Internet Journal of Medical Update

Journal home page: http://www.akspublication.com/ijmu

Review

Transfusion issues in surgery

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(Received 01 February 2012 and accepted 19 April 2012)

ABSTRACT: Transfusion, just as any other medical intervention has both benefits and risks, which should be balanced for each patient so that the benefits outweigh the risks. Blood and its products are considered drugs and hence careful consideration of therapy is essential to minimize the potential adverse reactions. Moreover, alternative modes of treatment should be considered and final decision to transfuse should be based on individual patient evaluation. Reviews of blood transfusion practices have found that most surgical procedures do not require blood transfusion. This review is focused on the transfusion needs of the surgical patients.

KEY WORDS: ***Blood transfusion, Surgery; Peri-operative transfusion***

INTRODUCTION

Blood transfusion services play a pivotal role in the field of medical science. The availability of blood led to the development of transfusion based surgical technologies and operations, which include cardiac, vascular, oncologic and joint replacement surgeries. The key objective of any surgical or anesthetic practice is reduction of patient morbidity and mortality. In addition, the decision to transfuse a surgical patient can often be difficult. In some surgical procedures, significant blood loss can be anticipated though there is a potential for unexpected blood loss to occur during any type of surgery. However, most effective and planned surgeries may not result in sufficient blood loss to require a blood transfusion.

Over the years, the trigger for blood transfusion has shifted from an optimal hemoglobin level to one that is required to meet the oxygen demands of the tissues. A number of autologous blood options are available that can decrease the demand for allogeneic blood transfusion. Besides, alternatives such as erythropoietin and blood substitutes have revolutionized the management of surgical patients. Reduction of intraoperative blood loss by the use of pharmacologic agents further contributes to decrease in exposure to allogeneic blood.

ANEMIA & SURGERY

Although allogeneic blood transfusion has become increasingly safe, the risk of transmissible diseases and transfusion reactions has not been entirely eliminated. Alternatives to allogeneic transfusion include preoperative autologous blood donation and priming with erythropoietin. A careful pre-operative evaluation of the patient is essential if blood loss is to be reduced and appropriate plans for transfusion alternatives are to be made. The pre-operative measurement of the hemoglobin level and hematocrit will detect the presence of anemia. Ensuring adequate hemoglobin levels pre-operatively will reduce the likelihood of blood transfusion during surgery. In a study by Carmel et al[1], exertional dyspnea did not occur until the hemoglobin concentration fell to <7g/dl. In another study, at levels <6g/dl, only 54% of patients experienced tachycardia, 32% had hypotension, 35% had impaired consciousness, and 27% had dyspnea.[2] In a study on patients with hip fracture aged more than 60 years, 55.6% patients received transfusion at a hemoglobin 8g/dl or higher while 90.5% received transfusion at a hemoglobin level less than 8g/dl. Only 6.6% of patients with postoperative hemoglobin of 10g/dl received a transfusion. The post operative mortality was not affected.[3] Recent Cochrane review on transfusion

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triggers states that restrictive transfusion strategies reduce the risk of receiving a red blood cell transfusion by 37% and lead to an absolute risk reduction of 33%. The restrictive strategies did not impact the rate of adverse events compared to liberal transfusion strategies but were associated with significant reduction in the rates of infection.[4] Preoperative cross matching of blood units for surgical patients is performed in anticipation of potential need which may not materialize and consequently many blood units are cross matched before surgery that are never transfused. Cross matching blood that is not transfused consumes blood bank resources unnecessarily and requires more maintenance of the blood inventory. This leads to increase in the number of units that become outdated. These patients can be better served by performing only a type and antibody screen. If in a rare instance blood is required for transfusion, group specific blood can be released in the absence of a positive antibody screen. Immediate spin cross match can be performed prior to release of blood. In order to limit the number of units held out of the circulation and outdating of blood units, a Maximum Surgical Blood Ordering Schedule (MSBOS) recommends that for patients likely to be transfused during surgery, the number of cross matched units should be twice the medium requirement for that surgical procedure (Cross match to Transfusion ratio or C.T. ratio 2:1).[5,6]

PRE OPERATIVE CORRECTION OF ANEMIA

The National Institutes of Health Preoperative Consensus Conference concluded that "otherwise healthy patients with hemoglobin values of 10g/dl or greater rarely require preoperative transfusion, whereas, those with acute anemia with resulting hemoglobin values of less than 7g/dl will frequently require red cell transfusions". Whether patients with hemoglobin values between 7 and 10g/dl should receive transfusions depends on the patient's clinical status.[7] The American Society of Anesthesiologists task force on perioperative blood transfusion suggest that red blood cells are usually administered when hemoglobin is less than 6gm/dl in young healthy patient and are usually not required when hemoglobin is more than 10gm/dl. Hemoglobin levels between 6gm/dl and 10gm/dl, need based transfusions may be given based on ongoing indication of organ ischemia, potential bleeding, patient's intravascular volume status and risk for complications of inadequate oxygenation.[8] The minimum acceptable level of hemoglobin varies for patients because individual persons may vary in their ability to tolerate and compensate for anemia. If a preoperative patient is anemic, an attempt should be made to find and treat the underlying cause. Anemia resulting from nutritional deficiencies is correctable but treatment takes weeks to months. If surgical procedures are required sooner, red blood cell transfusions may be given preoperatively to correct the anemia. In a recent study, the perioperative use of intravenous iron as a transfusion alternative was evaluated. The use of intravenous iron therapy was found to reduce the proportion of patients requiring transfusion and the number of units transfused. The multidisciplinary panel recommended intravenous iron administration to patients undergoing surgery and expected to develop post operative anemia.[9] Kitchens studied the rate of fatal complications due to anemia in 16 reports of the surgical outcome in Jehovah's Witness patients. All together, there were 1,404 procedures represented resulting in a mortality rate due to anemia of between 0.5 to 1.5%.[10] More often, a hospital-wide transfusion trigger policy is in place that may support transfusions at very conservative hemoglobin concentrations. It is therefore more difficult to determine the risk of transfusing too conservatively versus more liberally. Patients who donate blood for autologous transfusion may have a lower preoperative hemoglobin concentration and are more likely to receive a red cell transfusion in the event of operative blood loss. This can be prevented by not taking autologous donations from patients who are unlikely to need a transfusion during surgery. If at all such patients make them, donations should be made early to allow sufficient time for red cell regeneration.

INTRAOPERATIVE BLOOD LOSS AND TRANSFUSION

Red blood cells may be urgently needed for the surgical patient because of unexpected rapid and large amount of blood loss. If such a situation arises, blood may be issued by the emergency spin cross match technique with the consent of the treating physician. This abbreviated technique detects any major ABO incompatibility between the patient and the donor.[11] Routine cross match procedure is to be followed even after the unit is issued by emergency spin cross match technique and the unit may be retrieved back by the blood center if any incompatibility is detected. The surgeons and anesthesiologists should consult the transfusion medicine specialists and weigh the risks of an emergency transfusion versus a routine blood transfusion with complete compatibility testing.

Reduction of intraoperative blood loss

In addition to meticulous surgical hemostasis, intraoperative blood loss can be reduced by use of vasoconstrictors and intraoperative and postoperative salvage of blood in major surgeries.[12] Blood loss reduction drugs like desmopressin, antifibrinolytic agents (Tranexamic acid, Epsilon amino caproic acid and aprotinin) and local fibrin

glue or sealant have been used to decrease local bleeding in surgical procedures.

The key objective is to ensure normovolemia at all times during a surgical procedure. Hence, the rational approach should be replacement of surgical blood loss with crystalloid or colloid fluids to maintain normovolemia. ANH is a form of autologous blood donation that occurs immediately preoperatively after anesthesia is induced and before surgery begins.[13-15] The concept is that the hemoglobin concentration in the patient is aggressively reduced under careful monitoring of cardiovascular function and tissue oxygenation. The units of collected blood are set-aside at room temperature to be reinfused at the end of the procedure. The volume is replaced with acellular fluid; either colloid (at a 1:1 ratio with volume removed) or crystalloid (at a 1:3 ratio).[16] Since the volume of blood loss at surgery is not affected by having diluted the patient's hemoglobin concentration, the blood that is shed results in reduced absolute RBC loss. This can take care of a significant degree of blood loss before a blood transfusion becomes necessary. The goal of red blood cell transfusion is to prevent inadequate oxygenation, which causes tissue ischemia and damage. Hypovolemia and hypoxemia can also cause tissue ischemia and damage. Prolonged inadequate oxygenation that causes enough tissue damage can result in disseminated intravascular coagulation and a bleeding diathesis intraoperatively. It would be prudent to monitor and distinguish between inadequate blood volume, inadequate arterial oxygen content and inadequate oxygen carrying capacity. These factors can occur together or separately. Therapy must be directed appropriately to increase blood volume with fluids, arterial oxygen content by inspired oxygen, or hemoglobin concentration by red blood cell transfusion. A recent prospective randomized randomized control trial concluded that intra operative fluid restriction reduces peri operative red blood cell transfusion in elective cardiac surgery, especially in transfusion prone patients.[17] Another multicenter observational study suggests that intra operative blood transfusion in non cardiac surgical setting is associated with a higher risk of mortality and morbidity in patients with severe anemia (hematocrit less than 30%).[18]

The decision to transfuse blood to the patient should be based on estimation of volume of surgical blood loss, rate of blood loss, patient's clinical response to blood loss and signs indicating inadequate tissue oxygenation. A judgment is required to decide on the percent blood volume that can be safely lost or the lowest hemoglobin (or hematocrit) that can be tolerated. The ability of a patient to compensate for blood loss will be limited by age, preexisting anemia, and evidence of cardiorespiratory illness and use of drugs such as beta blockers.[19]

POSTOPERATIVE TRANSFUSION ISSUES

Blood loss and hypovolemia can develop in the postoperative period. Its prevention, early detection and treatment are of utmost importance for the patient's welfare and may again reduce the need for unnecessary transfusion. Special attention should be paid to postoperative hypoxia, monitoring of vital signs, fluid balance and analgesia. Authors have observed that higher intraoperative plasma to red blood cell transfusion ratio is associated with fewer plasma and red cell requirement in first 24 hours after surgery. They have also observed benefit of aggressive intraoperative plasma to correct perioperative coagulopathy.[20]

Staff caring for patients post operatively should be aware that some degree of hemodilution can be expected in patients who have undergone intraoperative blood loss. As a result, postoperative hemoglobin level is likely to be lower than the preoperative level. This alone is not an indication for blood transfusion. Postoperative hemoglobin drift can occur over a seven-day period due to various factors such as hemodilution, post surgical blood loss and phlebotomy for diagnostic tests.[20] The decision to transfuse should be made after a careful assessment of the general condition of the patient, coexisting cardiopulmonary illness, signs of inadequate tissue oxygenation and continued blood loss. In the later post operative period, iron supplementation will optimize the erythropoietic response and restore the hemoglobin values to normal more rapidly. Authors have observed a postoperative transfusion trigger of 8gm/dl as safe in hemodynamically stable patients.[21] A multivariate analysis showed a significant relation between post operative transfusion and estimated blood loss but no relation was observed between age, gender, body mass index, duration of surgery, type of anesthesia and pre operative hemoglobin levels.[22] Several studies have established a relation between pre operative hemoglobin level and post operative requirement of blood transfusion.[23,24]

SPECIAL CIRCUMSTANCES

Emergency Transfusion: In extreme emergencies when there is no time to obtain and test a sample, group 'O' Rh negative packed red cells can be released. In such a situation the clinician must give a written consent authorizing and accepting responsibility for the use of incompletely tested products as a life saving measure. An emergency issue procedure can be used to issue several units of red blood cells and have them delivered to the operating room within minutes. With this system, 82% of the units reached the operating room within

2 minutes of request, 91% within 3 minutes and 100% within 4 minutes thus preventing any delay in transfusion.[25]

Massive Transfusion: It is defined as transfusion approximating or exceeding the patients blood volume or transfusion of more than 10 units of blood within 24 hours.[26] Replacement of more than 50% of circulating blood volume in less than three hours or transfusion at the rate of more than 150ml/minute is also considered as massive transfusion.[27] Massive (or large volume) transfusions generally arise as a result of acute hemorrhage in surgical patients. A blood loss of less then 20% of the total blood volume is generally well tolerated, loss of 20% to 40% will cause change in the vital signs with evidence of impaired tissue perfusion. However, loss of greater than 40% of blood volume may lead to frank hemorrhagic shock and progress to circulatory system failure and cardiac arrest if not corrected.[28]
Ideally a massive transfusion protocol should be in place to obtain the needed products in a timely manner. One protocol suggests transfusion of 2 units of fresh frozen plasma (FFP) for every 4 units of packed red blood cells (PRBC), a pooled unit of random platelets after every 8th PRBC and a 10-pack cryoprecipitate by the 16th PRBC. Besides, calcium should be administered and therapy should be guided by laboratory results. The main aim of a massive transfusion protocol is to counteract the coagulopathy associated with massive transfusion of red cells leading to dilution of clotting factors and sequestration and activation of platelets at bleeding sites.[29]
Whereas all transfusions have potential adverse reactions, the transfusion of massive amounts of stored blood is associated with unique consequences, such as shift to the left in the oxygen dissociation curve, acid base imbalance, hypothermia, hypocalcaemia, dilutional coagulopathy and respiratory distress. The American College of Surgeons and the American Association of Blood Banks both recommend that the transfusion of blood and blood components should be guided by laboratory tests such as PT, PTT, platelet count and fibrinogen levels. Minimal level of coagulation factors are required for normal formation of fibrin and hemostasis, so normal plasma contains coagulation factors in excess, a reserve that usually allows patients to tolerate replacement of one or more blood volumes of red cells and crystalloid without needing fresh frozen plasma. Guidelines typically state that the threshold for therapeutic or prophylactic fresh frozen plasma is PT 1.5 times upper limit of normal or the mid point of the normal range and a PTT 1.5 times upper limit of normal in an appropriate clinical setting.[30,31] Use of FFP in cases of surgical or traumatic bleeding should be guided by clotting studies.[32] In the event of microvascular bleeding, empiric therapy with platelets and/or plasma may be initiated immediately after specimens are obtained. Besides periodic visual assessment of the surgical field, an assessment of microvascular bleeding should be done with the surgical team. In the event of micro vascular bleeding empiric therapy with platelets and/or plasma may be initiated immediately after specimens are obtained. In consumptive coagulopathy a platelet count of less than 50000/µl and fibrinogen level less than 100mg/dl are better predictors of hemorrhage than PT and aPPT.[33] The supplementation of FFP should be considered after one volume is lost and definitely started before blood loss equals to 150%. At this stage 4-5 units of FFP should be infused and subsequently 4 units FFP for every 6 units of red cells.[31] Some authors suggest that massive transfusion protocols should utilize a 1:1 ratio of plasma to RBCs for all patients who are hypocoagulable with traumatic injuries.[34] Others suggest that hemostasis is usually maintained when coagulation protein is 25% of normal. Hence, 2 units of FFP should be transfused initially to a patient with deranged international normalized ratio results and/or wide spread capillary bleeding, since routine practice of transfusing FFP after a certain number of PRBC units may lead to excessive transfusion and wastage of FFP.[35] Investigators have even proposed introduction of a transfusion package in the form of 5 PRBC units, 5 thawed plasma units and two pooled platelet concentrates to be administered in parallel. This provided a hematocrit of 30%, a clotting factor concentration above 40% and platelet count of about 80×109/l.[36] Platelets are usually administered when platelet count falls below 50,000/µl and is associated with bleeding. Platelet transfusion may be considered if platelet count is between 50,000 and 1,00,000/µl based on anticipated or ongoing bleeding.[8] Whatever the protocol be, judicious use of the appropriate component in the appropriate quantity at the right time can save a precious and scarce resource and at the same time benefit the right patient.

CONCLUSION

Blood transfusion practices in elective surgery have been shown remarkably inconsistent. There are wide variations in blood usage for the same procedure. Preoperative assessment of the patient for the presence of anemia and its correction can prevent the need for allogeneic transfusion during surgery. Reduction of intraoperative blood loss by several methods such as surgical hemostasis, blood salvage and use of drugs can also limit the transfusion requirement to some extent. Post operatively the patients should be monitored for identifying early signs of hypovolemia and blood

loss. There is no substitute for clinical judgment based on observation of the patient and appropriate hemodynamic monitoring. The added risks of transfusion reactions, infections and metabolic complications associated with massive transfusion should curtail the indiscriminate or routine prophylactic use of allogeneic blood products.

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