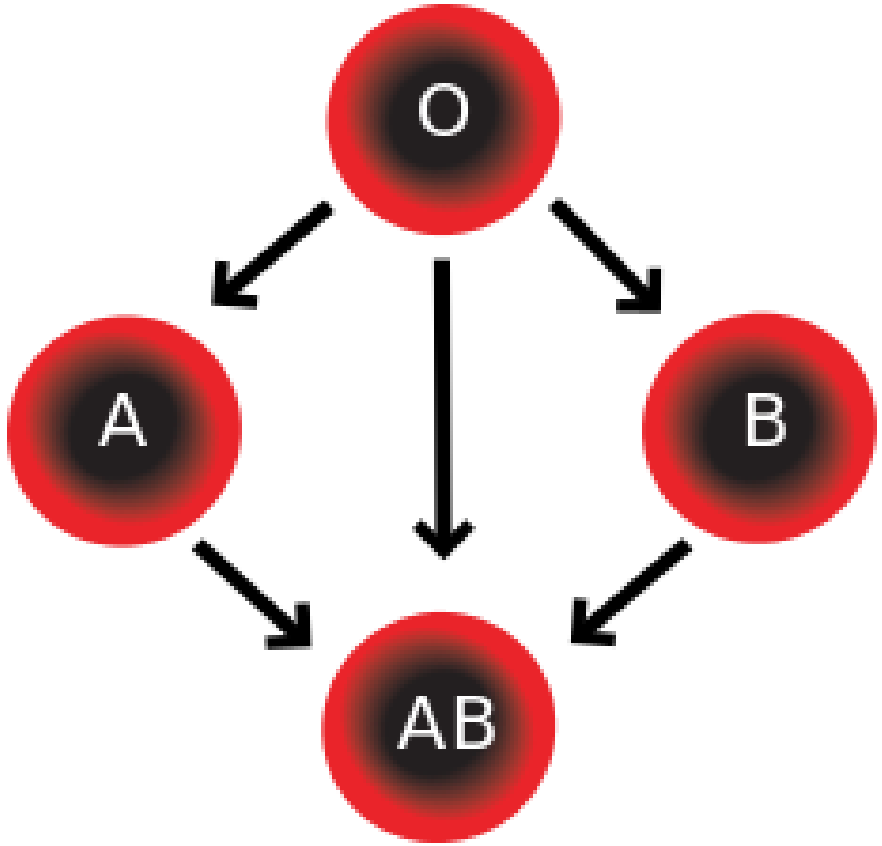
Cleveland Clinic

Transfusion Therapy

RED CELL TRANSFUSIONS

Transfusion of Red Cells

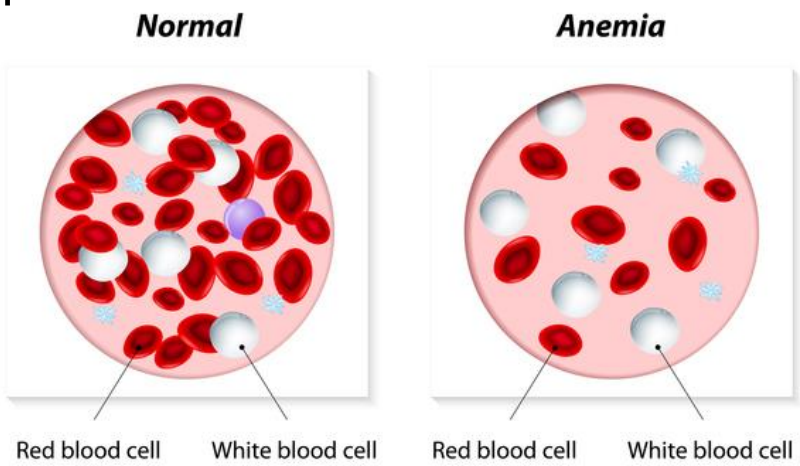
- When possible choose type specific red cells
- ABO compatible cells must be chosen



Clinical Indication for RBC transfusion

- Patients who need increased oxygen carrying capacity
- Surgery/traumatic bleeding
- Decreased RBC survival – hemolytic anemia
- Decreased bone marrow production – leukemia or aplastic anemia

Signs and Symptoms for RBC Transfusion
Pulse >100bpm
Respiration >30 breaths per minute
Dizziness, weakness
Chest pain



Levels Indicating RBC Transfusion

- **Levels indicating transfusion:** Hemoglobin of <7g/dL
  - In presence of disease may transfuse at 7-8 g/dL
- **Dosing:** 1 unit increases Hct 3% or Hgb 1 g/dL

Red Cell Exchange

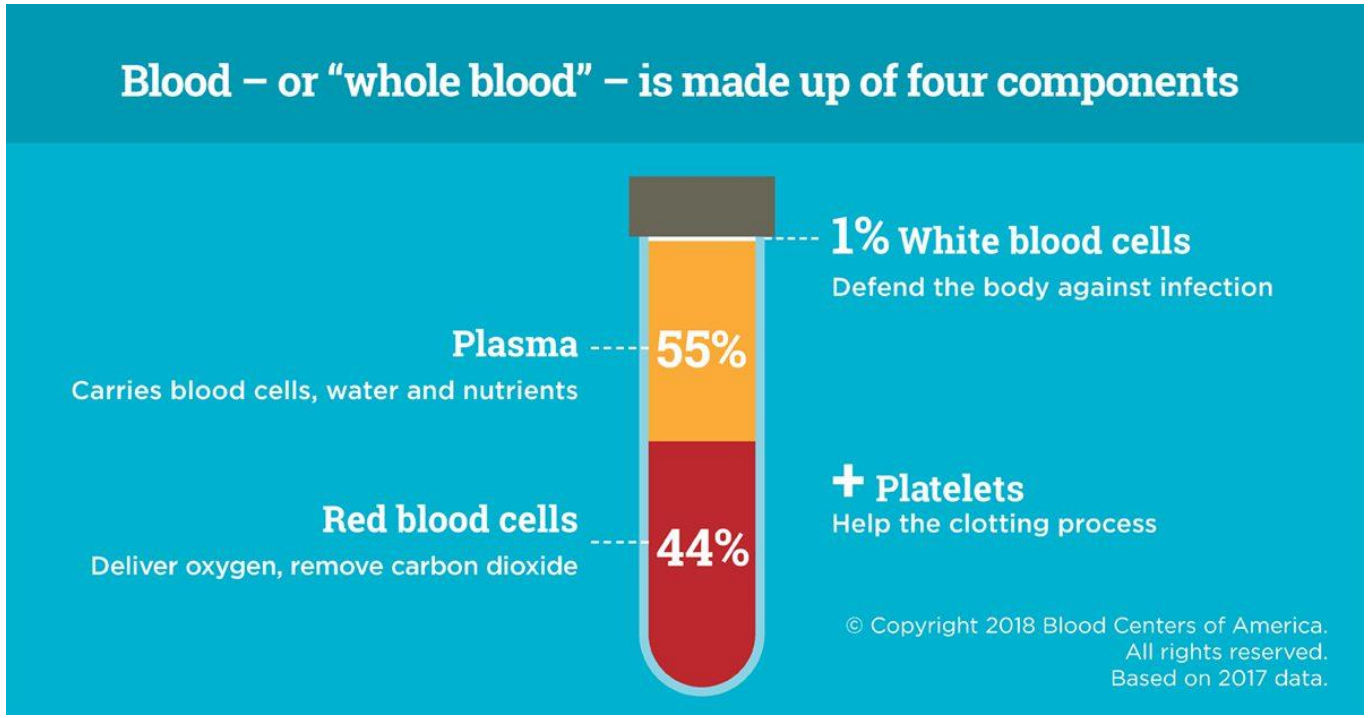
- Removes patient RBCs and replaces patient plasma/platelets along with compatible donor allogeneic RBCs
- Most common with sickle cell patients
  - Reduce levels of HgbS
- More rarely used for:
  - Malaria and Babesia infections (remove parasite load)
  - Remove incompatible RBCs

Intraoperative Blood Salvage

- Autologous blood collection during surgery
- Collect blood from surgical site, add anticoagulant, wash RBCs, and then re-infused
- Reduce use of allogeneic blood products

Clinical Indication for Whole Blood

- Replace loss of both RBC mass and plasma volume
- Very limited use
- Do NOT Use:
  - Anemia patients that have reduced RBCs but are compensated for by increased plasma volumes
  - Can cause volume overload

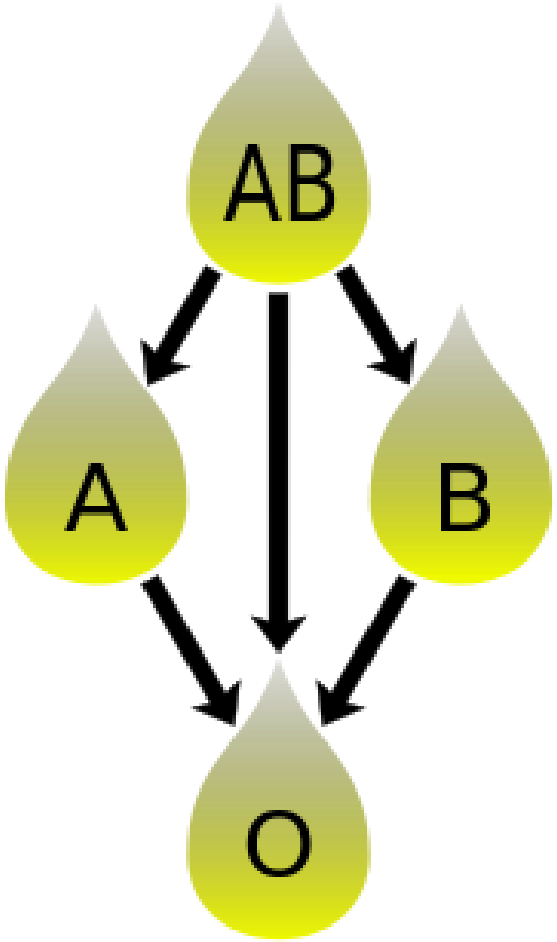


Must use ABO identical cells!

PLASMA TRANSFUSIONS

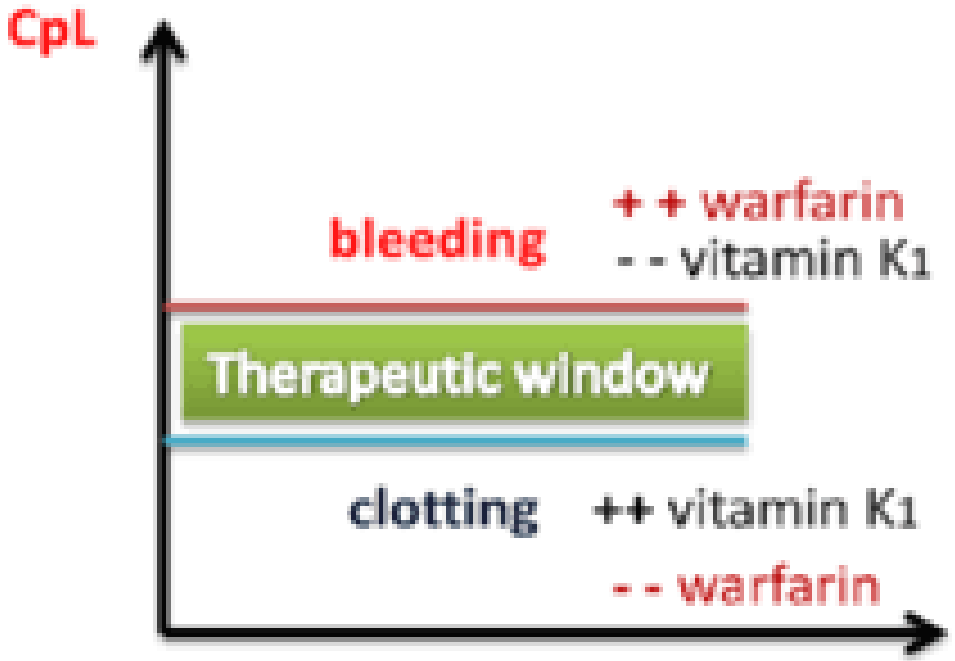
Transfusion of Plasma

- Give ABO type specific or compatible plasma
- Rh can be positive or negative



Clinical Indications for Transfusion of Plasma

- Treats multiple coagulation deficiencies
- Vitamin K Deficiency or warfarin overdose
  - Treat first with vitamin K orally, IV, or IM if liver function is adequate with adequate time before hemostatic event (surgery)
  - Give plasma if there is active bleeding or not enough time for warfarin reversal before surgery



Clinical Indications for Transfusion of Plasma

- Liver Disease or Liver Failure
  - Liver synthesizes coagulation factors and antithrombotic factors
  - In liver failure this synthesis is impaired
  - Give plasma before procedures or with active bleeding
- DIC (disseminated intravascular coagulation)
  - Plasma transfusion replaces consumed clotting factors

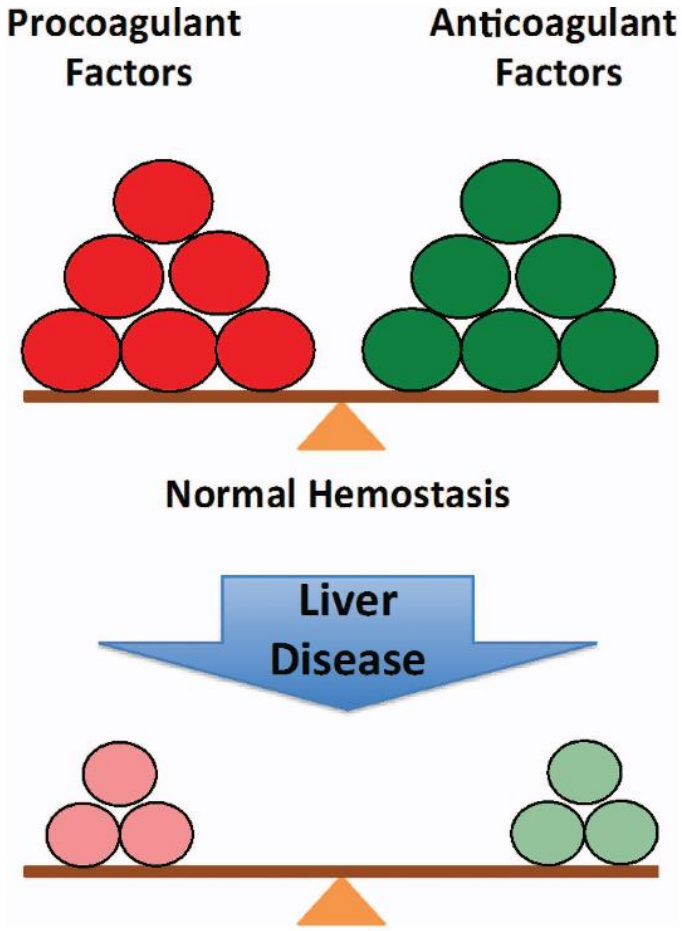


Figure 1. The normal balance of hemostasis and rebalanced h

Clinical Indications for Transfusion of Plasma

- Congenital coagulation factor deficiencies
  - Usually treated with single factor concentrates
  - Factor V, XI, XII deficiency treated with plasma – no factor concentrate available
- Massive transfusion – replenish coagulation factors

Levels Indicating Plasma Transfusion

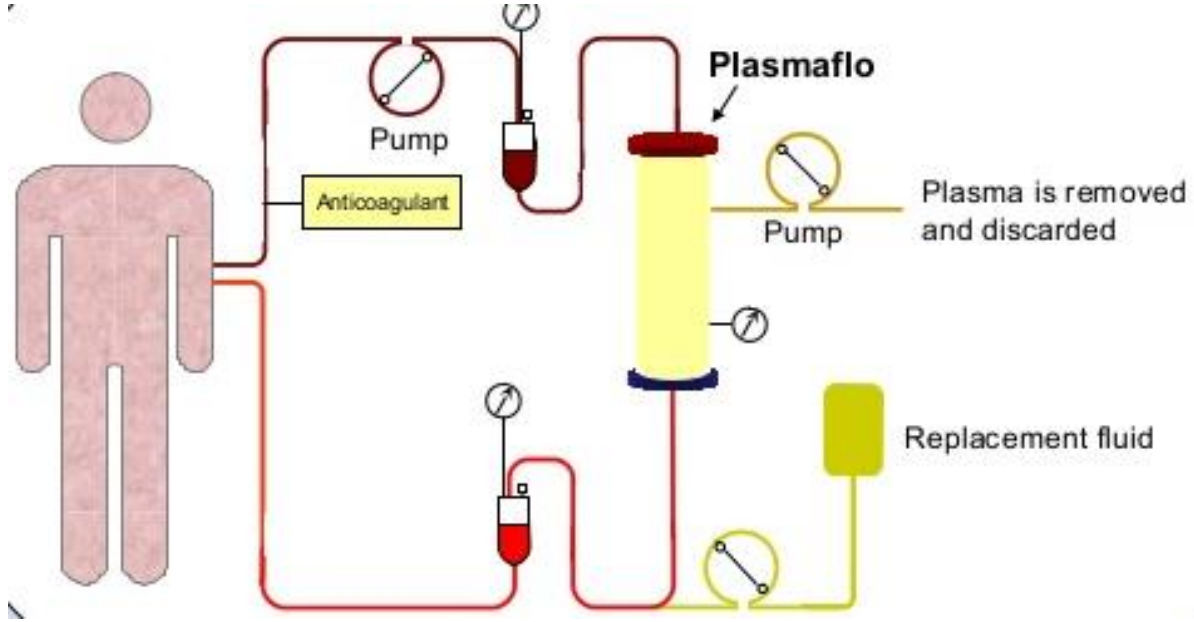
- PT INR of 0.8 to 1.1 is normal
  - Transfuse if PT is 1.5 times midrange of normal or INR >2.0
- APTT of 30-40 seconds is normal
  - Transfuse if APTT is >1.5 times the top of normal range

- **PT INR: measures how long it takes blood to clot**

Plasma Exchange

- Plasma removed and replaced with albumin, donor plasma, or both
- Remove disease provoking allo or auto antibody, immune complexes, abnormal proteins, or other toxic substances
- Requires multiple treatments

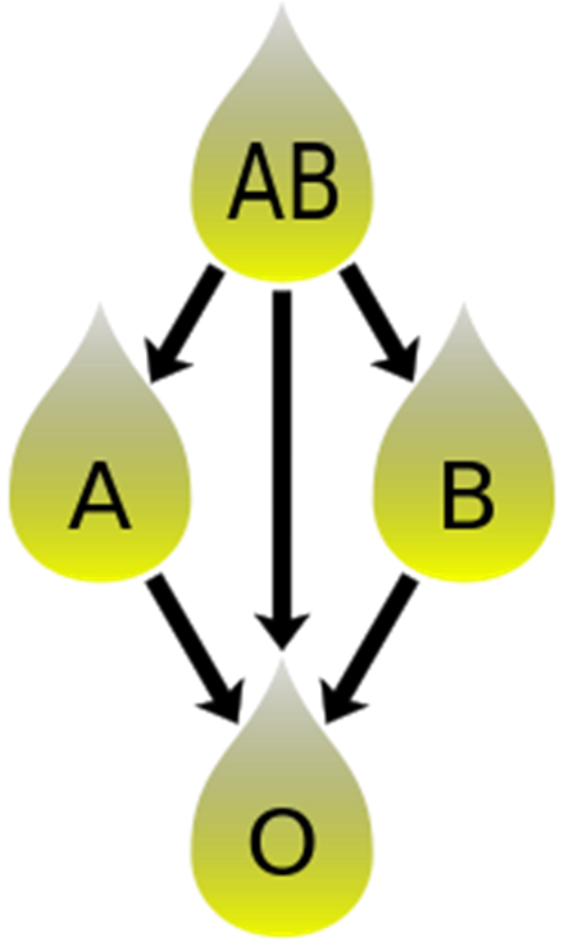
- Common indications for plasma exchange:
  - Thrombotic thrombocytopenic purpura (TTP)
  - Waldenstrom's macroglobulinemia
  - Guillain-Barre syndrome
  - Transplant rejection
  - Myasthenia gravis
  - Removal of HLA and ABO antibodies in preparation for solid organ and stem cell transplants



PLATELET TRANSFUSIONS

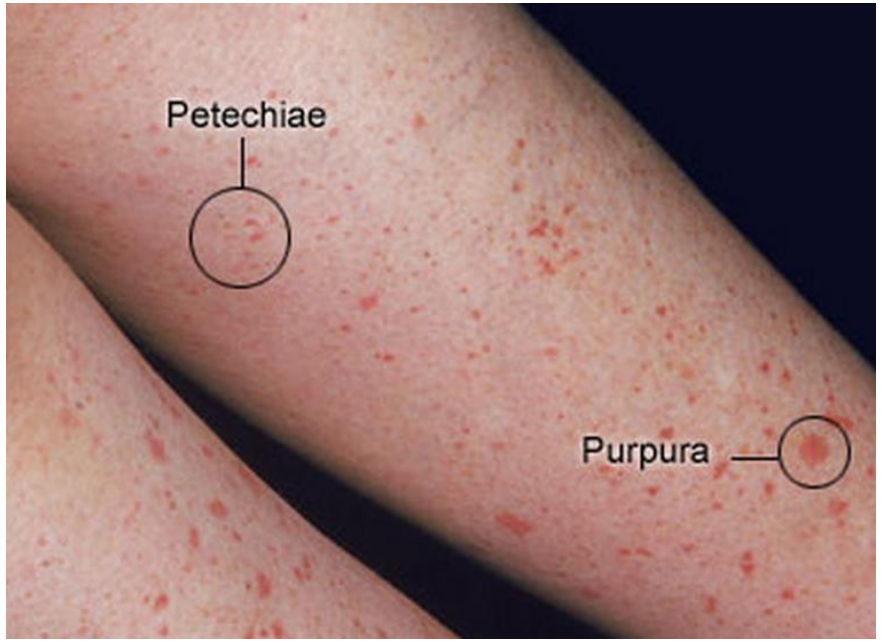
Platelet ABO Compatibility

- ABO antigens on platelets
- ABO antibodies in liquid portion
- Residual red cells: express Rh antigens
- Try to match ABO and Rh type to the patient
- Can receive out of type- smaller platelet count increases
- Women of child-bearing age that are Rh negative should always receive Rh negative



Signs/Symptoms for Platelet Transfusion

- Platelets essential for forming primary hemostatic plug
- Patients with severe thrombocytopenia can have:
  - Petechiae
  - Ecchymoses
  - Mucosal or spontaneous hemorrhage
- Thrombocytopenia can be due to:
  - Decreased platelet production (after chemotherapy for malignancy)
  - Increased platelet destruction (DIC)
  - Massive transfusion (rapid consumption of platelets)



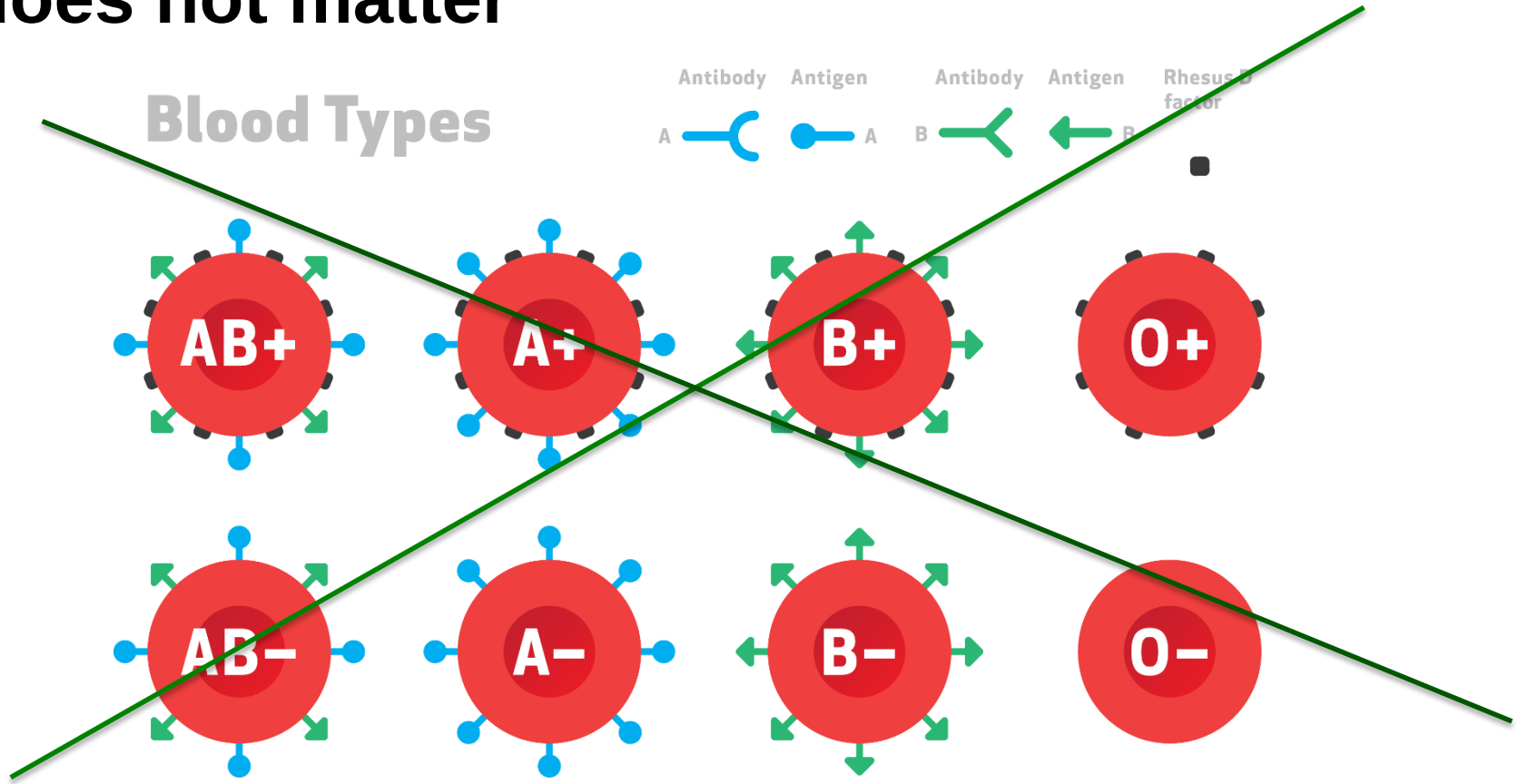
Clinical Indications for Transfusion of Platelets

- Normal platelet count: 150,000-450,000 platelets/µL
- Severe Thrombocytopenia with bleeding (low platelets)
- Bleeding, hemostatic challenge, DIC:
  - transfuse at <50,000 platelets/µL
- Intracerebral or pulmonary hemorrhage, cardiac bypass, or ECMO:
  - transfuse at <100,000 platelets/µL
- Chemotherapy for malignancy (decreased production)
  - <10,000 platelets/µL
- Massive Transfusion
  - <50,000-100,000 platelets/µL

CRYOPRECIPITATE TRANSFUSIONS

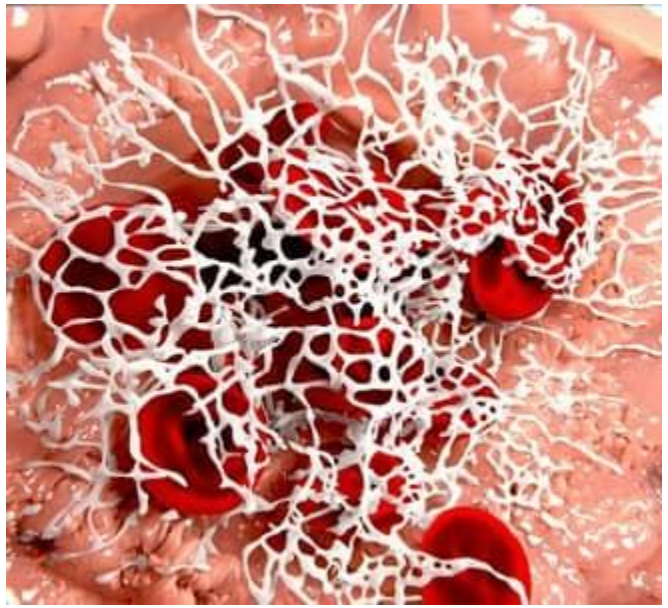
Cryo ABO compatibility

- Cryo is considered acellular
- ABO type does not matter



Clinical Indications for Transfusion of Cryo

- Contains fibrinogen, factor VIII, XIII, vWF, and fibronectin
- **Main use: fibrinogen replacement**
- Liver failure
- DIC
- Massive transfusion
- Congenital fibrinogen deficiency
- Normal fibrinogen range: 160-450 mg/dL
- Level of 100 mg/dL recommended for hemostasis during surgery/trauma



Cyroprecipitate Dosing

- One adult dose= 2 pools of 5 units
  - 1 unit per 5-10 kg
- Each unit of cryo concentrate must contain:
  - 150 mg fibrinogen
  - 80 IU of Factor VIII
- One pool therefore contains about 750-1,250mg fibrinogen

Cryoprecipitate Dosing Example

- Patient has a fibrinogen level of 30 mg/dL and the physician would like to raise this to 100 mg/dL (increase fibrinogen level by 70 mg/dL)
  - 1. Divide by 100 to convert mg/dL to mg/mL (70/100= 0.7mg/mL)
  - 2. Multiply by plasma volume (3,000 mL)- 3,000x0.7=2,100 mg
  - 3. Calculate number of pools needed (2,100mg/750mg/pool=2.8 pools)

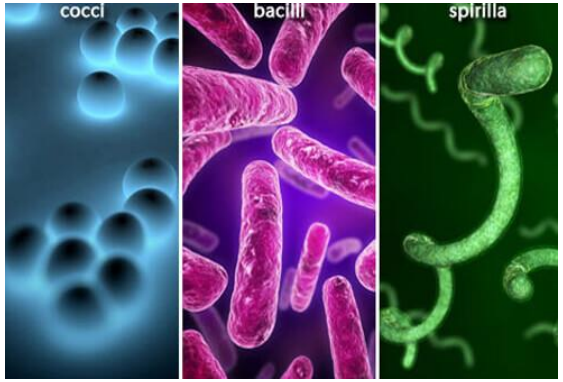
GRANULOCTYE TRANSFUSIONS

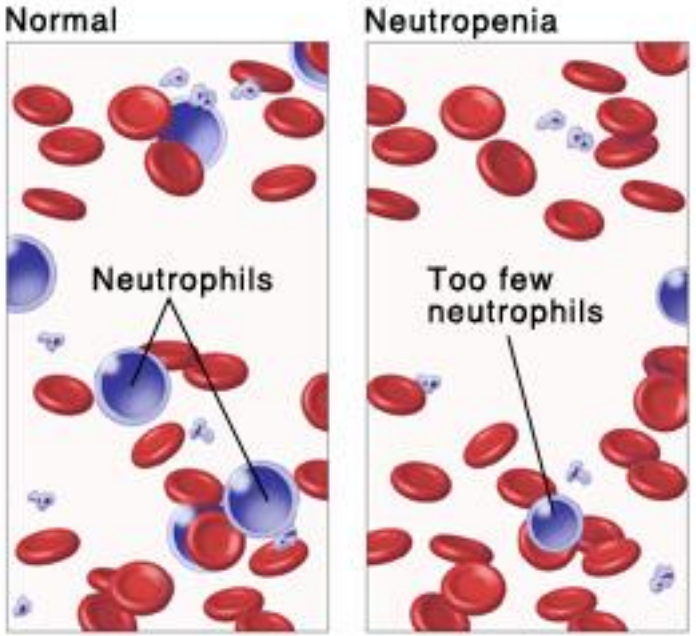
Granulocytes

- **Dosage:** 1 granulocyte daily for 4 or more days
- **ABO compatibility:** Must be crossmatched and ABO compatible due to high presence of RBCs

Clinical Indications for Transfusion of Granulocytes

- Severe neutropenia due to infection (<500µL/µL)
- Septicemia or bacterial/fungal infection
- Not responding to antibiotics





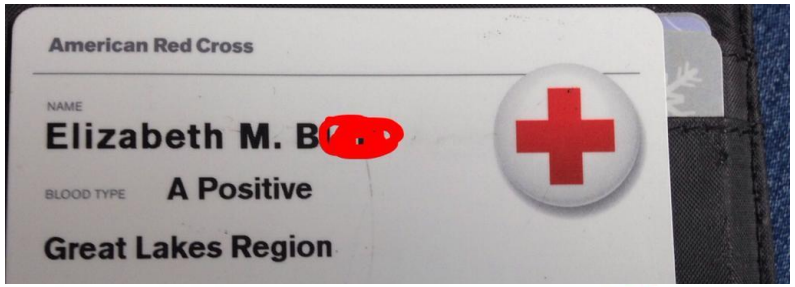
TRANSFUSION IN SPECIAL SITUATIONS

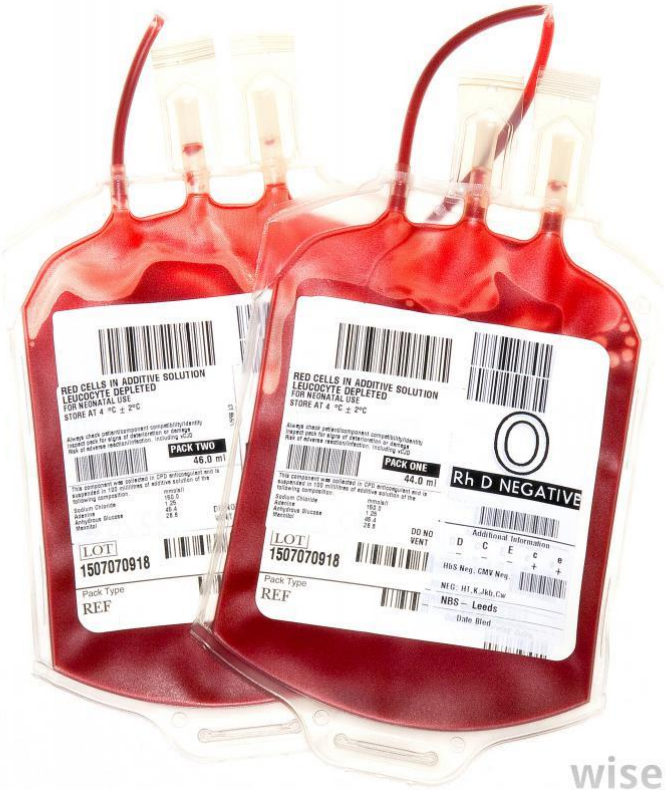
Transfusion in Special Situations: Sickle Cell Disease

- Chronically transfused with high rates of alloimunization
- Common to perform extended phenotype or genotype analysis and provide antigen matched units
  - If no current RBC antibodies – match the Rh and K antigens
  - If patient is already alloimmunized – match all significant antigens
- Patients often receive RBC exchange transfusions to replace sickled blood

Emergent Transfusions

- If not available blood type
  - Transfuse **O Negative RBCs**
  - Transfuse **AB or A plasma**
- If previous Rh positive blood type on file, can transfuse Rh positive RBCs
  - Females of child bearing age should receive Rh negative
- Physician must sign statement indicating the clinical situation was sufficiently urgent to release blood components
- Label must state that compatibility testing has not been performed
- All testing must be completed after transfusion





Massive Transfusion

- >10 RBCs in 24 hours or >4 RBCs per hour
- Standardize issue of blood in predetermined ratios
  - Usually 4-6 RBCs, 4 plasma, and 1 platelet
- If patient is Rh negative, may switch to Rh positive
- Give units lacking antigens patient has an antibody to
- With physician approval:
  - Give units without crossmatch
  - Give antigen untested units

Common Causes of Massive Transfusion

- Trauma- car accident, gunshot wounds, stabbings, etc.
- Obstetrics- pre/postnatal bleeding, DIC, abruption
- Surgery- liver, intestinal, and heart transplants, coronary artery bypass graft replacement, cardiac valve replacement, etc.
- Gastrointestinal bleeding
- Aneurysm- aortic, abdominal, or repair
- Bleeding with coagulation deficiency

Complications of Massive Transfusion

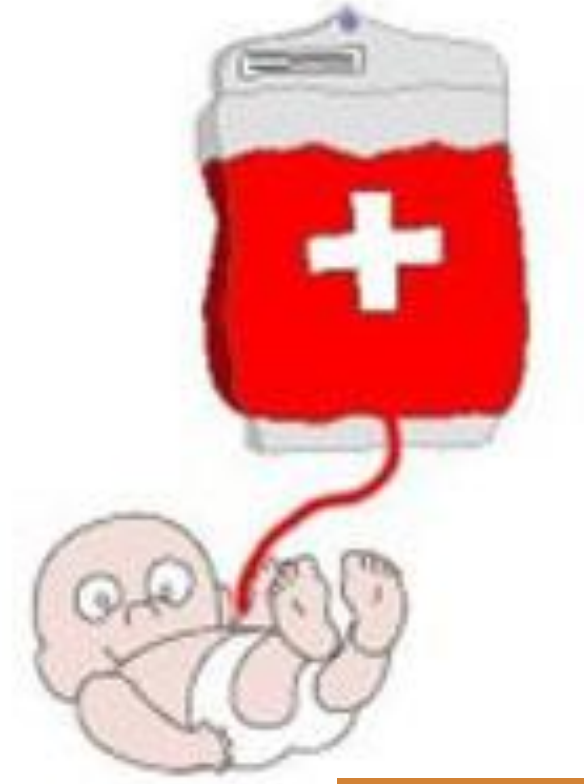
- Citrate toxicity and hypocalcemia – citrate in transfused blood binds up calcium in patient's body
- Hemostatic abnormalities – due to diluted platelets and coagulation factors
- Hypothermia
- Hyperkalemia or hypokalemia – extra K+ in supernatant of RBCs, can lead to heart problems
- Air embolism

Transfusion in Oncology Patients

- Bone marrow can be suppressed due to chemotherapy and radiation
- Patients with hematologic malignancies (Hodgin's disease or lymphoma) have increased risk of TA-GVHD due to chemotherapy treatments
  - Provide irradiated blood products

Neonatal Transfusion

- Group **O RBCs, Rh type specific**
  - Even if baby is A, B, or AB and we have completed testing, type O is transfused
  - Mom's antibodies are still present and could destroy transfused blood
- Unit <7 days old
  - 2,3-DPG declines as unit ages and neonates are less efficient at replenishing
  - The fresher the unit, the less plasma K+
- CMV negative
- Freshly irradiated (irradiation increases plasma K+ levels, therefore don't want blood irradiated long ago)
- Hemoglobin S negative
- Usually transfused in small-volume aliquots from the same donor to reduce the number of exposures to different donors

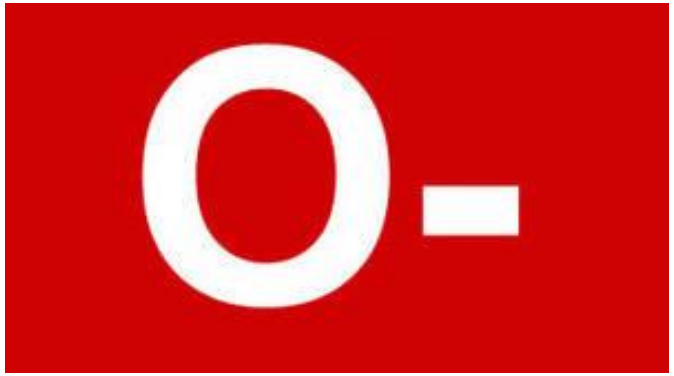


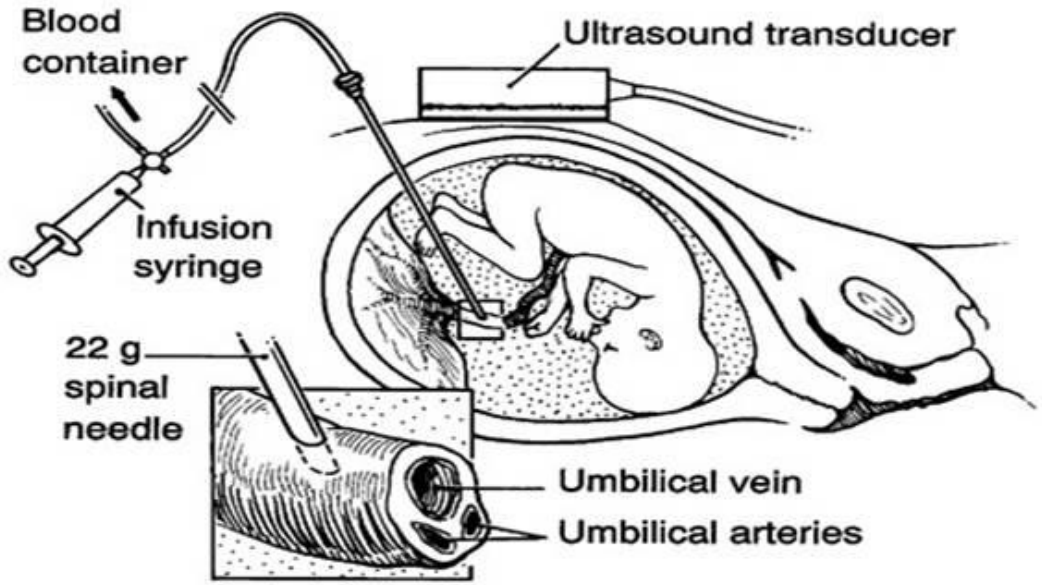
O-

O+

Intrauterine Transfusion

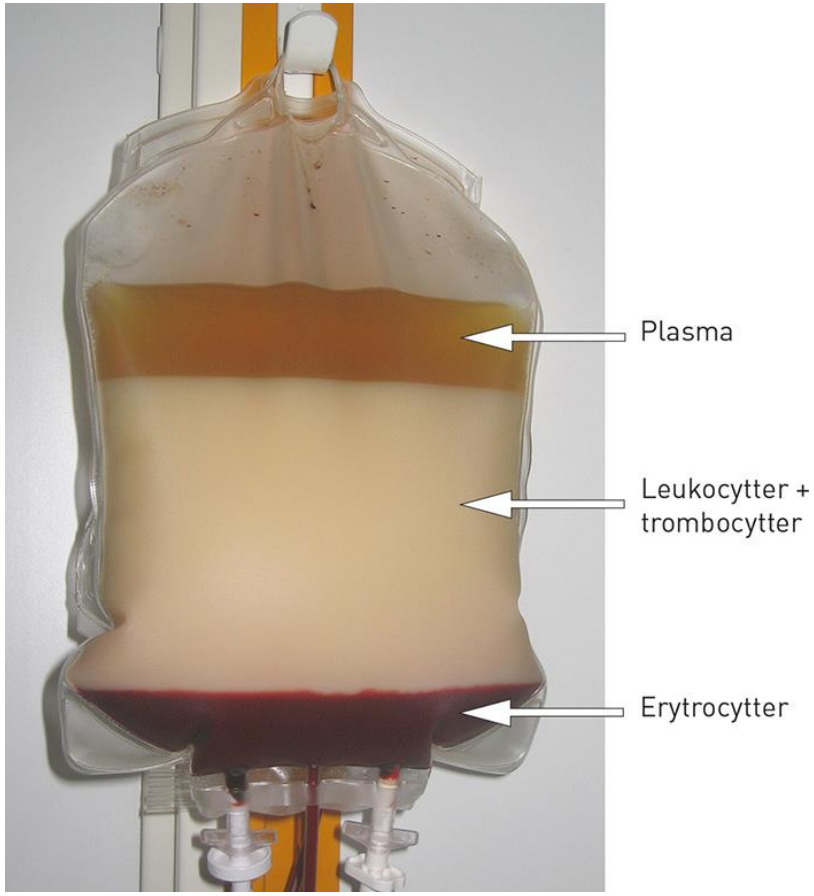
- Similar to Neonatal transfusion
- Group **O negative-** baby's blood type is unknown
- Unit <7 days old
- CMV negative
- Freshly irradiated
- Hemoglobin S negative





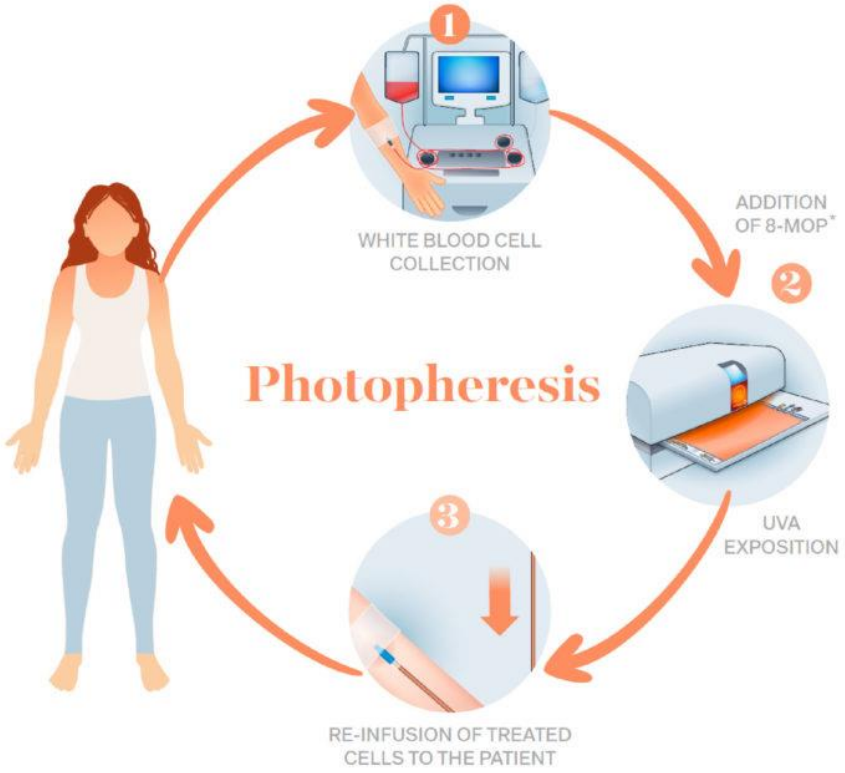
Cytapheresis

- Reduce or remove excessive or abnormal cellular elements in blood
- Leukapheresis:
  - Used to treat patients with hyperluekocytosis (WBC count >100,000/µL)
    - Can cause organ dysfunction due to formation of microthrombi
  - Used to reduce the amount of circulating WBCs
  - Acute myelogenous leukemia (AML)
- Plateletpheresis or thrombocytapheresis:
  - Treat patients with abnormally elevated platelet counts (>500,000/µL)
  - Can cause thrombotic or hemorrhagic complications
  - Essential thrombocythemia, polythycemia vera, chronic myelogenous leukemia



Extracorporeal Photopheresis

- Patient leukocytes collected and exposed to 8-methoxypsoralen and UV light to prevent DNA replication and reinfused
- Diseases treated:
  - Cutaneous T-cell lymphoma
  - Sezary syndrome
  - Steroid-resistant chronic GVHD
  - Solid organ transplant rejection

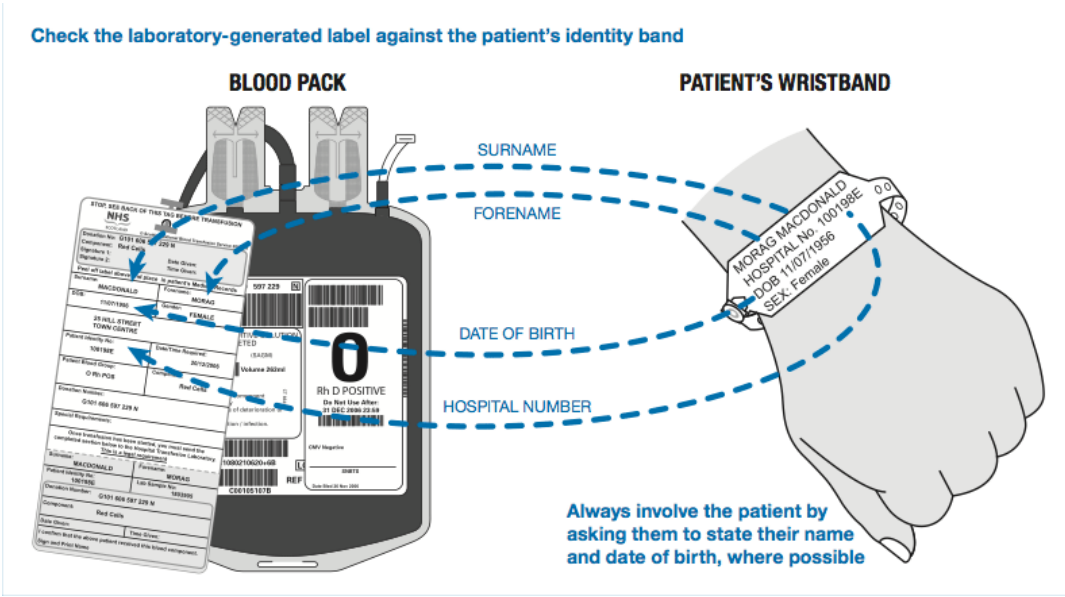


Selective Adsorption

- Ligand is bound to a column
- Plasma is separated using plasmapheresis and perfused through the column
- Selectively removes the unwanted substance by a antigen-antibody or chemical reaction
- Treated plasma is returned to the patient
- Examples:
  - Removal of LDL in Familial hypercholesterolemia
  - Charcoal for removal of bile acids
  - Polymixin B for removal of endotoxin
  - Cellulose acetate for removal of granulocytes and monocytes

Blood Administration

- All transfusion components must be ordered (prescribed) by a physician
- Transfusion recipients must sign a consent form
- Verifications at bedside:
  - Recipient's 2 identifiers (name, DOB, MRN, etc)
  - Recipient and donor ABO and Rh
  - Interpretation of crossmatch tests
  - All special transfusion attributes were performed (ex. Irradiation, CMV negative, etc.)
  - Blood product expiration
  - 2 individuals match patient wristband to patient info on blood product
  - All identification must remain attached to the unit until transfusion is complete



Blood Administration Cont.

- RBC products should be transfused with 0.9% sodium chloride (no other fluid is acceptable)
- Blood products usually administered over 1-2 hours (not to exceed 4 hours)
- Observe recipient closely for the first 15 minutes and periodically thereafter for any adverse reactions
- Document in the medical record:
  - Transfusion order
  - Patient consent
  - Component name and donor ID
  - Donor ABO/Rh
  - Vital signs taken throughout the transfusion
    - Before, during, and after
  - Amount of blood transfused
  - Identification of transfusionist
  - Any transfusion-related adverse events

Cleveland Clinic

Every life deserves world class care.