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Preoperative Anemia Management in Adult Outpatient Coronary Artery Bypass Graft Surgical Patients to Improve Treatment of Preoperative Anemia

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Preoperative Anemia Management in Adult Outpatient Coronary Artery Bypass Graft Surgical Patients to Improve Treatment of Preoperative Anemia

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Abstract

The transfusion of blood products can lead to life-threatening complications after surgery. In addition, blood products are a scarce and expensive resource. Even though anemia in coronary artery bypass surgery patients is currently undertreated, research has shown that the intravenous infusion of iron products, as well as a single dose of erythropoietin-alpha prior to surgery, decreases the amount of blood products used in the perioperative setting. The goal of this pilot project was to increase the number of patients screened for anemia, and if necessary, treated prior to coronary artery bypass graft surgery.

Methods: This was a practice improvement, pilot project within a preoperative assessment center in a large Midwestern health system. The population included outpatient coronary artery bypass graft surgical patients. The presence of anemia was determined prior to the required cardiac catheterization before coronary artery bypass graft surgery. Through a new process, patients diagnosed with anemia were referred to the preoperative assessment center for optimization and treatment management. The results of this quality improvement project showed an increase in the number of patients who received treatment for their anemia prior to surgery.

Conclusions: The literature suggests that a decreased use of blood products will result in fewer complications following cardiac surgery. While this pilot project did not show a statistical difference in the amount of blood products used, there was a clinically meaningful improvement as the new process for anemia management increased the number of patients treated for anemia prior to surgery.

Implications: This new referral process was successful in treating preoperative anemia. Continued improvement in the treatment of anemia is needed to decrease the number of post-surgical complications that may arise from anemia in this population of coronary artery bypass graft patients.
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Preoperative Anemia Management in Adult Outpatient Coronary Artery Bypass Graft Surgical Patients to Improve Treatment of Preoperative Anemia

Anemia is a condition where the amount of hemoglobin circulating in the blood is inadequate to meet the body’s physiologic needs. According to the World Health Organization (WHO) (2008), anemia is defined as a hemoglobin concentration of less than 12 g/dL in non-pregnant women and less than 13 g/dL in men. While there are many conditions that can lead to anemia, approximately 50% of occurrences are due to iron deficiency (WHO, 2008). Iron deficiency anemia is most often caused by malnutrition and is the most common form of anemia, followed closely by chronic disease anemia caused by inflammation or cancer (Peters, Ellermann, & Steinbicker, 2018). Anemia caused by inflammation may reduce iron availability, erythropoietin production in the kidney, and may result in a diminished bone marrow response to erythropoietin (Peters et al., 2018). Preoperative anemia is common among cardiac surgical patients with multiple comorbidities or advanced age. Moreover, major surgical procedures, such as cardiac surgery, may result in considerable blood loss either intra- or post-procedure, which can also result in anemia.

The treatment for iron deficiency anemia includes oral or intravenous (IV) iron supplementation, erythropoietin-alpha (EPO), or allogeneic red blood cell transfusion (aRBCt). A number of patients who have anemia due to blood loss require aRBCt. The likelihood of needing a blood transfusion is increased if preoperative anemia exists (Weltert et al., 2015). It is important to diagnose and treat anemia, as it is associated with poor outcomes after cardiac and non-cardiac surgery and can lead to increased length of hospital stay, adverse effects and complications from surgery, and mortality (Clevenger et al., 2016; dos Santos et al., 2013; Hung, Besser, Sharples, Nair, & Klein, 2011).
Even though aRBCt can improve oxygen delivery quickly, it is not the treatment of choice because of the associated complications, such as atrial fibrillation, stroke, respiratory infections, sepsis, myocardial infarction, and death (dos Santos et al., 2013; dos Santos, et al., 2014). For example, the use of aRBCt can impact increased postoperative mortality by 70% for patients who have cardiac surgery (dos Santos et al., 2014). Despite efforts to reduce aRBCt in cardiac surgery, it remains a common practice. Other therapies, such as the administration of iron therapy, whether oral or IV, in combination with EPO or as a single therapy, has been shown to increase hemoglobin concentration and reduce the use of aRBCt (Clevenger et al., 2016; Gurusamy, Nagendran, Broadhurst, Anker, & Richards, 2014; Lin, Lin, & Tran, 2013; Litton, Xiao, & Ho, 2013; Peters et al., 2018). Understanding the pathophysiology of functional iron deficiency is important when choosing to use EPO or iron supplementation to treat preoperative anemia as the origins of anemia change the course of treatment. A single dose administration of EPO prior to cardiac surgery has been shown to be effective in minimizing the need for aRBCt without increasing adverse events (Cladellas et al., 2012; Weltert et al., 2015; Yoo et al., 2011).

In addition to the complications of aRBCt, cost is also a burden. The average cost of aRBCt, when including all of the process steps, staff, and overhead cost, is $761 ± $294 per transfusion (Shander et al., 2010). Blood products are also a scarce resource. In July 2018, the American Red Cross reported a critical blood shortage that resulted in an emergency call for eligible donors (The American National Red Cross, 2018). Blood donations fell short of expectations in May and June 2018, resulting in 61,000 fewer donations than needed (The American National Red Cross, 2018). Due to the scarcity of blood and the associated complications, safe and effective strategies to reduce aRBCt are needed.

The purpose of this project was to implement an evidence-based practice improvement initiative to improve the treatment of iron deficiency anemia prior to coronary artery bypass
(CABG) surgery in a large Midwestern health system (MHS). Evidence regarding the assessment of the current state of the Midwestern health system is included.

**Current Practice**

The process used to assess preoperative patients for anemia in MHS was evaluated. Current practice included patient identification in the cardiac catheterization lab (cath lab) as a possible candidate for CABG by the interventional cardiologist. From there, a registered nurse within interventional cardiology services ordered the appropriate tests and referred the patient to cardiothoracic surgery (CTS) for evaluation. After the cardiothoracic surgeon met with the patient, the surgeon determined if surgery was the appropriate intervention. If surgery was indicated, it was scheduled within two to three weeks of the initial surgical consultation. The patient was then referred to the primary care provider for preoperative assessment and optimization of chronic diseases prior to surgery. The provider optimizes existing medical issues and recommends management of them in the perioperative period in coordination with other providers involved in care.

**Society of Thoracic Surgeon’s Data**

The Society of Thoracic Surgeon’s (STS) National Database was established as an initiative to improve patient safety and quality of care among cardiothoracic surgeons. The STS Adult Cardiac Surgery Database is the world’s leading clinical outcomes registry for adult cardiac surgery (D’Agostino et al., 2018). The database includes both national and specific organization data (D’Agostino et al., 2018). As of June 2018, 1081 organizations in the United States have participated in this database (D’Agostino et al., 2018). MHS uses the database as a benchmark to guide practice within CTS.

According to the STS 2018 data, 38% of all patients (inpatient and outpatient) in MHS who undergo cardiac surgery are anemic at the time of surgery. This is somewhat higher than a
large multicenter cohort study where the overall prevalence of preoperative anemia was 26% (Karkouti, Wijeysundera, & Beattie, 2008). Further, approximately 30% of patients in MHS from the outpatient setting who undergo cardiac surgery were anemic. Of these 30% who were anemic, only 17% of outpatient CABG patients were identified as anemic prior to surgery and treated with oral iron supplements, vitamin B-12, and/or EPO injections. Improvement in identification and treatment of anemia preoperatively was needed.

Assessment of the Health System

Model Overview

The Burke and Litwin Model of Organizational Performance and Change (1992) framework and a SWOT analysis were used to guide the organizational assessment for this project (see Appendix A). The Burke and Litwin model (1992) outlines 12 elements that may affect the overall success of an organizational change effort. The model includes casual elements, meaning that these elements interact with and affect each other. The structure of the model includes two dynamics that provide guidance for describing the macro and micro levels of organization: culture and climate, respectively. Culture is defined as the organization beliefs and values. Climate is defined in terms of how individuals perceive their local work unit is managed and how they and their coworkers work together. Climate is influenced by the overall culture of the organization.

The model distinguishes among the 12 elements by terming them transactional or transformational variables. Transactional variables are affected by human behavior on the micro level: everyday interactions and exchanges on the work unit such as the structure, management practices, systems, work unit climate, task and individual skills, motivation, and individual needs and values. Transformational variables are concerned with macro level organizational processes and culture changes in behavior. Transformational variables interact with the environment,
whether external or internal. These are the most influential in organizational change and include external environment, mission and strategy, leadership, and organizational culture. Changes in transformational processes are required to enact lasting change in an organization. While transformational variables influence lasting change, transactional variables remain important and should be assessed as both sets of variables interact and affect individual and organizational performance.

**Organizational Assessment**

The managing physician in the preoperative assessment center (PAC), an interventional cardiology registered nurse, and a clinical practice specialist for cardiothoracic surgery were interviewed to obtain a deeper understanding of the transactional dynamics of the organization. The external environment was a strong motivator to change practice and reduce blood usage due to the scarcity of blood products, the potential for serious adverse effects, and the high cost of blood products.

The mission and strategy, leadership, structure, work unit climate, individual abilities of staff, and culture all served as facilitators for this practice change initiative. The mission of MHS promotes quality improvement initiatives to “improve the health of communities…” that they serve. The climate and leadership qualities in both the CTS and PAC offices are strong, positive, and encourage change projects that will positively affect the patients. Each office is committed to quality improvement and strives to exceed the national benchmarks for adult surgical outcomes. An identified potential barrier was that this health system does not have an effective process in place for ordering and managing IV infusions. This was addressed prior to implementing the practice change.
Ethics and Protection of Human Subjects

The Institutional Review Boards (see Appendix B and C) of the university and site determined the project was quality improvement.

Stakeholders

A project cannot function properly without key stakeholders invested in the project (Moran, Burson, & Conrad, 2017). Key stakeholders in this anemia management project included healthcare providers (physicians, nurse practitioners, and physician assistants), registered nurses, pharmacists, infusion clinic staff, quality improvement specialists, laboratory technicians, outpatient cardiology office staff, and patients. Healthcare providers were included as stakeholders as prescribers of blood, iron infusion products, and preoperative testing. Pharmacists were included because they mix the iron infusion products and were instrumental in creating the algorithm for proper anemia management. Other stakeholders that were identified included infusion clinic personnel because they administer the infusion, laboratory technicians because of the need to draw appropriate labs, and finally the patients who receive the blood products or iron infusions. Outpatient cardiology office staff were instrumental in assisting the DNP student with the project.

SWOT: Strengths, Weakness, Opportunities, and Threats

A SWOT analysis is a tool used to perform an assessment of an organization’s strengths, weaknesses, opportunities, and threats (Moran, Burson, & Conrad, 2017). The evaluation of the internal strengths and weaknesses, along with the evaluation of the external opportunities and threats, provides a general overview of the current state of the organization. Strengths refer to the internal traits that are helpful to a program, such as efficient processes, experienced staff, or an aesthetically appealing environment (Moran, Burson, & Conrad, 2017). Weaknesses denote the internal traits that are harmful to a program, such as underlying tension in the office or
knowledge gaps. Opportunities are the external traits or changes that could help the program, while threats refer to the external traits or changes that may be harmful. The strengths, weaknesses, opportunities, and threats of the preoperative assessment center in a large MHS were analyzed per discussions with key stakeholders; specifically, with the nursing practice manager (see Appendix D).

The strengths of the PAC were identified and included motivated leaders and consistent, expert providers in the realm of preoperative assessment, and a close relationship to the connecting hospital. The PAC offers a comprehensive preoperative optimization visit with enhanced quality of care by incorporating evidence-based practice measures. The PAC was affiliated with a Magnet® designated health system, which is a distinction that honors nursing excellence and high-quality patient care. The PAC also has opportunities. The PAC has bandwidth for providers to see more patients to manage care prior to surgery. The PAC enjoys a close relationship with its existing providers and anesthesiologists, which has resulted in effective communication.

Weaknesses of the PAC included gaps in needed professions, such as a pharmacist to oversee medication changes and dosing, dieticians to aid in lifestyle education and modification, and a medical assistant to collect blood samples. Historically, MHS had not had a process in place to order and manage IV infusions. This frustrated providers, which may be why IV infusions were not done as frequently as needed.

Threats were also identified. CTS and the PAC did not have a working relationship, which may have caused hesitancy to collaborate due to a lack of trust. As an organization, MHS had not thus far encouraged preoperative anemia management, which may have caused some push-back from stakeholders during process change. It is important to be aware of and address these weaknesses and threats to lessen their effect on the practice change.
Clinical Practice Question

The clinical practice question was: If patients are referred to a preoperative assessment center prior to CABG surgery for preoperative anemia work-up, will the number of patients undergoing CABG surgery with untreated anemia decrease?

Review of the Literature

To determine best practice for preoperative anemia management, a literature review was conducted. The primary objective of the review was to identify detection and treatment of preoperative anemia in CABG patients. Therefore, safe, effective, and evidence-based methods to treat preoperative anemia were examined. The central theme of the review was iron infusion and EPO administration prior to cardiothoracic surgery, as they are safe and cost-effective alternatives to blood product use.

Methods

PRISMA. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline served as the framework for the review (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009). A comprehensive electronic search was conducted in the Google Scholar, PubMed, and Cochrane Library databases. The search was limited to reviews in the English language during the period of 2013 to 2018. Reference lists from the included studies were reviewed to identify potential additional sources. Keywords included: anemia, preoperative anemia, cardiac surgery, anemia management, cardiac, adult, iron infusion, and erythropoietin. Results were filtered to only show systematic reviews, meta-analyses, and randomized control trials.

Aim of the Review. This review answered four questions:

- Does any formulation of iron supplementation therapy increase hemoglobin concentration in anemic patients?
• What formulation of iron supplementation is safe and effective in improving hemoglobin levels in anemic patients?
• What formulation of iron supplementations reduces the risk of aRBCt in anemic patients?
• Is EPO therapy safe and efficacious in reducing the use of aRBCt in cardiac surgery?

Inclusion and Exclusion Criteria

Article Types. Included in the literature review were randomized control trials (RCT), systematic reviews, and meta-analyses. Excluded were studies less than an RCT.

Population. Included were samples that featured non-pregnant, anemic adults without chronic kidney disease. Pediatric populations, adults with chronic kidney disease, emergency surgeries, treatment refusal, and patients allergic to iron were excluded.

Intervention. Articles with multifactorial and single interventions were included in this review. Articles that only reported study results without stating the mechanisms of the intervention were excluded.

Comparison. Articles that included any type of iron preparation were included in this review. Articles that compared single or multifactorial interventions with a placebo were included in this review. Articles that used EPO as a single-dosed intervention or in conjunction with iron supplementation were included. Articles that did not use either iron supplementation or EPO therapy prior to surgery were excluded.

Outcome. Reviews that reported the outcome of an intervention on preoperative anemia measured in one of, or in a combination of the following were included: change in hemoglobin concentration pre- and post-intervention, morbidity and mortality, length of hospital stay, and blood transfusion requirement. Studies that did not include at least one of these measures were excluded.
Search Outcomes

The search yielded 324 studies (see Appendix E). Twenty-two were retrieved from the Cochrane Library, 241 from Google Scholar, and 61 from PubMed. Three articles were found through review of reference lists of included studies. Seven duplicates were found. After removing the duplicates, the titles and abstracts of 320 articles were screened. After reviewing the titles and abstracts, 290 articles were excluded for reasons pertaining to population, intervention, comparison, and outcome. Thirty full-text articles were assessed for eligibility using inclusion and exclusion criteria according to PRISMA criteria (Moher et al., 2009). Review of titles and abstracts resulted in removal of 22 articles that did not meet the inclusion criteria; the remaining eight articles were included in this review.

Summary of Results

Eight articles met the inclusion criteria and were included (see Appendix F). Included in this literature review were two Cochrane Reviews (Clevenger et al., 2016; Gurusamy et al., 2014), two systematic reviews (Lin et al., 2013; Litton et al., 2013), three RCTs (Cladellas et al., 2012; Weltert et al., 2015; Yoo et al., 2011), and one comprehensive review article (Peters et al., 2018).

Project Evidence

The authors of these reviews found use of iron therapy and/or EPO to correct preoperative anemia is safe and efficacious. The authors of four of eight reviews supported the use of iron therapy, specifically IV iron to treat anemia (Clevenger et al., 2016; Gurusamy et al., 2014; Litton et al., 2013; Peters et al., 2018). There was some evidence that oral iron is also efficacious in treating anemia, but less so than IV iron (Clevenger et al., 2016; Gurusamy et al., 2014; Lin et al., 2013). The authors of all articles measured a change in blood transfusion requirements. The authors of three reviews described a decrease in the proportion of people who
required blood transfusion after supplementation with both oral and IV iron compared with inactive control (Clevenger et al., 2016; Gurusamy et al., 2014; Peters et al., 2018). Two of the eight RCTs supported use of a single dose of EPO prior to cardiac surgery to reduce aRBCt (Welert et al., 2015; Yoo et al., 2011). Two of eight studies supported the use of EPO combined with IV iron to reduce aRBCt (Cladellas et al., 2012; Lin et al., 2013).

The authors of three of the eight studies examined a decrease in overall mortality (Cladellas et al., 2012; Clevenger et al., 2016; Welert et al., 2015). Overall, serious adverse events and mortality were not increased with the use of IV iron compared with oral or no iron or with the use of EPO, whether as single therapy or in combination with IV iron infusion (Litton et al., 2013; Yoo et al., 2011). It is important to note, however, that none of the studies included in this review found increased mortality. One study found an increased risk of all-cause infection associated with IV iron, but the authors admit that their result may have been a false positive and inconclusive due to the lack of associated infection in IV iron in other settings (i.e. dialysis, postsurgical iron infusions) (Litton et al., 2013).

The authors of all eight studies cited that iron supplementation with or without the use of EPO, or a single dose of EPO used separately, decreased the number of aRBCt per patient. Correcting anemia prior to surgery may decrease the risk of blood transfusion associated adverse events and shorten length of hospital stays (Cladellas et al., 2012; Clevenger et al., 2016).

Model to Examine Phenomenon

To help facilitate successful implementation and aid in sustaining the project, an implementation model guided the project execution. Conceptual models help to identify elements that are crucial to project success that may have otherwise been overlooked. The Promoting Action on Research in Health Sciences (PARiHS) framework (Kitson, Harvey, & McCormack,
1998) (see Appendix G) was used. The key elements of the PARiHS model are described in relation to this DNP project.

**PARiHS Model**

Kitson et al. (1998) argue that successful integration of research into practice can be defined by the interplay of three core elements: level of evidence, the context or environment where research will be placed, and the facilitation process. Unlike other preceding theories on research implementation, Kitson et al. (1998) stipulates that all three elements should have equal standing. This model can be used as a checklist for users to assess needs prior to implementing research into practice.

The central caveat of this model is derived from the following equation:

- \( \text{SI} = f(E, C, F) \)
  - Where SI = successful implementation, f = function of E = evidence, C = context, and F = facilitation.

The premise of this model is that successful implementation is directly influenced by the relationship between the strength and nature of the available evidence, the context of the change environment, and the change mechanisms utilized. Kitson et al. (1998) suggests that all of these dimensions be considered simultaneously rather than in a hierarchy.

**Evidence.** Kitson et al. (1998) defines evidence as a synthesis of research, clinical expertise, and patient choice. Research quality may be low (anecdotal or descriptive) or high (RCTs, systematic reviews, evidence-based guidelines). Clinical experience is rated on a spectrum from high (consistent consensus) to low (divided opinion). Patient preference is rated by either the lack of patient involvement in healthcare or a partnership between healthcare providers and patients. For successful implementation of research that supports change, the evidence needs to be high quality, high consensus, and have high patient input.
The evidence for IV iron in the treatment of anemia has been established in multiple systematic reviews and RCTs. Professional consensus on the adverse effects of blood transfusions and alternate therapies to avoid transfusions is also well established (Cladellas et al., 2012; Clevenger et al., 2016; dos Santos et al., 2013). Patient input was considered in this change initiative. Providers are expected to educate and involve patients in the treatment plan and be available for questions or concerns.

**Context.** Context is the venue where the change will be implemented (Kitson et al., 1998). Context is subdivided into three components: an understanding of the setting’s culture, the nature of relationships as seen through leadership roles, and how the organization measures its systems. Each of these three components runs along a range of high to low context. Culture is effective when the organization is patient-centered, appreciates employees, and values continued learning. Higher leadership consists of clear roles, effective teamwork, and clear structure. High context of measurement routinely utilizes internal and external performance measures.

As identified by the organizational assessment, there is a high level of context for this project. This project had a buy-in from leaders in organization. According to public information from the organization, a goal of MHS is to involve patients and families in their care and act with integrity, respect, and compassion. This organization is a teaching hospital that is open to change and ongoing learning. The proposed change project was welcomed at this organization. This project directly affected the cardiothoracic surgery group in the organization. This group was focused on quality measures and had well-attended, monthly meetings to discuss quality initiatives and how to improve the care they provide to patients.

**Facilitation.** Facilitation describes the behavior and support that is required to help people change their attitudes, skills, and ways of working (Kitson, et al., 1998). Successful facilitators must have strong attributes in three categories: characteristics, roles, and style. To
affect change, facilitators must be open, supportive, approachable, reliable, and have clarity around the facilitator role. Facilitators bring a personal set of skills as well as an ability to work within and across role boundaries in an organization (Kitson, et al., 1998). Even with high quality evidence and a context that is receptive to change, implementation may fail under non-existent or ineffective facilitation.

The DNP student acted as the facilitator in this change project. A barrier to facilitation was identified during the needs assessment. This organization has an unclear process when ordering infusions in the outpatient setting. After discussion with key stakeholders, it was clear that the barrier may prove detrimental to the change intended within the project, if not addressed. The DNP student conducted meetings with key stakeholders to discover solutions to the problem. It was decided that a practice manager from the infusion center would provide education on how to order an infusion and provide a tip sheet to the PAC. The infusion center practice manager went to the PAC to educate providers in December 2018, prior to implementation. This manager assured the PAC that the infusion centers had the ability to see more patients and that infusions would be timely. Providers at the PAC expressed understanding of the process and found it to be more convenient than previously thought. The DNP student remained a resource for providers during the implementation process. To further assist in facilitation of this DNP project, the student remained respectful and flexible during the course of this project. Addressing concerns and being available is crucial during the beginning of and throughout the course of a change project. Remaining empathetic to the interruption of the workflow and required effort during a change in practice helped to foster trust between the facilitator and the healthcare providers.

**Successful Implementation.** Successful implementation occurs most often when evidence is high, the context is ready for change, when feedback mechanisms in place, and when there is facilitation (Kitson, et al., 1998). All three of these dimensions should be considered
equally when implementing a practice change. As previously stated, the evidence for this DNP project was high, consisting of systematic reviews and RCTs. An organizational assessment and a SWOT analysis of the outpatient preoperative assessment center were conducted to better understand the context and need for facilitation in the setting for this project.

**Project Plan**

**Purpose of Project and Objectives**

The purpose of this project was to implement an evidence-based practice improvement initiative to improve the treatment of iron deficiency anemia prior to CABG surgery in a large MHS. The objectives for this project included: (1) conducting an organizational assessment of MHS to establish current state, (2) reviewing the literature to identify best-practice to treat iron-deficiency anemia that has the potential to reduce blood products used in the perioperative setting, and (3) restructuring the current process within the setting to improve identification and treatment of iron deficiency anemia prior to cardiac surgery. This project sought to answer this clinical question: If patients are referred to a preoperative assessment center prior to CABG surgery for preoperative anemia work-up, will the number of patients entering CABG surgery without anemia treatment decrease?

**Design for the Evidence-based Initiative**

This was a quality improvement project. The phenomenon was examined using the PARiHS model. The initiative was based on the Kotter (1996) framework. The student considered the three core elements of the PARiHS framework when designing the project.

**Setting**

Administrative approval to conduct the project at this facility was secured (see Appendix H). The DNP student implemented the project at the PAC associated with MHS. The PAC provides medical evaluation and optimization to assess risks prior to surgery. Typical
preoperative medical evaluation of patients is highly variable. In contrast, the PAC offers a standardized approach to preoperative medical evaluation and management to avoid preventable complications and mortality. In the current state, the PAC cared for orthopedic, bariatric, and vascular pre-surgical patients. There were four providers that service 3,800 patients a year; approximately half of the potential capacity. The goal for the PAC was to see all surgical patients in the health system in the next two to three years.

**Participants**

The project participants included the patients receiving the treatment for anemia and the healthcare providers in both the PAC and CTS offices. The scheduler for CTS, a medical assistant, were included to prep patient charts for surgeons prior to the initial consultation. The CTS scheduler worked with the PAC scheduler, a nursing technician, in scheduling patient appointments. The CTS surgeon performed the surgical consultation. The nurses in the CTS office were included to schedule the actual surgery and to educate patients on preoperative testing, if applicable. The healthcare providers in the PAC ordered the proper anemia treatment for the patients.

Patients were identified for anemia treatment based on hemoglobin and mean corpuscular volume (MCV) levels prior to cardiac catheterization. Anemia is defined as a hemoglobin concentration of less than 12 g/dL in non-pregnant women and less than 13 g/dL in men (WHO, 2008). MCV is the average size of red cells in a specimen (Curry, 2015). The MCV determines if an anemia is microcytic, normocytic, or macrocytic, as corrective therapy changes based on this result (Curry, 2015). The nurses in the CTS office ordered additional blood work for anemic patients based on their MCV from the blood work done pre-cardiac catheterization. The blood work was done prior to the appointment at the PAC so that providers had that information prior,
expediting the treatment process. Only anemic patients that were CABG candidates were included in this pilot project.

**Model Guiding Implementation**

Kotter’s eight steps of change were used as a guiding framework to support this practice change (see Appendix I). Kotter (1996) created the model after 40 years of observing organizations as they were attempting to implement changes. There are three phases, which include eight steps that are needed to successfully implement change in an organization. These three phases include creating a climate for change, engaging and enabling the organization, and implementing and sustaining for change (Kotter, 1996).

**Creating climate for change.** The first phase consists of the first three steps to help the organization prepare for change. The first step is to establish a sense of urgency (Kotter, 1996). This requires the facilitator to help others recognize the need for change through a bold statement that inspires immediacy (Kotter International, 2018). The second step is to build a guiding coalition (Kotter, 1996). This coalition is made of leaders and effective people to sponsor and guide change (Kotter International, 2018). The third and final step in this first phase is to create a vision for change (Kotter, 1996). This involves clarifying how the change will affect the future and will guide people how to make the future a reality (Kotter International, 2018).

**Engaging and enabling the organization.** The second phase consists of the next three steps to enable the organization to change through communication and generating momentum. The fourth step is to communicate the vision (Kotter, 1996). Facilitators and leaders need to communicate the change throughout the organization. Change champions may assist in this effort (Kotter International, 2018). The fifth step is to empower action (Kotter, 1996). At this step, barriers to success need to be addressed and removed to promote action among the team members (Kotter International, 2017). The sixth step in the second phase is to create quick wins
(Kotter, 1996). Achieving and celebrating short term goals motivates team members and allows all to see that the change delivers results (Kotter International, 2018).

**Implementing and sustaining for change.** The third phase consists of the final two steps in the change process. The seventh step is to build on the change (Kotter, 1996). At this point, it is important not to let up as the first successes of the change are enacted in the organization. These successes must be used to accelerate improvements of systems and policies (Kotter International, 2018). The eighth and final step of the process is to “make it stick” (Kotter, 1996). This happens by ensuring that the new changes are strong enough to replace old habits and by ensuring that the new changes are integral to the success of the organization (Kotter International, 2018).

**Implementation Steps and Strategies**

Implementation strategies for this project were selected based on the nature of the proposed project and the principles of Kotter’s Change Model (1996). A compilation of evidence-based strategies from Powell et al. (2015) was also used to guide the selection of specific implementation steps.

1. **Assess readiness and identify barriers and facilitators:** When considering a potential quality improvement project, it is imperative that the DNP student first took the time to complete an organizational assessment (Moran, Burson, & Conrad, 2017). This enhanced project implementation, organizational change, and determine the potential for sustainability. This strategy guided the DNP student to assess various parts of the organization to determine the degree of readiness to implement and to identify barriers and strengths that may hinder or help the project succeed (Powell, et al., 2015).

   - From May through July 2018, the DNP student spent approximately 40 hours meeting with nursing managers, clinical practice managers, lead registered nurses of
outpatient clinics, and the CTS Renal and Blood Utilization Group. This helped the DNP student gain an understanding of the current state of anemia management.

- From May through July 2018, the DNP student spent approximately 20 hours shadowing key stakeholders in their roles and holding meetings with appropriate personnel to assess the organization for readiness and willingness to change.
- In August 2018, the DNP student met with the PAC practice manager to perform a SWOT analysis of the PAC. This included the internal strengths and weaknesses and its external opportunities and threats.

2. **Build a coalition/Identify early adopters:** This strategy involves identifying and recruiting early adopters and cultivating positive relationships with key stakeholders (Kotter, 1996; Powell, et al., 2015).

- From May to November 2018, the DNP student sought to build a positive relationship with the clinical practice manager of cardiovascular medicine at MHS. The manager is well connected and has introduced the student to key stakeholders.
- In August 2018, the DNP student worked with the site mentor to recruit a small subcommittee of volunteers from the CTS Renal and Blood Utilization Group to assist in designing implementation strategies for the project. This small subcommittee included the DNP student, the practice manager, a quality improvement specialist and the quality manager for CTS. This group worked together to plan a process for anemia management in CABG patients (see Appendix J).
- On October 5, 2018, the DNP student shared the process for anemia management to the subcommittee and with key stakeholders from CTS and the PAC. This included the division chief of CTS, the medical director of the PAC, cardiovascular operations director, the DNP student, quality improvement specialists, the clinical practice
manager serving as the mentor to this project, and the director of surgical services. This process included the approved algorithm for anemia management (see Appendix K). The process change was introduced to CTS surgeons in late October and was approved by this group. A meeting to operationalize the process took place in November 2018 with the manager of CTS, the PAC manager, the DNP student and the cardiovascular practice manager serving as a mentor.

3. **Develop and distribute education materials/Conduct educational meetings:**

Providing education materials allows stakeholders to learn about the new process and can serve as a passive reminder tool during implementation (Powell, et al., 2015). This includes holding meetings with stakeholders to teach them about the project (Powell, et al., 2015).

- In November 2018, the DNP student and key stakeholders met to discuss the best strategies for provider education.
- During the November 2018 CTS staff meeting, the DNP student and project mentor presented the project to the stakeholders.
- During December 2018, CTS and PAC received information on the new PAC referral process and the anemia management order set. Information on workflow changes were provided. A tip sheet was designed to assist CTS staff in placing a referral to PAC and to assist in explaining the new process to patients (see Appendix L).

4. **Conduct tests of change:** This implementation strategy allows for small, cyclical tests before change is trialed system-wide. The results of small tests can be used to gain insight before implementing on a larger scale (Powell, et al., 2015).

- The pilot project started in December 2018. As part of current state, patients receive an order from the interventional cardiologist to have a complete blood count (CBC)
and basic metabolic panel drawn within one week prior to arriving to the cath lab. Patients were identified as surgical candidates by an interventional cardiology physician during the cath lab procedure if the patient’s heart disease is too advanced for cardiac stenting alone. Patients who were surgical candidates were then referred for surgical consultation. The registered nurse in the cath lab contacted the CTS scheduler who makes an appointment for the patient to see the cardiothoracic surgeon.

- In December 2018, the pilot project started with patients of one surgeon with a CABG procedure. Another surgeon was added to the pilot for the last four weeks of implementation. Using the new process change, the CTS scheduler prepped the patient charts for the surgeons prior to the initial surgical consultation and identified anemic patients using the CBC drawn prior to the cath lab procedure. If the patients were anemic, the CTS scheduler collaborated with the PAC scheduler to make tandem appointments for the patient to see the surgeon and a provider at the PAC on the same day, when possible. The nurses in the CTS office then scheduled the surgery following the initial surgical consultation appointment, provided pre-surgery education for the patients, and then directed them to the PAC for their surgical optimization appointment. The CTS registered nurses in the surgeon’s office also ordered additional laboratory studies as indicated, including iron studies, vitamin B12 levels, and folate levels.

- From December 2018 through February 2019, patients with anemia were sent to the PAC for presurgical optimization. The nurse practitioners in the PAC ordered the necessary treatment for the patient’s anemia. Referrals to the infusion center were
made, if needed. The medical director and the nurse practitioners in PAC remained in contact with the surgeon. PAC followed each patient until the date of surgery.

5. **Audit and provide feedback/facilitate relay of clinical data to providers:** This encompasses distributing performance data to key stakeholders over a specific period. This allows the student to provide feedback to providers, offers providers a tool for self-evaluation, and provides quick wins during the practice change (Kotter, 1996; Powell, et al., 2015).

   - Key stakeholders received weekly progress reports on the project and updates on how the practice change was progressing. This included how many patients were treated per protocol, what they were treated with, and potential barriers that arose during implementation, with possible solutions.
   - The DNP student sought feedback from providers regarding facilitators and barriers identified during the project. Pre-implementation data were collected in November 2018 for the period of August through October 2018. Post-implementation data was collected in March 2018 for the period of December 2018 to February 2019.
   - The DNP student collected measures using the STS data dashboard and through individual chart audit.

6. **Capture and share local knowledge:** Disseminating the results of the DNP project is an evidence-based strategy and can assist other organizations to improve their systems (Powell, et al., 2015).

   - In March 2019, the DNP student shared final project results with key stakeholders.
   - CTS and PAC received a post-implementation satisfaction survey regarding provider satisfaction with the process change. This clarified any added value of project implementation and project sustainability (see Appendix M & N).
• In April 2019, the DNP student provided a final report to MHS outlining project outcomes; and presented at the sites research council poster day on April 9, 2019.

• In April 2019, the DNP student conducted final DNP project defense to disseminate further goals, sustainability options, and results; and published in ScholarWorks©.

Measures

Measures are outlined below and shown in Appendix O:

• Data were collected through chart audit included patient age, sex, presence of anemia diagnosis, hemoglobin prior to cardiac catheterization, referral to the PAC, presence of anemia treatment, type of anemia treatment, hemoglobin prior to surgery, presence of blood product usage, type of blood products used, if any, and hemoglobin after surgery.

• The DNP student collected data from chart audits and using a tool (see Appendix P). Quality improvement specialists from cardiovascular services assisted the DNP student in collecting STS quality data.

• Provider satisfaction is integral to the continued success of a process change. A post-implementation survey regarding provider satisfaction with the process change was distributed after implementation, assisted by the PAC and CTS practice managers, to obtain information on project sustainability. CTS surgeons received a six-question survey in Likert format. PAC nurse practitioners received a five-question survey in Likert format. Both scales ranked answers from 1 “strongly disagree” to 5 “strongly agree” . In total, there were four surveys distributed and four surveys that were completed and returned. Each survey offered a comment section at the bottom.

• The number of patients appropriately screened and treated per protocol for anemia prior to CABG surgery were analyzed pre- and post-implementation by chart audit. This
information identified whether the process change resulted in increased awareness of anemia and treatment prior to CABG surgery.

- Use of perioperative blood products were measured during implementation to assess whether treatment of anemia resulted in a decrease in blood utilization. A comparison of a random sample of 10 patients not included in the pilot project were compared to patients in the pilot project. The DNP student obtained data from the MHS Blood Utilization Dashboard and through chart audit.

- A global change in hemoglobin was measured in two groups: the average hemoglobin in 10 patients not included in the pilot project were compared to patients in the pilot project. The data was obtained through chart audits.

**Data Collection Procedures**

The DNP student collected data for the project from the electronic health record (EHR) and STS quality data using a chart audit tool pre- and post-implementation in a Microsoft EXCEL spreadsheet. The pre-implementation audit was done in November 2018 and included all elective CABG surgeries from August 2018 through October 2018 (N = 54 surgeries). The post-implementation audit was done in March 2019 and included a random sample of 10 patients not included in the pilot project and 14 patients in the pilot project, December 2018 through February 2019. Satisfaction outcomes with the new process for preoperative management of CABG patients was obtained by a Likert-style survey designed by the DNP student. The survey was piloted for clarity, then distributed to CTS surgeons and PAC providers in March 2019 post-implementation with the assistance of the CTS practice manager.

**Data Management**

The DNP student was responsible for data management throughout this project. After data collection was completed, the DNP student, in collaboration with a university statistician,
transferred the de-identified data to SAS for analysis. Data was stored on MHS internal drive that is only accessible by approved individuals (identified by health system administration). All protected personal information was removed to protect patient identity. Data remained on the drive upon completion of the project.

Analysis

The data was analyzed with support from a university statistician. The proportion of patients entering surgery treated for anemia pre- and post-implementation were analyzed with a one sample test of proportions. The amount of blood products used in the perioperative setting pre- and post-implementation and average post-operative hemoglobin of CABG patients in the pilot group and the random sample of non-pilot group patients was analyzed using Wilcoxon Rank Sum test. Descriptive statistics were used to report satisfaction.

Resources & Budget

The budget for the project is shown in Appendix Q. Resources needed for this project included the time and monetary compensation of key stakeholders and participants (Salary.com, 2019). Resources such as computers and an electronic health record were already available at the organization. The main resource was compensation for time of stakeholders planning the project, time of staff during education, and the cost of anemia treatment.

The DNP student and GVSU statistician donated time for the project. Potential cost savings from this project include preventing the use of packed red blood cell transfusions in the perioperative period. At $761 ± $294 per unit, packed red blood cells are costly and are also potentially dangerous to patients (Shander et al., 2010). Packed red blood cells should not be first line for anemia in the perioperative period due to the associated complications (dos Santos et al., 2013; dos Santos, et al., 2014).

In a three-month period prior to the implementation of this project (August-October
2018), the majority of blood products used in surgery at MHS were used by anemic patients. In that three-month period, anemic patients in CABG surgery used 31 units of packed red blood cells while non-anemic patients used 17 units in that same period. The additional 14 units of aRBCt cost $10,654 (Shander et al., 2010). Any change in procedure that could reduce the use of packed red blood cells in surgery has proven to be potentially cost-saving and have a positive impact on patient outcomes (Cladellas et al., 2012; Litton et al., 2013; Welert et al., 2015; Yoo et al., 2011).

**Timeline**

To ensure that the objectives of the project were met, Kotter’s eight-step change process (1996) served as a guide. See Appendix R for the proposed timeline.

1. **Establish sense of urgency**: In September 2018, meetings with key stakeholders began. The DNP student met with clinical practice manager of cardiovascular medicine, quality improvement staff, and cardiothoracic surgery staff several times between September and October 2018 to begin planning the project.

2. **Build a guiding coalition**: The DNP student identified additional key stakeholders in the PAC and within the cardiothoracic surgery office in September 2018. The PAC agreed to manage preoperative anemia with the surgeons.

3. **Create a vision for change**: On October 5, 2018, a vision was created by the DNP student and clinical practice manager that defined the goals for the project.

4. **Communicate the vision**: In October 2018, the process for managing anemia in CABG patients was presented to key stakeholders. The leaders of the surgical team of the PAC agreed to begin a pilot project on preoperative management in CABG patients. The finalized, proposed process was disseminated to the PAC,
cardiothoracic surgical office staff, providers, and interventional cardiologists.

Education for these services was done in November and December 2018.

5. **Empower action**: The new process for anemia management was incorporated into standard practice of one surgeon’s CABG-only patients by December 2018.

6. **Create quick wins**: Weekly updates on the progress of the anemia management were disseminated via email to cardiothoracic surgery and to the PAC. Reinforcement of the new process was provided throughout this timeframe via site visits, emails, and dissemination at monthly quality meetings.

7. **Build on the change**: Weekly progress reports continued throughout the implementation. A final review was provided for stakeholders by March 15, 2019. The anemia management process remained in place as standard work. The final review was presented to the CTS Quality Subcommittee in April 2019.

8. **Make it stick**: The anemia management process was expanded into other cardiothoracic procedures and other surgeons.

**Results**

Twenty four patients divided into an intervention (n=14) and usual care (n=10) group were analyzed. The intervention group were 14 patients that were screened using the new referral process. The usual care group was a convenience sample of 10 patients that were not involved in the new referral process. The average age of Intervention group was 63.8 (Standard Deviation 9.8 [SD]) years and 68.8 (SD 9.7) years in the usual care group. The intervention group were 21.4% (3 of 14) female and usual care were 10% (1 of 10) female.

**Patients Screened for Anemia**

CABG patients of one CTS surgeon were screened for anemia for all 12 weeks of implementation using the new referral process. Another surgeon’s CABG patients were trialed
for the last four weeks of implementation. Of those in the intervention, 42.9% (6 of 14) were anemic at the initial CTS consultation. Of those with anemia 83.3% (5 of 6) patients were properly screened and referred to the PAC where they were evaluated. The one remaining patient was not identified and was not referred and did not receive treatment for anemia prior to surgery. Incidentally, this patient was no longer anemic at the time of surgery. Of the 20% (1 of 5) of the patients referred to the PAC did not receive treatment for anemia as the patient’s hemoglobin levels were considered to be baseline normal for that particular patient and care was subsequently individualized.

In total, 66.6% (4 of 6) patients who were anemic, were identified and treated compared to only 17% (7 of 41) of anemic outpatient CABG patients who were identified as anemic prior to surgery in the pre-implementation (D’Agostino et al., 2018). Following implementation, the proportion of patients treated for anemia were statistically greater than pre-implementation (p=.0006). Overall, there was a 49.6% increase in anemic patients receiving treatment prior to surgery when pre- post-implementation were compared (see Appendix S). Incidentally, one patient in the intervention group who was not anemic was prescribed EPO injections preoperatively due to an inability to receive blood products during surgery.

Use of Perioperative Blood Products

The median blood products used in the intervention group were 1.5 units compared to 2 units in the usual care group. In the intervention group 42.9% (6 of 14) received blood products, or 14 units of aRBCt. One unit of platelets was also used in Intervention group. Compared to usual care, where 50% (5 of 10) received blood products, or 6 units of aRBCt. Other types of blood products used include platelets (3 units) and cryoprecipitate (1 unit). While the intervention group used more units of aRBCt, a higher proportion of patients who had usual care received blood products. It should be noted that one patient received seven units of aRBCt in
thee intervention group, skewing the data. After completing within and between analysis, 50% (5 of 10) of the intervention group received blood compared to 42.9% (6 of 14) in the group that did not receive the intervention (p-Value = 1), showing no significant difference. Blood usage data is shown in Appendix S.

**Change in Hemoglobin**

The intervention group had 42.9% (6 of 14) who were anemic at the time of their first CTS surgical consult. One anemic patient was not referred nor treated, but was no longer anemic in the perioperative period, leaving 35.7% (5 of 14) anemic at the time of surgery. In the usual care group 20% (2 of 10) patients were anemic at time of their first CTS surgical consult. One patient that was not anemic at the time of the initial consult became anemic in the perioperative period, increasing to 30% (3 of 10) at the time of surgery.

The total average post-operative hemoglobin of all patients in the intervention group was 10.3 g/dL compared to 10.1 g/dL in the usual care group. There is not sufficient evidence to say that the distribution of post-surgical hemoglobin differs between the groups were significant (p=0.62). In the anemic patients, the total average post-operative hemoglobin in the intervention group was 9.27 g/dL compared to 10.0 g/dL in the usual care group.

**Provider Satisfaction: Survey Results**

Two CTS surgeons and 2 nurse practitioners at the PAC that were involved in the pilot project received the post-implementation survey (see Appendix M and N). The surveys for the CTS surgeons and PAC nurse practitioners are discussed separately below.

**CTS Survey.** This survey consisted of six questions. Both surgeons answered neutral or favorably to four questions. The second question “The referral process between the PAC and CTS was easy to navigate” was answered with a “5” from Surgeon 1 and a “2” from Surgeon 2. The fifth question “The communication between the PAC and CTS has met my expectations”
was answered with a “2” from Surgeon 1 and a “3” from Surgeon 2. Five questions were answered with a neutral or above-neutral average. The fifth question had an average Likert scale answer of 2.5, below neutral. The sixth question of this survey was related to sustainability. When asked, “,” both surgeons answered a “4,” or “Agree.” The graphic depiction of survey responses for CTS Surgeons can be found in Appendix T.

PAC Survey. This survey consisted of five questions. Both providers answered neutral or favorably to four questions. The first question, “This process change had no impact on my workflow” was answered with a “3” from Provider 1 and a “2” from Provider 2. The average answer of four questions was neutral or above-neutral. The first question had an average Likert scale answer of 2.5, below neutral. The last question related to the sustainability of this referral process. When asked, “I recognize the benefit of this referral process and am likely to continue to support it,” both providers answered “4” or “Agree.” Provider 2 offered these comments on their survey: "It took about [three] days with the last order for IV iron – "pending approval" before it turned to authorized and patient was contacted. Also patient referred within [two] weeks of surgery, so was only going to get [one] infusion [of IV iron]." The graphic depiction of survey responses for PAC providers can be found in Appendix T.

**Discussion**

The results suggest that the new process increased awareness of preoperative anemia and treatment with 50% of patients receiving care as expected. Four of the six patients who were identified as anemic were treated prior to surgery, at a rate of 66.6%. This is a statistically significant increase from the pre-implementation rate of 17% (p=.0006); in the pre-implementation period, only one of the six identified anemic patients (17%) would have been treated. Based on the results of the time limited project and the small pool of patients, this new referral process increased awareness of anemia treatment and decreased the number of anemic
patients who entered CABG surgery without anemia treatment, thereby improving the quality of patient care. This is similar to findings of the others (Edwards & Slawski, 2016).

Blood product usage was increased in our intervention group; however, it was noted that one patient in Intervention group used seven units of aRBCt and this may have skewed the data for. Excluding this patient, Intervention group used six units of aRBCt and Group 2 used five units of aRBCt. When examining the proportion of patients who used blood products, however, a smaller proportion of patients in Intervention group (42.9%; n=6) received any type of blood product while a larger proportion of Group 2 (50%; n=5) received blood products. This may be due to an increased awareness of the cost of aRBCt; in dollars, and in patient outcomes (Cladellas et al., 2012).

The average post-surgical hemoglobin of intervention group (10.3 g/dL) was higher than that of the usual care group (10.1 g/dL). This is not statistically significant, but it is clinically meaningful (p=0.6227). The intervention group had a higher average post-operative hemoglobin than the usual care group, even though more patients that were anemic (42.86% versus 20%). There may be other factors that contributed to this, but it may be that treating anemia prior to surgery could have had a positive effect on the post-operative hemoglobin in intervention group. This slight rise in hemoglobin in the intervention group, despite the higher number of anemic patients, is one reason to continue the referral process that results in more patients being treated for anemia.

Several colleagues recommended iron-deficient patients be treated with IV iron infusions prior to surgery to improve hemoglobin recovery after surgery and to reduce the risk of aRBCt in the perioperative period (Clevenger et al., 2016; Lin et al., 2013; Litton et al., 2013). In this project, two of the four patients were treated with IV iron. The other two patients were treated with oral iron supplementation. Oral iron has been shown to increase hemoglobin concentration,
but not as well as IV iron infusions (Clevenger, et al., 2016; Gurusamy et al., 2014; Litton et al., 2013). Had all applicable patients in Intervention group been treated with IV iron, it is possible that post-surgical hemoglobin and blood product usage may have more noticeably changed.

In order to determine if iron infusions are successful in increasing hemoglobin, iron levels are drawn one month following the last iron infusion. This information was not available in most cases in this project. One patient that received iron infusions prior to surgery had a longer wait time between the last iron infusion and surgery than average (three weeks for this pilot project). This patient’s time between the last iron infusion and surgery was six weeks. In that time, the patient’s pre-iron infusion hemoglobin of 9.1 g/dL rose to 11.4 g/dL just prior to surgery. This robust hemoglobin change is consistent with findings from the literature (Clevenger et al., 2016; Gurusamy et al., 2014; Litton et al., 2013; Peters et al., 2018).

Post-implementation surveys were distributed to clarify sustainability and added value of this new referral process. In general, the satisfaction surveys were answered favorably, but some concerns were noted. One provider at the PAC stated that the process changed work flow. The provider was not specific on how the process changed their work flow and if this change was negative or positive. Both PAC providers expressed some trepidation regarding the ease of ordering iron infusions in the EHR. They found that the insurers were slow to authorize the iron infusions and that patients were not always contacted in a timely manner for an appointment by the infusion center, resulting in delayed patient care. However, all four providers were willing to continue with the new referral process and answered favorably regarding added value.

Notably, ease of the referral process responses were disparate for both CTS and PAC. Navigating the referral process proved difficult for one surgeon and communication between the two offices lacked efficiency for the other surgeon. One surgeon found the process very easy and the other surgeon found it difficult. The surgeon who found the process difficult was only
involved in the process for four weeks, rather than the entire implementation period, which may have contributed to this rating. Similarly, the provider at the PAC who found the referral process easier than their counterpart was involved for a longer period of time in the project. These responses suggest a correlation between the time involved in the process and the perception of ease for the new referral process.

There were some differences noted between the original, proposed budget and the actual final budget. The original budget noted a potential savings of $10,654, based on data available for the three months prior to implementation. In that three-month period, anemic patients in CABG surgery used 31 units of packed red blood cells while non-anemic patients used 17 units in that same period. These numbers include surgeries performed by all CTS surgeons at MHS. The additional 14 units of aRBCt cost $10,654 (D’Agostino et al., 2018; Shander et al., 2010).

Anemic patients, predictably, used more blood products than do non-anemic patients in the three-month period prior to this implementation. This project also had a smaller sample size. This is mostly due in part because there are fewer CTS surgeons involved than originally anticipated. Seven surgeons were originally predicted to be involved. The management at CTS elected to start this project with only two surgeons, rather than seven. So two surgeons’ patients were ultimately included in the pilot. Achieving a cost savings of over $10,000 is not feasible when the actual sample size is so much smaller than the predicted size. In this small pilot project, there was not a significant change in blood usage between the intervention group and usual care. There was a potential for cost-savings as originally predicted; however, one patient in the intervention group used seven units of aRBCt, which skewed the data. This project did not investigate any other cost saving measures, such as length of stay. Evidence has shown that correcting anemia to reduce use of aRBCt will positively affect the length of stay (Cladellas et
al., 2012; Clevenger et al., 2016). Further investigations into how anemia can adversely affect length of stay for CABG patients are needed in the future.

An unintended positive consequence of this project was that patients were referred to a preoperative assessment center that specialized in pre-surgical optimization of chronic diseases. The patients that were referred also received close assessment of their other chronic diseases, which may have resulted in better optimization on the whole. The screening and treatment of preoperative anemia in CABG surgery increased due to the relationship between CTS and PAC. The results of post-implementation provider surveys indicate that this process is sustainable.

**Limitations**

Limitations of this project include the following. This project had a short implementation period and also had to function within the constraints of the organization. The organization required that this project start with only one surgeon’s CABG-only patients, rather than trialing the entire group of cardiothoracic surgeons. This resulted in a small sample size. The sample size made it difficult to evaluate statistical significance.

During the implementation period, the staff member who prepped the charts for CTS went on leave, requiring another staff member to take over the duties of that position as well as their own. The staff member that went on leave was involved in the pilot project from the beginning and was invested. The new staff member was not as involved and was not as invested. This resulted in patient’s receiving a delayed referral to the PAC and a postponement of required treatment for anemia. Even though the DNP student was present in the CTS office to assist, there remained one patient referral fallout. Efforts to minimize limitations included close facilitation by the DNP student in both the CTS and PAC offices. Weekly email updates were used to energize staff on the status of the project and to celebrate successes.
Examining the data, one patient alone received seven units of aRBCt in Intervention group. That patient acts as an outlier and skews the data for Intervention group, making analysis difficult. Post-operative hemoglobin was measured immediately after surgery. Per the anemia algorithm in Appendix K, hemoglobin levels will show change after approximately one month after the completion of iron therapy, however, this data was not available for this project.

Perioperative blood loss per patient was not collected. This information may have provided insight on the relationship between blood loss and blood product usage. It may have shown a correlation to what degree of perioperative blood loss is related to the transfusion of blood products. It is noted that in a study that measured blood loss in 200 patients, average blood loss in CABG surgery was around 500 milliliters (Bjessmo & Ivert, 2000).

Finally, nurses and support staff in the CTS office were not surveyed, making the survey information incomplete. This information may have provided a more complete look at how the new process was perceived.

**Sustainability Plan**

The results of this project were presented to the CTS Quality Subcommittee in their monthly meeting in April 2019. Key stakeholders within the organization and in cardiothoracic surgery have discussed further applications of this project model in different cardiac surgeries and in conjunction with the PAC. After a discussion with CTS and PAC leaders, the referral process will remain in place after the completion of this project. There is buy-in by key stakeholders. The high involvement and buy-in from leadership and the quality of evidence are strong indicators that this project is sustainable. There is also a possibility of a future DNP student continuing this work with other surgical teams to assist in the implementation of a more congruent preoperative optimization.
Dissemination of Results

Dissemination of results occurred with key stakeholders of CTS on April 10, 2019 at MHS. The final results were also shared with providers, the medical director, and the nursing manager at the PAC. The final product of this project was presented at the university in front of the DNP student’s advisory team and other members of the community who chose to attend on April 15, 2019. The final draft of the project paper was uploaded to ScholarWorks© and can be accessed by any interested party. This project was presented at MHS at an open forum poster showcase in April 2019. The DNP student was available for organization leaders and community members to answer questions and to explain the scope of the project.

Implications for Practice and Further Study in the Field

This project has multiple implications. Preoperative anemia can, and should, be treated. Evidence suggests that treating preoperative anemia can positively impact patient outcomes and is a cost-effective alternative to aRBCt in the perioperative period (Clevenger et al., 2016; Gurusamy et al., 2014; Litton et al., 2013; Peters et al., 2018; Shander et al., 2010). Evidence from this project also suggests that referring patients to the PAC can have a positive impact on anemia management.

Referring patients to the PAC proved to be a success in the treatment of iron deficiency anemia. Anemia that would otherwise have not been recognized was treated prior to surgery. Continuing to refer patients to the PAC will result in continued treated of anemia and will also involve close follow-up on other chronic conditions that may affect surgical outcomes. The PAC staff have a close relationship with many surgical entities in MHS and CTS patients can benefit from their expertise. The relationship between the PAC and CTS to treat anemia is not a static affiliation, but something that will need to be continuously managed.
Conclusion

Treating preoperative anemia in the CTS population is a focus of the CTS group at MHS. An organizational assessment revealed that preoperative anemia is prevalent in about 30% of all CTS patients at MHS. Preoperative anemia is currently undertreated at this organization resulting in increased use of aRBCt, which can result in negative outcomes after surgery. A literature review of treatment for preoperative anemia was conducted to identify best-practice interventions for the treatment of anemia for use at MHS. Evidence revealed that treating anemia prior to cardiac surgery can reduce the use of aRBCt in the perioperative period and lead to a decrease in mortality (Cladellas et al., 2012; Clevenger et al., 2016; Weltert et al., 2015). CTS partnered with a preoperative assessment center to optimize comorbid conditions prior to surgery and to treat preoperative anemia in CABG patients. One CTS surgeon was asked to refer his anemic patients to the PAC for treatment and surgical optimization. This one surgeon referred his anemic, elective CABG patients for a full twelve weeks. Another CTS surgeon was added to the pilot for the last four weeks of implementation. Implementation resulted in five patients being referred and treated for anemia.

Results revealed a statistically significant increase in the number of patients who were treated for anemia prior to CABG surgery. There was no change in blood product use, but data did reveal a lower proportion of patients who used blood products in the pilot group. This may be interpreted as an increased awareness of the cost of aRBCt, not only in dollars, and improving the quality of patient care. There was a clinically significant rise in post-operative hemoglobin between the pilot group and the random sample of patients. This result was not statistically significant, but it could be said that increased awareness and treatment of anemia prior to surgery may have had a positive effect on the post-operative hemoglobin in the pilot group. The surveys
for both CTS and PAC showed that all providers were willing to continue to support the new referral process for treating anemia in outpatient CABG patients.

The potential cost savings to patient quality of life by avoiding perioperative adverse effects relating to anemia and the cost of a unit of blood ($761 ± $294 per unit) are also important factors to consider (Shander et al., 2010). The referral of these patients to the PAC for their anemia also resulted in increased surveillance of their comorbid health conditions in the perioperative period. The treatment of anemia prior to surgery is best practice and evidence has shown that it improves outcomes after surgery.

**Reflection on DNP Essentials**

The American Association of Colleges of Nursing (AACN) requires that all DNP students be proficient in the eight foundational competencies for advanced practice registered nurses (AACN, 2006). Each essential was met throughout the development, implementation, and dissemination of this DNP project and is reviewed below.

**Essential I: Scientific Underpinnings for Practice**

Addressing current and future practice issues requires a strong scientific educational foundation. DNP graduates are prepared with a wide array of knowledge that is gleaned from social and natural sciences. DNP graduates have the ability to translate that knowledge quickly and effectively (AACN, 2006). This essential was achieved through this project in a number of ways. In the course of this project, the DNP student performed a literature review on anemia and best practice for treatment of perioperative anemia and applied those findings to a quality improvement project. Knowledge of the organizational problem related to the management of anemia in patients scheduled for CABG surgery was gleaned from clinical experts in the organization. Clinical experts were consulted through personal meetings. In addition, the PARiHS framework guided the implementation of the referral process to treat anemia. This
framework focuses on evidence, context, and facilitation (Kitson, et al., 1998).

**Essential II: Organizational and Systems Leadership**

Organizational and systems leadership skills are critical for DNP graduates to improve patient and healthcare outcomes. Doctoral level knowledge and skills in these areas contribute to the effort to eliminate healthcare disparities and to promote excellence in practice (AACN, 2006). The DNP student demonstrated organizational leadership by first meeting with leadership and performing an organizational needs assessment. This allowed the student to create a project that best met the organization’s needs. The DNP student used communication skills learned from the DNP program to lead this quality improvement initiative and negotiate the change process and gain buy-in from key stakeholders. This project addressed the need to treat perioperative anemia before cardiac surgery. Communication with leadership at both the PAC and CTS occurred frequently and through the use of email, conference calls, and in-person meetings. Budgetary issues and health policy discussions occurred frequently with the cardiovascular medicine manager, the CTS manager, and with the CTS clinical program specialist. Costs for patients and for the organization were discussed during project formulation as well.

**Essential III: Clinical Scholarship and Analytical Methods**

Research is a hallmark of doctoral education, but this essential focuses on the application of research into practice and the dissemination and incorporation of new knowledge. These are key attributes of the DNP graduates (AACN, 2006). Nursing exemplifies the relationship between research application, science, and human needs. This quality improvement pilot project was aimed at increasing anemia management in the cardiac surgical population as per best practice guidelines. This new referral process will help to improve treatment of anemia in the practice setting.
Essential IV: Information Systems/Technology

DNP graduates are able to use their abilities as leaders to use information technology to support and improve patient and healthcare system outcomes (AACN, 2006). DNP prepared nurses can use information systems to evaluate outcomes of care, care systems, and programs within the systems. Technology offers a way to apply budget and productivity tools, support decision, and foster learning to improve the care of patients (AACN, 2006). A quality dashboard to monitor blood usage at MHS was used frequently to inform the DNP student of any change in blood usage through the course of this pilot. Information technology was used as a tool to collect data throughout project implementation.

Essential V: Advocacy in Health Care Policy

Policy, whether it be organizational or in the government, provide a framework to facilitate the delivery of healthcare services. DNPs need to be engaged in healthcare advocacy to have a voice in policies that will affect the workplace and the patients that are served (AACN, 2006). Activism and commitment to policy development are central caveats to professional nursing practice and the DNP has an ability to be a leader in advocacy (AACN, 2006). During the course of the project, the DNP student took into account standard practice at the CTS office and the general policies and procedures of the organization as a whole. While this project did not involve any policy change, the goal was to move practice towards best practice for anemia treatment according to existing guidelines.

Essential VI: Interprofessional Collaboration

The healthcare environment of today requires contributions from individuals in multiple different professions. In order to accomplish safe, equitable, effective, and efficient patient care, healthcare professionals must function as a team. DNP graduates are prepared to lead and collaborate with different professionals in a complex environment to achieve goals (AACN,
The DNP student collaborated with many different disciplines in the CTS office, the PAC, and in cardiovascular medicine throughout the course of this project. Different disciplines that are integral to the progress of this project included surgeons, nurses, nursing managers, quality improvement specialists, pharmacists, statisticians, and faculty members. The student worked closely with providers at both the PAC and CTS to provide education during implementation and to answer questions.

**Essential VII: Clinical Prevention Population Health**

DNP graduates are prepared to engage in leadership to integrate evidence-based clinical prevention and population health services for individuals and the whole population. The DNP is prepared to promote clinical prevention to individual patients and is prepared with a foundation in population health (AACN, 2006). Concepts of public health concerns, health promotion, social determinants of health, and promoting cultural diversity guide the practice of the DNP (AACN, 2006). The student evaluated specific organization data related to the anemia status of CABG patients at MHS. This project was geared to improve the health status of patients in this specific population. The environmental and cultural needs of the organization and this group of patients were considered in the formulation of this pilot project.

**Essential VIII: Advanced Nursing Practice**

Due to the growth in specialization in the nursing field, no individual can master all advanced roles and the required knowledge for enacting these roles. DNP programs provide preparation within distinct specialties and mastery in one area (AACN, 2006). A DNP graduate is prepared to practice in and have mastery in one area of specialization; this is the hallmark of the DNP (AACN, 2006). DNP programs provide learning experiences that are based in a variety of patient care settings and are integrated throughout the whole program. These learning experiences help to inform future practice decisions. The student developed many partnerships...
during the course of this project. These partnerships exist between the DNP student and members of the organization as well as between two entities at MHS, the PAC and CTS. The DNP student was integral to the beginning of and the continuation of this relationship. The DNP student was available for questions and to facilitate other staff members in this implementation period that resulted in positive change for preoperative anemia management for elective CABG patients at MHS.
References


(2013). Impact on early and late mortality after blood transfusion in coronary artery
bypass graft surgery. *Revista Brasileira De Cirurgia Cardiovascular: Orgao Oficial Da
Sociedade Brasileira De Cirurgia Cardiovascular*, 28(1), 1–9.
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J. F. (2014). Therapeutic options to minimize allogeneic blood transfusions and their
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Hung, M., Besser, M., Sharples, L. D., Nair, S. K., & Klein, A. A. (2011). The prevalence and
association with transfusion, intensive care unit stay and mortality of pre-operative
anaemia in a cohort of cardiac surgery patients. *Anaesthesia*, 66(9), 812–818.
https://doi.org/10.1111/j.1365-2044.2011.06819.x
https://doi.org/10.1161/CIRCULATIONAHA.107.718353
doi:10.1136/qshc.7.3.149.
https://www.kotterinternational.com/8-steps-process-for-leading-change/


Activity-based costs of blood transfusions in surgical patients at four hospitals.  


Appendices

Appendix A

The Burke and Litwin Model of Organizational Performance and Change

Appendix B

Organization IRB Determination

Available upon request.
Appendix C

GVSU IRB Determination

DATE: June 22, 2018
TO: Sandra Spoelstra
FROM: HRRC
STUDY TITLE: Preoperative Anemia Management in Adult Outpatient Cardiothoracic Surgical Patients to decrease Intra/Post-operative use of packed red blood cells (PRBC)
REFERENCE #: 19-310-H
SUBMISSION TYPE: HRRC Initial Submission
ACTION: Not Research
EFFECTIVE DATE: June 22, 2018
REVIEW TYPE: Administrative Review

Thank you for your submission of materials for your planned scholarly activity. It has been determined that this project does not meet the definition of research* according to current federal regulations. The project, therefore, does not require further review and approval by the Human Research Review Committee (HRRC).

A summary of the reviewed project and determination is as follows:

This project will assess the current practices at a local hospital for recognizing cardiothoracic patients with pre-operative anemia to identify gaps between evidence-based care and current practice. This is a systematic investigation but it is not designed to create new generalizable knowledge. Therefore, this project does not meet the federal definition of research and does not require IRB oversight.

An archived record of this determination form can be found in IRBManager from the Dashboard by clicking the _x-Forms_ link under the "My Documents & Forms" menu.

If you have any questions, please contact the Office of Research Compliance and Integrity at (616) 331-3197 or rc@gvsu.edu. Please include your study title and study number in all correspondence with our office.

Sincerely,
Office of Research Compliance and Integrity

*Research is a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge (45 CFR 46.102 (d)).

Human subject means a living individual about whom an investigator (whether professional or student) conducting research obtains: data through intervention or interaction with the individual, or identifiable private information (45 CFR 46.102 (f)).

Scholarly activities that are not covered under the Code of Federal Regulations should not be described or referred to as research in materials to participants, sponsors or in dissemination of findings.
Appendix D

SWOT Analysis of the Preoperative Assessment Center

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aesthetically pleasing building</td>
<td>• Gaps in needed staff; need pharmacy, dietician, and more advanced practice providers</td>
</tr>
<tr>
<td>• Part of a Magnet designated hospital system</td>
<td>• Lack of infusion chairs readily available</td>
</tr>
<tr>
<td>• Motivated leaders and staff that support change projects.</td>
<td>• Need additional staff to provide more in-depth education classes.</td>
</tr>
<tr>
<td>• Consistent providers that specialize in preoperative assessment</td>
<td></td>
</tr>
<tr>
<td>• Close relationship to the hospital where surgeries take place</td>
<td></td>
</tr>
<tr>
<td>• Cohesive pre-surgical optimization visit</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Blood shortage, need for management to decrease the use of blood products</td>
<td>• Individual barriers to change, unwillingness to change</td>
</tr>
<tr>
<td>• Has bandwidth to see more patients</td>
<td>• Ordering infusions perceived as confusing process at this organization</td>
</tr>
<tr>
<td>• Close relationship with hospitalists and referring providers and anesthesia, leads to effective communication streams</td>
<td>• No current relationship with cardiothoracic surgery.</td>
</tr>
<tr>
<td>• Enhanced quality of care by incorporating evidence-based practice.</td>
<td>• Patients unable to get to infusion clinic/pay for new iron infusion supplements.</td>
</tr>
<tr>
<td>• A positive relationship between the PAC practice manager and a local infusion center</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix F
### Table of Evidence

Articles included in review with author, year, purpose, design, inclusion, intervention comparisons, results, conclusions

<table>
<thead>
<tr>
<th>Author (Year) Purpose</th>
<th>Design (N)</th>
<th>Inclusion Criteria</th>
<th>Intervention vs Comparison</th>
<th>Results</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yoo (2011) Investigate effect of a single preoperative bolus of erythropoietin (EPO) on perioperative transfusion requirement</td>
<td>Prospective, single-site, single blinded, randomized, and parallel-arm controlled trial N=74</td>
<td>Adults with preoperative anemia</td>
<td>500IU/kg EPO and 200mg iron sucrose IV 1 day before surgery. The control group received an equivalent volume of normal saline. Assessed transfusion requirement during surgery and 4 days postop. Reticulocyte count and iron profiles were measured serially and compared preoperatively and on post-op days 1, 2, 4, and 7.</td>
<td>-Transfusion occurred in 86% of the control group versus 59% of the EPO group. -The mean number of packed red blood cells transfused per patient and for 4 postoperative days was decreased in EPO group versus the control group (3.3 ± 2.2 vs 1.0 ± 1.1 units/patient).</td>
<td>A single IV administration of EPO and an iron supplement 1 day before surgery reduced perioperative transfusions in anemia patients undergoing valvular heart surgery</td>
</tr>
<tr>
<td>Cladellas (2012) Investigate whether the combined therapy (IV rhEPO and iron) before valve</td>
<td>Before-and-after study: RCT (Total N=134; anemic adults)</td>
<td>Anemic adults without emergency surgery, isolated CABG</td>
<td>-Intervention started 1-month prior to surgery, 500IU/kg/day rhEPO was given every week for four weeks and the fifth dose 48 hrs. before surgery. During each rhEPO session,</td>
<td>-Therapy increased hemoglobin concentration from 11.2 ± 1g/dL at baseline to 12.6 ± 0.9 g/dL before surgery.</td>
<td>Combined therapy of IV rhEPO and iron administered before cardiac valve replacement in anemic patients improved in postoperative outcomes and</td>
</tr>
<tr>
<td>Study</td>
<td>Description</td>
<td>Patients</td>
<td>Intervention</td>
<td>Outcomes</td>
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<tr>
<td>Lin (2013)</td>
<td>Assess IV iron efficacy to reduce perioperative red cell transfusions.</td>
<td>Adults with anemia scheduled for surgery, who were not pregnant</td>
<td>IV iron on anemia -EPO on anemia -EPO + IV iron on anemia</td>
<td>- A short preoperative regimen of EPO, or a single dose of EPO plus IV iron in the preoperative or intraoperative period may significantly reduce transfusion rates (number needed to treat to completely avoid RBC transfusions ranged from 3 to 6 infusions.) -Patients with preoperative iron deficiency anemia may have an earlier and more robust hemoglobin recovery with preoperative IV iron therapy than with oral iron supplementation.</td>
<td></td>
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<tr>
<td>Litton (2013)</td>
<td>Evaluate efficacy/safety of IV on hemoglobin, requirement for transfusion, and risk of infection</td>
<td>RCTs of IV iron compared with either no iron or oral iron</td>
<td>-Change in hemoglobin -Infection -Transfusion -Serious adverse event -Mortality</td>
<td>-Increased standardized mean hemoglobin concentration compared with oral iron or no iron supplementation (standardized mean difference 6.5 g/L, 95% confidence interval 5.1 g/L to 7.9 g/L) -Reduced risk for blood transfusion (risk ratio 0.74, 95% confidence interval 0.62 to 0.88) -Reduced risk ratio of requiring red blood cell transfusion after IV iron therapy.</td>
<td></td>
</tr>
<tr>
<td>Gurusamy (2014)</td>
<td>Cochrane Review (21)</td>
<td>Adults with mild-moderate anemia who were not pregnant</td>
<td>PO iron vs inactive controls</td>
<td>-Required blood transfusions was reduced from 27.9% in the inactive -Oral iron decreased those proportion of</td>
<td></td>
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</table>

| replacement improved postoperative mortality and morbidity; and extent to which aRBCt were decreased. | patients received iron infusion supplementation (max dose 200mg/day, calculated by body weight). Therapy was stopped if hemoglobin levels reached normal. | decreased in RBC transfusions |
Assess the safety and efficacy of iron therapies for the treatment of adults with anemia

- 4745 RCTs, pregnant/have kidney disease
- IV iron vs inactive controls (oral or IV placebo)
- Compared different iron preparations.
- Required blood transfusions was reduced from 18.2% in the inactive control group versus 15.3% in the IV iron group
- Hemoglobin in the IV iron group was 0.5 g/dL lower than the oral iron group.
- Hemoglobin in the IV iron group was 0.3 to 3.00 g/dL higher than the inactive control group.
- Hemoglobin in the oral iron group was 0.3 to 3.10 g/dL higher than the inactive control group.
- IV iron results in a modest increase in hemoglobin levels compared to oral iron or inactive control without clinical benefit.

Weltert (2015)
Assess single 80,000IU dose of human recombinant erythropoietin (HRE) 2-days before cardiac surgery effect on reducing perioperative allogeneic red blood cell transfusion.

- Prospective single-blind RCT
- Antiplatelet and anticoagulation stopped 5-days prior to surgery.
- Trigger hemoglobin level to transfuse: 8.0
- Adults undergoing heart surgery at the European Hospital in Rome, Italy with a hemoglobin of less than 14.5 g/dL
- Received HRE vs none
- Hemoglobin Baseline vs post-operative day 4
- Baseline ferritin and transferrin values to assess preoperative iron metabolism.
- HRE related adverse events 45-days’ post-surgery.
- 17% (51/300) in HRE group required PRBCs compared to 39% (117/300) in the control
- HRE reduced the risk of PRBCs 44% compared to control.
- Low rate of potential HRE related adverse events including infection, thrombosis, hypertension, and renal or neurologic complications.
- Mortality was similar between two groups.

Clevenger (2016)
Cochrane Review (64)

- RCTs irrespective of blinding.
- Oral iron vs placebo or no iron therapy
- Oral and IV iron demonstrated reduction in the risk of blood transfusion.
- IV iron improved hemoglobin

Single high dose of HRE administered 2-days before cardiac surgery reduced need for PRBCs without increasing adverse events, reducing transfusions.
<table>
<thead>
<tr>
<th>Assess efficacy and safety of iron therapies for adults with anemia</th>
<th>RCTs, N=9,004</th>
<th>publication status or date, study setting, and sample size.</th>
<th>-IV iron vs placebo or no iron therapy</th>
<th>transfusion when compared with inactive control (risk ratio(RR) 0.66, 95% confidence interval (CI) 0.48-0.90; and RR 0.84, 95% CI 0.73-0.97, respectively).</th>
<th>compared to oral or no treatment. No reduction in mortality. Reduced blood transfusion rates. Despite showing a greater hemoglobin response than oral iron, IV iron failed to show any other benefits over oral.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peters (2018) Investigate use of IV iron in the pre-/post-operative, settings</td>
<td>20 RCTs, 7 observational trials, and 5 retrospective studies</td>
<td>English articles, only studies with a control group</td>
<td>Measured hemoglobin levels, reticulocyte counts, and/or RBC concentrates.</td>
<td>-Pre- increased hemoglobin levels 0.4-1.2 g/dL, reduced RBC use</td>
<td>IV iron use strongest in the preoperative setting, and an individual treatment decision post-operatively</td>
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Appendix G

PARiHS Model

Appendix H

Site Advisor Approval Letter

Available upon request.
Appendix I

Kotter’s Eight Step Change Model

1. Establish sense of urgency
2. Build a guiding coalition
3. Create a vision for change
4. Communicate the vision
5. Empower action
6. Create quick wins
7. Build on the change
8. Make it stick

Implementing and sustaining for change

Creating the climate for change

Engaging and enabling the organization

Adapted from “Kotter’s 8-Step Process”, by J. Kotter. Copyright 2017 by Kotter International
Appendix J

Referral Process in Anemia Management for outpatient CABG

- Heart cath, findings indicating CTS referral
- Preop testing guidelines started. CTS Referral made
- CTS Office visit scheduled, 1-2 weeks.

Additional testing set up and patient given follow up appt with

Heart Team Referral

Uncertain

CABG candidate?

Yes

Consents obtained. Surgical date given. Boarding slip sent. Set up for teaching. Need labs within 7 days. **Need to see Preoperative Assessment Center**

PAC: Based on labs, if anemic*, follow Outpt Anemia Algorithm for proper labs and pathways.

Iron deficient?

Follow Iron Replacement Pathway on algorithm

Send referral to Infusion Center**

APP to order infusion order set, 2 doses Injectafer, 1 week apart

Infusion Center Specific: Insurance Preauthorization

Presurgical Optimization with PAC, communciation with CTS

CABG

---

*Anemia: Hgb < 13 for men or < 12 for women

**If established at SH Heart Failure clinic, may go there for infusions.
If Hgb < 13 for men or < 12 for women, first evaluate the CBC and MCV (If this is first anemic CBC, encourage healthy diet and recheck in 3 months. If Hgb still low, proceed).

**Microcytic (MCV < 80)**
- Check Ferritin, Iron and IBC Level
  - Ferritin < 30 mcg/L
  - Ferritin 31-99
  - Ferritin > 100
    - TIBC > 400mcg/dL OR Iron Level < 40mcg/dL OR Iron Saturation < 15%
      - Iron Deficiency
        - See Treatment Pathways Below
    - No Iron Deficiency
      - No Iron Deficiency
        - See Treatment Pathways Below

**Normocytic (MCV 80-100)**
- Check Iron, B12, Folate studies
  - If hemolysis present, consult hematology

**Macrocytic (MCV > 100)**
- Check Folate and Vitamin B12 levels
  - Folate < 4ng/mL OR B12 < 400pg/mL
    - Vitamin B12
      - Level 150-400pg/mL: B12 1000mcg PO daily OR 1000mcg IM monthly
        - Level < 150pg/mL: B12 1000mcg IM qWeek x4, then 1000mcg PO daily OR 1000mcg IM monthly
          - Recheck in 3 months
          - Increase egg, meat, fish, and dairy intake
  - Folate < 4ng/mL: B12 1000mcg IM monthly
    - Recheck in 3 months

**Iron Deficiency**
- See Treatment Pathways Below
  - All Others
    - Ferrous Sulfate 325mg PO TID
      - Take with water/juice on empty stomach
      - GI upset common! Try taking with food before discontinuing
      - If taking antacids/H2RA/PPI:
        - Take FeSO4 1 hour before acid-blocker
        - Take FeSO4 with juice

**Iron Replacement**
- Intravenous Ferric Carboxymaltose x 2 doses
  - < 50kg: 15mg/kg on day 1; repeat dose in 7-10 days
  - > 50kg: 750mg on day 1; repeat dose in 7-10 days
    - **Other relevant info here re: infusion center***
    - Recheck studies in 1-3 months
      - Fe Deficiency Corrected
      - Routine Outpatient Monitoring
      - Can repeat course if anemia reoccurs
  - Lifelong (?) as tolerated

**Treated deficiency as shown**
- Check LDH, haptoglobin
- Check Iron, B12, Folate studies
Appendix L

Scripting Tip Sheet for CTS: Referral to PAC

Preoperative Assessment Center (PAC)
Scripting for Cardiothoracic Patients

Epic Referral Code: REF943

Information for your patients why they are being referred to the SOC:

1. Why am I being referred to the PAC for medical evaluation and not my PCP?

Your surgeon has identified that your diagnosis of____ may put you at higher risk of post-operative complications. We would like to optimize your ____ prior to surgery to lower your risk for complications. Our goal is to make your surgery as safe as possible. The PAC provides assessments of medically complex patients. The PAC providers work directly with anesthesiology and your surgeon to ensure your safety for surgery. A thorough evaluation of your medical, surgical, family history, and medications you are currently taking will better inform your surgeon of your risk of surgery. The PAC team will also give you instructions on which medications you can take prior to your surgery. They will also order any appropriate testing or lab work that may be needed. The PAC can also help arrange home health services, if needed, when you are home. All of this information will be communicated to your surgeon and your PCP.

2. Will this delay my surgery?

The PAC is efficient in evaluating your needs based on the type of surgery, anesthesia, and your medical history. It is important that you are “optimized” or at your least risk possible of having complications during and after surgery. Other testing may be ordered to ensure your safety. This may at times cause some delay. This will be communicated to your surgeon.

3. What happens next?

A referral will be placed to the PAC by your surgeon. The PAC team will call you within 1-2 days to schedule your evaluation with one of their providers, usually 2 weeks prior to surgery.

4. What do I need to bring to my appointment at the SOC?

- A complete list of your medications and any over-the-counter medications, vitamins, and other supplements, including how often you take them
- Information about your medical conditions and prior surgeries
- You do not have to fast for this appointment
- The appointment will take approximately 45 minutes to 1 hour

5. Additional Information

- When the PAC calls the patient to schedule their appointment we will go over all this information with them and send them directions.
- Any additional notes put into the EPIC referral from the cardiothoracic team is helpful
- PAC team will communicate any patient concerns back to the cardiothoracic surgeon
Appendix M

Post-Implementation CTS Provider Satisfaction Survey Tool

Satisfaction Survey for Sustainability: Referring to the PAC for preoperative management in outpatient CABG patients

1. This process change had no impact on my workflow.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

2. The referral process between the PAC and CTS was easy to navigate.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

3. The appointment at the PAC was convenient for my patients.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

4. The preoperative optimization of my patients at the PAC met my expectations.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

5. The communication between the PAC and CTS has met my expectations.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

6. I am likely to continue to refer my patients to the Preoperative Assessment Center for preoperative management in the future.
   Strongly Disagree  1  2  3  4  5  Strongly Agree

Any comments or ideas for improving the process: ____________________________________________
________________________________________
_________________________________________________________________________________
Appendix N

Post-Implementation PAC Provider Satisfaction Survey Tool

Satisfaction Survey for Sustainability: Referring to the PAC for preoperative management in outpatient CABG patients

1. This process change had no impact on my workflow.
   Strongly Disagree   1   2   3   4   5   Strongly Agree

2. The referral process between the PAC and CTS was easy to navigate.
   Strongly Disagree   1   2   3   4   5   Strongly Agree

3. Ordering iron infusions through Epic was an easy process to navigate.
   Strongly Disagree   1   2   3   4   5   Strongly Agree

4. The communication between the PAC and CTS has met my expectations.
   Strongly Disagree   1   2   3   4   5   Strongly Agree

5. I recognize the benefit of this referral process and am likely to continue to support it.
   Strongly Disagree   1   2   3   4   5   Strongly Agree

Any comments or ideas for improving the process: ______________________________________________________
_____________________________________________________________________________________________

Table of Measures

<table>
<thead>
<tr>
<th>Concept measured</th>
<th>How measured (tool, survey, variable)</th>
<th>When measured</th>
<th>Who measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical System Change</td>
<td>Referral to PAC to anemia workup and treatment</td>
<td>Presence of referral order yes/no, presence of treatment yes/no: one sample test of proportions</td>
<td>December 2018-March 2019, throughout implementation</td>
</tr>
<tr>
<td>Patient Outcomes</td>
<td>Hemoglobin change</td>
<td>Chart audits: Wilcox Rank Sum Test</td>
<td>December 2018-March 2019, throughout implementation</td>
</tr>
<tr>
<td>Sustainability</td>
<td>Provider/clinician satisfaction for the process change</td>
<td>Survey: Likert scale</td>
<td>Post-Implementation</td>
</tr>
</tbody>
</table>
Appendix P

CABG Patients Chart Audit Tool – Surgical Referral

Age: ________
Reviewer Name: __________________________

<table>
<thead>
<tr>
<th>Questions</th>
<th>Chart Review Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the patient have a recent Complete Blood Count done PRIOR to a cardiac catheterization?</td>
<td>Yes  No  N/A</td>
</tr>
<tr>
<td>Is the patient anemic according to WHO standards? (Hemoglobin &lt; 13 in men; &lt; 12 in women)</td>
<td>Yes  No  Hgb level prior to cardiac catheterization: ___</td>
</tr>
<tr>
<td>If anemic, were follow up labs ordered based on the MCV (iron studies, vitamin B12, folate, etc.)</td>
<td>Yes  No  MCV: ___  If yes, what labs were ordered?: __________________________</td>
</tr>
<tr>
<td>Was referral to the PAC made?</td>
<td>Yes  No  N/A</td>
</tr>
<tr>
<td>Was the patient’s anemia addressed/treated?</td>
<td>Yes  No  If Yes, what treatment?: __________________________</td>
</tr>
<tr>
<td>Surgery:</td>
<td>N/A  N/A  Full name of surgery: __________________________  Date/Hgb prior to surgery: __________________________</td>
</tr>
<tr>
<td>Was blood used during surgery?</td>
<td>Yes  No  If yes, type and quantity of blood used: ________</td>
</tr>
<tr>
<td>Was blood used after surgery?</td>
<td>Yes  No  Hgb after surgery:  If yes, type and quantity of blood used: ________</td>
</tr>
</tbody>
</table>

Additional information: __________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________
Appendix Q

Project Budget

<table>
<thead>
<tr>
<th>Doctor of Nursing Practice Project Financial Operating Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative Anemia Management in Adult Outpatient</td>
</tr>
<tr>
<td>Coronary Artery Bypass Graft Surgical Patients to Decrease</td>
</tr>
<tr>
<td>Perioperative Use of Blood Products</td>
</tr>
</tbody>
</table>

### Revenue

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager Time (in-kind donation) ($34x90 hours)</td>
<td>3,060.00</td>
</tr>
<tr>
<td>Statistician (in-kind donation) ($28x4hrs)</td>
<td>112.00</td>
</tr>
</tbody>
</table>

### Cost mitigation

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention of blood usage in perioperative period (based on data 3 months prior to pilot)</td>
<td>10,654.00</td>
</tr>
</tbody>
</table>

**TOTAL INCOME**  
13,826.00

### Expenses

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Member Time:</td>
<td></td>
</tr>
<tr>
<td>7 Cardiothoracic Surgeons ($276x2 hours each)</td>
<td>3,864.00</td>
</tr>
<tr>
<td>1 Medical Director ($144x10 hours)</td>
<td>1,440.00</td>
</tr>
<tr>
<td>1 Nursing Manager ($45x10 hours)</td>
<td>450.00</td>
</tr>
<tr>
<td>1 Director of Surgical Services ($75x2 hours)</td>
<td>150.00</td>
</tr>
<tr>
<td>1 Operations Director ($81x5 hours)</td>
<td>405.00</td>
</tr>
<tr>
<td>2 Quality Improvement Specialist ($38x20 hours each)</td>
<td>1,520.00</td>
</tr>
<tr>
<td>1 Clinical Practice Manager - Cardiovascular Medicine ($45x20 hour)</td>
<td>900.00</td>
</tr>
<tr>
<td>1 Practice Manager - Cardiothoracic Services ($45x15 hours)</td>
<td>675.00</td>
</tr>
<tr>
<td>1 Cardiothoracic Anesthesiologist ($205x5 hours each)</td>
<td>1,025.00</td>
</tr>
<tr>
<td>4 Nurse Practioners ($53x5 hours each)</td>
<td>265.00</td>
</tr>
</tbody>
</table>

**TOTAL EXPENSES**  
10,694.00

| Description                                                   | Amount  |
| Net Operating Plan                                            | 3,132.00|
## Appendix R

### Project Timeline

<table>
<thead>
<tr>
<th>Step</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Complete proposal and acceptance of project by faculty at GVSU and key stakeholders within the organization by end of November 2018</td>
</tr>
<tr>
<td>2</td>
<td>Present the proposed referral process to CTS and to the PAC by December 2018 for feedback and comments.</td>
</tr>
<tr>
<td>3</td>
<td>Collect current data on anemia in CABG patients using retrospective chart audits on the current state of anemia management by November 30, 2018.</td>
</tr>
<tr>
<td>4</td>
<td>Present and educate CTS and PAC on final referral process and information on the anemia management order set by December 2018.</td>
</tr>
<tr>
<td>5</td>
<td>Additional lab work will be drawn if indicated to determine type of anemia. Anemic patients will be referred to the PAC for management of anemia prior to CABG surgery after initial surgical consultation for the implementation period of December 2018 through February 2019.</td>
</tr>
<tr>
<td>6</td>
<td>Send weekly progress reports on the progress of the new process to key stakeholders during project implementation, December 2018 through February 2019.</td>
</tr>
<tr>
<td>7</td>
<td>Collect post-implementation data under the new process (December 2018-February 2019) and deliver final report to appropriate healthcare providers by March 2019.</td>
</tr>
<tr>
<td>8</td>
<td>Deliver final reports to site mentor, practice managers, medical directors, and key stakeholders by March 2019.</td>
</tr>
<tr>
<td>9</td>
<td>Give a post-implementation survey regarding provider satisfaction to help clarify added value and process sustainability in March 2019.</td>
</tr>
<tr>
<td>10</td>
<td>Present results during April 2019 staff meeting, and give credit to all staff members who were involved with the project</td>
</tr>
</tbody>
</table>
Appendix S

Results: Anemic Outpatient CABG Patients Treated

![Bar chart showing treated if anemic](chart.png)
Appendix T

Results: Blood Usage for Intervention and Usual Care Groups
Appendix U

Results: Post-Implementation Provider Survey Results

**CTS Provider Post Implementation Survey**

<table>
<thead>
<tr>
<th>Question</th>
<th>Surgeon 1</th>
<th>Surgeon 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Q2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Q3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Q4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Q5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Q6</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**PAC Provider Post Implementation Survey**

<table>
<thead>
<tr>
<th>Question</th>
<th>Provider 1</th>
<th>Provider 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Q2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Q3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Q4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Q5</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
Preoperative Anemia Management in Adult Outpatient Coronary Artery Bypass Graft Surgical Patients to Improve Treatment of Preoperative Anemia

Katherine Mills
DNP Project Defense
April 15, 2019

Acknowledgements

• Advisor: Katherine Moran, DNP, RN, CDE, FAADE, Kirkhof College of Nursing Associate Dean for Graduate Programs
• Advisory Team:
  – Sandra Spoelstra, PhD, RN, FGSA, FAAN, Kirkhof College of Nursing Associate Professor
  – Denise Busman, MSN, RN, Manager, Clinical Practice, Education & Quality Cardiovascular Services
• Bree Stuk, BSN, RN, Clinical Program Specialist, Cardiothoracic Surgery (CTS)
• Kelsey Breithart, BA, Practice Manager, CTS
• Amy Pearce, MSN, RN, Preoperative Assessment Center (PAC) Manager
• Margaret Kline, GVSU Graduate Statistician
Objectives for Presentation

1. Review the clinical problem: preoperative anemia within the context of the organizational assessment
2. Review the literature review and proposed solution
3. Review the project plan, including theoretical models
4. Present results and sustainability plan
5. Discuss implications for practice, DNP essentials, and dissemination plan

Introduction

- Anemia: Hemoglobin concentration of less than 12 g/dL in non-pregnant women and less than 13 g/dL in men.
- Almost 50% of anemia is due to iron deficiency (World Health Organization, 2008)
- Anemia and red blood cell transfusions (aRBCt) are independently associated with poor outcomes after cardiac and non-cardiac surgery (Clevenger et al., 2016; dos Santos et al., 2013; Hung, Besser, Sharples, Nair, & Klein, 2011; Shander et al., 2010)
- Preoperative anemia is common among cardiac surgical patients → more likely to need blood transfusion in the perioperative period.
Project Purpose

- To implement an evidence-based practice improvement initiative to improve the treatment of iron deficiency anemia prior to coronary artery bypass (CABG) surgery in a large Midwestern health system (MHS) by restructuring the preoperative optimization process.
- Cardiothoracic Surgery (CTS) – Preoperative Assessment Center (PAC) collaboration
IRB Approval

• Site Institutional Review Board (IRB)
  • Scope limited to quality improvement
• GVSU Human Research Review Committee
  • Project not defined as research

Assessment of Organization

• Organizational assessment completed between May-August 2018
• Burke and Litwin Model (1992)
• Assessment included:
  – External factors (blood scarcity)
  – PAC & CTS: # providers and staff, # patients, and bandwidth, readiness for change
  – Cardiovascular Medicine: process of referral to CTS
The Burke and Litwin Model of Organizational Performance and Change (1992) (Burke & Litwin, 1992)

**Assessment of Organization**

**Strengths**
- Aesthetically pleasing building
- Part of a Magnet designated hospital system
- Motivated leaders and staff that support change projects.
- Consistent providers that specialize in preoperative assessment
- Close relationship to the hospital where surgeries take place
- Cohesive pre-surgical optimization visit

**Weaknesses**
- Gaps in needed staff; need pharmacy, dietician, and more advanced practice providers
- Lack of infusion chairs readily available
- Need additional staff to provide more in-depth education classes.

**Opportunities**
- Blood shortage, need for management to decrease the use of blood products
- Has bandwidth to see more patients
- Close relationship with hospitalists and referring providers and anesthesia, leads to effective communication streams
- Enhanced quality of care by incorporating evidence-based practice
- A positive relationship between the PAC and other surgery practices in the organization

**Threats**
- Individual barriers to change, unwillingness to change
- Ordering infusions is a confusing process at this organization
- No current relationship with cardiothoracic surgery.
- Patients unable to get to infusion clinic/pay for new iron infusion supplements.
Key Stakeholders

- CTS personnel (surgeons, schedulers, RNs, clinical practice managers)
- PAC personnel (medical director, nurse practitioners, practice manager, medical assistants, educators)
- Site pharmacists, infusion clinic staff, cardiovascular medicine staff, quality improvement specialists

Current State – Outpatient Referral

- Patient is identified as having multivessel disease following diagnostic heart catheterization
- Referral to CTS is made
- CT Surgeon meets with patient
- Surgery is scheduled within 2-3 weeks.
- The patient is referred to their primary care provider for preoperative assessment
Society of Thoracic Surgery (STS) Adult Cardiac Surgery Registry

- 38% of all patients at MHS who undergo cardiac surgery are anemic at the time of surgery.
- Further, approximately 30% of MHS patients from the outpatient setting who undergo CABG surgery are anemic.
- Of this 30%, only 17% of anemic, outpatient CABG patients were identified as anemic prior to surgery and were given treatment at MHS.

Clinical Practice Question

- If patients are referred to a preoperative assessment center prior to CABG surgery for preoperative anemia work-up, will the number of patients undergoing CABG surgery with untreated anemia decrease?
Literature Review

Literature Review Aims

- Typical treatment for iron deficiency: iron supplementation and erythropoietin (EPO)
- To determine best practice for preoperative anemia management:
  - Does any formulation of iron supplementation therapy increase hemoglobin concentration in anemic patients?
  - What formulation of iron supplementation is safe and effective in improving hemoglobin levels in anemic patients?
  - What formulation of iron supplementations reduces the risk of aRBCt in anemic patients?
  - Is EPO therapy safe and efficacious in reducing the use of aRBCt in cardiac surgery?
Review Method

- PRISMA guidelines served as the framework for the review. (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009)

- Keywords included: anemia, preoperative anemia, cardiac surgery, anemia management, cardiac, adult, iron infusion, erythropoietin, systematic review, meta-analysis, and randomized control trial.

Literature Review

• Included:
  – Two Cochrane Reviews (Clevenger et al., 2016; Gurusamy et al., 2016)
  – Two systematic reviews (Gurusamy et al., 2014; Lin et al., 2013)
  – Three randomized control trials (RCT) (Cladellas et al., 2012; Weltert et al., 2015; Yoo et al., 2011)
  – One comprehensive review article (Lin et al., 2013)

• Conclusion: Iron therapy and/or EPO to correct preoperative anemia is both safe and efficacious. (Clevenger et al., 2016; Gurusamy, Nagendran, Broadhurst, Anker, & Richards, 2014; Lin et al., 2013; Litton et al., 2013; Cladellas et al., 2012; Weltert et al., 2015; Yoo et al., 2011; Peters et al., 2018)

Literature Review Results Summary

• The authors of all eight articles described a decrease in blood transfusion requirements after iron supplementation and/or EPO injection (Clevenger et al., 2016; Gurusamy et al., 2014; Lin et al., 2013; Litton et al., 2013; Cladellas et al., 2012; Weltert et al., 2015; Yoo et al., 2011; Peters et al., 2018)

• The authors of five studies measured an increase in hemoglobin after the use of preoperative IV iron supplementation (Clevenger et al., 2016; Gurusamy et al., 2014; Lin et al., 2013; Litton et al., 2013; Peters et al., 2018)

• The authors of three studies saw a decrease in mortality (Clevenger et al., 2016; Cladellas et al., 2012; Weltert et al., 2015)
Evidence for Project

- Anemia is associated with worse outcomes and increased mortality after cardiac and non-cardiac surgery (Clevenger et al., 2016)
- Correcting anemia prior to surgery may decrease the risk of blood transfusion associated adverse events and shorten length of hospital stays (Clevenger et al., 2016; Cladellas et al., 2012)
- Correcting preoperative anemia is safer for patients and cost effective. (Shander et al., 2010)

Phenomenon Conceptual Model - PARiHS

Project Plan

Project Objectives

1. Introduce a new referral process to the PAC for CABG patients to treat anemia and other comorbidities
2. Improve the treatment of anemia in perioperative setting among CABG patients
3. Provide evidence that the referral process increased treatment of anemia in CABG patients
4. Evaluate provider satisfaction to clarify added value and sustainability
Project Purpose

• Purpose: implement an evidence-based practice improvement initiative to improve the treatment of iron deficiency anemia prior to CABG surgery at MHS by restructuring the preoperative optimization process.

Design

• Quality improvement project
• The implementation process was guided by Kotter’s eight steps of change (Kotter, 1996)
  – Three phases
    • Creating climate for change
    • Engaging and enabling the organization
    • Implementing and sustaining for change
Setting & Participants

- The PAC offers a standardized approach to preoperative medical evaluation and management to avoid preventable complications and mortality

- Participants:
  - Outpatient CABG candidates
  - Healthcare providers (RN, APPs, cardiologists, cardiothoracic surgeons, MAs)
Assess Readiness
- Organizational assessment
- SWOT analysis
- Shadowing experiences

Build Coalition
- Building positive relationships
- Gathering key stakeholders
- Forming subcommittees

Develop Education
- Strategies for provider education
- Presenting initial process draft to key stakeholders
- Educate CTS/PAC on new pilot assessment process for CABG patients

Conduct Change Tests
- Patients will be referred to PAC after initial surgical consult
- CTS will order the additional laboratory studies needed
- PAC will optimize patient for surgery, will order anemia treatment

Provide Feedback
- Weekly progress reports to providers on progress of pilot project
- Post-implementation data will be collected

Share Knowledge
- Final project results shared with key stakeholders
- Post-implementation satisfaction survey distributed and collected
### Timeline

1. **Complete proposal and acceptance of project by faculty at GVSU and key stakeholders within the organization by end of November 2018.**

2. **Present the proposed referral process to CTS and to the PAC by December 2018 for feedback and comments.**

3. **Collect current data on anemia in CABG patients using retrospective chart audits on the current state of anemia management by November 30, 2018.**

4. **Present and educate CTS and PAC on final referral process and information on the anemia management order set by December 2018.**

5. **Send weekly progress reports on the progress of the new process to key stakeholders during the project implementation for nine weeks during project implementation.**

6. **Collect post-implementation data under the new process (December 2018-February 2019) and the deliver final report to appropriate healthcare providers by March 2019.**

7. **Deliver final reports to site mentor, practice managers, medical directors, and key stakeholders by March 2019.**

8. **Give a post-implementation survey regarding provider satisfaction to help clarify added value and process sustainability in March 2019.**

9. **Present results during April 2019 staff meeting, and give credit to all staff members who were involved with the project.**

---

### Referral Process to PAC

**Preoperative Anemia Management in CABG Outpatients**

**PAC Involvement**

- Heart cath, findings indicating CTS referral
- Preop testing guidelines started, CTS Referral made
- CTS Office visit scheduled, 1-2 weeks.

**Heart Team Referral**

- CABG candidate?
  - Yes
    - Consents obtained. Surgical date given. Imaging due soon. Set up for teaching. Need labs within 7 days. Need to see Preoperative Assessment Center.
  - No
    - Refer back to cardiologist or PCP

**Follow Up Pathway to Algorithm**

- Send referral to Infusion Center
- APP to order infusion order set, 2 doses
- Instruct, 1 week apart
- Infusion Center: Specific, Insurance, Preauthorization
- Presurgical Optimization with PAC, communication with CTS

**CABG**

*Anemia: Hgb < 12 for men or < 12 for women
**IF established at UC Heart Failure clinic, may go there for infusions.*
### Evaluation & Measures

<table>
<thead>
<tr>
<th>Concept measured</th>
<th>How measured (tool, survey, variable)</th>
<th>When measured</th>
<th>Who measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referral to PAC to anemia workup and treatment</td>
<td>Presence of referral order yes/no, presence of treatment yes/no</td>
<td>December 2018-March 2019, throughout implementation</td>
<td>DNP Student</td>
</tr>
<tr>
<td>Blood Utilization</td>
<td>A comparison of a random sample of 10 patients (usual care group) not involved in the pilot project compared to the intervention group</td>
<td>December 2018-March 2019, throughout implementation</td>
<td>DNP Student</td>
</tr>
<tr>
<td>Post-Operative Hemoglobin Change</td>
<td>Average post-operative hemoglobin in the intervention group and the average post-operative hemoglobin in the usual care group (n=10)</td>
<td>December 2018-March 2019, throughout implementation</td>
<td>DNP Student</td>
</tr>
<tr>
<td>Provider/clinician satisfaction for the process change</td>
<td>Survey</td>
<td>Post-Implementation</td>
<td>DNP Student/CTS/PAC Practice Manager</td>
</tr>
</tbody>
</table>

---

### Outpatient Anemia Algorithm

#### Iron Deficiency

- **Iron Deficiency Algorithm**
  - **Pathways Below**
  - **When measured**: December 2018 - March 2019, throughout implementation
  - **Who measures**: DNP Student

#### Iron Replacement Algorithm

- **Pathways Below**
  - **When measured**: December 2018 - March 2019, throughout implementation
  - **Who measures**: DNP Student/CTS/PAC Practice Manager
Analysis Plan

- Data will be analyzed with support of university graduate student statistician.
  - One sample test of proportions: The proportion of patients entering surgery treated for anemia pre- and post-implementation
  - Wilcoxon Rank Sum Test:
    - A comparison of blood product usage of a random sample of 10 patients (usual care group) not involved in the pilot project compared to the intervention group (n=14)
    - Average post-operative hemoglobin in the intervention group (n=14) and the average post-operative hemoglobin in the usual care group (n=10).
- Sustainability: Post-implementation survey regarding provider satisfaction

Results
Results: Participant Characteristics

– **Intervention Group**: Patients involved in the pilot project that were screened using new referral process (n=14)
  • Average age: 63.8 years; 21.4% female
– **Usual Care Group**: Random sample of elective CABG patients that were not involved in the pilot project (n=10)
  • Average age 68.8 years; 10% female

– One surgeon’s elective CABG patients were screened for full 12 weeks of implementation, another surgeon’s elective CABG patients screened for last four weeks of implementation.

Results: Patients Screened

• 14 patients total screened in Intervention Group
• 42.86% (6 of 14) were anemic at the time of surgical consultation
  – 83.3% (5 of 6) were properly referred
  – 66.6% (4 of 6) were treated, compared to 17% (7 of 41) of anemic outpatient CABG patients pre-implementation (p=0.006)
• 49.6% (17% to 66.6%) increase in anemia treatment
Results: Anemic Outpatient CABG Patients Treated

- Treated if Anemic
- Treated

Results: Blood Product Usage

(p=1)

Intervention Group Blood Usage

Usual Care Group Blood Usage

14 aRBCs used in total

6 aRBCs used in total
Results: Post-Operative Hemoglobin

<table>
<thead>
<tr>
<th>Total Average Post-Operative Hemoglobin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention Group</strong></td>
</tr>
<tr>
<td>(42.9% (6 of 14) anemic patients)</td>
</tr>
<tr>
<td>10.3 g/dL</td>
</tr>
<tr>
<td><strong>Usual Care Group</strong></td>
</tr>
<tr>
<td>(20% (2 of 10) anemic patients)</td>
</tr>
<tr>
<td>10.1 g/dL</td>
</tr>
</tbody>
</table>

\[ p=0.62 \]

- There is a clinically significant difference in the post-operative hemoglobin. This slight rise in hemoglobin, despite the high number of anemic patients, is reason enough to continue the process.

Post-Implementation CTS Survey

Satisfaction Survey for Sustainability: Referring to the PAC for preoperative management in outpatient CABG patients

1. This process change had no impact on my workflow.
   - Strongly Disagree
   - 1 2 3 4 5 Strongly Agree

2. The referral process between the PAC and CTS was easy to navigate.
   - Strongly Disagree
   - 1 2 3 4 5 Strongly Agree

3. The appointment at the PAC was convenient for my patients.
   - Strongly Disagree
   - 1 2 3 4 5 Strongly Agree

4. The preoperative optimization of my patients at the PAC met my expectations.
   - Strongly Disagree
   - 1 2 3 4 5 Strongly Agree

5. The communication between the PAC and CTS has met my expectations.
   - Strongly Disagree
   - 1 2 3 4 5 Strongly Agree

6. I am likely to continue to refer my patients to the Preoperative Assessment Center for preoperative management in the future.
   - Strongly Disagree
   - 1 2 3 4 5 Strongly Agree

Any comments or ideas for improving the process:
Post-Implementation CTS Survey Results

CTS Provider Post Implementation Survey

Likert Scale: 1=Strongly Disagree; 5=Strongly Agree
Q1-Workflow Impact
Q2-Referral Process
Q3-Conveniency
Q4-Expectation
Q5-Communication
Q6-Continuation

Post-Implementation PAC Survey

Satisfaction Survey for Sustainability: Referring to the PAC for preoperative management in outpatient CABG patients

1. This process change had no impact on my workflow.
   Strongly Disagree 1 2 3 4 5 Strongly Agree

2. The referral process between the PAC and CTS was easy to navigate.
   Strongly Disagree 1 2 3 4 5 Strongly Agree

3. Ordering iron infusions through Epic was an easy process to navigate.
   Strongly Disagree 1 2 3 4 5 Strongly Agree

4. The communication between the PAC and CTS has met my expectations.
   Strongly Disagree 1 2 3 4 5 Strongly Agree

5. I recognize the benefit of this referral process and am likely to continue to support it.
   Strongly Disagree 1 2 3 4 5 Strongly Agree

Any comments or ideas for improving the process:
Discussion

- 49.6% increase in anemia treatment
- aRBCt usage: no statistical change
  - One patient outlier in Intervention Group, used 7 aRBCt alone
- Post-op hemoglobin improvement: clinical significance
  - 50% (2 of 4) were treated with IV iron: increase in IV iron use for more robust hemoglobin recovery post-op (Lin et al., 2013)
- Provider Satisfaction: all providers surveyed willing to continue the new referral process
- In addition to anemia treatment, patients also received assessment of chronic disease from PAC
Limitations

• Short implementation period
• Small sample size
  – Unable to generalize findings
  – Difficult to evaluate statistical significance
• Referred two surgeon’s CABG patients only, smaller than originally anticipated
• CTS scheduler on leave, less than expected buy-in from new staff
• In future:
  – Evaluate perioperative blood loss
  – Survey nursing staff members, not just providers

Resources & Budget

Doctor of Nursing Practice Project Financial Operating Plan
Preoperative Anemia Management in Adult Outpatient Coronary Artery Bypass Graft Surgical Patients to Decrease Perioperative Use of Blood Products

<table>
<thead>
<tr>
<th>Revenue</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager Time (in-kind donation) (534x90 hours)</td>
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<thead>
<tr>
<th>Expenses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Member Time:</td>
<td></td>
</tr>
<tr>
<td>7 Cardiothoracic Surgeons ($276x2 hours each)</td>
<td>3,864.00</td>
</tr>
<tr>
<td>1 Medical Director ($144x10 hours)</td>
<td>1,440.00</td>
</tr>
<tr>
<td>1 Nursing Manager ($45x10 hours)</td>
<td>450.00</td>
</tr>
<tr>
<td>1 Director of Surgical Services ($75x2 hours)</td>
<td>150.00</td>
</tr>
<tr>
<td>1 Operations Director ($81x5 hours)</td>
<td>405.00</td>
</tr>
<tr>
<td>1 Quality Improvement Specialist ($38x20 hours each)</td>
<td>1,520.00</td>
</tr>
<tr>
<td>1 Clinical Practice Manager - Cardiovascular Medicine ($45x20 hour)</td>
<td>900.00</td>
</tr>
<tr>
<td>1 Practice Manager - Cardiothoracic Services ($45x15 hours)</td>
<td>675.00</td>
</tr>
<tr>
<td>1 Cardiothoracic Anesthesiologist ($205x5 hours each)</td>
<td>1,025.00</td>
</tr>
<tr>
<td>4 Nurse Practitioners ($53x5 hours each)</td>
<td>265.00</td>
</tr>
<tr>
<td>TOTAL EXPENSES</td>
<td>10,694.00</td>
</tr>
</tbody>
</table>

Net Operating Plan

3,132.00
Implications for Practice

• Referral to the PAC resulted in successful treatment of iron deficiency anemia for preoperative CABG patients
• Referral to the PAC will expedite management of anemia as well as other chronic conditions impacting surgical outcomes

Sustainability Plan

• This referral process on anemia management in CABG patients will remain in place after the completion of this project.
  – Potential for expanding into different CTS procedures.
  – Large buy-in from leaders
Dissemination

• Shared results with leadership and participants of CTS and PAC on April 10, 2019
• Project presented at open forum poster showcase at the organization in April 2019
• Final draft to be published in ScholarWorks©

Conclusions

• A Midwest health organization sought to increase anemia treatment prior to CABG surgery
• Organizational assessment and literature review were conducted
• New referral process for CABG patients was implemented with a CTS and PAC collaboration
• Treatment of anemia increased by 49.6% for patients following the treatment pathway
• Project workflow and treatment algorithm have been adopted as standard work for anemic patients requiring cardiothoracic surgery
DNP Essentials Reflection

I. Scientific Underpinnings for Practice
   – Evidence-based treatment through literature review: Oral iron IV iron, Epogen
   – Use of PARiHS and Kotter’s 8-Step Change Model

II. Organizational and Systems Leadership
   – Performing organizational needs assessment
   – Cost analysis performed
   – Obtained IRB approval from MHS and GVSU

III. Clinical Scholarship and Analytical Methods
   – Research based interventions.
   – Dissemination of results

IV. Information Systems/Technology
   – Use of a quality dashboard for blood utilization
   – Regular chart audits

V. Advocacy in Health Care Policy
   – Change in standard practice at CTS and PAC

VI. Interprofessional Collaboration
   – Collaborated with numerous disciplines (pharmacy, surgeons, APPs, RNs, clinical program specialists, quality improvement specialists)
DNP Essentials Reflection

VII. Clinical Prevention Population Health
– Focused on CABG patient population – specific needs relating to anemia.

VIII. Advanced Nursing Practice
– Developed partnerships with providers
– Facilitator for project
– Implementation of evidence-based intervention

References

References (continued)