Blood transfusion is among the most common hospital procedures in the United States—over 16 million units of blood products were transfused in 2017,[1] and transfusion-associated costs accounted for 1% of total hospital budgets.[2] Blood transfusion is most often used in patients who are older, have co-morbidities, or are female.[3] Although blood transfusion is routine in many major surgical procedures, it is most frequently performed during cardiac procedures (45.3% of patients) and orthopedic-spine procedures (33.3% of patients).[4] Despite being a routine procedure, blood transfusion carries risks to the patient, ranging from mild non-hemolytic febrile reactions to serious complications, including acute hemolytic reactions, circulatory overload, acute lung injury, and sepsis.[5] Given the risks and costs associated with blood transfusion, a growing number of medical organizations have raised concerns about its overuse,[6] and best practice guidelines for patient blood management were published in an expert consensus paper in 2018.[7]

Best practice guidelines highlight 3 ways physicians can reduce unnecessary blood transfusion, namely, managing pre-operative anemia, employing interoperative strategies for blood conservation, and engaging in patient-centered care.[7,8] Anemia is common in surgical patients,[9] and a key recommendation is to evaluate anemia early to allow time for treatment, if possible, using a modality other than allogeneic blood transfusion.[7] Although anemia is defined as a hemoglobin (Hb) value of less than 11.0 g/dL, restrictive Hb thresholds for transfusion—between 7-8 g/dL—are as effective as liberal thresholds for 30-day survival and absence of adverse outcomes across a range of surgical procedures;[10] and should be used to guide the decision to transfuse.[7,11] Physicians should minimize blood loss during procedures by employing blood conservation strategies and use antifibrinolytic agents when appropriate.[8] This multi-faceted approach to reducing the need for interoperative blood transfusion is explained by Dr Hughs, an orthopaedic specialist at the University of Pittsburgh Medical Center: "[P]atients are evaluated for anemia and steps are taken preoperatively to correct their low blood count… . During the surgery…. blood can be collected using cell-saver techniques and immediately reinfused to patients... ."[13]

Despite the increasing adoption of best practice guidelines for patient blood management, many physicians continue to overuse blood transfusion in their surgical patients. In 2011, an estimated 50% of blood transfusions were conducted using Hb thresholds above guideline recommendations and were deemed clinically inappropriate by a panel of experts.[14] Transfusion practices for the same surgical procedure vary considerably across hospitals, as well as across physicians at a single hospital,[4,15] which suggests that the decision to transfuse is often subjective, and not based on published guidelines.[1] Patient-centered care regarding blood transfusion may also be inadequate: a survey of physicians and their patients demonstrated that patients, but not physicians, underestimated the potential harms of blood transfusion.[9] Taken together, the evidence suggests that physicians in surgical practice are not sufficiently aware of best practice guidelines for patient blood management, or if aware, are unable to implement them.

Many of the barriers that impede physicians from implementing patient blood management relate to physician behavior, including lack of awareness of best practice guidelines, ambivalence regarding the need for standardized guidelines, and low competency to carry out the complex decision-making required to implement guideline recommendations.[10] In a survey of surgeons and anesthesiologists engaged in continuing medical education (CME), blood patient management ranked among the top five

areas in which physicians desired further training.[ref] Physicians' failure to overcome barriers to blood patient management results in substantial healthcare costs, and more importantly, health risks to patients—in 2017 alone, 45 000 transfusion-related adverse events occurred.[5] But barriers to patient blood management can be overcome. Systematic reviews have shown that CME improves physician performance and patient outcomes,[16] and CME for patient blood management has been associated with a decrease in unnecessary transfusions and better patient outcomes.[10] CME that includes clinically-focused, interactive activities is particularly effective. To this end, this CME activity, aimed at an audience of surgeons and anesthesiologists, will not simply review the guidelines, but also engage participants in discussions of complex case studies to highlight strategies to reduce unnecessary blood transfusion while improving overall patient outcomes.

REFERENCES

1. Savinkina AA, Haass KA, Sapiano MRP, et al. Transfusion-associated adverse events and implementation of blood safety measures - findings from the 2017 National Blood Collection and Utilization Survey. *Transfusion*. 2020; 60 Suppl 2. doi:10.1111/trf.156542.

2. The Yale Global Health Review. Blood Transfusion Costs. https://yaleglobalhealthreview.com/2016/12/21/blood-transfusion-costs/. Published December 21, 2016. Accessed November 6, 2020.

3. Ferraris VA, Hochstetler M, Martin JT, Mahan A, Saha SP. Blood transfusion and adverse surgical outcomes: the good and the bad. *Surgery*; 2015; 158 (3): 608-617. doi:10.1016/j.surg.2015.02.027

4. Frank SM, Savage WJ, Rothschild JA, et al. Variability in blood and blood component utilization as assessed by an anesthesia information management system. *Anesthesiology*. 2012; 117(1):99-106. doi:10.1097/ALN.0b013e318255e550

5. Joint United Kingdom (UK) Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee. Handbook of Transfusion Medicine, 4th ed. https://www.transfusionguidelines.org/transfusion-handbook. Published 2013. Accessed November 4, 2020.

6. Society for the Advancement of Blood Management. Transfusion Overuse Exposing a International Problem and Patient Safety Issue. https://www.sabm.org/wp-content/uploads/SABM-Transfusion-Overuse-2019.pdf. Published 2019. Accessed November 3, 2020.

7. Mueller MM, Van Remoortel H, Meybohm P, et al. Patient Blood Management: Recommendations from the 2018 Frankfurt Consensus Conference. *JAMA*. 2019; 321(10):983-997. doi:10.1001/jama.2019.0554

8. Sullivan HC, Roback JD. The pillars of patient blood management: key to successful implementation (Article, p. 2840). *Transfusion*. 2019;59(9):2763-2767. doi:10.1111/trf.15464

9. Muñoz M, Laso-Morales MJ, Gómez-Ramírez S, Cadellas M, Núñez-Matas MJ, García-Erce JA. Pre-operative haemoglobin levels and iron status in a large multicentre cohort of patients undergoing major elective surgery. *Anaesthesia*. 2017;72(7):826-834. doi:10.1111/anae.13840

10. Carson JL, Stanworth SJ, Roubinian N, et al. Transfusion thresholds and other strategies for guiding allogeneic red blood cell transfusion. *Cochrane Database Syst Rev*. 2016;2016(10). doi:10.1002/14651858.CD002042.pub4

11. Raphael J, Mazer CD, Subramani S, et al. Society of Cardiovascular Anesthesiologists Clinical Practice Improvement Advisory for Management of Perioperative Bleeding and Hemostasis in Cardiac Surgery Patients. *Anesth Analg*. 2019;129(5):1209-1221.

doi:10.1213/ANE.0000000000004355

12. Engelman DT, Ben Ali W, Williams JB, et al. Guidelines for Perioperative Care in Cardiac Surgery: Enhanced Recovery after Surgery Society Recommendations. *JAMA Surg*. 2019;154(8):755-766. doi:10.1001/jamasurg.2019.1153

13. University of Pittsburgh Medical Center. Patient blood management and shoulder replacement surgery: an interview with Thomas Hughs, MD. https://www.upmc.com/services/patient-blood-management-bloodless-medicine/blood-management-resources/interviews/shoulder-replacement-surgery. Accessed February 17, 2021

14. Shander A, Fink A, Javidroozi M, et al. Appropriateness of allogeneic red blood cell transfusion: The international consensus conference on transfusion outcomes. 2011; 25(3):232-246. doi:10.1016/j.tmrv.2011.02.001

15. Ejaz A, Spolverato G, Kim Y, Frank SM, Pawlik TM. Variation in triggers and use of perioperative blood transfusion in major gastrointestinal surgery. *Br J Surg*. 2014;101(11):1424-1433. doi:10.1002/bjs.9617

16. Cervero RM, Gaines JK. *Effectiveness of continuing medical education: updated synthesis of systematic reviews*. Accreditation Council for Continuing Medical Education; 2014. Accessed February 17, 2021.

Gap	Learning objectives (*After completing the educational activity, the learner will be able to perform the following items.*)	Desired outcomes
Physicians are not using best practice recommendations to guide their decision to perform blood transfusion in surgical patients. Many transfusions are performed above the recommended Hb thresholds, which suggests that physicians are not aware of these thresholds and may be underutilizing anemia management and blood conservation strategies.	1) Use clinical investigations to comprehensively evaluate whether a blood transfusion is appropriate for patients undergoing specific operative procedures. (Knowledge/Competence) 2) In the preoperative period, evaluate patients for anemia, and clinically manage anemia, if present. (Competence/Performance) 3) Develop an appropriate plan for blood conservation based on a patient's clinical profile and the operative procedure. (Competence/Performance)	1) Physician self-report will reflect improvement in consistent use of best practice guidelines to evaluate patients' need for blood transfusion. 2) Physician self-report and hospital records will reflect a decrease in the proportion of patients undergoing a surgical procedure who have anemia. 3) Physician self-report and hospital records will reflect a decrease in the proportion of patients undergoing specific surgical procedures who require blood transfusion.
Physicians do not adequately implement a patient-centered approach to blood transfusion. Patients have low awareness of the risks and benefits of blood transfusion, which shows that physicians are not educating patients about transfusion or engaging them in informed decision-making regarding this procedure.	1) Adequately inform patients about the risks and benefits of interoperative blood transfusion. (Competence/Performance) 2) Engage patients in informed decision-making regarding blood transfusion using a flexibly structured patient Information guide. (Competence/Performance)	1) Patient surveys conducted during the preoperative period will reflect a high level of patient awareness of the risks and benefits of blood transfusion. 2) Patient and physician surveys will reflect a high level of patient engagement in decision-making regarding blood transfusion.