بسم الله الرحمن الرحيم

Pediatric Blood Transfusion

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Whole Blood

MD-3-49

Anticoagulants Used for WB?

- ACD & CPD preserve the unit for 21 days at 2-6ºC.
- CPDA-1 (anticoagulant/preservative for 35 days).
- C = Citrate→ to prevent clotting
- P = Phosphate→ to maintain pH
- D = Dextrose→ ATP generation
- A = Adenine-1→ substrate from which RBC produce ATP

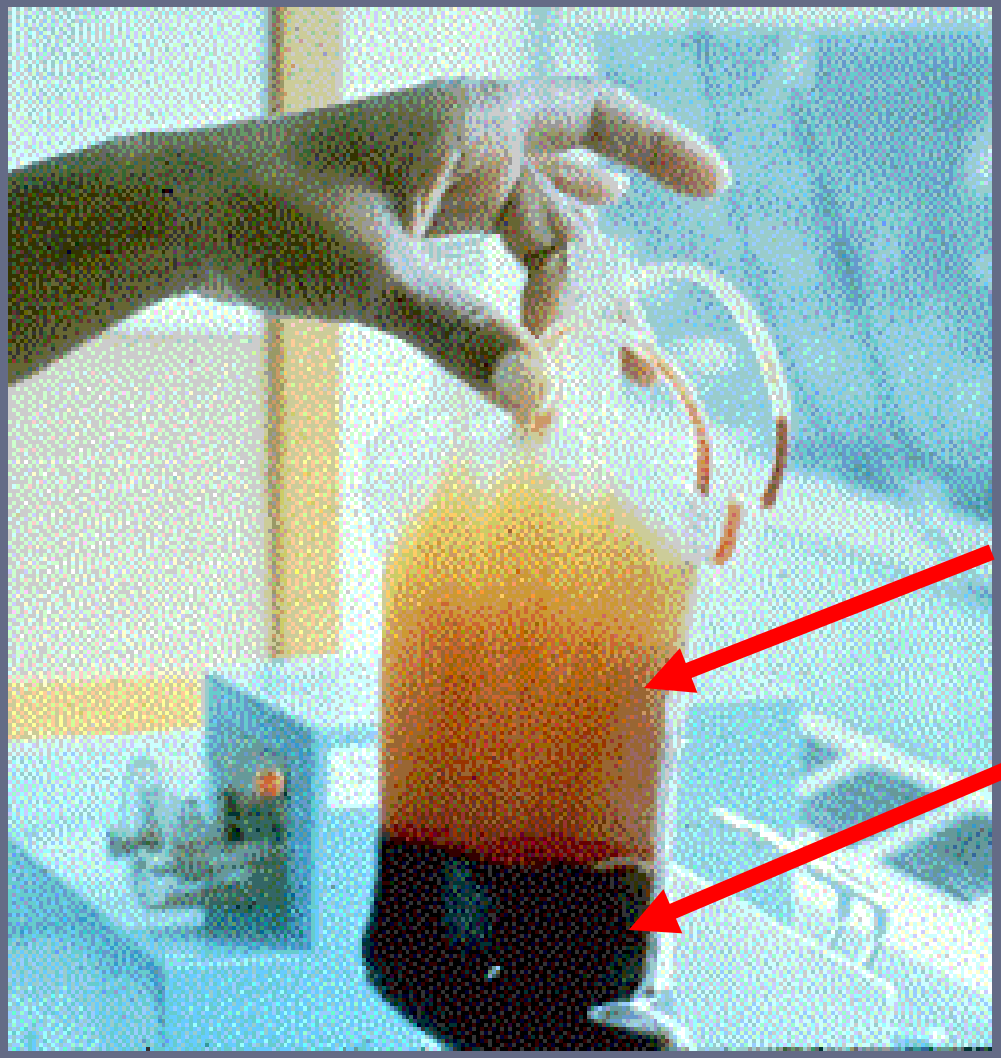
Anticoagulant ratio is 1.4 ml:10ml blood (63ml / 450ml)

Centrifugation Types?

There are two types of centrifugation:-

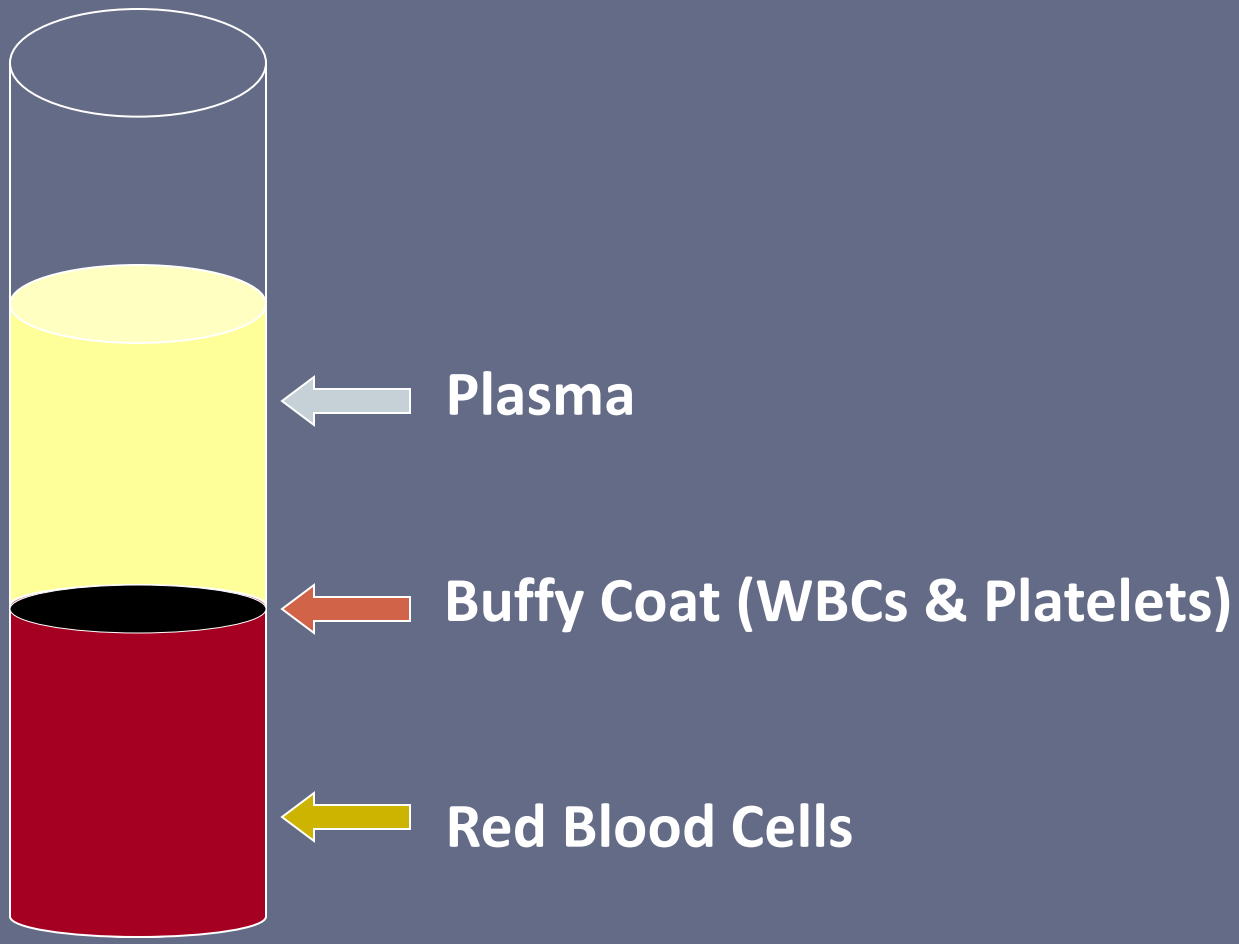
- **Light spin; (2000 rpm at 20ºC for 11 min)**
- **Heavy spin; (3500 rpm at 20ºC for 11 min)**

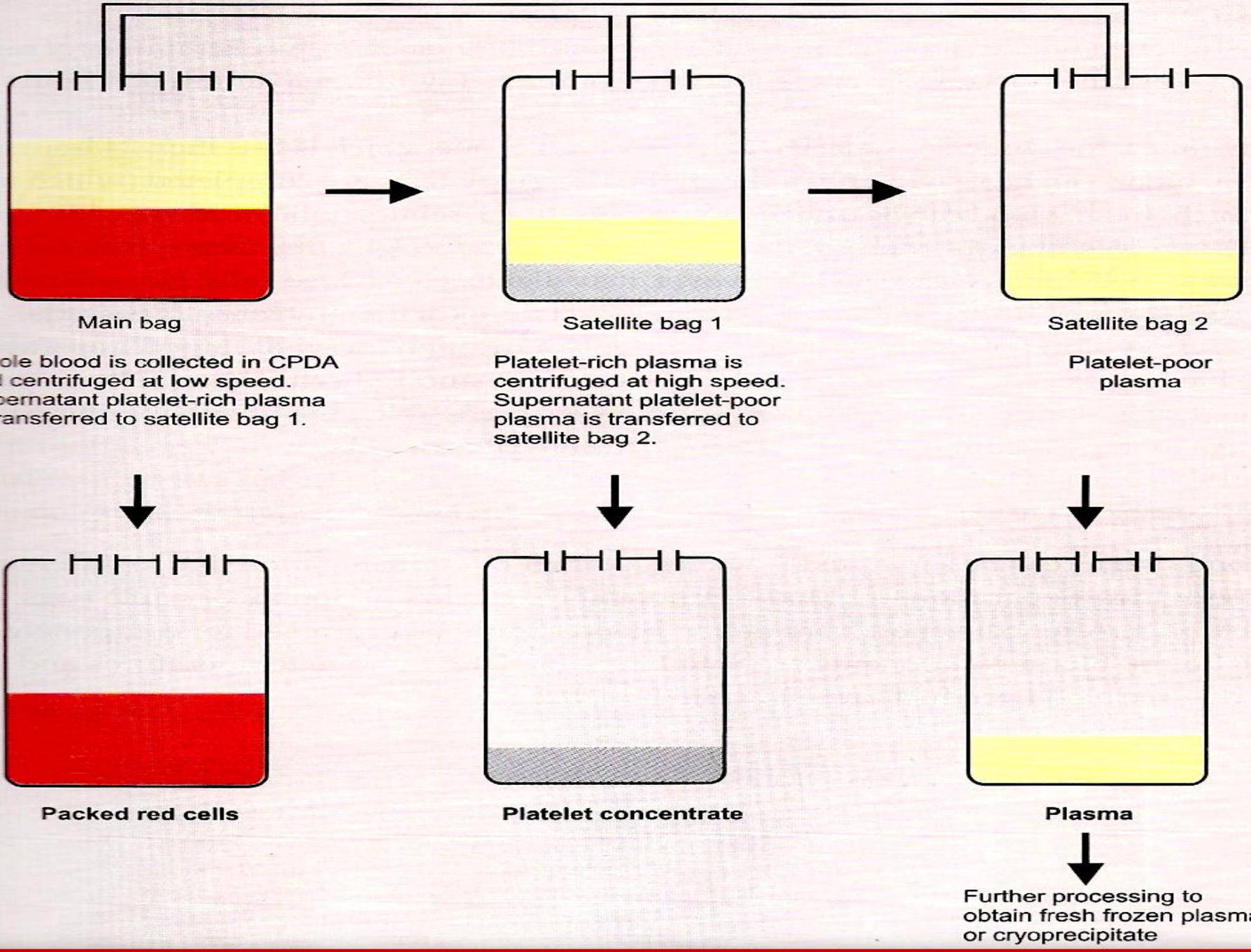
Whole Blood Unit

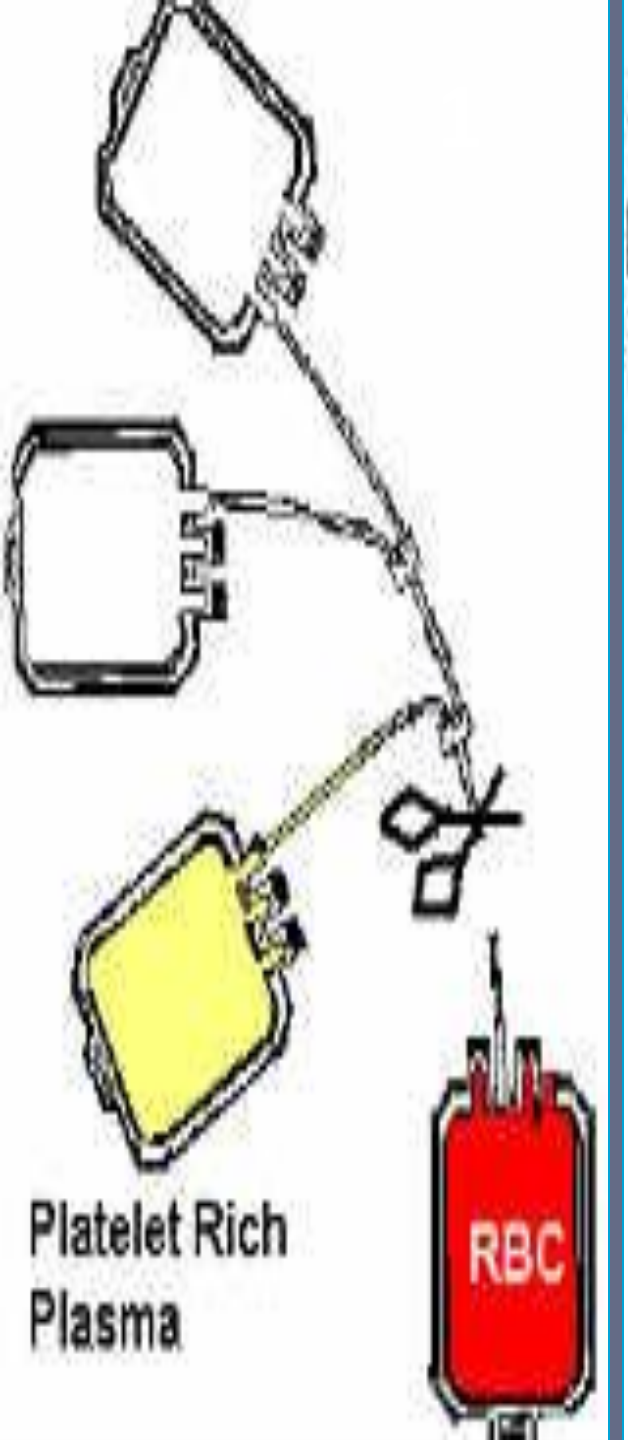


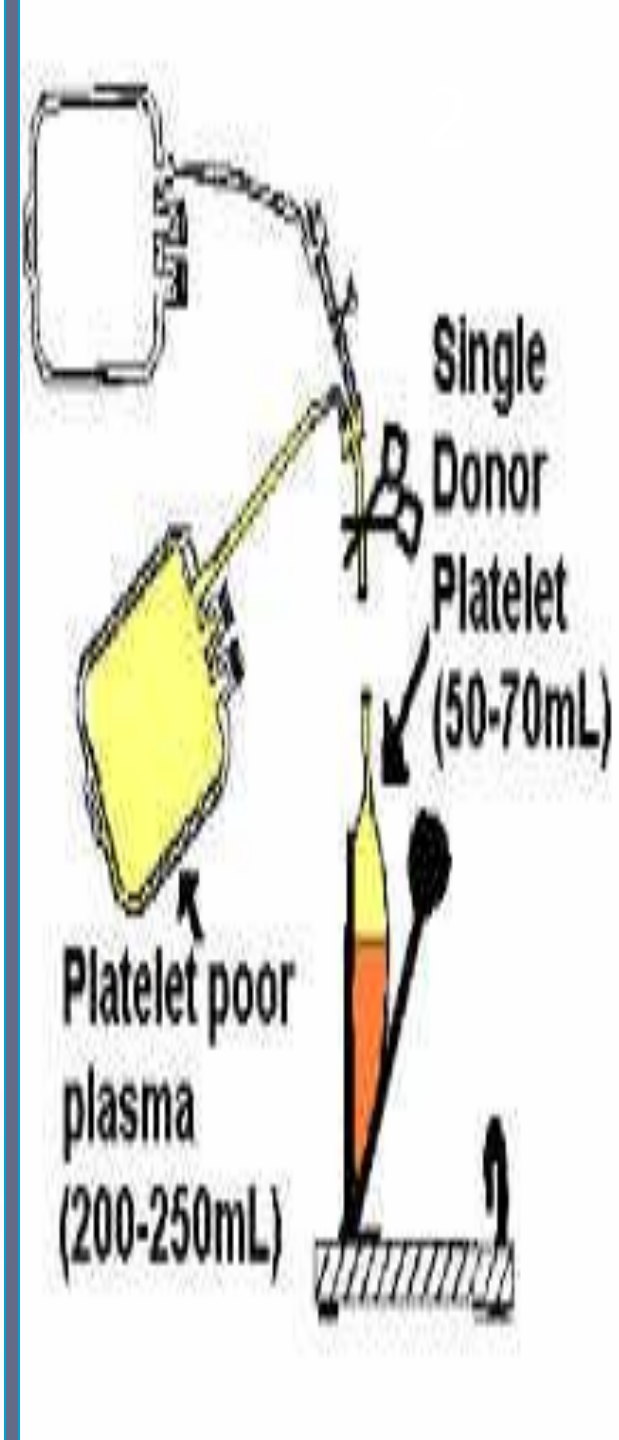
After centrifugation WB separates into **plasma & platelets** & **PRBCS**

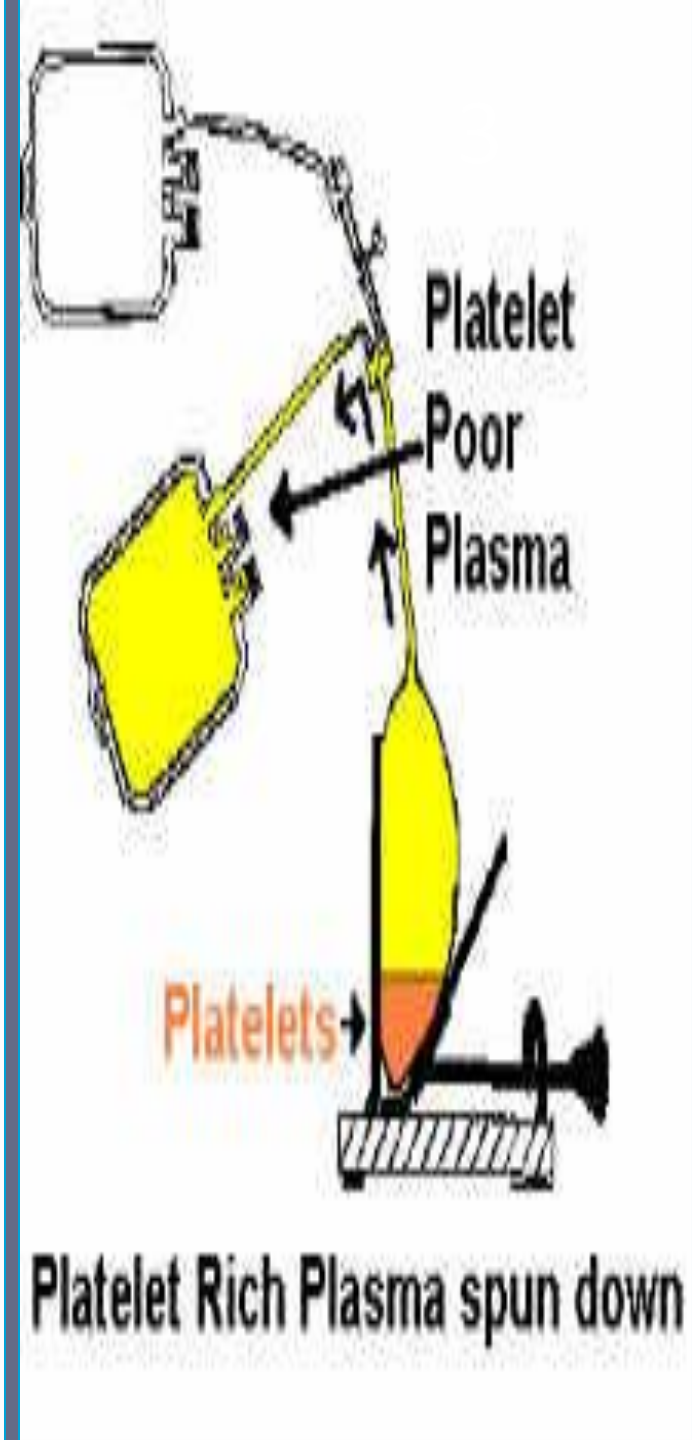
Centrifuged blood




Main bag
Satellite bag 1
Satellite bag 2
Whole blood is collected in CPDA and centrifuged at low speed. Supernatant platelet-rich plasma is transferred to satellite bag 1.
Platelet-rich plasma is centrifuged at high speed. Supernatant platelet-poor plasma is transferred to satellite bag 2.
Platelet-poor plasma
Packed red cells
Platelet concentrate
Plasma
Further processing to obtain fresh frozen plasma or cryoprecipitate


Platelet Rich
Plasma
RBC


Single
Donor
Platelet
(50-70mL)
Platelet poor
plasma
(200-250mL)


Platelet
Poor
Plasma
Platelets
Platelet Rich Plasma spun down

WHOLE BLOOD

Indication

- Acute , active blood loss with hypovolaemia
- Exchange transfusion

Contraindication

- Risk of volume overload : Chronic anaemia
  Incipient cardiac failure

WHOLE BLOOD

Administration

- Must be ABO and RhD compatible
- Never add medication to a unit of blood
- Use blood administration set

Dosage ,Storage

10-15cc/kg

2hr infusion(max 4)

2-6.c ref.

Packed red cell

Packed Red Cells

Indication

- Replacement of red cells in anaemic patients
- Use with crystalloid or colloid solution in acute blood loss

Dosage 10 - 15 ml / kg

PRC 1 unit → Hct 3 % or Hb 1 g/dL

10cc/kg → Hct 9 % or Hb 3 g/dL

Duration,Storage

2hr-4hr

Ref 2-6.cc

TABLE 470-1. Guidelines for Pediatric Red Blood Cell Transfusions*

CHILDREN AND ADOLESCENTS

Acute loss of >25% at circulating blood volume
Hemoglobin of <8.0 g/dL† in the perioperative period
Hemoglobin of <13.0 g/dL and *severe* cardiopulmonary disease
Hemoglobin of <8.0 g/dL and *symptomatic* chronic anemia
Hemoglobin of <8.0 g/dL and *marrow failure*

INFANTS WITHIN THE FIRST 4 MO OF LIFE

Hemoglobin of <13.0 g/dL and *severe* pulmonary disease
Hemoglobin of <10.0 g/dL and *moderate* pulmonary disease
Hemoglobin of <13.0 g/dL and *severe* cardiac disease
Hemoglobin of <10.0 g/dL and *major* surgery
Hemoglobin of <8.0 g/dL and *symptomatic* anemia

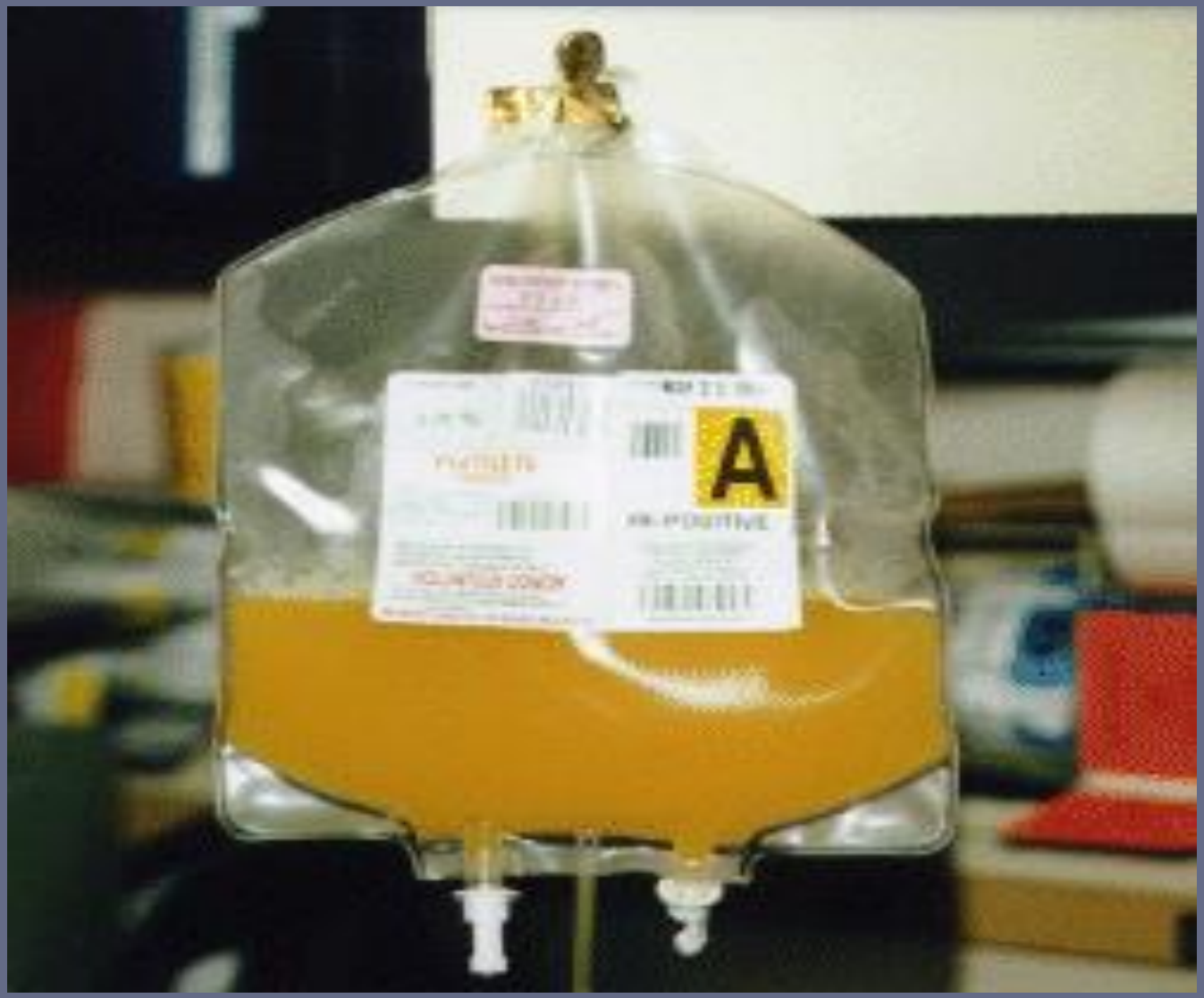
*Words in *italics* must be defined for local transfusion guidelines.
†Hematocrit estimated by Hb g/dL × 3.

- The traditional use of relatively fresh RBCs «7 days of storage)has been halted in many centers in favor of diminishing donor exposure by using a single unit of RBCs to obtain aliquots for transfusing each infant throughout its permitted duration of storage (currently 42 days).

- Neonatologists who insist on transfusing
- only fresh RBCs generally are fearful of the rise in the plasma potassium (K+) level that occurs in RBC units during extended storage. After 42 days of storage, plasma K+levels are approximately 50 mEq/L (0.05 mEq/mL), a value that, at 1st
- glance, seems alarmingly high. However, the actual dose of K+ transfused in the extracellular fluid is tiny.

- However,the safety of stored RBCs may not apply to large-volume(>25 mL/kg) transfusions infused rapidly, in which greater doses of K+may be harmful.

Platelet concentrate



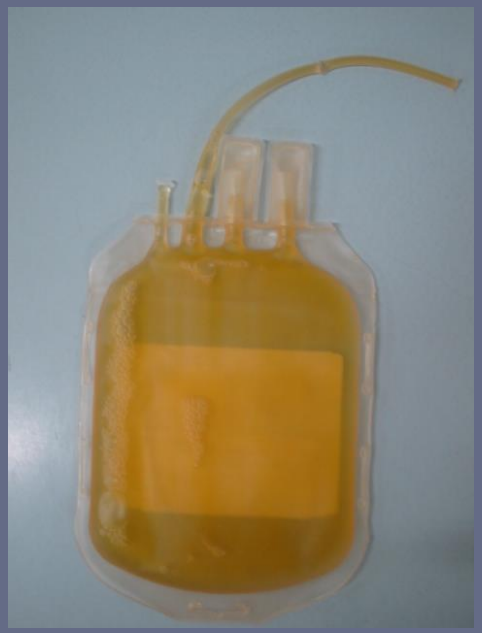
PLATELET CONCENTRATE

- Indications

  Treatment of bleeding due to

  - Thrombocytopenia
  - Platelet Dysfunction
  - Prevention of bleeding

PLATELET CONCENTRATE



- Storage
- Dosage
  - 1 unit of PC / 10 kg B.W.
  - 30000-50000 Increase.
  - Increment will be less in
    - Spleenomegaly
    - DIC
    - Septicemia

1 unit of PC → Platelet 5000-10,000 / ul ↑

PLATELET CONCENTRATE

Administration

- should be ABO & Rh compatible
- After pooling, should be infused as soon as possible
- Use blood administration or platelet infusion set
- Must not be refrigerated before infusion

Platelets Concentrate

Random donor Platelets

Whole blood ๑ unit → Platelet Concentrate ๑ unit

↓

≥ ๕.๕ x ๑๐^{๑๐} platelets in

๕๐ - ๗๐ ml of plasma

Single donor platelets

๑ Donor → Platelet concentrate

↓

≥ ๓ x ๑๐^{๑๑} platelets in

~ 3๐๐ ml of plasma

Single Donor Platelet

- Indication
  - same as random PC
  - special requirement → obtain from selected donor

- Dosage

  Usually 1pack of SDP = 1 therapeutic dose

Single Donor Platelet

- Administration

  same as random PC , but ABO compatible is more important

Vol ~ 300 ml

Vol ~ 50 – 70 ml

TABLE 471-1. Guidelines for Pediatric Platelet Transfusions*

CHILDREN AND ADOLESCENTS

PLTs $< 50 \times 10^9$/L and bleeding

PLTs $< 50 \times 10^9$/L and an *invasive* procedure

PLTs $< 20 \times 10^9$/L and *marrow failure* with hemorrhagic risk factors

PLTs $< 10 \times 10^9$/L and *marrow failure* without hemorrhagic risk factors

PLTs at any count, but with PLT dysfunction plus bleeding or an invasive procedure

INFANTS WITHIN THE FIRST 4 MO OF LIFE

PLTs $< 100 \times 10^9$/L and bleeding

PLTs $< 50 \times 10^9$/L and an invasive procedure

PLTs $< 20 \times 10^9$/L and *clinically stable*

PLTs $< 100 \times 10^9$/L and *clinically unstable*

PLTs at any count, but with PLT dysfunction plus bleeding or an invasive procedure

*Words in *italics* must be defined for local transfusion guidelines.

PLTs, platelets.

Platelets

- Platelets have both the ABO and HLA antigens. ABO compatibility is ideal but not required. (incompatibility will shorten the life span of the platelet)

- It is important to minimize repeated transfusion of group 0 PLTs to group A or B recipients because passive anti-A or anti-B in group 0 plasma can lead to hemolysis.

Storage

- Up to 72 hours at 20 – 24^0c with constant agitation.
- Max. period of storage is 3 to 5 days.
- Must not be refrigerated as this will reduce platelet function.

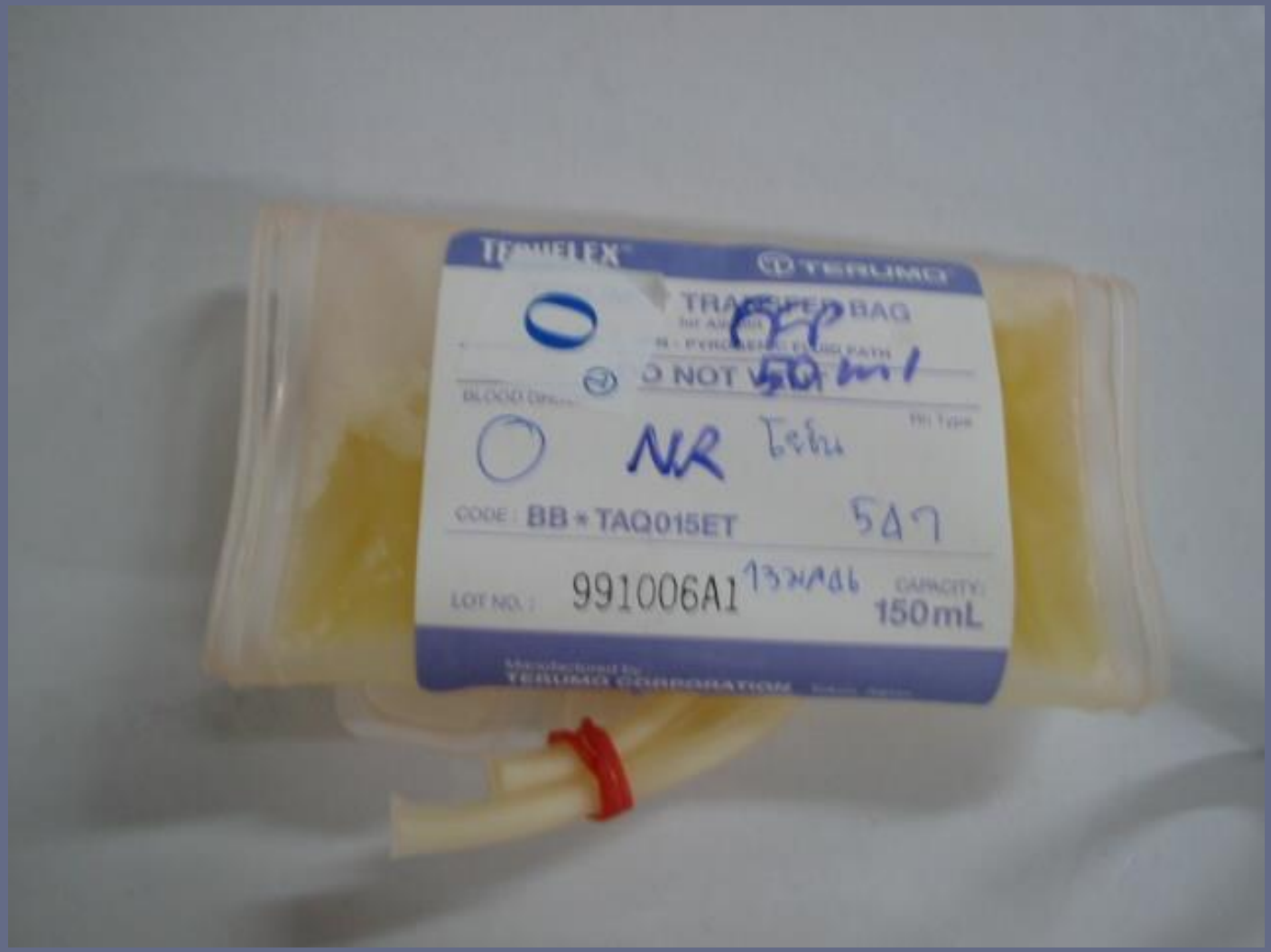
Plateletpheresis

- A portion of donor's platelet and some plasma is removed with the return of donor's RBCs, WBCs and remaining plasma.
- A routine procedure takes 1 to 1.5 hours.
- The product is prepared in closed system and can be stored for 5 days.

2
COBE Spectra

FRESH FROZEN PLASMA

PEDIATRIC FFP



FRESH FROZEN PLASMA

Indication

- Clinically significant deficiency of Factors II, V, X, XI
- Replacement of multiple coagulation

factor deficiencies :-

liver disease , warfarin treatment,

dilutional and consumption coagulopathy

FRESH FROZEN PLASMA

Contraindication

- Volume expansion
- Immunoglobulin replacement
- Nutritional support
- Wound healing

FRESH FROZEN PLASMA

Precaution

- Acute allergic reaction are common
- Anaphylactic reaction may occur

Dosage

Initial dose of 15 - 20 ml / kg

FRESH FROZEN PLASMA

Administration

- Must be ABO compatible
- Infuse as soon as possible after thawing

  (within 6 hrs)
- using standard blood administration set

TABLE 473-1. Guidelines for Pediatric Fresh Frozen Plasma Transfusions*

INFANTS, CHILDREN, AND ADOLESCENTS

Severe clotting factor deficiency and bleeding

Severe clotting factor deficiency and an invasive procedure

Emergency reversal of warfarin effects

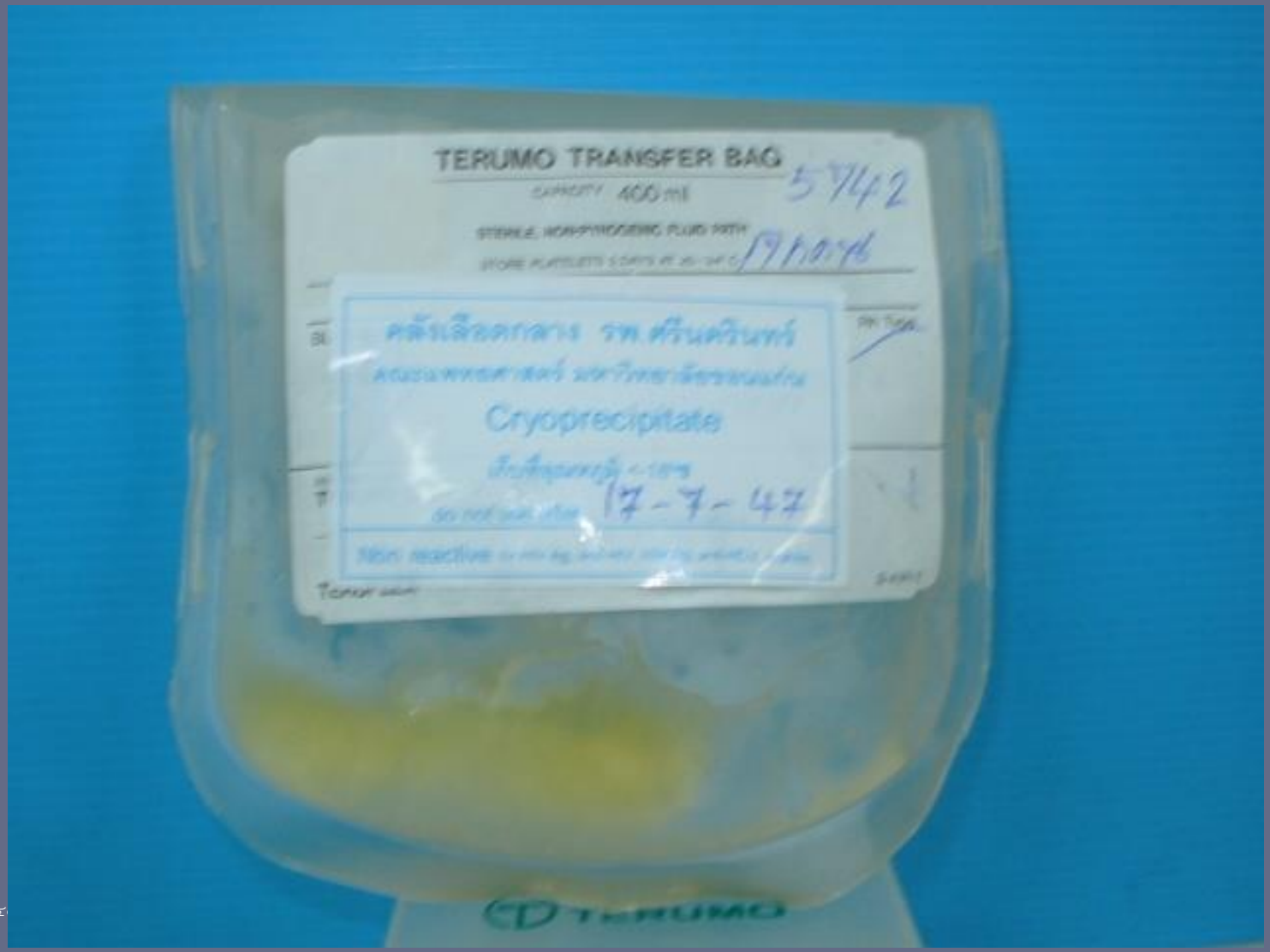
Dilutional coagulopathy and bleeding

Anticoagulant protein (antithrombin III, proteins C and S) replacement

Plasma exchange replacement fluid for thrombotic thrombocytopenic purpura

*Words in *italics* must be defined for local transfusion guidelines.

CRYOPRECIPITATE



Cryoprecipitate

Cryoprecipitate is the cold - insoluble portion of plasma that precipitates

when FFP is thawed between ๑-๖ ° C

FFP ๑ unit → Cryoprecipitate ๑ unit

(Volume ~ 10 - 15 ml)

Cryoprecipitate ๑ unit contains

- F VIII:c ๘๐ - ๑๕๐ IU
- Fibrinogen ๑๕๐ - ๒๕๐ mg
- F XIII (๒๐-๓๐% of WB level)
- vWF (๔๐-๗๐% of WB level)

CRYOPRECIPITATE

Indication

- Quantitative and Qualitative Fibrinogen Deficiency : DIC
- von Willebrand Disease
- Factor XIII deficiency
- Uremic Coagulopathy
- Factor VIII (haemophilia A)

CRYOPRECIPITATE

Administration

- ABO compatible if possible
- no compatibility testing required
- After thawing & pooling, infuse as soon as possible through blood admin. set
- must be infused within 6 hours of thawing

Storage

Components	storage temperature	shelf life
RBC (WB,PRC,LDRC)	๑-๖ ^{o}C	*closed system*: CPD - ๒๑days; CPD-A๑ - ๓๕days; AS - ๔๒days. *open system*: ๒๔ hrs.

Storage

Components	storage temperature	shelf life
Platelets (Random-donor)	๒๐-๒๔°C with agitation	๕ days

Storage

Components	storage temperature	shelf life
FFP	-๑๘°C	frozen - ๑ year.
	- 65°C	frozen - 7 year.

Storage

Components	storage temperature	shelf life
Cryoprecipitate	-๑๘°C or colder	frozen - ๑yr. thawed - ๖ hr.
Thawed Cryo (pooled)	๒๐-๒๔°C	- ๔ hr.

WHOLE BLOOD ABO AND RH COMPATIBILITY

	DONOR					
RECIPIENT	A	B	O	AB	Rh Positive	Rh Negative
A	•					
B		•				
O			•			
AB				•		
Rh Positive					•	•
Rh Negative						•

PACKED RBC ABO AND RH COMPATIBILITY

	DONOR					
RECIPIENT	A	B	O	AB	Rh Positive	Rh Negative
A	•		•			
B		•	•			
O			•			
AB	•	•	•	•		
Rh Positive					•	•
Rh Negative						•

PLASMA ABO AND RH COMPATIBILITY

	DONOR					
RECIPIENT	A	B	O	AB	Rh Positive	Rh Negative
A	•			•		
B		•		•		
O	•	•	•	•		
AB				•		
Rh Positive					•	•
Rh Negative					•	•

Transfusion Risks

- Risks of blood transfusion can be divided into two catagories
- Infectious
- Non-Infectious

Infectious Risks

- The transmittable risks are numerous and include:
- Hepatitis A, B, C, D, E
- Human T-cell lymphotropic viruses (HTLV-1 & HTLV-2)
- HIV-1 & HIV-2
- Cytomegalovirus
- Epstein-Barr virus

Infectious Risks

- Parvovirus B19
- GBV-C virus (also called hepatitis G)
- Transfusion-transmitted virus (TTV)
- Prions including Creutzfeldt-Jakob and variant
- Lyme Disease
- Bacterial infections including: malaria, Chagas disease, ehrlichiosis, babesiosis, and syphilis.

Bacterial Contamination

- Bacterial Contamination occurs at a much higher frequency than any other infections and is associated with substantial mortality.
- Rate of bacterial infection/contamination:

RBCs 1 in 30,000

Platelets 1 in 2,000

Bacterial Contamination

- The patient who receives contaminated blood will rapidly experience some combination of fever, chills, tachycardia, emesis, and shock. The patient may also develop DIC and acute renal failure.
- If the index of suspicion is high then the blood transfusion should be stopped immediately and blood cultures taken.

Exposure Estimates

- Hepatitis B 1 in 350,000
- Hepatitis C 1 in 2,000,000
- HIV 1 in 2,000,000
- HTLV 1 in 2,900,000
- Bacterial reactions from
  - RBC 1 in 30,000
  - Platelets 1 in 2,000

Noninfectious Risks

- The noninfectious risks associated with blood products are generally immunologically mediated.
- Reactions can occur as a result of the antibodies that are constitutive (Anti-A or Anti-B) or ones that have been formed as a result of prior exposure to donor RBCs, WBC, platelets, or proteins.

Noninfectious Risks

- The noninfectious adverse reaction with their approximate incidences are:
- Acute hemolytic transfusion reaction 1 in 25,000 to 50,000
- Delayed hemolytic transfusion reaction 1 in 2,500
- Minor allergic reactions 1 in 200 to 250
- Anaphylactic/-toid reactions 1 in 25,000 to 50,000
- Febrile reactions 1 in 200
- Transfusion related acute lung injury 1 in 5,000

Acute Hemolytic Transfusion Reactions (AHTR)

- Hemolysis of donor RBC's often leads to acute renal failure, DIC, and death
- Of the >300 antigens on the RBC, only several will produce these reactions: anti-A, anti-B, anti-Kell, anti-Kidd, anti-Lewis, and anti-Duffy

Signs and Symptoms of AHTR

- Fever
- Chills
- Nausea and Vomiting
- Diarrhea
- Rigors
- Hypotension
- Flushed appearance and dyspneic
- Chest pain and back pain
- Pt is restless, and has a headache
- Hemoglobinuria, and possible diffuse bleeding

Management of AHTR

- If a reaction is suspected, the transfusion should be stopped and the identity of the patient and the labeling of the blood rechecked.
- Management has 3 main objectives:
- Maintenance of systemic blood pressure
- Preservation of renal function
- Prevention of DIC

Management of AHTR

- Lab tests should include a repeat crossmatch and a direct antiglobulin (Coombs) test.
- The direct antiglobulin test is the definitive test for an acute hemolytic transfusion raction.
- It examines recipient RBCs for the presence of surface immunoglobulins and complement. Patient serum is also examined for antibodies that react with donor cells

Delayed Hemolytic Transfusion Reaction (DHTR)

- This reaction occurs when the donor RBCs have an antigen to which the recipient has been previously exposed by transfusion or pregnency, however over time the antibodies fall to levels too low to be detected by compatibility testing
- When re-exposure occurs the pt. undergoes an anamnestic response and produces more antibody that eventually lyses the foreign RBCs

DHTR

- Evidence of hemolysis is usually evident by the first or second week after exposure
- Symptoms are a low grade fever, increased bilirubin with or without jaundice, and a reduction in hemoglobin
- Diagnosis confirmed by a Coombs test
- The reaction is self-limiting and the clinical manifestations resolve as the transfused cells are removed

Minor Allergic Reactions

- Allergic reactions to *proteins* in donor plasma can cause urticarial reactions in 0.5% of all transfusions
- The reaction is almost always associated with FFP administration
- The pt. may have itching, swelling, and a rash as a result of histamine release
- Treatment is with diphenhydramine

Febrile Reactions

- Patients who receive multiple transfusions often develop antibodies to the HLA antigens on the *passenger leukocytes*
- During subsequent RBC transfusions, febrile reactions may occur as a result of antibody attack on donor leukocytes
- The response occurs in 1-2% of all RBCs transfused
- Temperature increase of greater than 1 degree centigrade within 4 hours that resolves within 48 hrs

Transfusion-Related Acute Lung Injury (TRALI)

- TRALI is a noncardiogenic form of pulmonary edema associated with blood product administration
- It is associated with administration of all blood products but occurs most frequently with RBCs, FFP, and platelets
- The incidence is 1 in 5000 units transfused
- TRALI has a mortality of 5 to 8%

TRALI

- TRALI occurs when agents present in the plasma phase of donor blood activate *leukocytes in the host*
- Those agents are usually antileukocyte antibodies in donor blood formed as a result of a previous transfusion or pregnancy
- TRALI usually requires a preexisting condition such as sepsis, trauma or surgery

TRALI

- The clinical appearance is similar to adult respiratory distress syndrome (ARDS)
- Symptoms usually begin within 6 hours after the transfusion and often more rapidly, the patient develops dyspnea, cyanosis, chills, fever, hypotension and noncardiogenic pulmonary edema
- CXR reveals bilateral infiltrates
- Severe pulmonary insufficiency can develop

TRALI

- Treatment is largely supportive
- The transfusion should be stopped if the reaction is recognized in time
- The patient should receive oxygen and ventilatory support as necessary, usually with a low tidal volume strategy

Other Non-Infectious Risks

- Hypothermia
- Volume Overload
- Dilutional Coagulopathy
- Decrease in 2,3-DPG
- Acid-Base changes
- Hyperkalemia
- Citrate Intoxication
- Microaggregate Delivery


THANK
YOU