Blood Management for Hip Reconstruction Surgery

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KEYWORDS

• Blood conservation • Transfusion • Hip reconstruction

Red cell transfusion is a common component of care in hip reconstruction surgery. Efforts to reduce the incidence and volume of transfusion have been reinforced recently for a number of reasons. First, blood transfusion is associated with both increased morbidity and postoperative length of stay. Second, blood components are a limited health care resource; their administration should be restricted to scenarios whereby they confer a benefit on the recipient. Finally, despite the enormous and largely successful efforts made to enhance blood safety in the North American blood systems, many patients remain skeptical about transfusion safety and would prefer to avoid allogeneic transfusion.[1] In the following article, we review the likelihood of transfusion events in reconstruction surgery and the risks and benefits of transfusion, and evolve strategies to reduce patient exposure to allogeneic blood perioperatively.

RISKS OF RED BLOOD CELL TRANSFUSION

Infectious disease testing has dramatically improved the safety of blood for transfusion in the North America, especially since the introduction of nucleic acid amplification testing.[2] The current estimated residual risk of HIV and hepatitis C virus transmission through blood transfusion is estimated to be approximately one case in 2 million transfusion events. Hepatitis B virus risk remains at one case in 200,000–500,000 transfusion events. Although there were early cases of transfusion-transmitted West Nile virus, none have been reported since the test sensitivity was increased in epidemic areas. Serious noninfectious complications from blood component transfusion are now more likely to occur than viral disease transmission.[3] These reactions may result from immunologic incompatibility between donor and host, bacterial contamination of the blood product administered, or from the volume of product transfused to patients who have limited cardiovascular reserve. An increased incidence of postoperative infectious complications also occurs in transfusion recipients and may result from modulation of the immune system function in the recipient. The use of universal leukodepletion at the time of donor unit collection may reduce such immunomodulation and the subsequent infectious sequelae.

PREDICTING THE LIKELIHOOD OF RED CELL TRANSFUSION DURING HIP RECONSTRUCTION

The likelihood of a patient receiving a transfusion after hip surgery has been assessed by a number of investigators; the major determinants are the initial hemoglobin concentration ($[Hb_i]$) and the perioperative blood loss. In a review of 9482 subjects who underwent total hip or knee arthroplasty, the lower the $[Hb_i]$, the more probable the transfusion of allogeneic blood.[4] Of the 3020 subjects who had an $[Hb_i]$ greater than 10 g/dL^{-1}

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but less than or equal to 13 g/dL^{-1}, 864 (29%) required a transfusion compared with 267 (8%) of 3374 subjects who had [Hb$_i$] greater than 14 g/dL^{-1}. In addition to an [Hb$_i$] of 12 g/dL^{-1} or less, positive associations exist between transfusion risk and age over 65 years, female sex, weight 60 kg or less, ASA classification greater than II, and revision surgery.[5] The use of acetylsalicylic acid has also been reported to increase the risk of red cell transfusions after total hip arthroplasty.[6]

Blood loss can be considerable during arthroplasty surgery and is often underestimated because the losses may not be obvious or easily measurable.[7] In a large multicenter analysis of blood management in subjects undergoing elective hip arthroplasty, the mean *estimated* blood loss for total hip arthroplasty was 750 mLs, whereas the actual *measured* loss was 1944 mLs. The blood loss that can be safely tolerated by a patient is directly related not only to the [Hb$_i$] but also to the patient's blood volume. Blood volume may be estimated in adults as being between 65–75 mL/kg^{-1}. The blood volume that a patient may lose and yet still maintain their [Hb] at a safe level has been termed the *safe allowable blood loss*. The higher the safe allowable blood loss that the patient will tolerate, the lower is the risk that they will require perioperative transfusion. In subjects undergoing primary or revision total hip replacement, those who had a safe allowable blood loss of 850 mLs or less were more likely to receive a postoperative transfusion than those who had a safe allowable loss greater than 850 mLs.[8] Although complicated formulae do exist to calculate allowable blood loss, there is a reasonable correlation between the measure of the percentage of estimated blood volume lost and the reduction in [Hb]. That is, if the blood lost perioperatively represents about 25% of the estimated blood volume, one can expect that the resulting [Hb] will be reduced in similar proportion from baseline levels.

Table 1
Risk factors for transfusion with hip reconstruction

Initial Hb level < 12 g-dl^{-1}
Weight < 60 kg
Age > 65 years
Major revision or pelvic surgery
Female sex
ASA classification > II
Presence of major cardiovascular disease

ANEMIA — INCIDENCE AND CONSEQUENCES

Anemia is very common in patients hospitalized for surgical interventions and is associated with increased morbidity and mortality and an increased length of hospital stay.[9] Conversely, a higher [Hb$_i$] in patients presenting with hip fracture is associated with shorter lengths of hospital stay and lower odds of readmission or death.[10] It is not clear whether the effects on outcome are caused by the anemia per se or by an association with other risk factors frequently prevalent in anemic patients. Variances from normal hematocrits (HCT) are associated with poor postoperative outcomes whether the HCT was lower or higher than normal values.[11] Even mild degrees of anemia or polycythemia are associated with an increased 30-day mortality and cardiac events in elderly patients undergoing major noncardiac surgery, suggesting that the comorbidity influencing the [Hb] may be as or even more relevant to outcome than the measured [Hb].

The extent of comorbidities may also amplify the adverse effects of a low [Hb] which in turn may have been a surrogate marker for severe underlying diseases. For example, anemia is linked as an independent risk factor for increased mortality, morbidity, increased length of hospital stay, and increased mortality in patients who have congestive heart failure or left ventricular dysfunction.[12] However, despite the association of anemia with cardiovascular morbidity and mortality, the presence of cardiac risk factors have not predicted the occurrence of silent myocardial ischemia perioperatively in patients undergoing major lower limb joint replacement surgery.[13] Nor has a restrictive (8 g/dL^{-1}) transfusion trigger resulted in an increased incidence of silent ischemia when compared with a more liberal (10 g/dL^{-1}) trigger in patients having elective hip and knee replacement surgery.[14] It may be that concurrent anemia amplifies the severity of illness when cardiac decompensation has occurred but does not usually cause it alone, even in at-risk patients who have a stable cardiovascular condition.

The lowest safe level of anemia was assessed by Carson and colleagues[15] in a retrospective cohort study of subjects over the age of 18 years who declined red cell transfusions for religious reasons. Of the 2083 subjects reviewed, 300 had postoperative [Hb] of 8 g/dL^{-1} or less. In subjects who had postoperative [Hb] of 7.1 to 8 g/dL^{-1}, none died and 9.4% had a morbid event. In subjects who had [Hb] of 4.1 to 5 g/dL^{-1}, 34.4% died and 57.7% had a morbid event. The odds of death in subjects who had a postoperative [Hb] of 8 g/dL^{-1} or less increased 2.5 times for each g/dL^{-1} decrease in [Hb].