools such as VQI CRI, which require extensive mathematics to compute a risk score, would not be available without the use of smartphone applications or website applications. Knowing this interface is acceptable to providers is valuable when choosing other tools/projects to implement in the future.

The results of the PDPA survey shed light on the providers' comfort of decision-making. Decisional conflict stems from the uncertainty about the course of action to take and involves weighing potential risks and benefits of a potential surgery. Providers must find value in the OAAA VQI CRI tool and consider it a positive influence in their decision-making process to further facilitate the use of the OAAA VQI CRI tool in practice. Providers had a low degree of conflict with the clinical decision to operate after using the VQI CRI tool (PDPA $\mu = 16.5$). A low degree of conflict parallels a greater sense of comfort with their decision. This information is useful; however it is important to note that the providers in this sample who completed the OAAA VQI CRI tool were not surgeons. They ultimately were not performing the operation; therefore their comfort with the decision to operate may be inflated. Additionally, the PDPA survey is not valid in this small sample. This information can be used to gain insight into the decision making process of the providers who used the tool, however cannot be generalized to all providers clinical decision-making processes.

Limitations

Project limitations included small sample size, poor compliance with intervention, and lack of follow up to track actual incidence of postoperative MI. The Department of Vascular Surgery performed fewer OAAA repairs during the implementation period than they did in previous years during the same period of time. The lower than anticipated OAAA repair cases

can be explained by patient population, surgeon preference, and patient preference. This organization is a certified aortic center at a large academic medical institution; therefore their patient population tends to be more high risk. High-risk patients are more appropriate for endovascular repair (EVAR). A meta-analysis by Thomas et al. (2014) concludes that EVAR has lower rates of 30-day mortality, 30-day MI, and length of stay in both elective and ruptured AAA repair. The surgeons within this organization prefer EVAR to OAAA repair. Over the last year, this organization performed 41 EVAR procedures compared to 18 OAAA procedures. Additionally, Winterborn et al. (2009) found that 84% of patients with AAA who were being monitored for growth said they would prefer a future EVAR repair opposed to open repair.

The overall compliance of implementing the OAAA VQI CRI tool into practice was 50%. When the tool was implemented into practice, it was implemented accurately 100% of the time. However, low compliance warrants further investigation into the barriers resulting in this outcome. Barriers to implementation included miscommunication between team members, gaps in knowledge, and slow adaptation to culture change. Prior to the implementation of the OAAA VQI CRI tool, there was no standard process for cardiac risk stratification at this organization. Inherently, using the OAAA VQI CRI tool is harder and more time-consuming than not performing risk stratification or consulting cardiology for risk stratification. One could argue this is not a reflection of the tool itself, but possibly a reflection of the implementation process and the culture within this organization. Additionally, there were only four opportunities to implement the tool over the 14- week implementation period. These opportunities were insufficient to create lasting practice change. The results illustrate that when the tool is implemented it is usable, however provider engagement in using the tool remains a barrier.

Roger's Diffusion of Innovation Theory (1983) would describe the stakeholders in this project as late adopters. Late adopters make up one-third of all members of a system. They typically wait until most of their peers have adopted the innovation and the innovation has been deemed successful to adopt the innovation themselves. The innovation- decision process for late adopters is relatively long. Implementation time and a larger sample size would contribute towards increased familiarity with the practice change. Future projects should focus on practice change and team culture.

The mean postoperative MI risk score for OAAA repair at this organization was 7.83%. However, the actually incidence of postoperative MI was not collected during this project. The lack of follow up to track actual occurrences of postoperative MI rates following OAAA repair is a limitation. The average incidences of postoperative MI following OAAA repair in the literature is reported to be between 3.3-5% (Bertges et al., 2016; Gualandro et al., 2017; Simons et al., 2013). However, the average postoperative MI risk score for OAAA repair is not found in the literature at this time. The data collected in this project may serve as a basis for more rigorous evaluation and implementation of vascular procedure-specific risk stratification tool. Evaluation of the tool's accuracy in predicting postoperative MI in this organization's OAAA population would assist in this secondary aim and ensure ultimate buy- in by the late adopters.

Sustainability

The confirmation stage of Roger's Diffusion of Innovation Theory deals with sustainability of the innovation, in this case the OAAA VQI CRI tool. During this stage, clinicians look for support for their decision to adopt, modify, or discontinue the use of the tool. The results of the project provide insight into the support for the tool. The results of the project were disseminated to end users following completion of the data analysis. The identified usability of the VQI CRI

tool and its positive effect on clinical decision-making informed the decision of the practice to continue implementation of this project past the pilot phase. Continued education about the importance of clinical decision making tools and cardiac risk stratification for vascular surgery patients is vital to reinforce the need for project continuation. Furthermore, additional research regarding the accuracy of the tool and its effects on patient outcomes would need to be performed to ensure sustainability and ultimate buy-in by the stakeholders.

Conclusion

Sustained improvements in clinical practice rely on the successful implementation of quality improvement initiatives. Recognizing the presence of a problem within the larger healthcare system is the initial step towards practice improvement. Postoperative MI is a preventable complication following OAAA surgery. Using a validated risk stratification tool has been shown to guide clinician decision-making and contribute towards more selective intervention, as well as inform prophylactic measures preoperatively. However, the success of any quality improvement initiative is limited by the performance of its implementation phase. Remaining work must be done to identify implementation barriers in order to refine or modify the implementation process. The iterative process of engagement, education, and evaluation of the implementation process should guide the Department of Vascular Surgery going forward to improve the success of the intervention and ideally implement meaningful change.

The major focus of this quality improvement process targeted the usability of the OAAA VQI CRI tool. Finding from this project demonstrate that the OAAA VQI CRI has high usability, however, the low compliance of its completion demonstrates that barriers exist towards its wide-scale application. Additionally the project demonstrated that the OAAA VQI CRI is a practical clinical decision- making tool to predict postoperative MI in vascular surgery patients

undergoing OAAA repair. This project provides initial support regarding the feasibility of implementing a standardized cardiac risk stratification tool for OAAA repair in the Department of Vascular Surgery. This was the first step in a multi- phase process of translating evidence into practice to reduce the risk of postoperative MI following OAAA repair. However, more rigorous evaluation and implementation of vascular procedure-specific risk stratification should be completed in the future.

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Table 1. Evidence Review Table

Authors, year	Study objective	Design	Sample (N)	Outcomes studied (how measured)	Results	Level Quality Rating

(Bertges et al., 2016)	The purpose of this study is to develop and validate the Vascular Quality Initiative Cardiac Risk Index (VQI CRI) to predict postoperative MI after vascular surgery, specifically carotid endarectomy (CEA), infrainguinal bypass (INFRA), suprainguinal bypass (SUPRA), endovascular aneurysm repair (EVAR) and open abdominal aortic repair (OAAA).
	
	Risk models for each procedure were developed and then external validation of the model was completed.
	
	**For the purposes of this review table and project we will focus on OAAA results.
		Retrospective multi center cohort study	N= 88,791 patients from the VQI database which is comprised of more than 350 hospitals in the United States and Canada.
			
			Sample was further divided into derivation cohort (n= 61,236) and validation cohort (n=27,555).
			
			Within the derivation cohort, OAAA (n = 2986).
			
			Within the validation cohort, OAAA (n= 3256)
			
			OAAA repair group included patients undergoing infrarenal open AAA repair. All AAA ruptures were excluded from this group.
				<u>Primary outcome measure:</u>
				Postoperative MI (POMI) occurring during hospitalization. Postoperative MI was defined as troponin elevation or clinical electrocardiographic changes consistent with ischemia.
				
				<u>Secondary outcomes/data collected:</u>
				Demographic information was collected on each patient including: age at time of procedure, gender, ethnicity, and race. Comorbidities information was collected on each patient including: history of CAD, DM (insulin dependent vs controlled on oral medications or diet), hypertension, tobacco use (never, <1 year prior, or current), renal insufficiency (defined as serum creatinine concentration >1.8mg/dL), results of preoperative stress testing (not performed, negative for ischemia, positive for ischemia, or both), prior coronary revascularization by CABG or percutaneous coronary intervention (within 5 years or greater than 5 years before surgery), and history of prior vascular procedure.
				
				<u>Data collection:</u> Data was collected and entered by physicians, nurses, or dedicated data abstractors. After data collection less than 0.2% of data was missing and these observations were excluded from the analysis.
				
				<u>Statistical analysis:</u>
				<u>Risk Model Construction:</u> In order to develop a predictive postoperative MI model, all procedures were separated
					Within the OAAA derivation cohort, POMI occurred in 4.9% of patients (n=142, P< .0001), with distribution of troponin-only POMI in 2.8% vs clinical/ECG diagnosed POMI in 2.0%.
					
					Patients with POMI were older, with no significant gender or racial differences. Patients with POMI had significantly more comorbidities including CAD, HTN, DM, CHF, COPD, and renal insufficiency. Anesthesia type does not show a statistical significant difference on POMI.
					
					Inconsistent discrimination was noted when the all procedures model was applied to the individual procedures. Given this, procedure-specific models were developed.
					
					Variables significantly associated with risk for POMI after OAAA can be interpreted through odds ratios for components of VQI CRI for open AAA
					• Age continuous (OR=1)
					• Creatinine >1.8 or dialysis (OR= 2)
					• Stress test
					  ○ Normal vs not done (OR =1.1)
					  ○ Abnormal vs not done (OR 1.4)
					• Prior vascular procedure (OR =1.7)
					• CHF any vs none (OR =1.5)
					• h/o CABG/PCI (OR= 1.5)
					• Race non white (OR= 1.6)
					• COPD
					  ○ History vs none (OR=1.6)
					  ○ Medication/oxygen vs none
						Level: II
						
						Quality: A

				out as individual covariates. Multiple statistical analyses were completed (t-test, χ^2 test, Fisher exact tests) to compare the POMI and no-POMI groups from the derivation data sets. Risk models were constructed and plotted against AUCs. Predictors needed to be within 1% of the AUC to be included in the final model. Multivariable logistic regression was used to create an all-procedure and individual procedure-specific risk calculators based on the derivation cohort. <u>Risk Model Validation:</u> Independent data sets were used for the external validation of the model (validation cohort). The coefficients of the model were used to estimate the probability of POMI for each patient in the validation cohort and resulting AUC was reported. Observations from the validation cohort were assessed for discrimination and calibration of the all-procedures model. The discrimination and calibration of the procedure-specific model was used to predict the outcome for the same patients and compared with the all-procedure model. The same was done for each individual procedure-specific model.	(OR= 1.4) • Proximal clamp o Above one renal artery (OR= 1.2) o Above two renal arteries (OR= 1.0) o Supraceliac (OR= 1.9) • Distal anastomosis o CIA vs aorta (OR= 1.1) o EIA/CFA vs aorta (OR= 1.3) • BMI o 2^{nd} vs 1^{st} quartile (OR= 0.9) o 3^{rd} vs 1^{st} quartile (OR=0.8) o 4^{th} vs 1^{st} quartile (OR= 0.6) BMI showed an inverse relationship, with the lowest quartile associated with the highest risk of POMI. OAAA model performance was fair, with an uncorrected AUC of 0.72 (95% CI, 0.69-0.77) and calibration was excellent (goodness of fit test P= 1). Procedure specific VQI CRI is a validated tool and a practical clinical decision making tool to predict POMI after vascular surgery.	
(Bertges et al., 2010)	The purpose of this study was to compare the accuracy of the RCRI with the Vascular Surgery Group of New England Cardiac Risk Index (VSG-CRI) to predict cardiac complications.	Prospective multi center cohort study	N= 10081 patients who underwent CEA, lower extremity bypass, EVAR, or OAAA within the Vascular Study Group of New England between 2003 to 2008. • CEA (n= 5293) • EVAR (n= 1005)	<u>Primary outcome measure:</u> In hospital cardiac complications defined as MI, clinically significant arrhythmia, or CHF. <u>Secondary outcome measures:</u> Over 70 demographic and comorbidity information was collected on every patient. <u>Statistical analysis:</u> <u>Comparison with RCRI</u>: The study	RCRI underestimated the risk of cardiac complications in patients undergoing LEB, EVAR, and OAAA across levels of low to high risk. RCRI underestimated the cardiac risk for OAAA by threefold in high risk patients. The VSG- CRI more accurately predicted cardiac complications after OAAA for both low and high-risk groups.	Level: II Quality: A

	**For the purposes of this review table and project we will focus on OAAA results.		• LEB (n= 2673) • OAAA (n= 1,110) The OAAA group excluded emergent operations, ruptured AAA and suprarenal open AAA repairs.	evaluated the incidence of cardiac outcomes in patients stratified according to the number of RCRI risk factors they possessed. The observed rates of cardiac outcome were compared with the predicted rates of cardiac outcomes by the RCRI. <u>Development of a risk prediction model for cardiac complications:</u> The sample was divided into derivation and validation cohorts. Multivariate logistic regression model were used to develop a scoring algorithm called the VSG-CRI. →Study analyzed the ability of RCRI to accurately predict in-hospital adverse cardiac events. Then developed a vascular surgery specific cardiac risk index and validated it within the sample.	The VSG-CRI was found to more accurately predict in-hospital cardiac events after vascular surgery compared to the RCRI in all vascular surgery procedures studied.	
(Bryce, Payne, Gibson, Kingsmore, Byrne, & Delles, 2012)	The purpose of this study is to examine and compare five validated preoperative risk stratification scoring systems for patients undergoing open AAA repair and assess their ability to predict mortality and adverse cardiac events. The five stratification systems: Glasgow Aneurysm Score (GAS), Vascular Physiology only Physiological and Operative Severity Score for enumeration of	Prospective observational multi-center cohort study	N= 106 patients undergoing OAAA repair	<u>Primary outcome measures:</u> All cause mortality, major adverse cardiac events (MI, CVD, CHF, chronic renal failure, COPD white cell count, and prothrombin time) and cardiac death. <u>Secondary outcome measures:</u> Information regarding demographics, comorbidities, procedural details, lab values and postoperative complications were collected on all patients in the study. <u>Statistical analysis:</u> All five risk stratification scoring systems were scored for each patient undergoing OAAA repair. The indices were then compared using ROC analysis and AUC estimates.	15% of patients suffered major adverse cardiac events within 30 days of surgery. Five patients suffered cardiac death and 11 patients suffered non-fatal MI. The 30-day overall mortality was 8.5%. The study found that patients who suffered a cardiac death had significantly higher platelet levels and prothrombin times (p= 0.019, p= 0.008). ROC analysis of the GAS, VBHOM, and RCRI scales revealed low accuracy in predicting cardiac death, major adverse cardiac outcomes and all cause mortality (GAS AUC 0.515, 0.515, 0.622) (VBHOM AUC 0.592, 0.626, 0.684) (RCRI AUC 0.525, 0.596, 0.578). The study found that the sensitivity and specificities were poor for all three scales and all scales performed poorly in predicting all outcome measures.	Level: II Quality: A

	Mortality (V(p)-POSSUM), Vascular Biochemical and Hematological Outcome Model (VBHOM), Revised Cardiac Risk Index (RCRI) and Preoperative Risk Score if the Estimation of Physiological Ability and Surgical Stress Score (PRS of E-PASS).				The V(p)-POSSUM and PRS of E-PASS performed well for predicting major adverse cardiac events, predicting cardiac death and predicting overall mortality (V(p)-POSSUM AUC 0.681, 20.5, 0.762) (PRS of E-PASS AUC 0.682, 0.703, 0.821)	
(Ford, Beattie, & Wijeysundera, 2010)	The purpose of this study was to evaluate the ability of the RCRI to predict cardiac complications and mortality after non-cardiac surgery.	Systematic review	N= 792,740 patients from 24 different studies	Data extraction: For each study the AUC for predicting the outcome of interest, number of outcomes of interest, type of surgery, outcome definitions, demographic information and comorbid conditions were collected.	After mixed non-cardiac surgery, the RCRI demonstrated moderate performance at discriminating between patients at low versus high risk for cardiac complications (AUC= 0.77). In homogenous groups, particularly patients who underwent vascular non-cardiac surgery, the RCRI performance was diminished and less accurate (AUC= 0.65).	Level: II Quality: A
(Gualandro et al., 2017)	The purpose of this study was to evaluate the performance of the RCRI and VSG CRI for prediction of major cardiac events in patients undergoing arterial surgery.	Retrospective analysis of prospectively collected multicenter registry data	N= 954 patients who underwent arterial vascular surgery	Primary outcome measure: Major cardiac event defined as MI, acute heart failure, major arrhythmias, and cardiac arrest. MI defined by the third universal definition. Statistical analysis: ROC curves and AUCs were computed and compared for each risk score using the method of Delong. CIs were constructed using bootstraps.	Risk stratification for cardiac events was underestimated by both the RCRI and VSG CRI tools. Using the ROC curves- RCRI (AUC 0.58), VSG CRI (AUC 0.63) MI occurred in 6.9% of patients. Of patients who underwent OAAA repair 15% experience cardiac events and 9.3% experienced perioperative MI.	Level: 11 Quality: A

(Gupta et al., 2011)	The purpose of this study is to develop and validate a predictive cardiac risk calculator and determine its accuracy compared to the RCRI.	Retrospective multi center experimental cohort study	N= 211,410 patients who underwent non-cardiac surgeries. Patients who underwent aortic or other non cardiac vascular surgery (n= 26183)	Primary outcome measure: Intraoperative or postoperative MI and cardiac arrest in patients undergoing all non-cardiac surgery procedures. Secondary outcome measures: Intraoperative or postoperative MI and cardiac arrest in patients undergoing aortic or non-cardiac vascular surgery. Statistical analysis: Univariate analysis was completed using x2 test or Fischer's exact test for categorical data and t tests for continuous data. Multivariate logistic regression was also performed. $P < 0.5$ was considered significant. The risk model performance was tested for discrimination (C statistic and AUC) and calibration (hosmer-lemeshow test). The RCRI and new risk scale were compared using multivariate logistic regression analyses and C statistic was used to compare performance of the risk calculators.	Patients who experienced MI or cardiac arrest had more complications than those who didn't experience MI or cardiac arrest. Operative time and hospital length of stay was significant longer ($p< 0.0001$). Death within 30 days was also significantly higher in patients with MI or cardiac arrest than those without ($P < 0.0001$). The new risk model created in non cardiac surgery group had a C statistic of 0.874 indicating excellent discrimination. The C statistic for RCRI model was 0.747. When the new risk model was applied specifically to patients who underwent aortic or other non-cardiac vascular surgery (n= 26183), the C statistic of the model was 0.746. When the RCRI was applied to that same sample (n=26183), the C statistic was 0.591.	Level: II Quality: A
(Kim et al., 2002)	The purpose of this study was to evaluate the association between postoperative cardiac troponin I (cTn1) levels, 6 month mortality, and perioperative MI in patients who have undergone vascular surgery.	Prospective observational cohort study	N= 229 patients undergoing aortic or infrainguinal vascular surgery or lower extremity amputation between June 1997 to September 1999.	Primary outcome measure: 6-month mortality and postoperative cTn1 levels. MI definition: → MI was defined using the universal definition. The 99th percentile normal reference concentration of the cardiac troponin 1 assay for Dade Stratus fluorometric enzyme immunoassay. Value predetermined at > 1.5ng/ml. • cTn1 levels: • < 0.35ng/mL = virtually none detected. (Reference group) • 0.4- 1.5 ng/mL= moderate elevation • 1.6- 3.0 ng/mL= significant elevations consistent with the definition of MI • >3.0 ng/mL = elevations more	Mortality at 6 months was significantly higher among patients with cTn1 levels > 1.5 ng/mL (21%) compared with those with levels < 1.5ng/mL (6%), resulting in a 15% absolute increase in mortality rate. Compared with patients with cTn1 levels below diagnostic threshold (< 1.5ng/mL), patients with cTn1> 1.5 ng/mL had a 4-fold increase in mortality risk (OR, 4.2; 95% CI, 1.4- 12.4). After controlling for other covariates in the adjusted model, the risk increase was 6-fold (OR, 5.9; 95% CI 1.6 to 22.4). There was a dose-dependent relationship between cTn1 concentration and 6- month mortality. Peak cTn1 levels were< 0.35 ng/mL in	Level: II Quality: A

				than twice the required for MI diagnosis. Secondary outcome measures: Perioperative MI. Statistical analysis: Univariate analysis using x2 test and Fischer's exact test were conducted. Multivariate analysis using means of Student's t test were completed. Estimated odds ratio and 95 percent confidence intervals were used. Survival analysis was performed using the Kaplan-Meier Method. The significance level was 0.5.	57% of patients, 0.4- 1.5 ng/mL in 31% of patients, 1.6- 3.0 ng/mL in 4% of patients, and >3.0 ng/mL in 8% of patients. 6-month mortality rates in these groups were 5%, 7%, 20%, and 22% respectively. CTn1 > 3.0 ng/mL was associated with a significant increase risk for 6-month mortality compared to the lowest reference group (OR, 4.9; 95% CI, 1.3 to 19.0). The survival analysis demonstrates that the difference in mortality associated with an elevated cTn1 does not emerge until 5 weeks after surgery. → Elevated cTn1 levels after vascular surgery are associated with an increased risk of short-term mortality and morbidity.	
(McFalls et al., 2008)	The purpose of this study was to identify the predictors and outcomes of those patients undergoing vascular surgery who had a troponin 1 level greater than 0.1mg/L.	Cohort study	N= 377 patients undergoing vascular surgery (unspecified)	Primary outcome measure: Troponin 1 greater than 0.1mg/L and troponin 1 less than 0.1mg/L and survival. MI definition: → MI was defined using the universal definition. The 99th percentile normal reference concentration of the cardiac troponin 1 assay for Dade Behring Dimension Analyzer. Value predetermined at < 0.1mg/L. Secondary outcome measures: Other outcomes and variables were tested but not reported for the purpose of this analysis. Statistical analysis: Univariate analysis and multivariate analysis were completed. The significance level was 0.5. Odds ratio and 95 percent confidence intervals were used. Survival analysis was performed using the Kaplan-Meier Method.	One-year mortality in patients with peak cardiac troponin 1 concentration greater than 0.1mg/L was 20% compared with 4.7% on patients with a peak concentration less than 0.1mg/L (P< .001). Median long term follow up after vascular operation was 2.5 years, the probability of survival in patients with peak cardiac troponin 1 concentration greater than 0.1mg/L was 73% compared with 84% in the remaining patients with peak troponin concentrations less than 0.1mg/L.	Level: II Quality: A

(Moses et al., 2017)	The purpose of this study was to compare and to validate the use of the NSQIP, RCRI, and VSG CRI risk calculators in estimation of adverse cardiac events in patients undergoing vascular surgery at one institution.	Retrospective single center cohort study	N=856 patients who underwent vascular surgery • CEA (n= 350) • INFRA (n=210) • OAAA (N=77) • EVAR (n= 219)	Primary outcome measure: Each tool predicts different adverse cardiac events NSQIP= cardiac arrest and MI RCRI- MI, PE, V fib, cardiac arrest, and complete heart block VSG CRI- postoperative MI Statistical analysis: Observed adverse cardiac events were determined using VQI database and confirmed with chart review.	Each calculator underestimates cardiac risk in at least on type of vascular intervention. For OAAA repairs, NSQIP (P=0.51) ad VSG CRI (p=0.98) were adequate predictors, but RCRI strongly underpredicted the adverse events (P< 0.0001). The pooled data from all vascular procedures found that the VSG CRI proved to be an accurate tool for prediction (P=0.34), whereas adverse cardiac events were underpredicted by NSQIP (P=0.0055) and RCRI (P< 0.001).	Level: II Quality: A
(Simons et al., 2013)	The purpose of this study was to evaluate the association between postoperative troponin elevation and long-term survival in patients who underwent vascular surgery.	Retrospective multi center cohort study	N= 16,363 patients who underwent CEA, CAS, lower extremity bypass, EVAR, or OAAA within the Vascular Study Group of New England between 2003 to 20011. • CEA (n= 7836) • CAS (n=481) • EVAR (n= 2172) • LEB (n= 3991) • OAAA (n= 1,883)	Primary outcome measure: Long-term survival and postoperative myocardial ischemia- divided into MI and troponin elevation. Secondary outcome measures: Information regarding demographics, comorbidities, procedural details, and postoperative complications were collected on all patients in the study. Statistical analysis: Descriptive statistics were used to determine the incidence of postoperative MI. Survival analysis was performed using the Kaplan-Meier Method. Cox Proportional hazards modeling was used to determine the magnitude of effect of postoperative MI on survival. The significance level was 0.5. All analyses were conducted using SAS version 9.2 software.	MI and troponin elevation occurred in 2%, and 1% respectively. Incidences of myocardial ischemia occurred significantly between procedure types, with the highest incidence occurring after open AAA repair (MI 5%, troponin elevation 4%). There was a significant difference in survival over the first 5 years when the cohort was stratified according to specific type of myocardial ischemia. Five-year survival in patients who experienced postoperative troponin elevation or MI was 54% and 33% respectively compared to the survival of those who did not experience myocardial ischemia was 73%. When survival was adjusted using Kaplan-Meier analysis, five year survival was 48% in troponin elevation, 35% in MI, and 78% in patient who experienced neither. Postoperative MI was a significant independent predictor of death over the first 5 years postoperatively compared to no myocardial ischemia (P< .0001).	Level: II Quality: A

					Postoperative troponin elevation was a significant independent predictor of death over the first 5 years postoperatively compared to no myocardial ischemia (P=.01). No significant interaction was found between procedure type and postoperative ischemia (P= .0952). → Demonstrates that any postoperative myocardial ischemia, whether troponin elevation or MI, is associated with lower survival over the first 5 years postoperatively.	
(van Waes et al., 2013)	The purpose of this study was to determine the predictive value of postoperative MI on 30-day mortality after non-cardiac surgery.	Prospective, observational cohort study	N= 2216 patients who underwent a variety of non-cardiac surgeries in 2011.	<u>Primary outcome measure:</u> All cause mortality within 30 days after surgery. <u>Secondary outcome measures:</u> The incidence of postoperative MI and length of hospital stay. MI definition: → MI was defined using the universal definition. MI was defined as a troponin 1 level > 0.6mg/L, which was the lowest value measurable with a 10% coefficient of variation above the 99th percentile of 0.04mg/L of the assay used. Troponins were analyzed using the third generation enhanced AccuTn1 assay (Beckman Coulter). <u>Statistical analysis:</u> SPSS was used for statistical analysis.	Postoperative MI was associated with increased risk of death. 8.6% of patients with MI died within 30 days compared to 2.2% with normal troponin 1 levels ($p < 0.01$). The median time to death after troponin 1 elevation was 12 days. After adjustment of association between MI and death for variables known to predict postoperative cardiovascular events, only emergency surgery and troponin 1 remained significantly related to death within 30 days. The relative risk of death was 2.4 ($p< 0.01$) in case of minor increase in troponin 1 (0.07-0.59 mg/L) and 4.2 in case of a troponin 1 elevation greater than 0.6mg/L. The median length of hospital stay was 10 days in patients with MI compared to 5 days in patients without MI ($p< 0.01$). Troponin 1 was elevated in 19% of patients. →Troponin 1 elevation was an independent predictor of 30-day mortality. The association with the risk of death was	Level: II Quality: A

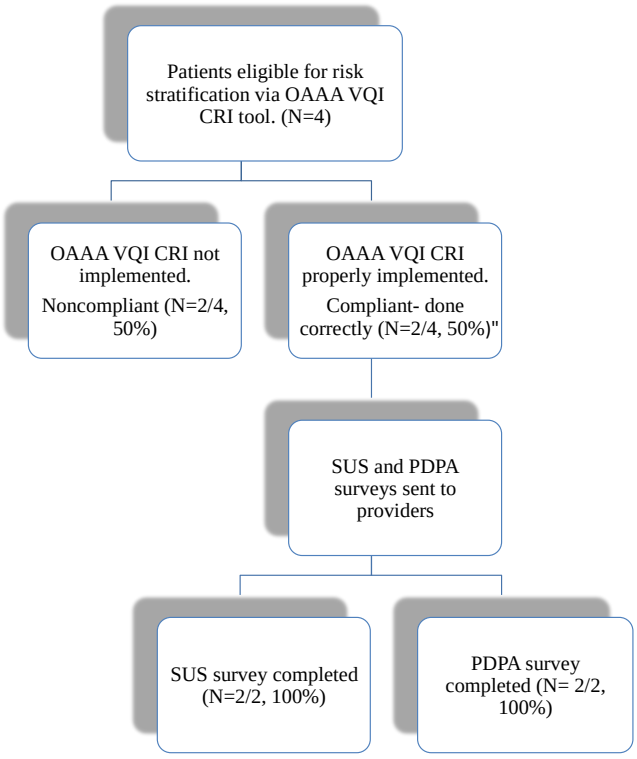
					dependent on the degree of the troponin 1 elevation.	

Table 2. Implementation Plan

Timeframe	Phase	Plan
Summer Semester 2017 (Pre-implementation Planning)	Pre-implementation Planning and Educational Planning	1. Obtain IRB for NHSR determination approval. 2. Creation of SUS and PDPA Surveys in SurveyMonkey. 3. Meet with Stakeholders/Champions: a. Identify project end users. i. End users= Vascular surgery NPs, PAs, and fellows. b. Discussed final workflow for using application and EPIC note template. i. Create EPIC note template ii. Test template to make sure working correctly and calculating accurate scores. c. Finalize dates for training session with end users. 4. Create education to present/ distribute to champions and end users. a. Presentation to include information about the general goals of the DNP project, the significance of the practice problem, education on the VQI CRI tool, and how to use and document the VQI CRI tool using the EPIC template. b. Information email sent to staff. Email included information about VQI tool as well as information regarding my QI project (purpose, anticipated outcomes, outcome measures, and timeline). Plus educational document/ handout. c. Creation of Education Badge Backer information cards made, printed, laminated and distributed to staff. 5. Signed off Champions as competent users after successful demonstration of tool use with standardize patient. 6. Set dates for weekly meetings (Friday AM rounds) to identify upcoming patients and provide continuing education regarding the project.
Week 1	Training and Implementation Go-live.	1. Ensure all technology is working correctly. 2. Sign off end users as competent after they successfully demonstrated accurate use of tool with standardize patient. 3. Create Excel Spreadsheet to aid in data collection. a. Ensure document and computer is password- protected

Weeks 1-14	Implementation and Ongoing Monitoring	1. Wednesday of Week 1 (8/30/17): Go-live with implementation a. Project Leader available on day of implementation to address any active issues. 2. Weeks 2-14: Ongoing monitoring of project by Project Leader. a. Attended morning rounds every Friday to answer any questions and/or address any active issues. Provide on-going education as needed. 3. When an appropriate patient is identified, users use the OAAA VQI CRI tool in the EPIC template to document patient's risk of postoperative MI. 4. Prospective data collection a. Data collection will be done by the DNP student. b. All data will be stored in password-protected laptop computer. c. No patient-specific information will be collected. d. During weekly visit, project leader will review weekly patient census and determine if any patients where appropriate for the use of the OAAA VQI CRI tool. Project leader will collect the number of patients who meet inclusion for intervention (Compliance data). i. Data analysis of compliance data will be computed using descriptive statistics. 1. Compliant- done correctly 2. Compliant- done incorrectly 3. Noncompliant 5. After completion of OAAA VQI CRI tool, Survey providers regarding usability and clinical decision-making. a. Distribute the SUS and PDPA surveys electronically (using SurveyMonkey) to all appropriate clinicians. b. Surveys are anonymous and voluntary
Week -14	End of Implementation and Data Analysis	1. Friday of Week 14 (12/1/17): End of implementation 2. Data collection: a. Collection of all SUS and PDPA surveys. 3. Data Analysis a. Transcribe SUS and PDPA survey answers into Excel spreadsheet. b. Analyze SUS and PDPA surveys using survey specific instructions. c. Analyze results of SUS and PDPA surveys using descriptive statistics d. Analyze VQI CRI postoperative MI risk scores using descriptive statistics.
Week 15	Dissemination	1. Dissemination of preliminary results to Division of Vascular Surgery.

Figure 1. Description of Sample and Compliance



Appendix A
OAAA VQI CRI

Age?
Race?
- Non-white
- White

BMI (kg/m^2)?
Creatinine?
- ≤ 1.8 mg/dL
- > 1.8 mg/dL or on Dialysis

Does the patient have COPD?
- No
- Yes, but not treated
- Yes, on medication and/or home oxygen

History of Congestive Heart Failure? *
- Yes
- No

Results of the Patient's Stress Test within Past 2 Years? +
- Abnormal
- Normal
- Stress test not performed

Previous CABG or PCI?
- Yes
- No

Any Prior Vascular Procedure? ∞
- Yes
- No

Planned Proximal Clamp Position?
- Infrarenal
- Above one renal artery
- Above both renal arteries
- Supraceliac

Planned Level of Distal Anastomosis?
- External iliac artery or common femoral artery
- Aorta
- Common iliac artery

* Yes includes a history of CHF but asymptomatic or symptomatic including mild, moderate, severe CHF.
+Cardiac stress test within 2 years prior to surgery and includes stress EKG, stress echo, assuming no intervening coronary intervention. If there has been coronary intervention and no new stress test then enter as not done.
∞ Prior vascular surgery includes previous carotid endarterectomy, carotid artery angioplasty and stenting, non-cardiac arterial bypass, arterial aneurysm surgery, major lower extremity amputation (above or below the knee), or peripheral vascular intervention (any non-coronary endovascular intervention of leg, arm, neck, renal, mesenteric artery).

Source: Bertges, D., Neal, D., Schanzer, A., Scali, S., Goodney, P., Eldrup-Jorgensen, Cronenwett, J. (2016). The vascular quality initiative cardiac risk index for prediction of myocardial infarction after vascular surgery. Journal of Vascular Surgery, 65 (5), 1411-1421.

Appendix B
Permission to Use VQI CRI tool

VQI CRI tool

Bertges, Daniel J. <Daniel.Bertges@uvmhealth.org> Tue, May 30, 2017 at 4:58 PM
To: Kelly Allen <kelly.allen@umaryland.edu>

Kelly
Sorry for late response
I am away at VQI meeting this week but will get this to you
This is exactly the type of thing we at VQI would like to help you with

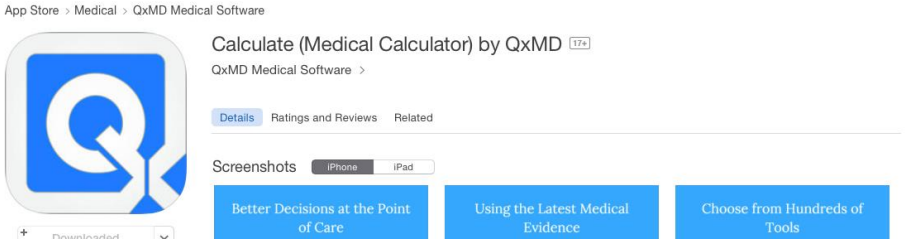
Danny Bertges
[Quoted text hidden]

Appendix C
Access to VQI CRI Tool Algorithm

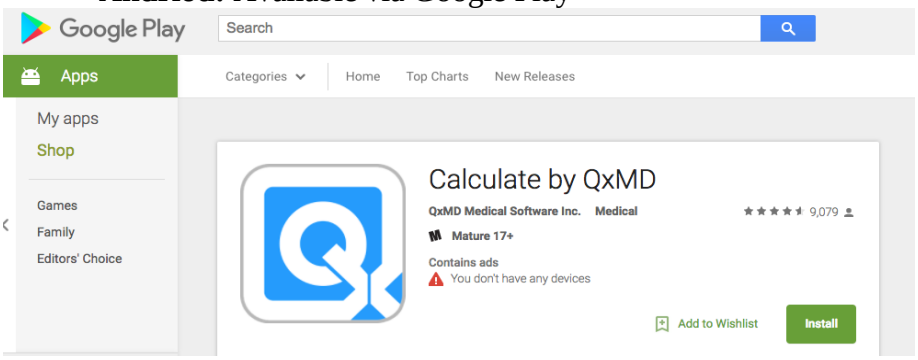
Free website access to OAAA VQI CRI tool:
https://www.qxmd.com/calculate/calculator_324/vascular-quality-initiative-vqi-cardiac-risk-index-cri-open-aaa-repair

Free smart phone application: Calculate (Medical Calculator) by QxMD

- **IOS:** Available via iTunes Store



- **Andriod:** Available via Google Play



Directions to access OAAA VQI CRI tool within the smart phone application:

1. Open application
2. Scroll down to Vascular Surgery- click to open
3. Find Vascular Quality Initiative Tools- click to open
4. Scroll down to Vascular Quality Initiative (VQI) Cardiac Risk Index (CRI) | Open AAA Repair- click to open
5. Fill out OAAA VQI CRI tool

Appendix D
VQI CRI EPIC Template

The OAAA VQI CRI EPIC note template can be found using the EPIC dot phrase ***.VASVQIOAAACardiacRiskIndex***. This dot phrase can be pulled into any type of note. The note is designed to pull in patient specific data from the electronic medical record in order to aid the provider in filling out the OAAA VQI CRI tool on the smart phone application or website provided in Appendix C. The final result of the tool will be entered into the note at ***. An example of the EPIC template note can be seen below.

Vascular Quality Initiative Cardiac Risk Index | Open AAA Repair

AGE: @AGE@
RACE: @RACE@
BMI: @BMI@
Cr: @LLAB(CREATININE)@

PMH: @PMHP@

PSH: @PSHP@

Cardiac Stress Test Result: (DROP_DOWN_MENU)

Planned Proximal Clamp Position: (DROP_DOWN_MENU)

Planned Level of Distal Anastomosis: (DROP_DOWN_MENU)

The above information was reviewed and entered into the VQI CRI tool. Based on the tool, the patient's probability of in-hospital postoperative myocardial infarction is ***.

Appendix E
System Usability Score (SUS)

	Questions	Strongly Disagree 1	Disagree 2	Neither Agree nor Disagree 3	Agree 4	Strongly Agree 5
1.	I think that I would like to use this product frequently	1	2	3	4	5
2.	I found the product unnecessarily complex	1	2	3	4	5
3.	I thought the product was easy to use	1	2	3	4	5
4.	I think that I would need the support of a technical person to be able to use this product	1	2	3	4	5
5.	I found that the various functions in this product were well integrated	1	2	3	4	5
6.	I thought that there was too much inconsistency in this product	1	2	3	4	5
7.	I would image that most people would learn to use this product very quickly	1	2	3	4	5
8.	I found the product very cumbersome to use	1	2	3	4	5
9.	I felt very confident using the product	1	2	3	4	5
10.	I needed to learn a lot of things before I could get going with this product	1	2	3	4	5

Adapted from: Bangor, A., Kortum, P., & Miller, J. (2008). An empirical evaluation of the System Usability Scale. International Journal of Human-Computer Interaction, 24 (6), 574-594.

Appendix F
How to score the System Usability Score (SUS)

The ODD number questions assess POSITIVE qualities of the system
The EVEN number questions assess NEGATIVE qualities of the system

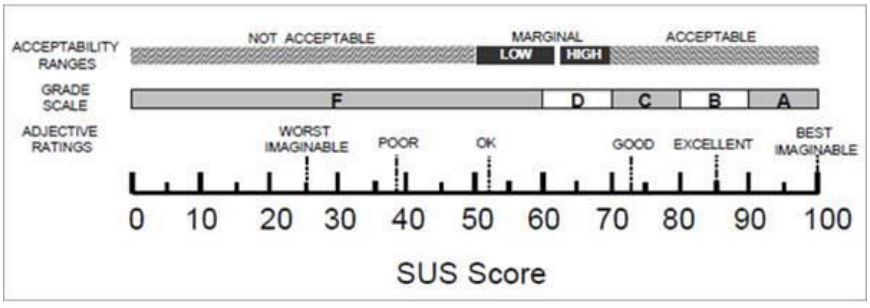
Scoring process:

1. Determine the numerical value for each question response.
    a. Strongly Disagree = 1, Disagree =2, Neither Agree nor Disagree = 3, Agree = 4, Strongly Agree= 5.
2. Fill out/ make a scoring table. One scoring table should be used per survey. Example scoring table below.
3. For each **ODD** number question, subtract 1 from the users response. (Score range 0 to 4)
4. For each **EVEN** number question, subtract the users response from 5. (Score range -4 to 0)
5. Find the sum of all the adjusted scores to obtain the adjusted overall score. (Score range 0 to 40)
6. Multiple the adjusted overall score by a factor of 2.5 to obtain a normalized final score. (Score range 0 to 100).

Example Scoring Table:

Question Number	Score	Formula	Adjusted Score
1		Score – 1 =	
2		5 – Score =	
3		Score – 1 =	
4		5 – Score =	
5		Score – 1 =	
6		5 – Score =	
7		Score – 1 =	
8		5 – Score =	
9		Score – 1 =	
10		5 – Score =	
Adjusted Overall Score = (Sum of all Adjusted Scores)			
Final Score = (Adjusted Overall Score X 2.5)			

SUS Interpretation Scale:



Adapted from: Bangor, A., Kortum, P., & Miller, J. (2008). An empirical evaluation of the System Usability Scale. International Journal of Human-Computer Interaction, 24 (6), 574-594.

Appendix G
Provider Decision Process Assessment Instrument

1. The decision was hard to make.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
2. I was unsure what treatment would really be best for this patient.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
3. It was clear what treatment would be best for this patient.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
4. When making the decision, I felt I did not know enough about the treatment alternatives, although the information is available in the literature.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
5. I had trouble making the decision because important information is either unknown or not readily available in the literature.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
6. When I made the decision, it was hard to decide if the benefits of the available treatments were more important than the risks or vice versa.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
7. It was easy to identify all of the considerations that affect the decision.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
8. I fully understand the patient's views regarding the important issues in making this decision.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
9. I believe that the patient fully understands the risks and benefits of the treatment I prescribed.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
10. I believe that the patient will comply with the treatment regimen I prescribed.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
11. I am satisfied with the decision that was made.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
12. I am satisfied that the process used to make the decision was as good as it could be.				
Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree

Adapted from: Dolan, J. (1999). A method for evaluating health care providers' decision making: The provider decision process assessment instrument. Medical Decision Making, 19 (1), 38-41.

Appendix H
How to score the Provider Decision Process Assessment Instrument

Scoring process:

1. Determine the numerical value for each question response- Refer to chart below.
    a. For item number 3, 7, 8, 9, 10, 11 and 12 (Score range from 1-5)
        i. Strongly Agree = 1, Agree =2, Neither Agree nor Disagree = 3, Disagree = 4, Strongly Disagree = 5.
    b. For item numbers 1, 2, 4, 5, and 6 (Score range from 1-5)
        i. Strongly Agree = 5, Agree =4, Neither Agree nor Disagree = 3, Disagree = 2, Strongly Disagree = 1.
2. Calculate the summary score by adding the responses to the individual items together. (Scores range from 12 to 60)
3. Lower scores indicate lower degree of conflict, therefore, greater comfort with the decision.

Question	**Strongly Agree**	**Agree**	**Neither agree nor Disagree**	**Disagree**	**Strongly Disagree**
1	5	4	3	2	1
2	5	4	3	2	1
3	1	2	3	4	5
4	5	4	3	2	1
5	5	4	3	2	1
6	5	4	3	2	1
7	1	2	3	4	5
8	1	2	3	4	5
9	1	2	3	4	5
10	1	2	3	4	5
11	1	2	3	4	5
12	1	2	3	4	5
Total Score:					

Adapted from: Dolan, J. (1999). A method for evaulating health care providers' decision making: The provider decision process assessment instrument. Medical Decision Making, 19 (1), 38-41.

Appendix I
Permission to Use PDPA Instrument

Provider Decision Process Assessment Instrument

Dolan, James G <James_Dolan@urmc.rochester.edu> Mon, Jun 5, 2017 at 8:43 AM
To: Kelly Allen <kelly.allen@umaryland.edu>

Hi Kelly,

It sounds like a great project. Feel free to use the PDPAI. Let me know if you need any information.

Regards,

James G. Dolan, MD

Associate Professor, Department of Public Health Sciences

University of Rochester Medical Center

265 Crittenden Blvd., CU 420644

Rochester, NY 14642

Phone: 585-276-5161

Fax: 585-461-4532

Email: james_dolan@urmc.rochester.edu

Appendix J
Project Proposal Summary

Background: Postoperative myocardial infarction (MI) is a common complication after open aortic abdominal aneurysm (OAAA) repair. Postoperative MI has been shown to negatively impact both short and long term mortality outcomes. In an effort to minimize cardiac risk associated with vascular surgery perioperative cardiac risk stratification should take place. The ACC/AHA clinical practice guideline for non-cardiac surgery recommends the use of the Revised Cardiac Risk Index (RCRI) for cardiac risk stratification. However, the RCRI underestimates cardiac complications in vascular surgery patients undergoing OAAA. In an effort to improve risk stratification, the Vascular Quality Initiative group has developed a validated vascular procedure specific risk stratification tool. VQI CRI calculates the probability of in-hospital postoperative MI. This project will utilize the OAAA VQI CRI tool. Risk predicative models have been shown to help guide providers clinical decision-making and help patients better understand their risks.

Purpose: The purpose of this DNP project is to implement and evaluate the utility and effects on clinical decision-making of the OAAA VQI CRI tool for patients undergoing OAAA repair at an academic medical center in the Mid- Atlantic region.

Implementation Plan:

Procedures and Timeline: The translation of evidence into practice will start with pre-implementation education and training for champions and end users on how and when to use the OAAA VQI CRI tool. Following education, the implementation phase will begin and take place over a 10-week period. Data collection will take place following implementation over a 2-week period. After implementation, all providers who completed the OAAA VQI CRI tool will be asked to complete the System Usability Scale (SUS) to measure the usability of the tool. In addition, all providers who completed the VQI CRI tool will be asked to complete the Provider Decision Process Assessment Instrument (PDPA) to measure the providers' degree of comfort with a medical decision, in this case predicting risk of postoperative MI.

Data Collection: Compliance data will be collected in a categorical manner (compliant versus noncompliant) on a weekly basis by the project leader. No patient specific information from the OAAA VQI CRI tool will be collected. Data will also be collected from the SUS and PDPA surveys. Surveys will be administered electronically and participation will be voluntary and anonymous.

Analysis Plan: All data will be analyzed using descriptive statistics. All data analysis will be performed in Microsoft Excel. The SUS and PDPA survey will be analyzed using their respective standardized methodologies.

Anticipated Outcomes: The anticipated outcomes of this DNP project are 1) facilitation of the use of standardized cardiac risk stratification tool in vascular surgery and 2) improved provider comfort with clinical decision-making.

Appendix K
University of Maryland Baltimore IRB for NHSR Approval

University of Maryland, Baltimore
Institutional Review Board
Phone: (410) 706-5037
Fax: (410) 706-4189
Email: hrpo@umaryland.edu

NOT HUMAN RESEARCH DETERMINATION

Date: August 8, 2017

To: Joan Davenport
RE: HP-00076586
Name: Implementation of Vascular Quality Index Cardiac Risk Index for Patients Undergoing Open Abdominal Aortic Aneurysm Repair (DNP811)

This letter is to acknowledge that the UMB IRB reviewed the information provided and has determined that the submission does not require IRB review. This determination has been made with the understanding that the proposed project does not involve a systematic investigation designed to develop or contribute to generalizable knowledge **OR** a human participant (see definitions below).

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are human subject research in which the organization is engaged, please submit a new request to the IRB for a determination.