Transfusion Medicine and Therapy

Objectives:

- Blood groups.
- Indication of blood transfusion.
- Blood components.
- Blood transfusion complications & treatment.
- Alternatives to blood products.

Resources:

- Davidson's.
- 436 doctor's slides
- Surgical recall.
- 435' team work.

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Color Index:

Notes , Important , Extra , Davidson's

Editing file

Feedback

Blood transfusion

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

Definition: Is the transfer of Blood or Blood Products from one person (Donor) into another Person's Blood (Recipient).

Sources of blood:
1. **Autologous** blood: Using your own blood.
2. Donor (**Allogeneic**) blood: Using someone else's blood.

Blood Donations: Depends on **age** & **health** of the donor.

Blood Collection (Blood Banking):

Blood centers are processing more than 90% of the units collected (they keep the blood safe and do all the needed tests to make sure it's good to be used).

- Traditional **allogeneic** (human to human) donation methods still predominate, but increasing use is being made of red cell apheresis technology[1]. They now only give the component the patient needs, which is more beneficial because you can get different components and give it to more than one person from one donor only.

Anticoagulants in Blood: You can't store blood without them

Blood collection bags contain an **anticoagulant-preservative** of (CPDA-1) :

1. Citrate : prevents calcium from triggering the coagulation pathway.
2. Phosphate: in the form of 2,3-DPG, gives nutrition to RBCs.
3. Dextrose: provides energy to cells.
4. Adenine : prolong storability by maintaining ATP to the RBC, and provides additional 2,3-DPG. It is very important to provide 2,3-DPG which helps in oxygen delivery.

- CPDA-1 ensures a shelf life (24 hours after infusion → viability[2] of at least 70% of the RBCs) of **35** days and hematocrit[3] of 70 to 80% for PRBCs[4]. Which means that if you take the blood 34 days after it is stored, still 70-80% of RBCs are viable and working. The more time passes, the more viability is lost.
- **Adsol**, **Nutricel**, **Optisol** are additive solutions which:
    1- provide **additional nutrients** → extending maximum storage to **42** days (for RBCs, so 7 more days were added)
    2- ↓**viscosity** → which makes infusion easier.
- If **PRBCs** are freezed immediately once collected, they may stay for **10 years**. Some people donate their own blood for themselves in the future in case they need it (**Autologous** transfusion).

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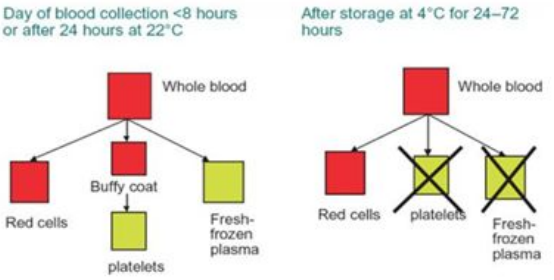
[1] It's a method by which red cells are separated from the blood at the time of collection, with the rest returned to circulation.
[2] The ability to carry O2 from lungs to tissue.
[3] The hematocrit measures how much space in the blood is occupied by red blood cells. It is useful when evaluating a person for anemia.
[4] packed red blood cells

Storage of Blood: "FREEZE IT IF YOU NEED IT FOR A LONG TIME"

- Storage impairs red cells function. Transfused blood delivers O2 to the tissues **less** efficiently.

Because storaged blood loses 2,3-DPG leading to increased oxygen affinity, thus, less oxygen delivered to tissues.

- Refrigerated at **1 to 6°C** (usually **4°C**). Even though you kept it in the fridge, cell metabolism continues and changes occur → (↓ in **pH** and ↓ in the **levels of 2,3-DPG**.) (Oxygen–Hgb dissociation curve shifts to left → more affinity) > If you want to refresh your memory, watch this 5 min. Video.
  - So when the pH goes down, oxygen carrying capacity shift to the right (low O2 affinity) then the level of 2,3-DPG falls. Once it falls, the oxygen carrying capacity shift to the left. So, it is a contradictory one shift to the right and one shift to the left so cells won't function properly.
  - Explanation of the picture: If you don't store blood properly, components will start to separate from each other, then platelets and FFP will die afterwards (**they are the first to die**).



- The deformability of RBCs makes them, over time, more **spherical** (They are concave in shape which make it easy for them to cross capillaries, so when they become spherical in shape it will be difficult to go through the capillaries & they will rupture.. So it's better to use the stored blood **as quickly as possible**, if you want to use the blood bags, use the older ones before using the new ones) and **rigid** → increasing resistance to capillary flow.
- Cell leakage of **Potassium** (≈ **6** mEq/U) → You have to take care because the patient may become **hyperkalemic.**

How do we store platelets?
By agitation, platelets have to stay moving, if we stopped that they will clot.

Blood typing

Identified red blood cell (RBC) antigens : {Group AB = Lucky people, Group O = Unlucky people}

- **ABO** and related carbohydrate antigens (**H**, **P**, **I**, and **Lewis**), the **48 Rh system** antigens, and more than 200 **non-ABO/Rh** antigens. (Not important, just for your information)
- Blood specimen from the patient is sent for the following tests: **ABO grouping**, **Rh typing**, and an **antibody screen for unexpected** -very rare but you have to do it- (non-ABO/Rh) **antibodies**.

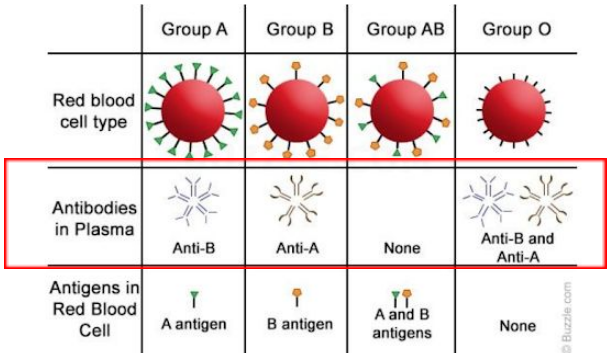
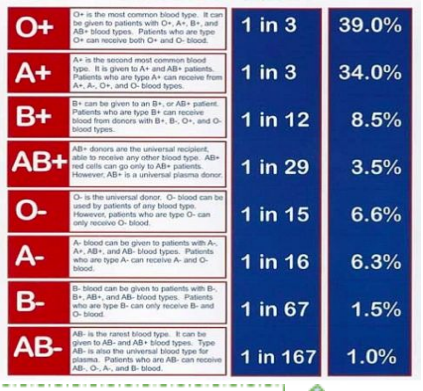


TABLE 113-1 RBC Blood Group Systems and Alloantigens

Blood Group System	Antigen	Alloantibody	Clinical Significance
Rh (D, C/c, E/e)	RBC protein	IgG	HTR, HDN
Lewis (Le^a, Le^b)	Oligosaccharide	IgM/IgG	Rare HTR
Kell (K/k)	RBC protein	IgG	HTR, HDN
Duffy (Fy^a/Fy^b)	RBC protein	IgG	HTR, HDN
Kidd (Jk^a/Jk^b)	RBC protein	IgG	HTR (often delayed), HDN (mild)
I/i	Carbohydrate	IgM	None
MNSsU	RBC protein	IgM/IgG	Anti-M rare HDN, anti-S, -s, and -U HDN, HTR

Abbreviations: RBC, red blood cell; HDN, hemolytic disease of the newborn; HTR, hemolytic transfusion reaction.



Example: Blood type A cannot take from blood type B because it has an **anti-B.** That's why we have blood incompatibilities so we need to know the antibodies in each blood type, and if the serum doesn't contain any antibody (like AB) it means they accept blood donation from any blood type.
And for the Rh typing: +ve can get blood from -ve, and -ve can get ONLY FEW AMOUNTS (1 to 2 units) of +ve because they'll develop antibodies to it afterwards.

This study was done in the US, not here.

Indication of blood transfusion

- Any Rh negative female above\near the age of childbearing we should never give her any blood other than Rh negative group, if we did she will develop antibodies so the next child will have erythroblastosis fetalis (rupture of the child's RBCs). (In case she is married to a Rh positive guy, she won't have any problem with her first pregnancy but the second pregnancy she has to take Anti-D injection)

Blood typing:

- **Forward type:** determines the **ABO** and **Rh** phenotype of the recipient's RBCs by using **antisera** directed against the A, B, and D antigens. (this method is not enough). 2 min. video.
- **Reverse type = cross matching** : detects **isoagglutinins**[5] in the patient's serum and should correlate with the ABO phenotype, or forward type. (mix serum of pt with RBCs of donor, and RBCs of pt with serum of donor, separately , and keep them incubated for 24 -if you have time, but if it's urgent you can do it faster but it won't be as accurate- hours in 37 degree **to make sure there's no reaction**).
- Rh typing can usually be determined by adding a **commercial reagent (anti-D)** to recipient RBCs.
- Those with type **AB** blood form no ABO group antibodies. (**universal recipient**).
- Those with type **O** have antibodies against **both**. (**universal donor**) - They are always kept in the ER for emergency.

Type & 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 SHOULD be done** by mixing recipient serum with donor RBCs as a final compatibility test prior to transfusion.

Take care and check for:
- Hepatitis A,B,C
- Malaria
- HIV

Crossmatch:

Done using a Coombs test (with serum incubated to 37° C), or the more rapid " **immediate spin crossmatch** " at room temperature, which will detect only ABO incompatibility. Thorough Coombs test can detect incompatibilities that were missed with the Ab screen.

Coombs test اسمه ونعمله عن طريق شيء Reverse type هو نفسه Crossmatch يعني

Blood and Products Transfusion. Why? Anything that can only be replaced by blood only.

- Increase **oxygen carrying capacity**. ex) To prevent hypoxic brain damage
- Restoration of red cell mass.
- Correction of bleeding caused by **platelet dysfunction**.
- Correction of bleeding caused by **factor deficiencies**. (hemophilia, von-willebrand, liver disease).
- Correction of anemia.

How much blood do we need to give?

Oxygen Delivery: 13 min. video

- **Oxygen Delivery (DO_2)** is the oxygen that is delivered to the tissues.
- **DO_2= COP x CaO_2**
- **Cardiac Output (CO)** = HR x SV (Stroke volume)

*1.39 = The amount of oxygen carried by each gram of hemoglobin. In another words, it's the capacity of each gram of hemoglobin that will carry 1.39 amount of oxygen.

*0.003 = PO2, partial pressure of O2 which means = oxygen dissolve in the plasma

[5] Isoantibody normally present in the serum of an individual that causes the agglutination of the red blood cells of another individual of the same species.

- **Arterial Oxygen Content (CaO_2)** : the amount of oxygen bound to hemoglobin plus the oxygen dissolved in plasma.
- **CaO_2 = (Hgb x 1.39) x O_2 Saturation + (PaO_2 x 0.003)**
  - **Hgb** is the main determinant of **oxygen content** in the blood.
- Therefore: **DO_2 = HR x SV x CaO_2**
- If HR or SV are unable to compensate, Hgb is the major determinant factor in O_2 delivery.

Administration: what should we do before administering blood?

- Legal Aspects:
  - Two qualified personnel check it at the bedside to prevent a potentially fatal clerical error.
  - **Recipient (ID)** & **unit identification** , confirmation of compatibility, expiration date. Very very important to prevent fatal consequences.
  - 60% of transfusions occur perioperatively. During surgery.
  - Responsibility of transfusing perioperatively is with the **anesthesiologist.**
- Urgent transfusion situations require flow rates faster than gravity can provide:

1. **Pressure bags** that completely encase the blood bag and apply pressure evenly to the blood bag surface. We put blood bag inside & then we increase the pressure so it will go faster and it is very very fast, its known as **Fast-transfusion SPS**. It can infuse 1 L of blood in 1 min (warm & ready).
2. If external pressure is anticipated → **large-bore needles** are recommended for venous access to prevent hemolysis.
3. If only a **small-gauge needle** is available → the transfusion may be diluted with normal saline (because blood is very viscous and if you give it to the patient very fast in a small needle it may cause blood clots), but this may cause unwanted volume expansion. (lactate ringer should not be used with the blood transfusion because it contains calcium which may lead to clotting.)

MANAGEMENT:

determinant factors:

1. Patient's age. (e.g. if the pt is a child → don't give him adult's blood bag because it'll lead to volume overload. If the pt is an elderly → don't give him blood too fast or overload will occur)
2. Severity of symptoms.
3. Cause of the deficit. If there's a heavy bleeding causing the deficit you need to stop it first! Otherwise he won't benefit from this transfusion.
4. Underlying medical condition. ex) SCA, Sickle Cell Anemia. In general any disorders which restrict the ability of **the heart to accommodate** to an increased blood volume > **don't give blood very fast!**
5. Ability to compensate for decreased oxygen-carrying capacity.
6. Tissue oxygen requirements are all considered.

Clinical evaluation:

1. Appearance (pallor, diaphoresis[6]).
2. Mentation (alert, confused).
3. Heart rate.
4. Blood pressure.
5. Nature of the bleeding (active, controlled, uncontrolled).
   - Active = stop bleeding, controlled = adjust it, uncontrolled = give more blood.
   - For Each **500 ml blood loss Hb will drop 1 gram**.
   - People **can't** tolerate losing more than 20% of blood.

[6] Sweating large amounts

Laboratory evaluation: To determine what to give to the patient.

1. Hgb.
2. Hematocrit.
3. Platelets.
4. Clotting function (coagulation profile).

When to transfuse? (indication)

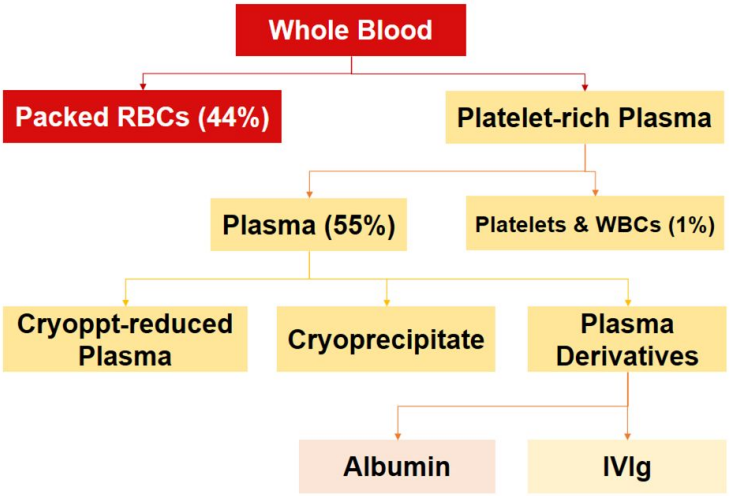
- TRICC **(Transfusion Requirements in Critical Care)** trial, demonstrated that in the critical care setting, a transfusion threshold of **7** g/dL of Hb was as safe as a threshold of **10** g/dL.
    - Patient can compensate with Hb as low as 7 g/dL, if he reaches it give him blood, if he is above it you don't need to give him.
    - Healthy pt can compensate with low Hb. (6 or 7 g/dL). IHD pt **can't**.
    - 10g/dL is mandatory for IHD. Because they benefit from higher number of Hemoglobin.

  So don't transfuse til Hb is 7 g/dL (or 10 g/dL in IHD pts)
- A subgroup analysis generated some concern that patients with **ischemic heart disease (IHD)** benefit from higher transfusion threshold.

Blood components

- **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 **whole blood is rarely used**.
- The more components the more chances of allergies and reactions.

➔ If you give pt more than 4 units of blood, you should give for each unit FFP, platelets & cryoprecipitate (critical for preventing DIC)



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	$5.5x10^{10}$/RD unit	Increase platelet count 5000-10,000 µL
	200-400	≥ $3x10^{11}$/SDAP product	CCI ≥ $10x10^{9}$/L within 1h and ≥ $7.5x10^{9}$/L within 24 h post-transfusion
Fresh frozen plasma (FPP)	200-250	Plasma proteins, **coagulation factors**, protein C and S, antithrombin	Increase coagulation factors about 2%
Cryoprecipitate	10-15	Cold – insoluble plasma proteins, **fibrinogen, factor VIII , vWF**	Topical fibrin glue, also 80 IU factor VIII

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:
STORAGE PERIOD			
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

Packed red blood cells	• Given to improve oxygen delivery to tissues at the **microvascular level**. • **American Society of Anesthesiologists:** 1. Transfusion is rarely needed with a Hgb concentration greater than 10 g/dL . 2. **Always needed when the Hgb is less than 6 g/dL. Because after that the oxygen carrying capacity of the blood will drop.** 3. Patients with a Hgb between 6 and 10 mg/dL require careful clinical judgment • Ischemic heart disease may render patients more intolerant of anemia, although more research is needed to clarify whether transfusion benefits these patients. • Physicians would still transfuse a patient with ongoing hemorrhage & unstable vital signs despite adequate fluid resuscitation & would occasionally consider withholding transfusion for Hgb levels even lower than 6 g/dL (if he's asymptomatic and he has a rare blood type) in a young, healthy, asymptomatic patient without ongoing hemorrhage. • In an average adult, 1 U of PRBCs **increases the Hgb by about 1 g/dL** or the hematocrit by about 3%. • **Most transfusions are given over 60 to 90 minutes (not longer than 4 hours). blood will get expired.** • Unused blood should be returned promptly to the blood bank because any units unrefrigerated for **more than 30 minutes** is discarded. • RBCs should be infused alone or with 0.9% NaCl (should be isotonic) through a 170µm clot-screen filter **NEVER** mixed with: • **Lactated Ringer's solution** can lead to clotting due to the added calcium **(give in another line.)** • Calcium containing solutions; may cause clumping or clots • Dextrose (Hypotonic); may cause hemolysis or clumping • Medications • Hypertonic solutions 
Fresh Frozen Plasma	• A unit of FFP typically has a volume of 200 to 250 mL, **must be ABO compatible** , and is given through blood tubing within 2 to 6 hours of **thawing**[7]. • 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.**
Platelets	• Cross-matching is unnecessary, BUT..**Rh-negative patients should receive Rh-negative platelets.** (may cause Rh sensitization). • In adults the traditional dose has been 4 to 6 U (a "**six pack**"of platelets). • In children it is 1U/10 kg body weight. • Platelet concentrates are 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).

[7] Thawing: putting the blood bag in a warm water - after getting it out of the fridge - till it restores its liquid form (إذابة).
مثل الدجاج اذا طلعناه من الفريزر ما نطبخه على طول, نحطه بمويه أول عشان يذوب الجليد.

Cryo-precipitate	• Cryoprecipitate is a source of fibrinogen, **factor VIII**[8] , 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.

Recall :

Which electrolytes is most likely to fall with infusion of stored blood? And Why?
Ionized calcium ; the citrate preservative used for storage of blood binds serum calcium.
What changes occur in the storage of PRBCs?
Decrease in Ca++ , 2,3-DPG and PMN.
Increase in K+ and H+ (reduce PH)
What is the thrombocytopenia?
Low platelet count (less than 100,000).
How much one unit of PRBCs will increase hematocrit?
Hematocrit is Hb level x 3 → about 3-4%
What are common causes of thrombocytopenia in surgical patient?
Sepsis, H2 blockers, heparin, massive transfusion , DIC, antibiotics , spurious lab value, Swann-Ganz catheter.
What common medication could cause irreversible platelet dysfunction?
Aspirin (inhibits cyclooxygenase).
What can be given to help correct platelet dysfunction from uremia , aspirin or bypass?
DDAVP (desmopressin)
What are general guidelines for blood transfusion?
Acute blood loss, Hb less than 10 with COPD or CAD, or healthy symptomatic patient with Hb less than 6.
Why not infuse lactated ringer's (LR)?
calcium in LR may result in coagulation within IV line.
For how long packed RBCs stored?
about 6 weeks (42 days).
What is the most common cause of transfusion reaction?
ABO incompatibility as result of clerical error.
What are the symptoms of hemolytic transfusion reaction?
Fever, chills, nausea , vomiting , hypotension, lumbar pain, chest pain, abnormal bleeding.
What is the treatment for transfusion hemolysis?
Stop transfusion, provide fluids, perform diuresis by lasix to protect kidneys, alkalinize urine (bicarbonate) and give pressors as needed
What component of blood can cause fever? WBCs
When should aspirin administration be discontinued pre-operativly?
At 1 week because platelets live 7 to 10 days (must use judgment if patient at risk for MI, stroke because it may be better to continue and use excellent surgical hemostasis in these patients.
What can move the oxyhemoglobin dissociation curve to the right?
Acidosis, 2,3- DPG, fever, elevated PCO2 (to the right means greater ability to release the O2 to the tissues.
What is the normal of RBC and platelet?
RBCs :120 days.
Platelets : 7-10 days.
What are the the coagulation factor deficient in hemophilia A and B?
Hemophilia A : factor 8
Hemophilia B : factor 9
How hemophilia A and B inherited? sex linked recessive
What is the preoperative treatment of hemophilia A? Factor 8 infusion
What is willebrand's disease inherited?
Is autosomal dominant disease which is caused by deficiency in von willebrand factor (vWF) and factor VIII:C.
What is used to correct willebrand's disease? DDAVP or cryoprecipitate
What coagulation study is abnormal in hemophilia A, B and willebrand's disease?
Hemophilia A : elevated PTT.
Hemophilia B : elevated PTT.
Willebrand's disease : elevated bleeding time
What is the effect of deficiency in protein C, protein S or antithrombin III? Hypercoagulable state.
What is the most common inherited hypercoagulable state? Factor V leiden

[8] Deficiency in this factor → hemophilia A

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, especially with pts with multiple blood transfusions.

IMMUNE-MEDIATED REACTIONS:

Acute hemolytic transfusion reactions (AHTR):

- Immune-mediated hemolysis occurs when the **recipient** has preformed antibodies that lyse donor erythrocytes.
- The **ABO isoagglutinins** 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.
- AHTR presents as hypotension, tachypnea, tachycardia, fever, chills, hemoglobinemia, hemoglobinuria, chest and/or flank pain (if pt is awake), and discomfort at the infusion site.
- Transfusion must be stopped immediately, intravenous access maintained, and the reaction reported to the blood bank so that they check the blood and know what's wrong.

The laboratory evaluation for hemolysis:

1. Measurement of serum haptoglobin[9].
2. Lactate dehydrogenase (LDH).
3. Indirect bilirubin levels.

Treatment of AHTR:

- The immune complexes that result in RBC lysis can cause **renal dysfunction and failure**.
- Diuresis should be induced with intravenous fluids and furosemide or mannitol.
- Tissue factor released from the lysed erythrocytes may initiate **DIC** (disseminated intravascular coagulation).
- Coagulation studies like prothrombin time (PT), activated partial thromboplastin time (aPTT), fibrinogen & platelet count should be monitored in patients with hemolytic reactions.

The doctor said read the rest ☺..

Febrile nonhemolytic transfusion reaction:

- **The most frequent reaction associated with the transfusion of cellular blood components is a febrile nonhemolytic transfusion reaction (FNHTR).**
- These reactions are characterized by chills and rigors and a ≥1°C rise in temperature.

Allergic reactions:

- Urticarial reactions[10] are related to plasma proteins found in transfused components.
- Mild reactions treated symptomatically by temporarily stopping the transfusion and administering antihistamines (diphenhydramine, 50 mg orally or IM).

Anaphylactic reaction: very very rare

- This severe reaction presents after transfusion of a few milliliters of the blood component.
- **Symptoms and signs**: difficulty in breathing, coughing, nausea and vomiting, hypotension, bronchospasm, loss of consciousness, respiratory arrest, and shock.

[9] A plasma protein that is a normal constituent of blood serum and functions in the binding of free hemoglobin in the blood stream.
[10] formation of pruritic (itchy), raised, red-rimmed wheals - انتفاخات - on the skin due to histamine release.

- Management: Stopping the transfusion, maintaining vascular access, and administering ***epinephrine*** (0.5–1 mL of 1:1000 dilution subcutaneously).
- Glucocorticoids may be required in severe cases.

Graft-versus-host disease:

- Graft-versus-host disease (GVHD) is a frequent complication of allogeneic stem cell transplantation, in which lymphocytes from the donor attack & cannot be eliminated by an immunodeficient host.
- Mediated by donor's T lymphocytes that recognize host HLA antigens as foreign & mount an immune response
- Manifested clinically by fever, a characteristic cutaneous eruption, diarrhea, & liver function abnormalities.

Transfusion-related acute lung injury:

- Presents as acute respiratory distress, either during or within 6 h of transfusing the patient.
- Characterised by respiratory compromise and signs of noncardiogenic pulmonary edema, including bilateral interstitial infiltrates on chest x-ray.
- Treatment is supportive, and patients usually recover without sequelae (complications).

NONIMMUNOLOGIC REACTIONS:

Fluid overload	Electrolyte toxicity	Hypothermia	Iron overload
- Blood components are excellent volume expanders, & transfusion may quickly lead to volume overload. - Monitoring the rate and volume of the transfusion and using a diuretic can minimize this problem.	-RBC leakage during storage increases the concentration of K^+ in the unit. - Citrate, commonly used for anticoagulation, hold the calcium and thereby inhibits the coagulation cascade. - Hypocalcemia[11] may result from multiple rapid transfusion. - Citrate is quickly metabolised to bicarbonate, calcium infusion is seldom required in this setting.	-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.	- 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 (e.g. thalassemia)). - Preventing this complication is 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.

[11] manifestations: circumoral numbness and/or tingling sensation of the fingers and toes.

INFECTIOUS COMPLICATIONS:

1- Viral infections :

- Hepatitis C virus.
- Human immunodeficiency virus type 1
- Hepatitis B virus
- Cytomegalovirus.
- Parvovirus B-19.

2- Bacterial contamination

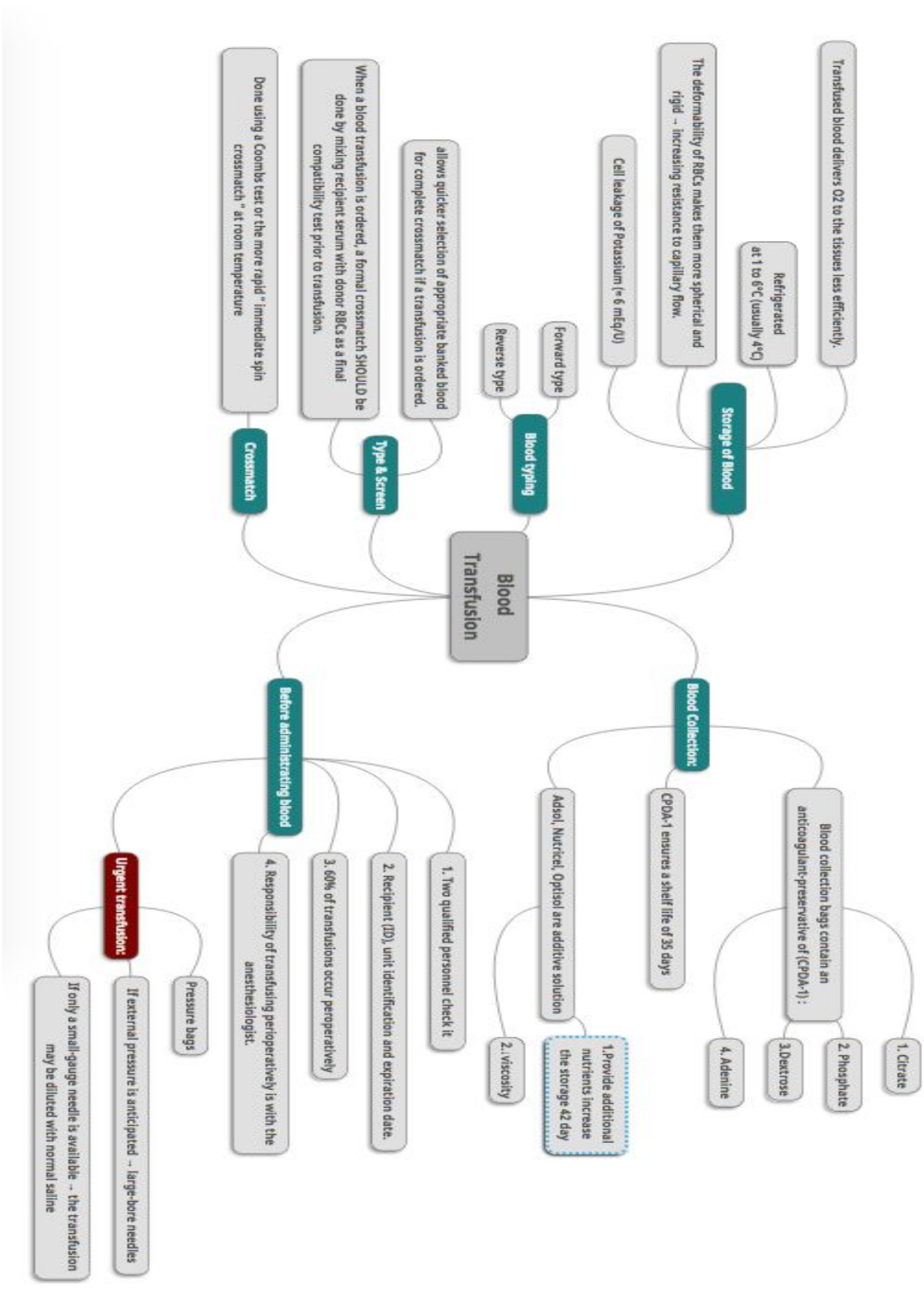
3- Other infectious agents:

- Various parasites, including those causing malaria, babesiosis, and Chagas disease, can be transmitted by blood transfusion.
- Dengue, chikungunya virus, variant Creutzfeldt-Jakob disease, and yellow fever
- Geographic migration and travel of donors shift the incidence of these rare infections.

ALTERNATIVES TO TRANSFUSION:

- Autologous blood is the best option when transfusion is anticipated. The cost-benefit ratio of autologous transfusion remains high.
- No transfusion is a zero-risk event; clerical errors and bacterial contamination remain potential complications even with autologous transfusions.

Summary


Blood Transfusion
Storage of Blood
Transfused blood delivers O2 to the tissues less efficiently.
Refrigerated at 1 to 6°C (usually 4°C)
The deformability of RBCs makes them more spherical and rigid → increasing resistance to capillary flow.
Cell leakage of Potassium (+ 6 mEq/L)
Blood typing
Forward type
Reverse type
allows quicker selection of appropriate banked blood for complete crossmatch if a transfusion is ordered.
Type & Screen
When a blood transfusion is ordered, a formal crossmatch SHOULD be done by mixing recipient serum with donor RBCs as a final compatibility test prior to transfusion.
Crossmatch
Done using a Coombs test or the more rapid " immediate spin crossmatch " at room temperature
Blood Collection:
Blood collection bags contain an anticoagulant-preservative of (CPDA-1) :
1. Citrate
2. Phosphate
3.Dextrose
4. Adenine
CPDA-1 ensures a shelf life of 35 days
Adsol, Nutricel, Optisol are additive solution
1.Provide additional nutrients increase the storage 42 day
2.. viscosity
Before administrating blood
1. Two qualified personnel check it
2. Recipient (ID), unit identification and expiration date.
3. 60% of transfusions occur peroperatively
4. Responsibility of transfusing perioperatively is with the anesthesiologist.
Urgent transfusion:
Pressure bags
If external pressure is anticipated → large-bore needles
If only a small-gauge needle is available → the transfusion may be diluted with normal saline

Q1/ 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

Answer: C

Explanation: CPDA-1 is important because it contains phosphate in the form of 2,3 DPG which functions in oxygen carriage, but optisol is one of the additive solutions which increase storage of RBCs to 42 days instead of 35, when only CPDA is added.

Q2/ 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.

Answer: D

Explanation: Rh incompatibility is more dangerous than ABO incompatibility in cases of erythroblastosis fetalis. The mother could have developed antibodies against the Rh+ factor from all 3 routes. If she married an Rh+ father, there is a chance that her first child was Rh+ as well, so her body created antibodies against the Rh factor, which attacked the RBCs of her second Rh+ baby during pregnancy.

Q3/ In donating blood, what is the factor that we can increase to have better tissue perfusion?

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

Answer: B

Explanation:
$CaO_2 = (Hgb \times 1.39) \times O_2 \text{ Saturation} + (PaO_2 \times 0.003)$
CaO_2 is the amount of oxygen bound to hemoglobin plus the oxygen dissolved in plasma.
Out of all the components of it's equation, Hgb is the major determinant of oxygen content in the blood.

Q4/ 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, increased LDH **B.** Increased haptoglobin, increased LDH
C. Absent haptoglobin, decreased LDH **D.** Decreased haptoglobin, absent LDH

Answer: A

Explanation: Haptoglobin is normally present in the plasma and binds to free hemoglobin from lysed red cells, preventing its toxic effects. Because haptoglobin levels become depleted in the presence of large amounts of free hemoglobin, decreased haptoglobin is a marker of hemolysis.
LDH is an enzyme that is released from damaged tissue cells into the plasma.

Q5/ After blood transfusion of packed RBCs, a patient developed a blood clot due to adding THIS solution to the RBCs:

A. 0.9% NaCl in the same line **B.** Lactate Ringer's solution in the same line
C. 0.9% NaCl in a different line **D.** Lactate Ringer's solution in a different line

Answer: B

Explanation: RBCs should be infused alone or with 0.9% NaCl (should be isotonic),
NEVER mixed with: Lactated Ringer's solution can lead to clotting due to the added calcium (give in another line)