BLOOD TRANSFUSION& CROSS-MATCHING

Objectives:

- To identify the key elements in the current blood bank services.
- To appreciate the implemented measurements and standards for obtaining the highest quality in the blood bank services.
- To have a general idea about the donation process and main blood components.
- To understand the inheritance and significance of the ABO system.
- To understand the nature and significance of the Rh blood group system.
- To understand the cross-matching process, including the antiglobulin test.
- To have an overview about main hazards of blood transfusion.

Color code:

Important.
Doctors Extra.
notes

References:

436 girls & boys' slides
435 teamwork slides

Editing file

Do you have any suggestions? Please contact us!

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or simply use this form

Blood Bank Units

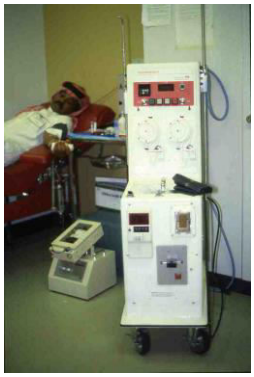
Traditionally, two parts: (important to know what happened in each service)

1) Donation services: donor area, component separation, infectious testing, ABO typing and RhD screening, inventory.

2) Transfusion services: inventory, Patient (recipient) ABO grouping, RhD and antibody identification screening, cross-match, component issuing*.

Currently in the major hospital, there is a apheresis unit (technique by which a particular substance or component is removed from the blood, the main volume being returned to the body.) (donation, therapeutic or prophylaxis).

In many tertiary hospitals, stem cell unit, cord blood unit and tissue banking.



For your info..

the device's name is shaker, The patient sits at a 45 angle and the blood is collected into the bags within 30 min

Donor Selection

-**Allogenic**: form others

-**Autologous** : from ones self (People storing blood for themselves in the future to avoid any reaction in case if transfusion)

What are the criteria for accepting blood donation?
Age: 17-70 y.o
Weight: above 50kg
Haemoglobin: more than 134g/l for men & more than 120g/L for women
All donors must pass the physical and health history examinations given prior to donation.
Minimum donation: no blood donation in the last 3 months, (16 weeks advised), and a maximum of 3 donations per year.
Pregnant and lactating women excluded (because of high iron requirements) donation referred 9 months after pregnancy
Two units of red blood cells can be donated at one time, using a process known as red cell. apheresis. This type of donation can be made every 16 weeks.
Aphaeresis for platelets or plasma up to 24 times in 12 months.

Exclusion of any donor returning to occupations such as driving bus, plane or train, heavy machine or crane operator, mining, scaffolding, etc. because delayed faint would be dangerous

Defer for 12 months after body piercing or tattoo, paid sex or homosexual sex, after acupuncture

Defer for 2 months after live vaccinations such as measles, mumps

Defer if travel history suggests risk of infection **Drugs**

Exclusion of those with:
Known cardiovascular disease, including hypertension
Significant respiratory disorders
Epilepsy and other CNS disorders
Gastrointestinal disorders with impaired absorption
Previous blood transfusions in the UK
Intravenous drug users
Insulin-dependent diabetes
Chronic renal disease
Cancer
Ongoing medical investigation or clinical trials

Everything highlighted is very important

Donor form (the form that we give the donor to fill before donating blood)

1-Powerful tool for screening.

2-Identify high risk behaviors.

3-Some issues can only be ruled out by systemic questionnaire.

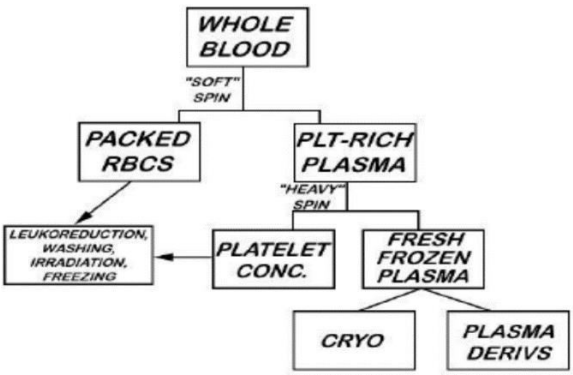
Infectious Testing

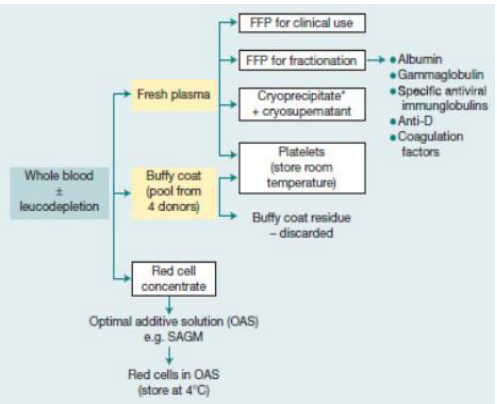
Extra testing (not in all cases):
1-Sickle cell.
2-G6PD level

Table 30.2 Donor testing in England and Wales.
1 Blood group, Rh status (D,C,E,c,e), K
2 Screen for red cell alloantibodies
3 *Microbiological tests*
Human immunodeficiency virus (HIV) 1 and 2; antibody and RNA
Hepatitis B virus (HBV) – antibody and RNA
Hepatitis C virus (HCV) – antibody and RNA
Human T-cell leukaemia viruses (HTLV) – antibody
Cytomegalovirus (CMV) – antibody, for immunosuppressed recipients
Malaria – antibody screening of potentially exposed donors
Chagas' disease – antibody screening of potentially exposed donors
Bacteria – all donations tested for antibody to syphilis
N.B. At the current time there is no reliable test for detecting prions in blood products.

Component Separation

Figure 30.1 The preparation of blood components from whole blood. FFP, fresh frozen plasma; SAGM, saline-adenine-glucose-mannitol.
* Cryoprecipitate is mainly a source of fibrinogen. Cryosupernatant is used for plasma exchange in thrombotic thrombocytopenic purpura.
Leucodepletion – see text.





Component Storage

Storage Details for Various Blood Products

Product	Storage
RBCs / Whole blood	35 days (CPDA-1) 42 days (Additives) 1-6 C
Frozen RBCs	10 years; –65 C; 24 hours after thaw
Washed RBCs	24 hours; 1-6 C
Platelets	5 days; 20-24 C (gentle agitation); 4 hours if pooled
Granulocytes	24 hours; 20-24 C (no agitation)
Fresh Frozen Plasma	1 year; –18 C OR 7 years, –65 C; 24 hours at 1-6 C after thaw
CRYO	1 year at –18 C 6 hours at 20-24 C after thaw (4 hours if pooled)

In the fridge

Stored In room temp.

In freezer

Cryoprecipitate

-Packed RBC unit

Volume:	350 mL (incl. additive)
Contents:	RBCs (200-250 mL)
Without leukoreduction	Plasma (≤ 50 mL)
	WBCs (10^9) and PLTs
	Anticoagulant (63 or 70 mL)
	Additive solution
	200-250 mg iron

Whole blood
1. The original blood product!
2. Minimal availability in most blood banks today
3. Specifics:

Volume:	450-500 mL الكميه اللي نسحبها
Contents:	RBCs (200-250 mL)
	Plasma (250-300 mL)
	WBCs (10^9)
	Platelets
	Anticoagulant (63 or 70 mL)

-Whole blood donor (5-6 pooled)

Volume:	40-60 mL
Contents:	PLTs (≥ 5.5 x 10^{10} in 90%)
	Plasma (40-60 mL)
	WBCs (10^7)
	pH ≥ 6.2 (90%)

Volume:	200-250 mL
Contents:	All coag factors
	- 400 mg fibrinogen
	- 1 IU/mL of all others
	Almost no viable WBCs
	NOTE: No QC testing

-Single donor (apheresis) adult dose

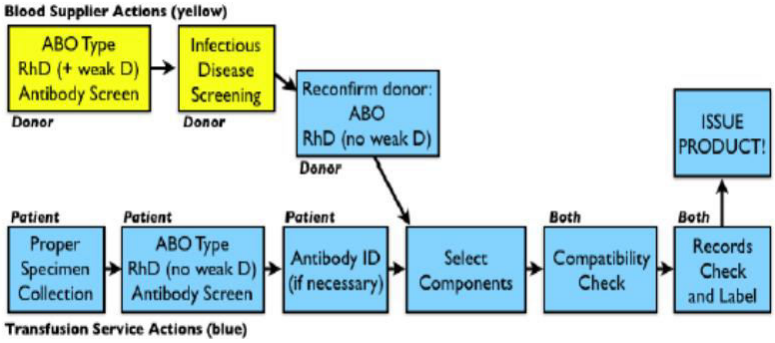
Volume:	100-150 mL (or more)
Contents:	PLTs (≥ 3.0 x 10^{11} in 90%)
	Plasma (100-150 mL)
	WBCs (< 5.0 x 10^8)
	pH ≥ 6.2 (90%)

Volume:	15 mL
Contents:	≥ 150 mg fibrinogen
	≥ 80 IU Factor VIII
	80-120 IU vWF
	40-60 IU Factor XIII
	Fibronectin

The most important substance is the fibrinogen

Transfusion Unit

These investigation are applied on both blood donor and patient



Blood group systems

- One of the main problems in the transfusion of blood is the avoidance of immunological reactions resulting from the differences between donor and recipient red cells.

  The most important thing is the immunological reaction, The infection substance takes time to come out
- When the red cells of a donor are transfused into a recipient who lacks these antigens, they may induce an immunological response.
- There are at least 30 major blood group systems (e.g. the ABO group, Rh group).

If the blood groups are totally different then it is fatal within minutes.

Table 30.3 Clinically important blood group systems.

Systems	Frequency of antibodies	Cause of haemolytic transfusion reaction	Cause of haemolytic disease of newborn
ABO	Almost universal	Yes (common) The most	Yes (usually mild)
Rh	Common	Yes (common)	Yes More then the ABO

other clinical important group systems (just know its name): Kell, Duffy, Kidd, Lutheran, lewis, P, MNS, Li.

1-ABO system

Practically all red cells have the H antigen, a carbohydrate group attached mainly to proteins on the cell membrane (FUT1, Ch19q).

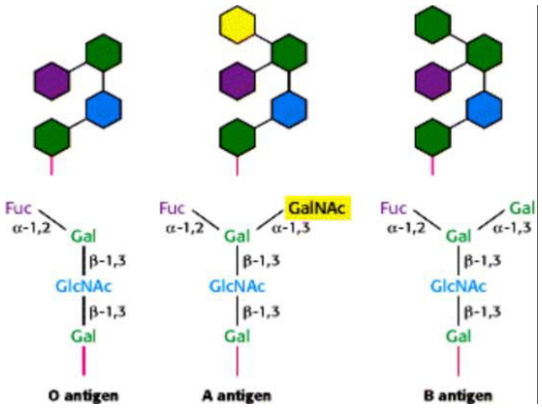
• This antigen is the basis for the ABO blood groups.

• The ABO locus is encoded on chromosome 9q, where one of three possible alleles may be found.

A allele	H antigen + N-acetylgalactosamine = A antigen	By encoding for a glycosyltransferase.
B allele	H antigen + galactose = B antigen	By encoding an alternative glycosyltransferase.
Allele O	The H antigen remains unmodified	Encode no functional enzyme at all.

Haemolytic reactions will occur immediately in the event of incompatible transfusion, and may be fatal.

1-ABO system cont.



	Group A	Group B	Group AB	Group O
Red blood cell type	A	B	AB	O
Antibodies in Plasma	Anti-B	Anti-A	None	Anti-A and Anti-B
Antigens in Red Blood Cell	A antigen	B antigen	A and B antigens	None

Type	Whites	Blacks	Asians	Native Americans
O	45%	49%	40%	79% highest
A	40%	27%	28%	16%
B	11%	20%	27%	4%
AB	4%	4%	5%	<1% lowest

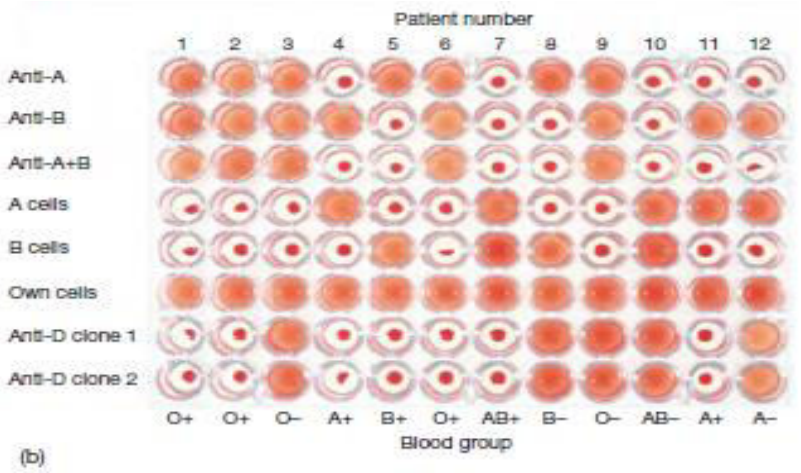
Distribution may be different for special racial and ethnic groups? YES!

Table 30.4 The ABO blood group system.

Phenotype	Genotype	Antigens	Naturally occurring antibodies	Frequency (UK) (%)
O	OO	O	Anti-A, anti-B	46
A	AA or AO	A	Anti-B	42
B	BB or BO	B	Anti-A	9
AB	AB	AB	None	3

Cross match test

Figure 30.3 **(a)** The ABO grouping in a group A patient. The red cells suspended in saline agglutinate in the presence of anti-A or anti-A + B (serum from a group O patient). **(b)** Routine grouping in a 96-well microplate. Positive reactions show as sharp agglutinates; in negative reactions the cells are dispersed. Rows 1–3, patient cells against antisera; rows 4–6, patient sera against known cells; rows 7–8, anti-D against patient cells.



The importance if this test:
1-Forward grouping
2-Backward grouping
3-RhD grouping for patient and donor.

2-Rh system The Rh system is most important in pregnancy

- The Rh system is also of great importance and can cause problems with both transfusion and pregnancy.
- The inheritance of the Rh blood group system is slightly more complex than that of the ABO system.
- Two separate genetic loci on chromosome 1 encode for a total of five antigens.
- The first locus, RHD, has alleles D or d; D encodes a transmembrane protein featuring the D antigen, while the allele d encodes a variant that does not bear this antigen.
- RHCE is an adjacent locus that encodes a transmembrane ion channel bearing the antigens C (or its variant, c) and E (or its variant, e). Alleles at this locus may be described as CE, Ce, cE and ce, denoting the set of antigens they encode. If positive capital D and if negative small d
- A complete description of the Rh haplotype for a patient will include alleles at both RHD and RHCE loci. The commonest haplotypes are DCe, dce and DcE.
- The D antigen is the most clinically important of the Rh group antigens, due to its high immunogenicity.
- An RhD-negative person (e.g. dce/dce) has over a 50% chance of developing anti-D antibodies after the transfusion of one unit of RhD-positive blood: it is therefore important that RhD-negative patients receive RhD-negative blood.
- Note that unlike the ABO system, Rh antibodies are not naturally occurring; they must be raised by exposure of an antigen-negative individual to the appropriate antigen, either through transfusion of incompatible blood or through pregnancy.
- After the exposure, **IgG antibodies** come to predominate, and hemolysis is generally extravascular (major cause of HDFN/HDN).

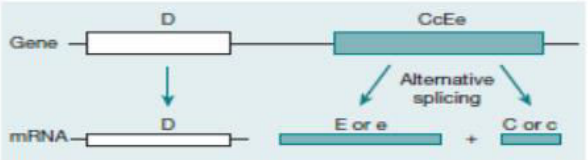


Figure 30.4 Molecular genetics of the Rh blood group. The locus consists of two closely linked genes, *RhD* and *RhCcEe*. The *RhD* gene codes for a single protein which contains the RhD antigen whereas *RhCcEe* mRNA undergoes alternative splicing to three transcripts. One of these encodes the E or e antigen whereas the other two (only one is shown) contain the C or c epitope. A polymorphism at position 226 of the *RhCcEe* gene determines the Ee antigen status whereas the C or c antigens are determined by a four amino acid allelic difference. Some individuals do not have an *RhD* gene and are therefore RhD–.

Table 30.5 The most common Rh genotypes in the UK population.

CDE nomenclature	Short symbol	Frequency in white people (%)	Rh D status
cde/cde	rr	15	Negative
CDe/cde	R_1r	31	Positive
CDe/CDe	R_1R_1	16	Positive
cDE/cde	R_2r	13	Positive

Management of mother and child

-Women who are negative for RhD are given routine antenatal anti-D prophylaxis at 28 weeks, 34 weeks and within 72 hours of delivery.
-This involves an intramuscular injection of anti-D immunoglobulin, which prevents active immunization in the case of red cell transfer across the placenta.
-Any potentially sensitizing event is also treated with additional anti-D administration: such events include abdominal trauma, threatened abortion, or any spontaneous abortion after 12 weeks

3-Other blood group systems important

- Other blood group antibodies, which are sometimes a problem during blood transfusion, include the following:
  - -anti-K (Kell system)
  - -anti-Fya (Duffy system)
  - -anti-Jka (Kidd system)
  - -anti-S (part of the MNSs blood group system).

  Very rare and weak (immunological affect is less then RhD)
- These antigens are relatively poorly immunogenic.
- Their potency in stimulating antibody production is 10-1000 times **less** than that of RhD.
- Consequently, these antigens may not need be routinely assessed prior to transfusion.

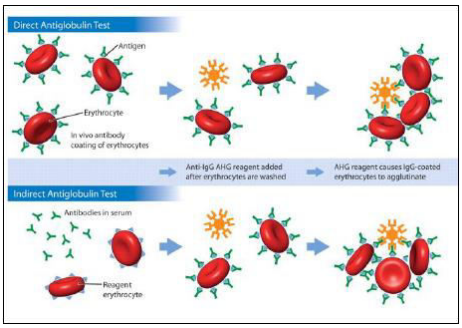
• Compatibility

- The purpose of cross-matching blood before transfusion is: to ensure that there is NO antibody present in the recipient's plasma that will react with any antigen on the donor's cells. (Major cross-match, IAT)
- The basic technique for detecting such antibodies relies on their ability to **agglutinate** red cells that bear the appropriate antigen.

Blood Transfusion: Don't worry, basics

Blood compatibility testing (CROSSMATCH)	
Front type	Back type
Determines which antigens("Flags") in the ABO blood group system are on the patient's Red Blood Cells as follows:	identifies the isohaemagglutinin (Naturally Occurring AntiBody in the patient's serum and should correspond to the antigens found on the Red Blood Cells as follows:
B antigen only > Type B A and B antigens >Type AB Neither A or B >Type O	Anti-A >Type B Anti-A and anti-B >Type O Neither anti-A or anti-B >Type AB
In addition, RBCs are Rh typed and identified as "D" positive or negative	

Antiglobulin Test:



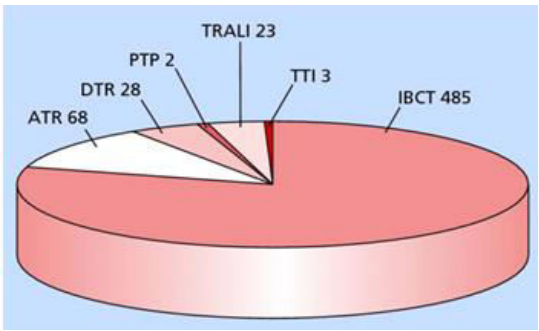
Its purpose is to detect antibodies to red cell surface constituents, either bound to the red cell surface or free in the serum. can be used in two ways :

detect antibody already on the patient's cells in vivo. (direct antiglobulin test)	detect the presence of antibody in serum (indirect antiglobulin test)
-Red cells are washed to remove the free IgG in the plasma, which would otherwise react with and neutralize the antiglobulin. -After washing, anti-human globin is added and, if the red cells are coated with antibody, agglutination takes place -used in the diagnosis of autoimmune haemolytic anaemia	-as in the crossmatching of blood for transfusion. -In this case, serum from the patient who requires transfusion is incubated with donor red cells. -Any antibody present in the recipient's serum that has specificity for antigens on the donor's cells will interact with those cells. -After washing, addition of anti-human globulin will bring about red cell agglutination.

Hazards of blood transfusion: very important

Figure 15.1 Pie chart showing hazards of transfusion in the UK from 1996-2010 as reported to the SHOT Committee. *Notes:* TRALI - transfusion-associated acute lung injury; TTI - transfusion-transmitted infection; ATR - acute transfusion reaction; DTR - delayed transfusion reaction; PTP - post-transfusion purpura; IBCT - incorrect blood component transfused

Source: UK SHOT Committee report 2010.



Measures to protect recipient	
Donor selection Being that he fits the criteria and right choices	Leucodepletion* of cellular product
Donor deferral /exclusion	Post-collection viral inactivation of FFP
Stringent arm cleaning	Monitoring and testing for bacterial contamination
Microbiological testing of donations	Pathogen inactivation of cellular component
immunohaematological testing of donation	Safest possible source of donor for plasma products
Discarding the first 20-30 ml of blood collected	FFP fresh frozen plasma

*White blood cells removal

Complications of blood transfusion

Immediate Transfusion Reactions	Delayed Transfusion reactions
• Hemolytic reactions (Immediate IgM or delayed IgG) • Allergic reactions • Clotting abnormalities after massive transfusion • Transfusion related acute lung injury (TRALI) • Bacterial contamination • Circulatory overload (From over transfusion) • citrate toxicity • Air embolism • Hyperkalemia • Hypocalcemia (infants, massive transfusion) • Pyrogenic reactions(to plasma proteins/HLA ABs) • Post-transfusion purpora • Anaphylaxis • Thrombophlebitis* • Reactions caused by infected blood	• Transmission infection • Transfusional iron overload • Immune sensitization e.g to red cells, platelets or RhD antigen • Transfusion associated Graft vs Host disease. • Solution: irradiation

Management of Transfusion Reactions

- **The first action is always to stop the transfusion and clarify that the correct patient's details** are on the component being transfused.
- The reaction happens after 50 cc of blood or within 10 -15 min the reaction happens.
- If there is any complication we have stope the blood transfusion immediately
- Any suspicion of ABO incompatibility should lead to the institution of circulatory support with IV fluids, careful monitoring of pulse, blood pressure and urine output, and supportive management of any developing DIC.
- The component bag should be returned to the transfusion laboratory with a fresh cross-match sample from the patient.
- Samples should also be sent to assess for intravascular hemolysis - including a full blood count, serum haptoglobin, and hemoglobinuria.
- It is important to ensure that the possibility of bacterially contaminated units has been addressed through taking blood cultures.

*an inflammatory process that causes a blood clot to form and block one or more veins, usually in your legs.

Management of Transfusion Reactions (Cont'd)

- If necessary, broad-spectrum antibiotics may be commenced empirically after cultures have been drawn.
- Severe allergic reaction should be treated initially by stopping the transfusion and returning the unit to the laboratory.
- Chlorpheniramine may help, but severe reactions are likely to require oxygen and nebulized salbutamol, plus intramuscular adrenaline in the case of circulatory collapse.
- With mild fevers only, simple interventions may suffice (e.g. giving an antipyretic and slowing the transfusion); similarly, if a mild allergic reaction is evident (e.g. urticaria), chlorpheniramine followed by a slower reinstatement of the transfusion may help.
- Appropriate investigations include a full blood count, a direct antiglobulin test, serum bilirubin and assessment of renal function

Massive Transfusion

➢ What is massive transfusion:

The replacement of one blood volume over **24 hours**, or as the replacement of **50%** of circulating volume in **3 hours**.

➢ When to use it:

Patients with acute hemorrhage (i.e loss of red cells snd plasma) may need to be transfused with large quantities of packed red cells.

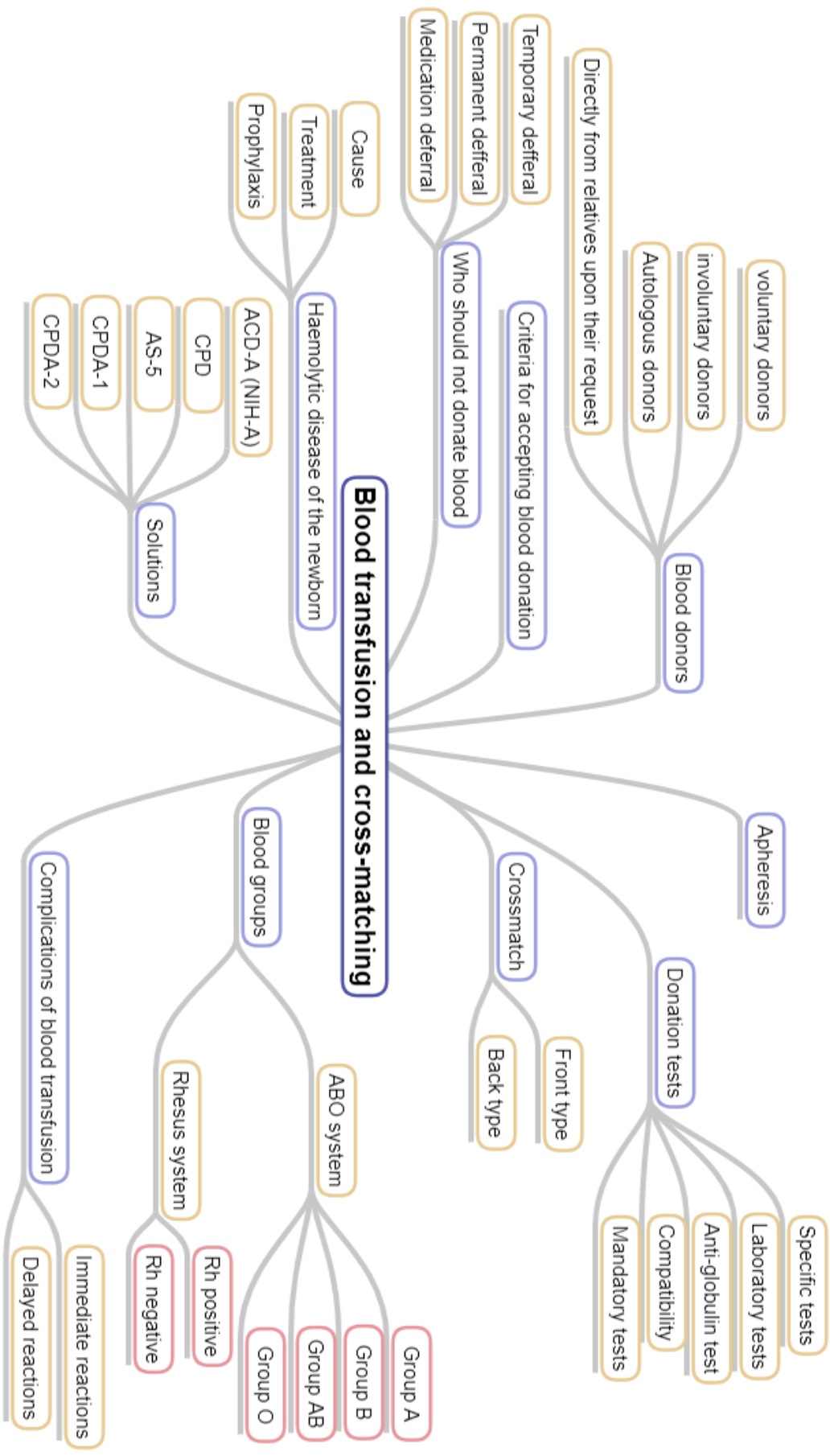
➢ Complications:

With the transfusion of many units of packed red cells, the patient may become **deficient in key plasma components** such as clotting factors and may also become Thrombocytopenic (even in the absence of *disseminated intravascular coagulation DIC*)

➢ Solution

1- the administration of one unit of FFP per unit of red cells may be effective in replacing clotting factors.
2- Fibrinogen and platelets should also be replaced, with 2 pools of cryoprecipitate and 1 adult dose of platelets per 6-8 units of packed red cells.

Summary:


Blood transfusion and cross-matching
Blood donors
voluntary donors
involuntary donors
Autologous donors
Directly from relatives upon their request
Who should not donate blood
Temporary defferal
Permanent defferal
Medication deferral
Criteria for accepting blood donation
Haemolytic disease of the newborn
Cause
Treatment
Prophylaxis
Solutions
ACD-A (NIH-A)
CPD
AS-5
CPDA-1
CPDA-2
Apheresis
Crossmatch
Front type
Back type
Donation tests
Specific tests
Laboratory tests
Anti-globulin test
Compatibility
Mandatory tests
Blood groups
ABO system
Group A
Group B
Group AB
Group O
Rhesus system
Rh positive
Rh negative
Complications of blood transfusion
Immediate reactions
Delayed reactions

MCQs:

Q1: Sarah is scheduled for a Rhinoplasty next month and she wishes to donate blood, what is the type of donation in her case?
A- Voluntary donation
B- Involuntary donation
C- autologous donation.

Q2: Ali is an AIDS patient, when is it allowed for him to donate blood?
A- After 3 years
B- Never
C- After 6 months

Q3: The basis of the ABO blood groups is?
A- H antigen
B- anti-K
C- anti-D

Q4: You are covering a shift in the A&E department and you have a motor vehicle accident patient who lost a lot of blood and requires an immediate blood transfusion, there is no prior history of this patient and his blood type is unknown, what should you do?
A- Wait for the lab results
B- Give him O-ve
C- give him O+ve

Q5: An RhD-positive mother is pregnant with an Rhd-negative baby, what is the appropriate response?
a- There is no danger in this case
b- Exchange transfusion for the infant
c- anti-D injection for the mother

1-C
2- B
3- A
4-B
5- A

Good Luck!

Team members:

Girls

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Aseel Alsulaimani

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Wejdan Alzaid

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Safa Al-Osaimi

Abdulaziz Al-Hussainy