Department of Anesthesia Techniques

Blood transfusion

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Blood products:

- any therapeutic substance prepared from human blood.

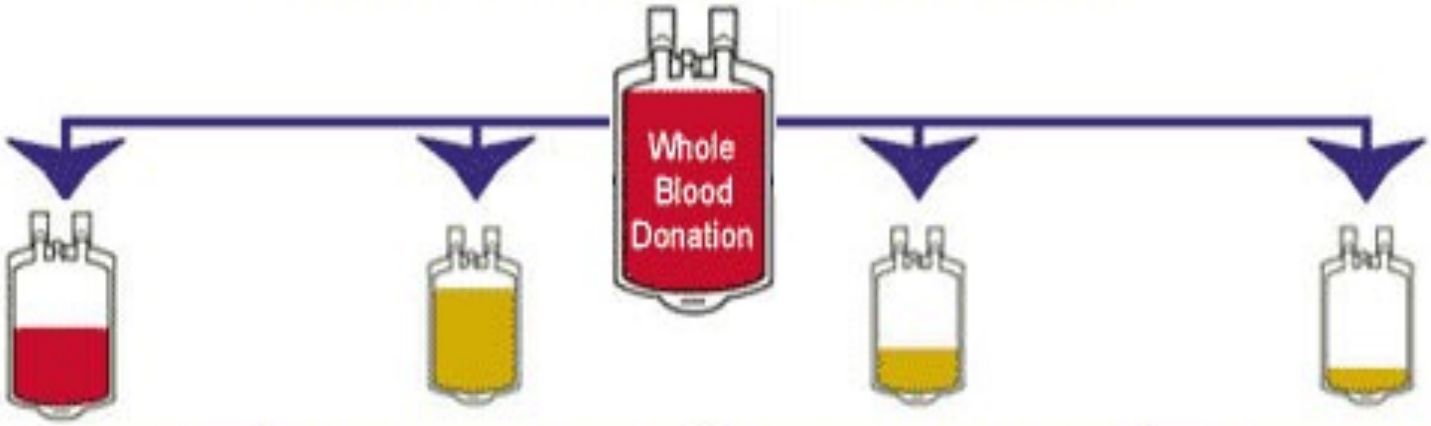
•Whole blood:

Unseparated blood collected into an approved container containing an anticoagulant-preservative solution.
A constituent of blood, separated from whole blood, such as:

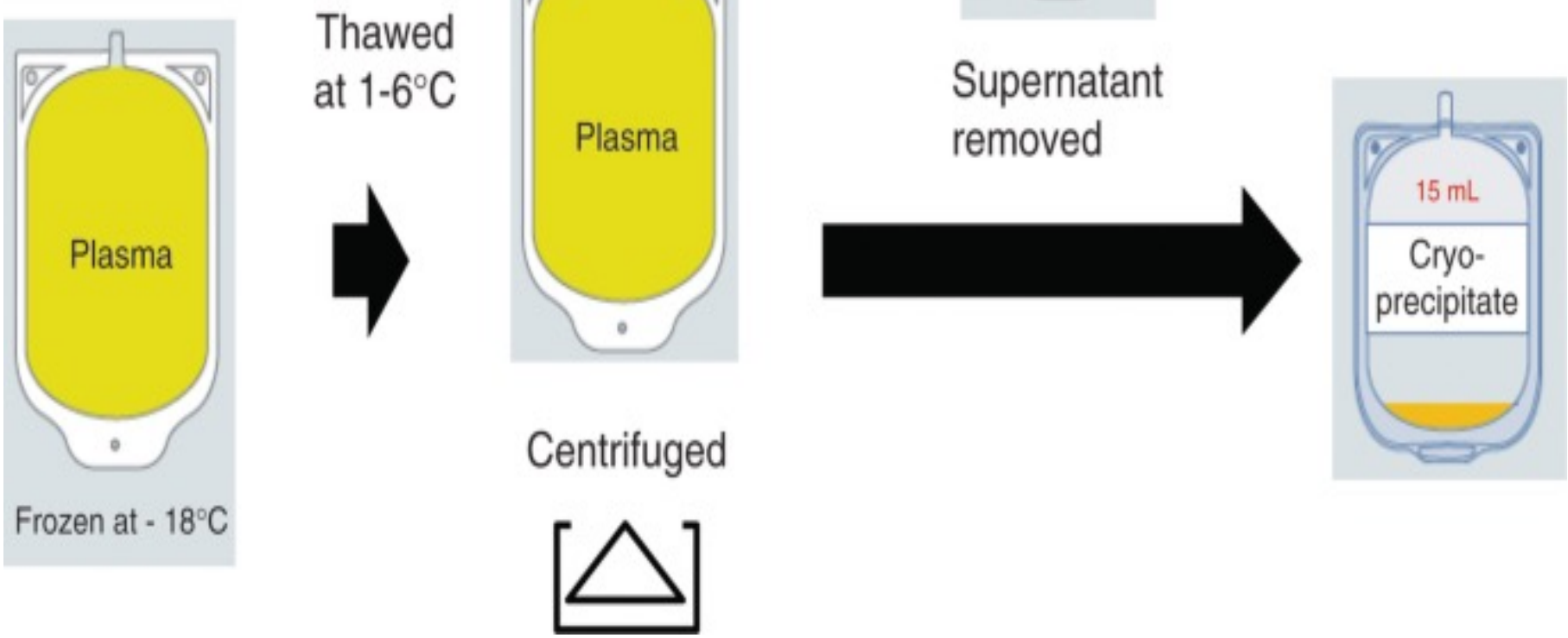
- **Red cell concentrate**
- **Plasma**
- **Platelet concentrates**
- **Cryoprecipitate (prepared from fresh frozen plasma)**.

- Human plasma proteins prepared under pharmaceutical manufacturing conditions, such as:
  - **Albumin.**
  - **Coagulation factor concentrates.**
  - **Immunoglobulins**.

HUMAN BLOOD



Red Blood Cells	Fresh Frozen Plasma	Concentrate of Platelets	Cryoprecipitate
To increase the amount of red blood cells after trauma or surgery or to treat severe anemia.	To correct a deficiency in coagulation factors or to treat shock due to plasma loss from burns or massive bleeding.	To treat or prevent bleeding due to lowplatelet levels. To correct functional platenet problems	To treat fibrinogen deficiencies:
S T O R A G E P E R I O D			
42 days in the refrigerator or 10 years in the freezer	1 year in the freezer	5 days at room temperature	1 year in the freezer


Plasma
Frozen at - 18°C
Thawed
at 1-6°C
Plasma
Centrifuged
Cryo-
super-
natant
Supernatant
removed
15 mL
Cryo-
precipitate

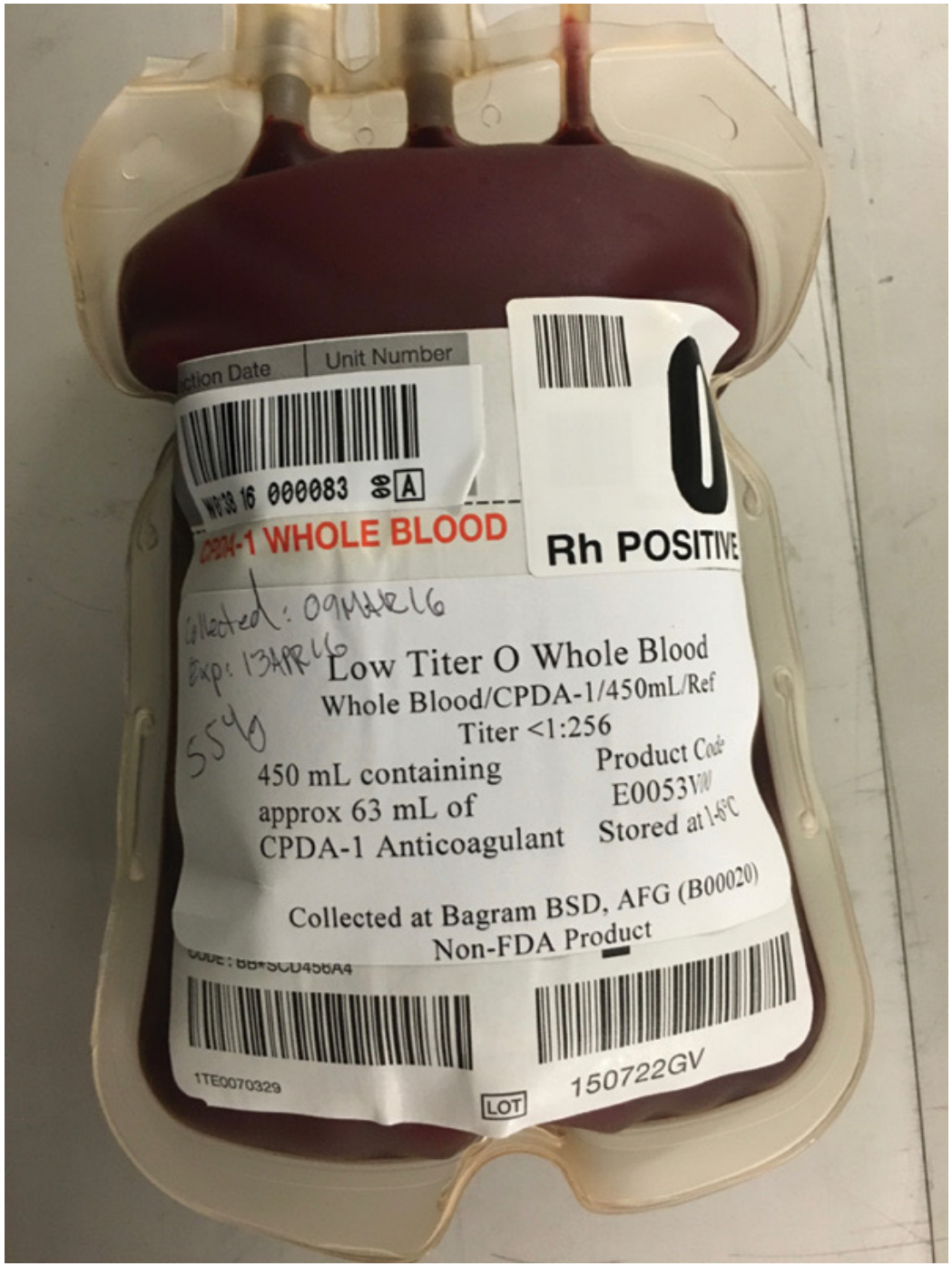
1-whole blood

There have been few widely indications for whole blood in modern transfusion practice.

Whole blood is not available from most blood banks in the US.

Dose: 6 ml/kg of WB raise Hemoglobin level 1 g/dl.

- One unit of WB will raise the hemoglobin of an average-size adult by ~ 1g/dl.
- During donation, blood is collected into a sterile, disposable, plastic pack which contains an anticoagulant-preservative solution.
- This solution usually contains **citrate, phosphate, dextrose and often adenine (CPDA).**


ction Date
Unit Number
W038 16 000083 80 A
CPDA-1 WHOLE BLOOD
O
Rh POSITIVE
Collected: 09MAR16
Exp: 13APR16
554
Low Titer O Whole Blood
Whole Blood/CPDA-1/450mL/Ref
Titer <1:256
450 mL containing
approx 63 mL of
CPDA-1 Anticoagulant
Product Code
E0053V00
Stored at 1-6°C
Collected at Bagram BSD, AFG (B00020)
Non-FDA Product
1TE0070329
LOT
150722GV

Functions of anticoagulant-preservative solution in blood collection pack

Solutions	Functions
C Sodium citrate	Binds with calcium ions in blood in exchange for the sodium salt so the blood does not clot
P Phosphate	Supports metabolism of the red cells during storage to ensure they release oxygen readily at tissue level
D Dextrose	Maintains the red cell membrane to increase storage life
A Adenine	Provides energy source

Effects of storage on whole blood.

1. Reduction in the pH (blood becomes more acidic).
2. Rise in plasma K^+ concentration (extracellular K^+).
3. Loss of all platelet function in whole blood within 48 hours of donation.
4. Reduction in Factor VIII to 10–20% of normal within 48 hours of donation.

2- Red blood cell.

- **Packed RBCs** are the commonly utilized blood product, providing oxygen-carrying capacity in cases of acute or chronic blood loss.
  - **Advantages**
- Simple and inexpensive to prepare.
  - **Disadvantages**
- It has a high ratio of red cells to plasma (high viscosity) increasing the time required for transfusion through a small gauge needle or cannula.
- The white cells are a cause of febrile non-hemolytic transfusion reactions in some patients.

PRBCs transfusion guidelines

- **Hemodynamic instability**: bleeding with unresponsive (or incompletely responsive) to infusion of 2- 3 Liters crystalloid
- **Hemodynamically Stable**:
  - ICU Patients: Hemoglobin <7 g/dL
  - Post-Operative: Hgb ≤8 g/dL
  - Cardiovascular Disease: Hgb ≤8 g/Dl.

Dose: 4 ml/kg of RBC increase Hemoglobin level 1 g/dl.

- One unit of RBC will raise the hemoglobin of an average-size adult by ~ 1g/dl
- Transfuse slowly for first 15 minutes.
- Complete transfusion within 4 hours.

3-White cells (leukocytes)

White cell transfusions have no proven clinical uses.

indicated in neutropenic patients with bacterial infections not responding to antibiotics.

Transfused granulocytes have a very short circulatory life span, so that daily transfusions of $10^{\wedge}$ 10 granulocytes are usually required

4- plasma

- separated from whole blood and frozen at –25°C or colder within 6–8 hours of donation in order to preserve its labile coagulation factors (Factors V and VIII).
- FFP can be stored for at least one year or longer if low temperatures can be maintained.
- When plasma is stored at a temperature of

2–6°C, the labile clotting activity of Factors V and VIII will decline to 10–20% within 48 hours.

- Dosage: Initial dose of 15 ml/kg.

Indications of plasma transfusion

1. **International normalized ratio (INR) >1.5 with**: Anticipated invasive procedure or surgery.
2. Massive hemorrhage (over one blood volume)
3. **Emergent reversal of anticoagulant (warfarin) therapy.**
4. **Treatment of isolated factor deficiencies.**
5. **The correction of coagulopathy associated with liver disease.**

5-platelate

- The platelet count at 1 hour post transfusion of a unit of platelets should increase by 5,000 to 10,000 platelets/µL.
- Platelets separated from plasma obtained from 4–6 donations of whole blood are often pooled to produce a therapeutic dose of platelets for an adult platelet apheresis unit, by 30,000–60,000 × 10^9/L.
- Dosage: 1 unit of platelet concentrate/10 kg body weight


EXPIRES
Place Product Label here after container is filled.
Store Platelets 5 days at 20-24 C.
PL 2209 plastic
E2457
LP-CPD
LIQUID PLASMA/CPD
LIQUID PLASMA
mL from CPD Whole Blood
Affix Collection/Processing I.D. Label Here
FM21A12024

Indications of platelet transfusion:

- **Thrombocytopenia or Dysfunctional platelets with:**
  1. **Active bleeding**
  2. **Bleeding tendency**
- Neurosurgical procedures: 100,000 platelets/µL
- Vaginal delivery and minor surgical procedures: <50,000/µL
- Massive transfusion: < 50,000 platelets/µL
- Disseminated intravascular coagulation: 20,000–50,000 /µL

Leukocyte-depleted red cells

Special leukocyte filters can be used to remove virtually all the white cells.

The majority of red cells and platelet transfusions in the United States & UK are currently leukocyte reduced.

Advantages

1. Reduces acute transfusion reactions.
2. Reduces cytomegalovirus infection (CMV).

Disadvantages

1. Cost: special blood packs and equipment are required
2. More skill and operator training are needed.

6-Cryopreciptate

Cryoprecipitate is obtained from a single donation of FFP at about 4°C and is rich in factor VIII, von Willebrand factor (VWF), factor XIII, and fibrinogen.

Cryoprecipitate is usually administered as a transfusion of single units.

- Each 5- to 15-mL unit contains over 80 units of factor VIII and about 200 mg of fibrinogen.
- **Indications of transfusion**
  - Hemophilia A
  - von Willebrand disease
  - Hypofibrinogemia
  - Uremic bleeding

Blood Component Characteristic

	Red Cells	Platelet Concentrate	Fresh Frozen Plasma	Cryoprecipitate
Storage Temperature	2-6°C	20-24°C	-30°C	-30°C
Shelf Life	35 day	5 day	1 yr (frozen)	1 yr (frozen)
Volume	200-350	30-50 ml/unit	150-200ml/unit	10-15 ml/unit
Transfusion Interval	Transfuse within 30 min of removal from blood refrigerator. Transfuse unit over maximum of 4 hr	Start transfusion as soon as received from blood bank. Transfuse unit within 30 min	Once thawed, should be transfused within 4 hr	884 hr
Compatibility Testing Requirement	Must be compatible with recipient ABO and Rh D type	Preferably ABO identical with patient. Rh negative females under the age of 45 yr should be given Rh negative platelets	FFP and cryoprecipitate should be ABO compatible to avoid risk of hemolysis caused by donor anti-A or anti-B	
Administration	Infuse through a blood administration set—platelet concentrates should not be infused through blood sets that have been used for blood.			

Complications of blood transfusion

1) **IMMUNE Complications.**

2) **INFECTIOUS Complications.**

3) **MASSIVE BLOOD TRANSFUSION Complications.**

1) **IMMUNE Complications**

- Hemolytic reactions
  1. Acute hemolytic reaction.
  2. Delayed hemolytic reaction.
- Nonhemolytic reactions
  1. Febrile reactions
  2. Urticarial reactions
  3. Anaphylactic reactions
  4. post-transfusion purpura
  5. Transfusion-Related Acute Lung Injury
  6. Graft-versus-host disease

Complications of Blood Transfusion

2) Infectious (all products)

Transfusion-Transmitted Infection	Residual Risk Per Transfused Component
HIV	1 in 1,467,000
Hepatitis C	1 in 1,149,000
Hepatitis B	1 in 282,000
West Nile Virus	Uncommon
Cytomegalovirus	50-85% of donors are carriers. Leukocyte reduction is protective.
Bacterial Infection	1 in 2-3,000 (mostly platelets)
Parasitic Diseases Babesiosis, Chagas, Malaria	Relatively uncommon

3) **Complications of massive blood transfusion**

- Coagulopathy
- Hypothermia
- Citrate Toxicity
- Acid–Base Balance
- Serum K^+ Concentration

1. Immune complications

- **Acute hemolytic transfusion reaction: ABO incompatibility.**
- **Delayed HTR: incompatible red cell antigen.**
- **Febrile non-HTR: anti-WBC antibodies in recipient.**
- **Urticarial reactions: antibody to donor plasma proteins.**
- **Anaphylactic: antibody to donor plasma proteins (IgA).**
- **Transfusion-related acute lung injury (TRALI)**: neutrophil antibodies in donor product.

Hemolytic reactions

1. Hemolytic reactions usually involve specific destruction of the transfused red cells by the recipient's antibodies. Less commonly, hemolysis of a recipient's red cells occurs as a result of transfusion of red cell antibodies.

Hemolytic reactions are commonly classified as either

acute (intravascular)

delayed (extravascular).

Acute hemolytic reaction

Acute intravascular hemolysis is usually due to **ABO blood incompatibility**, and the reported frequency is approximately 1:38,000 transfusions.

- The most common cause is misidentification of a patient, blood specimen, or transfusion unit.
- These reactions are often **severe**, and may occur after infusion of as little as 10–15 mL of ABO-incompatible blood.
- The risk of a fatal hemolytic reaction is about 1 in 100,000 transfusions.

- **Symptoms In awake patients,** include:
  - Chills
  - Fever
  - nausea
  - chest and flank pain.
- **In anesthetized patients, an acute hemolytic** reaction may be manifested by:
  - a rise in temperature
  - unexplained tachycardia
  - Hypotension
  - Hemoglobinuria
  - diffuse oozing in the surgical field.
  - DIC , shock, and kidney failure can develop rapidly.
- The severity of a reaction often depends upon the volume of incompatible blood that has been administered.

Management of hemolytic reaction

1. If a hemolytic reaction is suspected, the **transfusion should be stopped immediately and the blood bank should be notified.**
2. The **unit should be rechecked against the blood slip and the patient's identity bracelet**.
3. Blood should be drawn to identify hemoglobin in plasma, to repeat compatibility testing, and to obtain coagulation studies and a platelet count.
4. A urinary catheter should be inserted, and the urine should be checked for hemoglobin.
5. Osmotic diuresis should be initiated with mannitol and intravenous fluids.

Delayed hemolytic reaction

Also called **extravascular** hemolysis, is generally **mild** and is caused by antibodies to non-D antigens of the Rh system or to foreign alleles in other systems such as the Kell, Duffy, or Kidd antigens.

- Following an ABO and Rh D-compatible transfusion, patients have a 1– 1.6% chance of forming antibodies directed against foreign antigens in these other systems.

- The hemolytic reaction is therefore **typically delayed 2–21 days** after transfusion, and symptoms are **generally mild, consisting of malaise, jaundice, and fever.**
- The patient's hematocrit typically fails to rise or rises only transiently, in spite of the transfusion and the absence of bleeding.
- The treatment of delayed hemolytic reactions is primarily **supportive.**

Nonhemolytic immune reactions:

- Nonhemolytic immune reactions are due to sensitization of the recipient to the donor's WBC, platelets, or plasma proteins.
- The risk of these reactions may be minimized by the use of leukoreduced blood products.
- **A- Febrile Reactions:**
  B- Urticarial Reactions:
  C- Anaphylactic Reactions:

D-Transfusion-Related Acute Lung Injury (TRALI):

- presents as acute hypoxia and noncardiac pulmonary edema
- occurring within 6 h of blood product transfusion.
- It may occur as frequently as 1:5000 transfused units, and with transfusion of any blood component, but especially platelets and FFP.

BLOOD TRANSFUSION REACTIONS

TRANSFUSION-RELATED ACUTE LUNG INJURY

TRALI is when acute lung damage is caused by the recipients neutrophils as a reaction to the donor's blood. This is rare but very serious.

SIGNS & SYMPTOMS

OCCURS WITHIN 6H

RISK FACTORS INCLUDE HISTORY OF TRALI, LIVER TRANSPLANT, CHRONIC ETOH ABUSE SMOKERS, VOLUME OVERLOAD, AND SHOCK

SEVERE DYSPNEA

HYPOXIA

FEVER

HYPOTENSION

NURSING MANAGEMENT

1. 

STOP THE TRANSFUSION & ASSESS THE PT

2. 
HANG NS

3. 
CALL RRT & BLOOD BANK

4. 
OBTAIN STAT CXR AS ORDERED

CXR OFTEN SHOWS NEW BILATERAL INFILTRATES

ANTICIPATE THE FOLLOWING:

OXYGEN SUPPORT
- SUPPLEMENTAL O2
- LIKELY INTUBATION

IV FLUIDS

VASOPRESSORS

TRANSFER TO ICU

MORE INFO @ HEALTHANDWILLNESS.ORG

- transfusion of antileukocytic or anti-HLA antibodies results in damage to the alveolar–capillary membrane.
- Treatment: similar to that for ARDS with the important difference that TRALI may resolve within a few days with supportive therapy.

E-Graft-Versus-Host Disease:

F-Post-Transfusion Purpura:

G-Transfusion-Related Immunomodulation:

H-Infectious complications

Viral Infections: Hepatitis C, Acquired Immunodeficiency Syndrome (AIDS), Cytomegalovirus (CMV) and Epstein–Barr virus

Parasitic Infections: malaria, toxoplasmosis, and Chagas' disease.

Bacterial Infections: Both gram-positive (Staphylococcus) and gram-negative (Yersinia and Citrobacter) bacteria can contaminate blood transfusions and transmit disease.

Massive transfusion

- Massive transfusion, historically defined as **the replacement by transfusion of 10 units of RBC in 24 hours, is a response to massive and uncontrolled hemorrhage**
- may be defined either as **the acute administration of more than 1.5 times the patient's estimated blood volume, or as the replacement of the patient's total blood volume by stored homologous bank blood in less than 24 h.**

- Other definitions of massive blood transfusion (MBT) :
- **Replacement of one entire blood volume within 24 h**
- **Transfusion of >10 units of packed red blood cells (PRBCs) in 24 h**
- **Transfusion of >20 units of PRBCs in 24 h**
- **Transfusion of >4 units of PRBCs in 1 h when on-going need is probable**
- **Replacement of 50% of total blood volume (TBV) within 3 h.**

1-Complications of massive blood transfusion

1. Coagulopathy
2. Hypothermia
3. Citrate Toxicity
4. Acid–Base Balance:
5. High Serum Potassium Concentration

BLOOD TRANSFUSION REACTIONS

ACUTE HEMOLYTIC REACTION

An acute hemolytic reaction is when there is incompatibility between the donor blood and the recipient blood.

This is rare but is severe and can be life-threatening

SIGNS & SYMPTOMS

OCCURS WITHIN 24H

FEVER & CHILLS

BACK OR FLANK PAIN

HYPOTENSION

RED OR BROWN URINE

DIC (OOZING FROM IV)

NURSING MANAGEMENT

1. 

STOP THE TRANSFUSION & ASSESS THE PT

2. 
HANG NS

3. 

NOTIFY MD OR RRT & NOTIFY BLOOD BANK

4. 

RECHECK BLOOD TAGS & LABELS

ANTICIPATE THE FOLLOWING:

NS @ 100-200ML/HR OR BOLUS

IV DIURETICS

ADDITIONAL TESTING FOR DIC

TRANSFER TO ICU

MORE INFO @ HEALTHANDWILLNESS.ORG