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Blood Component Therapy: Indications for Transfusion

Allogeneic (Homologous) Blood

- PRBCs contain the same amount of Hb as whole blood, but much of the plasma has been removed.
- The Hct value of PRBCs is approximately 60%
- Other than severe hemorrhage, most indications for RBCs can be effectively treated with PRBCs, conserving the plasma and the components for other patients

- The administration of PRBCs is facilitated by utilizing crystalloid or colloid as a carrier; however, not all crystalloids are suitable. Solutions containing Ca^{2+} may precipitate clotting.

- Lactated Ringer solution is not recommended for use as a diluent or carrier for PRBCs because of the Ca^{2+} although several experimental studies found lactated Ringer solution and normal saline to be equally acceptable.
- A more important factor may be whether the diluent is hypotonic with respect to plasma. In hypotonic solutions, the RBCs will swell and eventually lyse

- Solutions that cause hemolysis are :

1. 5% dextrose in water
2. Plasmanate
3. 5% dextrose in 0.2% saline

- Recommended solutions compatible with packed erythrocytes are :

1) 5% dextrose in 0.45% saline,
2) 5% dextrose in 0.9% saline,
3) 0.9% saline,
4) Normosol-R with a pH of 7.4.

- RBC transfusions are given to increase O_2-carrying capacity.

- Increasing intravascular volume in the absence of significant anemia is not an indication for blood transfusion because volume can be augmented with administration of intravascular fluids that are not derived from human blood (e.g., crystalloids)

- As such, a sole Hb value should not be the only basis for a transfusion decision.

- It should be the overall status of the patient that prompts transfusion therapy:
  - hemodynamics
  - organ perfusion and oxygen delivery
  - anticipated surgical needs

- Even so, the Hb value has become the basis for many transfusion strategies. It is the prime criterion for defining restrictive versus liberal transfusion strategies.

- When a patient is hemorrhaging, the goals should be :
- ✓ to restore and maintain intravascular volume
- ✓ cardiac output
- ✓ organ perfusion to normal levels.

- By using crystalloids, colloids, or both to treat hypovolemia, normovolemic dilutional anemia may be created.

- Increasing cardiac output enhances O_2 delivery to the tissues only to a limited extent

- patients with Hb value more than 10 g/dL rarely require perioperative blood transfusions
- patients with acute anemia with a Hb value of less than 7 g/dL frequently require blood transfusions.
- patients with chronic anemia (as in renal failure) might tolerate an Hb concentration of less than 6 to 7 g/dL.

- The ultimate determination of the Hb or Hct value at which blood should be given is a clinical judgment based on many factors, such as:
- cardiovascular status
- age
- anticipated additional blood loss
- arterial oxygenation
- mixed venous O_2 tension
- cardiac output
- intravascular blood volume

Additional Blood Transfusions

The following key components of information to consider include:

- 1. Measurement and trend of vital signs
- 2. Measurement of blood loss and assessment of anticipated blood loss
- 3. Quantitation of intravenous fluids given
- 4. Determination of Hb concentration
- 5. Surgical concerns.

factors	class1	class2	class3	class4
Blood loss(ml)	750	750–1500	1500–2000	2000 or more
Blood loss (%blood volume)	15	15–30	30–40	40 or more
Pulse (beat/min)	100	100	120	140 or more
Blood pressure	Normal	normal	decreased	decreased
Pulse pressure (mmHg)	Normal or increased	decreased	decreased	decreased
Capillary refill test	normal	positive	positive	positive
Respiration per minute	14–20	20–30	30–40	35
Urine output (ml/h)	30	20–30	5–10	negligible
CNS:mental status	Slightly anxious	Mildly anxious	anxious confused	confused lethargic

Measurement of Blood Loss

- Measuring blood loss is obviously important when assessing the need for both the initial and subsequent blood transfusions

- . standard approach includes a combination of visualization and gravimetric measurements based on weight differences between dry and blood-soaked gauze pads.

Preoperative Anemia

- low Hb value in women <12 g/dL
- in men <13 g/dL
- It is a common comorbidity among patients undergoing major surgery with an incidence up to 40%

- an independent risk factor for increased perioperative mortality, and postoperative acute kidney injury (AKI)

- In patients with a moderate to high risk of significant blood loss (defined as >500 mL), the Hb value ideally should be obtained 3 to 8 weeks prior to surgery.

- This provides sufficient time for the patient to undergo iron therapy or to correct nutritiona deficiencies.

- Erythropoiesis-stimulating agents, especially intravenously administrated iron therapy, may be beneficial for treatment of preoperative anemia.

- The concept of treating anemia preoperatively as a means to decrease the need for intraoperative transfusions is widely accepted.

- For example intravascular iron therapy in patients undergoing abdominal surgery significantly
- ✓ increased preoperative Hb levels
- ✓ reduced the need for transfusion
- ✓ and shortened hospital length of stay

- Oral therapy, if given with sufficient time preoperatively and tolerated by the patient, may be just as effective at correcting the anemia as intravenous therapy.

- Erythropoiesis-stimulating agents (ESAs), such as darbepoetin alfa, act by stimulating red cell progenitor cells in the bone marrow and inducing erythropoiesis

- They are frequently prescribed for patients with anemia who have end-stage renal disease or who are undergoing chemotherapy treatment to increase their Hb levels and reduce the incidence of transfusion

Liberal Versus Restrictive Transfusion Strategy

- It is based on the Hb value when a transfusion decision is made.

- A restrictive policy is the administration of blood transfusion when the Hb value is 7 to 8 g/dL or less.

- In contrast, a liberal policy is the administration of blood transfusion when the Hb value is 9 to 10 g/dL or greater.

- The most recent randomized controlled studies continue to show no benefit to a liberal strategy compared with a restrictive strategy

- One conclusion is that if no clinical advantages are associated with the liberal transfusion policy, perhaps the restrictive approach should be used.

- Certainly, fewer transfusion reactions would be expected with the restrictive approach

- In the presence of incomplete data, the ASA's 2015 updated practice guidelines offer these recommendations:

- 1. Transfusion is rarely indicated when the Hb concentration is more than 10 g/dL and is almost always indicated when it is less than 6 g/dL, especially when the anemia is acute.

- 2. A restrictive transfusion strategy (Hb <8 g/dL) should be employed to reduce the patient's transfusion requirements and decrease the potential harmful effects of transfusions

- 3. Multimodal protocols and algorithms should be employed to reduce intraoperative blood loss and transfusion requirements.

- These pathways include point-of-care testing to direct care

- 4. The use of a single Hb trigger for all patients and other approaches that fail to consider all important physiologic and surgical factors affecting oxygenation is not recommended

- 5. When appropriate, intraoperative and postoperative blood recovery, acute normovolemic hemodilution (ANH), and measures to decrease blood loss (i.e., deliberate hypotension and pharmacologic drugs) may be beneficial

Platelet Concentrates

- Platelet concentrates are obtained either as pooled concentrates from 4 to 6 whole-blood donations or as apheresis concentrates obtained from one donor.

- If platelets are stored at room temperature, they can be used up to 7 days after collection with constant and gentle agitation.

- Bacterial contamination, mainly from platelet concentrates, is the third leading cause of transfusion-related deaths although the incident rate has steadily declined over the last 15 years.

- Because the use of multidonor platelet products stored for 5 days results in an incidence of sepsis five times higher than use of those stored for 4 days, shorter storage times are being emphasized.

- At present, platelet concentrates are routinely tested for bacteria and are the only blood product stored at room temperature.

- For any patient who develops a fever within 6 hours after receiving platelets, sepsis from platelets should be considered.

The most recent guidelines published in 2015 by the ASA Task Force on Perioperative Blood Management provide the following recommendations regarding management for platelet transfusions:

- 1. Monitor platelet count, except in situations of massive transfusion.
- 2. Monitor platelet function, if available
- 3. Consider use of desmopressin in patients with excessive bleeding or suspected platelet dysfunction.

- 4. Platelet transfusion may be indicated despite an adequate platelet count if there is known or suspected platelet dysfunction:
- cardiopulmonarym bypass
- bleeding
- recent use of antiplatelet therapy
- congenital platelet dysfunction

- 5. Prophylactic platelet transfusion is rarely indicated in surgical or obstetric patients when the platelet count is greater than 100 × 109/L and is usually indicated when the platelet count is less than 50 × 109/L.

- The determination of whether patients with intermediate platelet counts (50- 100 × 109/L) require therapy should be based on the patient's risk for bleeding.

- Many institutions have strict thresholds targeted to the patient’s condition that outline the minimum platelet count needed for the categories of :
- (1) prophylaxis
- (2) periprocedural (based on type of procedure)
- (3) active bleeding

- In the first category, a required platelet count may be 10 × 109/L in patients receiving

chemotherapy.

In the second category, patients undergoing bone marrow biopsy or lumbar puncture should have platelet counts between 20 and 30 × 109/L.

For neurosurgery, a platelet count of 100 × 109/L may be targeted.

Such

- Patients with severe thrombocytopenia (<20 × 109/L) and clinical signs of bleeding usually require platelet transfusion.

However, patients may have very low platelet counts (much lower than 20 × 109/L) and not have clinical bleeding.

These patients probably do not need platelet transfusions

- When possible, ABO-compatible platelets should be used.

- The platelet membrane has immunoglobulins, and any additional deposit of recipient antibodies is difficult to detect

- ABO-incompatible platelets produce very adequate hemostasis.
- The effectiveness of platelet transfusions is difficult to monitor

- Under ideal circumstances, one platelet concentrate usually produces an increase of approximately 7 to 10 × 10⁹/L at 1 hour after transfusion in the 70-kg adult.

- Ten units of platelet concentrates are required to increase the platelet count by 100 × 10⁹/L

- However, many factors may lead to decreased survival and decreased recovery of transfused platelets including
  - splenomegaly
  - previous sensitization
  - fever
  - sepsis
  - active bleeding,

Fresh Frozen Plasma

- FFP is the most frequently used plasma product.
- It is processed shortly after donation, generally frozen within 8 hours or 24 hours (PF24)

- It contains all the plasma proteins, particularly factors V and VIII, which gradually decline during the storage of blood.
- PF24 is comparable to FFP, except for a slight reduction in factor V and approximately 25% decrease in factor VIII.

- Thawed plasma is stored at 1 °C to 6 °C for up to 5 days

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- The use of FFP carries with it the same inherent risks that are observed with the use of any blood product, such as sensitization to foreign proteins.

- Although FFP is a reliable solution for intravascular volume replacement in cases of acute blood loss, alternative therapies are equally satisfactory and considerably safer.

- The risks of FFP administration include
  - TRALI
  - TACO
  - allergic or anaphylactic reactions.

- In 2015 the ASA Task Force recommended the following guidelines regarding the administration of FFP:

- 1**. Prior to the administration of FFP, coagulation studies should be obtained when feasible**.

- 2. **For the correction of coagulopathy when the international normalized ratio (INR) is greater than 2, in the absence of heparin**

- 3. **For the correction of coagulopathy due to coagulation deficiencies in patients transfused with more than one blood volume (approximately 70 mL/kg) when coagulation studies cannot be easily or quickly obtained**

- 4. **Replacement of known coagulation factor deficiencies with associated**

bleeding, disseminated intravascular coagulation (DIC), or both, when
specific components are not available.

- 5. **Reversal of warfarin anticoagulation when severe bleeding is present and**

prothrombin complex concentrations are not available.

Cryoprecipitate

- Cryoprecipitate is prepared when FFP is thawed, and the precipitate is reconstituted.

The product contains :

- factor VIII
- vWF
- fibrinogen
- factor XIII
- fibronectin

- Cryoprecipitate is frequently administered as ABO compatible; however, this probably is not very important because the concentration of antibodies in cryoprecipitate is extremely low

- Cryoprecipitate may contain RBC fragments, and cryoprecipitate prepared from Rh-positive donors can possibly sensitize Rhnegative recipients to the Rh antigen.

- Cryoprecipitate should be administered through a filter and as rapidly as possible.

- The rate of administration should be at least 200 mL/h, and the infusion should be completed within 6 hours of thawing.

- transfusion of cryoprecipitate is rarely indicated when the fibrinogen levels are greater than 150 mg/dL in nonobstetric patients.

- The following indications were provided regarding the administration of cryoprecipitate:

1. When testing of fibrinogen activity reveals evidence for fibrinolysis

- **2. When fibrinogen concentrations are less than 80 to 100 mg/dL in patients experiencing excessive bleeding**

- **3. Obstetrical patients who are experiencing excessive bleeding despite a measured fibrinogen concentration greater than 150 mg/dL**

- **4. In patients undergoing massive transfusion when the timely assessment of fibrinogen concentrations cannot be determined**

- 5. In patients with congenital fibrinogen deficiencies and when possible, in consultation with the patient' hematologist

- 6. In bleeding patients with von Willebrand disease types 1 and 2A who fail to respond to desmopressin or vWF/FVIII concentrates (or if not available)

- 7. **In bleeding patients with von Willebrand disease types 2B, 2M, 2N, and 3 who fail to respond to vWF/FVIII concentrates (or if concentrates are not available**)