PREVENTING MISTRANSFUSIONS: AN EVALUATION OF INSTITUTIONAL KNOWLEDGE AND A RESPONSE

Topics of focus: ¹Patient Safety, ²Adverse Drug Event, ³Best Practice, ⁴Safety Science

Brief statement by an executive leader in support of the application.
Executive Summary

Blood product mistransfusions occur when a process error causes transfusion of incompatible blood products. These events are known sources of negative patient outcomes. One such event demonstrated an institutional knowledge gap and an opportunity to effectively eliminate this source of transfusion errors. Our primary focus was to evaluate the application of point-of-care cognitive aids to bridge potentially lethal knowledge gaps in blood product to patient compatibility. A blood product safety quiz consisting of an ABO antigen compatibility grid of Red Blood Cells and Fresh Frozen Plasma between patient and donor blood types and a quick reference blood product ABO compatibility cognitive aid were developed. After inclusion of the cognitive aid, mean quiz Red Blood Cell scores improved from 84.7% to 98.3% (p<0.001). Mean Fresh Frozen Plasma scores improved from 54.2% to 99.6% (p<0.001). Inclusion of the cognitive aid for determining blood product compatibility may have significantly improved performance for clinical staff correctly matching patient and blood product ABO type. A knowledge gap-mediating “forcing function” based on the cognitive aid was also adopted by our blood bank for use prior to dispensing blood products from the blood bank and for use during checking the blood product at the bedside.

Background

While much attention has been given to blood safety since the early 1980s, there has been comparably less of a focus on transfusion safety during the same time period. As a result, while the risk of infectious disease transmission through blood products has decreased, mistransfusion has been and continues to be, a...
serious leading cause of serious hazards from transfusion\textsuperscript{3,4}. Indeed, some have estimated that the risk of transfusing the wrong blood to the wrong patient is three times higher than the risk of infectious disease transmission\textsuperscript{5}. Although a number of technological interventions have been introduced to reduce mistransfusion\textsuperscript{2}, hazardous events related to processes resulting in the delivery of correct blood and blood products to the correct patient remain a major problem. We report on our experience with a transfusion event in the operating room, our investigation, our findings and a solution.

A patient involved in a motor vehicle accident was admitted to our emergency room and subsequently to the operating room for emergency surgery. During the intraoperative period, the patient required multiple blood product transfusions, including packed red blood cells (RBC) and fresh frozen plasma (FFP). The patient's ABO blood type was type AB. In the blood bank, a technologist mistakenly removed type A plasma from storage and sent it to the operating room. Type A plasma arrived in the operating room and was checked by two members of the anesthesia team. One member of the team having experience at another facility assumed that the Blood Bank was out of type AB plasma and thus sent an appropriate alternative to type AB plasma\textsuperscript{6,7,8}. The plasma was administered. The other member of the team did not question the difference in ABO type. Sometime later, the blood bank discovered the error and notified operating room personnel however, the FFP transfusion had been completed. The patient recovered from his injuries and surgery and was discharged home. According to recent literature regarding the safe use of type A plasma as a universal donor unit, no negative sequelae were expected
or recorded with this patient 6,7,8. However, this type of event is a prime example of mistransfusion events.

A root cause analysis was performed. During the investigation, it became apparent that a knowledge gap existed regarding plasma ABO compatibility. This led us to question our knowledge of ABO compatibility throughout our institution, especially in circumstances where the providers are under extreme time and performance pressure (i.e. severe hemorrhage requiring massive transfusion).

**Effort to Improve Transfusion Safety**

We designed a Blood Product Safety Quiz (BPSQ) (Figure 1a), using a grid with recipient’s ABO type along the Y axis and blood product ABO type along the X axis. A separate grid was used for packed red blood cells (RBC) and fresh frozen plasma (FFP) compatibility. In order to simulate performance pressure as might be experienced during an actual resuscitation; examinees were given only 2 minutes to complete the quiz.

An initial pilot quiz was distributed to 117 voluntary participants, which included medical faculty, residents, and registered nurses from various patient care units. To based on results from the pilot quiz, a cognitive aid was developed using the described BPSQ grid with stars placed in boxes where compatibility exists between recipient ABO type and blood product ABO type (Figure 1b). The cognitive aid is intended to be worn with a hospital identification badge and used as a quick reference for blood product to recipient compatibility.
A second study was conducted, which included newly hired registered nurses and incoming postgraduate year-one residents at Arrowhead Regional Medical Center from May 2015 through September 2015. Residents and registered nurses are responsible for bedside ordering and/or administration of blood products at this institution. Prior to clinical deployment, both RNs and PGY-1s are required to participate in similar, but separate, hospital orientations with ARMC blood product and transfusion policy and procedure education. As part of their respective initial hospital orientations, time was allocated to administer BPSQs first without and with the cognitive aid to both RNs and PGY-1s with no prior notice of the BPSQ and before taking part in ARMC blood product administration education. Under proctored conditions with no reference materials permitted, BPSQ without the cognitive aid was distributed to all individuals with instructions to place a personal identifier on the quiz to link BPSQ without and with scores. Participants were given two minutes to complete the BPSQs with no performance feedback delivered between tests. Figure 2 presented the detailed logistics of the study design.

BPSQ score was determined by tabulating total number of correctly marked and unmarked boxes for a score out of 16 for both grids; RBC and FFP. Quizzes with no markings were given a score of 0 out of 16 for each unmarked grid. Raw scores were converted to percent for later evaluation.

Results

The blood product safety quizzes evaluating the cognitive aid were administered to a total of 111 clinical staff. The mean, standard deviation and median of both RBC
and FFP scores were similar for PILOT and BPSQ1. There was no difference between RBC and FFP PILOT vs BPSQ1 scores when evaluated at 95% confidence level, (p = 0.556 and 0.552 respectively). A statistically significant improvement in the correct answer percentage was observed when the cognitive aid was included in testing. Specifically, the correct RBC answer percentage increased from 84.7% to 98.3% (average improvement 13.6% ± 18.3%, p<0.001, Figure 3); the correct FFP answer percentage increased from 54.2% to 99.6% (average improvement 45.4% ± 20.1%, p<0.0001). When comparing BPSQ1 vs BPSQ2 an observed increase in RBC No difference in the improvement of correct RBC and FFP percentage was detected and FFP scores by 13.6% and 45.4% demonstrated a p<0.001 (94.7% to 98.3% for RBC and for FFP from 54.2% to 99.6%) (Figure 2). 95% confidence intervals for BPSQ2 RBC and FFP scores were 96.7% to 99.9% and 99.1% to 100%.

between registered nurses and resident physicians. However, participants with lower baseline RBC and FFP score showed larger improvement in the correct answer percentage for RBC and FFP (p<0.001), respectively.

The cognitive aid has since been distributed institution-wide to all personnel involved with blood and blood product transfusion. Additionally, the blood bank added the cognitive aid grids to both blood order forms and the transfusion forms attached to each unit of blood product (RBCs and FFP). Staff receiving blood products from the blood bank must use the grid to check the blood product first with the blood bank technician by drawing a line across the row corresponding to the patient's ABO type and then drawing a line down the column corresponding to the ABO of the product they are receiving. Staff then verify where the two lines...
intersect, there is a star in the box, indicating correct ABO type. Once at the bedside, the two providers checking the blood product also complete the grid on the transfusion form, drawing lines as described previously and verifying a star in the box where the lines intersect indicating a correct ABO match prior to transfusing. Following implementation of these interventions, no additional instances of mistransfusion have been reported at ARMC.

Discussion of Results

Through the use of a simple 2 minute quiz, at our institution we uncovered a serious clinical gap related to knowledge of RBC and FFP compatibility. We have attempted to mitigate the risk of ABO mismatch associated with this knowledge gap in 2 ways: First, by providing a cognitive aid as a quick guide to ABO compatibility to be worn on the ID badge holder of all personnel involved in transfusion of blood products. Second, we have added a “forcing function” to our process of distributing blood products from the blood bank and checking blood products at the bedside. Completion of the ABO grid, as described above, must occur before the blood bank will release blood products (the forcing function). Completion of the ABO grid is also performed a second time as part of the bedside verification process before transfusion. Transfusion forms returned from the bedside that do not have the grid completed are tracked by the blood bank and the nursing supervisor is notified immediately so that staff can have remedial education or corrective action as required.
Despite a number of interventions that have been introduced to reduce mistransfusion, hazardous events related to error in the delivery of correct blood products to the correct patient remain a problem. Mistransfusion has consistently been a leading cause of preventable transfusion related death reported in the literature and according to the most recently published FDA transfusion fatality statistics. Disturbingly, a 2003 report from The College of American Pathologists documented a decline in the performance of the bedside check before transfusion. Persisting concerns of pre-transfusion bedside check failures indicate a longstanding trend of poor process performance. This is a process we believe should be “hardwired” everywhere transfusions are administered.

Based on the results of our ABO compatibility quiz, we believe that a contributing factor to the failure to perform the bedside check or failure to perform it appropriately is a lack of knowledge or lack of “reflex memory” regarding ABO compatibility. While we acknowledge that most practitioners could determine correct compatibility if given enough time, the time pressures associated with busy medical units or extreme time and performance pressures associated with resuscitation conditions impair the ability to recall such data accurately and/or in a timely manner. Cognitive aids or decision support tools reduce variability in response among providers, help to improve adherence to best practice, reduce the need to commit knowledge to memory and improve decision making during high pressure situations. Eliminating variation in clinical decision making among providers, via consistent education and deployment of...
quick reference knowledge aids, supports decreased clinical decision errors and increased patient safety (213).

We have been able to demonstrate that the use of a cognitive aid may significantly mitigate a potentially lethal ABO compatibility knowledge gap among healthcare providers. In addition, we believe that the adoption of a forcing function based on the cognitive aid will reduce the chances of ABO mismatch related to ABO compatibility knowledge gaps.

We believe our three-way approach to mitigating knowledge gaps (cognitive aid, forcing function, and remedial education) has successfully limited the exposure of ARMC patients to mistransfusion. Although there are no direct analogues for comparison to other mistransfusion interventions, we believe the cost effectiveness of this approach to be one of it’s most compelling features. Although mistransfusions are admittedly more rare than some medical errors, cognitive aid and forcing function interventions can be deployed quickly, cheaply and effectively to resolve many potentially lethal knowledge gaps.

Sustainability

It is now policy for all staff handling blood products to wear the badge-borne cognitive aid and complete the forcing function when issuing, checking and transfusing blood products. There were a total of three institution-wide changes required to implement these interventions. First, the badge-borne cognitive aid was developed, sent through the hospital transfusion safety committee with approved policy changes for requiring staff to wear the cognitive aid, and issued
to all staff through the human resources department. The forcing function added to the blood product release form and bedside transfusion form was sent though the hospital transfusion safety committee, approved and physically added to the forms and workflow of transfusion. A reporting system, between the blood bank and clinical unit administrators, identifying instances of cognitive aid or forcing function policy noncompliance among staff was implemented. This tool allows for trending of individual, unit, and hospital transfusion safety performance. Based on reported deficiency, remedial training by the unit administrators and hospital education department is utilized to correct any knowledge or process deficit. Once this system was initialized and integrated into the administrative and clinical apparatus at ARMC it has been self staining, cost effective, and most importantly safe.

The long term effectiveness of these specific interventions for preventing mistransfusion will be difficult to distill, however application of this safety system to other medical error scenarios is planned. Further study will need to be made regarding the scaling of this achievement.

Lessons learned