Implementation of a Standardized Red Blood Cell Transfusion Policy in a Level IV Neonatal Intensive Care Unit

A Quality Improvement Project

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ABSTRACT

Background: Within the neonatal intensive care unit (NICU), infants frequently receive packed red blood cell (PRBC) transfusions. Although medically necessary, potential negative long- and short-term outcomes exist following PRBC transfusions in very low birth-weight (VLBW) infants (<1500 g). Synthesis of the literature demonstrates that the use of a restrictive PRBC transfusion policy can lead to a decreased number of transfusions administered with no increase in long-term neurodevelopmental outcomes. Blood transfusions have also been linked to the diagnosis of necrotizing enterocolitis (NEC) or intraventricular hemorrhage (IVH) in VLBW infants.

Purpose: For this quality improvement project, a restrictive PRBC transfusion policy was implemented in a level IV NICU to promote consistent care and evaluate changes in PRBC administration.

Methods: The data were collected both pre- and post-policy implementation including: the number of blood transfusions, diagnosis of NEC, and diagnosis of IVH among infants <1500 g.

Results: The data showed no significant change in the number of PRBC transfusions administered. Likewise, few infants were diagnosed with NEC or IVH during this same time period with minimal change between pre- and post-policy implementation data.

Implications for Practice and Research: Following policy implementation, there was a significant improvement in communication among providers regarding transfusion ordering and the inclusion of hematocrit thresholds in daily progress notes. This unintended outcome has helped to promote sustainability and enhance patient care within the NICU where this policy was implemented. Continued data collection may be beneficial in indicating whether a standardized PRBC transfusion policy will impact the administration of transfusions and diagnosis of NEC or IVH.

Key Words: blood transfusion, neonatal intensive care unit, quality improvement, very low birth weight

PROBLEM DESCRIPTION

Packed red blood cell (PRBC) transfusions have been a widely debated topic in the field of Neonatology. Several studies have been published in the last few years examining PRBC transfusions in the neonatal intensive care unit (NICU) and their impact on short- and long-term outcomes of the neonate. Several high-quality clinical trials have demonstrated that a policy of higher vs lower hematocrit transfusion threshold has no effect on the composite outcome of neurodevelopmental impairment or death. When assessing long-term patient outcomes, these studies have shown that allowing a neonate’s hematocrit to decrease to lower levels prior to transfusion has not caused an increase in poor long-term neurodevelopmental outcomes. Lower transfusion thresholds have also helped to decrease the number of overall transfusions administered in some studies. With a decrease in overall transfusion rates, institutions have noted significant cost savings, as well as decreased use of resources. A study by Beniwal et al found that the use of a standardized guideline for PRBC ordering saved their healthcare institution an estimated $31,000 from the decrease in transfusions administered during the 6-month time frame following policy implementation.
A reduction in PRBC transfusions not only benefits the institution but can also decrease the risk of associated comorbidities for neonatal patients. PRBC transfusions have been associated with comorbidities such as intraventricular hemorrhage (IVH), necrotizing enterocolitis (NEC), bronchopulmonary dysplasia (BPD), and retinopathy of prematurity (ROP) in the neonatal population. This study focused on the diagnoses of IVH and NEC as these are prevalent in the institution where this study took place. Additionally, IVH was chosen for this study due to the significant impact on cost and long-term outcomes that come with a diagnosis of IVH. Likewise, a diagnosis of NEC was chosen for this study due to the potential for prevention of NEC by reducing the number of blood transfusions. Proper transfusion practices may be beneficial in preventing the disease, which is therefore a pressing issue for neonatologists. The problem remains in many institutions that there is no set policy to determine when a transfusion is needed. Due to this inconsistency, providers may be utilizing more PRBC transfusions than needed.

**AVAILABLE KNOWLEDGE**

A review and synthesis of the literature and critical approval of the evidence relevant to this area of clinical practice revealed findings that could be categorized into 3 groups: risk for long-term neurodevelopmental outcomes, risk for secondary outcomes (ie, NEC and IVH), and standardized PRBC transfusion policies. Two systematic reviews fit within the search criteria for this project and were utilized as evidence to promote a PRBC transfusion policy. Two multicenter randomized control trials were also important in guiding the use of a standardized blood transfusion policy. Additional studies included retrospective reviews, retrospective cohort studies, literature reviews, and observational cohort studies, all supporting the use of a standardized blood transfusion policy.

**LONG-TERM OUTCOMES**

A prevalent clinical inquiry surrounding blood product administration in the NICU is the potential for negative long-term neurodevelopmental outcomes (ie, cognitive delays, cerebral palsy, or hearing/vision loss) and death. They both found that neonates did not have an increased risk of negative long-term neurodevelopmental outcomes when randomized to the restrictive transfusion groups and found a modest decrease in the number of transfusions for the restrictive threshold group compared to the liberal threshold group.

**SECONDARY OUTCOMES OF RED BLOOD CELL TRANSFUSIONS**

IVH in the neonate has been hypothesized as a potential negative outcome due to PRBC transfusions. Two retrospective analyses looked at this potential correlation and found an association between blood transfusions in the first 7 days of life and the development of IVH. Despite a correlation between IVH and blood transfusions, these studies were unable to determine whether the transfusions themselves, or the reason for administering the transfusions, caused the IVH. One systematic review by Kalteren et al did note a correlation between anemia and cerebral hypoxia in preterm infants, which may support an increased incidence of IVH. Similar to other studies, they also could not show a definitive association between anemia and the development of IVH in their study. The TOP and ETTNO trials also looked at the incidence of IVH as a secondary outcome and could not find a definitive association between PRBC transfusions and diagnosis of severe IVH. Overall, it has been difficult to determine whether an IVH was present prior to blood transfusions and due to clinical illness, or as a result of a PRBC transfusion.

NEC is another potential negative outcome of PRBC transfusion in the neonate that has been noted in various retrospective analyses and cohort studies. A retrospective analysis by Stritzke et al was able to identify an association between PRBC transfusions and NEC but found no significant difference in morbidity and mortality for infants with transfusion-associated NEC and those who developed NEC with no transfusions. Although some have noted a correlation between the two, other studies have had difficulty proving a definitive link between blood transfusions and NEC. Similar to IVH, Kirpalani et al and Franz et al evaluated NEC as a secondary outcome in their studies and found it difficult to determine if NEC had been caused by a blood transfusion itself or rather from a reperfusion injury due to low hemoglobin level prior to transfusion. Overall, studies have been able to demonstrate a potential link between transfusions and NEC, but there is no definitive correlation between the administration of PRBCs and the development of NEC.
RED BLOOD CELL TRANSFUSION POLICIES

There is currently no national guideline for neonatal PRBC transfusion practices in the United States, and many NICUs throughout the nation have adapted their own individual policies based on the latest evidence. Likewise, a survey of transfusion practices in Europe by Scrivens et al noted a lack of consensus in transfusion criteria, guided by a lack of evidence until recently. The TOP trial and the ETTNO trial have both served as baselines for many institutions looking to implement restrictive (low hematocrit threshold) blood transfusion policies. The TOP trial in particular found that utilization of a restrictive blood transfusion policy did not lead to worse long-term neurodevelopmental outcomes and also led to a decrease in the overall number of blood transfusions administered. The ability to decrease transfusion rates through the utilization of a restrictive policy has helped promote utilization in a clinical setting. Along with a decrease in transfusion rates, the implementation of policies promoting low hematocrit thresholds such as these has been shown to decrease the number of transfusions administered and decrease costs to the institution.

RECOMMENDATIONS

According to evidence in the literature, the implementation of a standardized policy has been shown to improve standardization of PRBC ordering practices and decrease the number of blood transfusions administered. In the TOP trial, 97% of infants in the liberal, or high hematocrit threshold, group and 88% of infants in the restrictive, or low hematocrit threshold, group received PRBC transfusions. This 9% difference equated to 81 fewer transfusions when utilizing a restrictive policy. A retrospective review by Beniwal et al also estimated that a standardized policy helped eliminate 39 transfusions within the first 6 months of implementation. The ability to decrease rates of transfusion also means decreased risks related to administration of PRBCs in the neonatal population. Potential risks include comorbidities such as NEC, BPD, ROP, and IVH. Although many studies have not been able to determine whether the development of these comorbidities is related to prematurity alone, or the administration of a blood transfusion, they have not been able to definitively disprove a link. Lastly, 2 recent randomized control trials (TOP trial and ETTNO trial) were able to show that restrictive blood transfusion policies did not lead to an increased incidence of morbidity or negative long-term neurodevelopmental outcomes. These studies also noted that the use of a restrictive policy did result in a decrease in the overall number of blood transfusions administered.

PROJECT AIMS

The goal of this project was to implement a standardized PRBC transfusion policy in a level IV NICU and evaluate its impact on PRBC transfusion rates. In the unit that implemented this project, there was a large practice gap in that the decision to provide a blood transfusion was left up to the discretion of the healthcare team and not based upon the most current evidence. The goal of this project was to decrease the number of unnecessary blood transfusions administered in the NICU and improve consistency of care by implementing a standardized blood transfusion policy.

METHODS

Setting
The setting in which this quality improvement project took place was a 56-bed, level IV NICU. The population in this NICU includes patients born at 23- and 0/7-week to 42- and 0/7-week gestation. Additionally, patients may be transferred to this institution from other hospitals for the management of acute illnesses or multidisciplinary management. Participants included providers in the NICU who order blood transfusions (ie, Neonatal Nurse Practitioners, Physician Fellows, Physician Residents, and Attending Neonatologists).

Sample
The target population for this policy was neonates in the NICU without clinical signs of anemia and an estimated gestational age of 22 to 36 weeks. Exclusion criteria included neonates with clinical conditions that would significantly alter tolerance of anemia (ie, septic shock with or without coagulopathy, severe congenital heart disease, and congenital diaphragmatic hernia). Patient utilization of this policy was dependent on meeting inclusion criteria (Supplemental Digital Content, Appendix A, available at: http://links.lww.com/ANC/A273).

IMPLEMENTATION FRAMEWORK

Preimplementation
The Johns Hopkins Nursing Evidence-Based Practice Model was utilized to guide this project. The 3-step practice question, evidence, and translation (PET) process was used to determine the best way to translate the latest research findings into patient care. For this project, it was noted that there was a gap in practice when ordering blood transfusions, as providers would rely on individual practice and knowledge when deciding what hematocrit threshold should be used to determine when a patient needed a blood transfusion. The clinical inquiry (practice question) was raised whether the
current practice of provider-dependent blood transfusion ordering is evidence-based. Following a synthesis and critical appraisal of the literature (evidence), it was determined that a standardized blood transfusion policy may help to decrease the number of transfusions administered to patients in this population and also create more consistent practice among providers. Further review revealed that a restrictive transfusion policy has been shown to decrease the number of overall transfusions administered to NICU patients without causing an increased risk of negative long-term neurodevelopmental outcomes. This knowledge was translated into practice, and a standardized blood transfusion policy was developed for implementation (translation).

**Policy Implementation**

For this project, the restrictive transfusion threshold policy utilized in the randomized control trial by Kripalani et al, known as the TOP trial, was formatted to this institution’s standards for use in the NICU. The TOP trial utilized a restrictive blood transfusion policy (ie, low hematocrit thresholds) in infants <1000 g and evaluated the impact on long-term neurodevelopmental outcomes. It was found that allowing a lower transfusion threshold did not lead to negative long-term outcomes and led to a decrease in the number of transfusions administered. For this project, the restrictive hematocrit thresholds utilized in the TOP trial were used for the standardized blood transfusion policy implemented in this institution. This policy included hematocrit thresholds for patients in the NICU based on age (ie, week 1, week 2, and week 3+) and respiratory support (no support vs respiratory support). Respiratory support is defined as mechanical ventilation, continuous positive airway pressure, FiO2 greater than 35%, or nasal cannula flow greater than 1 L per minute. The policy also included background information regarding blood transfusions and inclusion/exclusion criteria (Supplemental Digital Content, Appendix A, available at: http://links.lww.com/ANC/A273). After finalizing the policy, Neonatology leadership was approached to receive institutional approval. The policy was also presented to the NICU Joint Practice Committee for approval.

**Education/Training**

Education for this policy was provided to staff in the Neonatology department that regularly order PRBC transfusions, including Advanced Practice Providers, Physician Fellows, and Attending Neonatologists. At the time of this study, 32 Advanced Practice Providers (including Neonatal Nurse Practitioners and Physician Assistants), 9 Neonatology fellows, and 12 Neonatologists received training. Education began 2 weeks prior to policy implementation to allow for provider awareness of the topic prior to utilization on the unit. The policy was presented during monthly Neonatal Advanced Practice Provider staff meetings and sent to all NICU providers. A PowerPoint presentation was also created (Supplemental Digital Content, Appendix B, available at: http://links.lww.com/ANC/A273) to discuss background information on transfusions, a brief review of the latest evidence, and a chart with the transfusion policy. All information was shared via email, in order to provide education for those who were unable to attend staff meetings. Staff were encouraged to respond to the email with any questions or concerns regarding the policy and provide feedback on improvements that could be made. The physician champion was a strong advocate and facilitator of the project and added validation for their peers. The majority of education and feedback was provided in a virtual format due to restrictions from Covid-19.

**POSTIMPLEMENTATION**

**Intervention**

**Data Analysis**

Data points collected for this project included number of PRBC transfusions administered, diagnosis of NEC, and diagnosis of IVH among infants with a birth weight <1500 g. Data were collected from 2 months prior to policy implementation and staff education, through 2 months following policy implementation. A 2-week period of time between policy implementation and data collection was in place to allow for staff to have the ability to utilize the policy and resolve any unexpected barriers to implementation. The data points from pre- and post-policy implementation were compared to evaluate if there was a significant change in blood transfusion administration once a standardized policy was in place. No additional short-term negative outcomes to patients were noted, such as acute deterioration or transfusion reactions, as these are not an item of focus for this study.

**Ethical Considerations**

To ensure that individual consent for data collection was not required for this project, Institutional Review Board approval was pursued. It was determined that this research was within the exemption category of 45 Code of Federal Regulations (CFR) parts 160 and 164, and subparts A and E. A waiver of the Health Insurance Portability and Accountability Act (HIPAA) was granted. Before implementing the project, a human subjects research determination form was completed at The Ohio State University, which
deemed the project as evidence-based quality improvement and indicated that no further institutional review board approval was necessary at The Ohio State University (OSU).

RESULTS

For this project, a total of 73 patients with a birth weight of <1500 g qualified for inclusion. Patient gestational ages ranged from 23 weeks, 2 days to 34 weeks, 2 days at birth. Patient birth weights ranged from 470 to 1500 g.

Chart reviews both pre- and post-policy implementation were completed for all patients to collect data regarding blood transfusions and diagnosis of NEC and IVH (Figures 1 and 2). Number of transfusions included those given to any infant with a birth weight of <1500 g, during each particular month. In September, 14 patients were admitted to the NICU and 27 blood transfusions were administered. Of these patients, 2 were diagnosed with NEC and 1 was diagnosed with IVH. In October, 13 patients were admitted to the NICU and 59 blood transfusions were administered. Of these patients, one was diagnosed with NEC and 3 were diagnosed with IVH.

In November, the policy was fully implemented on the unit. Data were collected to continue trend-ing blood transfusion administrations, but these data were not utilized for analysis in this project. Post-policy implementation data were then obtained (Figures 1 and 2). In December, 10 patients who were admitted to the NICU qualified for data collection and 50 blood transfusions were administered. There were no diagnoses of NEC and 4 diagnoses of IVH. In January, 12 patients were admitted to the NICU and 55 blood transfusions were administered. There was 1 patient diagnosed with NEC and 2 diagnosed with IVH. In the month of February, 7 patients were admitted and 14 blood transfusions were administered. There were no diagnoses of IVH and 1 diagnosis of NEC among these patients. In March, 14 patients were admitted and 31 blood transfusions were administered. There was 1 diagnosis each of NEC and IVH. Lastly, in April, 3 additional qualifying patients were admitted with 35 blood transfusions administered. There was 1 diagnosis of NEC and 2 diagnoses of IVH.

Incidental findings include a noted improvement in provider communication regarding blood transfusion hematocrit thresholds. Prior to policy implementation, daily progress notes did not include mention of a hematocrit threshold, unless the patient had a specific requirement dictated by specialty teams. Following policy implementation, patient notes routinely included the hematocrit threshold as determined by the new policy. Additionally, discussions were more customary during daily rounds regarding thresholds to transfuse. These incidental findings were noted through individual provider feedback and a review of daily progress notes in patient charts throughout the duration of data collection. Although this was not an intended or measured outcome for this project, it has led to a positive change in practice and may help to ensure the sustainability of this policy.

DISCUSSION

This project implemented a blood transfusion policy aimed to standardize blood transfusion administration. Evaluation of data points did not indicate that there was a significant change in the number of blood transfusions were administered. There was 1 patient diagnosed with NEC and 2 diagnosed with IVH. In the month of February, 7 patients were admitted and 14 blood transfusions were administered. There were no diagnoses of IVH and 1 diagnosis of NEC among these patients. In March, 14 patients were admitted and 31 blood transfusions were administered. There was 1 diagnosis each of NEC and IVH. Lastly, in April, 3 additional qualifying patients were admitted with 35 blood transfusions administered. There was 1 diagnosis of NEC and 2 diagnoses of IVH.

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Fusions administered following policy implementation. One potential reason that there was inconsistent blood transfusion administration following policy implementation may be that average birth weights varied broadly among patients included in data collection. As many patients with varying birth weights are admitted to the NICU where this policy was implemented, there is a wide range of average birth weights among infants <1500 g (Figure 3). It can be noted that in some months where average birth weights were higher, such as September and March, the rate of blood transfusions was lower. This could indicate that the unit experienced a smaller percentage of small babies admitted during these months, and therefore, lower incidence of blood transfusion administrations. Other factors that may have impacted stronger outcomes are the short implementation period included for the initial project. Additional data collection following sustained implementation may demonstrate different outcomes long term.

The data collected does not indicate that there was a correlation between the diagnosis of NEC or IVH and the administration of a blood transfusion. The incidence of NEC or IVH diagnosis among infants <1500 g remained between 0 and 4 infants per month (Figure 2). There was no significant change between pre-policy implementation months and post-policy implementation months.

NURSING PRACTICE IMPLICATIONS

Although there was not a significant change in the number of blood transfusions or diagnoses of NEC and IVH, there was a notable change in practice among providers ordering blood transfusions. Prior to policy implementation, very few daily patient progress notes would reference the appropriate hematocrit threshold for patients at risk for or diagnosed with anemia. Following the implementation of a policy, the majority of patient notes now mention this threshold. The addition of this information to patient progress notes has helped to standardize blood transfusion ordering practices. This change in practice has enhanced communication among the healthcare team and resulted in a more consistent blood transfusion ordering practice. For example, the presence of a standard policy to follow encouraged routine discussion of transfusion thresholds in daily rounds and allowed providers a way to offer clear transfusion plans for nursing. Although this was not a formal measure for this project, it is an important noted outcome that will enhance and improve practice.

LIMITATIONS

Due to fluctuations in patient population at this level IV institution, some months had more patients admitted with a birth weight of <1500 g, which increased the number of patients that could be included in data collection. The increased admission of infants <1500 g may have led to more frequent blood transfusion administrations in certain months. Restraints in education provision due to Covid-19 may have also impacted initial provider utilization of the blood transfusion policy. At the time of project implementation, all meetings were virtual at the institution implementing this policy, leading to an inability to provide in-person education and feedback. If education had been
provided in person, it may have created an environment for feedback and may have improved provider understanding of the new policy. Additionally, this project had to rely on providers routinely checking emails and attending virtual meetings.

Lastly, delays in policy approval due to Covid-19 led to less time for staff to utilize the policy prior to pre-policy implementation data collection. For purposes of this project, a 2-week gap between policy implementation on the unit and data collection was in place to ensure that staff had adequate time to use the policy in daily practice. The initial project goal was to allow for a 4-week gap prior to data collection. The inability to allow for a longer time prior to data collection may have impacted the initial provider utilization of the policy.

**INTERPRETATION**

This institution has a strong culture of quality improvement and implementation of evidence-based practice. These values help to encourage the use of new policies to improve patient care and helped in receiving approval for this policy from the Neonatology department and Joint Practice Committee. Most importantly, there was a noted improvement in standardization of practice among providers ordering blood transfusions. This institution’s culture of evidence-based practice allowed for success in meeting the project goals within a short time period and will support continued data collection following project completion to evaluate impact on patient care practices.

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**Summary of Recommendations for Practice and Research**

**What we know:**
- Blood transfusions are not without risk in the neonatal population.
- Many institutions have varying thresholds for administration of blood transfusions, leading to inconsistent care.
- Standardization of care has been shown to improve patient outcomes.

**What needs to be studied:**
- Long-term impact of frequent blood transfusions in the neonatal population.
- The impact on outcomes when utilizing a restrictive vs liberal blood transfusion policy.
- Impact of NEC and IVH rates in infants receiving multiple blood transfusions vs those who do not.
- Impact of a standardized blood transfusion policy on provider practice and satisfaction.

**What we can do today:**
- Implement policies for blood transfusion thresholds to help standardize care and improve provider communication.
- The process used to develop the protocol implemented in this project could be extended to other areas of practice to improve the standardization of care.
CONCLUSIONS

Data collection did not indicate success in consistently reducing the number of blood transfusions administered among infants <1,500 grams. Although data collection did not indicate a significant change in transfusion administration, practice coalesced in the NICU where this project was conducted. The addition of a standardized policy encouraged inclusion of hematocrit thresholds in daily progress notes, as well as discussion during daily patient rounds. This change in practice led to enhanced communication among the healthcare team and encouraged discussion regarding necessity of blood transfusions. Although there was no change in transfusion rates, the ability to provide more consistent patient care may impact transfusion administration practices and may be noticeable during further data collection. The process used to develop and implement these transfusion guidelines could also be utilized by other units to help standardize their own blood transfusion ordering practices. Likewise, similar processes could be used within the NICU to guide other quality improvement projects and further impact patient care practices.

References