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A Patient Blood Management Program in Prosthetic Joint Arthroplasty Decreases Blood Use and Improves Outcomes

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ABSTRACT

The objective of this study was to determine if a Patient Blood Management (PBM) program implemented for patients undergoing THA or TKA would result in a decrease in the percentage of patients transfused PRBCs and improve outcomes. Decision support, a key driver for this program, was built into the electronic medical record. This retrospective cohort study included 12,590 patients and demonstrated a 44% decrease in the percentage of patients transfused. This was associated with a significant reduction in complications, 30 day readmissions and HLOS. A PBM program for patients undergoing prosthetic joint arthroplasty for primary and revision total hip and knee arthroplasty results in fewer transfusions and is associated with improved outcomes.

Patient Blood Management (PBM) is an "evidenced based, multidisciplinary approach to optimizing the care of patients who might need a transfusion" [1]. PBM programs emphasize three areas of focus: appropriate indications, minimizing blood loss and optimizing red cell mass. Of these, an appropriate indication, in the form of a transfusion trigger has generated a great deal of interest over the past 15 years [2, 3]. In critically ill patients no difference in outcome was found when a hemoglobin level of less than 7 g/dl was used rather than a more liberal trigger of 9 g/dl [4]. More recently a restrictive transfusion practice has been applied to patients undergoing high risk hip surgery [5] which concluded that it was reasonable to withhold a transfusion in this patient population in the absence of symptoms of anemia.

In the past, preoperative autologous blood donation (PABD) was considered an acceptable way to avoid transfusing allogeneic packed red blood cells (PRBCs) and any associated risks in patients undergoing orthopedic procedures. This practice has also been challenged since it has been shown that when the number of autologous transfusions increased, the number of allogeneic transfusions also increased in patients undergoing total knee arthroplasty (TKA) [6]. For those undergoing total hip arthroplasty (THA) the anemia produced from the PABD increases the likelihood of an autologous transfusion and increases the cost without a benefit to the patient [7]. A PBM program focusing on appropriate indication and applied to a broader patient population undergoing orthopedic procedures should lead to better utilization of PRBCs.

In order to improve the utilization of PRBCs in patients undergoing prosthetic joint arthroplasty, our healthcare system implemented a PBM program for this patient population. Our hypothesis was that a PBM program focusing on an appropriate indication would lead to a reduction of allogeneic PRBC transfusions, which would be associated with improved outcomes compared to a historical control.

Methods

This is a retrospective cohort study over a two year period comparing the before and after results following the implementation of a PBM program for adult patients undergoing prosthetic joint arthroplasty. A total of 12,590 consecutive patients were included. Sixteen hospitals (ranging in size from an 18 bed critical access facility to a 668 bed Level 1 trauma center), along with 104 orthopedic surgeons, participated in the program. The patient population included adults (18 years of age and older) undergoing primary or revision total hip arthroplasty (THA) or total knee arthroplasty (TKA). The baseline period was from January 1, 2012 to December 31, 2012. The PBM program study period began on January 1, 2013 and extended through December 31, 2013. Elective, urgent and emergent patients (ASA 1–5) were

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included. A multidisciplinary oversight team of physicians, nurses and quality improvement personnel was organized to define, design and implement the PBM program across the system based on our previously described model [8]. Since this was a systemwide initiative, it required approval from the Board of Directors and support by the Senior Management Team. This study was approved by the healthcare system's Institutional Review Board (Project No. 01-14-0070, Reference No. 014766).

The specific clinical practice for the program states, "All hemodynamically stable adult patients will not receive packed red blood cells if the hemoglobin level is above 7.0 grams/deciliter." Hemodynamically stable was defined as a systolic blood pressure greater than or equal to 100 mm Hg and a heart rate less than or equal to 100 bpm. Recommended components of perioperative management included the following.

- Identify patients preoperatively who are at high risk for postoperative blood transfusions so that available measures can be taken to reduce the need for packed red blood cell transfusions in this population who consume the majority of blood products.
- Optimize hemoglobin pre-operatively with erythropoietin and iron therapy as clinically indicated prior to elective surgery to raise preoperative hemoglobin levels and minimize the risk for blood transfusions.
- Discontinue donation of autologous blood due to induction of phlebotomy-induced anemia, unnecessary costs, and potential complications related to reinfusion.
- If a patient meets the criteria for a blood transfusion, then order and transfuse PRBCs one unit at a time rather than the traditional two units. Patients are to be assessed with a physical examination or laboratory testing prior to an additional transfusion.
- Always take into account a patient's clinical status as well as laboratory parameters. While the 7 g/dl red cell transfusion threshold for hemodynamically stable patients serves as a guideline for the majority of patients, there may be clinical circumstances that necessitate red cell transfusion at hemoglobin levels higher than 7 g/dl. Examples may include patients with signs or symptoms of anemic hypoxia and/or organ ischemia, patients with ongoing blood loss, and patients at risk of complications due to inadequate oxygenation.

Decision support for this program was built into the electronic medical record. Decision support included an alert to the ordering provider when the order "Nursing to administer PRBCs" was selected and the following criteria were met: hemoglobin greater than or equal to 7.0 g/dl and the patient's vital signs are hemodynamically stable at the time the order is signed. The alert notified the ordering provider that transfusions are not recommended in patients with hemoglobin greater than or equal to 7 g/dl, unless they meet specific criteria. If a hemoglobin result is not recorded in the previous 24 hours the alert includes a reminder to check the hemoglobin prior to transfusing the patient. If the provider wished to continue with the transfusion, then an override was available as an option.

The primary objective measure was the percentage of patients receiving a blood transfusion. The patient population includes adults undergoing THA, TKA or revisions of these types of procedures. This patient population comprised the denominator and was categorized as such using the MS-DRG codes (Revision knee or hip: 466, 467, 468 or major joint arthroplasty lower extremity: 469, 470). Patients who were assigned any of these MS-DRG codes and also had any of the blood transfusion ICD-9 indicator codes (99.00, 99.02, and 99.04) were counted in the numerator. The secondary objective compared the outcomes (complications, 30 day readmissions, mortality, length of stay, and direct cost) of patients between the baseline year (January 1, 2012–December 31, 2012) and the study year (January 1, 2013–December 31, 2013). Process measure, patient/case characteristics and outcomes were pulled electronically from the electronic medical record (Cerner, Wilmington, DE) and two administrative databases, TSI (Transition Systems Incorporated, Boston, MA.) and MedSeries4 (Siemens Medical Solutions USA, Inc., Malvern, PA.).

All statistical analyses were performed using SAS Enterprise (version 6.1; Cary, NC) on a Windows 7 (Microsoft, Redmond, WA) platform. The means for patients' demographic, clinical and surgical factors between the baseline and PBM program study year were compared using two sample t-test or chi-square tests, depending on their variable types. A P-value of <0.05 was considered statistically significant for the tests. The means of patient's outcomes between baseline and PBM program study year were also compared using either a two sample t-test or chi-square test. The distributions of outcome variables were then examined in order to determine the most appropriate response distributions in the generalized linear models. In order to see if our PBM program was associated with specific outcomes, a binary variable "PBM Program" was created to represent baseline year (PBM Program = 0) and PBM program study year (PBM Program = 1). Then the associations between the outcomes and the explanatory variables: "Transfusion" and "PBM program" were investigated in the setting of generalized linear models. All patient demographic, clinical and surgical factors considered were included in the models to adjust for their impact on outcomes. A P-value of <0.05 was considered statistically significant for associated variables in the model. The parameters estimates were estimated by maximum likelihood method. The estimated odds ratios were also calculated in logistic regressions. To adjust the over-dispersion issue in logistic regression, Pearson adjustment was performed.

Results

A total of 12,590 patients were included in this study over a two year period. The outcomes of 5997 consecutive adult patients undergoing either a primary or revision total knee or hip prosthetic joint arthroplasty in the baseline period were compared to 6593 consecutive patients after the implementation of a PBM program. Patient demographics and case characteristics were compared (see Table 1). There were significant differences based on gender, race, the use of navigation and whether tranexamic acid was dispensed. The study period saw a greater percentage of male and Caucasian patients. The use of navigation increased ($P < 0.0001$) from the baseline period (14.3%) to the study period (20.2%). The use of tranexamic acid significantly increased ($P < 0.0001$) from the baseline period (4.9%) to the study period (26.9%).

Table 1
Characteristics of Patients and Surgical Procedures.

Characteristic	Baseline	PBM Program	Total/Overall	*P* Value
Patient demographics				
Patients	5997	6593	12,590	
Age, y, mean ± SD	69.64 ± 11.52	69.51 ± 11.54	69.57 ± 11.54	0.5528
Female, *n* (%)	3651 (62.7)	3879 (60.8)	7530 (61.7)	0.0025
Race, *n* (%)				0.0451
Caucasian	5281 (88.1)	5870 (89.0)	11,151 (88.6)	
Hispanic	423 (7.1)	420 (6.4)	843 (6.7)	
Other	293 (4.9)	303 (4.6)	596 (4.7)	
Wound class, *n* (%)				0.1967
1 or 2	5764 (98.9)	6316 (99.1)	12,080 (99.0)	
3 or 4	62 (1.1)	57 (0.9)	119 (1.0)	
ASA class, *n* (%)				0.0641
1 or 2	2000 (34.3)	2117 (33.2)	4117 (33.8)	
3, 4 or 5	3825 (65.7)	4254 (66.8)	8079 (66.2)	
Navigation, *n* (%)				<0.0001
With navigation	832 (14.3)	1288 (20.2)	2120 (17.4)	
Without navigation	4995 (85.7)	5089 (79.8)	10,084 (82.6)	
Transfusion				
Transfusion rate	20.9%	11.7%	16.1%	<0.0001
PRBC units per 1000 patients	447.48	262.51	350.62	<0.0001
PRBC units per transfused patient	2.28	2.34	2.30	0.336
Tranexamic acid usage, *n* (%)	295 (4.9%)	1777 (26.9%)	1972 (16.5%)	<0.0001