5-2020

Implementing a Workflow to Improve Bleeding Risk Assessment for Patients Undergoing Coronary Angiography

Lindsay Marie Nutting
St. Catherine University

IMPLEMENTING A WORKFLOW TO IMPROVE BLEEDING RISK ASSESSMENT FOR PATIENTS UNDERGOING CORONARY ANGIOGRAPHY

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

St. Catherine University
St. Paul, Minnesota

Lindsay Marie Nutting
May 2020

ST. CATHERINE UNIVERSITY
ST. PAUL, MINNESOTA

This is to certify that I have examined this
Doctor of Nursing Practice DNP project manuscript
written by

Lindsay Marie Nutting

and have found that it is complete and satisfactory in all respects,
and that any and all revisions required by
the final examining committee have been made.

Dr. Gretchen A. Moen, DNP, APRN, CNP
Name of Faculty Project Mentor

4/30/2020
Date

DEPARTMENT OF NURSING

Abstract

Coronary angiography is an invasive procedure that puts patients at risk for post-procedure complications, such as bleeding, which are associated with increased cost, length of stay, and mortality (Strauss et al., 2014). While intra- and post-procedure interventions have been utilized to mitigate risk of bleeding, a formal pre-procedure assessment has not been available until recently. The American College of Cardiology CathPCI Bleeding Risk Calculator is a validated tool that providers can use to calculate a bleeding risk score prior to coronary angiography (American College of Cardiology [ACC], 2017). This DNP project sought to determine if providing an educational program to advanced practice providers (APPs) on assessing bleeding risk using the ACC CathPCI Bleeding Risk Calculator would affect documentation of pre-procedure bleeding risk compared to standard practice. A pre-project implementation survey was given to the APPs to determine current standard of practice, attitudes toward risk scores, and openness to practice change. Education was also provided regarding factors that increase risk for post-procedure bleeding. During implementation, APPs calculated pre-procedural risk scores using the ACC CathPCI Bleeding Risk Calculator, communicated scores with patients and the interventional cardiologist, and documented risk scores in the consent note within the electronic medical record. Advanced practice providers were then surveyed to evaluate their experience with project elements such as formal bleeding risk assessment process and willingness to change practice. Results of the quality improvement project support the use of a formal process to document and communicate bleeding risk prior to the procedure, however providers were neutral about the usefulness and reliability of the bleeding risk calculator. Future projects are necessary to answer subsequent questions such as whether having the risk calculator changed the incidence of post-procedure bleeding events.

Introduction

Problem Statement

Coronary angiography is an invasive procedure that is used to assess coronary artery anatomy. Femoral artery access and blood thinner use during the procedure increase the risk for bleeding for all patients but individual factors increase risk for some patients. During and after coronary angiography, evidence-based efforts are made to minimize bleeding risk. For example, radial artery access is used when appropriate due to the association with decreased bleeding events; blood thinners, such as heparin, are dosed based on the patient's weight; and closure devices are used in the femoral artery if patient anatomy allows (Singh, 2015). Efforts to minimize bleeding events are carried into the post-procedure setting where specially-trained nurses manage arterial access sites with manual pressure and frequent monitoring (Bontrager & Abraham, 2017).

Pre-procedure assessment to identify patients at higher risk for bleeding from coronary angiograms is not a standardized practice among cardiac catheterization laboratory (CCL) peri-procedure providers at the project site. Pre-procedure bleeding risk assessment at the project site has not been routinely used or formalized in the past at least in part because a validated tool for bleeding risk assessment did not exist until recently (American College of Cardiology [ACC], 2017). Major bleeding events remain a significant potential complication for patients undergoing coronary angiography and percutaneous coronary intervention (PCI) despite interventions in the intra- and post-procedure setting (Rao et al., 2013). Major bleeding events are associated with increased cost and increased mortality (Rao et al., 2013). Therefore, vetting for bleeding risk in the pre-procedure setting is necessary and may help identify patients at higher risk for bleeding so interventions to decrease risk can be employed.

Purpose Statement and PICO Question

A quality improvement project was developed in response to the lack of a formalized assessment, documentation, and communication of bleeding risk prior to coronary angiograms performed at a local teaching hospital in an urban setting. The question posed was: in advanced practice providers evaluating patients prior to coronary angiogram, how does an educational program on assessing bleeding risk using the ACC CathPCI Bleeding Risk Calculator compared with standard practice affect documentation of pre-procedure bleeding risk? In the practice setting where the project occurred APPs evaluate patients prior to coronary angiogram, review risks of the procedure with the patient, and obtain the patient's informed consent for the procedure.

Currently, APPs rely on patient health history and laboratory values such as international normalized ratio (INR) to assess a patient's bleeding risk prior to the procedure. It is unclear how the level of risk is characterized, documented, or communicated to the interventional cardiologist prior to the procedure. Formal assessment of bleeding risk has not been standard of practice because a validated tool to estimate risk has not existed until recently (ACC, 2017). To answer the question regarding use of a standardized tool for pre-procedure assessment of bleeding risk, the ACC CathPCI Bleeding Risk Calculator was selected.

The ACC CathPCI Bleeding Risk Calculator was created based on a study by Rao and colleagues (2013) that produced a model used to predict bleeding events in patients undergoing coronary angiography. The study authors updated the National Cardiovascular Data Registry (NCDR) CathPCI Registry's definition of clinically significant post-procedure bleeding by expanding the definition to improve the capture of these events (National Cardiovascular Data Registry [NCDR], n. d.; Rao et al., 2013). They then used a three-year period of bleeding event

data from the NCDR CathPCI registry to randomly assign development and validation groups and determined 33 baseline characteristics of the patients in those groups. Using chi-square testing, they found 10 statistically significant variables associated with post-procedure bleeding among the baseline characteristics; these 10 variables and a scoring system were used to create the ACC CathPCI Bleeding Risk Calculator. There was no statistically significant difference of bleeding event prediction using the 10 variables and scoring system between the development group and validation group. The calculator can be accessed on the internet via web browser or as a free smartphone application. It takes roughly one minute to calculate the post-procedure bleeding risk score for any given patient and no patient identifiers are used within the calculator, so privacy and confidentiality were maintained. Ten patient-specific data points are entered into the calculator such as creatinine, body mass index, and history of heart attack and prior stenting (ACC, 2017).

The main objective of this project was to assess APP acceptance of and compliance with the use of a bleeding risk calculator to estimate, document, and communicate bleeding risk of patients undergoing coronary angiography. Other project objectives included gauging APP attitudes toward current standard of practice, practice change, and risk scores. These additional objectives were included because APP attitudes could impact compliance with and use of the bleeding risk calculator.

Theoretical Framework

The Plan-Do-Study-Act (PDSA) method was used to guide the development of this quality improvement project. The PDSA problem-solving method utilizes four distinct steps to address carry out small tests of change by planning and implementing an intervention, assessing its effectiveness, and, if successful, acting to incorporate the intervention as the new standard

(Minnesota Department of Health [MDH], n. d.). It is a common and useful technique for quality improvement (QI) in healthcare and thus is recommended by entities such as the Royal College of General Practitioners and the Institute for Healthcare Improvement for QI initiatives (Crowfoot & Prasad, 2017; Institute for Healthcare Improvement, n. d.). The effectiveness of the PDSA method has been demonstrated for QI initiatives in many different healthcare settings including emergency medicine, surgery, and geriatrics (Cooper, 2015; Baird et al., 2019; Hansjee, 2018). Given that this method is ideal for healthcare QI projects, particularly small tests of change, the PDSA method was employed as the theoretical framework for this project.

The plan phase of this project included identifying a need for change and strategizing how to carry out the change. Stakeholders, such as peri-procedure APPs and CCL leadership, were also identified and informed during this phase. Once the strategy was developed, a small pilot project was carried out with two of the peri-procedure CCL APPs. The test of change was then studied using qualitative data collection via an online survey completed by the participants.

In the act phase of PDSA, if the project is successful then the improvement is integrated into standard of practice; however, if it is not successful, then the process restarts at the plan phase to strategize a new or altered approach (MDH, n. d.). The post-implementation survey results revealed that the participants found the project workflow to be an effective way of assessing, documenting, and communicating bleeding risk. However, they were neutral about the ACC CathPCI Bleeding Risk Calculator because it does not incorporate traditional bleeding indicators such as INR and anticoagulation medications. Given the mixed results of the post-implementation survey, the plan was not integrated into standard of practice. Ideally, there would have been time to alter the approach and attempt another PDSA cycle, but this was not

possible since the CCL at the project site was temporarily shuttered for elective cases due to the coronavirus pandemic.

Review of Literature

Search Strategy

A search strategy was employed to guide the literature review about the use of a pre-procedure bleeding risk assessment tool for persons undergoing coronary angiogram and the PDSA cycle as a theoretical framework for healthcare QI. Four article databases were searched: Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE EBSCO (Elton B. Stephens Company), PubMed, and Health Source. Boolean search of the databases was altered for each of the three topics relevant to the PICO question as well as for evidence regarding use of the PDSA cycle for healthcare QI.

MEDLINE EBSCO and PubMed were searched using the terms *bleeding*, *percutaneous coronary intervention*, and *risk assessment* to find evidence supporting bleeding risk assessment for patients undergoing percutaneous coronary intervention (PCI). The searches were limited to academic journal articles written in English and published in 2012 and 2014 or later, respectively. The MEDLINE EBSCO search yielded 337 results, three of which were included in the evidence summary table. Although the PubMed database search yielded 358 results, no additional articles were found for inclusion in the appendices.

To answer the question regarding implementation of risk assessment tools, searches of the CINAHL, MEDLINE EBSCO, and PubMed databases were structured using the search terms *implementation strategies or implementation methods* and *risk assessment tools or risk assessment scales*. Using these terms, the CINAHL database search was limited to articles published in 2013 or later and yielded 18 results. The MEDLINE EBSCO database was then

searched using the same terms but limited to articles published in 2013 or later. This search yielded 27 results, many of which were also resulted in the CINAHL search and therefore none were included in the appendices. Finally, PubMed was searched and limited to articles published within the last five years and articles that had free full text available; this yielded 164 results.

The CINAHL, Health Source, and MEDLINE EBSCO databases were then searched for evidence regarding implementing practice change among nurse practitioners. *Implementing, practice change,* and *nurse practitioner or advanced practice nurse or APN or NP* were the search terms used and results were limited to articles written in English and published in 2011 (Health Source and MEDLINE EBSCO) and 2012 (CINAHL) or later. This resulted in 20 articles from CINAHL, six articles from Health Source, and 16 articles from MEDLINE EBSCO. Two articles from this collective search were included in the appendices.

To find evidence supporting the use of the PDSA theoretical framework in healthcare QI, the CINAHL and MEDLINE EBSCO databases were searched. Searches were conducted using the terms *plan do study act* and *quality improvement* and were limited to peer-reviewed articles from scholarly journals published in 2015 or later. The search term *health care* was omitted because it limited the volume of results. This search strategy resulted in 389 articles from CINAHL and 625 articles from MEDLINE EBSCO; two articles from this aggregate search were included in Appendix D.

Evidence Appraisal

The search strategy for evidence to answer the PICO question resulted in 946 total articles between the four databases; nine articles were included in the appendices. A mix of evidence types was included for review including retrospective cohort, prospective cohort, and longitudinal studies. Level of evidence ranged from I to VI and eight of nine articles were of

grade B or good quality. The article with the highest level of quality was a systematic review of nine randomized, controlled trials by Ilic and Maloney (2014). The exploratory, multiple-case design study by Kaasalainen and colleagues (2015) was considered low quality (level VI, grade C) due to small sample size limiting the generalizability of the results.

While not all the articles were of good or high quality, the article with low quality was included in the appendices because it studied evidence-based practice change among APPs which was helpful in answering the PICO question. The most useful information extrapolated from all articles included for review was validation of post-PCI bleeding risk assessment models, methods for execution of practice change among nurse practitioners, and implementation of risk assessment tools in other healthcare settings.

The search strategy for evidence to support the use of the PDSA method in healthcare QI yielded 1,014 total articles from the CINAHL and MEDLINE EBSCO databases. Three articles from the search results were included in the appendices. The quality improvement studies by Thomason and colleagues (2016) and Mains, Graham, and Hayes (2020) were considered level V, grade B quality of evidence. The article by Knudsen and colleagues (2019) was deemed level III, grade B quality of evidence because although it is a systematic review, the articles reviewed were all quality improvement projects.

Synthesis of the Evidence

Evidence gathered for review was divided into separate categories to address each element of the quality improvement project question: use of validated tools and models to predict post-PCI bleeding (Appendix A), implementation of risk assessment tools in practice (Appendix B), and facilitating practice change among nurse practitioners and other healthcare providers (Appendix C). Additionally, evidence supporting the use of the PDSA method for healthcare QI

was categorized (Appendix D). Several themes emerged from the reviewed literature to address these elements.

Three articles were included to address use of validated tools and models to predict post-PCI bleeding. Each of the three articles validated a specific tool or model to stratify risk for post-PCI bleeding. The article by Rao and colleagues (2013) demonstrated the validity of the ACC CathPCI Bleeding Risk Calculator which is the risk stratification tool that was used in this DNP project (ACC, 2017). A common theme among two of the articles was a reduction in post-PCI bleeding complications with use of a validated tool which led to practice changes including utilization of bleeding avoidance strategies during the procedure (Spertus, et al., 2015; Strauss et al., 2014). The authors of all three articles advocated for the implementation of pre-procedure bleeding risk stratification for patients undergoing PCI (Rao et al., 2013; Spertus, et al., 2015; Strauss et al., 2014).

Three articles were reviewed to support the implementation of risk assessment tools in practice. These articles provided evidence that risk assessment tools are commonly utilized in practice to screen for risk associated with multiple procedures and conditions. Another common theme among the articles was that implementation of risk assessment tools can be accomplished in many ways, however thorough staff education regarding the purpose of the tool was the most effective method. The article by Scovil and colleagues (2014) found that not only the staff members but the organization as well must support the use of risk assessment tools. Additionally, and perhaps most importantly, the authors of these articles advocated for the use risk assessment tools to improve documentation and patient outcomes (Skytt et al., 2016; Scovil et al., 2014; Park et al., 2018).

To address the element of facilitating practice change among nurse practitioners and other healthcare providers, three articles were reviewed. The systematic review by Ilic and Maloney (2014) found that teaching evidence-based practice (EBP) leads to greater EBP competency after teaching although a validated assessment tool may be helpful in assessing EBP knowledge. The articles by Kaasalainen and colleagues (2015) and Jefferies and Shah (2011) found that education regarding practice change is most successful if disseminated through multiple teaching modalities, including educational meetings, seminars, laminated pocket cards, and web-based algorithms. Kaasalainen and colleagues (2015) identified the nurse practitioner and clinical nurse specialist as the bridge between receipt of data from researchers and implementation of research recommendations in practice.

Ultimately, a total of nine articles were used to answer the PICO question and several themes were identified among the literature (Appendices A, B, & C). For example, the article by Rao and colleagues (2013) supports the utilization of a validated risk assessment tool for risk stratification of patients undergoing PCI. Park and colleagues (2018) suggested in their research that implementation of risk assessment tools is most successful when staff are thoroughly educated regarding the use and purpose of the tool. Education drives practice change and can be achieved through several different modalities. Collectively, the data from these nine articles supports the plan for the quality improvement project, which is to provide an educational program on assessing bleeding risk using the ACC CathPCI Bleeding Risk Calculator to improve documentation of pre-procedure bleeding risk for patients undergoing PCI.

Three articles were reviewed to determine the usefulness of the PDSA method in healthcare QI. The systematic review of quality improvement projects in healthcare by Knudsen and colleagues (2019) demonstrated the effectiveness of the PDSA method in healthcare QI with

98% of projects reviewed reporting improvement. However, the authors questioned the legitimacy of PDSA given the lack of adherence to methodological features in many of the projects that were reviewed. The quality improvement projects by Mains, Graham, and Hayes (2020) and Thomason and colleagues (2016) supported the implementation using PDSA of two features like those in this DNP project. Mains, Graham, and Hayes (2020) utilized an education program to increase pressure ulcer risk assessment while Thomason and colleagues (2016) were successful with increasing the use of a validated pressure ulcer monitoring tool to standardize care.

Project Implementation

Project Setting and Participants

This DNP project was carried out at a mid-sized, urban teaching hospital. The cardiac catheterization laboratory staff is comprised of five interventional cardiologists, three cardiology fellows, and four APPs. Approximately 2,000 coronary angiograms are performed every year.

At the time of project implementation, four different APPs were rotating through the CCL, working one week at a time as the peri-procedure APP. The peri-procedure APP obtains patient consent for the procedure, communicates with the interventional cardiologist, and provides post-procedure care for CCL patients, including entering post-procedure orders and assessing patients as needed. Two of the four providers were asked to participate in this pilot project, and both accepted. One of the participants is a physician's assistant and the other is a nurse practitioner. They have a combined total of five years of independent practice, all of which have been in cardiology.

Risk Factor Education

Prior to this DNP project, peri-procedure APPs did not routinely receive formal education about risk factors for post-procedure bleeding before beginning work in the CCL. A PowerPoint presentation addressing risk factors for post-procedural bleeding was created and distributed to the stakeholders, including the project site mentor, CCL leadership, quality personnel, and the peri-procedure APPs one week before project implementation. The presentation included information on the background of post-procedure bleeding at the project site and prior attempts to address the issue with various quality improvement interventions. An introduction to the project, which included information about the study by Rao and colleagues (2013) and the risk calculator, was also presented as well as education regarding risk factors for post-procedure bleeding in patients having coronary angiogram (Appendix E).

Project Workflow

Participating APPs were instructed to calculate a bleeding risk score for each patient scheduled for a coronary angiogram on the project site mentor's schedule. The site mentor is an interventional cardiologist and medical director in the CCL. The APPs communicated the risk score to the patient during the consenting process and documented the score in the consent note within the electronic medical record (EMR). After discussing the score with the patient and documenting it, the APPs would report the score to the interventional cardiologist prior to the procedure, either verbally or via text page.

Pre- and Post-implementation Surveys

. The pre-implementation survey comprised of seven questions and responses were formatted using a 5-point Likert scale. The questions addressed the current practice for assessing, documenting, and communicating bleeding risk and attitudes toward using risk scores

to inform clinical practice (Appendix G). The participants were surveyed after completion of the project. The post implementation survey design included eight questions with responses formatted using a 5-point Likert scale and was aimed at evaluating provider attitudes toward assessing, communicating, and documenting the bleeding risk score during the implementation period (Appendix H). Additionally, participants were asked if they would be willing to change current standard of practice to include the formal bleeding risk assessment process. Participants were also given the opportunity to offer other comments and observations regarding the project implementation period in a short answer format.

Ethical and Social Justice Issues

Participants included a convenient sample of two providers who were homogeneous in terms of race, background, and experience. The project was initially planned to include more than two participants, however, staffing changes among the APPs led to the reduction in overall providers rotating through the peri-procedure role from six to four. Given the reduction in the peri-procedure APP group size, two providers were ultimately included in the project and the implementation description was shifted to a pilot project. The pilot project was designed to yield a small test of change using the PDSA cycle and was not intended to include the entire interventional cardiology department. Therefore, no ethical or social justice issues were identified in this convenient sample.

Barriers

The pilot project encountered two barriers to completion: small sample size and abrupt cessation of the project limiting the duration of the implementation phase. Initially, the implementation period with APPs using the project workflow was planned to span eight weeks. Due to the emergence and precipitous spread of the coronavirus pandemic in the United States

throughout late winter and early spring of 2020, all elective cases were canceled in the CCL at the project site thus reducing the project duration from eight weeks to four weeks. Although the duration of the project was limited, each of the participants had an opportunity to utilize the workflow within the adjusted timeline.

Evaluation

The results of the pre-project implementation survey revealed that both participants often use risk assessment scores to support decision-making in clinical practice and find these scores moderately important for clinical decision-making. They both rated the quality of prior formal education about factors that increase risk for bleeding as fair. Provider A described their current process for assessing and documenting bleeding risk as reviewing laboratory values, anticoagulation medications, and past medical history but did not have a process for documenting risk. Provider B described their current process as chart review, medication reconciliation, and history and physical review. Both participants answered that they strongly agreed that changing current practice to implement the project workflow would be manageable and beneficial to patients.

Table 1

Post-Implementation Survey Results

Survey Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The education and instructions provided in the PowerPoint were sufficient for understanding the problem and implementing the workflow.	0%	0%	0%	50%	50%
Using the ACC CathPCI Bleeding Risk Calculator enhanced pre-procedure assessment of patients undergoing coronary angiogram.	0%	0%	100%	0%	0%
The project workflow was an effective way of assessing, documenting, and communicating bleeding risk.	0%	0%	0%	100%	0%
In the future, I would use the project workflow as the new standard of practice for assessing the bleeding risk of patients undergoing coronary angiography.	0%	0%	50%	50%	0%
For each risk score that I calculated, I was able to document the score in the consent note.	N/A	0%	N/A	100%	N/A

Survey Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
What were the barriers, if any, to implementing the workflow?	Provider A: "None" Provider B: "No barriers, was all pretty quick and simple!"				
What, if anything, would you change about the workflow?	Provider A: N/A Provider B: "Nothing"				
Additional comments.	Provider A: "I don't know that the ACC tool offers much insight into actual bleeding risk of our patients. Doesn't account for INR, platelets, bleeding diatheses, medications, etc." Provider B: "Think it is a good risk calculator to use that may help the interventional with choice of radial vs. femoral"				

The results of the post-project implementation survey were mixed. Both participants agreed that the education was sufficient to understand the problem and that the project workflow was an effective process for assessing, documenting, and communicating bleeding risk. Provider A answered that they were neutral about using the project workflow as the new standard of practice while Provider B agreed that they would use the project workflow as the new standard of practice. Both providers reported they were 100% compliant with project workflow use for all eligible patients.

The participants were neutral about the impact of the ACC CathPCI Bleeding Risk Calculator on enhancing bleeding risk assessment. Although this was not the purpose of the project, it was a surprising finding. For example, Provider A commented on the risk calculator's lack of accounting for traditional bleeding indicators such as INR, platelet level, and anticoagulation medications. Provider B remarked that the risk calculator and thus risk score may be helpful in choosing whether a procedure is done via radial versus femoral approach.

Although the results were mixed, the post-project implementation surveys adequately addressed the PICO question. After viewing the educational program about risk factors for post-procedure bleeding and use of the ACC CathPCI Bleeding Risk Calculator, the participants used the project workflow and documented a risk score for every eligible patient throughout the

duration of the implementation period. This was an improvement compared with standard practice, which differed for both participants but lacked any formalized process for assessing, documenting, and communicating bleeding risk.

The PDSA method was appropriate for this DNP project. This method was ideal for quality improvement in healthcare and for small tests of change such as pilot projects (Institute for Healthcare Improvement, n. d.; MDH, n. d.). However, the effectiveness of the PDSA method in this project was somewhat limited. The method's recommended structure includes an initial test of change, study period, and, if successful, adoption of the improvement as the new standard (MDH, n. d.). Given that the results of this DNP project were mixed, there ideally would have been an opportunity to adjust and test the change again. Unfortunately, due to the coronavirus pandemic and subsequent cancelation of elective cases at the project site, the project was abruptly stopped and there was no opportunity for adjustments and additional tests of change. Although the sample size of this project was limited, the project design is amenable for translation to a larger group as it was originally designed to include more participants.

Discussion, Conclusion, and Recommendations

The results of the project were affected by the abbreviated duration. In PDSA methodology, successful tests of change can be adopted into practice without subsequent tests of change (MDH, n. d.). The project was only partially successful since the APPs embraced some elements of the workflow but were critical of the bleeding risk calculator. The project timeline limited the opportunity to adjust and test the change again.

An unexpected revelation from the project was that the APPs were disapproving of the ACC CathPCI Bleeding Risk Calculator. This was unexpected because the calculator has been tested and validated and was supported by the American College of Cardiology. The APP

disapproval of the ACC CathPCI Bleeding Risk Calculator also came as a surprise because the APPs indicated in the pre-project implementation survey that they often use risk assessment scores in clinical practice and find those scores moderately important for clinical decision-making. Since there is no other bleeding risk calculator for patients undergoing coronary angiogram and since the APPs use risk assessment scores in clinical practice, an assumption was made that the APPs would find the ACC CathPCI Bleeding Risk Calculator useful. Acceptance of the risk calculator may have been affected by APP bias prior to using it. For example, the APPs expressed surprise about the score some of their patients received. Prior to calculating the risk score, the APPs assumed that a patient's risk was higher than the national average based on the patient's comorbidities, laboratory values, and medications. The discrepancy between what the APPs expected the bleeding risk to be and the actual score calculated using the ACC CathPCI Bleeding Risk Calculator raised doubts about the tool's validity and resulted in lack of faith in the results among the APPs.

The project concluded with partial success despite the limited number of participants and shortened duration. The aims of the project were to provide an educational program on assessing bleeding risk and implement the use of the ACC CathPCI Bleeding Risk Calculator to impact communication and documentation of risk. The project participants were critical of the bleeding risk calculator, but they embraced the standardized workflow for communicating and documenting risk and expressed willingness to incorporate those elements of the workflow into clinical practice.

In the future, subsequent tests of change are needed. Since the participants did not trust the accuracy of the ACC CathPCI Bleeding Risk Calculator, a future test of change would include additions made to the calculator or possibly development of a new risk assessment tool.

Given that the small sample size was a barrier in this DNP project, upcoming projects would include a larger participant pool to achieve a more robust sample size. Additionally, the duration of a future project would be at least eight weeks as was originally planned for this project. Although the small sample size of this test of change inhibited the generalizability of the results, findings support similar implementation strategies in like settings. The design of this project lends itself to quality improvement projects with a larger sample size.

This project has implications for nursing practice. For example, advanced practice nurses have a significant role in the consenting process of patients undergoing procedures. Objective and formalized risk assessment can improve the consenting process, therefore benefiting the patient, proceduralist, and advanced practice nurse. Additionally, advanced practice nurses in any setting could benefit from similar workflows to further establish their role in peri-procedure practice by enhancing documentation and communication of critical information.

Future research is needed to understand whether having the risk calculator changed the incidence of post-procedure bleeding events. Upcoming projects are needed to establish what interventions to employ in response to a high bleeding risk score. Furthermore, research is needed to determine if such interventions have an impact on the rate of major bleeding events among patients undergoing coronary angiography.

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Appendix A

Use of validated post-PCI bleeding risk tools and models

Category (Level Type)	Total Number of Sources/Level	Overall Quality Rating	Synthesis of Findings Evidence That Answers the PICO Question
Level III • Non-experimental study • Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis • Qualitative study or systematic review of qualitative studies with or without meta-synthesis	Three: • Strauss et al., 2014 • Spertus et al., 2015 • Rao et al., 2013	Grade B	• Validation of post-PCI bleeding risk tools/models • Practice changes (use of bleeding avoidance strategies) based on bleeding risk results calculated from the tools/models • Reduction in post-PCI bleeding complications with use of tools/models • These findings supported pre-procedure bleeding risk stratification for patients undergoing percutaneous coronary intervention

Appendix B

Implementation of risk assessment tools in practice

Category (Level Type)	Total Number of Sources/Level	Overall Quality Rating	Synthesis of Findings Evidence That Answers the PICO Question
Level III • Non-experimental study • Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis • Qualitative study or systematic review of qualitative studies with or without meta-synthesis	Three: • Skytt et al., 2016 • Scovil et al., 2014 • Park et al., 2018	Grade B	• Evidence-based risk assessment tools are available for multiple conditions • Implementing use of such tools can be done in various ways although thorough staff education is the most effective method • Staff and organization must support tool implementation • Risk assessment tools can improve documentation and patient outcomes

Appendix C

Facilitating practice change among nurse practitioners and other healthcare providers

Category (Level Type)	Total Number of Sources/Level	Overall Quality Rating	Synthesis of Findings Evidence That Answers the PICO Question
Level I • Experimental study • Randomized Controlled Trial (RCT) • Systematic review of RCTs with or without meta-analysis	One: • Ilic & Maloney, 2014	Grade B	• Some methods of teaching evidence-based practice may be superior to others but larger studies are needed to confirm • Teaching EBP leads to greater EBP competency after teaching • A validated assessment tool may be helpful in assessing EBP knowledge among providers
Level III • Non-experimental study • Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis • Qualitative study or systematic review of qualitative studies with or without meta-synthesis	Two: • Kaasalainen et al., 2015 • Jefferies & Shah, 2011	Grade B	• Education regarding practice change is most successful if multiple modalities are used to educate • Strategies include: educational meetings, seminars, laminated pocket cards, and web-based algorithms • Advanced practice nurses play an important role in receiving data from researchers and implementing the research recommendations in practice

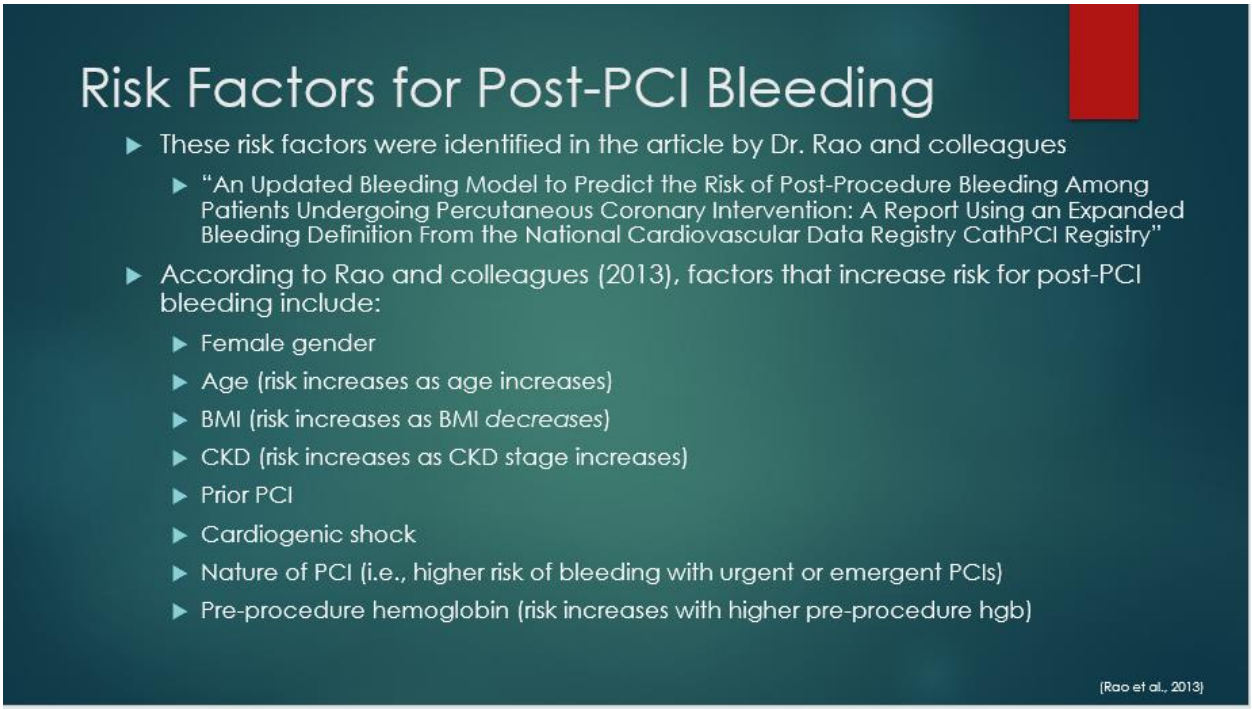
Appendix D

Using the Plan-Do-Study-Act theoretical framework for healthcare quality improvement

Category (Level Type)	Total Number of Sources/Level	Overall Quality Rating	Synthesis of Findings
Level III • Systematic review of quality improvement projects in the healthcare setting	One: • Knudsen et al., 2019	Grade B	• PDSA method was used in all 120 articles included in the systematic review • 98% of the projects resulted in improvement • Many QI projects lacked sufficient documentation of PDSA cycles for full review of key features
Level V • Quality improvement projects	Two: • Thomason et al., 2016 • Mains, Graham, & Hayes, 2020	Grade B	• Implementation of a validated risk assessment tool can be successful using PDSA methodology • Education program on risk factors can increase utilization of standardized risk assessment

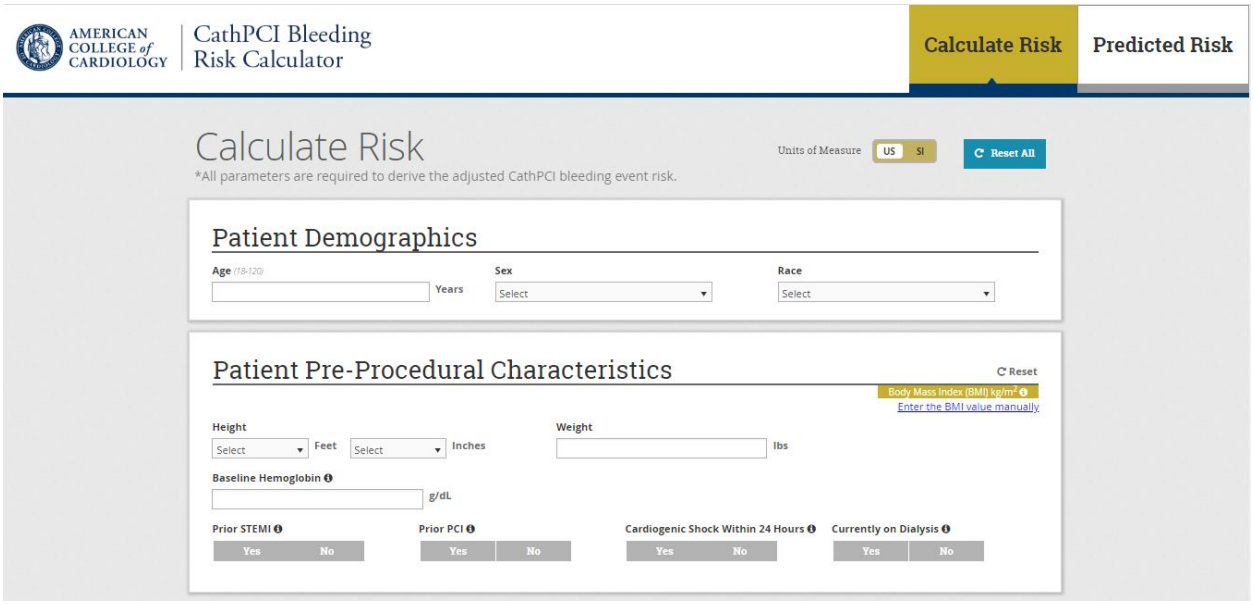
Appendix E

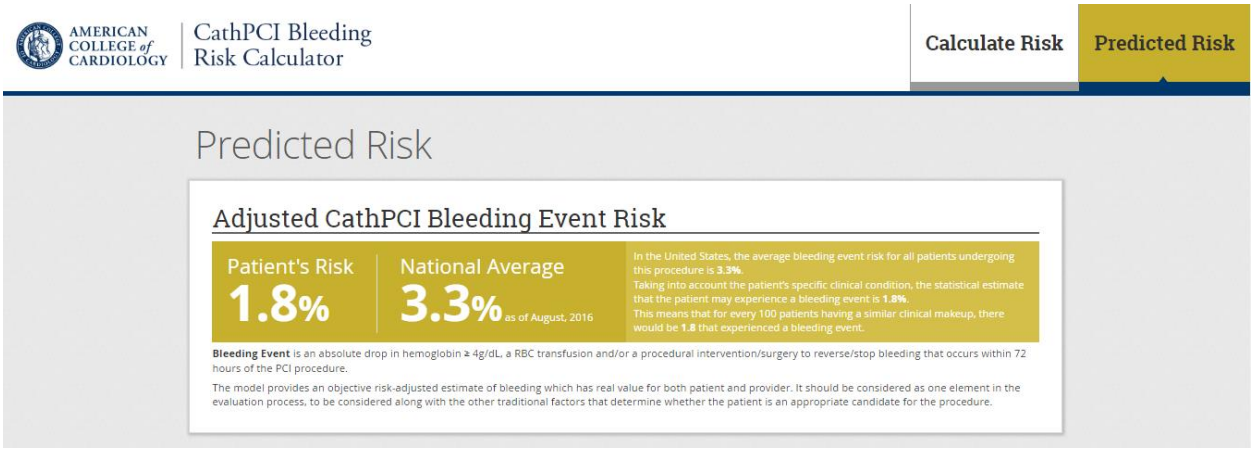
Education Slide on Risk Factors for Post-Procedure Bleeding



Appendix F

ACC Cath PCI Bleeding Risk Calculator





Appendix G

Pre-Implementation Survey

Survey Question	Answer Option
How often do you use any type of risk assessment scores to support decision-making in your clinical practice?	Never / Rarely / Sometimes / Often / Always
If you have previously used risk assessment scores, how important were the scores in your clinical decision-making?	Not at all important / Slightly important / Moderately Important / Very Important / Extremely Important
If you have never or rarely used risk assessment scores in your clinical decision-making, what factors impacted that decision?	Open-ended
In training for your role as a peri-procedural Cath Lab APP, what was the quality of formal education you received about factors that increase risk for post-PCI bleeding?	Very Poor / Poor / Fair / Good / Excellent
What is your current process for assessing and documenting bleeding risk of patients undergoing coronary angiography?	Open-ended
Changing current practice to implement the risk assessment process described in the PowerPoint presentation ('APP Role in Project') will be beneficial for patients and manageable for workflow.	Strongly Disagree / Disagree / Neutral / Agree / Strongly Agree
Additional comments.	Open-ended

Appendix H

Post-Implementation Survey

Survey Question	Answer Option
The education and instructions provided in the PowerPoint were sufficient for understanding the problem and implementing the workflow.	Strongly Disagree / Disagree / Neutral / Agree / Strongly Agree
Using the ACC CathPCI Bleeding Risk Calculator enhanced pre-procedure assessment of patients undergoing coronary angiogram.	Strongly Disagree / Disagree / Neutral / Agree / Strongly Agree
The project workflow was an effective way of assessing, documenting, and communicating bleeding risk.	Strongly Disagree / Disagree / Neutral / Agree / Strongly Agree
In the future, I would use the project workflow as the new standard of practice for assessing the bleeding risk of patients undergoing coronary angiography.	Strongly Disagree / Disagree / Neutral / Agree / Strongly Agree
For each risk score that I calculated, I was able to document the score in the consent note.	Agree / Disagree
What were the barriers, if any, to implementing the workflow?	Open-ended
What, if anything, would you change about the workflow?	Open-ended
Additional comments.	Open-ended