



Round : Major Surgery - Blood transfusion

Group no : B3

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* Blood components :-

1. 55% Plasma $\rightarrow$ (water, ions, nutrients, wastes, gases, proteins $\left\{ \begin{array}{l} \rightarrow \text{Albumin} \\ \rightarrow \text{Globulin} \\ \rightarrow \text{Fibrinogen} \end{array} \right.$)
2. 44% RBCs.
3. 1% Platelets + WBCs.

* Terms From HLS:-

- hemopoiesis : formation of blood cellular components by Red bone marrow (primarily)
- Prothrombin time (PT) : tests of extrinsic coagulation pathway , to monitor blood clot formation which is triggered by external trauma , or to monitor patients on Warfarine therapy.
- Partial thromboplastin time (PTT) : tests of intrinsic coagulation pathway , used to monitor patients on heparin therapy , diagnose hemophilia , assess liver function.
- Hematocrit : The packed cell volume , the % of total blood volume occupied by RBCs (men : 40-48% / women : 36-42%)
- Hemophilia A : Deficiency in Factor VIII , the PTT is elevated.
- Hemophilia B : Deficiency in factor IX , the PTT is elevated.
- von will brand disease : Deficiency in vWF and factor VIII , the patient present with abnormal bleeding time
it has 3 types → type 1+2 → AD
 ↳ type 3 → AR
- extrensic pathway it's triggered by external trauma , begin with the activation of tissue factor (Factor III), which interacts with factor VII to initiate a cascade that lead to Factor X activation.
- interensic pathway : is triggered by blood vessels endothelium , it involves Factors XII, XI, IX and VIII leading to the activation of Factor X.

*Types of Blood Transfusion:-

1. Autologous transfusion: طريقة آمنة تماماً خلالها سحب دم من المريض وخزنه الى لاحقاً لعملية جراحته وقت لاحق.
2. Allogenic transfusion: استقراض دم من متبرع ، تستخدم خلاصة الطوارئ والتلاصيم والهيوفيليا.

* what do we transfere?

1. whole blood: all of blood contents are present, it is rich in Coagulation factors

uses:- Large volume hemorrhage like trauma.

2. Packed RBCs: 1 unite = 300 ml $\pm$ 50 ml, no platelet or clotting factors

uses:- Active bleeding, Symptomatic anemia. الهدف من إعطاءه تحسين نقص الأكسجين

3. Platelets: for blood clotting

uses:- patients with thrombocytopenia; ex: pt with leukemia, chemotherapy, Liver cirrhosis.

4. Fresh Frozen Plasma: to replace clotting factors (V and VIII), has no RBC, WBC, Platelets.

uses:- managing DIC, reversing anticoagulants like Warfarin

5. Cryoprecipitate: concentrated FFP, replaces fibrinogen, vWF, clotting factor VIII, XII

uses:- hemophilia A, vWD, Factor XII defi., hypofibrinogenemia in Massive bleeding or DIC

6. Albumin: uses:- hypovolemia (colloid pressure), hyponatremia ($\downarrow$ Na⁺)

↳ liver cirrhosis $\rightarrow$ give them albumin + diuretics.
↓
↳ nephrotic syndrome
↓
↳ Heart failure
Spiralactone

7. Hyperimmune globulin: (IVIG)

uses:- 1. Immunodef. diseases

2. Autoimmune diseases: SLE, Myasthenia gravis.

3. Guillain-Barre Syndrome (GBS) :- مرض مناعي يصيب الأعصاب

8. Prothrombin Complex concentrate: contains factor II, IX, X, VII

uses:- Vit K deficiency

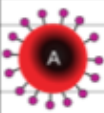
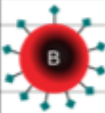
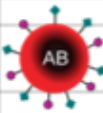
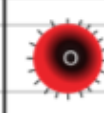
* Blood Types:-

The universal donor for PRBCs → O-

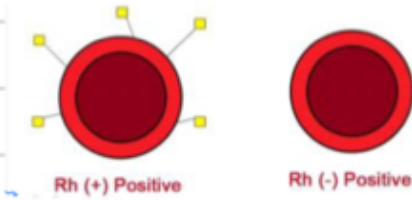
The universal donor for FFP → AB

The universal recipient → AB

* ABO system:-

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma			None	
Antigens in red blood cell	A antigen	B antigen	A and B antigens	None

* Rh system (D-Antigen)



* The incompatibility in pregnancy:-

ABO [More common, less severe]

mother = O baby = AB

* The Ab cross the placenta

↳ destruction baby RBC

↳ hemolytic anemia

↳ jaundice

Rh [more severe, less common]

mother = Rh- baby = Rh+

* In the first baby → Mother develop Anti-Rh antibodies.

* Pregnant again with +Rh baby → the Ab cross placenta

* give Rho D immunoglobulin:-

↳ week 28

↳ 72h after delivery

↳ after miscarriage or trauma

↳ damage baby RBCs

↳ hemolytic anemia

↳ death

* Transfusion indications:

1. replace the blood lost in surgery or trauma
2. In inherited blood disorders (Thalassemia, Sickle cell anemia)
3. Low Hb level < 6

↳ The normal Hb in $\left\{ \begin{array}{l} \text{Men: } 13.5 - 17.5 \\ \text{Women: } 12.0 - 15.5 \end{array} \right.$

* Pre-transfusion procedure:

1. Separate blood components.
2. Test for infections [hepatitis B-C, HIV 1-2]
3. Leukoreduction $\left\{ \begin{array}{l} \rightarrow \text{remove WBCs by filtration, to reduce immune reaction.} \\ \rightarrow \text{especially CMV, HTLV that hide in WBCs.} \end{array} \right.$
4. Pathogen reduction treatment $\left\{ \begin{array}{l} \rightarrow \text{to inactivate the pathogen.} \end{array} \right.$
5. Test ABO, Rh group. $\left\{ \begin{array}{l} \rightarrow \text{Using Mirasol PRT riboflavin (vitamin B12)} \\ \rightarrow \text{Ultraviolet light: to damage DNA or RNA of the pathogen.} \end{array} \right.$

* Symptoms of transfusion reaction:

1. fever, Chills.
 2. Nausea.
 3. Hypotension
 4. Headache
 5. Lumbar pain **
 6. Chest pain **
 7. Abnormal bleeding.
 8. Facial flushing.
- } $\rightarrow$ Don't forget to ask about blood transfusion in these cases!!

* Complications of single transfusion:-

مريض هنا

1. Incompatibility hemolytic reactions:-

* الجواز المناعي يحتاجه RBCs

* within 24h post-transfusion, due to ABO incompatibility.

* Pt present with classical triad of :- 1- Fever

* Can end with death or renal failure. 2- flank pain

3- red-brown urine

2. Febrile transfusions reactions.

* السبب استجابة الجسم البروتينات الموجودة في WBCs المنقولة

* **Fever**, headache, Chills → Use Leuko reduced blood.

3. Allergic reactions:

* These reactions are IgA-mediated cause release of Histamine.

* Can lead to:- 1. pruritus

2. Urticaria

3. Anaphylactic shock.

* management :- give anti-histamine or Epinephrin.

4. Transfusion-related acute Lung injury. (TRALI)

* Antibodies directed toward HLA in FFP.

* Symptoms begin within 6h.

* The patient presents with **ARDS**.

تفاعل AB بالبلازما المنقولة مع WBCs المريض

↪ Pulmonary edema
↪ 1. SOB

2. Hypoxia

3. ARDS that leads to death.

5. Infections :-

* Management :- Do pathogen reduction.

6. Air embolism:-

* نادر جدًا أثناء النقل يدخل الهواء إلى الدورة الدموية أثناء عملية نقل الدم

* The patient presents with: 1. Cyanosis 2. Respiratory distress 3. Hypotension

4. Cardiac arrhythmia. 5. Loss of consciousness

* Management :- Place the patient on the left side with head down to displace air bubble from pulmonic valve

* Complications of Massive transfusion:-

1. Hypothermia:

* Blood should be warmed because it stored at 4°C.

* effect:- 1. ↓ efficiency of clotting factor.

2. ↑ risk coagulopathy.

2. Coagulopathy:

* stored blood has virtually no effective platelets and no coagulation factors, so it can lead to coagulation defect.

* Causes:- dilute clotting factor + platelet leading to impaired clot formation.

* effect:- ↑ risk of bleeding

* Management:- Replace clotting factor with FFP, Platelet, cryp to replenish fibrinogen level.

3. Acid-Base distribution:-

* each RBC contain 1-2 mmol of **Citrate** that undergo hepatic metabolism to HCO_3^- so metabolic alkalosis could develop.

* 4. Hypocalcemia:-

* **citrate** in stored blood binds to calcium ions in rapid transfusion, this can lead to:-

a- myocardial depression

b- muscles cramps

c- prolonged QT on ECG.

* management:- administer Ca^{+2} gluconate or Ca^{+2} Chloride

5. Iron overload:-

* repeated transfusion → ↑ iron deposition in organs $\begin{matrix} \text{liver} \\ \text{heart} \\ \text{pancreas} \end{matrix}$ → Organ damage

* each transfused unit of RBCs contain 250mg of iron.

* management:- iron Chelating agent (**deferoxamine**) → دواء بربط بالحديد وينظف هووا الحديد يخرج تترسب بالبول از البراز .

6. Post transfusion purpura:-

* antibodies to platelet antigens "HP1a" causes abrupt onset of severe thrombocytopenia

* Management and treatment:- intravenous Immunoglobulin (IVIg), plasmapheresis or corticosteroids, avoid platelet transfusion.

* Treatment of transfusion hemolysis:-

1. Stop transfusion

2. Give IV fluids $\rightarrow$ normal Saline :- 1. adequate BP

2. Promote kidney function

3. To flush Hb.

3. Diuresis (Lasix) $\rightarrow$ To protect kidney.

$\hookrightarrow$ mechanism:- By hemolysis; the Hb accumulate in renal tubules $\rightarrow$ obstruction + toxicity.

The diuretics $\rightarrow$ $\uparrow$ urine output + wash out Hb to prevent damage.

4. Alkalinize the urine (Bicarbonate)

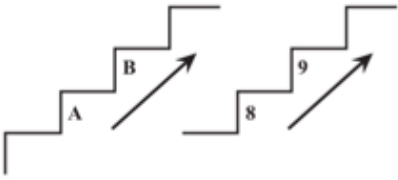
* Free Hb by hemolysis $\rightarrow$ oxidative damage to kidney.

* Raising pH with HCO_3^- prevents Hb accumulation in renal tubules $\rightarrow$ Crystals
وهذا لأن بخصائص Hb بالبول دون تكوين Crystals

Surgical Recall

Define the following terms:

PT	Prothrombin Time: Tests extrinsic coagulation pathway	What is a type and cross?	Patient's blood is sent to the blood bank and cross-matched for specific donor units for possible blood transfusion
PTT	Partial Thromboplastin Time: Tests intrinsic coagulation pathway	What is thrombocytopenia?	Low platelet count ($<100,000$)
INR	International Normalized Ratio (reports PT results)	What are the common causes of thrombocytopenia in the surgical patient?	Sepsis/ H_2 blockers/heparin/massive transfusion/DIC/antibiotics/spurious lab value/Swann-Ganz catheter <i>pulmonary artery cath.</i>
Packed red blood cells (PRBCs)	One unit equals ≈ 300 ml (± 50 ml); no platelets or clotting factors; can be mixed with NS to infuse faster	What can be given to help correct platelet dysfunction from <u>uremia</u> , <u>aspirin</u> , or <u>bypass</u> ?	DDAVP (desmopressin) <i>platelet donor</i> $\uparrow$ vWF
Platelets	Replace platelets with units of platelets (6–10 units from single donor or random donors) <i>هون ما بهمني نوع زمرة الدم</i>	What common medication causes platelets to irreversibly malfunction?	Aspirin (inhibits cyclooxygenase)
Fresh frozen plasma (FFP)	Replaces clotting factors; (no RBCs/WBCs/platelets)	What is Plavix®?	Clopidogrel—irreversibly inhibits platelet P2Y ₁₂ ADP receptor (blocks fibrin crosslinking of platelets)
Cryoprecipitate (cryo)	Replaces fibrinogen, von Willebrand factor, and some clotting factors	What platelet count is associated with spontaneous bleeding?	$<20,000$
Which electrolyte is most likely to fall with the infusion of stored blood? Why?	<i>مع بضان لسبح التخيل ولكن يرتبط Ca^{+2}</i> Ionized calcium; the citrate preservative used for the storage of blood binds serum calcium	What should the platelet count be before surgery?	$>50,000$
What changes occur in the storage of PRBCs?	<i>يخرج ما يخرج من PRBC الى البلازما</i> <i>يتركز داخل البلازما ويتركز البوتاسيوم</i> $T Ca^{+2}, c K^{+}, T 2,3-DPG, c H^{+}$ (T pH), <i>تقل T PMNs</i> <i>يقله بتخزين Hb من</i> <i>الأكسجين</i>	When should “prophylactic” platelet transfusions be given?	With platelets $<10,000$ (old recommendation was 20,000)
What are the general guidelines for blood transfusion?	Acute blood loss/Hgb <10 and history of CAD/COPD or healthy symptomatic patient with Hgb <7	How to reverse the effect of Clopidogrel (Plavix®)?	No reversal known. Many treat with platelet transfusion
What is the rough formula for converting Hgb to Hct?	$Hgb \times 3 = Hct$ $Hb \times 3 = Hct$	What is microcytic anemia “until proven otherwise” in a man or postmenopausal woman?	Colon cancer
One unit of PRBC increases Hct by how much?	$\approx 3\%$ to 4%	Why not infuse PRBCs with Lactated Ringer's?	Calcium in LR may result in coagulation within the IV line (use NS)
Which blood type is the “universal” donor for PRBCs?	O negative	For how long can packed RBCs be stored?	About 6 weeks (42 days)
Which blood type is the “universal” donor for FFP?	AB	Why not infuse PRBCs with Lactated Ringer's?	Calcium in LR may result in coagulation within the IV line (use NS)
What is a type and screen?	Patient's blood type is determined and the blood is screened for antibodies; a type and cross from that sample can then be ordered if needed later	For how long can packed RBCs be stored?	About 6 weeks (42 days)
		What is the most common cause of transfusion hemolysis?	ABO incompatibility as a result of clerical error
		What is the risk of receiving a unit of blood infected with HIV?	≈ 1 in 1,000,000
		What are the symptoms of a transfusion reaction?	Fever, chills, nausea, hypotension, lumbar pain, chest pain, abnormal bleeding
		What is the treatment for transfusion hemolysis?	Stop transfusion; provide fluids; perform diuresis (Lasix) to protect kidneys; alkalize urine (bicarbonate); give pressors as needed

What is the normal life of platelets?	7 to 10 days	What coagulation is abnormal with the following disorders:	
What factor is deficient in hemophilia A?	Factor VIII	Hemophilia A	PTT (elevated)
How can the clotting factor for hemophilia A be remembered?	Think: "Eight" sounds like "A"	Hemophilia B	PTT (elevated)
What is the preoperative treatment of hemophilia A?	Factor VIII infusion to $\geq 100\%$ normal preoperative levels	von Willebrand's disease	Bleeding time
What coagulation study is elevated with hemophilia A?	PTT	What is the effect on the coagulation system if the patient has a deficiency in protein C, protein S, or antithrombin III?	A hypercoagulable state
How do you remember which coagulation study is affected by the hemophilias?	There are two major hemophilias and two T's in PTT	What is a "left shift" on a CBC?	Juvenile polymorphonuclear leukocytes (bands); legend has it that the old counters for all the blood cells had the lever for bands on the LEFT of the counter <i>↳ immature WBCs.</i>
What factor is deficient in hemophilia B?	Factor IX	What is the usual "therapeutic" PT?	With coumadin, usually shoot for an INR of 2.0–3.0
How do you remember which factors are deficient with hemophilia A and hemophilia B?	Think alphabetically and chronologically: A before B—8 before 9 Hemophilia A = factor VIII Hemophilia B = factor IX	What component of the blood transfusion can cause a fever?	WBCs
		What is the transfusion "trigger" Hct in the IOU?	21%
How are hemophilias A and B inherited?	Sex-linked recessive	What is the widely considered "optimal" Hgb in a patient with a history of heart disease or stroke?	Focus Trial = Liberal (<10 Hgb) US restrictive (<8 Hgb) Trigger = No difference in mortality or morbidity
What is von Willebrand's disease?	Deficiency of von Willebrand factor (vWF) and factor VIII:C	When should aspirin administration be discontinued preoperatively?	At 1 week because platelets live 7 to 10 days (must use judgment if patient is at risk for stroke or MI; it may be better to continue and use excellent surgical hemostasis in these patients)
How is von Willebrand's disease inherited?	Autosomal dominant	What can move the oxyhemoglobin dissociation curve to the right?	Acidosis, 2,3-DPG, fever, elevated P_{CO_2} (to the right means greater ability to release the O_2 to the tissues)
What is used to correct von Willebrand's disease?	DDAVP or cryoprecipitate	What is the normal life of RBCs?	120 days
		What is the normal life of platelets?	7 to 10 days
		What factor is deficient in hemophilia A?	Factor VIII
		What is the acronym basis for the word WARFARIN?	Wisconsin Alumni Research Foundation-ARIN
		What is the most common inherited hypercoagulable state?	Factor V Leiden (Think: LEiden = LEader) <i>↳ mutation in F5 ↳ resistance to activation ↳ ↑ risk of DVT and PE.</i>