Clinical Practice Guideline: Red Blood Cell Transfusion in Adult Trauma and Critical Care

Lena M. Napolitano, MD, Stanley Kurek, DO, Fred A. Luchette, MD; for the EAST Practice Management Workgroup: Gary L. Anderson, DO, Michael R. Bard, MD, William Bromberg, MD, William C. Chiu, MD, Mark D. Cipolle, MD, PhD, Keith D. Clancy, MD, Lawrence Diebel, MD, William S. Hoff, MD, K. Michael Hughes, DO, Imtiaz Munshi, MD, Donna Nayduch, RN, MSN, ACNP, Rovinder Sandhu, MD, Jay A. Yelon, MD; and for the American College of Critical Care Medicine (ACCM) Taskforce of the Society of Critical Care Medicine (SCCM): Howard L. Corwin, MD, Philip S. Barie, MD, Samuel A. Tisherman, MD, and Paul C. Hebert, MD, MHSc

STATEMENT OF THE PROBLEM

Red blood cell (RBC) transfusion is common in critically ill and injured patients. Many studies[1–6] have documented the widespread use of RBC transfusion in critically ill patients and the data from these studies from diverse locations in Western Europe, Canada, the United Kingdom, and the United States reveal remarkably similar findings, with approximately 40% of patients receiving RBC transfusions, with a mean of five RBC units transfused per patient, and a pretransfusion hemoglobin (Hb) of 8.5 g/dL.

RBC transfusions are used for the treatment of hemorrhage and anemia as well as to improve oxygen delivery to tissues. Blood transfusion is clearly indicated for the treatment of hemorrhagic shock, particularly in patients who have reached critical oxygen delivery. Independent of the mechanism of injury, hemorrhagic shock consistently represents the second leading cause of early deaths among the injured, with only the central nervous system injury consistently more lethal.

However, most RBC transfusions in the intensive care unit (90% in the CRIT trial in the United States) are used for the treatment of anemia (Anemia and Blood Transfusion in Critical Care[1] and Anemia and Blood Transfusion in the Critically Ill [CRIT[2]] trials). The efficacy of RBC transfusion in hemodynamically stable trauma and critically ill patients with anemia has not been demonstrated in most clinical settings. Historically, the decision to transfuse has been guided by a Hb concentration, "transfusion trigger." A reevaluation of this practice has been prompted by the growing recognition of transfusion-related complications such as transfusion-related infections and immunosuppression, studies that demonstrate RBC transfusion may be associated with worse clinical outcomes, and lack of evidence documenting efficacy.

Although recent data suggest that critically ill patients in general can tolerate anemia to a Hb level of 7 g/dL, concerns have been raised that this level of anemia may not be well tolerated by certain critically ill or injured patients, such as those with preexisting coronary, cerebrovascular, and pulmonary disease. Finally, some clinicians retain the belief that certain conditions may require higher Hb concentrations, such as acute respiratory distress syndrome (ARDS), sepsis and multiple organ failure, traumatic brain injury, and cerebrovascular diseases.

A number of previous guidelines regarding the indications for RBC transfusion have been published,[7–15] but none have specifically addressed the issue of RBC transfusion in critically ill and injured adult patients. This guideline reviews the evidence regarding RBC transfusion in adult trauma and critical illness. It will not address issues related to neonates and children.

GOALS OF THE GUIDELINE

1. To review the evidence regarding efficacy of RBC transfusion in trauma and critical care.

Submitted for publication July 6, 2009.
Accepted for publication August 3, 2009.
Copyright © 2009 by Lippincott Williams & Wilkins
From the Department of Surgery (L.M.N.), University of Michigan Health System, Ann Arbor, Michigan; Department of Surgery, Loyola University Health System (F.A.L.), Maywood, Illinois; Department of Surgery (S.K.), University of Tennessee Medical Center, Knoxville, Tennessee; The American College of Critical Care Medicine Taskforce of the Society of Critical Care Medicine (H.L.C., P.S.B., S.A.T., P.C.H.); The Eastern Association for Surgery of Trauma Practice Management Workgroup (G.L.A., M.R.B., W.B., W.C.C., M.D.C., K.D.C., L.D., W.S.H., K.M.H., I.M., D.N., R.S., J.A.Y.).
The American College of Critical Care Medicine (ACCM), which honors individuals for their achievements and contributions to multidisciplinary critical care medicine, is the consultative body of the Society of Critical Care Medicine (SCCM) that possesses recognized expertise in the practice of critical care. The College has developed administrative guidelines and clinical practice parameters for the critical care practitioner. New guidelines and practice parameters are continually developed, and current ones are systematically reviewed and revised.

The Eastern Association for the Surgery of Trauma (EAST) Practice Management Guidelines Committee develops and disseminates evidence-based information to increase the scientific knowledge needed to enhance patient and clinical decision-making, improve healthcare quality and promote efficiency in the organization of public and private systems of healthcare delivery.

These guidelines are being copublished by the Eastern Association for the Surgery of Trauma (www.east.org) in the *Journal of Trauma.*
Address for reprints: Lena Napolitano, MD, University Hospital, Rm 1C4211500, East Medical Center Drive, Ann Arbor, MI; email: lenan@umich.edu.

DOI: 10.1097/TA.0b013e3181ba7074

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

2. To review the evidence regarding risks of RBC transfusion in trauma and critical care.
3. To review indications for RBC transfusion in critically ill and injured patients.
4. To review possible alternatives to RBC transfusions.
5. To review practices that have been associated with decreased need for RBC transfusion.

PROCESS

The joint planning group (Eastern Association for the Surgery of Trauma and Society of Critical Care Medicine [SCCM]) conducted a computerized search of the National Library of Medicine (MEDLINE, EMBASE, and Cochrane Databases). Peer-reviewed English language citations during the period of 1980 through July 2008 using the words transfusion, blood transfusion, and RBC transfusion were identified from the database of journal articles. Additional references were identified by review of bibliographies of relevant published articles. Of the articles identified, those dealing with either prospective or retrospective series were selected. The following groups of articles were eliminated from analysis: (1) literature review articles; (2) wartime experiences; and (3) articles from institutions, which were duplicative. The articles were reviewed, and this practice management guideline was developed by a joint taskforce of the Eastern Association for the Surgery of Trauma and SCCM.

Assessment (Grading) of Scientific Evidence

All relevant empirical data were evaluated for clinical benefits and harms of the various interventions. Attempts were made to collect as much quality scientific data as possible. This included using previously published national consensus-based guidelines. Proper methods, including a variety of databases and cross-checking of citations, were used to ensure that these standards were met and biases avoided. Reference sections of the articles identified were also used to gather additional articles, and the Cochrane database was used to assure that all prospective randomized controlled trials were identified and collected for review. The scientific evidence assessment methods used by the Canadian and US Preventative Task Force were applied when classifying the articles identified for review.

RECOMMENDATIONS SUMMARY

Recommendations Regarding Indications for RBC Transfusion in the General Critically Ill Patient

Level 1

1. RBC transfusion is indicated for patients with evidence of hemorrhagic shock.
2. RBC transfusion may be indicated for patients with evidence of acute hemorrhage and hemodynamic instability or inadequate oxygen delivery.
3. A "restrictive" strategy of RBC transfusion (transfuse when Hb <7 g/dL) is as effective as a "liberal" transfusion strategy (transfusion when Hb <10 g/dL) in critically ill patients with hemodynamically stable anemia, except possibly in patients with acute myocardial ischemia.

Level 2

4. The use of only Hb level as a "trigger" for transfusion should be avoided. Decision for RBC transfusion should be based on individual patient's intravascular volume status, evidence of shock, duration and extent of anemia, and cardiopulmonary physiologic parameters.
5. In the absence of acute hemorrhage, RBC transfusion should be given as single units.
6. Consider transfusion if Hb <7 g/dL in critically ill patients requiring mechanical ventilation. There is no benefit of a "liberal" transfusion strategy (transfusion when Hb <10 g/dL) in critically ill patients requiring mechanical ventilation.
7. Consider transfusion if Hb <7 g/dL in resuscitated critically ill trauma patients. There is no benefit of a "liberal" transfusion strategy (transfusion when Hb <10 g/dL) in resuscitated critically ill trauma patients.
8. Consider transfusion if Hb <7 g/dL in critically ill patients with stable cardiac disease. There is no benefit of a "liberal" transfusion strategy (transfusion when Hb <10 g/dL) in critically ill patients with stable cardiac disease.
9. RBC transfusion should not be considered as an absolute method to improve tissue oxygen consumption in critically ill patients.

Level 3

10. RBC transfusion may be beneficial in patients with acute coronary syndromes who are anemic (Hb ≤ 8 g/dL) on hospital admission.

Recommendations Regarding RBC Transfusion in Sepsis

Level 1

1. There are insufficient data to support level I recommendations on this topic.

Level 2

2. The transfusion needs for each septic patient must be assessed individually because optimal transfusion triggers in sepsis patients are not known and there is no clear evidence that blood transfusion increases tissue oxygenation.

Recommendations Regarding RBC Transfusion in Patients at Risk for or With Acute Lung Injury and Acute Respiratory Distress Syndrome

Acute lung injury (ALI) and ARDS are common clinical sequelae of massive transfusion. Previous studies have suggested that RBC transfusion is associated with respiratory complications, including ALI and ARDS, which remains even after adjusting for potential confounders.

© 2009 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

Level 1

1. There are insufficient data to support level I recommendations on this topic.

Level 2

2. All efforts should be initiated to avoid RBC transfusion in patients at risk for ALI and ARDS after completion of resuscitation.
3. All efforts should be made to diagnose and report transfusion-related acute lung injury to the local blood bank because it has emerged as a leading cause of transfusion-associated morbidity and mortality, despite underdiagnosis and underreporting.
4. RBC transfusion should not be considered as a method to facilitate weaning from mechanical ventilation.

Recommendations Regarding RBC Transfusion in Patients With Neurologic Injury and Diseases

Level 1

1. There are insufficient data to support level I recommendations on this topic.

Level 2

2. There is no benefit of a "liberal" transfusion strategy (transfusion when Hb $<$10 g/dL) in patients with moderate to severe traumatic brain injury.

Level 3

3. Decisions regarding blood transfusion in patients with subarachnoid hemorrhage must be assessed individually because optimal transfusion triggers are not known and there is no clear evidence that blood transfusion is associated with improved outcome.

Recommendations Regarding RBC Transfusion Risks

Level 1

1. There are insufficient data to support level I recommendations on this topic.

Level 2

2. RBC transfusion is associated with increased nosocomial infection (wound infection, pneumonia, and sepsis) rates independent of other factors.
3. RBC transfusion is an independent risk factor for multiple organ failure and systemic inflammatory response syndrome.
4. There is no definitive evidence that prestorage leukocyte depletion of RBC transfusion reduces overall complication rates, but some studies have shown a reduction in infectious complications.
5. RBC transfusions are independently associated with longer intensive care unit and hospital length of stay, increased complications, and increased mortality.
6. There is a direct relationship between transfusion ALI and ARDS.

Recommendations Regarding Alternatives to RBC Transfusion

Level 1

1. There are insufficient data to support level I recommendations on this topic.

Level 2

2. Recombinant human erythropoietin administration improves reticulocytosis and hematocrit and may decrease overall transfusion requirements.
3. Hb-based oxygen carriers are undergoing investigation for use in critically ill and injured patients but are not yet approved for use in the United States.

Recommendations Regarding Strategies to Reduce RBC Transfusion

Level 1

1. There are insufficient data to support level I recommendations on this topic.

Level 2

2. The use of low-volume adult or pediatric blood sampling tubes is associated with a reduction in phlebotomy volumes and a reduction in blood transfusion.
3. The use of blood conservation devices for reinfusion of waste blood with diagnostic sampling is associated with a reduction in phlebotomy volume.
4. Intraoperative and postoperative blood salvage and alternative methods for decreasing transfusion may lead to a significant reduction in allogeneic blood usage.
5. Reduction in diagnostic laboratory testing is associated with a reduction in phlebotomy volumes and a reduction in blood transfusion.

SCCM Website

To view the tables and complete article, please visit the website of the Society of Critical Care Medicine at http://www.learnicu.org/Quick_Links/Pages/default.aspx.

The full guidelines are available at www.sccm.org and are also being copublished by the Society of Critical Care Medicine in the journal Critical Care Medicine 2009.

REFERENCES

1. Vincent JL, Baron JF, Reinhart K, et al; ABC (Anemia and Blood Transfusion in Critical Care) Investigators. Anemia and blood transfusion in critically ill patients. *JAMA.* 2002;288:1499–1507.
2. Corwin HL, Gettinger A, Pearl RG, et al. The CRIT Study: anemia and blood transfusion in the critically ill—current clinical practice in the United States. *Crit Care Med.* 2004;32:39–52.
3. Shapiro MJ, Gettinger A, Corwin H, et al. Anemia and blood transfusion in trauma patients admitted to the intensive care unit. *J Trauma.* 2003;55:269–274.
4. Hebert PC, Wells G, Blajchman MA, et al. A multicenter, randomized, controlled clinical trial of transfusion requirements in critical care. Transfusion Requirements in Critical Care Investigators, Canadian Critical Care Trials Group. *N Engl J Med.* 1999;340:409–417.

© 2009 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

5. Rao MP, Boralessa H, Morgan C, et al; the North Thames Blood Interest Group. Blood component use in critically ill patients. *Anaesthesia.* 2002;57:530–534.
6. Palmieri TL, Caruso DM, Foster KN, et al; the American Burn Association (ABA) Multicenter Trials Group. Effect of blood transfusion on outcome after major burn injury: a multicenter study. *Crit Care Med.* 2006;34:1602–1607.
7. American College of Physicians. Practice strategies for elective RBC transfusion. *Ann Intern Med.* 1992;116:403–406.
8. Practice Guidelines for blood component therapy: a report by the American Society of Anesthesiologists Task Force on Blood Component Therapy. *Anesthesiology.* 1996;84:732–747.
9. American Society of Anesthesiologists Task Force on Perioperative Blood Transfusion and Adjuvant Therapies. Practice guidelines for perioperative blood transfusion and adjuvant therapies: an updated report by the American Society of Anesthesiolgists Task Force on Perioperative Blood Transfusion and Adjuvant Therapies. *Anesthesiology.* 2006;105:198–208.
10. Perioperative RBC transfusion. *Natl Inst Health Consens Dev Conf Consens Statement.* 1988;7:1–6.
11. Scottish Intercollegiate Guidelines Network (SIGN). Perioperative blood transfusion for elective surgery. A national clinical guideline. Edinburgh (Scotland): Scottish Intercollegiate Guidelines Network (SIGN). 2001: 34. (SIGN publication; no. 54). [173 references].
12. Scottish Intercollegiate Guidelines Network (SIGN). Perioperative blood transfusion for elective surgery. Update to printed guideline. Edinburgh (Scotland): Scottish Intercollegiate Guidelines Network (SIGN). 2004: 1. [2 references].
13. Guidelines for RBC and plasma transfusion for adults and children. Report of the Canadian medical association expert working group. *Can Med Assoc J.* 1997;156(11 suppl):S1–S24.
14. West MA, Shapiro MB, Nathens AB, et al. Guidelines for transfusion in the trauma patient. Inflammation and the host response to injury, a large-scale collaborative project: patient-oriented research core—standard operating procedures for clinical care. *J Trauma.* 2006;61:436–439.
15. Society of Thoracic Surgeons Blood Conservation Guideline Task Force; Ferraris VA, Ferraris SP, Saha SP, et al. Perioperative blood transfusion and blood conservation in cardiac surgery: the Society of Thoracic Surgeons and The Society of Cardiovascular Anesthesiologists clinical practice guideline. *Ann Thorac Surg.* 2007;83:S27–S86.

© 2009 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.