University of Washington Medical Center 1959 NE Pacific Street. Seattle, WA 98195 Transfusion Services Laboratory Policies and Procedures Manual	Original Effective Date: 07-26-2021 Revision Effective Date:	Number: PC-0094.02

TITLE: Preparing RBCs for Intrauterine (IUT) and Neonatal Exchange Transfusions

PURPOSE:

To define the process for packing and reconstituting red blood cell components (RBC) for intrauterine and neonatal exchange transfusions

PRINCIPLE & CLINICAL SIGNIFICANCE:

Principle

Total blood volume and hemoglobin levels of fetuses, newborns and NICU patients vary based on age, size, and clinical status. The ability to pack RBCs and prepare reconstituted whole blood allows the Transfusion Service laboratory to prepare components especially suited for this patient population.

Clinical Significance

The main indication for intrauterine transfusion (IUT) is the treatment of fetal anemia due to maternal RBC alloimmunization. Exchange transfusion (ET) with reconstituted whole blood is usually indicated for the treatment of severe hemolytic disease of the fetus and the newborn (HDFN) and reduce severe hyperbilirubinemia and maternal alloantibodies present in the neonate. Other clinical situations may require IUT, or ET as determined by the medical provider.

POLICIES:

- **Notify** the Transfusion Service Laboratory (TSL) Medical Director on-call for any IUT or exchange transfusions
- **This is a multistep process.** Please review the Appendix Workflow Overview Diagram for clarification.
- **Selection Requirements for Red Blood Cell Component (RBC)**
    - O negative, leukoreduced
    - <7 days from collection date (older RBCs requires TSL MD approval and initiation of a QI form)
    - NOT irradiated – Irradiation occurs after centrifuging to pack the RBCs
    - Hemoglobin S negative
    - Antigen negative for any maternal antibodies and crossmatch compatible with maternal plasma.

      NOTE: Consult with TSL MD if appropriate O negative, antigen negative unit is not in stock prior to ordering from blood supplier

- **Desired Final Hematocrit (HCT) Requirements -**
    - Intrauterine Transfusion: HCT 72 -75%
    - Exchange Transfusion/Reconstituted Whole Blood (RWB): provider to specify final HCT (usually 45%)
    - Send RBC samples to hematology to determine HCT

- **Reconstituted Whole Blood (RWB**) for exchange transfusion
  - RBCs used to manufacture RWB should be packed by centrifugation followed by irradiation prior to reconstitution
  - The following information is required **prior to reconstituting** a packed RBC component. If any of the information is missing from the order, contact the ordering provider to obtain the required information.
    - Date and time of planned transfusion
    - Total volume of RBC to be transfused
    - Desired hematocrit
  - **Selection of Fresh Frozen Plasma for reconstitution**
    - Group AB (Rh type does not matter)
    - Freshly thawed
  - In some situations, a provider may request reconstitution with platelets instead of plasma.
    - **Platelet** requirements:
      - Apheresis in plasma or PAS platelets are acceptable
      - Irradiated or pathogen reduced (PRT)
      - ABO/RH

Neonate	Platelet ABO/Rh
Any ABO and Rh Negative	AB Negative
Any ABO and Rh Positive	AB Positive or AB Negative

      - If a platelet matching the ABO/Rh requirement above is not available, call the TSL MD on-call to ask if a different ABO group is acceptable prior to ordering a group AB platelet from a blood supplier

    - Notify the TSL manager prior to processing for guidance on how to process document and relabel product. SQ does not allow for reconstitution with platelets

SPECIMEN REQUIREMENTS:

NA

REAGENTS/SUPPLIES/EQUIPMENT:

Reagents:	Supplies:	Equipment:
None	• Transfer packs • Centrifuge balance discs • Counterweight bags filled with saline or water • Plasma Transfer Set • Hemostats • Scissors • Tubing stripper • Plastic overwrap bags	• Sterile Welder • Plasma Extractor • Tube Sealer • Scale • Refrigerated Centrifuge

QUALITY CONTROL:

Sample of final component is sent to Hematology to determine the final hematocrit

INSTRUCTIONS:

Table of Contents:

[Selecting and Testing Components Prior to Component Processing](#)
[Packing RBCs by Centrifugation](#)
[Relabeling and Irradiating Packed RBC](#)
[Reconstituting Whole Blood](#)
[Appendix1: Workflow Overview Diagram](#)

Selecting and Testing Components Prior to Component Processing

<table>
<tr><th>STEP</th><th>ACTION</th></tr>
<tr><td>1</td><td>Notify the TSL MD on-call of orders for an IUT or ET order</td></tr>
<tr><td>2</td><td>
<table>
<tr><th>If order is for</th><th>Then</th></tr>
<tr><td>Reconstitution with platelets</td><td>Notify a TSL manager to provide guidance for process, documenting and labeling the reconstituted RBC

NOTE: SQ does not allow reconstitution with platelets</td></tr>
<tr><td>Reconstitution with plasma or IUT</td><td>Go to the next step</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Select the appropriate red blood cell component
O negative RBC, leukoreduced
<7 days from collection date (older RBCs requires TSL MD approval and initiation of a QI form)
Hemoglobin S negative
Antigen negative for any maternal antibodies and crossmatch compatible with maternal plasma
NOTE: Consult TSL MD if appropriate O negative, antigen negative unit is not available in stock prior to ordering from blood supplier</td></tr>
<tr><td>4</td><td>Perform crossmatching with maternal sample, and phenotyping of the selected RBC based on maternal antibodies, as required</td></tr>
<tr><td>5</td><td>
<table>
<tr><th>If transfusion is for</th><th>Then</th></tr>
<tr><td>Neonate IUT</td><td>Go to next step</td></tr>
<tr><td>Exchange Transfusion/Reconstituted Whole Blood</td><td>
<table>
<tr><th>Reconstituting with</th><th>Select</th></tr>
<tr><td>Plasma</td><td>Frozen AB plasma. Thaw and place in refrigerator until needed</td></tr>
<tr><td>Platelets</td><td>Refer to the requirements specified in the policy section above</td></tr>
</table>
</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>Discard the segment farthest from the bag retaining the other segment to send to Hematology for a HCT</td></tr>
<tr><td>7</td><td>Label a clean test tube with the unit number</td></tr>
</table>

STEP	ACTION
8	Remove the remaining segment, cut the tip, and allow the contents to empty into the labeled test tube
9	Cap the test tube and deliver to Hematology for a **STAT** hematocrit request a printed report of the results
10	Go to section Packing RBC by Centrifugation

Packing RBC by Centrifugation

<table>
<tr><th>STEP</th><th>ACTION</th></tr>
<tr><td>1</td><td>Verify temperature of the centrifuge
<table>
<tr><th>If internal temperature is</th><th>Then</th></tr>
<tr><td>Between 1-6°C</td><td>Continue to next step</td></tr>
<tr><td>>6°C</td><td>• Press the snowflake to precool
• Set a timer for 30 min.
• Press stop when centrifuge has precooled for 30 min.
• Confirm the internal temperature is between 1-6°C
<table>
<tr><th>If temperature is</th><th>Then</th></tr>
<tr><td>Between 1-6°C</td><td>Go to next step</td></tr>
<tr><td>>6°C</td><td>Repeat precool</td></tr>
</table></td></tr>
</table></td></tr>
<tr><td>2</td><td>Tare the electronic scale with an empty blood bag then weigh the packed RBC (refer to SOP Scale Operation Entris 2202-1S Balance)</td></tr>
<tr><td>3</td><td>Divide the weight (in grams) by the specific gravity (1.088) to determine the volume (ml) of the packed RBC component (pRBC)

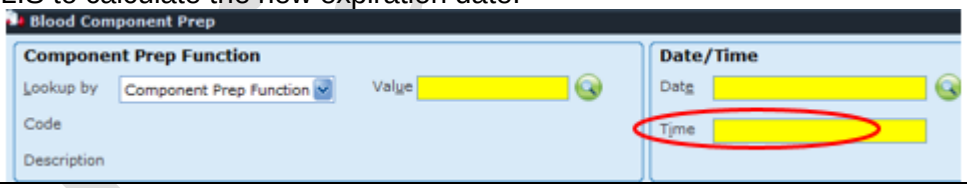
Volume of pRBC (mL) = Weight (g) / 1.088 (specific gravity)</td></tr>
<tr><td>4</td><td>Using the HCT obtained from hematology, calculate the volume of anticoagulant to remove to reach the desired HCT and volume of the packed RBC. Note: for IUT calculate the desired HCT = 72%

1) Desired Final RBC Volume (mL) = $\frac{\text{Starting Volume of RBC x Starting HCT}}{\text{Desired HCT}}$

2) Weight of supernatant to remove (g) = (Starting Volume – Desired Volume) x 1.088

EXAMPLE:
Request= 72% HCT
Starting HCT of RBC = 62.5%
Starting Volume of RBC = 311

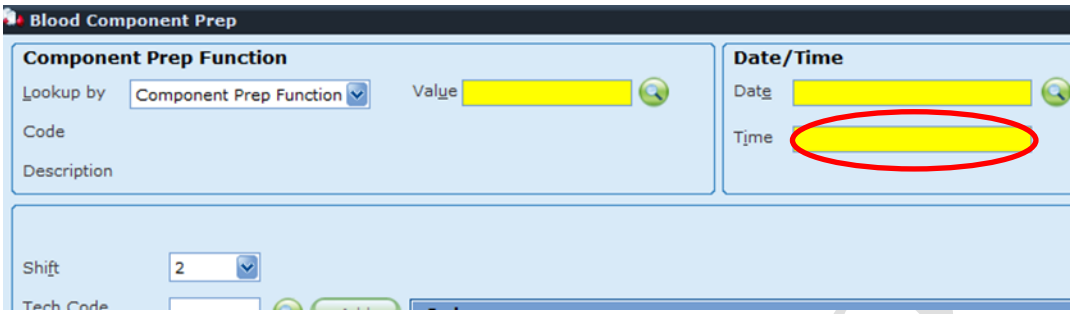
Desired Final RBC Volume (mL) = $\frac{311 \times 62.5}{72}$ = 286 mL
Weight of supernatant to remove (g) = (311 mL – 286 mL) x 1.088 = 27g</td></tr>
</table>

STEP	ACTION
5	Attach a transfer bag to the RBC using a sterile tubing welder, leaving at a minimum 14" of tubing connecting the bags (refer to SOP *Sterile Welder Operation, Cleaning & Maintenance SOP)* **NOTE:** Place a plastic clamp on the tubing prior to welding to prevent the RBCs from flowing into the transfer pack
6	Verify the following centrifuge conditions are met and document on the *Refrigerated Centrifuge QC Log*: • Verify internal temperature is within 1-6°C range • RCF = 4200g • Timer = 5 minutes Deceleration = 6
7	Following SOP *Refrigerated Centrifuge Operation and Maintenance* centrifuge the RBC to separate the red blood cells from the plasma and additives **NOTE:** It may be necessary to use a transfer bag filled with saline as a balance instead of weights
8	Carefully remove the unit from the centrifuge without disturbing the contents upon completion of the cycle
9	Insert the packed RBC, with the label facing the back, into the plasma extractor
10	Place the transfer bag on the scale and tare the scale
11	• Note the time • Release the plasma extractor plate handle and unclamp the tubing between the RBC and the transfer bag to express the supernatant into the transfer pack until the weight calculated in step 4 above is reached **NOTE:** The time noted is entered during the Blood Component Processing step in the LIS to calculate the new expiration date. 
8	• Clamp the tubing with the plastic clip • Press down and latch the plasma extractor plate handle in the open position
9	Strip the tubing towards the transfer pack and place a hemostat to prevent plasma from running back into the tubing
10	Heat seal the tubing between the bags close to the transfer pack
11	Remove and discard the transfer pack
12	Strip and mix the tubing 4 times • Strip the length of tubing attached to the RBC back into the component • Without releasing the stripper, mix the contents of the RBC • Release and allow RBCs to flow back into the tubing

STEP	ACTION
13	Use the heat sealer to make two segments long enough to provide a1 mL sample, approximately 3-4 inches long segments **EXAMPLE:** 
14	Discard the segment farthest from the bag retaining the other segment to send to Hematology for a HCT
15	Label a clean test tube with the unit number
16	Remove the remaining segment, cut the tip, and allow the contents to empty into the labeled test tube
17	• Cap the test tube and deliver to Hematology for a **STAT** hematocrit request a printed report of the results
18	Tare the scale with an empty blood bag then weigh the packed RBC (refer to SOP *Scale Operation Entris 2202-1S Balance*)
19	Divide the weight (in grams) by the specific gravity (1.088) to determine the volume (ml) of the packed RBC component (pRBC) **Volume of pRBC** (mL) = Weight (g) / 1.088 (specific gravity)
20	Obtain the printed hematocrit report
21	**If transfusion is for** / **Then** Neonate IUT → **If HCT result is:** / **Then**: Between 72-75% → Go to next step <72% → Repack the RBC >75% → Notify the TSL MD on-call to contact the provider to determine if the HCT is acceptable Exchange Transfusion/ Reconstituted Whole Blood → Go to next step
21	Go to section Relabeling and Irradiating Packed RBC

Relabeling and Irradiating Packed RBC

STEP	ACTION
1	Open the SQ Blood Component Preparation Module (BCP)
2	• Follow SOP ***Blood Component Preparation*** to complete documentation and relabeling of the packed (volume reduced) component • Enter the time noted in step 7 of section **Packing RBCs by Centrifugation** in the

<table>
<tr><th>STEP</th><th>ACTION</th></tr>
<tr><td></td><td>time field
 
</td></tr>
<tr><td>3</td><td>IRRADIATE the new component following SOP Irradiation of Blood Components then follow SOP Blood Component Preparation to modify in SQ and relabel as irradiated</td></tr>
<tr><td>4</td><td><table><tr><th>If transfusion is for</th><th>Then</th></tr><tr><td>Intrauterine Transfusion</td><td>• Go to next step</td></tr><tr><td>Exchange Transfusion/ Reconstituted Whole Blood</td><td>• Go to section Reconstituting Whole Blood</td></tr></table></td></tr>
<tr><td>5</td><td>• Go to SQ Blood Product Entry
• Add the ‘IUT and the HCT as a comment using ‘Modify Unit…’

EXAMPLE: IUT HCT = 72.5</td></tr>
<tr><td>6</td><td>Notify the patient care area when the reconstituted RBC is available</td></tr>
</table>

Reconstituting Whole Blood

STEP	ACTION
1	Verify the RBC is packed, irradiated and relabeled accordingly per previous sections: Packing RBCs by Centrifugation and Relabeling and Irradiating Packed RBC
2	Calculate the amount of pRBC and thawed FFP needed to make the requested volume of reconstituted whole blood (RWB) using the following equations **pRBC** volume (mL) needed = $\frac{\text{RWB Volume (mL) requested x Desired HCT (40 - 50\% NICU)}}{\text{HCT of RBC unit}}$ **FFP** volume (mL) needed = RWB Volume (mL) requested – pRBC volume (mL) needed (from above equation) **EXAMPLE:** The provider request 450 ml of reconstituted whole blood with a hematocrit of 45%. The hematocrit of the pRBC is 68%. **pRBC** volume (mL) needed = $\frac{450 \times 45}{68}$ = 297 mL **FFP** volume (mL) needed = 450 – 297 = 153 mL

<table>
<tr><th>STEP</th><th>ACTION</th></tr>
<tr><td></td><td>NOTE: 1 gm of plasma can be considered equivalent to 1 ml of plasma and does not require adjustment due to the specific gravity</td></tr>
<tr><td>3</td><td>
<table>
<tr><th>If the prepared pRBC is</th><th>Then:</th></tr>
<tr><td>Adequate to complete processing</td><td>Place the required amount of RBC in bag according to the SOP Dividing Blood Components according to the SOP Dividing Blood Components
NOTE: Be sure the bag will hold the entire final volume prior to starting</td></tr>
<tr><td>Inadequate to complete processing</td><td>Consult with the TSL MD concerning the shortage and need for an addition pRBC</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>Select a thawed Group AB plasma with sufficient volume to reconstitute the RBC</td></tr>
<tr><td>5</td><td>Contact the patient care area to verify timing of the transfusion prior to continuing to the next step</td></tr>
<tr><td>6</td><td>Obtain a plasma transfer set and close the clamp on the tubing</td></tr>
<tr><td>7</td><td>Insert one spike into the plasma bag and the other into the RBC unit using aseptic technique</td></tr>
<tr><td>8</td><td>Place the RBC unit on the scale and TARE the scale to 0</td></tr>
<tr><td>9</td><td>Elevate the FFP, open the clamp and allow the volume of plasma required to flow into the RBC bag</td></tr>
<tr><td>10</td><td>Close the clamp when the desired volume is reached</td></tr>
<tr><td>11</td><td>Heat seal the tubing leaving approximately 5” of tubing on the transfer pack incase reattachment is necessary (refer to SOP Tube Sealer: Operation and Cleaning)

NOTE: Having adequate tubing on the RBC bag ensures an accurate HCT measure</td></tr>
<tr><td>12</td><td>Strip and mix the tubing 4 times
• Strip the length of tubing attached to the RBC back into the component
• Without releasing the stripper, mix the contents of the RBC
• Release and allow RBCs to flow back into the tubing</td></tr>
<tr><td>13</td><td>Use the heat sealer to make two segments long enough to provide a1 mL sample, approximately 3-4 inches-long segments

EXAMPLE:
 
</td></tr>
<tr><td>14</td><td>Discard the segment farthest from the bag

NOTE: The remaining 3-4 inches long segment will be used to verify the hematocrit of the volume reduced unit</td></tr>
<tr><td>15</td><td>Label a test tube with the unit number</td></tr>
<tr><td>16</td><td>Remove the remaining segment, cut the tip, and allow the contents to empty into the labeled test tube</td></tr>
</table>

<table>
<tr><th>STEP</th><th>ACTION</th></tr>
<tr><td>17</td><td>• Cap the test tube and deliver to Hematology for a STAT hematocrit
• Obtain a printed report of the results</td></tr>
<tr><td>18</td><td>
<table>
<tr><th>If HCT</th><th>Then</th></tr>
<tr><td>= HCT ordered</td><td>Proceed to modification in BBLIS</td></tr>
<tr><td>< HCT ordered</td><td>• Verify calculations are correct
• Determine the volume of plasma to remove
• Pack the RWB component according to section Packing RBCs by Centrifugation
• Remove the excess plasma</td></tr>
<tr><td>> HCT ordered</td><td>• Recheck calculations
• Determine the volume of plasma to add
• Add the additional plasma</td></tr>
</table>
</td></tr>
<tr><td>19</td><td>Follow SOP Blood Component Preparation to complete documentation and relabeling of the reconstituted whole blood component</td></tr>
<tr><td>20</td><td>• Go to SQ Blood Product Entry
• Add the HCT as a comment using ‘Modify Unit to

EXAMPLE: HCT = 45</td></tr>
<tr><td>21</td><td>Notify the patient care area when the component is available</td></tr>
</table>

CALCULATIONS/INTERPRETATIONS/RESULTS REPORTING/NORMAL VALUES/CRITICAL VALUES
NA

CALIBRATION:
NA

PROCEDURE NOTES AND LIMITATIONS:
- If a washed RWB is requested, TSL MD consultation and approval with proper documentation is required
- Modification to irradiated must occur after reduced volume modification in SQ and before modification to reconstituted.
- Following exchange transfusion, plasma bilirubin levels may increase due to re-equilibration of the plasma with the extravascular tissues. Repeat exchange transfusions may be required

REFERENCES:
AABB Technical Manual, 18th Ed., Bethesda, MD; AABB, 2014
AABB Standards for Blood Banks and Transfusion Services, Bethesda, MD, Current edition.

RELATED DOCUMENTS:
Form Component Prep Downtime Log

Form Refrigerated Centrifuge QC Log
SOP Irradiating Blood Component
SOP Blood Component Preparation
SOP Helmer Plasma Thawer Operation and Maintenance
SOP Refrigerated Centrifuge Operation and Maintenance
SOP Sterile Welder Operation and Maintenance
SOP Tube Sealer Operation and Maintenance
SOP Scale Operation & Maintenance: Entris 2202-1S Balance

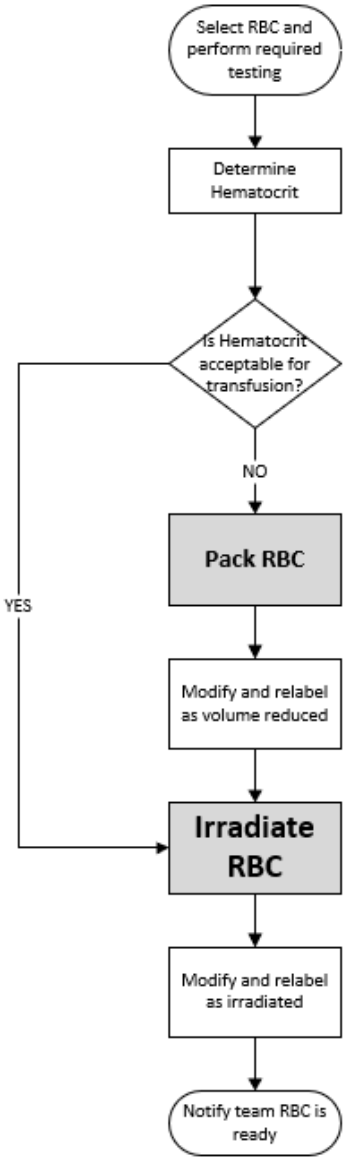
UWMC SOP Approval:

UWMC CLIA Medical Director	Mark H. Wener, MD	Date	
Transfusion Service Manager	Nina Sen	Date	
Compliance Analyst	Christine Clark	Date	
Transfusion Service Medical Director	Monica Pagano, MD	Date	
UWMC Biennial Review:			
		Date	
		Date	

REVISIONS:
07/22/21: Raise HCT requirements per NICU request

APPENDIX 1: Workflow Overview Diagram

Intrauterine Transfusion



Neonatal Exchange Transfusion – Reconstituted RBC