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Intraoperative Transfusion Targets: Avoiding the Extremes

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Blood transfusion can save lives when patients need it, but only increases risks and costs when they do not. In the operating room, our job is not only to decide who needs a transfusion, but also to give the optimal amount or "dose" of blood—not too much and not too little. This concept defines both the art and the science of perioperative medicine and applies to virtually everything we give to our patients.

In this issue of *Anesthesia & Analgesia*, Will et al[1] describe an optimal target to guide intraoperative red blood cell (RBC) transfusion based on the initial postoperative hemoglobin (Hb) concentration. The authors define this postoperative target Hb to be in the range of 7.5–11.5 g/dL based on clinical outcomes that were inferior both below the low end and above the high end of this range. Recognizing that 4 g/dL represents a relatively wide range (or a big target), 2 things become apparent: (1) it should be relatively easy to hit and (2) we should aim for the lower end of the range because clinical outcomes at 1-g/dL increments within the range were not different. Why would we add risks and costs by transfusing more blood than is needed, without benefit?

In the study, over 8000 noncardiac surgery patients who received ≥1 intraoperative RBC units were included over a 5-year period. Patients were categorized based on their initial postoperative Hb concentration into 6 groups defined by 1-g increments, with the extreme values of <7.5 and ≥11.5 g/dL representing the lowest and highest postoperative Hb groups. Patients whose postoperative Hb fell into either of these 2 extreme groups had statistically and clinically significant fewer hospital-free days. Patients whose postoperative Hb was <7.5 g/dL had on average nearly a day and a half longer hospital stay, and those with a postoperative Hb ≥11.5 g/dL had nearly a 1 day longer hospital stay, compared to patients whose postoperative Hb was between the extremes. Moreover, although the effect was not as robust after adjustment for multiple comparisons, a postoperative Hb in either extreme group was also associated with worse outcomes in several of the secondary outcomes. A

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postoperative Hb <7.5 g/dL was associated with increased odds of acute kidney injury, cerebral ischemia, and mortality, suggesting that a postoperative target Hb <7.5 g/dL may be low enough to cause end-organ ischemia. In addition, a postoperative Hb ≥11.5 g/dL was associated with increased odds of postoperative mechanical ventilation. Although the incidence of transfusion-related acute lung injury (TRALI) and transfusion-associated circulatory overload (TACO) was not specifically reported, the same Mayo Clinic investigators have shown that both of these adverse events may be much more common than previously reported,[2,3] so there should at least be some suspicion.

Like any retrospective transfusion study, this one has its limitations. Because both anemia and transfusion are strongly associated with sicker patients having bigger procedures,[4] risk adjustment is essential. Using multivariable models, the authors have thoughtfully controlled for a significant number of important confounding variables. Given the retrospective design, it is not unexpected that there were baseline differences between patients based on their postoperative Hb groups. Interestingly, intraoperative estimated blood loss, cell salvage volume, perioperative vasopressors, and emergency surgery were increased in the <7.5 g/dL group, while intraoperative blood loss and RBC transfusion volume were increased in the ≥11.5 g/dL group. These baseline differences suggest that over- or undertransfusion is more likely to occur when blood loss is higher, which supports our experience and belief that providers know when to give blood, but do not always know when to stop. Knowing when to stop often requires careful communication with the surgeons, and vigilant observation of the surgical field, as well as meticulous measurement of blood loss, which can be challenging. In other words, hitting even a large transfusion target during surgery is not always easy.

This study is both important and novel. First, the development of a data-driven postoperative Hb target adds a new parameter to consider when transfusing patients, beyond the well-understood and commonly practiced Hb-based trigger. Most of the high-quality studies that inform evidence-based transfusion practice, including the landmark randomized trials comparing liberal to restrictive transfusion strategies, emphasize the “Hb trigger” but generally ignore the “Hb target,”[5] which is usually buried in the fine print in these publications. The Hb trigger describes the Hb threshold used to initiate transfusion, and the target is the Hb level at which transfusion is stopped.[6] The difference between the trigger and target Hb level is essentially the dose of blood, which is important because it defines the end point of a transfusion.[7] For example, in the randomized transfusion trials, the Hb target was usually 1–1.5 g/dL higher than the Hb trigger, given the single-unit transfusion strategy used in the trials (1 RBC unit raises Hb by ≈1 g/dL in a typical adult).[8] An overreliance on an evidence-based Hb trigger transfusion strategy without consideration of the Hb target can result in giving more blood than is needed. Again, overtransfusion increases the risks and costs to the patient, and as this study demonstrates, it also may result in adverse outcomes.

Second, Will et al[1] should be applauded for taking on the topic of intraoperative transfusion because, as the authors nicely point out, the pretransfusion Hb concentration may be an unreliable indicator for when transfusion is appropriate. In this study, 90% of the intraoperative transfusions occurred at a pretransfusion threshold of >7 g/dL, despite institutional guidelines recommending a pretransfusion Hb threshold of <7 g/dL for stable patients. One obvious explanation for why pretransfusion Hb is unreliable, and clinicians may not use it to guide intraoperative transfusion, is that it has no clear relationship with total circulating red cell mass, which depends on intravascular volume. Acute bleeding will not drop the Hb concentration until intravenous (IV) fluids are given to replenish intravascular volume, but it will significantly decrease total red cell mass and oxygen delivery. In addition, deeper anesthesia leads to hypotension, which when treated with crystalloids or colloids leads to hemodilution and a resulting decrease in Hb.[9] In addition, blood loss can also occur acutely, requiring transfusion before a Hb can be measured, depending on the available vascular access to draw a blood sample and the turnaround time for laboratory test results in a given institution. Because of these complexities, patient blood management programs sometimes give a “free pass” to intraoperative transfusions[10] because it is difficult or sometimes impossible to audit them based on the nadir Hb alone. For these reasons, the initial postoperative Hb (the Hb target) makes more sense to monitor than the intraoperative Hb trigger.

In summary, the findings by Will et al[1] are helpful in guiding an intraoperative transfusion strategy, a topic that is difficult to study and therefore relatively ignored in the literature. Their findings suggest that there is a middle range for the end-of-case target Hb concentration, between 7.5 and 11.5 g/dL, where clinical outcomes are superior. Avoiding Hb targets below and above this range may improve outcomes, and targeting the lower end of this range may avoid the added risks and costs associated with unnecessary transfusions. Perhaps, this study is a lesson in practicing moderation for intraoperative transfusion, the message being to avoid the extremes.

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REFERENCES

1. Will ND, Kor DJ, Frank RD, et al. Initial postoperative hemoglobin values and clinical outcomes in transfused patients undergoing noncardiac surgery. Anesth Analg. 2019;129:819–829. [PubMed: 31425225]
2. Clifford L, Jia Q, Yadav H, et al. Characterizing the epidemiology of perioperative transfusion-associated circulatory overload. Anesthesiology. 2015;122:21–28. [PubMed: 25611653]
3. Clifford L, Jia Q, Subramanian A, et al. Characterizing the epidemiology of postoperative transfusion-related acute lung injury. Anesthesiology. 2015;122:12–20. [PubMed: 25611652]
4. Shander A, Javidroozi M, Ozawa S, Hare GM. What is really dangerous: anaemia or transfusion? Br J Anaesth. 2011;107(suppl 1):i41–i59. [PubMed: 22156270]
5. Carson JL, Guyatt G, Heddle NM, et al. Clinical practice guidelines from the AABB: red blood cell transfusion thresholds and storage. JAMA. 2016;316:2025–2035. [PubMed: 27732721]
6. 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;117:99–106. [PubMed: 22531332]
7. Frank SM, Resar LM, Rothschild JA, Dackiw EA, Savage WJ, Ness PM. A novel method of data analysis for utilization of red blood cell transfusion. Transfusion. 2013;53:3052–3059. [PubMed: 23621848]
8. Sadana D, Pratzer A, Scher LJ, et al. Promoting high-value practice by reducing unnecessary transfusions with a patient blood management program. JAMA Intern Med. 2018;178:116–122. [PubMed: 29159367]

9. Sikorski RA, Hensley NB, Frank SM. Auditing intraoperative transfusions to promote high-value perioperative care. Anesth Analg. 2018;126:1433–1434. [PubMed: 29672378]

10. Goodnough LT, Shieh L, Hadhazy E, Cheng N, Khari P, Maggio P. Improved blood utilization using real-time clinical decision support. Transfusion. 2014;54:1358–1365. [PubMed: 24117533]