Transfusion Guidelines

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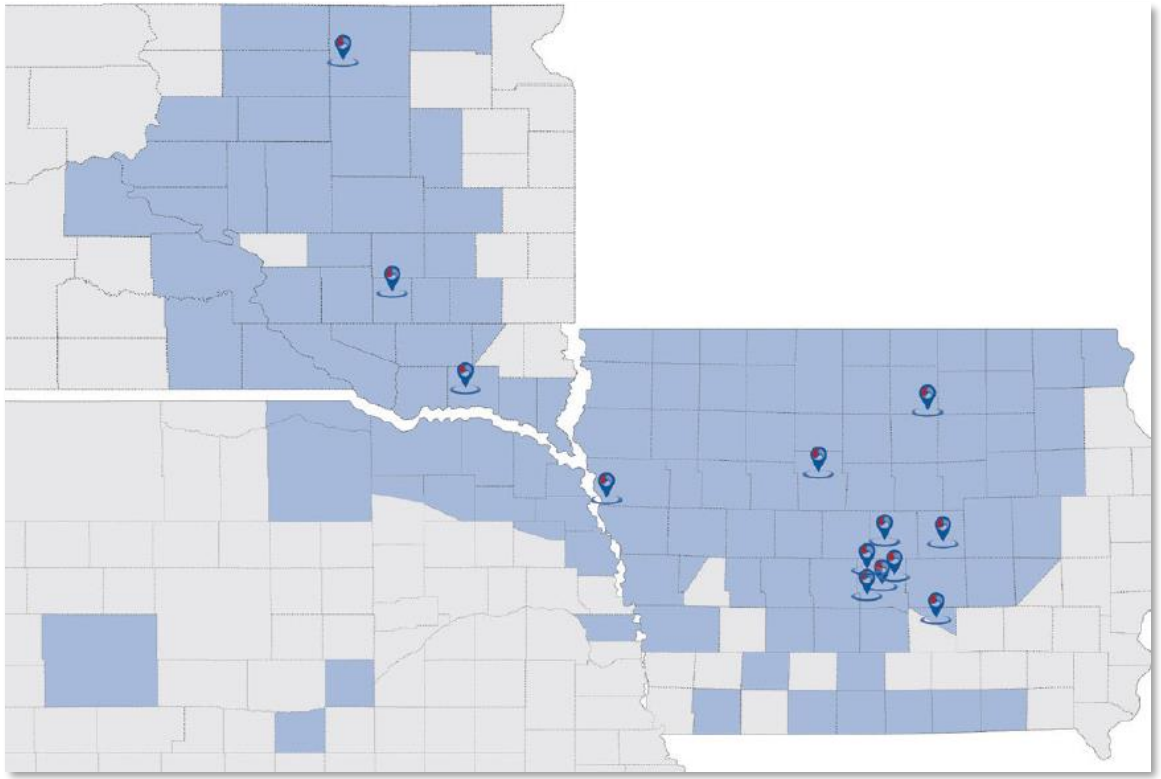
Topics

- Current transfusion guidelines
  - Red blood cells
  - Plasma
  - Platelets
  - Cryoprecipitate
- Blood product modifications
- Platelet refractoriness
- Massive transfusions

What is LifeServe Blood Center?



- Over 136,000 registered donors
  - Over 157,000 blood products per year
- Distribute blood products to 158 hospitals

What is LifeServe Blood Center?

- Freeze and store blood from donors with rare blood types for up to 10 years
- Perform testing for blood banks
  - Crossmatching
  - Antibody ID

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Where Do Blood Products Come From?

Two methods to collect from donors

1. Whole blood donations
2. Apheresis

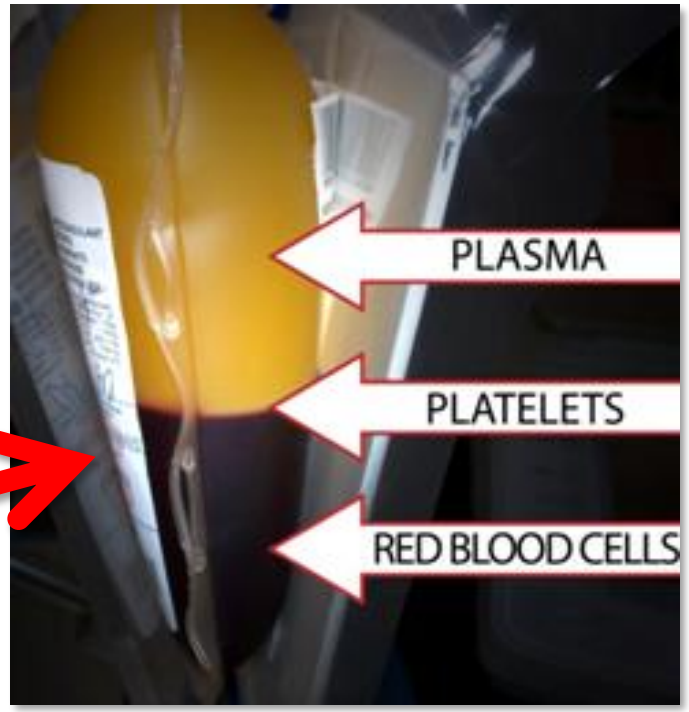
Whole Blood Donation

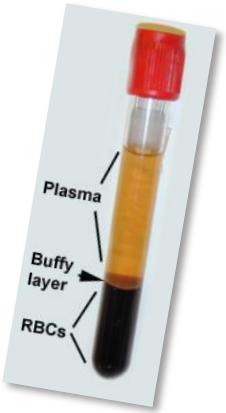
- Most common method

Whole Blood Donation

whole blood

centrifuge





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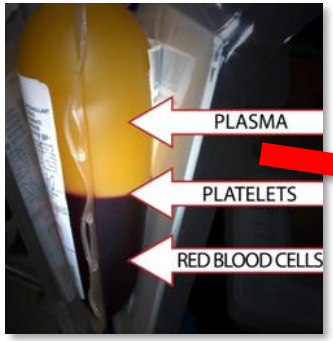
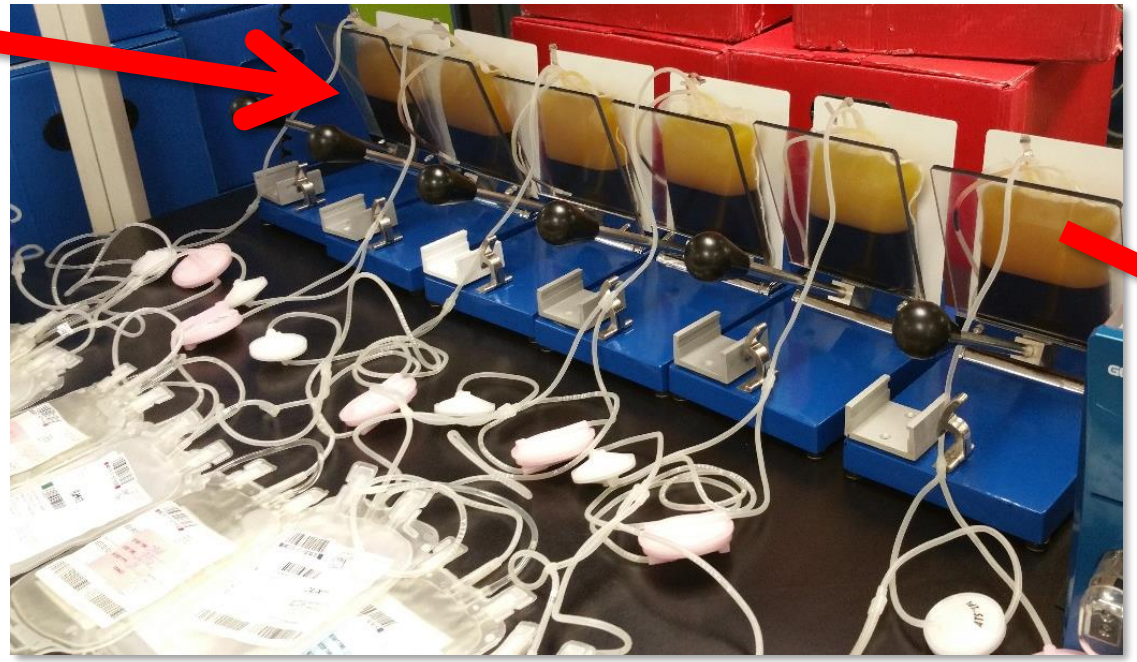
Whole Blood Donation



expresser



platelet-rich plasma

RBCs

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Whole Blood Donation

plasma

platelets

What remains in the bag are the platelets

platelet-rich plasma

Centrifuge

Most of plasma is expressed off

Platelets form a pellet at the bottom of the bag

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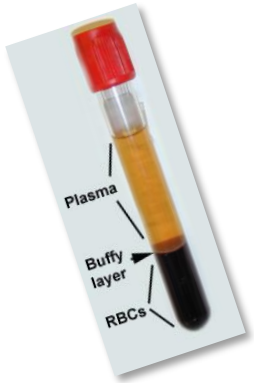
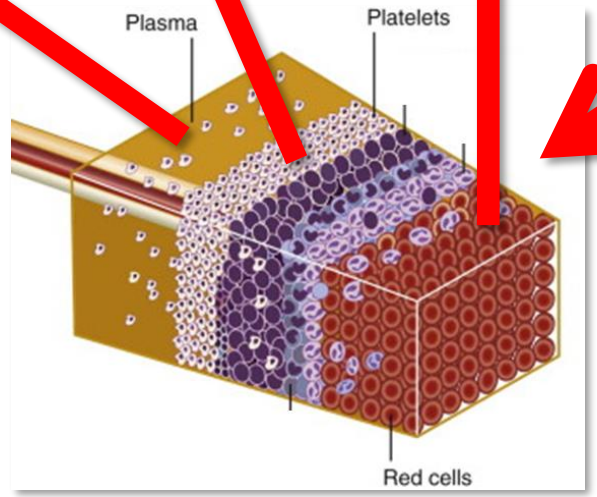
Apheresis Donation

plasma

platelets

RBCs





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Red Blood Cells (RBCs)

RBCs

- Most patients can physiologically compensate for a lower hemoglobin, up to a point

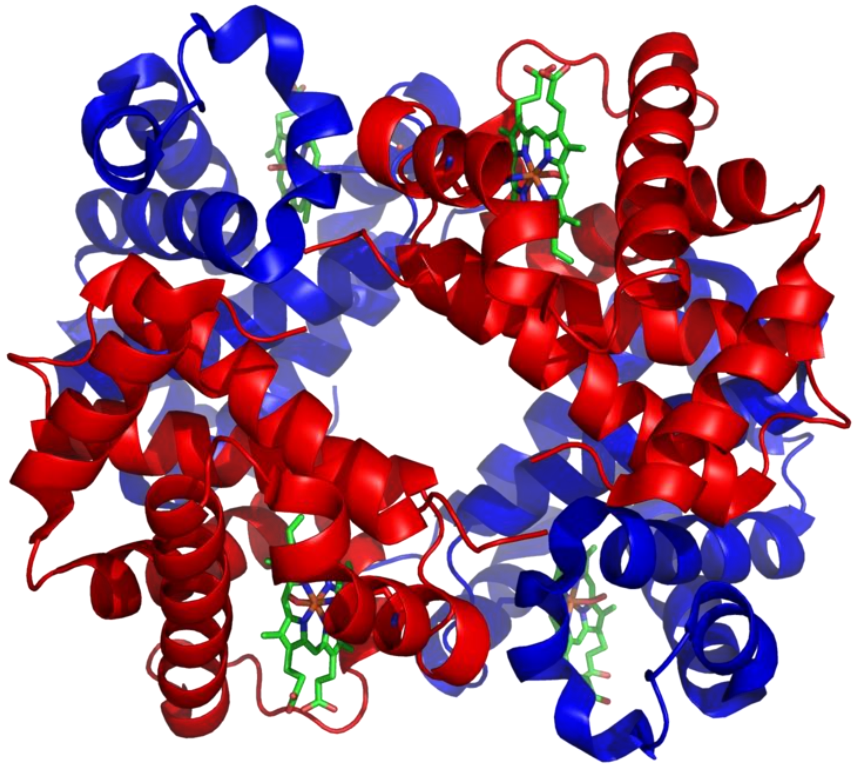
oxygen delivery (DO_2) =
cardiac output (CO) x arterial oxygen content (CaO_2)

CO = heart rate (HR) x stroke volume (SV)

- When CaO_2 is low, HR and SV will increase
  - At rest, oxygen delivery is about 4 times the amount needed
- Patients with decreased ability to increase HR and/or SV are at greater risk for ischemic damage

RBCs

- pRBCs (packed red blood cells) and RBCs are the same thing
- Most oxygen delivery occurs via hemoglobin (Hb)
- Low Hb (anemia) results in less oxygen delivery to tissues
  - If oxygen delivery is too low, tissue damage may occur



RBCs – Indications

- Ideal is to transfuse just enough to maximize clinical outcome
  - Decrease risk of side effects
  - Blood is always in short supply → ensures enough for everyone
- Evidence-based transfusion guidelines exist, but all patients are unique, so clinical judgement is required
  - Clinical status
  - Comorbidities
  - Patient's desires

RBCs – Indications

Thresholds for red blood cell transfusion in adults

Condition	Hemoglobin threshold for transfusion
Symptomatic patient (eg, myocardial ischemia, hemodynamic instability)	10 g/dL*[1]
Hospitalized patient	
Preexisting coronary artery disease	8 g/dL*
Acute coronary syndromes, including acute MI	8 to 10 g/dL¶[2]
ICU (hemodynamically stable)	7 g/dL*[3,4]
Gastrointestinal bleeding (hemodynamically stable)	7 g/dL*[5,6]
Orthopedic surgery	8 g/dL*[1]
Cardiac surgery	7.5 g/dL*[7,8]
Ambulatory outpatient	
Oncology patient in treatment	7 to 8 g/dL¶
Palliative care setting	As needed for symptoms; hospice benefits may vary

These thresholds are not a substitute for direct assessment of the patient and clinical judgment. Refer to UpToDate topics on red blood cell transfusion and specific clinical settings for further details. Hospitalized patients with heart failure are an especially challenging case because there are no data from large randomized trials, and the improvement in oxygenation from transfusion must be balanced against the risks of worsening heart failure due to the volume of the transfused blood. The authors generally use a threshold of 7 to 8 g/dL in this population, erring on the side of a higher hemoglobin level in those who are expected to be able to better tolerate the volume load. In patients who do not fit into these clinical subgroups, we recommend that transfusion based on the location of care (ICU versus other) or the similarity of their underlying disease to those patient groups where data are available. In most cases, a 7 or 8 g/dL threshold is appropriate.

MI: myocardial infarction; ICU: intensive care unit.

* Based on results from clinical trial(s). Some experts may use different values. As an example, in individuals with gastrointestinal bleeding, it is often difficult, if not impossible, to estimate what the nadir hemoglobin will be, and some experts recommend a transfusion threshold of 8 g/dL[6].

¶ There are no large clinical trials yet performed in this setting. These recommendations are based on the authors' opinions.

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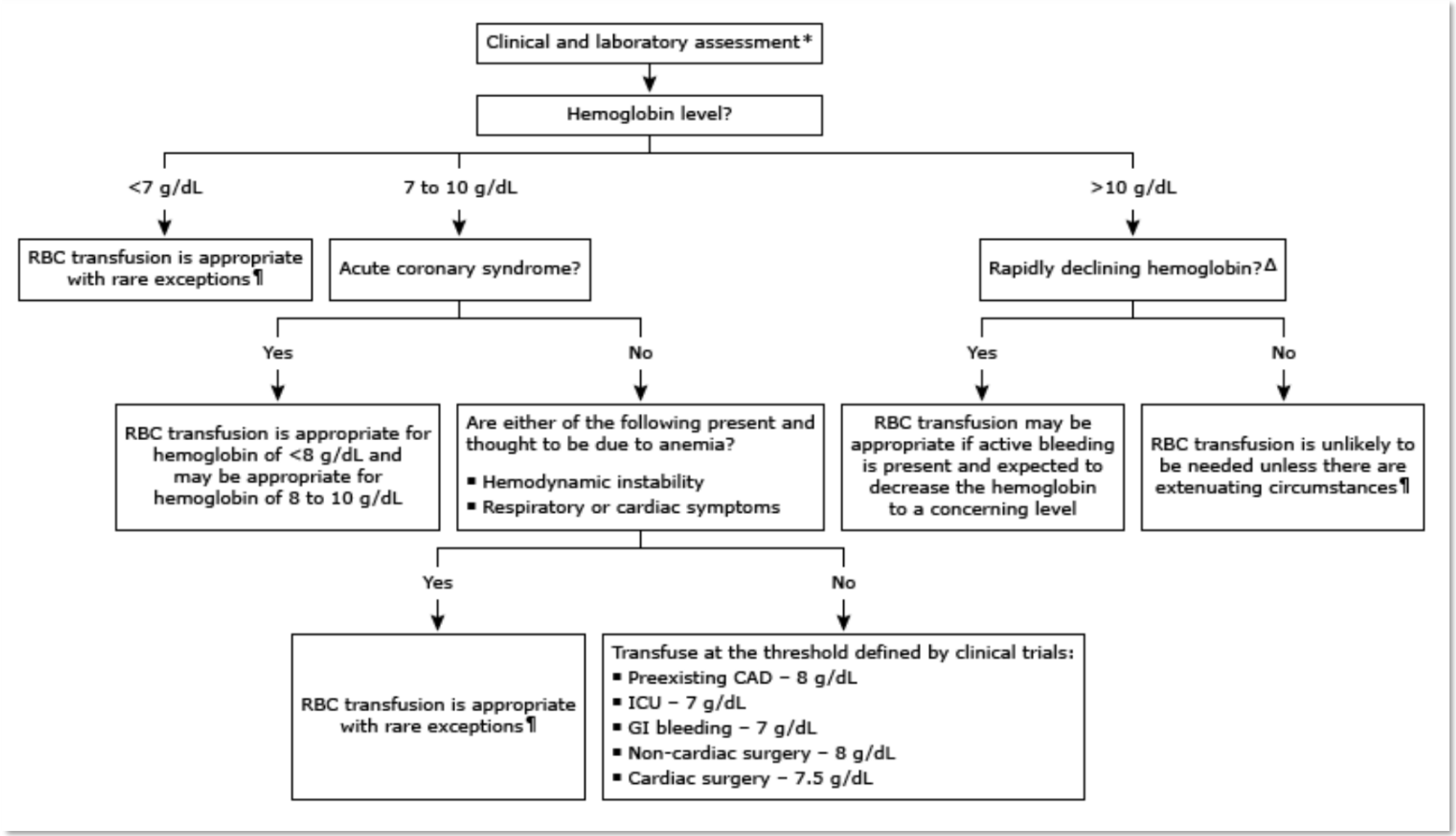
RBCs – Indications



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RBCs – Indications

The decision to transfuse always incorporates an assessment by the clinician caring for the patient. Thresholds included here are based on data from clinical trials; refer to UpToDate for details. This algorithm does **not** apply to individuals with hemoglobinopathies (sickle cell disease, transfusion-dependent thalassemia); separate criteria apply to these individuals as discussed in UpToDate. To convert hemoglobin to g/L, multiply by 10 (hemoglobin of 7 g/dL = 70 g/L). Refer to UpToDate topics on indications for transfusion for further details and discussions.

RBC: red blood cell; CAD: coronary artery disease; ICU: intensive care unit; GI: gastrointestinal.

* Assessment includes:
  - Symptoms (and whether attributable to anemia)
  - Clinical status (vital signs, signs of hemodynamic instability, cardiac and respiratory examination)
  - Underlying comorbidities
  - Hemoglobin level
  - Rate of hemoglobin decline and cause (active bleeding versus ongoing hemolysis versus decreased RBC production)

¶ Rarely, an individual with hemoglobin below an accepted threshold may decline transfusion (Jehovah's Witness, healthy young adult); it is important that they understand the risks and alternatives. Rarely, an individual with a hemoglobin above 10 g/dL may warrant transfusion, such as if there are clear symptoms attributable to anemia and the cause of anemia cannot otherwise be rapidly treated.

Δ Rapidly declining hemoglobin includes rapid bleeding associated with hemodynamic instability or a fall in hemoglobin of ≥2 g/dL per day.

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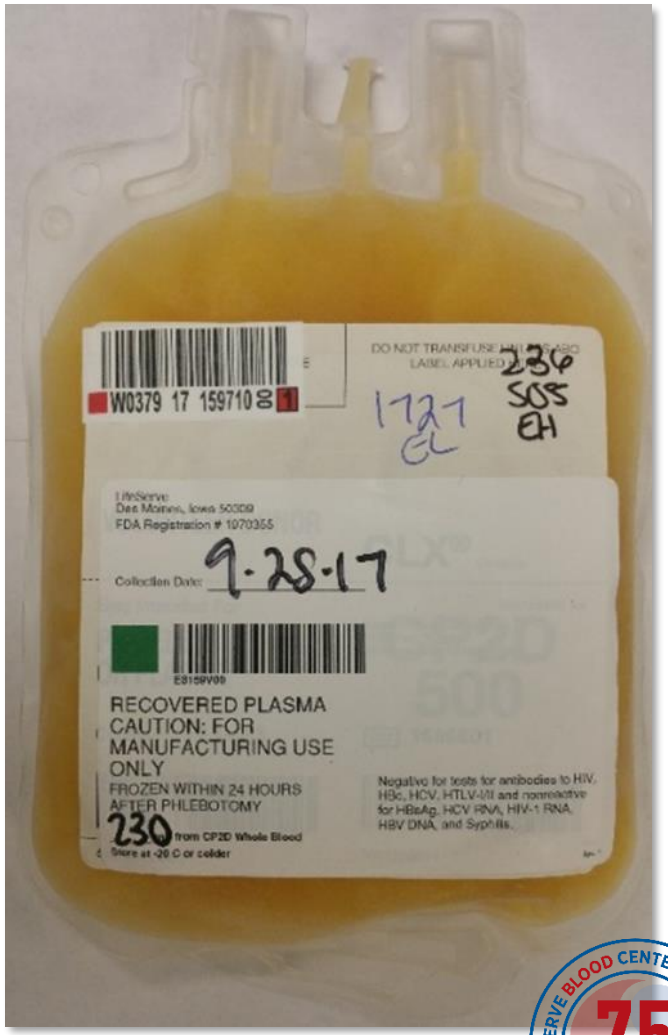
Plasma


W0379 17 159710
LifeServe
Des Moines, Iowa 50309
FDA Registration # 1970355
Collection Date: 9-28-17
RECOVERED PLASMA
CAUTION: FOR
MANUFACTURING USE
ONLY
FROZEN WITHIN 24 HOURS
AFTER PHLEBOTOMY
230 from CP2D Whole Blood
Store at -20 C or colder
Negative for tests for antibodies to HIV, HBc, HCV, HTLV-I/II and nonreactive for HBsAg, HCV RNA, HIV-1 RNA, HBV DNA, and Syphilis.

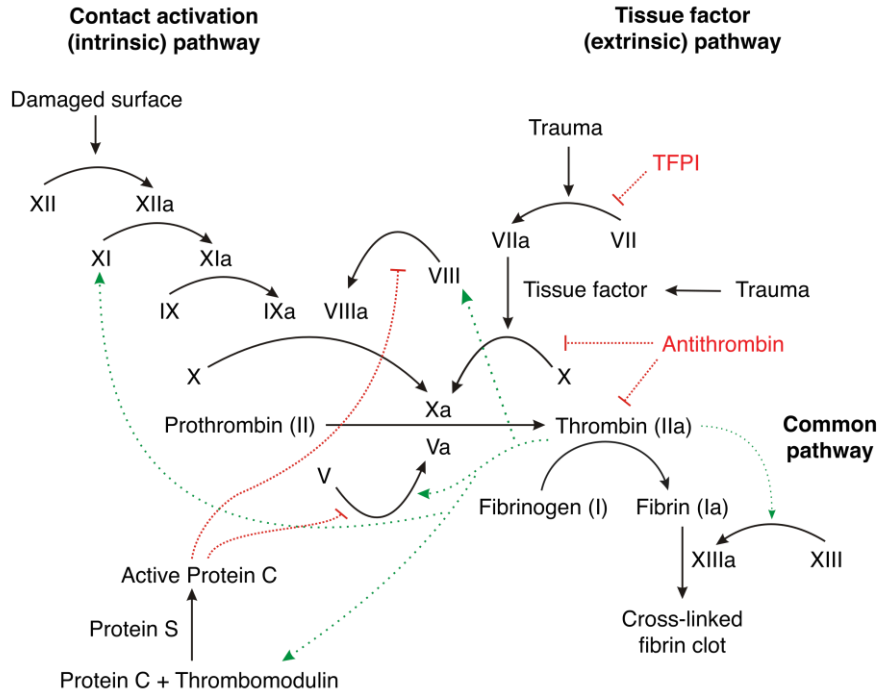
Plasma

- Contains…
  - All soluble plasma proteins and clotting factors
- Often not used appropriately
  - Source of albumin or nutrients
  - Increase blood volume
  - Reverse warfarin when there is no bleeding
  - Correct a minimally elevated INR
    - < 1.85 in a bleeding patient
    - < 2 in a nonbleeding or preop patient



Plasma – Indications

- Patients with multiple coagulation factor deficiencies who are bleeding or expected to bleed (surgery)
  - Liver disease
  - Disseminated intravascular coagulation (DIC)
  - Massive transfusion
  - Warfarin anticoagulated or overdose not corrected by vitamin K and/or prothrombin complex concentrate (PCC)
    - Vitamin K-dependent coagulation factors (II, VII, IX, and X), protein C, and protein S



Platelets

Platelets – When to Transfuse

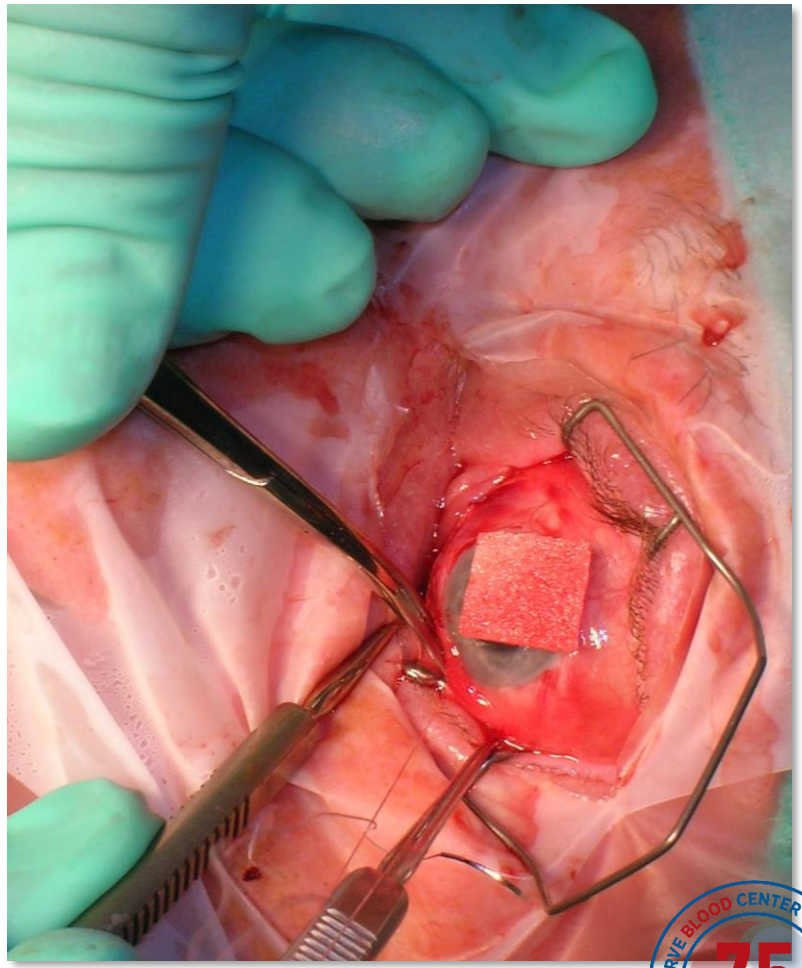
- Platelet count when previously bled
- Mucosal bleed, epistaxis

- Prevention of spontaneous bleeding
  - Afebrile: < 10,000/µL
  - Fever, infection, or inflammation: < 15,000 to 20,000/µL
  - Acute promyelocytic leukemia (APL): < 30,000 to 50,000/µL

- Active bleed
  - CNS: < 100,000/µL
  - Elsewhere: < 50,000/µL

Platelets – Indications

- Preparation for an invasive procedure
  - Neurosurgery or ocular surgery: < 100,000/µL
  - Most other major surgery: < 50,000/µL
  - Endoscopy: < 50,000/µL
  - Bronchoscopy with bronchoalveolar lavage (BAL): < 20,000 to 30,000/µL
  - Central line placement: < 20,000/µL
  - Lumbar puncture
    - Without hematologic malignancy: < 40,000 to 50,000
    - With hematologic malignancy: < 10,000 to 20,000/µL
  - Neuraxial analgesia/anesthesia: < 80,000/µL
  - Bone marrow aspiration/biopsy: < 20,000/µL



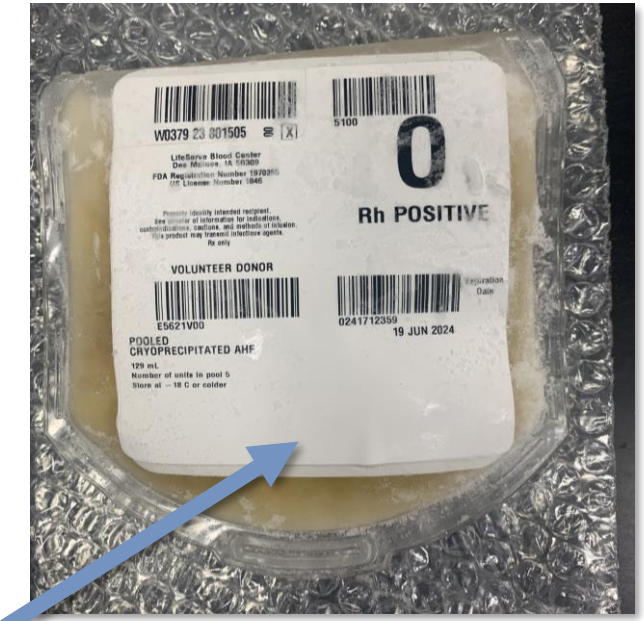
Cryoprecipitate

plasma

thaw between 1 and 6° C

centrifuge

pool four to five units



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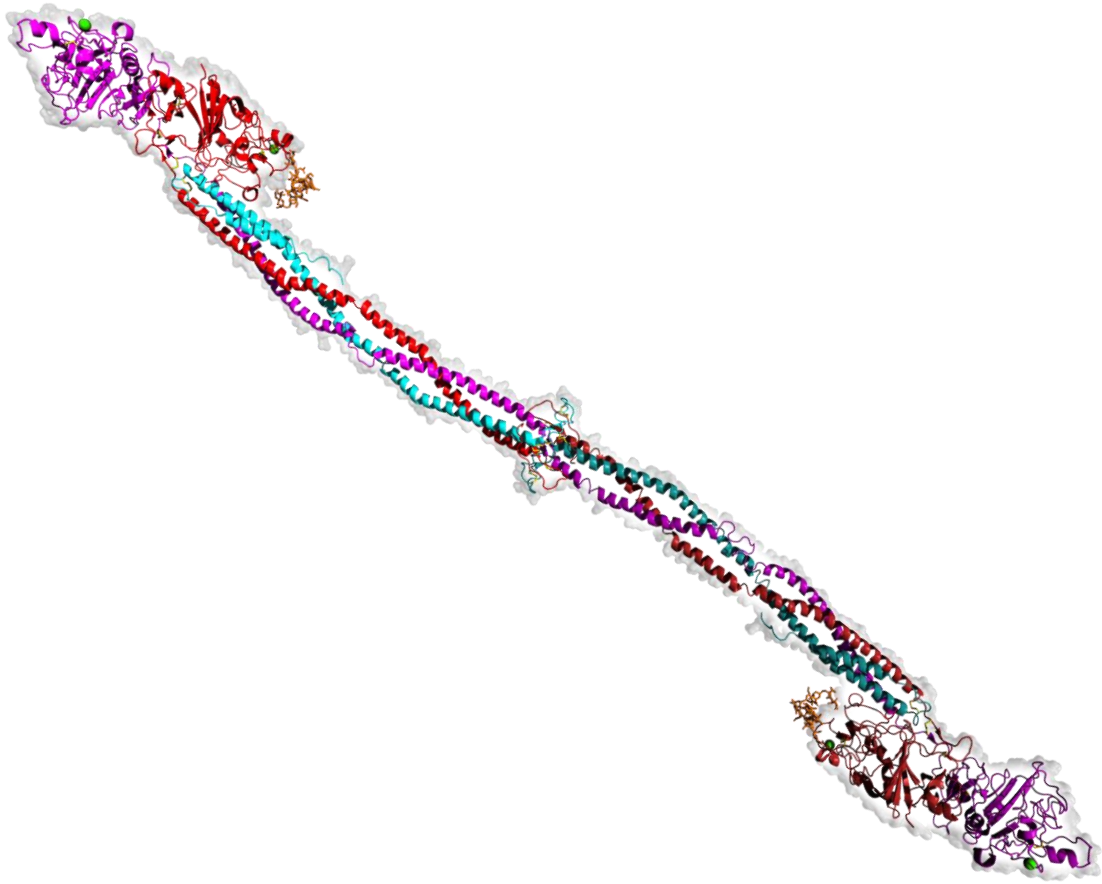
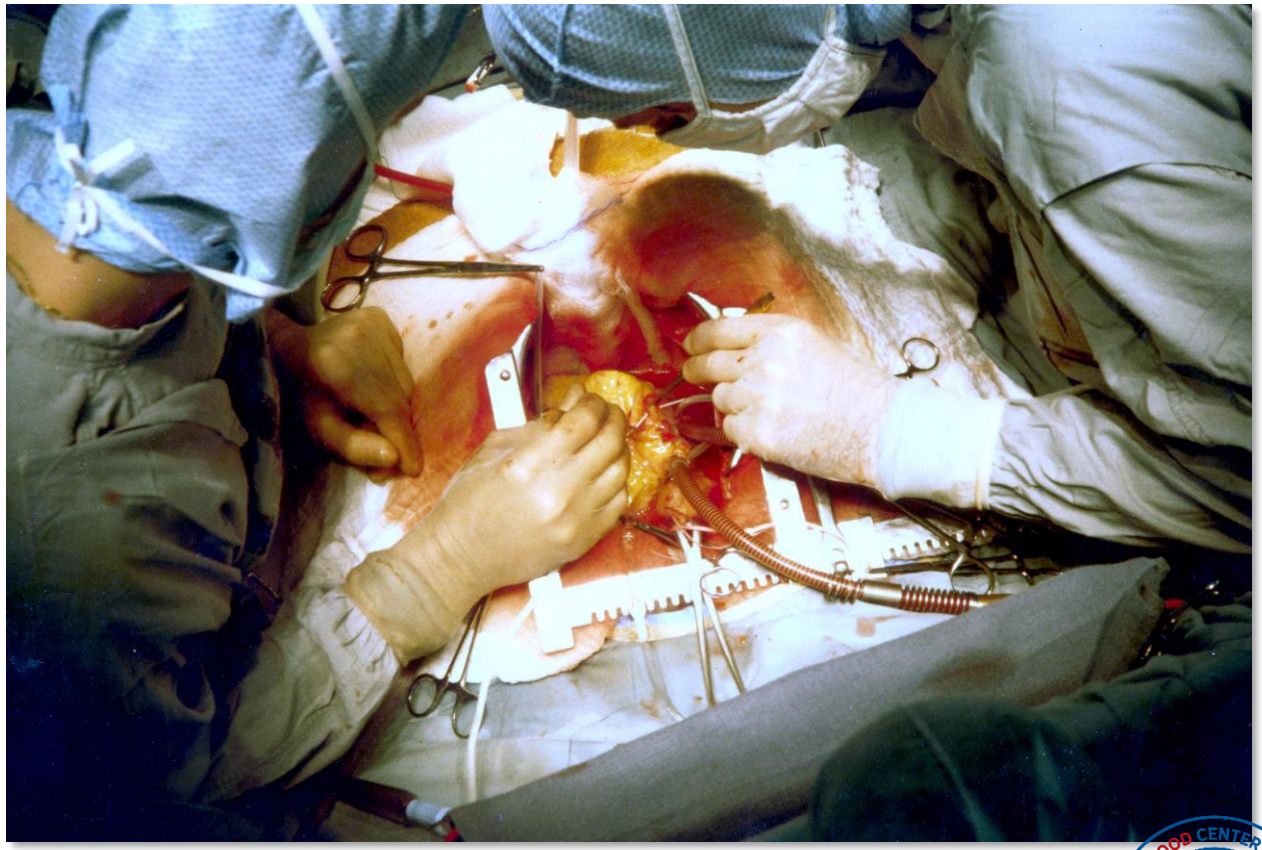
Cryoprecipitate

- Contains
  - Factor VIII
  - Factor XIII
  - von Willebrand factor
  - Fibronectin
  - Fibrinogen
- Increased bleeding risk when fibrinogen is low



Cryoprecipitate – Indications

- Congenital fibrinogen disorder
- Cardiac surgery
- Postpartum hemorrhage
- Trauma
- Disseminated intravascular coagulation (DIC)
- Liver disease
- Kidney disease



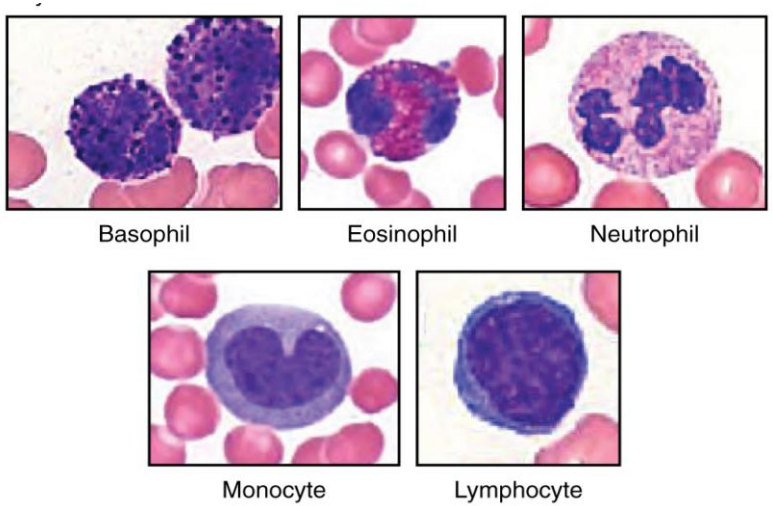
Blood Product Modifications

Modifications

- Leukoreduction
- Irradiation
- Washed
- Volume reduction

Leukoreduction

- Each whole blood or RBC unit contains 2.0 to 5.0 x 10^9 leukocytes
- Leukocytes in blood products can cause adverse effects
  - Fever
  - Human leukocyte antigen (HLA) antibody formation
  - Transmission of intracellular viruses, e.g. cytomegalovirus (CMV)
- Leukoreduction removes 99.9 to 99.99% of leukocytes
- All blood products are leukoreduced
  - Bedside leukoreduction no longer occurs

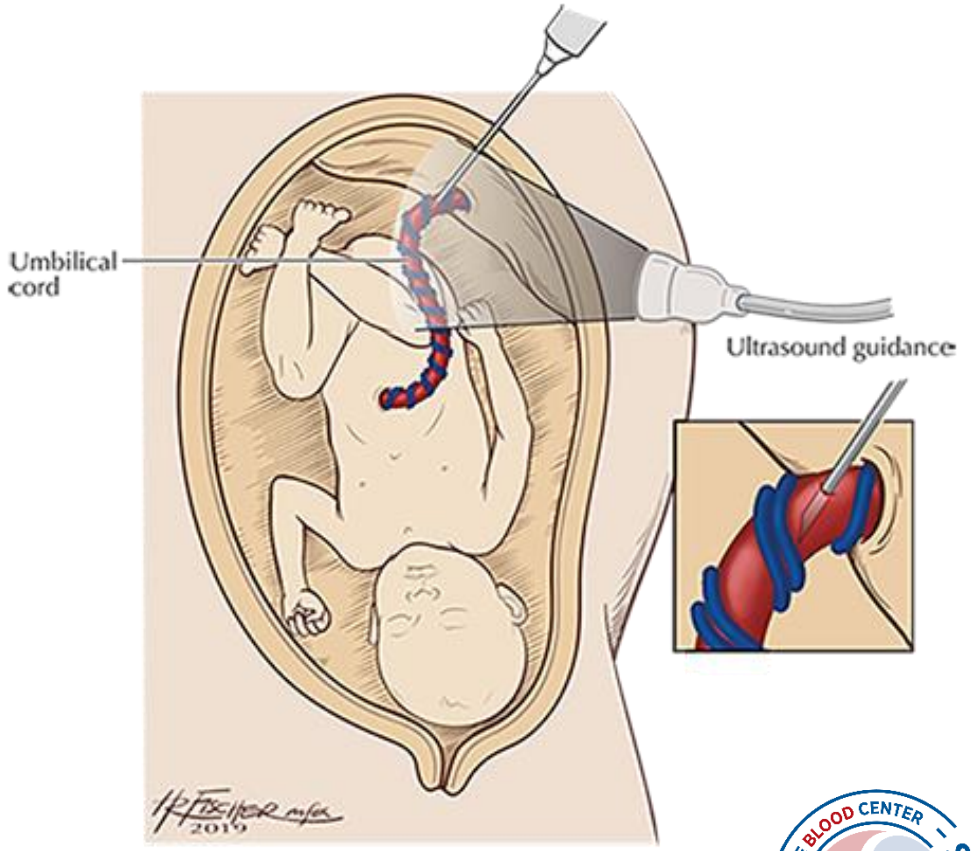


Irradiation

- Transfused leukocytes can attack a patient's cells
  - Transfusion-associated graft-vs-host disease (TA-GVHD)
- Irradiation sources
  - X-rays
  - Gamma rays (being phased out)
    - Cesium-137
    - Cobalt-60
- Disadvantages
  - Increases potassium leakage from RBCs
    - Problematic in certain populations
    - Reduces shelf life to 28 days
  - Adds cost

Irradiation – Indications

- Patients who cannot mount an attack against transfused leukocytes
  - Intrauterine or neonatal exchange transfusion
  - Premature neonate
  - Congenital cell-mediated immunodeficiency
  - Patients on certain immunosuppressive therapies
    - Purine analogs
    - Antithymocyte globulin
    - Monoclonal antibodies
  - Stem cell transplant
  - Hodgkin lymphoma
  - At risk for partial HLA match with blood donor
    - Directed donations
    - HLA-matched products
    - Genetically homogeneous population

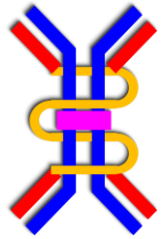


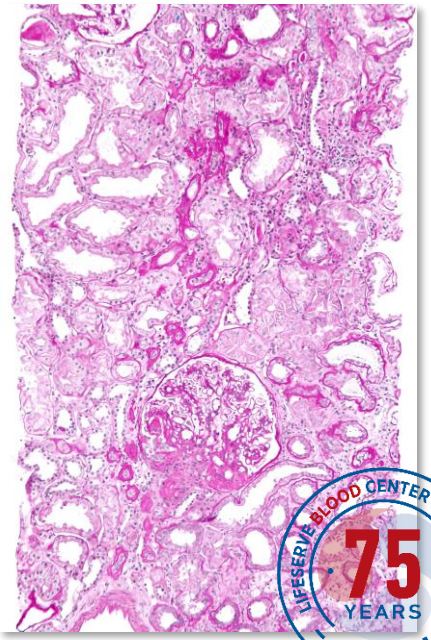
Washed

- RBCs are stored in an "additive solution" that keeps them healthy, but a small amount of the donor's plasma will remain
  - Platelets are stored in plasma
- The residual plasma can be problematic for some patients, so the unit can be "washed" with saline
  - Adds cost
  - Reduces the shelf life to four hours

Washed – Indications

- Plasma contains…
  - Substances that may, rarely, cause an allergic reaction
    - Indication: severe or recurrent allergic reactions
  - IgA
    - If a patient does not make their own IgA, they may see a donor's IgA as "foreign" and make an antibody against it
    - May result in a severe anaphylactic reaction
    - Indication: IgA-deficiency
  - Potassium
    - Over time, RBCs in a unit will release potassium → increases the potassium in the unit
    - This can be problematic for patients at risk for hyperkalemia
    - Indications
      - Severe renal impairment
      - Newborns and infants



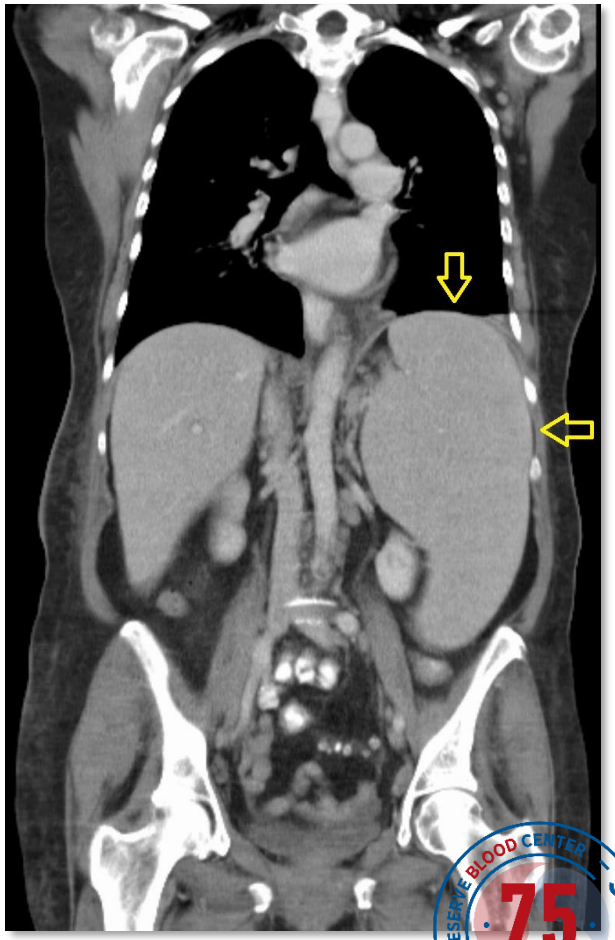


Volume Reduction

- Transfusions increase a patient's blood volume, and are often overlooked as a source of hypervolemia
- Most of the solution in an RBC unit can be centrifuged out immediately prior to transfusion
- Indication: patients at risk for transfusion-associated circulatory overload (TACO)
  - Small stature
  - Low body weight
  - Very young or old
  - Cardiac dysfunction
  - Renal dysfunction
  - High number of units already transfused (trauma)
  - High rate of transfusion (trauma)

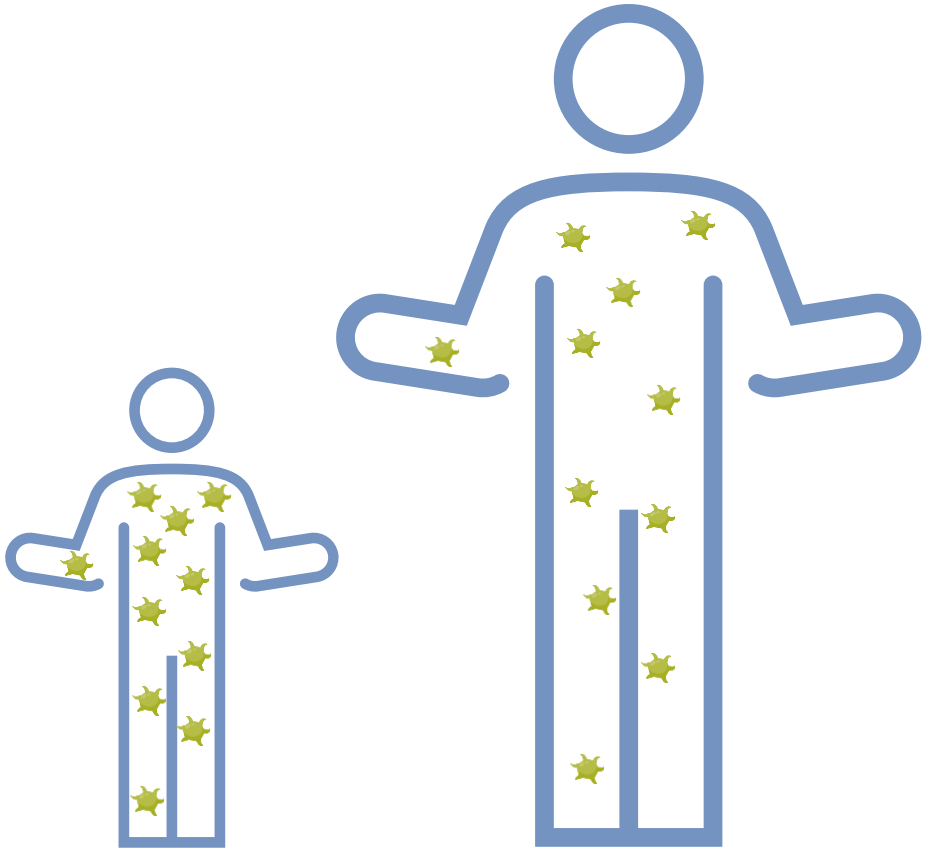
Platelet Refractoriness

- Definition
  - Lower than expected platelet count increase after two platelet transfusions
- Causes
  - **Non-immune**
    - Active bleeding
    - Fever, infection, sepsis
    - Splenomegaly
    - DIC
    - Medications
    - Stem cell transplant
  - **Immune**
    - Antibodies against human leukocyte antigens (HLA) on the platelet
    - Antibodies against human platelet antigens (HPA) on the platelet



Platelet Refractoriness – Evaluation

- Post-transfusion platelet count
  - Check platelet count after the transfusion is completed
    1. 10 minutes to one hour, and
    2. After 24 hours
  - Platelet count is measured as the number of platelets per µL
    - Larger patients have a higher blood volume, so the same number of platelets would be more diluted than a smaller patient
    - This results in a lower platelet count



Platelet Refractoriness – CCI

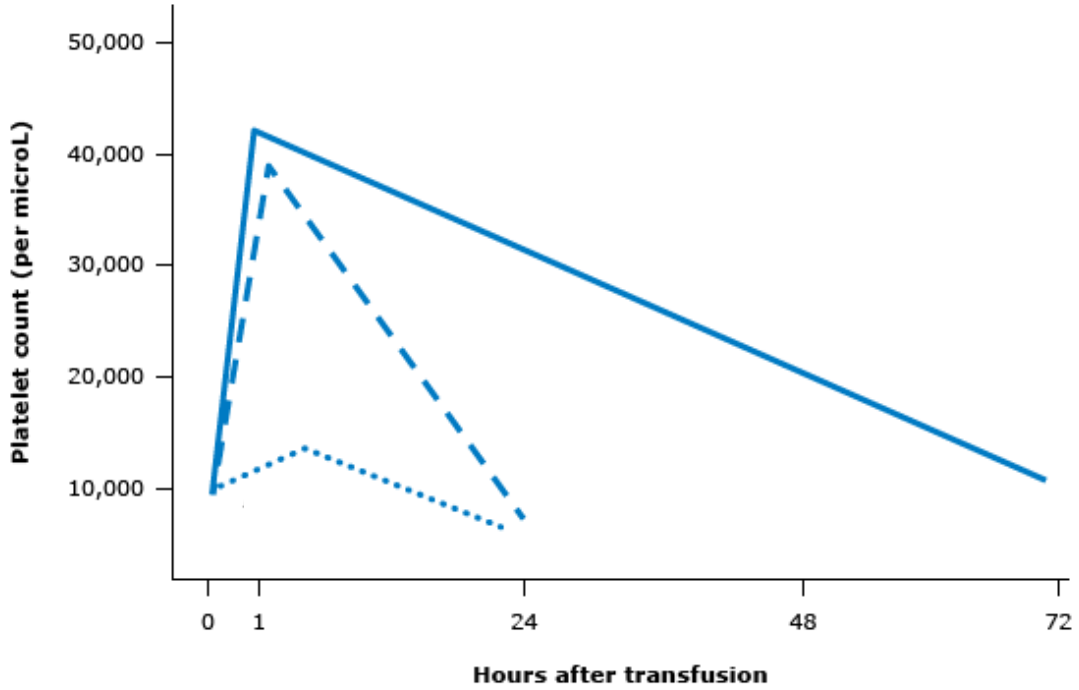
- To accommodate for differences in patient volume, calculate a corrected count increment (CCI)

$$\frac{(\text{pretransfusion platelet count} - \text{posttransfusion platelet count}) / \text{body surface area}}{\#\ \text{of platelets transfused}}$$

- The hospital blood bank can give you the number of platelets that were in the unit
  - Otherwise use 3.0×10^{11}

Platelet Refractoriness – CCI

- Calculate a CCI for two subsequent platelet transfusions at least 24 hours apart
  - If CCI ≥ 10,000 after each transfusion → likely non-immune
  - If CCI < 10,000 after either transfusion → likely immune



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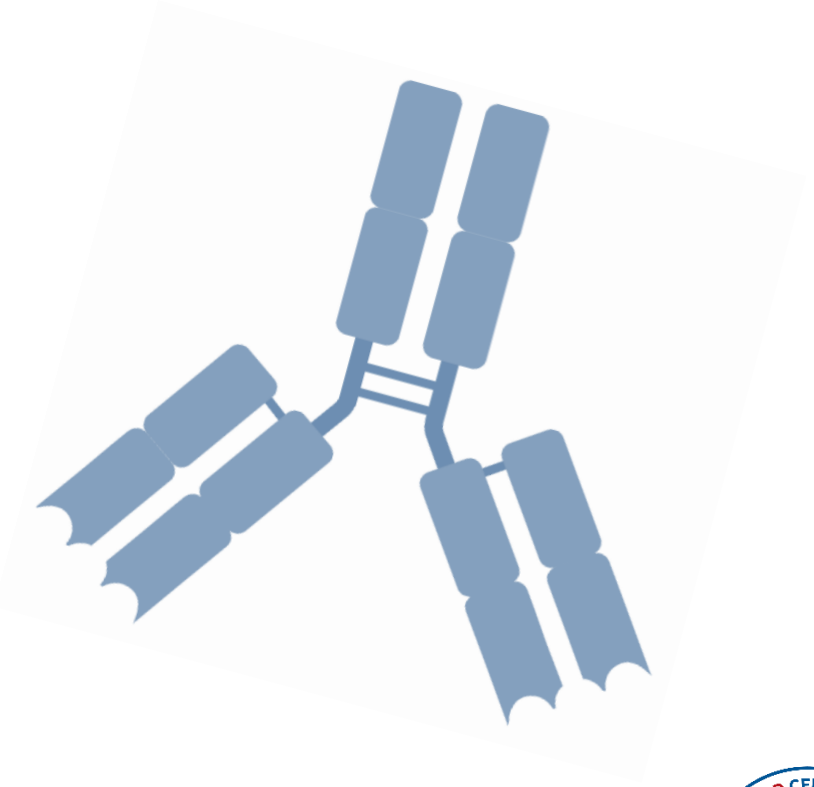
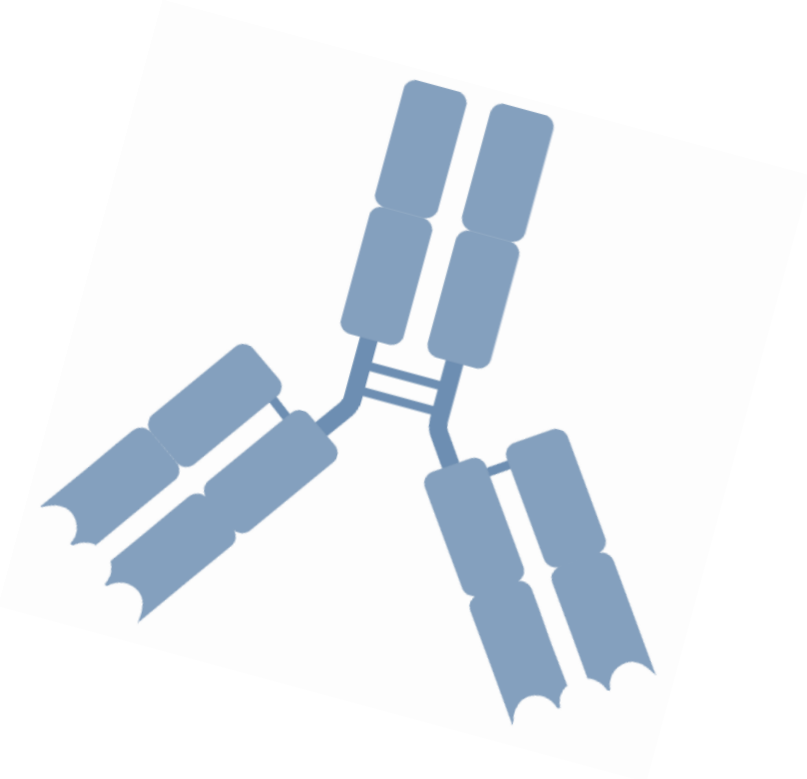
Platelet Refractoriness – Management

- Non-immune
  - Treat the underlying cause
- Immune
  - Random platelet unit
    - If the patient does not destroy the transfused platelets, the person who donated the platelet can be asked to donate more
    - Disadvantage: the patient is already forming HLA antibodies → higher risk of creating antibodies against the donor's HLAs



Platelet Refractoriness – Management

- Immune (cont.)
  - Crossmatched platelets
    - Mix the patients serum with a sample from a platelet unit
    - If the platelets in the sample are not destroyed, the unit is compatible
    - Disadvantage: not always accurate
  - HLA-matched platelets
    - Determine what HLA antibodies the patient has
    - Find a donor without the concomitant antigens
    - Disadvantages
      - Time to receive platelets
      - Cost



Massive Transfusions

Massive Transfusions

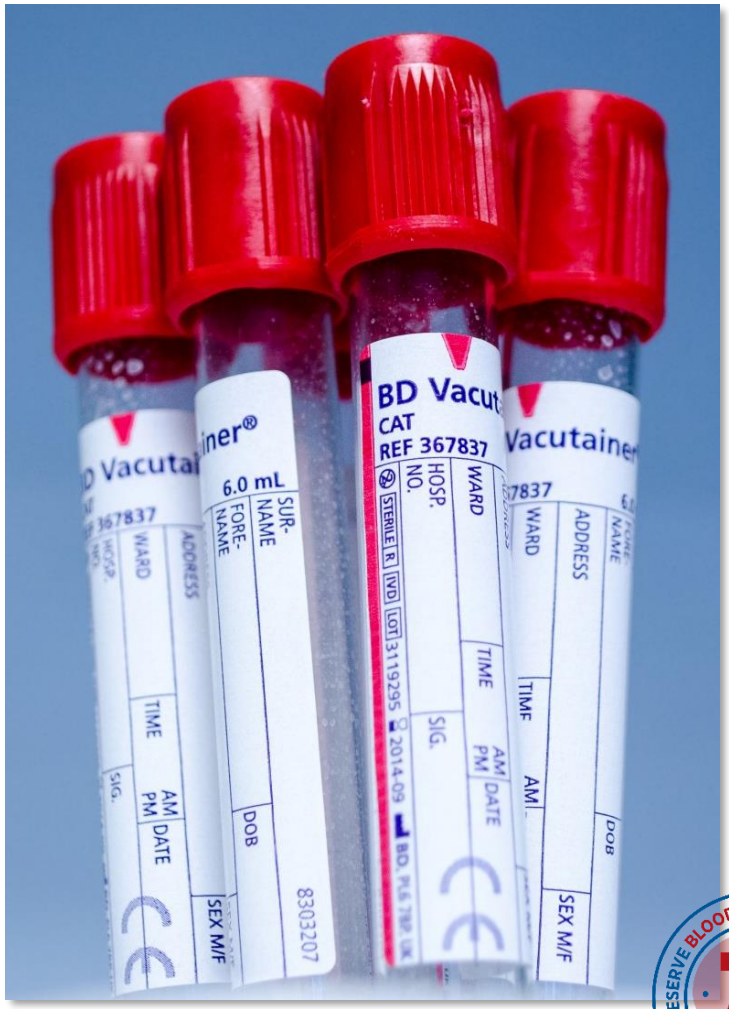
- A treatment for massive hemorrhage
  - Definition
    - Tends to be arbitrarily defined and dependent on the institution
    - Blood loss is a continuum
    - Clinical judgement is required
    - Examples
      - Ten or more RBC units transfused in 24h
      - Three or more RBC units transfused in one hour
      - 4 or more blood components (RBCs, plasma, platelets) transfused in 30 minutes

Massive Transfusions

- Common indications
  - Trauma
  - Cardiac surgery
  - Obstetric bleeding
  - Liver disease
- Massive transfusion protocol (MTP)
  - Instead of ordering individual blood components, the blood bank will send a cooler of blood components to where the massive transfusion is occurring
  - Dependent on the facility
  - Typically, the ratio is 2:1:1 (RBCs to plasma to platelets)
    - 10 RBC units, 5 plasma units, 5 platelet units
    - Cryoprecipitate is often included

Massive Transfusions

- Lab testing to monitor progress
  - CBC
  - PT
  - PTT
  - Fibrinogen
  - Thromboelastography (TEG)
  - pH
  - Blood gases
  - Electrolytes
  - Glucose
  - Lactate



Massive Transfusions

- Complications
  - Coagulopathy
  - Acidosis
  - Hypothermia
  - Hypocalcemia
  - Hyperkalemia

Questions?


LIFESERVE BLOOD CENTER
75
YEARS
SAVING LIVES
LifeServe
BLOOD CENTER
YOUR BLOOD. YOUR HOSPITAL. YOUR NEIGHBORS.

Outreach

- Physician available 24/7
  - Practitioners with transfusion-related questions/issues
  - Blood bank-related questions/issues
  - **(515) 309-4840**
- Keep up to date on transfusion-related topics and educate the medical community

Thank you!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