RBC Exchange (RBCEx)
Shan Yuan, MD
Last Updated Aug 20, 2011

I. Introduction

- RBC Exchange (RBCEx): removal of patient RBCs with concomitant replacement with donor RBCs
- Common applications: sickle cell disease and its complications, protozoal infections

II. Technical Considerations

- RBCEx can be performed manually with the use of syringes attached by a three-way stopcock, alternating between removal of blood and infusion of donor blood. Very labor intensive. Still done on neonates
- Automated, programmable instruments now widely used
  - Enter patient’s gender, wt, ht and hct, the instrument will calculate total blood volume (TBV) and RBC volume
  - Enter the fraction of RBC that should remain (FCR) at the end of the procedure, desired final hematocrit, and the hematocrit of the replacement RBC unit.
  - FCR setting: depends on the condition being treated and the proportion of abnormal cells
  - Instruments then calculates the volume of RBCs (and plasma if needed) to be removed, and stipulate the volume of replacement RBC units of the needed based on the specified hct
  - Replacement unit’s hct:
    - ~55% for AS (Adsol) units
    - ~71% for washed units
    - Units of specific hct can be made by resuspending RBCs in saline or plasma
  - Anticoagulant (AC) to whole blood (WB) ratio may be set to default (1:13) value, or adjusted/customized:
    - E.g. Less AC needed for patient with higher hct b/c there will be less plasma per volume of WB
    - E.g. More AC for patients with high platelet count to limit platelet clumping
  - Instrument allows gradual rise in hematocrit
- Generally 1 RCV exchange will remove 70% of patient’s RBCs (FCR of 30%), two-RCV exchange will remove about 90%
- Selecting FCR value:
  - If a sickle cell patient has not been transfused recently, assume HgbS fraction is 100%, set FCR to be 30% to reach the target HgbS fraction of 30% (1 RCV exchange). A higher FCR (and smaller RBC Ex) can be used if starting HgbS fraction is lower
- A large exchange (>1RCV) may remove enough plasma to cause depletion of some coagulation factors, which may be significant in patients with pre-existing
coagulopathy. One might use replacement unit with higher hematocrit to minimize plasma removal

- Small pediatric patients (<20kg) or patients with severe anemia (hct < 18%): may require priming the circuit with RBC units rather than normal saline to avoid large extracorporeal volume loss (ECV) during the procedure. With RBC priming, donor RBCs enter the patient as soon as patient’s RBCs are removed.
- ECV removal > 15% during RBC Ex should be avoided at all times to prevent sudden anemia and hypoxemia
- RBC units selected:
  - Should be leukoreduced to minimize transfusion reactions
  - Consider partial phenotype matching (Rh and Kell) for SCD patients
- Access
  - Use peripheral access whenever possible. 16 to 18 gauge for blood withdrawal, 19 to 20 gauge for return. AC vein often suitable
  - If central catheter placed and patient not expected to have more procedures in the near future, remove catheter to avoid catheter-related complications
  - Implanted ports
    - Risk of infection very low because it is completely buried below the skin
    - Surgically inserted below the clavicle, with a drum membrane lying below the skin covering a reservoir.
    - Catheter runs subcutaneously between the drum and the subclavian vein.
    - Access for apheresis obtained with a special needle that pushes into the reservoir
    - Single or double lumen port. If single lumen, use a peripheral vein for return
  - A-V fistula can be occasionally used. Higher risk of occlusion

III. Side Effects and Procedural Complications

- Transfusion reactions can occur. Limit by provision of leukoreduced products and premedication
- Citrate reaction with symptoms of hypocalcemia can occur due to anticoagulant used. Can use higher WB to AC ration (14 or 15 to 1) ratio and calcium supplementation
- Patients with platelet clumping (platelet count usually > 300,000/microL); use more AC, or give patient aspirin on the day before RBC Ex

IV. Indications

- Sickle cell disease
  - Prevention and treatment of stroke
    - During acute stroke: goal is to keep HgbS fraction < 30% and keep hct < 30% or near baseline (higher hct is bad because of the higher viscosity)
- Long term management: Regimen of RBCEx in combination with simple RBC transfusions to maintain HgbS fraction <30% for 3-4 years, then <50% thereafter.
  - Acute chest syndrome
  - Retinal infarction
  - Persistent priapism
  - Repeated intractable pain crises resistant to conservative management
  - In some cases: During pregnancy and before prolonged anesthesia
- Thalassemia
  - RBC Ex limits Fe overload associated with simple transfusions as in SCD
- Protozoal Infections
  - Malaria (severe): presenting with hyperparasitemia (>5%), encephalopathy, jaundice, hct<20%, ARF with Cr > 3.0mg/dL, respiratory distress, hypoglycemia, DIC, or septic shock
  - Babesiosis: severe cases (>20% parasitemia) can be seen in patients with splenectomy or immunosuppression. RCE very effective at lowering parasite load due to lack of extraerythrocytic reservoir of parasites.
  - In either condition:
    - 1.5 to 2.0 RCV, with 10-20% FCR RBC exchanges should be performed
    - Hct raised to 35% to correct anemia and improve oxygenation
    - Pre and post RBCEx parasite counts to assess outcome
    - Repeat procedure may be needed in high parasitemia
- Miscellaneous
  - Mismatched RBC Transfusion: E.g. O neg young woman given O pos RBCs in an emergency. Could do RBC Ex with O neg RBCs ASAP, then followed by RhIg to prevent alloimmunization to the Rh(D) antigen
  - Prevent hemolysis in ABO mismatched marrow transplantation. For example a blood group A donor can undergo RBC Ex to receive O RBCs before receiving the group marrow graft from a blood group O donor
  - CO poisoning: RBC Ex along with 100% O2
  - Methemoglobinemia: for patients refractory to methylene blue