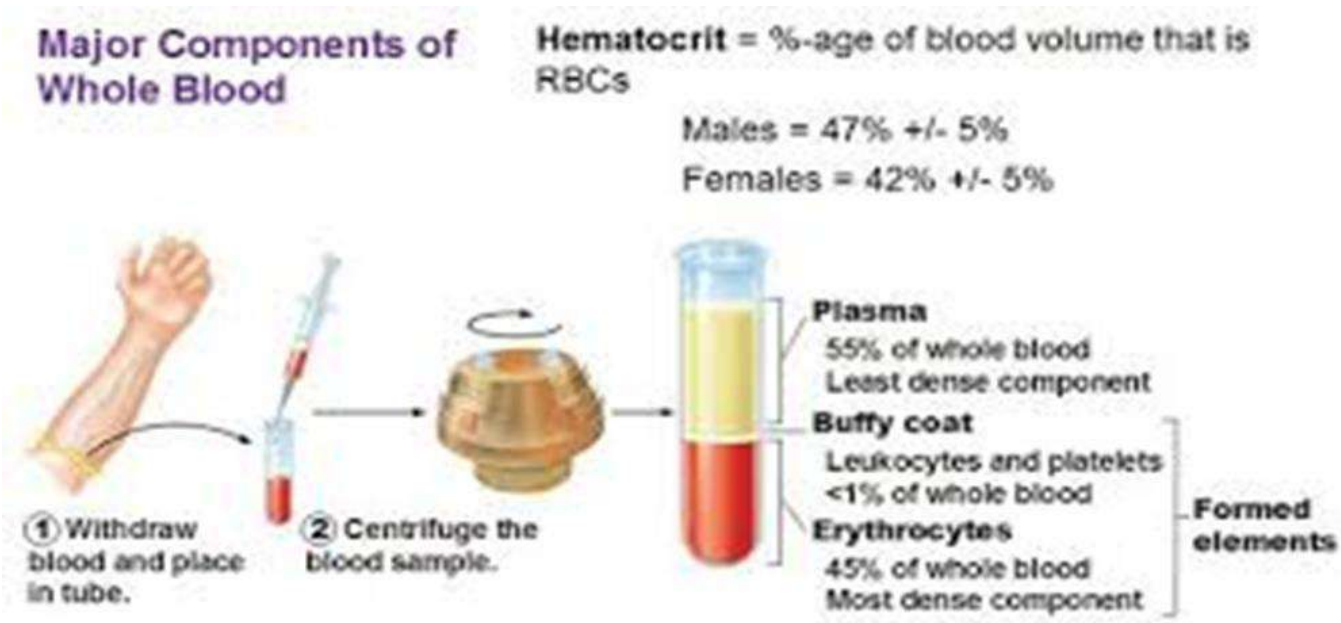
Blood components: The separated parts of whole blood. Separated from one another by conventional blood bank method by centrifugation because of their different specific gravities, different centrifugal force, different time, and different temperature change according to needs.

Type of Blood components:

1. **Cellular components:** RBCs or packed cells, leukocytedepleted red cells, platelets concentrate, platelet apheresis, leukocytes-depleted platelet concentrate

2. **Noncellular plasma components**: Fresh frozen plasma, cryoprecipitate, and cryopoor plasma



Functions of main Blood Components

1. **RBC:** (Erythrocytes = Red Blood Cells = RBCs) It supplies oxygen to different parts of the body and carries carbon dioxide and other waste products

2. WBC: (Leukocytes = White Blood Cells = WBCs) It fights/prevents infections of diseases. White blood cells (WBCs) producing antibodies to develop immunity against infections .

3. **Platelets**: Platelets are produced in the bone marrow. The function of platelets is to prevent bleeding (important for blood clotting).

4. **Plasma**: It is the liquid part of blood, composed of about 92% water, 7% vital proteins and 1% mineral salts, sugars, fats, hormones and vitamins. The plasma also contains three types of proteins, including:

Albumin is the most common type of protein in the plasma. It is made by the liver. It carries nutrients and hormones around the body.

Immunoglobulins (also known as antibodies) are proteins that recognize foreign organisms that have invaded the body. They destroy these "germs".

Clotting Factors are a group of proteins that help stop bleeding when we are injure.

Benefits and Advantages of Blood Components: Separating blood into its components has many advantages like:-

1. Maximize the yield of products form a single donation.

2. Ability to use optimal product for specific disease.

3. Reducing the exposure of foreign material to the donor to minimum.

4. The required components can give maximum benefit to a patient with minimum risk.

5. Better proper patient management with appropriate deficient parts

6. Reduce risk of transfusion transmitted disease as well adverse reaction of blood transfusion.

7. Cost-effective product, from a unit of whole blood can prepare different types of components and supply according to patients' needs and cost-benefit goes to blood bank.

8. Components have greater shelf life than whole blood.

Production of Blood Components :

Blood which is to be used for component production is collected into special collection system in which 2 or 3 smaller satellite bags are attached to the main collection bag. Blood components are prepared from whole blood in large centrifuges which are refrigerated. The blood can be subjected to a light spin or a heavy spin depending upon components to be produced. For preparation of platelet concentrate, centrifugation is performed at room temperature (20° C to 24° C); for all other blood components, centrifugation is carried out between 1°C and 6°C.

Blood Component	Centrifugation	Storage		Indication
		Temp	Time	
PRBCs	WB Light spin= 2000rpm-20ºC -11min. PRBCs + PRP	2-6ºC	**+SAGM 42d**	✚ Anemia ✚ Newborn exchange transfusion
PC	PRP heavy spin= 3500rpm-20ºC -11min. PC + FFP	R.T	3-5 d	✚ Bleeding ✚ Operation if plt. Less than 20000/µl
FFP		18ºC 65ºC →	1year 7year	✚ Clotting factor deficiencies ✚ Severe burns
Cryo Cryoprecipitate	1. WB special heavy spin= 3500rpm at 4ºC -11min. RBC + Plasma 2. Plasma store at -18 ºC then thaw at 4 ºC then heavy spin at 4ºC	30ºC	1year	✚ Hemophilia A ✚ Von Willebrand disease

ABO grouping system

is a classification of blood based on the presence and absence of antibodies . These antigens may be proteins , carbohydrates , glycoproteins , or glycolipids , depending on the blood group system . Some of these antigens are also present on the surface of other types of cells of various tissues .

Blood types are inherited and represent contributions from both parents . A total of 35 human blood group systems are now recognized by the International Society of Blood Transfusion (ISBT). **The two most important** ones are ABO and the RhD antigen ; they determine someone's blood type **(A , B , AB and O , with + , −)** .

Many **pregnant women** carry a fetus with a blood type which is different from their own , which is not a problem . What can matter is whether the baby is RhD positive or negative . Mothers who are RhD- and carry a RhD+ baby can form antibodies against fetal RBCs . Sometimes these maternal antibodies are **IgG**, a small immunoglobulin , which can cross the placenta and cause hemolysis of fetal RBCs , which in turn can lead to hemolytic disease of the newborn called erythroblastosis fetalis, an illness of low fetal blood counts that ranges from mild to severe . Sometimes this is lethal for the fetus ; in these cases it is called hydrops fetalis.

Blood Group Testing :

Identification of blood groups: In grouping, two main systems are tested for,

Anti A Anti B Anti D

Blue Yellow Colorless

ABO system that represents the major obstacle in all transfusions by the presence of natural antibodies (it is also a system of tissular histocompatibility antigens HLA).

Rh system since the D antigen is the most immunogenic of all the blood group antigens.

ABO system

Antibody	Antigen	Blood Group
Anti b	A	A
Anti a	B	B
-	A and B	AB
Anti a & anti b	-	O

Rh (D) Antigen

Rh is a blood group system with many antigens, one of which is D.
Rh refers to the presence or absence of the D antigen on the red blood cell.

The D antigen is very immunogenic, individuals exposed to it will very likely make an antibody to it. For this reason all individuals are typed for D, if negative must receive Rh (D) negative blood.
Rh antigens are an integral part of the red cell membrane. They are protein in nature with a phospholipid component . Rh antigens do not exist in the soluble form and, therefore are not excreted in body fluids.
Unlike ABO antigens, Rh antigens are present only on red blood cells. These antigens are not found on other blood cells including platelets and leukocytes
The most important patient population to consider is females of child-bearing age. If immunized to Rh (D) antigen the antibody can cross the placenta and destroy Rh (D) positive fetal cells resulting in death. This is why Rh negative women are given anti-D after birth of Rh positive baby.

Rh system	
Blood group	Antigen
Rh +ve	D
Rh -ve	-

The main manual methods can be used when performing blood grouping:

: Slide or white porcelain tile Method (forward method): This technique may be used for emergency ABO grouping tests or for preliminary grouping particularly in an outdoor camp. Slide or tile testing is not recommended for routine .

Advantages:

1. Can be used in emergency and blood camps for preliminary grouping.

2. Easy to perform

3. Quick

Disadvantages

1. Less sensitive than the tube test

2. Drying up of the reaction mixture can cause aggregation of cells , giving false positive results

3. Weaker reactions are difficult to interpret s

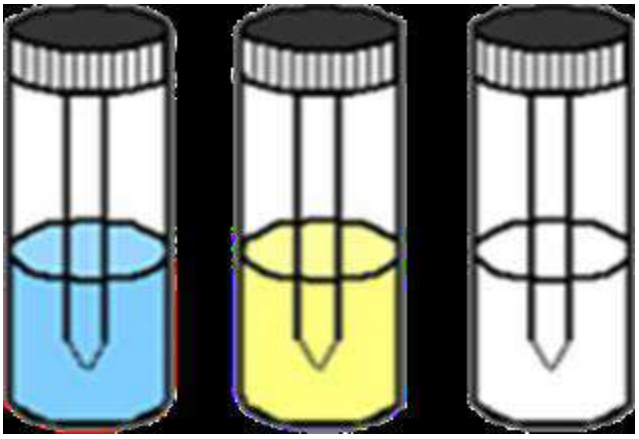
4. Not reliable for weak reactions as negative results cannot be checked microscopically.

5. Serum testing cannot be performed.

Slide Blood Typing proceture:

When testing for blood groups, 3 bottles of reagent containing a specific type of antibody each is used. Each antibody is given a characteristic and universal color.

Blue Yalow Colorless



Anti A Anti B Anti D

Method :-

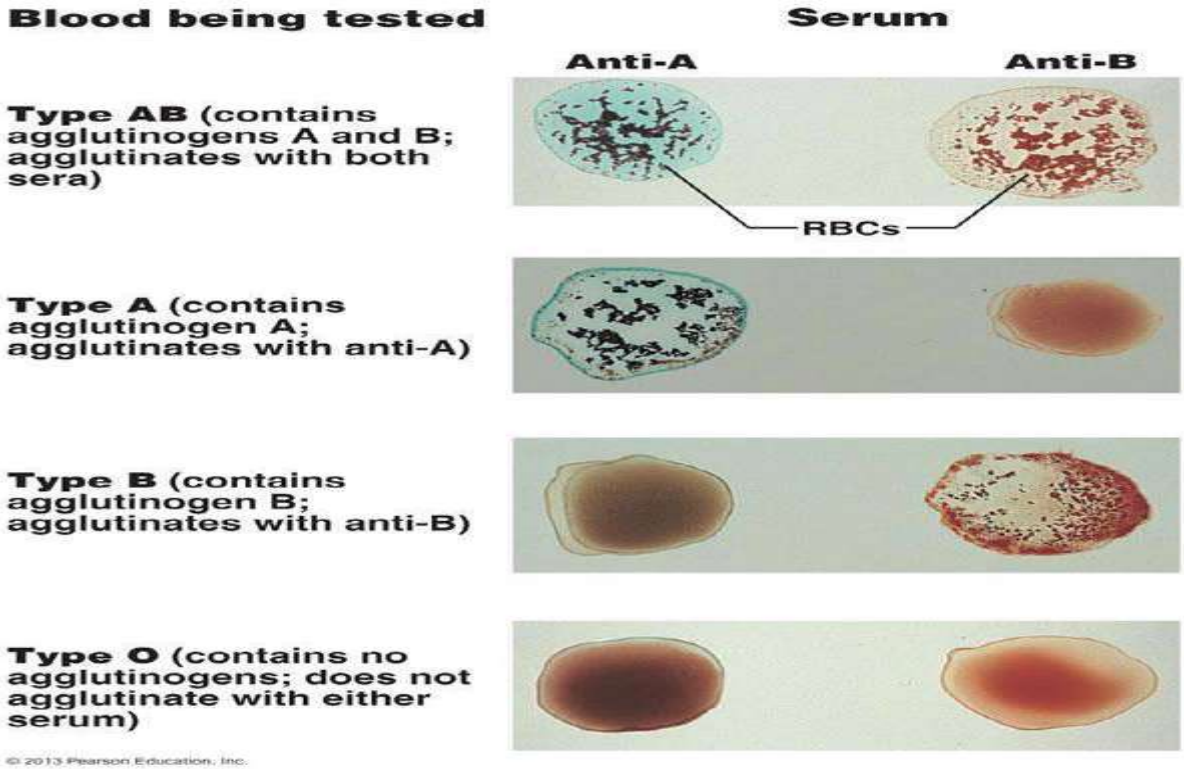
- Clean a finger with surgical spirit, and prick with a sterile lancet.

- Put three drops of blood on to a slide

- Add a drop each, of anti A, anti B and anti D onto them, taking care not to touch the blood drop with the pipette.

- Now, take another slide and using its edge, mix the drops thoroughly.
- Use different corners of this slide to mix, in order to avoid mixing the different reagents.
- Observe for agglutination under a microscope
- Note that anti D takes time to clump.
- Clumping may also be seen with the naked eye, However, microscope is better.

Interpretation



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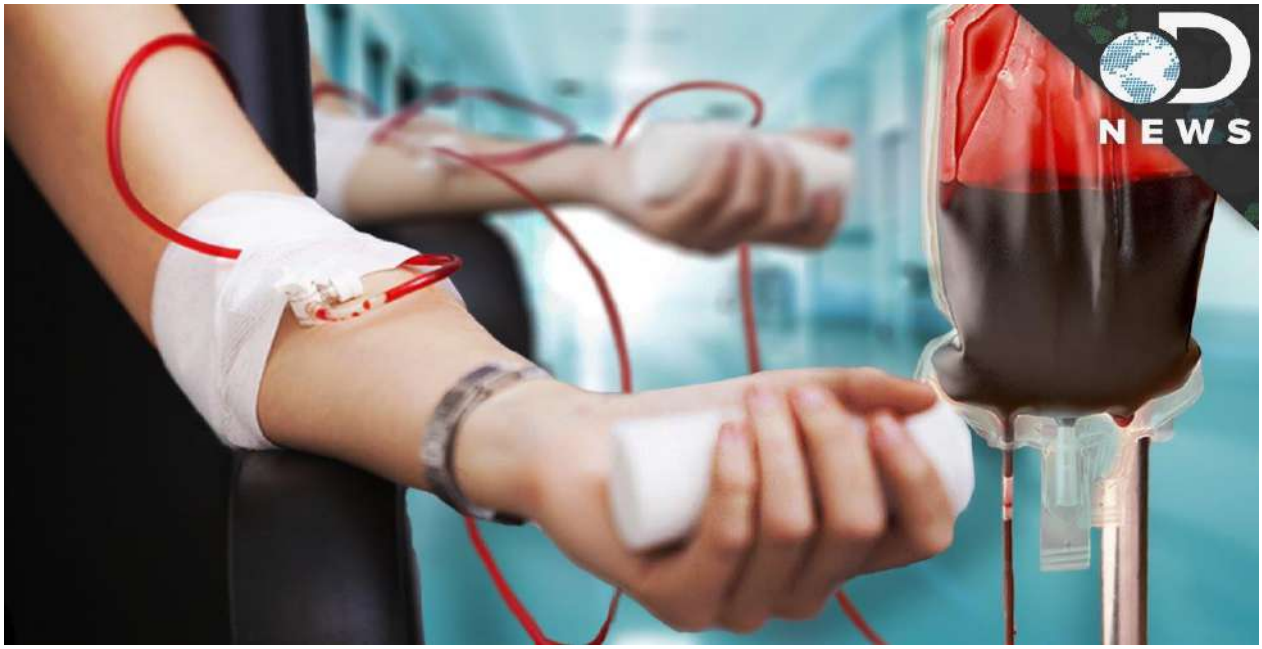
Blood Donation

During a blood transfusion, a small needle is used to insert an IV line into one of your blood vessels . Through this line , you receive healthy blood . The procedure usually takes 1 to 4 hours , depending on how much blood you need . Blood transfusions are very common.



Blood Donor Requirements

Not just anyone can donate blood. There are limitations in place for the safety of both the donor and the recipient. First, you can't donate blood every day. While the amount you donate is only about a pint, your body has to regenerate that blood before you can donate again. A person can donate blood every 90 days (3 months).

Body recovers the Blood very quickly:

Blood plasma volume– *within 24 - 48 hours*

Red Blood Cells – in about 3 *weeks*

Platelets & White Blood Cells – *within minutes*

Safety Concerns

To ensure “Blood Safety”,

1-Strict “Pre-Donation selection”

2-“Testing” of collected blood to WHO specified standards

3-Strict “cross-matching” of blood samples to ensure safe transfusion to patient

There are additional criteria that will exclude you from being a blood donor. For example, if you have or suspect you may have HIV/AIDS you will not be allowed to donate blood as this puts the recipient at risk for contracting the disease. You'll also be turned away if you have ever used needles for illegal drug or steroid injections,

Pre-Donation selection :

1-Registration Required information:

Name (First name, Father’s name, Last name)

Date and time of donation

Address,Telephone

Sex , Age (date of birth).

Additional identification: Medical insurance no., driving license ,

2-Donor criteria

Age: 18 - 60 years

Weight : > 45 kgs

Hemoglobin level: >12 gms/dl for men and 12.5 gms/dl for women

In good health

Temperature :Less than or equal to 37.5°C

Pulse :Between 50-100 bpm

Blood Pressure ;Systolic ≤180 mm Hg

Diastolic ≤100 mm Hg

General physical examination ,

The donor should not show:

Drug-induced mental impairment

Signs of infection

Skin lesions on arms (IV drug use)

Should appear alert

3-Donor Deferral Criteria

Asking questions helps determine the overall suitability of the donor; from this, the donor will be:

6 Months	**1 year**	Accepted –Temporarily-Permanently deferred **Life long**
Tattooing or body piercing	Surgery	HIV patients.
Dental extraction	Typhoid	Viral hepatitis.
Malaria	Dog bite	Jaundice of unknown cause.
Vaccination	Unexplained weight loss	Malignant tumors.
	Continuous low grade fever	Fainting
		Abnormal bleeding tendency.
		Known HBsAg tests.
		Serious cardiopulmonary disease

What is apheresis?

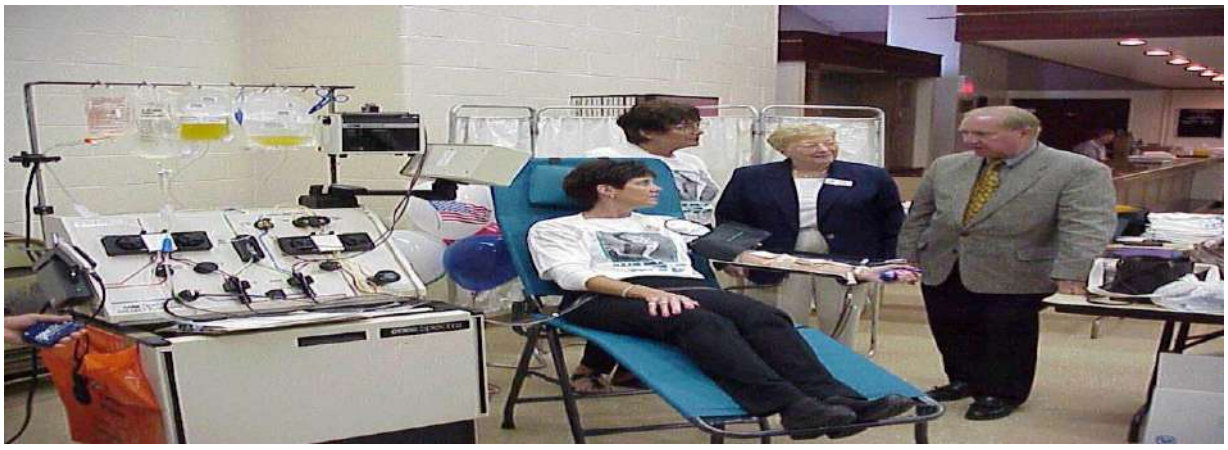
Apheresis is a medical procedure that involves removing whole blood from a donor or patient and separating the blood into specific components. The remaining blood components then are re-introduced back into the blood stream of the patient or donor. Apheresis is used for the collection of donor blood components (such blood cells, platelets or plasma) for the treatment for certain medical conditions like leukemia in which a part of the blood that contains disease-provoking elements is removed. Apheresis is also called pheresis or hemapheresis.

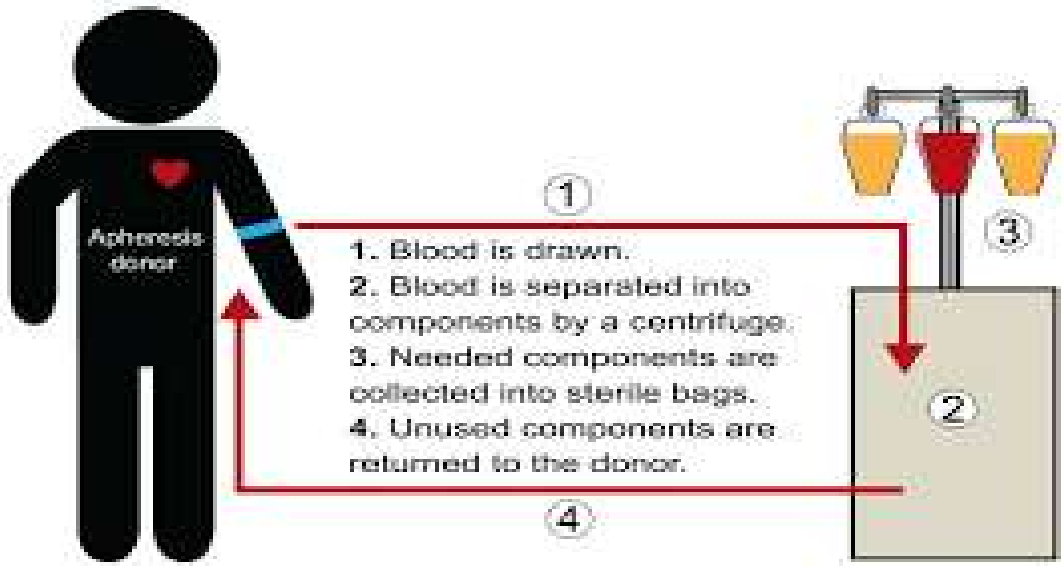
The terminology used may also reflect the component of blood that is being removed, as follows:-

1-Red blood cells (erythropheresis).
2-Leukocytes (leukopheresis or leukapheresis).
3-Lymphocytes (lymphopheresis or lymphapheresis).
4-Platelets (plateletpheresis).
5-Plasma (plasmapheresis).

How is apheresis performed?

All apheresis procedures involve connecting the blood in the patient/donor's veins through tubing to medical device that separates the blood components. The separation is done by either a centrifuge process or a filtration process.





Complications of apheresis?

Minor complications of donor apheresis can include bleeding at the donation site and feelings of light headedness that usually resolve quickly.

Serious complications of donor apheresis are rare. More serious complications can occur when apheresis is used to treat serious conditions and include:

1- Bleeding and a tendency to bleed (because clotting factors are removed).

2- Infection and a tendency toward infection (because the immune system is somewhat suppressed when antibodies are removed).

3- Low blood pressure (as fluids are removed).

4- Muscle cramping (as low blood calcium can occur and other electrolytes can be imbalanced).

Contraindications to apheresis

Hemapheresis is generally avoided if a patient has the following conditions:-

1- Active infection.

2- Unstable heart or lung conditions.

3- Severely low white blood cell or platelet counts.

4- Bleeding tendency.

5- Low blood pressure

Hemolytic disease of newborn (HDN)

Haemolytic disease of the new born and fetus (HDN) is a destruction of the red blood cells (RBCs) of the fetus and neonate by antibodies produced by the mother.

Causes

During pregnancy, RBCs from the unborn baby can cross into the mother's blood through the placenta. HDN occurs when the immune system of the mother sees a baby's RBCs as

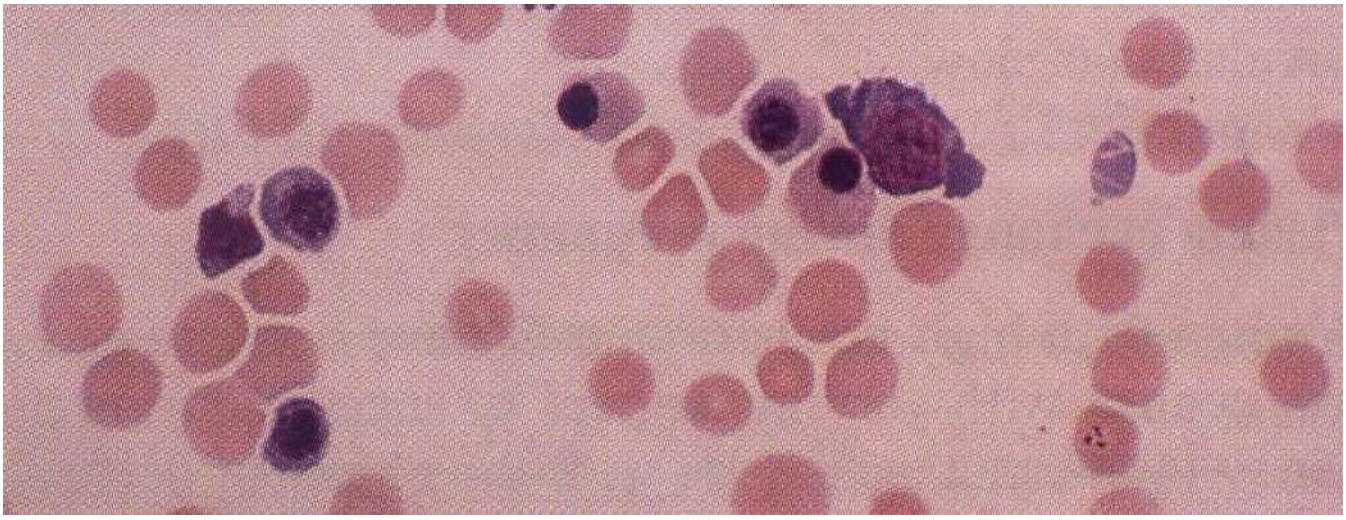
foreign. Antibodies then develop against the baby's RBCs. These antibodies attack the RBCs in the baby's blood and cause them to break down too early.

HDN may develop when a mother and her unborn baby have different blood types. The types are based on small substances (antigens) on the surface of the blood cells.

Clinical features

Less severe form :causes Mild anemia

Severe forms: causes Intrauterine death, Kernicterus, Severe growth retardation Hydrops fetalis Also called Hydrops fetalis as Severly affected fetuses may develop generalized edema, called "**Hydrops fetalis** :Oedematous, ascites, & friable placenta



(Blood film of a fetus affected by HDN showing polychromasia and increased number of normaoblasts)

How is hemolytic disease of the newborn diagnosed?

Hemolytic disease of the newborn can be diagnosed during pregnancy or after the baby is born.

Tests conducted during pregnancy may include:

complete blood count test for the mother

ultrasound

amniocentesis

cordocentesis

After birth, tests may include:

complete blood count test for the baby

umbilical cord blood test

What are the treatments for HDN?

Hemolytic disease of the newborn can be treated during pregnancy or after the baby is born. Treatment during pregnancy may include:

blood transfusion

early delivery of the baby if severe complications arise and baby's lungs are mature

After birth, treatment may include:

blood transfusion

intravenous fluids

oxygen or mechanical breathing machine

exchange transfusion to replace the baby's damaged blood with fresh blood

- Before delivery, sometimes blood transfusions for the fetus
- After delivery, sometimes more transfusions
- Treatment of jaundice if present

If anemia is diagnosed in the fetus, the fetus may be given blood transfusions before birth. Transfusions may be done until the fetus has matured and can be delivered safely. Before delivery, the mother may be given corticosteroids to help the fetus's lungs mature to prepare for the possible delivery of the fetus earlier than usual if necessary. After delivery, the newborn may need more transfusions.

Severe anemia caused by hemolytic disease of the newborn is treated in the same way as any other anemia (see treatment of anemia). Doctors also observe the newborn for jaundice. Jaundice is likely to occur because the rapid breakdown of red blood cells produces a lot of bilirubin. Bilirubin is a yellow pigment, and it gives the newborn’s skin and whites of the eyes a yellow appearance. If the bilirubin level gets too high, it can injure the baby. High bilirubin levels can be treated by exposing the newborn to special

bright lights (phototherapy or "bili lights") or, occasionally, by having the newborn undergo an exchange transfusion. Very high levels of bilirubin in the blood can lead to brain damage (kernicterus) unless it is prevented by these measures.

Compatibility testing

Also called **pre transfusion testing**

Purpose:

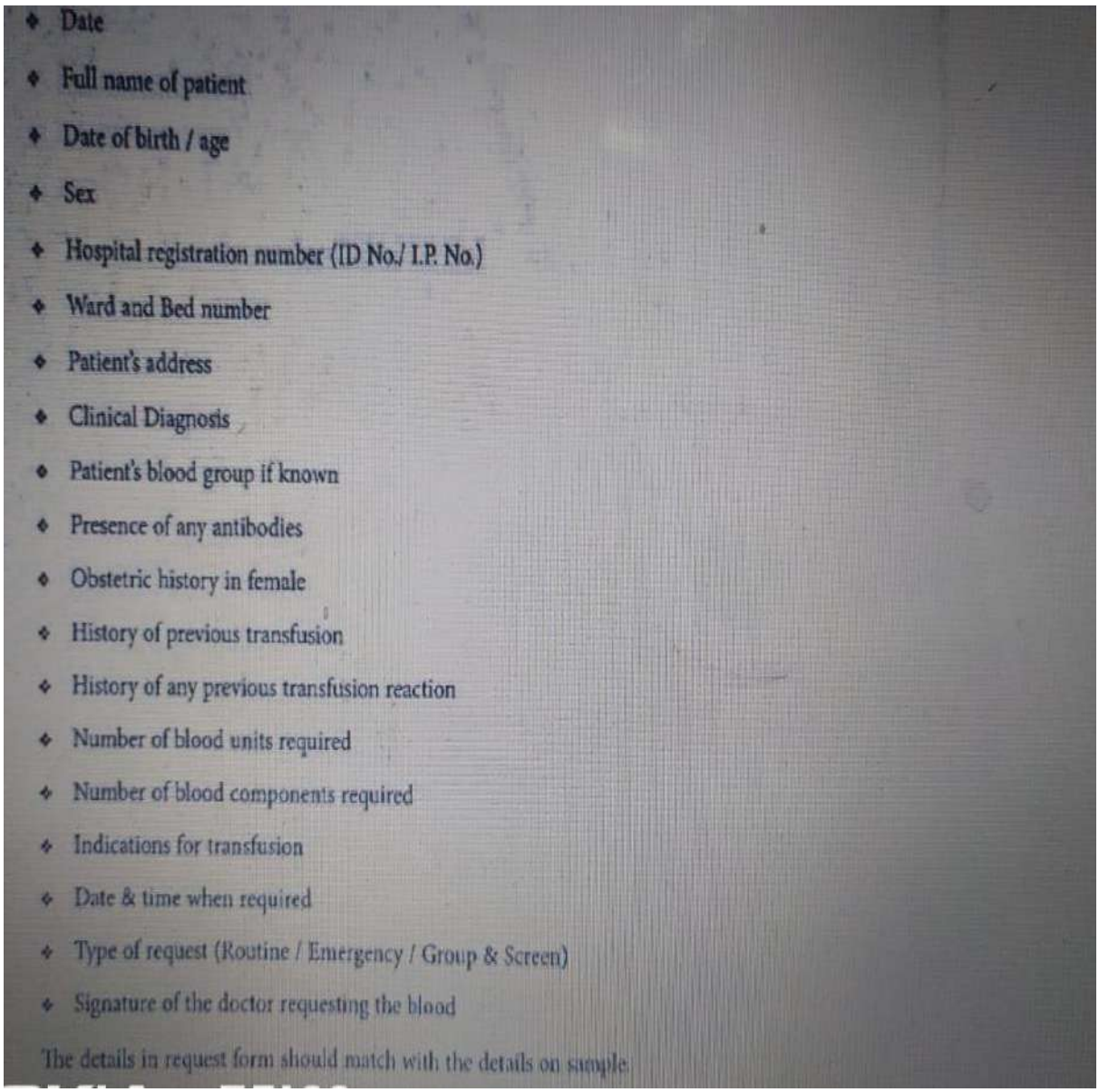
Pre-transfusion "Compatibility testing" is to ensure that the transfused red cells should have an acceptable survival rate and there should not be significant destruction of the recipient's own red cells.

Definition

The term compatibility testing or Pre - Transfusion testing refers to a set of procedures required before blood is issued as being compatible.

1.Identification of Recipient's (Patient's) blood sample:

A. Request form for blood



2.Checking the patients previous records

If the patient has history of transfusion, his/her previous records must be checked for …

1.ABO & Rh blood group

2.Presence of unexpected antibodies

3.Any problems in compatibility testing

4.Any transfusion reactions

3. ABO & Rh grouping

ABO and Rh collections of patients' samples should be performed using recommended techniques for determination of blood type and Rh factor

4. Selection of blood :

Blood must be selected to suit the need of each individual patient. Following points are to be kept in mind, while selecting blood for transfusion

1. It is preferable to use ABO group specific blood / components for the recipient.

2. When group specific blood is not available, use alternate ABO compatible blood (Table 8.1).

Table 8.1: Choice of alternative blood

Patient's Blood Group	Alternative Blood Group	
	First Choice (Given as Packed Cells)	Second Choice (Given as Packed Cells)
O	None	None
A	O	None
A_2 with anti A_1	A_2	O
B	O	None
A_1B	A or B	O
A_2B	A or B	O
A_2B with Anti A_1	A_2 or B	O

Cross Matching

Cross-matching is a test performed before a blood transfusion as part of blood compatibility testing. Normally, this involves adding the recipient's blood plasma to a sample of the donor's red blood cells. If the blood is incompatible, the antibodies in the recipient's plasma will bind to antigens on the donor red blood cells.

This antibody-antigen reaction can be detected through visible clumping or destruction of the red blood cells, or by reaction with anti-human globulin.

Along with blood typing of the donor and recipient and screening for unexpected blood group antibodies, cross-matching is one of a series of steps in pre-transfusion testing.

There are two types of blood cross matching tests: major cross match and minor cross match.

Major cross-match: Here the Recipient serum is tested against donor packed cells to determine if the recipient has preformed antibodies against any antigens on the donor's cells.

Minor cross-match: Here the Recipient red cells are tested against donor serum to detect donor antibodies directed against a patient's antigens.

The two main functions of cross match test are

1. It is final check of ABO compatibility between the donor and patient
2. detect the presence of antibodies in the recipient against the red blood cells of the donor. These antibodies attach to the red blood cells of the donor after transfusion. An incompatible transfusion can result in a severe hemolytic anemia and even death.

The main purpose of this test

- severe anemia or a condition that causes severe anemia, such as sickle cell disease, thalassemia, or the effects of chemotherapy for cancer
- bleeding disorder, such as haemophilia
-pregnant, to find out if you are Rh negative or positive May be getting an organ, bone marrow, or tissue transplant

Requirements

1.Centrifuge

2.Test tubes

3.pasteur pipettes

4.Normal saline

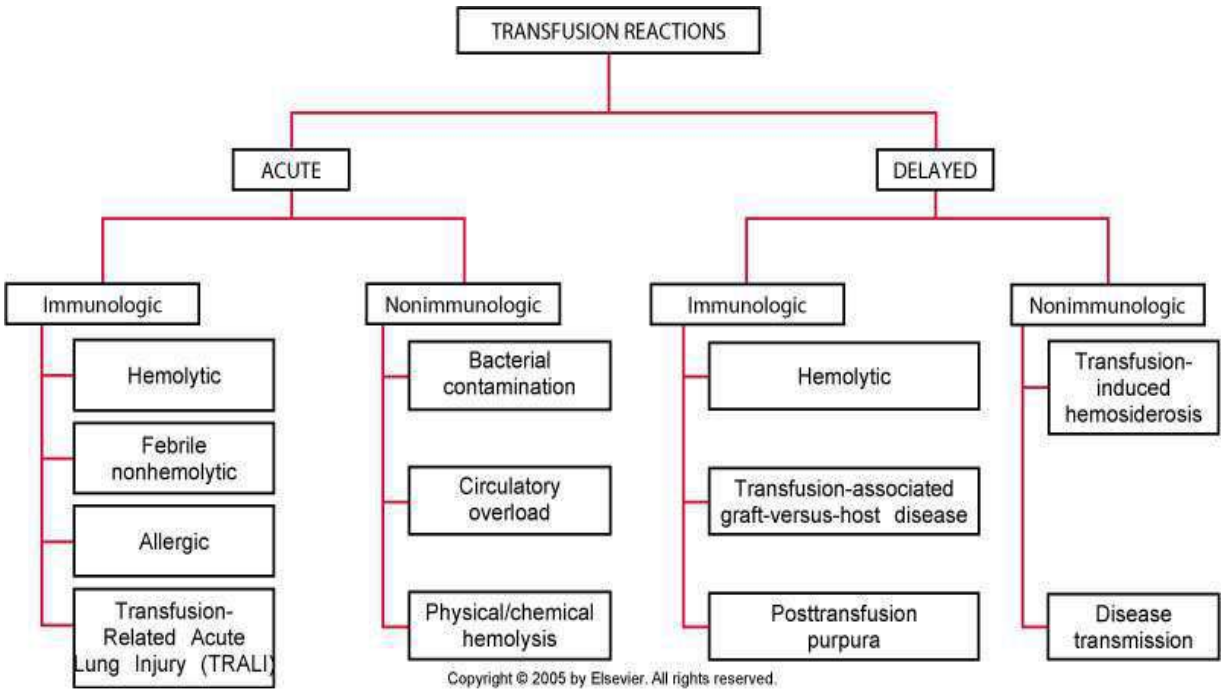
5.Glass slides

6.Microscope

Transfusion Reactions

Transfusion reactions are defined as adverse events associated with the transfusion of whole blood or one of its components. These may range in severity from minor to life-threatening. Reactions can occur during the transfusion (acute transfusion reactions) or days to weeks later (delayed transfusion reactions) and may be immunologic or non-immunologic. A reaction may be difficult to diagnose as it can present with non-specific, often overlapping symptoms. The most common signs and symptoms include fever, chills, urticaria (hives), and itching. Some symptoms resolve with little or no treatment. However, respiratory distress, high fever, hypotension (low blood pressure), and red urine (hemoglobinuria) can indicate a more serious reaction.

Types of transfusion reactions include the following: acute hemolytic, delayed hemolytic, febrile non-hemolytic, anaphylactic, simple allergic, septic (bacterial contamination), transfusion-related acute lung injury (TRALI), and transfusion-associated circulatory overload (TACO). All suspected reactions should result in immediately stopping the transfusion and notifying the blood bank and treating clinician.



Acute complications:

1-Immediate (acute) Hemolytic Reactions

A hemolytic transfusion reaction is a serious complication that can occur after a blood transfusion. The reaction occurs when the red blood cells that were given during the transfusion are destroyed by the person's immune system. When red blood cells are destroyed, the process is called hemolysis.

Symptoms:

Fever, Pain at infusion site, Back/chest pain Hypotension-Bleeding-Renal failure Hemoglobinuria

Steps taken if hemolytic reaction is suspected

- Stop transfusion
- Keep IV line open with physiologic saline
- Perform bedside clerical checks
- Contacts patient's physician & blood bank
- Return unit, set & attached solutions to Lab
- Collect suitable blood samples for evaluation

2-White Cell Reactions ((Febrile Reactions))

Most common, 2% of all transfusions

- Caused from HLAs on the WBCs of the donor that react with the recipient antibody
- Leukocytes reduced units may be given

3- Transfusion Related Acute Lung Injury(TRALI)

- Can be due to:

Hypervolemia

Donor antibodies that react with the recipient's granulocytes which cause embolism to blood vessels in lung tissue

Then fluids and proteins leak into alveolar space/ interstitium

The lungs fill with a high-protein fluid cause pulmonary edema

4-Urticaria((Allergic reaction))
Second most common type of TR , Characterized by a pruritic rash during or following transfusion Allergic reactions are IgE mediated. If not accompanied by other signs or symptoms, transfusion can be continued

5-Bacterial Contamination
Etiology: At time of collection: either from the donor or the venipuncture site. Usually involves endotoxins ☺*Pseudomonas, E.coli, Yersinia*)Transfusion must be stopped immediately (Gram stain & blood cultures should be done on the unit).

6- Circulatory Overload
Rapid increases in blood volume to patient can causes Risk factors: cardiovascular disease , small intravascular volume (elderly, young children).
Signs and Symptoms Dyspnea, , hypertension or heart failure.
Treatment: Stop infusion and place patient in sitting position.

Delay complications :
1-Delayed Hemolytic Transfusion Reactions DHTRs occur at least 24 hrs after transfusion

2-Graft-versus-Host Disease(GvHD)
Rare but fatal condition . May be caused by donor lymphocytes transfused into an immunocompromised recipient – acute graft-versus-host-disease is characterized by damage to the liver, skin and mucosa, and the gastrointestinal tract

3- Post Transfusion Purpura (PTP)
Post Transfusion Purpura (PTP) is a rare delayed transfusion reaction where a patient develops a sudden and dramatic drop in their platelet count typically between 6-10 days following red blood cell transfusion

4-Transfusion induce haemosideriosis
is the accumulation of iron in the body due to frequent blood transfusions. Iron accumulates in the liver and heart, but also endocrine organs.

5-Transfusion transmitted pathogens Hepatitis (C, B viruses) , HIV,Malaria ,Syphilis