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BLOOD TRANSFUSION & BLOOD PRODUCTS

Blood transfusion is the process of transferring blood or blood-based products from one person(**donor**) into the circulatory system of another(**recepient**) after an illness or injury. Blood is made up of various parts, including ***red blood cells, white blood cells, platelets , and plasma***.. "Whole blood" refers to blood that has all of them. In some cases, you may need to have a transfusion that uses whole blood, but it's more likely that you'll need a specific component.

-Every person has one of the following blood types: **A, B, AB, or O**. Also, every person's blood is either **Rh-positive** or **Rh-negative**. So, if you have type A blood, it's either A positive or A negative.

-Type O blood is safe for almost everyone. People who have this blood type are called **universal donors**. Type O blood is used for emergencies when there's no time to test a person's blood type.

-People who have type AB blood are called **universal recipients**. This means they can receive any type of blood.

-If you have Rh-positive blood, you can get Rh-positive or Rh-negative blood. But if you have Rh-negative blood, you should only get Rh-negative blood.

		donor							
		O-	O+	B-	B+	A-	A+	AB-	AB+
recipient	AB+	🩸	🩸	🩸	🩸	🩸	🩸	🩸	🩸
	AB-	🩸		🩸		🩸		🩸	
	A+	🩸	🩸			🩸	🩸		
	A-	🩸				🩸			
	B+	🩸	🩸	🩸	🩸				
	B-	🩸		🩸					
	O+	🩸	🩸						
	O-	🩸							

The indication for B.T. in surgical practice are;

1-**Trauma** in which there have been sever blood loss.
2-Haemorrhage from pathological lesions , ex.from GIT. leukemia or kidney disease
3-Following sever burns, there may be associated hemolysis
4-Pre-operatively in cases of chronic anaemia in which surgery is indicated urgently.
5-During major operative procedures in which a certain amount of blood loss is inevitable, ex. abdominal operations & cardiovascular operations.
6-Post-operatively in a patient who has become severly anaemic.
7-To arrest hemorrhage or as a prophylactic measure prior to surgery in patient with a haemorrhigic state ex.thrombocytopenia, haemophilia or liver disease.

Preparation of blood products for transfusion

Before a blood transfusion is given, there are many steps taken to ensure quality of the blood products, compatibility, and safety to the recipient
The World Health Organization (WHO) recommends that all donated blood should be fit, No evidence of infection especially hepatitis B &C ,HIV infection, Treponema pallidum (syphilis) Trypanosoma cruzi (Chagas disease) and Plasmodium species (malaria).
-15 G needle is introduced into the median cubital vein & 410 ml of blood is aspirated into the bag containing 75 ml of anticoagulant (**citrate,phosphate,dextrose;CPD**).blood can be stored for up to **42 days**
-during collection, the blood is constantly mixed with the anticoagulant to prevent clotting.
-All blood should be stored in special blood bank refrigerator at **4C +/-2C.**

Prolong storage may cause the following changes;

i. Leakage of intracellular K
ii. Reduced level 2,3-DPG
iii. Degeneration of functional granulocytes and platelets
iv. Deterioration of clotting V and VIII
v. Ammonia concentration rises
vi. Decrease in PH
vii. Decrease in RBC deformability and viability

Component separation:

Early transfusions used whole blood, but modern medical practice commonly uses only components of the blood, such as red blood cells, white blood cells, plasma, clotting factors, and platelets
Donated blood is usually subjected to processing after it is collected, to make it suitable for use in specific patient populations. Collected blood is then separated into blood components by centrifugation: red blood cells, plasma, platelets, albumin protein, clotting

factor concentrates, cryoprecipitate, fibrinogen concentrate and immunoglobulins (antibodies).

Red cells work as **oxygen transporters**, plasma is used as a supplement of **coagulation factors,** and platelets are transfused when their number is very scarce or their function severely impaired. Blood components are usually prepared by **centrifugation.**

Blood fractions

1-packed red cells;Advisable in patients with chronic anaemia, elderly, small children & patients in whom large volume of fluid may cause cardiac failure .

2-platelet-rich plasma;Suitable for patient with thrombocytopenia.

3-platelet-concentrate;For patients with thrombocytopenia .

4-plasma;

5-human albumin 4.5%;Albumin may be stored for several months at 4C & are suitable for protein replacement ex. In sever burns

6-fresh-frozen plasma(FFP). Its good source for all the coagulation factors, albumin & Ig. It should not be used as a plasma expander in hypovolemia.

7-cryoprecipitate;The cryoprecipitate is a very rich source of factor VIII. Its stored at -40C,its good for haemophilic patients, also good source of fibrinogen in patient with hypofibrinogenemia

8-factorVIII&IX concentrate. These are available in freeze dried form

9-fibrinogen;Used for patients with DIC or congenital afibrinogenemia,

10-SAG-Mannitol blood;All plasma is removed & is replaced with 100 ml of crystalloid solution containing; Nacl, Adenine, Glucose & Mannitol. This maintains good cell viability, but contain no protein(albumin).

Blood grouping & cross-match.

RBC have many different Ag on their surface.2 main groups of major importance;

A-Ag of the ABO blood groups;

These are strongly antigenic & are associated with naturally occurring Abs in the serum.4 different ABO cell groups;

Red cell group	serum contains;
A	Anti-B Antibody
B	Anti-A Antibody
AB	No ABO Antibody
O	Anti-A&Anti-B Antibody

B-Ags of the rhesus blood groups

The important Ag in this group is Rh(D) which is strongly Antigenic & is present in 85% of the population & Abs to the D Ag are not naturally present in the remaining 15% but their formation may be stimulated by the transfusion of Rh +ve.

Such acquired Abs are capable during pregnancy of crossing the placenta& may cause sever hemolytic anaemia & even death (hydropes fetalis) in a Rh +ve fetus in utero.

Incompatibility

If Abs present in the recipients serum are incompatible with the donors cells ,a transfusion reaction will result because of **agglutination & hemolysis** of the donated cells,leading in sever cases to **acute tubular necrosis** & renal failure. So for this reason all transfusion should be preceeded by;

1-ABO & Rh grouping of the recipient & donor cells , so that only ABO& Rh(D) compatible blood is given

2-Direct matching of the recipients serum with the donor cells to confirm compatibility

Blood grouping & cross-matching take 1 hr. If emergency , blood volume may be restored by **saline, gelatin(ex,haemaccel),dextran or human albumin 4.5%.** Alternatively **O-ve** should be given.

Autotransfusion

Transfusion of patients own blood,ex. In ruptured ectopic pregnancy when blood is collected from peritoneal cavity & put in sterile container to give to the patient after filtering it.

Complications of BT

A-Immune complications

1-Hemolytic

i. acute
ii. delayed

2-non-hemolytic

i. febrile
ii. urticarial
iii. anaphylactic
iv. pulmonary oedema(non-cardiogenic)
v. graft vs. host
vi. purpura
vii. immune suppression

B- non-immune complications

1. complications associated with massive B.T
   i. coagulopathy
   ii. citrate toxicity
   iii. hypothermia
   iv. acid-base disturbance
   v. change in serum K concentration

vi. iron accumilation
vii. volume overload

infectious complications

i. hepatitis
ii. AIDS
iii. Other viral agents(CMV,EBV,HTLV)
iv. Parasites & bacteria

Other complications

i. thrombophlebitis
ii. air embolism

A. Immune Complication

These are primarily due to the sensitization of the recipient to donor blood cells (either **red or white), platelets or plasma proteins**. Less commonly, the transfused cells or serum may mount an immune response against the recipient

1. Hemolytic reactions

usually involve the destruction of transfused blood cells by the recipient's antibodies. Less commonly, the transfused antibodies can cause hemolysis of the recipient's blood cells. There are **acute** (also known as intravascular) hemolytic reactions and **delayed** (also known as extravascular) hemolytic reactions.

i. acute hemolytic reactions

the majority of hemolytic reaction are caused by transfusion of **ABO incompatible blood**.,eg group A,B or AB cells to a group O patient. Most hemolytic reaction are the result of **human error** such as error in labeling or checking the specimen.

The severity of the reaction often depends in the amount of blood given.

Non-immune hemolysis of RBCs in the blood container or during administration can occur due to physical disruption (**temperature changes, mechanical forces,non-isotonic fluid**)

The pt. develops **chills, fever, nausea, chest pain and flank pain,pain along iv line, hypotension, dark urine, uncontrolled bleeding** due to DIC in awake pt.. In anasthetized pt., you should look for **rise in temperature, unexplained tachycardia, hypotension , hemoglobin urea, oozing in the surgical field,DIC, shock and renal shutdown**.

Management of acute hemolytic reaction:

These patients usually require **ICU support**. trasfusion should be stoped immediately .The unit should be re-checked. Blood from the recipient patient should be drawn to test for hemoglobin in plasma, repeat compatibility testing and coagulation tests. A **foley catheter** should be placed to check for hemoglobin in the urine. **Osmotic diuresis** with mannitol(or frusemide) and **fluids** should be utilized (low-dose **dopamine** may help renal function and

support blood pressure).**dialysis** may be necessary. With rapid blood loss, **platelets** and **fresh frozen plasma** may be indicated.

ii. Delayed hemolytic reactions

Pts may develops Abs to red cells Ags(Ab. To **non-D Ag** of the Rh system or to the **kell,duffy or kidd Ags**). Antibodies can occur naturally, or may arise as a consequence of previous transfusion or pregnancy. . Following a normal, compatible transfusion there is a 1-1.6% chance of developing antibodies to these foreign antigens(alloimmunisation). This takes weeks or months to happen - and by that time, the original transfused cells have already been cleared. Re-exposure to the same foreign antigen can then cause an immune response

. Most delayed haemolytic reactions produce **few symptoms** and may go **unrecognised**, however, there may be **malaise, jaundice, fever**, a fall in Hematocrit despite transfusion, and an increase in unconjucated bilirubin. Diagnosis may be facilitated by the direct **coombs test** which can detect the presence of antibodies on the RBC membrane

2. Non-hemolytic reaction

Are Due to sensitization of the recipient to donor WBC, platelets, or plasma proteins.
These reactions include;

i. Febrile Reactions

Cause: Fever and chills during transfusion without evidence of hemolysis are thought to be caused by recipient antibodies reacting with white cell antigens .
Management: Symptomatic, paracetamol. If the fever is accompanied by significant changes in blood pressure or other signs and symptoms, the transfusion should be ceased and investigated.

ii. Urticarial (allergic)reactions

Are characterized by **erythema**, **hives** and **itching** without fever. on rare occasions it may be associated with **laryngeal oedema** and **bronchospasm**. Again, this is a relatively common reaction and occurs in about 1% of all transfusions. It is thought to be due to sensitization against plasma proteins.
Management; If urticaria occurs in isolation (without fever and other signs), **slow the rate** or **temporarily stop transfusion**. If symptoms are bothersome, consider administering an **antihistamine** before restarting the transfusion.

iii. Anaphylactic reactions

Are rare and occur in about 1 of 150,000 transfusions. These are severe reactions that can occur with very small amounts of blood (a few milliliters). Typically, these reactions occur in

pts with **IgA deficiency** who **have anti-IgA** antibodies. These antibodies react to transfusions containing IgA.
Anaphylactic and anaphylactoid reactions have signs of cardiovascular instability including **hypotension, tachycardia**, **loss of consciousness**, **cardiac arrhythmia**, **shock** and **cardiac arrest**. Some time respiratory involvement with **dyspnea** and **stridor** are prominent.
Patients with known IgA deficiency should receive **washed packed red blood cells**, or IgA free blood units
Management by immediately **stop transfusion**,supportive care including **airway management** may be required. **Adrenaline** may be indicated. Usually given as 1;1000 solution s.c,i.m or slow i.v.,**fluids** and **corticosteroids**

iv. Transfusion-related acute lung injury

Some pts can develop **acute hypoxemia** and non-cardiogenic **pulmonary oedema** and present with a picture that looks like adult respiratory distress syndrome(ARDS) developing within 2-8 hrs hours after a transfusion. This is a rare (1 in 5000) but serious complication that is thought to be secondary to **cytokines** in the transfused product or from interaction between **donar antileucocyte antibodies** with the **patient white cells** antigens (or vice versa) causing them to aggregate in the pulmonary circulation. Treatment; involves **symptomatic support** for respiratory distress includes oxygen administration and may require intubation and mechanical ventilation . symptoms generally resolves over 24-48 hours.

v. Graft versus Host disease

This seen exclusively in **immunocompromised** patients when **donor lymphocytes** proliferate and damage target organs especially **bone marrow, skin, liver and gastrointestinal tract**. The clinical syndrome comprises **fever, skin rash, pancytopenia, abnormal liver function and diarrhoea** and is fatal in over 80% of cases. The usual onset is 8-10 days post transfusion,
Prevention: **Gamma irradiation** of cellular blood products (whole blood, red blood cells, platelets, granulocytes) for at risk patients.(pts with **hodgkins disease, aplastic anaemia, AIDS, cytotoxic drugs**)

vi. Post-transfusion purpura

is common with the development of **platelet antibodies**. The external purpura signal a reaction that may lead to profound thrombocytopenia which usually occurs about one week post transfusion. **Plasmapheresis** is the recommended treatment.

Non-Immune Complications

1. complications associated with massive B.T

Massive Transfusion is usually defined as the need to transfuse a volume of blood equivalent or exceeding the patients own volume in a less than a 24-hours period or more

than 50% of blood volume in 4 hours.(adult blood volume is approximately 70 ml/kg, in children over 1 months old is approximately 80 ml/kg.

Massive transfusion occurs in settings such as **severe trauma**, **ruptured aortic aneurysm surgery,liver transplant and obstetrics complications.**

i. Coagulopathy

The most common cause of bleeding following a large volume transfusion is **dilutional thrombocytopenia**(each 10-12 units can produce a 50% fall in the platelet count, thus, significant thrombocytopenia can be seen).

ii. Citrate toxicity

Citrate is the anticoagulant used in blood products. It is usually rapidly metabolised by the liver. Rapid administration of large quantities of stored blood(one unit over five minutes or so) may cause **hypocalcaemia and hypomagnesaemia** when citrate binds calcium and magnesium. This can result in **myocardial depression or coagulopathy.**

Patients most at risk are those with liver disease or dysfunction or neonates with immature liver function having rapid large volume transfusion.

Management: Slowing or temporarily stopping the transfusion allows citrate to be metabolised. Replacement therapy with **intravenous calcium** administration may be required if there is clinical(transient tetany, hypotensiov) or ECG or lab evidence of hypocalcemia or hypomagnesaemia

iii. Hypothermia

Rapid infusion of large volumes of stored blood contributes to hypothermia. Infants are particularly at risk during exchange or massive transfusion.

Prevention and Management: Appropriately maintained **blood warmers** should be used during massive or exchange transfusion

iv. Acid-Base imbalance

can be seen after massive transfusion. The most common abnormality is a **metabolic alkalosis.** Patients may initially be acidotic because the blood load itself is acidic and there may be a prevailing lactic acidosis from hypoperfusion. However, once normal perfusion is restored, any metabolic acidosis resolves and the citrate and lactate are then converted to bicarbonate in the liver.

v. Potassium Effects

stored red cells leak potassium proportionally throughout their storage **hyperkalaemia** can occur during rapid, large volume transfusion of older red cell units in small infants and children.

Prevention: Blood less than 7 days old is generally used for rapid large volume transfusion in small infants (eg cardiac surgery,exchange transfusion)

vi. Iron accumulation

Iron accumulation is a predictable consequence of chronic RBC transfusion. Organ toxicity begins when reticuloendothelial sites of iron storage become saturated. Liver and endocrine dysfunction creates significant morbidity and the most serious complication is cardiotoxicity which causes arrhythmias, and congestive heart failure. Patients receiving chronic transfusion usually have their iron status monitored and managed by their physician.

Management and Prevention: Iron chelation therapy is usually commenced early in the course of chronic transfusion therapy

vii. Volume overload

Pts with **cardiopulmonary disease** and **infants** are at risk of volume overload especially during rapid transfusion of large volume of blood

Management; : Stop the transfusion, administer oxygen and diuretics as required.its advisable in chronic anaemia to give packed RC in addition to diuretic.The transfusion should be given slowly(one unit over 4-6hrs).

2. Infectious complications

Hepatitis May be transmitted from donor & cause sever hepatitis , usually 3 mths after transfusion. it should be avoided by screening of the blood donor.

AIDS All blood is tested for the anti-HIV-1 antibody which is a marker for infectivity. Unfortunately, there is a 6-8 week period required for a person to develop the antibody after they are infected with HIV and therefore infectious units can go undetected

CMV and EBV . Immunocompromised and immunosuppressed patients are particularly susceptible to CMV and should receive CMV negative units only.

Parasitic diseases

reported to be transmitted via blood transfusion include **malaria, toxoplasmosis, and Chagas' disease.**

Bacterial Contamination

Bacteria may be introduced into the pack at the time of blood collection from sources such as **donor skin**, donor bacteraemia or **equipment** used during blood collection or **processing**.or it may results from **faulty storage**,especially when donor blood being Left in a warm room for some hrs before transfusion .Transfusions should not proceed beyond the recommended infusion time (4 hours).

Symptoms: Very high **fever, rigors, profound hypotension, nausea and/or diarrhoea**.

Management: Immediately stop the transfusion and notify the hospital blood bank.

After initial supportive care, blood cultures should be taken and broad-spectrum antimicrobials commenced. Laboratory investigation will include culture of the blood pack.

Blood substitutes

1-Albumin

Human albumin can be used while cross-matching is being performed.2-3 units are given IV over 30min.Its valuable in burns & hypovolemia. Shelf life is one year at room temp. but 5-yr at 2-8C

Human albumin(4.5%) is valuable in burn&hypovolemia.

Human albumin(20%) concentrated salt poor used in sever hypoalbuminemia with salt&water overload ex. Liver failure with ascitis.

2-Dextrans

These are polysaccharide polymers of varying molecular wt.ex.dextran70 & dextran40.

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3-Gelatin(ex.Haemaccel,Gelofusin)

Used commonly as plasma expander.Up to 1000ml given IV .It has low rate of anaphylactic reaction

4- Hydroxyethyl starches

It has low incidence of anaphylactic reaction. It may cause intractable itching, coagulopathy may occur due to reduction in factor VIII& platelets