Welcome to eSessions

Presented by CaridianBCT
Red Blood Cell Exchange and Depletion Procedures

COBE Spectra® Apheresis System
Red Blood Cell Exchange (RBCX) Procedures
Presentation Overview

- Indications and procedure goals for RBCX procedures
- Overview of operational principles and data entry
- Unique features of RBCX procedures
- Helpful hints
Participants will be able to

- Name two indications for RBCX procedures.
- List two procedure goals of RBCX procedures.
- Identify four procedure variables that would prevent the expected outcome of the procedure.
Indications for RBCX

- Sickle cell disease
- Thalassemia
- Protozoal infections of red blood cells (RBCs)
- Incompatible transfusion
- Carbon monoxide poisoning
Sickle Cell Disease (SCD)

- Inherited, chronic disease resulting from the production of abnormal hemoglobin S (HbS).
  - May be homozygous SS (HbSS) or in combination with HbC (HbSC), or with beta thalassemia (HbS Beta).

- Most common inherited hematologic disorder. Increased prevalence in African, Mediterranean and Indian populations.
• Under certain conditions, cells containing HbS become sickle shaped and rigid. They increase blood viscosity and lodge in small vessels, resulting in tissue ischemia and painful crises.

• Sickle cells have a shortened survival time, approximately 7 to 20 days, which results in accelerated hemolysis of RBCs and chronic anemia.
Thalassemia

• Group of inherited disorders caused by mutations in one or more of the genes that code for globin proteins which are part of the hemoglobin molecule.

• Result in a deficiency of alpha or beta globin chains, causing reduced production or absence of HbA.

• Prevalent in the Mediterranean basin through the Middle East, and India to Southeast Asia.
Hemoglobin

Alpha chain

Beta chain

Iron molecule

2, 3-DPG

Oxygen

Carbon dioxide
Role of RBCX in Hemoglobinopathies

- Replace abnormal patient RBCs with normal donor RBCs to improve oxygen delivery and clinical condition more efficiently than simple transfusions.
- Maintain the patient’s hematocrit (Hct) at an appropriate level.
- Prevent or decrease iron overload associated with either the disease process or the use of simple transfusion.
Protozoal Infections

• Malaria
  - Mosquito-borne illness caused by infection of RBCs with Plasmodium protozoa.
  - Symptoms include:
    • Fever
    • Chills
    • Headache
    • Anemia
 Protozoal Infections (cont)

• Babesiosis
  - Tick-borne, malaria-like illness caused by infection of RBCs with Babesia protozoa.
  - Symptoms relate to the degree of parasitic load and include:
    • Fever
    • Hemolytic anemia
    • Hemoglobinuria
Role of RBCX in Protozoal Infections

RBCX can be used adjunctively to reduce high parasitic loads observed with protozoal infections, especially with P. falciparum.
Other Indications

• Incompatible RBC transfusion
  - Removal of Rh-positive cells from Rh-negative recipient.
  - Removal of ABO-incompatible RBCs post-transplant or post-transfusion.

• Carbon monoxide poisoning
  - Competition between carbon monoxide (CO) and oxygen for binding sites on hemoglobin.
  - Removal of CO-saturated RBCs.
Spectra System RBCX Procedure Goals

- Reduce the number of defective or infected RBCs and replace them with the appropriate amount of replacement RBCs.
- Maintain or alter the patient’s (Hct).
- Control fluid balance.
Overview of Operational Principles
Fluid Pathway
RBC, WBC & Platelet out

Plasma returned

Whole Blood In

RBC Single-Stage Channel Separation
Data Entry

- Sex, height, weight
- Patient’s Hct
- Average replacement fluid Hct
- Desired end Hct for the patient
- Fluid balance
The Spectra system uses the Hct values you enter to calculate the pre- and post-procedure red cell volume of the patient, and the red cell volume of the replacement fluid.

The system then uses these red cell volumes to determine the volume of replacement fluid required to achieve the desired end results.

Patient Hct= 22 %,  End Hct= 30 %
Average replace Hct= 55 %  OK(YES/NO)?
After you enter the initial data, the following screen appears:

**Calculate replacement fluid volume needed.**

(YES/NO)?

To let the Spectra system calculate the required replacement volume, press YES.
Enter the desired fraction of red cells remaining (FCR). The default FCR is 40%.

Enter desired Fraction of red cells remaining:  FCR = {40}%  (YES/NO)?
FCR is the percentage of the patient’s original RBCs remaining in the patient at the end of the procedure.
Using the FCR

Donor RBC/HbA (50%)

Patient RBC/HbS (50%)

RBCX

20% HbS

HbA

FCR 40%
Using the FCR to Meet HbS Goals

Desired end HbS conc
----------------------------- x 100 = FCR
Starting HbS conc

Example:

Desired end HbS = 20%
Starting HbS = 50%

\[
\frac{20}{50} \times 100 = 40\%
\]

→ During data entry, enter 40% as the desired FCR.
Enter the desired FCR:

Enter desired Fraction of red cells remaining: FCR = \{20\}%

The Spectra system calculates and displays the run results:

Replace = 3398 ml, FB = 100\%, FCR = 20\%, End Hct = 30\%, time = 151 min (YES/N0)?
Changing the FCR changes the replacement fluid volume required.

Example:

**Enter desired Fraction of red cells remaining:** FCR = **40**

**Replace = 1934 ml, FB=100%, FCR= 40%, End Hct= 30%, time= 87 min OK(YES/N0)?**
Two options are available for calculating required replacement fluid volume prior to the procedure:

• Spectra system calculation.

• “Replacement Volume Estimation Tool for RBC Exchange Procedures” (available at www.caridianbct.com).
### Replacement Fluid Volume Estimation Tool

#### Estimated Replacement Volume for Spectra RBC Exchange Procedures

**Input Patient Data**
- Data Units
- Patient Sex
- Patient Height (in, cm)
- Patient Weight (lb, kg)
- Patient TBY (ml)

**Input Procedure Data**
- Patient Starting Hematocrit (%)
- Patient Ending Hematocrit (%)
- Replace Hematocrit (%)
- Fluid Balance (%)
- FCH (%)

**Result**
- Estimated Replacement Volume (ml)

#### Example of Estimated Replacement Volume Calculation for Spectra RBC Exchange Procedures

**Input Patient Data**
- Data Units: ENGLISH
- Patient Sex: MALE
- Patient Height (in, cm): 49
- Patient Weight (lb, kg): 89
- Patient TBY (ml): 2568

**Input Procedure Data**
- Patient Starting Hematocrit (%): 26
- Patient Ending Hematocrit (%): 30
- Replace Hematocrit (%): 60
- Fluid Balance (%): 100
- FCH (%): 40

**Result**
- Estimated Replacement Volume (ml): 1066
Replacement Fluid Volume

- Replacement fluid volume can be determined by
  - Value from the calculation tool or from the Spectra system
  - Physician’s order
  - Volume the blood bank has available
Once you enter the initial data, the following screen appears:

**Calculate replacement fluid volume needed (YES/NO)?**

To enter a specific replacement fluid volume, press NO. The Spectra system then prompts you to enter the replacement fluid volume:

**Enter total replacement fluid volume:**

{ 0} ml.
Enter the available replacement fluid volume:

Enter total replacement fluid volume: {1500}ml.

The Spectra system calculates and displays the run results:

Replace=1500 ml, FB=100%, FCR= 48%, End Hct= 30%, time= 68 min OK(YES/N0)?
Data Influencing Predicted Run Results

- Predicted run results
- Desired FCR
- End Hct
- Fluid balance
- Patient Hct
- TBV
- Replacement fluid Hct
- Replacement fluid vol
Unique Features of RBCX Procedures
AC Infusion Rate

- AC data screen is unavailable during the procedure.
- The default AC infusion rate is 0.9 mL/min/L TBV.
- AC infusion rate alarm limit is 1.4 mL/min/L TBV.
- The citrate in the replacement fluid is not considered.
This calculation tool helps to estimate the AC volume delivered from the AC bag to the patient and to the waste bag during an RBCX or depletion procedure.

<table>
<thead>
<tr>
<th>INPUT DATA</th>
<th>AC VOL TO PATIENT</th>
<th>AC VOL TO WASTE BAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBV (ml)</td>
<td>5000</td>
<td>213</td>
</tr>
<tr>
<td>Replace Volume (ml)</td>
<td>2210</td>
<td></td>
</tr>
<tr>
<td>Starting Hct (%)</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>End Hct (%)</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Replace Hct (%)</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>FCR (%)</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Fluid Balance (%)</td>
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<td></td>
</tr>
<tr>
<td>AC Ratio</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

AC Volume Calculation Tool
Rinseback is *not recommended*, because the prediction for end Hct and FCR does not consider the rinseback volume.
Helpful Hints

- Enter accurate patient Hct. This is a MUST!
- Know the Hct and volume of each unit of replacement RBCs.
- If the RBC units contain Adsol solution, a spun Hct will be inaccurate.
- For sickle cell patients, screen the replacement RBC units for sickle cell trait.
- Be aware that platelet and WBC counts can decrease 30% to 50%. 

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• Consider leukoreducing replacement RBC units prior to the procedure.

• Entering a combination of values that approach upper and/or lower extremes will result in invalid process time or replacement fluid volume alarms.

• Target time can be changed only by changing the collect/replace volume.

• After the “divert prime operation,” changes to replacement fluid Hct are invalid.
Red Blood Cell (RBC) Depletion Procedures
Presentation Overview

- Indications for RBC depletion procedures
- Procedure goals for RBC depletion procedures
- Data entry
Participants will be able to

• List one indication for an RBC depletion procedure.
• Identify one RBC depletion procedure goal.
• Name the data entry value that causes the Spectra system to perform an RBC depletion procedure.
Indications for RBC Depletion

- Polycythemia vera
- Iron overload
  - Primary hemochromatosis
  - Secondary hemochromatosis
    - Iron-loading anemia
    - Chronic transfusion
Polycythemia Vera

• Myeloproliferative disorder characterized by uncontrolled production of normal RBCs, granulocytes, and platelets, resulting in Hcts as high as 80%.

• Major symptoms result from an increase in RBC mass and blood viscosity. Symptoms include:
  - Increased blood pressure
  - Headache
  - Visual disturbances
Hemochromatosis

- Primary hemochromatosis is a genetic disorder that interferes with iron metabolism. It results in excess iron being deposited in organs and tissue.

- Secondary hemochromatosis can result from iron-loading anemias such as thalassemia, or from chronic transfusion.
Procedure Goals

- Rapid removal of greatly elevated numbers of RBCs to reduce blood viscosity and red cell volume, or removal of RBCs to reduce iron load and maintain normal iron levels.

- Control of the fluid balance by replacement of removed volume with appropriate fluids.
Automated RBC depletion can remove larger volumes of RBCs than manual phlebotomy can, and allows volume replacement with appropriate fluids.
Data Entry

- Sex, height, weight
- Patient’s Hct
- Average replacement fluid Hct ⇒ Enter 0%
- Desired end Hct for the patient
- Fluid balance
1. Verify the entered Hcts:

   Patient Hct = 65 %, End Hct = 45 %
   Average replace Hct = 0 %.
   OK (YES/NO)?

2. Once you enter the initial data, the following screen appears:

   Calculate replacement fluid needed (YES/NO)?

3. To let the Spectra system calculate and display the run results, press YES:

   Replace = 1360 ml, FB = 100%, FCR = 100%
   End Hct = 45%, time = 36 min
   OK (YES/NO)?
References


7. Takeshita, K., “Thalassemia, Beta,” eMedicine, February 20, 2002, 