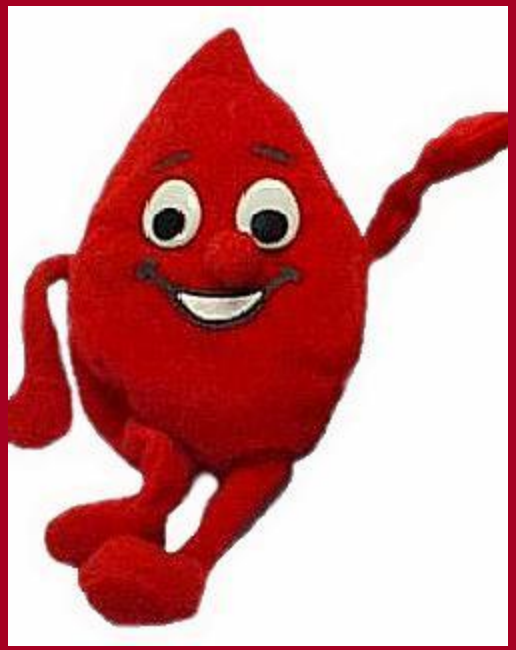
Blood Components & Indications for Transfusion



Neda Kalhor

Blood products

- **Cellular Components**:
  - Red blood cells
    - Leukocyte-reduced RBCs
    - Washed RBCs
    - Irradiated RBCs
  - Platelets
    - Random-donor platelets
    - Single-donor platelets (Apheresis Platelets)
  - Granulocyte

Blood products

- **Non-cellular Components**:
  - fresh-frozen plasma (FFP)
  - Cryoprecipitate
  - Cryoprecepitate-Depleted Plasma
  - factor concentrates (VIII, IX)*
  - Albumin*

* Provided by pharmacy

Red cells

- Appx Hct is 75%
- Appx volume is 250 ml (RBC 200ml; 50ml plasma)
- With Adenine-Saline added (100ml within 72 hours of phlebotomy) the Hct is 60% and appx volume is 330 ml

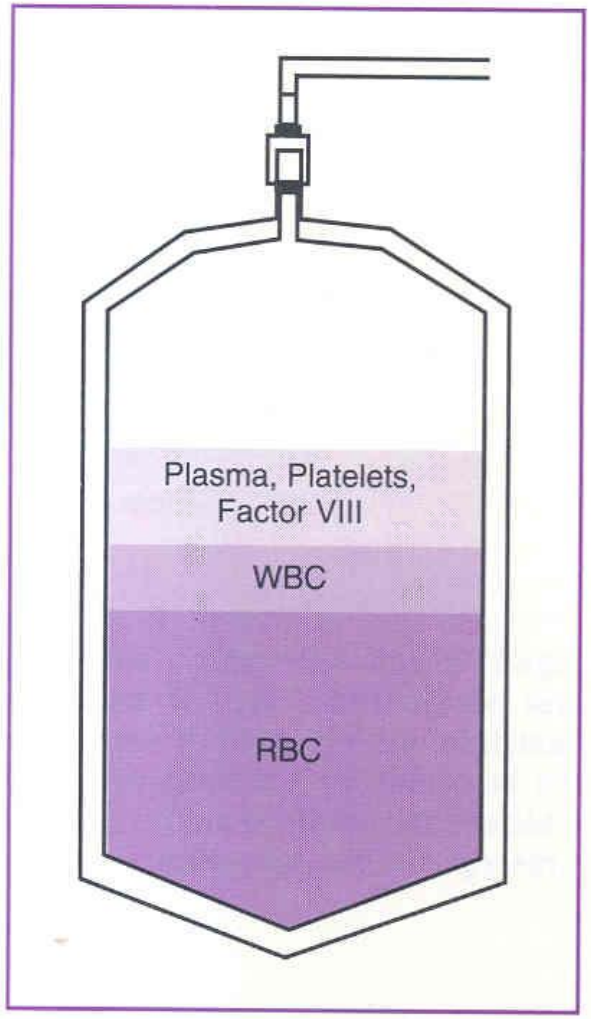
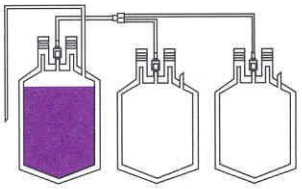
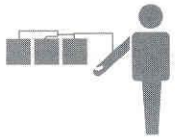
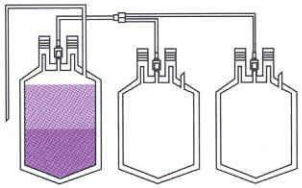


FIGURE 9–3 Separation of various components in a unit of whole blood after settling/centrifugation.

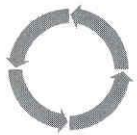


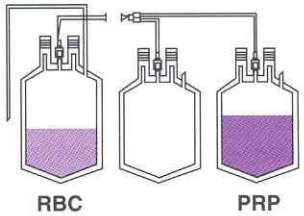
Step 1
Whole blood is in Bag A (primary bag). Bag B (platelet bag) and Bag C (plasma bag)are termed "satellite bags."



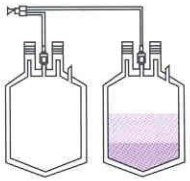


Step 2
Bags are spun in centrifuge, seperating components within primary bag. Platelet-rich plasma rises to the top; red blood cells sink to the bottom.

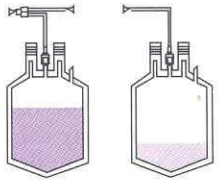




Step 3
Platelet-rich plasma (PRP) is forced into Bag B; red blood cells (RBC) remain in the bottom of Bag A. Bag A is separated from Bags B and C. Red blood cells are stored at 4 to 6°C.



Step 4
Bags are spun again, longer and harder than initial spin. Plasma and platelets are separated in Bag B. Plasma rises to the top; platelets sink to the bottom.



Step 5
Plasma is forced into Bag C. Bags B and C are separated. Bag B contains a platelet concentrate in 40 to 70mL of plasma. Plasma in Bag C can be made into fresh frozen plasma or other products.

Other compatible diluents

- High Hct with resultant high viscosity may slow transfusion rate. Diluents that may be used:
  - 0.9% NaCl
  - ABO compatible plasma

Storage

- The **shelf life** of blood is dictated by the recovery rate of transfused cells 24 hours after transfusion; this value must average 75% or more. At 1-6 C:
  - With CPD : 3 weeks
  - With CPDA-1: 5 weeks
  - With AS : 6 weeks

Leukoreduced products

- Now, most red cells are leukoreduced
- Cellular blood products with a leukocyte content of less than 5×10^6/unit
- Currently achieved by the use of filters which achieve 99.9 % reduction
- Filtration is done at the blood center*, laboratory or bedside.
- Can also be achieved on apheresis devices

* Our hospital

Why Leukoreduce?

Leukocytes have been implicated in several adverse effects of transfusion

- Alloimmunization in the recipient
  - febrile non hemolytic transfusion reactions
  - Platelet refractoriness
  - Transplant rejection
- Infections
  - CMV, HTLV, EBV
  - bacteria
  - ?prion disease transmission
- Immunosuppression

- Alloimmunization and platelet refractoriness: 50% of patients undergoing multiple transfusions become alloimmunized and are refractory to platelet transfusion

- Immuno-suppression: There is increasing evidence that allogeneic blood transfusions have a major impact on the immune system of patients undergoing surgery who require transfusion. Transfusion-associated immune suppression results in increased incidence of infection in transfused patients after trauma and surgery

WBC associated viruses

- Risk per three unit transfusion episode

virus	incidence
CMV	*
EBV	1:333,333
HHV-8	N/A
HTLV 1&2	1:23,333
HIV	1:2,000,000

* Approximately 50-80% of blood donors have antibodies to CMV. Asymptomatic infections in transfusion recipients have been reported at 9%. Infection and adverse consequence risk is greater in immune compromised transfusion recipients

Washed red cells

- 99% of plasma is removed
- Shelf life of **24 h** after washing
- Appx volume is 180 ml and Hct 75%
- Indications:
  - History of severe or frequent allergic transfusion reactions
  - Paroxysmal nocturnal hemoglobinuria
  - IgA deficiency
  - Hyperkalemia, especially in a child or infant

Irradiated blood cells

- Prevention of transfusion-associated GVHD
- Irradiated with cesium-137 or cobalt-60
- Shelf life: 4 weeks or original date of expiration, whichever comes first

Transfusion Associated GVHD

- Possible mechanism
  - donor lymphocytes undergo multiplication in an immunocompromised host and recognize host tissue as foreign
- Signs appear within 3-50 days
  - fever, skin rash, diarrhea, marrow aplasia
  - mortality rate ~90%

Absolute indications for irradiated products

- Congenital cellular immune deficiency
- Allogeneic and autologous stem cell transplant
- Hodgkins disease
- Granulocyte transfusions
- Intrauterine transfusion
- Biologic relatives

Relative indications for irradiated products

- Premature neonates <1200g
- Hematologic malignancies treated with cytotoxic agents
- HLA matched or crossmatched platelets
- High dose chemotherapy
- Neuroblastoma
- Rhabdomyosarcoma

Controversial

- Solid organ recipients
- Large volume transfusions in full term infants
- Aplastic anemia not on immunotherapy

Not indicated

- HIV
- Hemophilia
- Term neonates on ECMO
- Small volume transfusions in term infants
- Elderly patients
- Immunocompetent surgical patients
- Pregnancy
- Sickle cell disease, etc
- Patients with most solid tumors

Question

- 21yo Pt with bladder rhabdomyosarcoma, who received chemotherapy, developed MDS. He received BMT x 2, with first one (cord BMT) rejected and 2nd one (autologus BMT) was 30 days ago.
- Request of 2 U of RBC and 3 U PLT.
- Request of washed, irradiated, CMV(-), and leukocyte-reduced RBC

- Is there an indication for washed RBCs ?

Frozen RBCs

- RBCs can be frozen and glycerol is used as the cryoprotective agent
- Indications
  - long term preservation of rare blood groups
  - red cells known to lack multiple antigens
  - autologous blood
- Unit can be stored up to 10 years
- Once thawed, unit washed to remove glycerol; thus must be used within 24 hours
- Appx volume 180ml and Hct 75%

Platelet transfusion

- Platelet
  - Random donor
  - Single donor (Apheresis Platelets)

Platelet transfusion indications

- Thrombocytopenia
  - Thrombocytopenic bleeding, massive tx
  - Prevention of spontaneous bleeding
  - For surgery or invasive procedure if count is <50,000
- Platelet dysfunction (thrombocytopathia)
- Some combination of above

Indications in thrombocytopenia

- Plt < 5000; greatest risk of spontanous, life-threatening hemorrhage
- 5000- 10'000; increased risk of spontaneous hemorrhage
- 10'000- 50'000; an increased risk of hemorrhage during hemostatic challenge
- >50'000; bleeding unlikely

Platelet dysfunction in uremia

- Alteration of the PLT-membrane receptor for VIII-vWF
- Treatment:
  - DDAVP (increased secretion of VIII-vWF)
  - Epo
  - Conjugated estrogens
  - Cryo
  - Keep hematocrit at 30- 35

Platelet Transfusion not indicated

- Not indicated in TTP, ITP, heparin-induced thrombocytopenia
- Sepsis-associated thrombocytopenia may be unresponsive to Plt transfusion
- Uremia-associated plt dysfunction is unresponsive to plt transfusion

Platelets (random donor)

- Platelets, plasma, leukocytes, <0.5ml of RBC
- Volume 50 -70ml
- Lifespan: 10 days
- Stored at 20-24 C (room temperature), for a maximum of 5 days
- Frequently pooled ; if pooled should be used in 4 hours
- Washed platelets: 4 hours
- **One unit** of platelets usually increase the platelet count in a 70 kg person by **5000-10,000/uL**

Platelets (random donor)

- Platelets have Platelet specific antigens, ABO and HLA antigens
- The contaminating RBCs have Rh antigens
- Whenever possible ABO compatible platelets should be used
- D negative individuals should receive platelets from D negative donors, (if not give RHIG)

Single-donor platelets (Apheresis)

- Platelets, plasma, most are leukocyte reduced, <0.5ml RBC
- A dose of platelets collected from a single donor using apheresis techniques
- platelet content is equal to 5-6 units random platelets
- Appx volume is 200-400 ml
- Reduction in donor exposures and risk of alloimmunization

- Indications
  - for HLA matching or crossmatching for refractory patients
  - minimal donor exposure

Neonatal alloimmune thrombocytpenic purpura

- Maternal anti-PlA1 crosses placenta
- Rx: washed maternal platelets

Granulocyte transfusions

- Granulocyte and other WBC, RBC (2ml), platelet and plasma
- Should be given once daily for at least 5 days
- Appx volume 200-300 ml
- Stored at 20 - 24 C
- Transfused within 24 hours
- Indication: Granulocytopenia with persistent fever or infection not responding to antibiotic or antifungal therapy in patients whose bone marrow function is expected to recover

FFP

- Plasma separated from red cells of a donor within 6 hours is "FFP"
- All coagulation factors and other proteins
- Volume 200 -260ml
- Stable for 1 year at -20

FFP

- "Plasma Protein Fraction" contains *albumin* (85%), *gamma globulin* (1%), *Na* and *K*. It can be used as a volume expander, or to treat hypoalbunemia or hypoproteinemia

- 70% of original Factor VIIIc and at least similar quantities of the other labile coagulation factors and naturally occuring inhibitors

Plasma

- Indications
  - bleeding with multiple factor deficiencies
  - deficiency of factors V or XI
  - PT/ PTT > 1.5 x normal
  - replacement fluid in plasmapheresis
  - Dose 10- 20ml/kg (4-7 units for a 70 Kg adult) will increase coagulation factors by 30%

Cryoprecipitate

- Contains factors VIII, XIII, vWF, fibrinogen and fibronectin
- Indications:
  - Hypofibrinogenemia
  - Von Willebrand disease unresponsive to DDAVP
  - Uremia
  - Hemophilia A (factor VIII concentrate available)
- Appx volume 10-15 ml
- Generally transfused in pools of 6 units which increases fibrinogen level by 30-60 mg/dL
- For uremic bleeding, the dose of CRYO is 6-10 units

Cryoprecepitate-poor plasma

- The product after removing cryoprecepitate
- **Cryosupernant (Cryosuper)**
- A source of all coagulation and plasma proteins, except for factor VIII, fibrinogen, von Willebrand factor and fibronectin
- Stable for 5 years if stored in -20 C

Question

- 70 yo female with liver transplant one month ago, now with oozing from cath Site.
- Blood bank was requested for 20 U cryo.
- Fibrinogen: 330
- Is there an indication for cryo?

Acknolwedgment

Orieji Illoh, MD
Amer Wahed, MD