RBC Products: Packed RBCs, Frozen RBCs, & Whole Blood
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Updated 2/9/2011

Description

<table>
<thead>
<tr>
<th>Volume: 250 – 300 ml/unit</th>
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<tbody>
<tr>
<td>Contents: RBCs in reduced plasma, inactive WBCs, platelets and additive/preservative solutions</td>
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<tr>
<td>Hematocrit: Hct ~ 55% with additive solution, ~70-80% with CPD/CPDA preservatives</td>
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<td>Fe content: Board trivia: Each unit contains 200 mg or iron</td>
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Anticoagulant and Shelf Life:
- CPD/CP2D: 21 days
- CPDA: 35 days
- Additive (AS1, AS3, AS5): 42 days
  - Various anticoagulant/preservative solutions allows blood to be stored for extended periods without clotting or drastic changes in most metabolic and therapeutic qualities.
  - Traditional anticoagulant/preservatives: Citrate-phosphate-dextrose (CPD) and citratephosphate-dextrose-dextrose (CP2D). Allows 21 days of RBC/Whole Blood storage.
  - Citrate-phosphate-dextrose-adenine (CPDA-1) has extra adenine compare to CPD or CP2D as a source of ATP, which allows 35 days of RBC/Whole Blood storage.
  - Additive solutions: Have more dextrose and adenine. Increases shelf life of RBCs to 42 days. Most common types are AS-1 (Adsol®), AS-3 (Nutricel®) and AS-5 (Optisol®). AS-1 and AS-5 also have mannitol.

Dose response:
- In an average adult (70kg): one unit increases Hgb by 1 g/dL (Hct by ~3%)
- Infant: 10-15ml/kg to achieve Hgb increment of 2-3g/dL

Indications:
- To increase oxygen carrying capacity in the following settings:
  - Treatment of chronic, symptomatic anemia in patients unresponsive to conservative therapy or when medical necessity does not allow time for conservative therapy (hemolysis, marrow failure)
♦ Treatment of an actively bleeding patient (i.e. from trauma, surgery, spontaneous hemorrhage) when blood loss exceeds 25% of blood volume
  o “Transfusion trigger” must be customized for each patient, based on patient factors such as cardiopulmonary status, age, acuity of anemia, patient tolerance, etc.
  o In most patients, a hemoglobin level of 7 g/dL is sufficient to maintain an adequate oxygen carrying capacity.
  o Rarely need to transfuse patient with Hgb>10g/dL
  o Transfusion of RBCs is not indicated when restoration of blood volume can be accomplished using crystalloids or colloids alone (generally when blood loss is less than 20% of blood volume).

Compatible Infusion Fluids:
  • ONLY the following can be infused in the same line as RBCs
    o Normal Saline (0.9%)
    o ABO compatible plasma
    o 5% Albumin
    o Plasmalyte
  • Incompatible fluid: Everything else!
    o Osmotic hemolysis if infused with hyper- or hypo-tonic fluids. E.g., 0.45% NS, antibiotics/other drugs, or TPN
    o Lactate Ringer solution contains Ca2+, may bind to citrate anticoagulant in the RBC unit -> clotting.

Frozen RBC Products:
  • Method: freeze with 40% glycerol, store at -65C for 10 years (or at -120C if 20% glycerol was used)
  • Freeze within 6 days of collection without an additive, or if an approved specific additive used (this is called rejuvenation), can freeze up to 3 days after RBC expiration
  • Before transfusing
    • Thaw at 37C for 30 minutes
    • Deglycerolize: wash with solution of decreasing osmolarity (NaCl solutions, 12%, 1.6%, 0.9% with 0.2% dextrose).
    • Deglycerolization removes glycerol, WBC fragments, and plasma.
    • Deglycerolized RBC is considered equivalent to washed RBCs, but not equivalent to leukoreduced products
    • Store at 1-6C, shelf life is 24 hours after deglycerolization
  • Contents: RBCs in minimal plasma, WBCs, platelets and glycerol.
    Should recover >80% of RBC in original unit after deglycerolization. Final hematocrit should be <80%
    • Once thawed and not needed, if unit is exceptionally rare, can be refrozen after rejuvenation
  • Indications for preparing frozen cells:
Phenotyped units with rare RBC antigen phenotype, e.g. Jk null, U-S-s-, etc.

Autologous units
- A large number of preoperative autologous blood donations is required, e.g. before scoliosis surgery
- Surgery delayed

### Whole Blood (WB)

| Volume: ~500mL of blood,  
| 70 ml of anticoagulant-preservative  
| Hematocrit is ~ 36-44% |

- One unit of WB should increase the hgb by 1g/dL and hct by 3% in an adult.
- In an infant, a 2-3g/dL rise in Hgb can be achieved at a dose of ~10-15ml/kg.
- Store at 1-6°C. Shelf life depends on the preservative used.
- WB stored longer than 24 hours has few viable platelets, or granulocytes. Levels of Factor V and VIII also decrease with storage. Other clotting factor levels are relatively well maintained for up to 12 days of storage.
- Indications: because WB provides both RBC and plasma, WB is primarily indicated for patients with large blood loss and need both RBC and clotting factor/volume replacement. The use of WB limits donor exposure.
- However, if volume replacement is not needed, use of WB increases the risk of volume overload.

- Fresh whole blood (WB collectd within the last 48hours) has been used extensively in combat settings, and may have some advantage over component therapy in terms of correction of coagulopathy.
- Some evidence that use of fresh WB may improve the outcomes of infants undergoing complex cardiac surgeries.
- Using fresh WB is difficult because unit likely needs to be transfused before infectious disease tests are completed. Logistically challenging.
- In the military setting, a “Walking Blood Bank” consisting of frequently tested donors can be used to provide a n inventory of fresh WB. This is difficult in the civilian setting.

### Additional Modifications:
- RBCs can undergo leukofiltration, irradiation, washing/volume reduction. See notes on Special RBC/Platelets Products.