L6

Revised by

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Transfusion of blood and plasma products

Objectives:

- Describe the blood donation
- Discuss the blood components
- Discuss the plasma products
- Discuss the red cell serology
- Identify the pre-transfusion testing
- Recognize the indications for transfusion
- Discuss the blood administration
- Identify the adverse effects of transfusion
- Describe the autologous transfusion
- Recognize the methods to reduce the need for blood transfusion

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Editing file

Blood Donation

A nice short video, that we recommend watching

- The era of modern blood transfusion began in the early 1900s with discovery of the ABO red cell antigen system.
- World War I it was known that adding citrate enabled the storage of anticoagulated blood.

- The standard donation (480 mL) contains approximately 200 mg of iron, the amount that healthy donors can tolerate when they lose..
- Blood components (red cells, platelets and plasma) can be separated from the donated blood by the use of a cell separator, in a process called apheresis.

- Because of concerns regarding transmission of variant Creutzfeldt–Jakob disease (vCJD)1 by transfusion, a number of new precautions have been introduced. Since 1999 all blood donated in the UK has been filtered to remove white blood cells (leucodepletion), UK plasma has been excluded from fractionation[1]

Blood Banking (Blood Collection):

- Blood centres are processing more than 90% of the units collected.
- Traditional allogeneic (human to human) donation methods still predominate, but increasing use is being made of red cell apheresis technology; it's a method by which red cells are separated from the blood at the time of collection, with the rest returned to circulation.

Storage of Blood:

- Refrigerated at 1 to 6°C (usually 4°C ideally).
- Storage impairs red cells function
    - Transfused blood delivers oxygen to the tissues less efficiently.
- Cell metabolism continues and changes occur → (↓in pH and↓in the levels of 2,3-DPG[2]).
- The deformability of RBCs makes them, over time, more spherical and rigid → increasing resistance to capillary flow.
- **Cell leakage of Potassium (≈ 6 mEq/U). = Hyperkalemia**
- Platelets are stored by agitation, platelets have to stay moving, if we stopped that they will clot.

1. Blood plasma fractionation refers to the general processes of separating the various components of blood plasma.
2. 2,3 DPG important for O2 delivery and shifting the oxygen dissociation curve to the right, thus prolonged storage of blood lead to acidosis and decrease the oxygen delivery.

Blood Component

Blood Component:

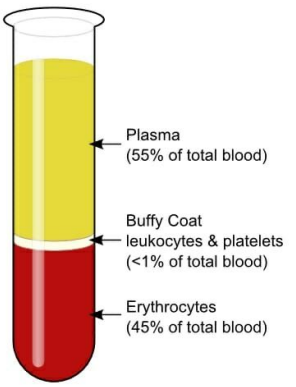
- Whole Blood is not as economical as component therapy, although there has recently been renewed interest in the benefits of using fresh whole blood in military field hospitals.
- In modern transfusion medicine is rarely used.

01 **Red blood cells in additive solution – Packed RBCs (PRBC)**

02 **Platelets**

03 **Fresh Frozen Plasma (FFP)**

04 **Cryoprecipitate**



1- Red blood cells in additive solution – Packed RBCs (PRBC):

- Donated whole blood is collected into an anticoagulant. Centrifugation removes virtually all of the associated plasma, and a solution is added to provide optimal red cell preservation.
- The red cell concentrate is run through a leucodepletion filter to reduce the white cells to a very low concentration.
- The final product has a haematocrit of 55–65% and a volume of approximately 300 mL.

Solutions added (anticoagulant) to RBCs:

CPDA-1

- Blood collection bags contain an anticoagulant -preservative of:
  - **Citrate** Anticoagulant.
  - **Phosphate**
  - **Dextrose** as a nutrient for blood cells to preserve their ability to carry O2 for a long period of time.
  - Adenine
- Ensuring a shelf life (viability of at least 70% of the RBCs 24 hours after infusion) of 35 days and hematocrit of 70 to 80% for PRBCs. Which means it keeps at least 70% of RBCs viable at the end of 35 days, thus the fresher the blood, the better the oxygen carrying capacity.

SAGM

- a solution of **s**aline, **a**denine, **g**lucose and **m**annitol (**SAGM**) is added to provide optimal red cell preservation.

Additive

- **Adsol, Nutricel, Optisol** are additive solutions which: Provide additional nutrients → extending maximum storage to 42 days for RBCs.
- ↓ Viscosity → which makes infusion easier.

1- Red blood cells in additive solution – Packed RBCs (PRBC):

01
- PRBCs are given to improve oxygen delivery to tissues at the **microvascular** level.
- This product is indicated for acute blood loss, anaemia and patient who receives chemotherapy (as it decreases RBCs).

02
- Ischemic heart disease may render patients more intolerant of anemia, although more research is needed to clarify whether transfusion benefits these patients.

03
- Physicians would still transfuse a patient with ongoing hemorrhage and unstable vital signs despite adequate fluid resuscitation, and would occasionally consider withholding transfusion for Hgb levels even lower than 6 g/dL in a young, healthy, asymptomatic patient without ongoing hemorrhage.

04
- In an average adult, 1 U (300ml) of PRBCs increases the Hgb by about 1 g/dL or the hematocrit by about 3%.

05
- PRBCs are run through a filter with a **large-bore intravenous line** with normal saline.
- Lactated Ringer's solution can lead to clotting due to the added calcium, and hemolysis may result with a hypotonic solution.

06
- Most transfusions are given over 60 to 90 minutes (not longer than 4 hours) due to loss of storing capacity in cold atmosphere and increasing the risk of infections.
- **Unused blood should be returned promptly to the blood bank** (any units unrefrigerated for 30 minutes are discarded).

★ American Society of Anesthesiologists:

01

Transfusion is **rarely** needed with a Hgb concentration greater than 10 g/dL corrected with fluids.

02

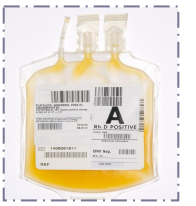
Always needed when the Hgb is <6 g/dL.

03

Patients with a Hgb between 6 and 10 mg/dL require careful clinical judgment.

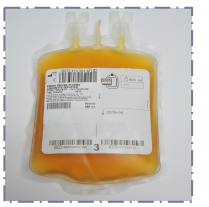
- Judgment is based mainly on patient status.
- E.g: We may consider withholding transfusion for healthy asymptomatic individual with Hb<6.
  while Ischemic Heart disease patients " as they're more intolerant of anemia" needs special judgment <10 g/dl is the cut of point for transfusion.

2- Platelets:



- Cross-matching is unnecessary, **but Rh-negative patients should receive Rh-negative platelets** .(may cause Rh sensitization).(Rh-positive can receive from both -ve and +ve)
- In adults the traditional dose has been 4 to 6U(a"six pack"of platelets). **Rh compatible** (may contain some RBCs & plasma), In children it is 1 U/10 kg body weight.
- Cannot be refrigerated "susceptible to infections"
- Stored at 22°C & Remain for 5 days only.
- Made from 4-6 separate donations pooled together (random donor platelets [RDP] Or from one donor using apheresis (single donor platelets [SDP]).
- Indicated in thrombocytopenia, when platelet function is defective and in patients receiving massive blood transfusions when there is microvascular bleeding (oozing from mucous membranes, needle puncture sites and wounds).

3- Fresh Frozen Plasma (FFP)[1]:



- Fractionated products are manufactured from large pools (several thousand donations)
- A unit of FFP typically has a volume of 200 to 250 mL, is ABO compatible, and is given through blood tubing within 2 to 6 hours of **thawing**[2].
- It contains all clotting factors.It should be given in doses calculated to achieve a minimum of 30% of plasma factor concentration,traditionally calculated as 10 to 15 mL/kg of FFP.
- Stored at -30°C & Remain for 3 years.
- Indicated in multiple coagulation factor deficiencies, can be used in blood loss cases if needed.

Plasma products: not IMP

Albumin	Factor VIII & factor IX concentrates	Prothrombin Complex concentrates	Immunoglobulins Preparation(90% IgG)
1- pasteurised at 60°C for 10 hours. There are no compatibility requirements 2- Indicated in Hypoproteinemia & burns	widely used in the treatment of haemophilia[3].	contain factors II, IX and X, and may also contain factor VII[4] Indicated in prophylaxis & treatment of bleeding	Prepared from individuals known to have high levels of specific antibodies[5].

1. Plasma is currently used by dermatologists for hair loss.
2. defrosting using a hot water bath
3. But It have almost completely been replaced by recombinant products to reduce (Because they carry risk of vCJD transmission).
4. vitamin K-dependent clotting factor
5. Indicated in hyperimmune globulin against hepatitis B, herpes zoster, tetanus and RhD.

4- Cryoprecipitate:

- Removed from FFP, Stored at -30°C & Remain for 3 years.
- Cryoprecipitate is a source of fibrinogen, factor VIII, and **von Willebrand factor (vWF).** It is ideal for supplying fibrinogen to the volume-sensitive patient.
- When factor VIII concentrates are not available, cryoprecipitate may be used since each unit contains approximately 80 units of factor VIII.
- Cryoprecipitate may also supply vWF to patients with dysfunctional (type II) or absent (type III) von Willebrand disease and in DIC to replace the depleted fibrinogen.

Brief summary:

	Red blood cells	Fresh Frozen plasma[2]	Concentrate of platelets[3]	cryoprecipitate
Indicated	To increase the amount of red blood cells after trauma or surgery or to treat severe anemia.	To correct deficiency in coagulation factors or to treat shock due to plasma loss from burns or massive bleeding	To treat or prevent bleeding due to low platelet levels. To correct platelet problems.	To treat fibrinogen deficiencies
Storage period	42 days in the refrigerator or 10 years in the freezer[1]	1 year in the freezer	5 days at room temperature	1 year in the freezer



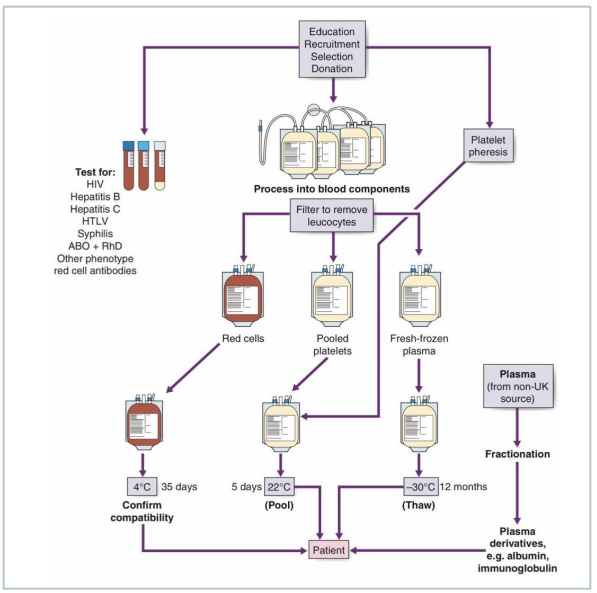



TABLE 113-2 Characteristics of Selected Blood Components

Component	Volume, mL	Content	Clinical Response
PRBC	180–200	RBCs with variable leukocyte content and small amount of plasma	Increase hemoglobin 10 g/L and hematocrit 3%
Platelets	50–70	5.5×10^{10}/RD unit	Increase platelet count 5000–10,000/μL
	200–400	$\geq 3 \times 10^{11}$/SDAP product	CCI $\geq 10 \times 10^{9}$/L within 1 h and $\geq 7.5 \times 10^{9}$/L within 24 h posttransfusion
FFP	200–250	Plasma proteins—coagulation factors, proteins C and S, antithrombin	Increases coagulation factors about 2%
Cryoprecipitate	10–15	Cold-insoluble plasma proteins, fibrinogen, factor VIII, vWF	Topical fibrin glue, also 80 IU factor VIII

Abbreviations: CCI, corrected count increment; FFP, fresh-frozen plasma; PRBC, packed red blood cells; RBC, red blood cell; RD, random donor; SDAP, single-donor apheresis platelets; vWF, von Willebrand factor.

1. If the blood melted after refrigerating, it couldn't be refrigerated again = should be disposed
2. Usually after 5-6 units of PRBC, FFP is transfused for the coagulation factors.
3. Centrifugation of whole blood = random donor platelets [RDP]. Apheresis = single donor platelets [SDP].

Red Cell Serology & Pre-transfusion Testing

01

Identified Red Blood Cell (RBC) Antigens[1]:

- ABO antigens.
- Related carbohydrate antigens (H , P , I , and Lewis).
- The 48 Rh system antigens.
- More than 200 non-ABO/Rh antigens.

02

Pre-transfusion testing consists of three steps:

- ABO grouping +RhD typing.
- Antibody screen;
  - about 2% of population have antibodies targeted against RBCs that are non(ABO/Rh) antibodies.
- Cross-Matching.

ABO Grouping:

	A+	A-	B+	B-	AB+[2]	AB-	O+	O-[3]
Abs in Plasma	Anti-B		Anti-A		None		Anti-B & Anti-A	
Antigens in RBC	A antigen		B antigen		A & B antigens		None	
Can donate to	A+ & AB+	A-, AB-, A+ & AB+	B+ & AB+	B-, AB-, B+, & AB+	AB+	AB-, & AB+	O+, A+, B+, & AB+	All blood types
Can receive	A+, A-, O+, & O-	A- & O-	B+, B-, O+, & O-	B-, & O-	All blood types	AB-, A-, B-, & O-	O+ & O-	O-
Percentage	the second most common(1 in 3 = 34%)	isn't very common (1 in 16 = 6.3%)	1 in 12 = 8.5%	1 in 67 = 1.5%	1 in 29 = 3.5%	1 in 167 = 1%	the most common (1 in 3 = 39%)	1 in 15 = 6.6%

1. The antigens are found on the RBCs surface
2. Universal recipient (has no antibodies)
3. Universal donor (han no antigens)

→ Rhesus (Rh) factor is an inherited protein found on the surface of red blood cells.

- Present Antigen→ Rh positive
- Absent Antigen →Rh negative
- **Rh positive can receive from both Rh+ve and -ve. However, Rh-ve only receive -ve.**

Blood Typing:

- Blood specimen from the patient is sent for the following tests: **ABO grouping, Rh typing,** and an **antibody screen**,for unexpected (non-ABO/Rh) antibodies.
- ABO grouping requires that the recipient's red cells be tested with anti-A and anti-B serum, and that their serum be tested with A and B red cells.

- Those with type AB blood form no ABO group antibodies → **(universal recipient).**
- Those with type O have antibodies against both → **(universal donor).**

01 Forward typing

- determines the ABO and Rh phenotype of the recipient's RBC by using antiserum directed against the A,B,and D antigens.
- Detect ABO Antigens on the cells by directing antibodies against them[1].

02 Reverse typing

- detects isoagglutinins in the patient's serum and should correlate with the ABO phenotype,or forward type.
- Opposite to forward, detect the antibodies in the serum by adding cells express opposite antigens. E.g : if the patient blood type is A, then we mix it with another sample typed B. if agglutination (clot)occurred, then the type A confirmed.

03 Rh typing

- Can usually be determined by adding a commercial reagent (anti-D) to recipient RBCs

Cross-matching:

- This can be done using a Coombs test (with serum incubated to 37° C) takes around 45 min- 1 hour, or the more rapid "Immediate spin crossmatch" at room temperature, which will detect only ABO incompatibility in case of emergencies.
- Thorough Coombs test can detect incompatibilities that were missed with the antibody screen.

Type and Screen:

- The type and screen allows quicker selection of appropriate banked blood for complete crossmatch if a transfusion is ordered.
- When a blood transfusion is ordered, a formal crossmatch is done by mixing recipient serum with donor RBCs as a final compatibility test prior to transfusion.

1. if we said "that patient blood type is B", then we mean the forward typing. Reverse typing used only to confirm Forward typing.
2. We use screening & cross-matching to choose the "optimal" blood, if there's an emergency we can give blood depending on ABO typing only.

Transfusion Indications

Oxygen Delivery:

- **Oxygen Delivery (DO_2)**[1] is the oxygen that is delivered to the tissues.

$$DO_2 = CO \times CaO_2$$

  - Cardiac Output (CO): HR x SV
  - Oxygen Content (CaO2):
    - $(Hgb \times 1.39)^2 \times O_2$ Saturation + $(PaO_2 \times 0.003)^3$
    - Hgb is the main determinant of oxygen content in the blood

- Therefore: $DO_2 = HR \times SV \times CaO_2$
- If HR or SV are unable to compensate (because they increase until certain level only), **Hgb is the major determinant factor in O_2 delivery**.(if Hgb increases blood carrying capacity will increase)
- Each gram of Hgb can carry 1.39ml of O2

Why Do We Transfuse Blood?

01

- Increase oxygen carrying capacity.
- Restoration of red cell mass.(increase intravascular volume)

02

- Correction of bleeding caused by platelet dysfunction.
- Correction of bleeding caused by factor deficiencies.

03

- Correction of anemia.

When To Transfuse?

- TRICC (Transfusion Requirements in Critical Care) trial, demonstrated that in the critical care setting, a transfusion threshold of 7 g/dL of Hb was as safe as a threshold of 10 g/dL.
- A subgroup analysis generated some concern that patients with ischemic heart disease (IHD) benefit from higher transfusion threshold.
- Haemoglobin concentration is not a reliable clinical indicator for transfusion in acute haemorrhage; however, In a clinically stable situation, red cell transfusion is usually not required with a haemoglobin concentration of >100 g/L. a transfusion threshold of 70–80 g/L is appropriate, as this leaves a margin of safety over the critical level of 40–50 g/L

1. Oxygen delivery equation is used to know how much blood do we need to give
2. 1.39ml of O_2 is carried by each gram of haemoglobin.(**oxygen carrying capacity**)
3. (PaO_2 X 0.003) in this equation represent the dissolved oxygen in the plasma. It's a small fraction & it can be neglected. "Increasing O2 pressure will not help patients with low Hb".

Blood administration

Legal Aspect:

- Two qualified personnel check it at the bedside to prevent a potentially fatal clerical error.
- Recipient and unit identification, confirmation of compatibility, expiration date (due the decrease in the oxygen carrying capacity which result in useless transfusion).
- 60% of transfusions occur **perioperatively**
  - Responsibility of transfusing perioperatively is with the **anesthesiologist**.

Urgent Transfusion:

- **Urgent transfusion situations require flow rates faster than gravity can provide :**
  - Pressure bags are available that completely encase the blood bag and apply pressure evenly to the blood bag surface.(to squeeze the blood out)
  - If external pressure is anticipated → **large-bore needles** (14, 16, or 18 G) are recommended for venous access to prevent hemolysis (deformity of RBCs shape as they pass through the needle).
  - If only a small-gauge needle is available → the transfusion may be diluted with normal saline, but this may cause unwanted volume expansion.

Management:

Determinant factors	Clinical evaluation	Laboratory evaluation
• Patient's age and weight. • Severity of symptoms (with mild cases start with fluids and colloids). • **Cause of the deficit.** (e.g. hemorrhage, iron deficiency) • Underlying medical condition. (some heart and lung diseases are not compatible with massive blood transfusion) • Ability to compensate for decreased oxygen-carrying capacity (some patients needs 7 Hb, others needs 10 Hb to maintain normal condition). • Tissue oxygen requirements (e.g. cyanide toxicity) are all considered.	• Appearance (pallor, diaphoresis). • Mentation (alert, confused) Indicate Hypoxia. • **Heart rate (Increase HR, Decrease BP)**. indicate shock • Blood pressure. • Nature of the bleeding (active, controlled, uncontrolled).	• Hgb • Hematocrit • Platelets • Clotting function • Electrolytes

Adverse Reactions of Blood Transfusion

- The most common reactions are not life threatening, although serious reactions can present with mild symptoms and signs.
- Reactions can be reduced or prevented by modified (filtered, washed, or irradiated) blood components.
- Human error are the most common cause of these adverse reaction

Immune mediated reactions VS **Non -Immune mediated reactions**

- Acute Hemolytic Transfusion reactions.
- Febrile nonhemolytic transfusion reaction.
- Allergic reaction
- Anaphylactic
- Graft-versus-host-disease
- Transfusion-related acute lung injury

- Fluid overload
- Hypothermia
- Electrolyte toxicity
- Iron overload

Immune mediated reactions:

1 Acute Hemolytic Transfusion reactions

- Immune-mediated hemolysis occurs when the **recipient** has preformed antibodies that lyse **donor** erythrocytes.
- The ABO isoagglutinins (incompatibility) are responsible for the majority of these reactions, although alloantibodies directed against other RBC antigens, i.e., Rh, Kell, and Duffy, may result in hemolysis.

Symptoms

- develop within minutes hypotension, tachypnea, tachycardia, fever, chills, hemoglobinemia, hemoglobinuria, chest and/or flank pain, and discomfort at the infusion site.

Lab

Measurement of :

- serum haptoglobin low
- Lactate dehydrogenase (LDH) High
- Indirect bilirubin levels High

Management

- **Transfusion must be stopped** immediately, intravenous access maintained, and the reaction **reported to the blood bank.**
- **Diuresis** should be induced with IV fluids to prevent renal dysfunction (to boost the urine output, that caused by RBC lysis as Hb is toxic to renal Epithelium) and furosemide or mannitol.
- Tissue factor released from the lysed erythrocytes may initiate DIC.
- prothrombin time (PT), activated partial thromboplastin time (aPTT), fibrinogen, and platelet count should be monitored in patients with hemolytic reaction.

Immune mediated reactions cont.:

2 Febrile nonhemolytic transfusion reaction (FNHTR)

- The **most frequent** reaction associated with the transfusion of cellular **blood components**[1] (Due to donor WBC).
- characterized by **chills** and **rigors** and a ≥1°C rise in temperature.
- Treatment : stopping transfusion and the reaction should be reported to the blood bank.

3 Allergic reaction

- Urticarial reactions are related to plasma **proteins** in transfused components.
- Mild reactions treated symptomatically by temporarily **stopping the transfusion** until the symptoms resolve and administering **antihistamines** (diphenhydramine, 50 mg orally or IM).

4 Anaphylactic

- This severe and dangerous reaction presents after transfusion of a few milliliters.
- Type 1 hypersensitivity reaction, results from previous transfusion and exposure to the antigens causing the antibodies formation, and in the second exposure anaphylaxis occurs.

Symptoms

- Difficulty in breathing.
- Coughing.
- Nausea and vomiting.
- Hypotension
- Bronchospasm
- Loss of consciousness, Respiratory arrest
- Shock.

Management

- **Stopping the transfusion**.
- Maintaining vascular access.
- Administering **epinephrine** (0.5–1 mL of 1:1000 dilution subcutaneously).
  - Glucocorticoids may be required in severe cases

1. Since FNHTR is the most frequent reaction, to prevent it blood banks nowadays do leukoreduction to remove the WBC from the products which significantly reduced the incidence of FNHTR. In addition, CMV which can be transmitted through blood transfusion infect the WBCs thus it can be avoided by leukoreduction.

Immune mediated reactions cont.:

Doctor: not important

5 Graft-versus-host-disease

- a frequent complication of allogeneic **stem cell transplantation**, in which lymphocytes from the **donor** attack and cannot be eliminated by an immunodeficient host.
    - Mediated by donor T lymphocytes that recognize host HLA antigens as foreign and mount an immune response
- Rare in transfusion

Symptoms:
- Fever.
- A characteristic cutaneous eruption.
- Diarrhea.

Lab:
- Liver function abnormalities.

6 Transfusion-related acute lung injury

- As result of receiving More than 10-20 units, where the donor antibodies attack the recipient WBCs and pulmonary endothelial cells.

Symptoms:
- Presents as acute respiratory distress, during or **within 6h** of transfusion.
  Respiratory compromise, hypoxia, and signs of noncardiogenic pulmonary edema, including bilateral interstitial infiltrates on chest x-ray.

Management:
- Treatment is supportive, and patients usually recover without sequelae.

Non-Immune mediated reactions:

1 Fluid overload

- Blood components are excellent volume expanders, and transfusion may quickly lead to volume overload.
- Monitoring the rate and volume of the transfusion and using a diuretic can minimize this problem.

2 Hypothermia

- **Refrigerated** (4°C) or **frozen** (–18°C or below) blood components can result in hypothermia when rapidly infused.
- Cardiac dysrhythmias can result from exposing the sinoatrial node to cold fluid.
- Use of an **in-line warmer** will prevent this complication.

3 Electrolyte toxicity

Doctor: not important

1. RBC leakage during storage increases the concentration of potassium in the unit.
2. Citrate, commonly used to anticoagulate blood Components, chelates (bind with) calcium and thereby inhibits the coagulation cascade and cause hypocalcemia.
3. Hypocalcemia, manifested by circumoral numbness and/or tingling sensation of the fingers and toes, may result from multiple rapid transfusions.
4. Citrate is quickly metabolized to bicarbonate, calcium infusion is seldom required in this setting.

4 Iron overload

- Known as secondary hemochromatosis and occurs with the frequent blood transfusion e.g. thalassemia.
- Each unit of RBCs contains 200–250 mg of iron.
- Symptoms and signs of iron overload affecting endocrine, hepatic, and cardiac function are common after 100 units of RBCs have been transfused (total-body iron load of 20 g).
- Preventing this complication by using alternative therapies (e.g., erythropoietin) and judicious transfusion is preferable and cost effective.
- Chelating agents, such as deferoxamine and deferasirox, are available, but the response though is often suboptimal.

5 Infectious complications

Viral	• Hepatitis C & B. • HIV Type 1. • HTLV (human T-cell leukaemia virus).	• Cytomegalovirus. • Parvovirus B-19. • West Nile virus
Parasite	• Malaria • chagas disease (Trypanosoma cruzi) • Babesiosis	
Bacterial	• syphilis	
Rare infections	• Dengue, chikungunya virus, Variant Creutzfeldt-Jakob disease ,and yellow fever. • Geographic migration and travel of donors shift the incidence of these rare infections.	

1. All donations are tested for evidence of these infectious agents.
there's another classification –reference classification- for the adverse effects mentioned in the summary, please check it !

Alternatives to transfusion:

01

Autologous blood[1] is the best option when transfusion is anticipated.

02

The cost-benefit ratio of autologous transfusion remains high.

03

No transfusion is a zero-risk event; clerical errors and bacterial contamination remain potential complications even with autologous transfusions.

Autologous blood:

Three main autologous programmes exist.

- 1. Preoperative donation: blood is taken and stored in advance of planned surgery and is used like volunteer donor blood as required –stored for 1 year maximum- .
- 2. Isovolaemic haemodilution: blood is taken just before surgery and replaced with fluid and then returned unmanipulated immediately after the operation.
- 3. Cell salvage: blood is collected from the operative field and replaced during or immediately after the surgical procedure.(many liters can be saves far more than with other autologous techniques).

Methods that reduce the need for blood transfusion:

1- Acute volume replacement: Non-plasma colloid volume expanders of large molecules, such as dextran, are first-line management in volume depletion as a result of bleeding.

2- **Mechanisms for reducing blood use in surgery:**

A-Preoperative: by making sure patient has a normal haemoglobin and by correcting any pre-existing anaemia.

B-Intraoperative: the skill, experience and the competence of the surgeon is the most important factors in reducing operative blood loss. Also posture, the use of vasoconstrictors, tourniquets, and avoidance of hypothermia.

C-Postoperative: Postoperative cell salvage and the Appropriate use of antifibrinolytic drugs reduce postoperative transfusion.

1. Is the collection of blood from a single patient and re-transfuse it back to the patient when required.

Summary

Recall

Q1:Which electrolyte is most likely to fall with the infusion of stored blood? Why?
Answer: Ionized calcium; the citrate preservative used for the storage of blood binds serum calcium

Q2: What changes occur in the storage of PRBCs?
Answer ↓Ca+, ↑K+, ↓2,3-DPG, ↑H+ (↓pH), ↓PMNs

Q3: One unit of PRBC increases Hct by how much?
Answer ≈3% to 4%

Q4: What is a type and screen?
Answer Patient's blood type is determined and the blood is screened for antibodies

Q5: What is a type and cross?
Answer Patient's BLOOD is sent to the blood bank and cross-matched **for specific donor units for possible blood transfusion**

Q6: What is the transfusion "trigger" Hgb?
Answer <7.0

Q6: What is the normal life of RBCs?
Answer 120 days

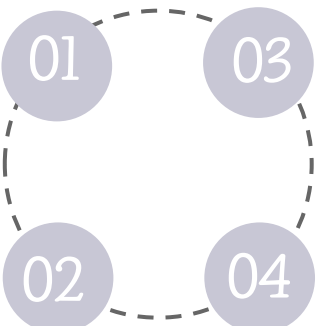
Q6: What common medication causes platelets to irreversibly malfunction?
Answer Aspirin (inhibits cyclooxygenase)

Q6: What should the platelet count be before surgery?
Answer >50,000

Blood & Plasma component

PRBCs
- Administer with normal saline
- 1 unit increase Hb 1g/dL
- 1 Unit increase hematocrit 3%

Platelets
- Cannot be refrigerated
- Should be Rh negative



Plasma
- Used mainly by dermatologist
- Contains (Albumin, Immunoglobulin, Factor VIII, IX, & Prothrombin)

Cryoprecipitate
- Source of fibrinogen & vWF

RBC serology

	A+	A-	B+	B-	AB+	AB-	O+	O-
Abs in Plasma	Anti-B		Anti-A		None		Anti-B & Anti-A	
Antigens in RBC	A antigen		B antigen		A & B antigens		None	
Can donate to	A+ & AB+	A-, AB-, A+ & AB+	B+ & AB+	B-, AB-, B+, & AB+	AB+	AB-, & AB+	O+, A+, B+, & AB+	All blood types
Can receive	A+, A-, O+, & O-	A- & O-	B+, B-, O+, & O-	B-, & O-	All blood types	AB-, A-, B-, & O-	O+ & O-	O-

Summary

Pre-transfusion testing

ABO grouping +RhD typing	Described in the previous slide
Antibody screen	For non (ABO/D) antigens
Cross-Matching	Patient's BLOOD is sent to the blood bank and cross-matched **for specific donor units for possible blood transfusion**

Transfusion Indications

- Threshold of Hb <7
- Increase oxygen carrying capacity.
- Restoration of red cell mass.
- Correction of bleeding caused by platelet dysfunction .
- Correction of bleeding caused by factor deficiencies .
- Correction of anemia.

Administration

- Double check
- Check by Id not by name
- Check Expiration date
- DO2= CO x CaO2
- Cardiac Output (CO) = HR x SV
- Oxygen Content (CaO2):
- (Hgb x 1.39)1 x O2 Saturation + (PaO2 x 0.003)2
- Hgb is the main determinant of oxygen content in the blood

Transfusion Adverse effects

1 Acute Immunological

- Hemolytic
- Febrile-Non Hemolytic
- Transfusion-related Acute Lung Injury
- Urticarial (allergic)
- Anaphylactic

2 Delayed Immunological

- Hemolytic
- VHD

3 Acute non-Immunological

- Fluid overload
- Hypothermia
- Electrolyte toxicity

4 Delayed non-Immunological

- Iron Overload
- Infections

Quiz!

Q1: A 26 year old mother of B- blood type had a miscarriage due to an unfortunate case of erythroblastosis fetalis, what could be the cause?

A) She received a blood transfusion of an Rh+ blood type
B) She was impregnated by an Rh+ father
C) Her first baby was of Rh+ blood type
D) All of the above

Q2: After his blood transfusion, a 45 y/o male patient developed signs of hypotension, tachycardia, fever, chills, hemoglobinemia, and flank pain. What are the findings you would see in a lab analysis?

A) Decreased haptoglobin, absent LDH
B) Decreased haptoglobin, increased LDH
C) Increased haptoglobin, increased LDH

Q3: which of these should be monitored in patients with hemolytic reactions?

A) Prothrombin time (PT)
B) activated partial thromboplastin time (aPTT)
C) platelet count
D) All of the above

Q4: For a 70 kg patient, 1 unit of platelets transfusion increases platelets count by approximately:

A) 500-1000
B) 5000-10000
C) 15000-20000

Q5: What is the solution, if added to donated blood, would maximize the storage duration of RBCs?

A) CPDA-1
B) 2,3 DPG
C) Optisol

Q1	D	Q4	B
Q2	B	Q5	C
Q3	D	Q6	

Quiz!

Q1: Blood transfusions may cause all of the following except:

A) Microcirculation thrombosis
B) Increase platelets count
C) Transmission of malaria
D) Bronchospasm

Q2: Which of the following about blood transfusion is false?

A) Fresh frozen plasma (FFP) is considered as the first-line therapy in coagulopathic haemorrhage.
B) A haemoglobin level of 10 g/dL or less is now considered a typical indication.
C) Cryoprecipitate is useful in low-fibrinogen states and in factor VIII deficiency.
D) Patients can pre-donate blood up to 3 weeks before surgery for autologous transfusion.

Q3: In an average adult, 1 U of PRBCs increases the Hgb by about

A) 1 g/dL
B) 2 g/dL
C) 3 g/dL
D) 4 g/dL

Q4: when will RBCs become no longer good to use?

A) 42 hours in the refrigerator
B) after 11 months in the freezer
C) after 3 months in the refrigerator
D) after 5 weeks in the freezer

Q5: In donating blood, what is the factor that we can increase to have better tissue perfusion?

A) Hemoglobin
B) Oxygen carrying capacity
C) Partial pressure of O2
D) Oxygen saturation

Q1	B	Q4	C
Q2	B	Q5	A
Q3	A	Q6	

القادة

رزان المهنا　　في الدوسري　　محمد الغامدي

نوف الضلعان　　وعد أبو نخاع

الأعضاء

رزان المنجومي
ريم الحازمي
مشاري العنزي

حسبي الله لا إله إلا هو عليه توكلت وهو رب العرش العظيم.
اللهم إني أستودعك ما قرأت وما حفظت وما تعلمت فرده لي عند حاجتي إليه إنك على كل شيء قدير.

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