

Evaluation and Management of Perioperative Anemia

Ajay Kumar, MRCP, MD, FACP and Tomas Villanueva, DO, MBA, FACPE, SFHM

REFERENCES

1. Izaks GJ, Westendorp RG, Knook DL. The definition of anemia in older persons. *JAMA*. 1999;281:1714-1717.
2. Salive ME, Cornoni-Huntley J, Guralnik JM, et al. Anemia and hemoglobin levels in older persons: relationship with age, gender, and health status. *J Am Geriatr Soc*. 1992;40:489-496.
3. Carson JL, Poses RM, Spence RK, Bonavita G. Severity of anaemia and operative mortality and morbidity. *Lancet*. 1988;1:727-729.
4. Jazieh AR, Hussain M, Howington JA, et al. Prognostic factors in patients with surgically resected stages I and II non-small cell lung cancer. *Ann Thorac Surg*. 2000;70:1168-1161.
5. Dunne JR, Malone D, Tracy JK, et al. Perioperative anemia: an independent risk factor for infection, mortality, and resource utilization in surgery. *J Surg Res*. 2002;102:237-244.
6. Aldemir M, Ozen S, Kara IH, et al. Predisposing factors for delirium in the surgical intensive care unit. *Crit Care*. 2001;5:265-270.
7. Halm EA, Wang JJ, Boockvar K, et al. The effect of perioperative anemia on clinical and functional outcomes in patients with hip fracture. *J Ortho Trauma*. 2004;18:369-374.
8. Pfeifer K, Carson JL. Anemia and bleeding. In: Cohn SL, Smetana G, Weed HG. *Perioperative Medicine: Just the Facts*. 1st ed. New York, NY: McGraw-Hill; 2006:320-326.
9. Hoffman R, Furie B, Benz EJ, et al. Hematology: *Basic Principles and Practice, Expert Consult Premium Edition*. 5th ed. Philadelphia, PA: Churchill Livingstone Elsevier; 2009.
10. IV. NKF-K/DOQI Clinical Practice Guidelines for anemia of chronic kidney disease: update 2000. *Am J Kidney Dis*. 2001;37(suppl 1):S182-S238. [Erratum in: *Am J Kidney Dis*. 2001;38:442.]
11. Janik J, Seeler AS. Perioperative management in children with sickle hemoglobinopathy. *Pediatr Surg*. 1980;15:117-120.
12. Rutledge R, Croom RD 3rd, Davis JW Jr, et al. Cholelithiasis in sickle cell anemia: surgical considerations. *South Med J*. 1986;79:28-30.
13. Gibson JR. Anesthesia for sickle cell diseases and other hemoglobinopathies. *Sem Anesthesia*. 1987;4:27-35.
14. Ware R, Filston HC, Schultz WH, Kinney TR. Elective cholecystectomy in children with sickle hemoglobinopathies. Successful outcome using a preoperative transfusion regimen. *Ann Surg*. 1988;208:17-22.
15. Esseltine DW, Baxter MR, Bevan JC. Sick cell states and the anaesthetist. *Can J Anaesth*. 1988;35:385-403.
16. Vichinsky EP, Haberkern CM, Neumayr L, et al. A comparison of conservative and aggressive transfusion regimens in the perioperative management of sickle cell disease. *N Engl J Med*. 1995;333:206-212.
17. Koshy M, Weiner SJ, Miller ST, et al. Surgery and anesthesia in sickle cell disease. Cooperative Study of Sickle Cell Disease. *Blood*. 1995;66:3676-3684.
18. Hirst C, Williamson L. Preoperative blood transfusions for sickle cell disease (review). The Cochrane Library. 2010;2:CD003149. Available at: <http://www.thecochanelibrary.com/SpringboardWebApp/userfiles/ccoch/file/CD003149.pdf>. April 20, 2010.

19. Al-Jaouni S, Al-Muhayawi SM, Qari MH, et al. Randomized clinical trial to evaluate the safety of avoiding pre-operative transfusion in sickle cell anemia. *Bahrain Medical Bulletin*. 2006;28:164-167.
20. The Management of Sickle Cell Disease. 4th ed. Bethesda, MD: National Institutes of Health. National Heart, Lung, and Blood Institute. NIH Publication No. 02-2117; June 2002. Available at: http://www.nhlbi.nih.gov/health/prof/blood/sickle/sc_mngt.pdf. Accessed April 20, 2010.
21. Rogers MAM, Blumberg N, Saint S, et al. Hospital variation in transfusion and infection after cardiac surgery: a cohort study. *BMC Med*. 2009;7:37.
22. Shiba H, H, Ishida Y, Wakiyama S, et al. Negative impact of blood transfusion on recurrence and prognosis of hepatocellular carcinoma after hepatic resection. *J Gastrointest Surg*. 2009;13:1336-1342.
23. Koval KJ, Rosenberg AD, Zuckerman JD, et al. Does blood transfusion increase the risk of infection after hip fracture? *J Orthop Trauma*. 1997;11:260-265; discussion 265-266.
24. Bierbaum BE, Callaghan JJ, Galante JO, et al. An analysis of blood management in patients having a total hip or knee arthroplasty. *J Bone Joint Surg (Am)*. 1999;81:2-10.
25. Maluenda G, G, Lemesle G, Ben-Dor I, et al. Value of blood transfusion in patients with blood hematocrit level of 24% to 30% after percutaneous coronary intervention. *Am J Cardiol*. 2009;104:1069-1073.
26. Carson JL, Duff A, Berlin JA, et al. Influence of perioperative blood transfusion on postoperative mortality. *JAMA*. 1998;279:199-205.
27. Hebert PC, Wells G, Blajchman MA, et al. A multicenter randomized controlled clinical trial of transfusion requirements in critical care. *N Engl J Med*. 1999;340:409-417.
28. American Heart Association. Study finds no significant cardiovascular differences between more aggressive or restrictive post-operative treatment of anemia [news release]. Available at: <http://americanheart.mediaroom.com/index.php?s=43&item=886>. Accessed April 20, 2010.
29. Carson JL, Grossman BJ, Kleinman S, et al. Red blood cell transfusion: a clinical practice guideline from the AABB. *Ann Intern Med*. 2012;157:49-58.
30. Krantz SB. Pathogenesis and treatment of the anemia of chronic disease. *Am J Med Sci*. 1994;307:353-359.
31. Bezwada HP, Nazarian DG, Henry DH, Booth RE Jr. Preoperative use of recombinant human erythropoietin before total joint arthroplasty. *J Bone Joint Surg Am*. 2003;85-A(9):1795-1800.
32. Feagan BG, Wong CJ, Kirkley A, et al. Erythropoietin with iron supplementation to prevent allogeneic blood transfusion in total hip joint arthroplasty. A randomized, controlled trial. *Ann Intern Med*. 2000;133:845-854.
33. Goldberg MA, McCutchen JW, Jove M, et al. A safety and efficacy comparison study of two dosing regimens of epoetin alfa in patients undergoing major orthopedic surgery. *Am J Orthop*. 1996;25:544-552.
34. Heiss MM, Tarabichi A, Delanoff C, et al. Perisurgical erythropoietin application in anemic patients with colorectal cancer: a double-blind randomized study. *Surgery*. 1996;119:523-527.
35. Weber EW, Slappendel R, Hémon Y, et al. Effects of epoetin alfa on blood transfusions and postoperative recovery in orthopaedic surgery: the European Epoetin Alfa Surgery Trial (EEST). *Eur J Anaesthesiol* 2005;22:249-257.
36. Information for healthcare professionals: erythropoiesis stimulating agents (ESA) [Aranesp (darbepoetin), Epogen (epoetin alfa), and Procrit (epoetin alfa)]. US Food and Drug

Administration Web site. Available at:

<http://www.fda.gov/Drugs/DrugSafety/PostmarketDrugSafetyInformationforPatientsandProviders/>

ucm126481.htm. Accessed April 20, 2010.

37. Singh AK, Szczech L, Tang KL, et al. Correction of anemia with epoetin alfa in chronic kidney disease. *N Engl J Med.* 2006;355:2085-2098.

38. Bennett CL, Silver SM, Djulbegovic B, et al. Venous thromboembolism and mortality associated with recombinant erythropoietin and darbepoetin administration for the treatment of cancer-associated anemia. *JAMA.* 2008;299:914-924.

39. Drüeke TB, Locatelli F, Clyne N, et al. Normalization of hemoglobin level in patients with chronic kidney disease and anemia. *N Engl J Med.* 2006;355:2071-2084.

40. Corwin HL, Gettinger A, Fabian TC, et al. Efficacy and safety of epoetin alfa in critically ill patients. *N Engl J Med.* 2007;357:965-976.

41. Careless PA, Henry DA, Moxey AJ, et al. Cell salvage for minimizing perioperative allogeneic blood transfusion. *Cochrane Database Syst Rev.* 2006;(4):CD001888.

42. Goodnough LT. Autologous blood donation. *Crit Care.* 2004;8:S49-S52.

43. Jacob M, Bruegger D, Conzen P, et al. Development and validation of a mathematical algorithm for quantifying preoperative blood volume by means of the decrease in hematocrit resulting from acute normovolemic hemodilution. *Transfusion.* 2005;45:562-571.

44. Segal JB, Blasco-Colmenares E, Norris EJ, Guallar E. Preoperative acute normovolemic hemodilution: a meta-analysis. *Transfusion.* 2004;44:632-644.

45. Jarnagin WR, Gonen M, Maithel SK, et al. A prospective randomized trial of acute normovolemic hemodilution compared to standard intraoperative management in patients undergoing major hepatic resection. *Ann Surg.* 2008;248:360-369.

46. Carson JL, Gordon Guyatt, Heddle N M, et al. Red blood cell transfusion: a clinical practice guideline from the AABB. *JAMA.* 2016; 316(19)