COMMENTARY

Improving Outcomes in a Complex Health Care System: Lessons From Complex Cranial Vault Reconstruction

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Reducing blood donor exposure (BDE) is a meaningful improvement goal for many conditions and procedures that require a transfusion of blood products. Complex cranial vault reconstruction (CCVR) in children is a procedure that routinely requires a large-volume blood transfusion, with intraoperative blood loss routinely exceeding the circulating blood volume[1–4] and ongoing losses often leading to postoperative transfusions. Large-volume transfusions increase the risk for coagulopathy[5] and a need for additional blood products; increasing donor exposure increases the risk for infection, transfusion reactions, and alloimmunization.[6]

Optimizing the transfusion management for CCVR requires a high degree of care coordination because multiple providers are involved in the care of these children in the preoperative, intraoperative, and postoperative setting.[1] In addition, an optimal transfusion strategy for this particular population has not been previously established. In this issue of *Hospital Pediatrics*, Muhly et al[7] report the use of sequential interventions and the evaluation of outcomes over time to achieve an overall goal of reducing BDEs. They also achieve a secondary goal of reducing the overall blood transfusion volume in the CCVR population. Although several of the described interventions have been separately studied and published,[1,8,9] the authors of this work look at the interventions in aggregate across time, evaluating the effectiveness of a systematically modified care bundle in the "real world" health care setting. In this real-world setting, not all patients receive all interventions, yet the overall care package is shown to improve outcomes via measurement on appropriate statistical process control charts.

The authors of this work suggest that certain interventions in combination may be most effective. Best results were found with a care bundle of fresh whole blood for intraoperative transfusions, intraoperative antifibrinolytics, and the implementation of postoperative transfusion guidelines.[9] In this effort, when fresh whole blood was not available, reconstituted blood was used. Using this strategy, the team achieved a significant reduction on BDE per patient from a baseline average of 4 to 1.7, essentially halving the exposure. In the final iteration of testing, there was a significant reduction in the perioperative transfusion volumes from 84 to 53 mL/kg.

Although this care approach is highly relevant to all those who care for children with cranial vault reconstruction surgery, and specific interventions can plausibly extend to other high-transfusion surgical conditions, there are several more general concepts from this improvement effort that are broadly applicable to any provider seeking to improve care for patients who cross care settings and provider types.

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For the provider who is seeking to improve care across a complex health system, consider these broad learnings from the work of Muhly et al[7]:

- Establishment of a condition-specific registry to track outcomes prospectively: The use of a prospective registry greatly aids in the evaluation of interventions over time when key data are collected and managed. Key data for such a registry include relevant patient demographics, conditions, and procedure details, as well as process, outcome, and balancing measures.
- Clear aims: When all parties understand the specific and global aims of an improvement effort, energy and attention is appropriately focused in the same direction. In this work, all stakeholders understood the goal of reducing BDEs.
- Involving all stakeholders: This project required the investment of stakeholders from anesthesiology, plastic surgery, pharmacy, the operating room, the blood bank, and the ICU, all working together for a common aim. Omitting a key stakeholder would almost certainly have hindered the effort.
- Development and implementation of care guidelines to assist providers at each stage and setting of care: In this project, guidelines were implemented regarding intraoperative transfusion strategies (initiated preoperatively), intraoperative antifibrinolytic therapy (applied in the operating room), and postoperative transfusion (applied in the critical care unit). The development of guidelines should not be confused with implementation; this improvement team included process measures that reflected the implementation of guidelines in the intraoperative areas. Compliance with postoperative transfusion guidelines was not reported, although the authors note an "enthusiastic" reception by the intensive care practitioners.
- Creating an effective and productive relationship between different care systems: In this work, surgical and anesthesiology stakeholders worked together with the blood bank to develop and then systematically adjust a protocol that was flexible enough to be adapted to individual circumstances (eg, when no fresh whole blood was available) but standard enough to allow for measurement of effectiveness.
- Using failure as a learning opportunity: The improvement team was interested in learning from failures to adjust their approach. For example, in epoch 1 of the intervention, the team noticed an increase in transfusion volumes (ie, the opposite of expected). When investigating this phenomenon, they noticed that providers were topping off transfusion volumes in anticipation of subsequent losses. This observation led to the next intervention, the development of a transfusion guideline, which was ultimately part of the successful approach.

In addition, perhaps the most important lesson from Muhly et al[7] is that in a complex health system, the best approach to achieving an improvement aim may be elucidated through a strategy of introducing sequential changes over time, measuring outcomes, adjusting the approach, and testing again. In short, Muhly et al[7] demonstrate that the iterative approach to testing interventions over time, via the plan-do-study-act model for improvement,[10] may be applied to a highly complex clinical problem with great success.

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