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Improving Systems of Care to Manage Preoperative Anemia in Patients Who Elect to have Total Hip or Total Knee Replacement Surgery

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Improving Systems of Care to Manage Preoperative Anemia in Patients Who Elect to have Total Hip or Total Knee Replacement Surgery

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

St. Catherine University
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This is to certify that I have examined this
Doctor of Nursing Practice systems change project
written by

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

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__________________December 12, 2012_____________
Date

DEPARTMENT OF NURSING

This change project is dedicated to my friend and colleague, Kate Glasenapp for her invitation and companionship on this journey;
To Dr. Maggie Dexheimer Pharris for her words of encouragement and wisdom;
To my loving husband, Bob for his never ending support of my educational endeavors;
And, to our children Becky, Michael, Brenda, and Megan for the ongoing life lessons.

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Executive Summary

Total knee arthroplasty (TKA) and total hip arthroplasty (THA) are surgical procedures performed for painful, dysfunctional joints most often caused by osteoarthritis. These procedures are increasing in demand for not just the elderly, but young adults as well. They are elective procedures associated with a three to five gram decrease in hemoglobin postoperatively, considered a major blood loss. International research results, verified by analysis of a 228 patient sample from the system in this study, demonstrate that patients who enter these procedures with anemia are more likely to require postoperative blood transfusions. With a decreasing supply due to a shrinking donor pool and added costs due to stringent testing, allogeneic blood used for transfusions demands that providers use stewardship with this precious resource. Autologously donated blood as an option is falling out of favor because it further reduces the preoperative hemoglobin, is costly, and unused units are wasted. Blood use for transfusions, whether autologously donated or allogeneic, is associated with many risks including but not limited to fluid volume overload, delayed wound healing, postoperative infections, and longer hospitalizations. Anemia is an abnormal finding and, in the setting of elective surgical procedures with major blood loss, should be corrected preoperatively to decrease the need for blood transfusions. This change project describes interventions to increase red blood cells preoperatively, weaving the interventions into an evidenced-based algorithm for consideration in practice by members of the healthcare team. The evidence-based algorithm and study findings will be shared with providers to invoke discussion on strategies for implementation and evaluation. Furthermore, this project serves as an example of research-guided changes, designed by a doctorally prepared nurse, capable of enhancing positive health care outcomes for both the patient and the healthcare system.

Background

This change project was born in a spirit of interdisciplinary inquiry. It originated in a dialogue between an advanced practice nurse (APN) and an orthopedic surgeon regarding the need for postoperative blood transfusions in patients who electively have total hip or total knee replacement surgeries. Areas of discussion included: differences in observed procedural blood loss versus postoperative hemoglobin levels; the management of preoperative anemia in this patient population; the risks involved with blood transfusions; and the judicious use of blood as a scarce resource. Questions raised by both providers inspired this research designed to clarify whether current practice patterns align with evidence-based practice leading to optimum outcomes for patients who opt to have elective total hip or total knee replacement surgeries.

The setting for the research is a Catholic health care system in the Midwest, which has multiple hospitals where orthopedic procedures are performed. This particular health care system has a service-based mission and vision steeped in social justice principles whereby communities are offered compassionate patient service and clinical excellence. This particular research study aligns with the system strategic goals of clinical excellence and stewardship. Clinical excellence is defined as valuing superior performance, exceeding expectations, seeking continuous ways to improve care, meeting challenges and opportunities in a creative manner, and using the best practices to help the organization achieve its goals with a spirit of teamwork. Stewardship is defined as responsible use of human, financial, and natural resources entrusted for the common good, with special attention to the poor.

A review of the literature provides the basis for clinical excellence in care of patients who elect to have total hip or total knee replacement surgery specifically as it relates to preoperative anemia and the utilization of postoperative blood transfusions. Data collection and analysis of practice patterns utilized in this healthcare system for patients who have total knee arthroplasty (TKA) and total hip arthroplasty (THA) procedures provides real life information from which to compare. Analysis of results guides recommendations for appropriate, minimal, safe, and cost-effective utilization of blood, which will help ensure that the call for stewardship is fulfilled.

Project objectives

The objectives for this change project are as follows:

1. Utilize patient data to analyze preoperative anemia and postoperative transfusions associated with elective THA and TKA
2. Review relevant literature on preoperative anemia and its impact on postoperative blood transfusions associated with TKA and THA elective procedures
3. Create an algorithm to address preoperative anemia for patients who elect to have TKA and THA surgical procedures based on identified gaps between study findings and the literature
4. Stimulate interdisciplinary inquiry into health care practices by sharing this project with members of the orthopedic and healthcare community
5. Fulfill requirements for a Doctorate in Nursing change project while demonstrating how this role can be utilized to improve patient care

Challenges

Healthcare in our country is referred to as a system. The structure of the healthcare system is complex in nature and not well understood. Healthcare providers, who represent what should be inter-connective parts of the system, often operate in isolation, devoid of communication with other team members. Interdisciplinary communication is critical to the improvement of patient outcomes. Herein lay the challenges for this change project, namely, the need to stimulate system players to work together, while developing a sense of inquiry into practices that improve the quality of the patient experience. This particular healthcare system has multiple professionals at multiple sites performing these orthopedic procedures. The sites are in the process of becoming integrated.

Research Questions

The study was designed to answer the following specific research questions:

1. Is there a relationship between preoperative anemia and the use of postoperative blood transfusions?
2. What risk factors are associated with postoperative blood transfusions?
3. Is there a change in postoperative hemoglobin levels by surgical type over the initial postoperative days?

Summary

Following a review of current literature and the study of a sample of surgical patients, this research will culminate in the design of an algorithm for preoperative care of patients with anemia who elect to have TKA and/or THA within this healthcare system. This practice tool will be shared with members of the orthopedic community for consideration. It is one of many steps, which, if instituted, can improve blood management for these and other elective surgical procedures.

Theoretical Framework

Strategizing for structural change within the organization demands a theoretical framework that can be applied to both the individual and the team as a whole. In order to obtain synergistic energy from a team, it is essential for individuals to grow in self-actualizing skills at the same time the team is developing mutual actualizing talents. The Human Systems theory represents a formula to help both individuals and team members succeed.

Hanlon (1968) devoted his career to the development of a Human Systems Theory to guide education and administration. Sinnen (1981) furthered the work of Hanlon by defining the profession of nursing with a nurturance theory and model based on the Human Systems Theory. Human Systems Theory involves seven basic human operations: learning, creation of worldview, creation of ideal pattern, conceptualization, climate creation, environment creation, and cybernetics. In the educational realm, the mastery of these processes leads to self-actualization for the individual. The role of the educator is to assist the individual in this process of mastery. Likewise, the mastery of these same seven human processes at the group level leads to synergistic behaviors. The role of the administrator is to assist groups to reach this level of actualization. The role of the advanced practice nurse is that of the educator, nurturing patients toward mastery of these seven human operations. Additionally, the advanced practice nurse is prepared to assume the role of administrative leader assisting healthcare teams to actualize common learnings which inform the operations of worldview and ideal pattern construction so that decision making, problem solving, planning, and evaluation (conceptualization) can be accomplished for the benefit of improvements in patient care. With that common foundation, the operations of creating a climate and environment specifically designed for the patient by the healthcare team can become a reality. The work involved in creating a healthcare team that can actualize, in essence, practice at the level of cybernetic mastery is intense, but so are the rewards for all involved with results benefiting patient care.

The absence of this administrative leadership is evident in health care today. Fragmentation of care, failure to institute best practice measures into care, inconsistent outcomes, and lack of coordinated communication between health care team members are some of the more noted observations. In order to improve healthcare, it is imperative that health care leaders understand and work with teams to actualize the seven basic operations. It is only through such strategies that systems of care and patient outcomes will experience lasting improvements.

This project seeks to increase teamwork involved in the care of patients who elect to have THA or TKA. The focus is improving systems of care involved in anemia management for this group of patients. The goal is to stimulate team learning and create a common worldview woven from inquiry, a common ideal pattern, common conceptualization within a climate, and an environment consistent with optimal patient outcomes. After comparing best practice standards recommended in the literature with current practice patterns, it will be up to the team to make decisions based on analysis of identified discrepancies, to initiate appropriate changes, and to develop a plan to evaluate the results while moving forward with further inquiries into practice.

Review of the Literature

Paramount to improving systems to manage preoperative anemia for patients who electively have TKA or THA procedures is an understanding of pertinent literature. This review of the literature explores preoperative anemia, TKA and THA procedures, and the impact of preoperative anemia on the utilization of blood transfusions in the postoperative phase of patient care.

Significance of Preoperative Anemia

Anemia is defined as lack of sufficient healthy red blood cells in the body and is detected by serum hemoglobin levels (National Anemia Action Council, 2009). Hemoglobin is responsible for carrying oxygen from the lungs throughout the body. Anemia can be acute accompanying a major episode of bleeding or chronic as seen with slower bleeds, vitamin or iron deficiencies, and in association with chronic disease (National Anemia Action Council, 2009). Symptoms depend on the degree of anemia and may include fatigue, shortness of breath or chest pain with exertional activities, dizziness, anorexia, or depression (National Anemia Action Council, 2009). Signs of anemia can include pale skin, brittle nails, coldness of extremities, murmur, and irregular heartbeats (National Anemia Action Council, 2009). Mild forms of anemia respond easily to treatment while more severe and long lasting forms left undiagnosed and untreated can be life threatening (National Anemia Action Council, 2009). The World Health Organization (2008) identifies anemia as a hemoglobin level of less than 13 g/dL in adult men and less that 12 g/dL in adult non-pregnant females. Iron deficient anemia (IDA), the most prevalent form of anemia, has been associated with delayed cognitive development and poor physical performance. IDA is a major factor contributing globally to the burden of disease (World Health Organization, 2008). In an analysis of the literature on IDA, Killip, Bennett and

Chambers (2007) elaborate on causes stemming from inadequate dietary intake of iron, malabsorption of iron, or losses in women of reproductive age. They link IDA prevalence to gender and ethnicity, reporting a prevalence of 2% in adult men, 9-12% in non-Hispanic white women, and nearly 20% in Black and Mexican-American women (Killip, et al., 2007 p. 675). Anemia is more common in the elderly but it is not a consequence of the normal aging process (Holdener & Liang, 2007). Anemia is an abnormal laboratory result reflective of a clinical condition that warrants attention.

Anemia represents a substantial economic burden. In a study designed to examine the economic impact of anemia, Ershler, Chen, Reyes and Dubois (2005) looked at a managed care patient population and compared patients with anemia associated with six identified chronic conditions with patients in a nonanemic cohort. Direct and indirect health care costs as well as impact of work productivity were calculated and, once demographic differences were adjusted for, those with anemia had substantially higher costs. Based on the results, the authors estimated that per one million lives, those with anemia related to these identified chronic conditions incur $110 million greater costs. Those responsible for the care of patients with anemia are urged to identify and correct this condition for both clinical and economic reasons (Ershler, et al., 2005).

The World Health Organization (2008) defines anemia as less than 12.0 g/dL for females as and less than 13.0 g/dL in males. Preoperative hemoglobin levels greater than 13.0 g/dL for TKA and THA correlate to fewer transfusions. Keating, Meding, Faris, and Ritter (1998), conducted research in an effort to better understand factors associated with transfusions for patients who electively have knee replacement surgery. The results of this study demonstrated that preoperative hemoglobin levels, pre-donation hemoglobin levels, and estimated blood volume negatively correlate with risk of transfusions for patients in both unilateral and bilateral knee replacement surgeries. Joint replacement surgery involves significant blood loss. A drop in hemoglobin level of 3.85 g/dl was associated with unilateral knee surgery, while those who had bilateral knee replacement surgery experienced an average hemoglobin drop of 5.42 g/dL. The patient group with preoperative hemoglobin levels greater than 13 g/dL had only an 8% chance of transfusion. Those considered anemic with preoperative hemoglobin levels less than 13 g/dL had a 30 % chance of transfusions. Patients who donated autologous units prior to surgery had an 11.6 % chance of receiving allogeneic transfusions and a 50% chance of receiving their autologous units (Keating, et al., 1998).

Preoperative anemia has been associated with poor patient outcomes including death. Anemic elderly patients with underlying cardiovascular disease are notably at higher risk of complications (Kumar & Carson, 2008). Prudent preoperative care involves a thorough history and physical, diagnostic testing for evaluation of cause of anemia, and correction of the condition (Kumar & Carson, 2008.) It is recommended that a hemoglobin level is obtained thirty days before the surgical procedure with a thorough analysis of unexplained anemia leading to postponing of elective surgery if necessary (Goodnough, et al., 2005).

Total Hip and Total Knee Arthroplasty

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are elective surgical procedures done to relieve chronic pain, recover joint function, and improve quality of life for those who suffer from joint failure caused by osteoarthritis (OA), rheumatoid arthritis (RA), or other chronic inflammatory processes (Liang, et al., 1986). The demand for these procedures is increasing. In a 2007 update of adult reconstructive surgical procedures, Lonner and Deirmengian (2007) noted a 400% increase in TKA procedures from 1971 to 2003, with adjustment for age and gender. Total hip arthroplasty procedures during that timeframe increased by 55%. Projections include a 600% increase in TKA and 137% for THA procedures, between 2005 and 2030. This review also noted that osteoarthritis has replaced rheumatoid arthritis as the predominate diagnosis for THA and TKA procedures, while a younger patient population is being treated, with the largest percentage of increase seen in those less than fifty years of age (Lonner & Deirmengian, 2007). Anticipating the increase in numbers of patients seeking these surgical procedures it becomes important to focus on economic resources and improvements in operational efficiencies (Lonner & Deirmengian, 2007).

One of the greatest challenges to improving operational efficiencies and enhancing patient outcomes for THA and TKA procedures involves the management of associated blood loss. While visible blood losses are recorded, the numbers underestimate true losses. The term ‘hidden losses’ has been coined to describe additional blood losses accounting for the drop in hemoglobin levels seen postoperatively. In a review of 324 patient charts from 1987 through 1989, calculated blood losses of 3.2 ± 1.3 units for a primary THA and 4.0 ± 2.3 units for revision procedures were noted. These losses were associated with transfusion rates of 2.0 ± 1.8 units for primary and 2.9 ± 2.3 units for revision THA procedures (Toy, Kaplan, McVay, Strauss, & Stehling, 1992). Similarly, TKA procedures have hidden losses. Primary TKA are linked to a 3.0 gm/dl drop in hemoglobin (Sehat, Evans, and Newman, 2004). The average patient loses about 4 grams of hemoglobin after THA or TKA according to Keating and Ritter (2002).

Transfusions add to the already high costs associated with these joint replacement procedures. In reviewing the financial impact for primary TKA procedures, Cook, Warren, Ganley, Prefontaine and Wylie (2008) noted Center for Medicare & Medicaid Services (CMS) reimbursed over $2 billion in 2006. Of further concern is that CMS reimbursement is less than actual hospital bills, forcing some institutions to disallow these procedures from their list of services due to the unfavorable finances (Cook, Warren, Ganley, Prefontaine & Wylie, 2008).

Transfusions

Elective surgeries that involve major blood loss can involve critical decision making regarding the use of blood transfusions. The use of blood transfusions is unavoidable under certain circumstances, there are clinical and financial reasons mandating a closer examination of the use of transfusions with elective surgical procedures (Lemaire, 2008). The use of allogeneic transfusions in elective procedures is of concern because, in parts of the country, blood is a scarce resource with a notable shrinking donor pool. With the number of surgical patients on the increase, decisions to transfuse require careful consideration by all members of the surgical team (Monk, 2004). The blood supply is notably safer due to stringent testing, yet, blood transfusions are associated with adverse effects, including but not limited to, transfusion reactions, transmission of infectious disease, transfusion related acute lung injury, administrative errors, and currently unknown side effects (Lemaire, 2008). There are concerns that blood transfusions cause immunosuppression, thought to increase the risk of postoperative infection, delay wound healing, and prolong hospitalization. The medical community believes that the risk of immunosuppression from transfusions is real and linked with adverse clinical outcomes (Spahn & Casutt, 2000). These concerns have resulted in a process of leukocyte depletion for allogeneic blood (Slappendel, Dirksen, Weber & van der Schaaf, 2003). Leukocyte depletion is a process aimed at meditating the effects of allogeneic transfusions on the immune system. Additional research is investigating the changes that red blood cells undergo when exposed to cold storage. Koch, et.al., (2008) compared the effects of old blood, stored more than 14 days, with newer blood on 2872 patients who had cardiac surgery and required transfusions. The findings demonstrated a significant increase in the risk of postoperative complications and in short-term and long-term mortality in those who were transfused with blood stored longer than two weeks (Koch, et. al, 2008).

There are two forms of blood transfusions. Autologous blood is donated by patients in advance of their surgical procedure, placed in cold storage, and transfused back if and when needed. Allogeneic, the most common type of transfusion, is donated, undergoes rigorous testing, and is placed in cold storage and made available to the public. All blood transfusions have associated risks and can be correlated with a greater chance of infection, fluid overload, and prolonged hospital stays (Kumar, 2009). The surgical team is urged to use interventions that limit transfusions, conserve blood, and correct preoperative anemia in order to improve surgical outcomes (Monk, 2004). To that end, the concept of “bloodless medicine” has become more popular (Kickler, 2003). “Bloodless medicine” refers to clinical strategies for patient care designed to avoid allogeneic blood transfusions (Goodnough, Shander, & Spence, 2003). It is one area of blood management programs that have been established worldwide (Kickler, 2003). Blood management techniques have grown because of treating patients who have refused blood products due to religious beliefs (e.g. Jehovah witness) or other reasons. This has stimulated a belief that minimizing transfusions represents quality and safe care that should be available to all patients (Shander & Goodnough, 2006). Blood conservation strategies are described as falling within three pillars of impact: those interventions which augment preoperative red blood cell mass; those interventions which reduce surgical blood loss; and, the acceptance of lower hemoglobin levels (Gombotz, Rehak, Shander, & Hofmann, 2007).

Autologous blood donation. Autologous blood donation (PAD) is a controversial option to blood management for patients who electively have THA or TKA procedures. While still an option, there is growing concern related to the inconvenience, cost, waste, and preoperative anemia associated with this intervention (Pierson, Hannon, & Earles, 2004). Unused autologous units cannot enter the blood center supply because of policy and laws. Therefore, unused PAD units are wasted, leading to concerns about efficient resource utilization. Autologous transfusions hold the same risk profile of allogeneic transfusions. These include administration errors, risk of postoperative infection, fluid overload, and the risks associated with impair red blood cells altering the delivery of oxygen to tissues, potentially adding to the systemic burden of inflammation (Boucher & Hannon, 2007).

Keating and colleagues (1998) reviewed the hospital records of 279 patients who had either unilateral or bilateral knee replacement procedures. The sample included patients who participated in the autologous donation program and those who did not. Those who participated in the autologous donation program had a notable 76% of their donated blood wasted. A logistic regression analysis was performed on a variety of data elements to determine the independent predictors for transfusions for this patient population. This research culminated in the design of a critical pathway with specific emphasis on correction of preoperative anemia as the most important factor influencing the use of allogeneic blood transfusions in knee replacement surgeries (Keating, et al., 1998).

Similarly, Hatzidakis, Mendlick, McKillip, Reddy, and Garvin (2000) sought to analyze risk factors for allogeneic transfusions and appropriate strategies for the use of autologous donation in total joint arthroplasty in their Nebraska setting. Employing a retrospective chart audit of 489 consecutive patients who had total joint arthroplasty procedures and logistic regression analysis of several factors, they were able to clarify patients at lowest risk of transfusions. Like the other studies, lower preoperative hemoglobin was associated with the need for allogeneic transfusions. The results link the type of surgery performed, age of the patient, and the preoperative hemoglobin level as factors for identifying those at most risk for transfusions with total arthroplasty procedures. Patients with minimal risk of needing transfusions have higher initial hemoglobin (130 to 150 grams per liter), are less than sixty-five years of age, and are scheduled for primary joint replacement surgery. While the authors continue to recommend the use of PAD, patients in the minimal risk category are provided better information to aid in deciding if the PAD program is worth the associated effort (Hatzidak, et al., 2000).

Using prospective, randomized methodology, Billote, Glisson, Green and Wixson (2002) studied patients scheduled for primary total hip surgery with a preoperative hemoglobin level $\geq$ 120 g/L, dividing a group of 96 into those who donated autologous units and those who did not donate. There were no significant differences noted in demographics of the donors and non-donors or blood-loss volumes associated with the surgical procedures. Neither group required an allogeneic transfusion. Twenty-nine of the 42 patients (69%) who participated in PAD received an autologous transfusion postoperatively. The authors concluded that for nonanemic patients undergoing a primary total hip surgery there is no benefit in PAD, in fact donation increased the use of autologous transfusions, wasting of units, and the cost associated with the procedure (Billote, et al., 2002).

PAD programs remain in vogue for elective surgery due to public perception that the allogeneic blood supply is unsafe. When used inappropriately, PAD contributes to preoperative anemia which is the most important factor linked to postoperative transfusions. PAD units may be transfused perioperatively simply because they are available, not necessarily because they are needed. It is important for providers to understand the evidence and published guidelines behind

PAD as a practice option, to utilize it with careful preoperative planning, and to help educate the public on the economic impact involved in this process (Keating & Meding, 2002). While the practice of PAD is on the decline, it is still considered a useful option in those with multiple antibodies making donor blood difficult to obtain (Kumar, 2009).

The Impact of Anemia on Recovery

The postoperative period for some patients who have TKA or THA procedures includes admission to an inpatient rehabilitation unit to maximize function of the joint in a supervised setting. Lower hemoglobin levels affect the patient's ability to participate in physical therapy. This was the research topic of a retrospective study of 184 patients admitted to an acute rehabilitation facility from 2001 to 2003. The study, funded by Ortho Biotech, measured patient function using the Functional Independence Measure (FIM) Instrument and through multivariate analysis, correlated length of stay, hemoglobin levels, and changes in FIM scores (Diamond, Conaway, Mody, & Bhirangi, 2006). Findings from this study verify that a higher baseline hemoglobin level is associated with a shorter length of stay and faster functional gains. While additional studies such as this one are recommended, the results further confirm that strategies, which limit blood loss and increase hemoglobin levels in this population affect the entire patient experience (Diamond, Conaway, Mody, & Bhirangi, 2006). Of concern are the interventions that help maximize hemoglobin levels in a safe, efficient, and cost effective manner.

Summary

Anemia is an abnormal condition that influences the quality of life for many persons and preoperatively leaves patients vulnerable for postoperative transfusions. Those found to be at greatest risk include women, particularly Black and Mexican-American women, the elderly, and those with chronic comorbid conditions. Transfusions are associated with complications, costs, and longer hospitalizations. TKA and THA are surgical procedures electively selected by patients to improve mobility, functionality, and quality of life. These procedures are associated with major blood loss. Optimizing preoperative hemoglobin levels decreases the chance for transfusions in the postoperative surgical phase of TKA and THA procedures.

Project Design and Methodology

Project Design

This descriptive change project was designed to examine preoperative anemia and postoperative transfusions associated with elective THA or TKA procedures for patients in one system, to compare findings to recommendations in relevant literature, and to make recommendations for practice changes based on a gap analysis. The setting for this study was a Midwest multi-hospital health care system. A retrospective chart audit was the method used to collect data to examine the relationship between preoperative anemia and postoperative blood transfusions, to identify other risk factors associated with postoperative blood transfusions, and to ascertain if there is a change in hemoglobin levels associated with these procedures in the initial postoperative days.

Approval for this study was obtained from the Institutional Review Boards (IRB) of St. Catherine University as well as the healthcare system prior to beginning the data collection portion of the research study. The study was retrospective in nature. The information technology department (IT) completed a data search. The results of this search identified patients who elected to have TKA or THA procedures at one of three acute care sites within the healthcare system over a three-month timeframe between January 1, 2009 and March 31, 2009. The total number of patients noted from the initial data pull was 235 patients, of which 228 patients met inclusion criteria. Patients age eighteen and older who had unilateral or bilateral, primary or revision total knee or total hip surgical procedures were included in the database. Several patients had only partial procedures and were therefore excluded. Informed consent for participation in this research was incorporated into the signed surgical consent. The consent gives permission for medical education or scientific research as long as the patient cannot be identified in the research. It is assumed that the consent form was reviewed in a patient exchange prior to surgery and that the patient fully understood the information.

A review of the literature revealed the data elements worth collecting. A codebook for data collection was designed using the identified variables (see Appendix A). These elements include patient demographics, pre and postoperative hemoglobin and hematocrit levels, number of autologous or allogeneic blood transfusion utilized, length of stay, and financial data associated with the hospitalization for the surgical procedures. An associate from the data management department assisted in the development of excel spreadsheets for the data collection process. The author of the change project was the sole person involved in collecting the data. The medical record number was the only patient identifier extracted from the electronic health chart. A code number was assigned to each medical record number, after which the medical record column was removed from the data set. A sheet containing the medical record number-code number match is retained in a locked cabinet in the principal investigator's office. This was separated from the data analysis spreadsheet and analysis run sheets, and kept in a password protected on-line folder. Only the principal investigator had access to the medical record number information. Once the study was completed, the medical record-code number match sheet was destroyed. The data used for analysis are secured and will be maintained by the principal investigator for seven years, in accordance with IRB policy.

Methodology

Statistical Package for the Social Sciences (SPSS) program was used for data analysis. The three research questions were analyzed in the following manner (Table 1):

Table 1 *Methodology for Analysis of Research Questions*

Research Questions	Data Analysis
Is there a relationship between preoperative anemia and the use of postoperative blood transfusions?	Chi square analysis
What risk factors are associated with postoperative blood transfusions?	Chi Square analysis
Is there a change in postoperative hemoglobin levels by surgical type over the initial postoperative days?	Repeated measures general linear model analysis

Methodology for Enacting the Change Process

Key stakeholders are being informed of the findings and additional champions of the change process are being identified. Results are being disseminated to interdisciplinary colleagues with the goal of defining action steps for implementing the algorithm into practice. Ongoing utilization of transfusions with TKA and THA will be aligned with the quality department so that results of the change can be monitored. Additionally, in sharing this research, it is hoped that team members will be stimulated to make other inquires into practice so that the work of enhancing the patient experience is continually maximized and validated with evidenced based knowledge.

Data Analysis

This study sample included 228 surgical patients who had either TKA or THA procedures within a three-month timeframe at one of several acute facilities in a Midwest healthcare system. Demographic data for the patients in this retrospective study are synchronized in Table 2. The sample was made up of one hundred and fifty-seven (69%) females and seventy-one (31%) males ranging in age from 26 to 90 years of age with a mean age of sixty-five years. The age variable was further grouped as listed in the table. The majority of the patients were Caucasian / White (86%), had underlying hypertension (73%), and had total knee procedures (66%). Some of the variables were reduced to dichotomous groupings due to limited numbers.

Table 2 *Sample Population Demographics and Factors*

Characteristics	Means	Ranges	N	%
Length of stay (in days)	3.35	1 - 8		
Preoperative weight	90 kg	46 –210kg		
Age	65.1	26 – 90		
Categories:				
< 50			21	(9)
51-65			93	(41)
66-79			92	(40)
80 +			22	(10)
Gender				
Males			71	(31)
Females			157	(69)
Surgical procedures				
Hip procedures			77	(34)
Knee procedures			151	(66)
Categories:				
Unilateral (primary)THA			73	(32)
Unilateral (primary)TKA			139	(61)
Revision hip (RH)			4	(2)
Revision knee (RK)			9	(4)
Bilateral hip (BH)			0	(0)
Bilateral knee (BK)			3	(1)

Co morbid conditions				
Cardiovascular Disease			68	(30)
Hypertension			167	(73)
Rheumatoid arthritis			7	(3)
Diabetes Mellitus			42	(18)
Chronic Kidney Disease			21	(9)
Pulmonary Disease			51	(22)
Cancer			24	(11)
Hematological Disease			11	(5)
Liver Disease			6	(3)
Gastrointestinal Bleed			5	(2)
Neurological / Cerebral Vascular Accident			12	(5)
Preoperative medications				
Immunosuppressive agents			3	(1)
Anticoagulation agents			17	(8)
Epoetin alfa			0	0
IV or oral iron			20	(9)
IM or oral B_{12}			14	(6)
Folic acid			11	(5)

Findings by Research Question

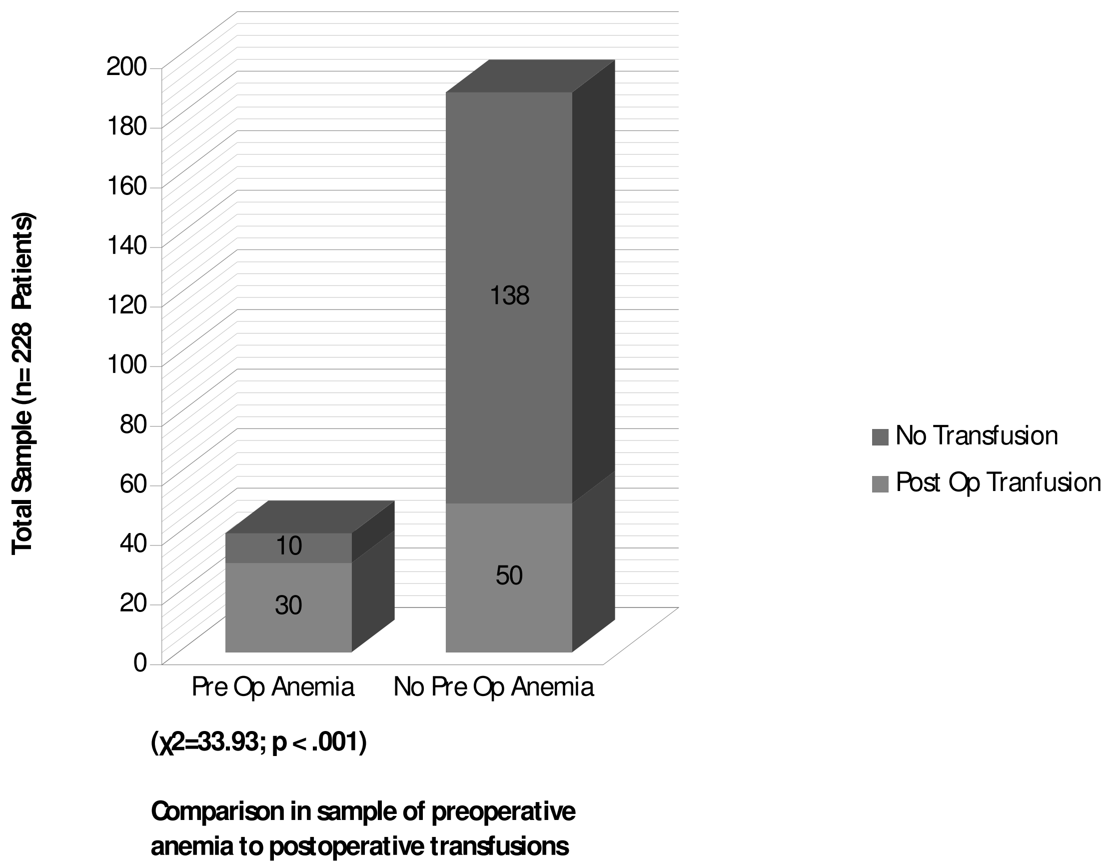
Research question 1. Was there a relationship between preoperative anemia and the use of postoperative blood transfusions? Anemia was defined as females with a hemoglobin level less than 12.0 g/dL and males with a hemoglobin level less than 13.0 g/dL. Using a Chi Square analysis, the findings support a statistically significant relationship between preoperative anemia and the use of postoperative blood transfusions in this patient sample. Of the 40 subjects who were anemic, 30 (75%) were treated with postoperative blood transfusions (χ 2= 33.93; $p< .001$), as shown in Table 3 and further illustrated in Figure 1. Of the 188 subjects without preoperative anemia, 50 (26.6%) were transfused. There was no identified standard protocol for postoperative transfusion criteria.

Table 3 *Chi Square Analysis of Relationship between Preoperative Anemia and Postoperative Transfusions*

	Preoperative Anemia n (%)		
	No	Yes	Total
Transfused Postoperatively No	138 (73.4)	10 (25)	148 (64.9)
Yes	50 (26.6)	30 (75)	80 (35.1)
Totals	188	40	228

$\chi^2 = 33.93$, $p < .001$

Figure 1 *Comparison of Preoperative Anemia to Postoperative Transfusions*

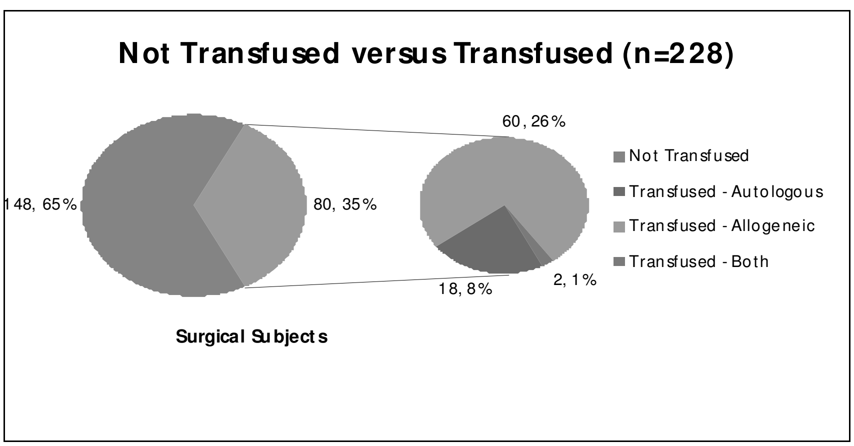


Transfusions in the sample. As illustrated in Figure 2, eighty patients (35%) of the sample received blood transfusions in the hospital during the postoperative period. Twenty-four patients (10%) participated in the autologous donation program and donated either one or two units preoperatively. Twenty-one (9%) patients donated two units. Twelve (5%) patients received both units, four (1.8%) patients received one unit, and five (2%) patients did not receive any PAD units in the postoperative period. Three (1.3%) patients donated and received one PAD unit postoperatively. In total, forty-five units of PAD blood were donated, 68% of these were transfused while fourteen (31%) of these units were not transfused and therefore, wasted.

Sixty-two patients (26%) were transfused with allogeneic blood following their surgery. Thirty (13%) patients received one unit; twenty-five (11%) were transfused with two units; four (1.8%) patients required three units while one patient each was transfused with four, five and six units.

Two (1%) patients who had participated in the PAD program received their two units in return and required an additional allogeneic unit.

Figure 2: *Detail of Postoperative Transfusions in Total Hip and Total Knee*



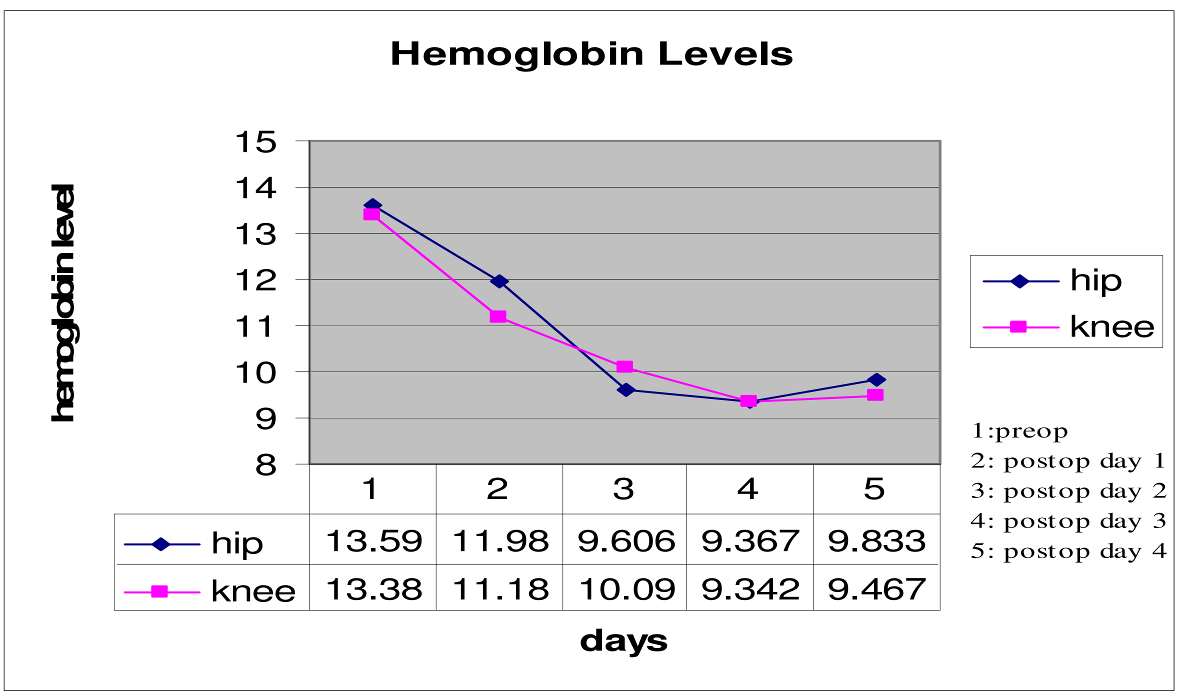
Research question 2. What risk factors were associated with postoperative blood transfusion? Chi Square tests were completed on each of the demographic and factor variables on transfusions. Significant results were found in several areas. Female gender significantly impacted postoperative transfusions (χ^2= 4.29, p=.038). Older age was also a factor in postoperative transfusions (χ^2= 7.88, p=.049). Fifty one percent of the patients who received a transfusion were in the age range of 66 to 79 years. Length of stay indicated blood transfusion was not associated with longer stays (χ^2 =13.57, p<.001). There was a statistical significance between having a hematological comorbid condition and receiving postoperative transfusion (χ^2 =4.13, p=.042). Diabetes Mellitus as a co morbid condition, while not statistically significant, does point to a relationship factor for transfusions. A borderline statistically significant relationship was also noted between those not using preoperative iron and the need for a postoperative blood transfusion (χ^2 =3.81, p=.051).

Table 4 C*hi Square Analysis of Selected Factors Compared to Postoperative Blood Transfusion Use*

Demographic and risk factors	Transfused n (%) No	Transfused n (%) Yes	Totals N=228 (%)	χ^2
Age Groups				
< 50	16 (10.8)	5 (6.3)	21 (9.2)	
51-65	68 (45.9)	25 (31.3)	93 (40.8)	
66-79	51 (34.5)	41 (51.3)	92 (40.4)	7.88, p=.049
80+	13 (8.8)	9 (11.3)	22 (9.6)	
Gender				
Female	95 (64.2)	62 (77.5)	157 (68.9)	4.29, p=.038
Male	53 (35.8)	18 (22.5)	71 (31.1)	
Length of Stay				
Short 1-3 days	113 (76.4)	42 (52.5)	155 (68)	13.57, p<.001
Long 4+days	35 (23.6)	38 (47.5)	73 (32)	
Hematological disease				
no	144 (97.3)	73 (91.3)	217 (95.2)	4.13, p=.042
yes	4 (2.7)	7 (8.8)	11 (4.8)	
Diabetes mellitus				
no	126 (85.1)	60 (75)	186 (81.6)	3.55, p=.060
yes	22 (14.9)	20 (25)	42 (18.4)	
IV or oral iron				
no	139 (93.9)	69 (86.3)	208 (91.2)	
yes	9 (6.1)	11 (13.8)	20 (8.8)	3.81, p=.051

Research question 3. What was the rate of change in postoperative hemoglobin levels by surgical type over the initial postoperative days? A general linear model was used to compare preoperative hemoglobin lab results with postoperative sequential hemoglobin lab results for hip and knee subjects. There exists heterogeneity in the measures of within subject effects; therefore, the Huynh-Feldt statistic was used to detect the effect. The observed F ratio was statistically significant $F(2,103) = 58.67$, $p < .001$. In comparing TKA and THA surgical procedures in this patient sample, there is no statistically significant difference in hemoglobin levels in the postoperative period. However, there is a statistically significant decrease in hemoglobin levels in both surgical procedures from baseline hemoglobin levels to a nadir hemoglobin level on postoperative day three. As depicted in Figure 3, the hemoglobin levels for hip and knee procedures reach a nadir on postoperative day three dropping approximately four grams.

Figure 3 *Comparisons of Preoperative Hemoglobin Lab Results to Postoperative Hemoglobin Lab Results for Total Hip and Total Knee Surgical Subjects*



Discussion of Results, Practice Algorithm, and Implications

Discussion of Results

The utilization of blood transfusions for elective TKA and THA is not a novel theme isolated to this particular healthcare system; it continues to be a topic of research globally. This sample of 228 patients who elected to have TKA and THA surgical procedures in this Midwest healthcare system in the timeframe of January 1, 2009 through March 31, 2009 experienced results similar to those reported in the current literature. The prevalence of anemia in elective surgical patients is estimated to be 75% is some populations with a wide range from 5% to 76% according to the literature (Goodnough, et. al., 2005; Kumar, 2009; Saleh, McClelland, Hay, Semple, & Walsh, 2007). Forty patients (18%) in this sample were noted to have preoperative anemia as defined by the WHO criteria, a conservative number. While WHO criteria are recommended to assess anemia, a hemoglobin level of 13.0 g/dL or greater is suggested as a starting point for those who elect to have TKA and THA procedures (Keating, et al., 1998). Applying 13.0 g/dL as the baseline hemoglobin level for men and women would likely result in a larger number of patients in this sample who qualify for preoperative interventions. An estimated 35% of those scheduled to have elective TKA and THA procedures have preoperative hemoglobin levels less that 13.0 g/dL, nationally (Goodnough et. al, 2005).

Preoperative anemia is associated with a higher risk of postoperative transfusions (Keating, et. al., 1998). Similarly, 75% of those noted to have preoperative anemia within this sample, received a transfusion in the postoperative phase. In addition to preoperative anemia and autologous donations, age may be a factor in predicting postoperative transfusions for patients who elect to have TKA and THA procedures (Hepinstall, Colwell, & Macaulay, 2003). This study demonstrated that female gender, age over 66, known diagnosis of anemia, lack of preoperative iron supplementation, and to a lesser degree a comorbid diagnosis of diabetes mellitus were factors associated with postoperative blood transfusions.

Total knee arthroplasty and total hip arthroplasty procedures are associated with major blood losses seen in a 3 to 5 gram hemoglobin decrease postoperatively (Keating, & Ritter, 2002). Falling in line with the literature, the results from this study sample demonstrated an average decrease in hemoglobin level for TKA from 13.38 g/dL preoperatively to a nadir of 9.34 g/dL, a 4.04 g/dL loss. For the patients having THA procedures the average hemoglobin decrease is 13.50 g/dL to 9.39 g/dL, a 4.11 g/dL drop. The literature supports longer hospitalizations for those patients who receive postoperative transfusions (Bierbaum, et al., 1999). However, even with this hemoglobin drop from preoperative to postoperative day three, and the resulting thirty-five percent transfusion rate, the length of stay in the study sample favors three days over a longer hospitalization. One way to decrease the costs associated with these procedure is to reduce the hospital stay. Further research is needed to determine how that shortened length of stay in the acute setting influences patient and financial outcomes for the entire episode of care.

The data from this study may not be generalizable due to the ethnicity of the surgical subjects. The fact that this sample is comprised of mostly Caucasian women is intriguing and raises another set of research questions, especially when this particular healthcare system is located near a large metropolitan area with a diversified population**.** This is of further interest because TKA and THA are elective procedures, increasing in frequency, performed for pain and immobility related to joint failure most commonly for arthritis; incongruently, arthritis is noted to have a disproportionate burden in minority populations, women, the elderly, and those compromised due to a lack of education, employment, and income (Marks & Allegrante, 2007). Arthritis is a condition associated with chronic pain and physical impairment, often robbing persons of the mobility essential to availing oneself of societal goods, and thus impacting access to health and health care (Mackenzie, Miller, & Fins, 2005, p.7). Healthcare providers from an ethical perspective of justice share the responsibility of alleviating pain and functional limitations associated with diseases such as arthritis, thus promoting the common good in all communities.

Gap analysis. Taking into account the study results and literature, there are opportunities to improve the care for patients who elect to have TKA and THA procedures within this healthcare system. Identified gaps highlighting the need for change include:

- The lack of assessment and correction of preoperative anemia leading to the need for postoperative transfusions - a patient safety issue
- Allowances for autologous donation (PAD), a practice that is being discouraged due to its association with increased preoperative anemia, high costs and wastage - a resource utilization issue, and, as with all transfusions, patient safety issues
- The use of allogeneic blood transfusions, without a clearly defined blood conservation protocol - a matter of distributive justice, resource utilization, stewardship, and evidenced based quality care

Creating a Practice Algorithm

Algorithms. Practice tools, such as algorithms can be designed to guide decisions to correct preoperative anemia and thereby decrease postoperative transfusions in patients who elect to have TKA and THA procedures. In the overall scope of a blood management program, the utilization of algorithms may seem minuscule. Nel (2008) notes that it is better to start with an elementary approach designated to be modifiable, while crafting a culture of continuous quality improvement with the goal of safe and efficient use of the blood supply.

In fact, there are many examples of algorithms and pathways being successfully used globally to change practice patterns. Goodnough and colleagues (2005) developed a pathway as a multidisciplinary physician group to assist in the process of detecting, evaluating, and managing preoperative anemia. It begins with a complete blood count and differential thirty days preoperatively. Any abnormal hemoglobin level is evaluated according to the cell indices, and strategies to rectify the anemia are taken. Interventions to correct anemia are based on the underlying cause and may include vitamin B12 injections, oral or intravenous iron supplementation, and/or consultative services with gastroenterologists or nephrologists (Goodnough, et al., 2005)

In a 2005 review of blood management issues associated with total joint arthroplasty, Callaghan, O'Rourke, and Liu, shared an algorithm from their practice adapted from Pierson, Hannon, and Earles (2004). The algorithm outlines options individualized for the patient. Based on the preoperative hemoglobin and the anticipated surgical procedure, expected hemoglobin losses are calculated which offer the lowest predictable postoperative hemoglobin level. With a threshold of 8.0 g/dL, preoperative interventions of autologous donation or epoetin alfa injections are recommended based on the calculated lowest hemoglobin level. This approach allows for current scientific information regarding blood management for total joint surgeries to be applied in a patient-specific manner (Callaghan, O'Rourke, & Liu, 2005).

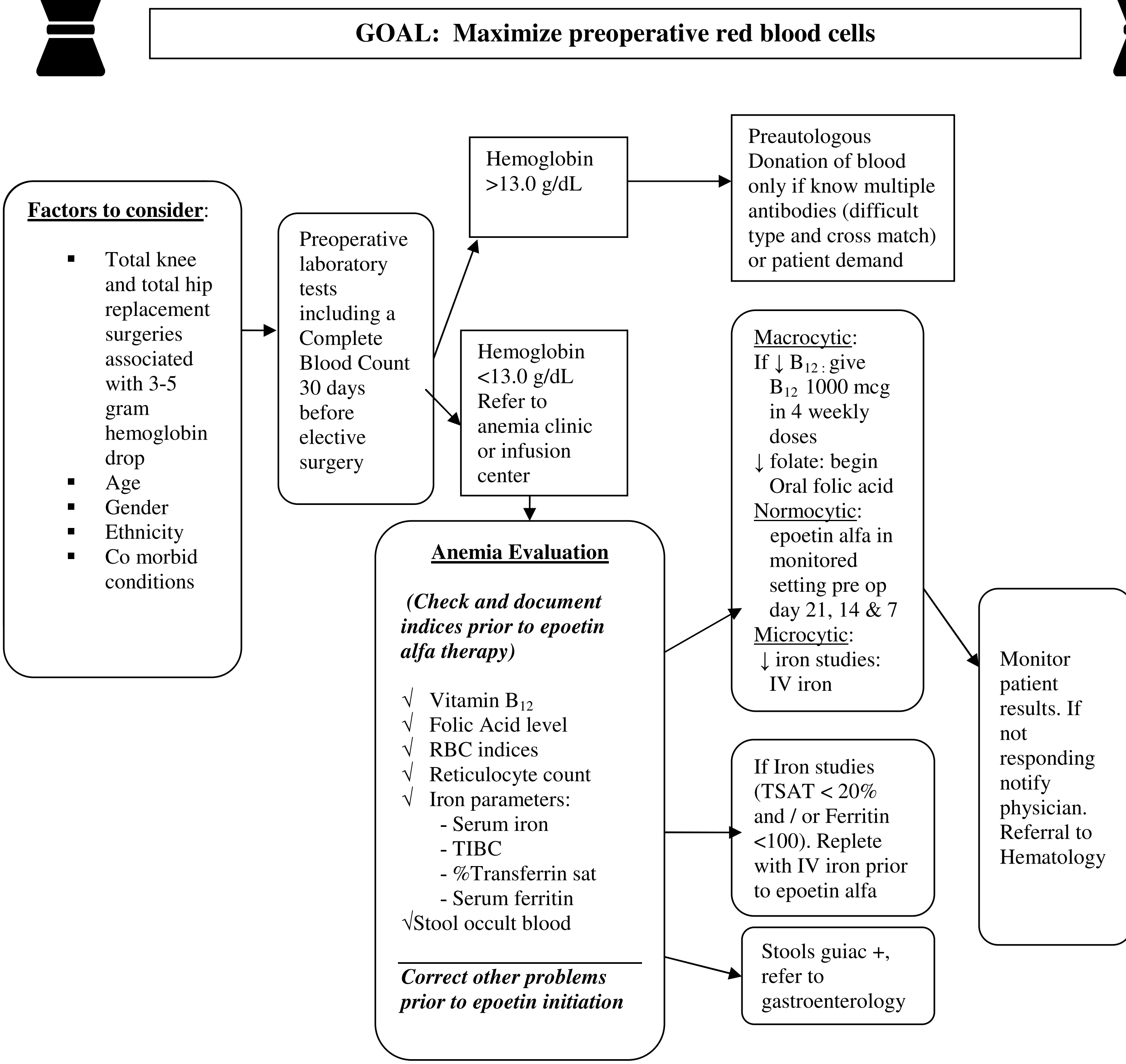
Development and impact of a one-page flow chart to guide blood transfusions practice in total joint patient experiences was the focus of study in Switzerland by Müller, Exadaktylos, Roeder, Pisan, Eggli, and Jüni (2004). The flow chart was simple in design, widely distributed, endorsed by local leaders, and developed by the staff, which added to the ownership. The practice changes seen with the flow chart demonstrated a decrease in allogeneic transfusions from 35% to 20% and a decrease in the use of autologous blood from 29% to 6% (Müller, Exadaktylos, Roeder, Pisan, Eggli, & Jüni, 2004).

In France, Martinez, Monsaingeon-Lion, Cherif, Judet, Chauvin, and Fletcher (2007) developed and successfully used an algorithm as part of a quality improvement program to yield a 50% decrease in postoperative transfusions. The algorithm consisted of calculation of expected losses with the surgical procedure and tolerated losses expressed in a mathematical equation. If the calculation resulted in expected losses being greater than the tolerated losses for the individual patient, then a transfusion-sparing procedure was recommended. Interestingly, the normal practice for this patient population includes a preoperative consultation with an anesthesiologist one month prior to surgery. Development of the algorithm ensured that the surgeon ordered a complete blood count, which was then available at this patient visit allowing the anesthesiologist time to analyze and implement of the most appropriate strategy to limit the use of transfusions based on the calculations. Transfusion-sparing strategies included the use preoperative epoetin alfa, prudent use of autologous blood donation, red blood cell salvage, or a combination of these strategies resulting in not only cost-neutrality, but in medical and quality improvements in care.

Advocating for patient-specific strategies (PSS), Stulberg and Zadzilka, (2007) outlined strategies in the preoperative, intraoperative, and postoperative phases of total joint surgery, which can be employed for blood management. Preoperatively, a baseline hemoglobin three weeks before surgery is recommended with treatment using epoetin alfa as warranted to boost the hemoglobin. They do not recommend autologous donation due to associated preoperative anemia, cost, and wastage. Pulling together outlined strategies with a planned blood management program for total joint surgeries, they realized PAD decreases of 117 units in 226 patients, a 20% drop in transfusion rate, and greater than $50,000 savings in one year (Stulberg & Zadzilka, 2007).

Proposed algorithm. Figure 4 is the initial algorithm proposed for practice within this setting. It is designed to serve as a tool guiding the assessment and management of preoperative anemia for elective surgical procedures with an anticipated blood loss of three units of blood or greater. The goal is in line with the first pillar identified in blood conservation strategies namely, maximizing preoperative red blood cell mass (Gombotz, Rehak, Shander, & Hofmann, 2007).

Figure 4: *Algorithm for Assessment and Management of Pre-operative Anemia for Elective Surgical Procedures Anticipating Blood Loss of ≥ 3 Units of Blood*



**** Remind patient to stop medications that can hinder coagulation prior to surgery as ordered, including prescription, over the counter, and herbal supplements**

Key characteristics verified by the literature and the sample surgical patients from the study help frame the algorithm. TKA and THA procedures are associated with 3 to 5 grams of hemoglobin loss. Additionally, age, ethnicity, gender, and comorbid conditions can increase the likelihood that patients may have preoperative anemia. Preoperative blood work done thirty days before the scheduled surgery that includes a CBC is warranted, so that preoperative anemia can be corrected prior to the surgery. This is not a current practice pattern within this particular healthcare system. Results from the patients in the sample demonstrated that timing of the preoperative CBC is closer to the surgical procedure than the recommended thirty-day window needed to treat noted anemia. Of the 228 patients, 50% had their blood tests completed in a window of seven to ten days prior to surgery. Another 44% had their blood tests completed in days 11 to 29 days preoperatively. Only 6% had a known preoperative hemoglobin level done thirty days prior to surgery.

If the hemoglobin in noted to be above 13.0g/dL, PAD should not be offered as an option with exceptions made for patients with known antibodies and/or those who firmly demand to use this process (Kumar, 2009). The literature demonstrates that this practice is not beneficial due to time inefficiencies for patients and the laboratory personnel, associated costs, wastage of the units not utilized, and preoperative anemia noted in those who donated in advance of their surgical procedure (Bierbaum et al., 1999).

If the hemoglobin level is below 13.0 g/dL, further studies are warranted to ascertain the reason for preoperative anemia. Algorithms used for assessing and treating preoperative anemia differentiate the condition using the red blood cell indices, specifically the mean corpuscular volume (MCV) to determine if the anemia is macrocytic, microcytic, or normocytic. In macrocytic anemia, the MCV is greater than 100 fl suggestive of vitamin B_{12} or folate deficiency. Microcytic anemia with an MCV less that 80 fl suggests an iron deficiency. Normocytic anemia is defined when the MCV is in the 80 to 100 fl range. Supplementing with folate, B_{12}, or iron is recommended to correct the anemic condition (Goodnough, et. al 2005).

If iron deficiency is noted, it can be corrected with intravenous (IV) iron. There are IV iron preparations that are safe, efficient, and effective. The IV route of administration is recommended when the patient is intolerant of oral iron preparations, or when there is inadequate time for oral agents to respond (Cuenca, García-Erce, & Muñoz, 2008). The time to surgery for oral iron to be effective is 30 – 45 days (Cuenca, García-Erce, Muñoz, Izuel, Martínez, & Herrera, 2004).

The treatment of preoperative iron deficiency anemia in patients undergoing orthopedic surgery was the subject of a prospective study done in Switzerland by Theusinger, Leyvraz, Schanz, Seifert, and Spahn (2007). A noted 21% of the patients undergoing elective major orthopedic surgeries had iron deficient anemia and were treated with 900 mg of IV iron sucrose over the course of ten days four weeks before surgery. A significant increase in hemoglobin was noted ($p < 0.0001$) with the mean maximum increase of 1.0 ± 0.6 g/dl. This peak hemoglobin was seen two weeks after the initiation of IV iron, but the increase was not sustained throughout the surgical episode. Eight of the twenty patients required perioperative transfusions. The authors speculate the endogenous erythropoietin decrease, which accompanied the hemoglobin increase, is the reason for this response and therefore, recommend the IV iron two weeks preoperatively (Theusinger, et al., 2007).

If normocytic anemia is detected and/or the use of IV iron does not increase the hemoglobin above 13.0 g/dL, epoetin alfa (EPO) is recommended. Epoetin alfa is indicated for use preoperatively in total joint replacement surgical patients to boost red blood cell production in those patients found to have preoperative anemia. While expensive, this medication has been shown to decrease the use of blood transfusions postoperatively in patients who electively have THA and TKA surgical procedures (Cushner, Lee, Scuderi, Arsht, & Scott, 2006). Epoetin alfa use for preoperative anemia has been studied and is in use globally.

In one study using EPO (Rosencher, Poisson, Albi, Aperce, Barre, & Samama, 2005) the number of EPO injections required to reach a hematocrit of 40% in moderately anemic patients was compared to the use of autologous blood donations. This study received financial support from Janssen-Cilag Laboratory and was stimulated by a recommendation from the French authorities that allogeneic transfusions be limited to life threatening situations and alternative therapeutic strategies be used for all other patient care. Outcomes demonstrated that those patients who were given epoetin alfa preoperatively had a higher volume of red blood cell (RBC) production, and had a significantly higher hematocrit on days one and three after surgery and at discharge. These patients also had better energy scores as measured by questions on fatigue, headaches, malaise, nausea, palpitations, and dyspnea, and they required less transfusion. Two injections of epoetin alfa were sufficient in most cases to reach goal, thus lowering the associated transfusion expenses. While both the use of epoetin alfa and PAD aim to decrease the use of allogeneic transfusions, the study noted that interventions should be individualized based on erythrocyte volume and predicted total blood loss (Rosencher, et al., 2005).

In another Canadian study, with grant support from Janssen-Ortho Inc., a random double blind multicenter trial was designed to examine two modified dose regimens of epoetin alfa with placebo. The factors under study were EPO dosing, the use of allogeneic transfusions, and thromboembolic events. The study involved thirteen teaching hospitals, four community hospitals, and a patient population that was ineligible for PAD. A total of 201 THA patients with preoperative hemoglobin levels 98 to 137 grams were assigned to one of three groups. Group one was treated with 40,000 units of subcutaneous epoetin alfa preoperatively for four weeks. Group two received 20,000 units of epoetin alfa a total of four weeks preoperatively and the third group was treated with placebo. All of the patients were given oral iron in the amount of 450 grams for 42 days or more preoperatively. Hemoglobin levels, reticulocyte counts, and doppler studies of lower extremities were compared. This study found that patients who received EPO needed significantly less blood and had better hematological responses than those treated with placebo. Patients dosed with 40,000 units of EPO had lower transfusion rates than those treated with 20,000 units. The incidence of thromboembolic events did not differ (Feagan, et al., 2000).

Attempting to study the use of epoetin alfa in the elderly, Lofthouse, Boitano, Davis, and Jinnah (2000) compared its use preoperatively for patients seventy years of age or older having major elective orthopedic surgeries with a matched group as control. Using an open-label, nonrandomized, parallel group study, control patients were matched for age, history, and surgical procedures. The study group protocol utilized 40,000 units of EPO given in two doses to patients in need of TKA and three doses for those having THA surgery. All patients received oral iron for at least fourteen days preoperatively. End points of the study were pre and postoperative hemoglobin and hematocrit levels and transfusion requirements. Transfusion triggers for the study remained at 10 g/dL. The study group had 12.5% use of blood transfusions as compared to the control group, which had a 74% use of blood transfusions. Epoetin alfa was deemed safe and efficient when used preoperatively in the elderly who elective to have TKA or THA according to this study, which noted no hematologic complications in the study group (Lofthouse, Boitano, Davis, & Jinnah, 2000).

Epoetin alfa has an indication for use preoperatively in anemic patients who elect to have THA and TKA procedures for the purpose of increasing red blood cell volume. As with all medications, there are safety concerns with EPO. In this indication, it is recommended that EPO only be used with prophylactic anticoagulation, due to the increased risk of thromboembolic events (Kumar, 2009). In one prospective, open-label, randomized study specifically looking at the use of EPO in patients with spine surgery without the use of prophylactic anticoagulation, a higher rate of deep vein thrombosis was found in those treated with EPO when compared to a control group (Stowell, Jones, Enny, Landholff, & Leitz, 2009). One case study further illustrates the fact that hemoglobin levels need to be closely monitored while patients are receiving EPO. This particular patient was treated both preoperatively and postoperatively with EPO, at 10,000 units daily as well as prophylactic anticoagulation therapy for her orthopedic surgery. On postoperative day eight, with complaints of chest pain, she was transferred to the intensive care unit where a hematocrit level of 48% was noted and further tests revealed a ventricular thrombus. The authors recommend monitoring of blood counts with the use of EPO (Karabinos, et al., 2007).

Interventions to correct preoperative anemia and to maximize red blood cell volume take time, assessment skills, and ongoing monitoring. If the assessment reveals guiac positive stools, then a gastroenterological workup is warranted. Likewise, in the course of treatment, if the patient is not responding with an increasing hemoglobin level, then the team deserves timely notification so that other interventions can be ordered. There are anemia management clinics is place within this particular healthcare system which are specifically designed to assist the team in the management of preoperative anemia. These clinics have standard order sets, utilize point of care hemoglobin testing equipment, and are associated with a high level of patient satisfaction.

Implications for Practice

This change project was designed from inquiry between two professionals interested in the impact of preoperative anemia on postoperative blood transfusions for patients who electively have TKA and THA surgical procedures. Truly, there are opportunities to influence patient care with improvements that can make the surgical experience for TKA and THA procedures safer and more satisfying. Clinical and technical knowledge regarding these surgical procedures continues to evolve. Hence, there is a need for those involved in the care of these patients to stay focused on analysis of the research. This analysis should lead to necessary practice changes primarily for the sake of patient care, but also to remain competitive in the marketplace.

There are many members of the healthcare team assigned to total joint replacement surgeries. It is essential for the team to learn from one another, to form a common ever-expanding worldview while remaining focused on the value of creating the best patient experience. Decision-making, problem solving, and evaluating practice as a team is crucial in this rapidly changing healthcare environment. Teams who can accomplish these tasks will set the stage for patient care that is clinically excellent and up-to-date, and will therefore remain competitive. This study, completed by an advanced practice nurse, is but one example of reviewing current practice with the goal of informing the team of opportunities to improve patient care for those who elect to have TKA and THA procedures in this healthcare setting.

Costs and Benefits

The project would not be complete without attention to the costs and benefits associated with the recommended changes in practice. Understanding the financial risk involved in clinical change projects is essential in these economically strained times. It is essential to keep in mind that anemia is a multiplier of morbidity and mortality and therefore deserves attention (Kumar, 2009). The costs and benefits of preoperative medications to correct anemia for elective surgery need to be compared to the use of blood transfusions postoperatively. The administration of EPO and IV iron preoperatively, appropriately monitored, are safe and effective in increasing red blood cells. There are significant expenses associated with the use of these medications. That expense needs to be balanced against the use of blood transfusions for elective surgeries, which is a complicated task. It is hard to get a handle on the exact cost of a unit of allogeneic blood and the treatment of potential resulting adverse effects, but the associated monies for a unit of blood will increase with further safety testing and shortages. In looking at the costs of epogen over the use of allogeneic transfusions, Keating, Callaghan, Ranawat, Bhirangi and Ranawat (2007) note that it would be inappropriate to recommend allogeneic transfusion over EPO simply on the basis of direct cost. Blood transfusions may be more costly than blood conservation efforts when the calculation includes the risks and scarcity of blood, the liability associated with transfusion errors, and the costs of testing, storing, and transfusing blood (Keating, Callaghan, Ranawat, Bhirangi & Ranawat 2007, p. 331-332)

The case for conserving blood is compelling according to Longjohn, Dorr, McPherson (1999); because shortages are common, there is a shrinking donor pool, and surgeries around the nation have been canceled due to the unavailability of blood. This necessitates judicious utilization. From a safety standpoint, every unit of blood transfused has associated risks, even when closely monitored. From an institutional aspect, Joint Commission plans to implement a performance measure surrounding blood utilization and conservation necessitating interventions, such as a preoperative algorithm to prove compliance (Joint Commission Accreditation of Healthcare Organizations, 2007).

Conclusion

In summary, this particular change project challenges providers engaged in the practice of providing care to patients who elect to have TKA or THA surgical procedures to reexamine the patient care experience in light of best practices, particularly those related to reducing preoperative anemia and postoperative transfusions. There are strategies that can enhance the surgical experience, making it safer for patients and more ethically sound and socially just for providers.

Next Steps

Moving the change process forward will involve a number of steps. Weaving the Human Systems Theory into the change process will be vital to setting the tone for team participation. The seven basic human operations of learning, constructing worldview, constructing ideal pattern, conceptualization, creating climate, creating environment, and cybernetics serve to establish the human group, the health care team. Engaging team members to learn from this research will take place through a variety of dissemination methods, some written and some oral. The research will serve to demonstrate how the worldview can be expanded and practice enhanced by incorporating evidence-based knowledge from a global perspective. United in professional values to deliver quality, safe, effective, efficient care in a fiscally responsible manner within the health care system drives a common ideal pattern for team members. Implementation of the algorithm will involve intention, planning, decision-making, problem solving, and evaluation, in essence, all of the steps from the human process of conceptualization. The work to create a climate and environment, which is conducive to autonomous professionals uniting in ongoing collaboration, cannot be underestimated. If this, in fact, is possible the synergy that pours out from such teamwork will ensure achievement of mission, vision, values, and sustained marketability for the system.

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Appendix A. Codebook. Improving Systems of Care to Manage Preoperative Anemia and Postoperative Transfusions in Patients who Elect to have Total Knee or Total Hip Surgery

Data Collection and Coding Sheet		Coding directly done to computer excel spreadsheet
Variable	Method of data collection	Data collected by researcher
Hospital	obtained by IT query	SFH (1) EMH (2) SJH (3)
Last name	obtained by IT query	OMIT
First name	obtained by IT query	OMIT
Middle name/initial	obtained by IT query	OMIT
MRI #	obtained by IT query	OMIT
Account #	obtained by IT query	OMIT
ID number for de-identified data 1- 228	manually created by author	Whole number 1 to 228
Gender	obtained by IT query	Female (1) male (2)
Age	obtained by IT query	Whole number
Ethnicity	obtained by IT query	Native American (1) Asian/Pacific Islander (2) African American / Black (3) Caucasian / White (4) Hispanic (5) unknown (6)
Pre-operative weight	manually extracted	Whole number + decimal kilograms
Length of stay	obtained by IT query	Whole number
Co morbid conditions		
Cardiac disease	manually extracted	No (0) yes (1)
HTN	manually extracted	No (0) yes (1)
Rheumatoid arthritis	manually extracted	No (0) yes (1)
Diabetes mellitus	manually extracted	No (0) yes (1)
Chronic kidney disease	manually extracted	No (0) yes (1)
Pulmonary disease	manually extracted	No (0) yes (1)
Cancer	manually extracted	No (0) yes (1)
Hematologic disease	manually extracted	No (0) yes (1)
Liver disease	manually extracted	No (0) yes (1)
GI bleed	manually extracted	No (0) yes (1)
Neurologic disease / CVA	manually extracted	No (0) yes (1)
Preoperative medications:		
Immunosuppressive agents	manually extracted	No (0) yes (1)
Anticoagulation agents	manually extracted	No (0) yes (1)
Epoetin alfa	manually extracted	No (0) yes (1)
IV or oral iron	manually extracted	No (0) yes (1)
IM or oral B_{12}	manually extracted	No (0) yes (1)

Folic acid	manually extracted	No (0) yes (1)
Surgical procedures:		
Total hip (primary) (THA) Total knee (primary) (TKA) Revision hip (RH) Revision knee (RK) Bilateral hip (BH) Bilateral knee (BK)	manually extracted	THA (1) TKA (2) RH (3) RK (4) BH (5) BK (6)
Orthopedic surgeon		
ID number for de-identified data	manually created by author	Whole number 1 through
Surgery		
Estimated blood loss	manually extracted	Whole numbers in cc's
Type of anesthesia	manually extracted	General (0) spinal (1)
Blood tests		
Preoperative hemoglobin	manually extracted	Number + decimal
Preoperative hematocrit	manually extracted	Whole number (%)
Timing of preoperative CBC	manually extracted	7-10 days (1) 11-29 days (2) 30 days or longer (3) Unknown (4)
Post op: Day 1 hemoglobin	manually extracted	Number + decimal
Day 1 hematocrit	manually extracted	Whole number (%)
Day 2 hemoglobin	manually extracted	Number + decimal
Day 2 hematocrit	manually extracted	Whole number (%)
Day 3 hemoglobin	manually extracted	Number + decimal
Day 3 hematocrit	manually extracted	Whole number (%)
Day 4 hemoglobin	manually extracted	Number + decimal
Day 4 hematocrit	manually extracted	Whole number (%)
Transfusions		
Preautologous donation number of units	manually extracted	Whole number
Transfused	manually extracted	No (0) yes (1)
Allogeneic number of units	manually extracted	Whole number
Autologous number of units	manually extracted	Whole number
Costs		
Insurance	obtained by IT query	Self pay (1) Medicare (2) Medicaid (3) Workers comp (4) Commercial (5) managed care (6)
Charges	obtained by IT query	Whole number
Transfusion charges	obtained by IT query	Whole number
reimbursement	obtained by IT query	Whole number