BLOOD GROUP ANTIGENS AND ANTIBODIES

- Over 20 blood group systems having approximately 400 blood group antigens are currently recognised.
- The ABO and Rhesus (Rh) blood group systems are of major clinical significance.
- less important blood group systems are: Lewis system, P system, I system, MNS system, Kell and Duffy system, and Luthern system.
ABO SYSTEM

- consists of 3 major allelic genes: A, B and O, located on the long arm of chromosome 9.
- There are four main types of blood group- A, B, AB, and O.
- Antigens of ABO system are: A (A1, A2), B and H.
- In addition to RBC, they are also expressed on WBC, platelets and various body secretions.
- According to Landsteiner’s law, anti-A or anti-B antibodies are always present in plasma of individuals who lack corresponding antigen on their red cells.
- These antibodies are usually of IgM class.
• An O group individual who inherits A or B genes but fails to inherit H gene from either parent is called Oh phenotype or **Bombay blood group**.
• These individuals contain anti-A, anti-B and anti-H. Therefore, Oh blood group persons should be transfused only with Oh blood.
Rhesus System

- The Rh allelic genes are C or c, D or d and E or e, located on chromosome 1.
- The importance of this system lies in high immunogenecity of Rh D antigen, which can cause severe hemolytic reaction.
- The presence of D in either homozygous or heterozygous state make the individual Rh positive, while Rh neg individuals are homozygous for d (d/d).
- Rh antigens are expressed on RBCs only and not on any other tissue.
- There are no naturally-occurring Rh antibodies.
BLOOD TRANSFUSION
Pre-transfusion compatibility testing

- ABO and Rh(D) grouping of the patient (recipient).
- Antibody screening of the patient’s serum to detect the presence of clinically significant antibodies.
- Selecting the donor blood of the same ABO and Rh group.
- Cross-matching the patient’s serum against donor red cells to confirm donor-recipient compatibility.
Complications of Blood Transfusion

- Immunologic transfusion reactions - against red blood cells (haemolytic reactions), leucocytes, platelets or immunoglobulins.
- Non-immune transfusion reactions
- Circulatory overload in massive transfusion
- Transmission of an infectious agent.
IMMUNOLOGIC TRANSFUSION REACTIONS
Haemolytic transfusion reactions

- may be immediate or delayed,
- intravascular or extravascular

ABO incompatibility:

- Very rapid cell destruction
- Intravascular haemolysis
- naturally-occurring antibodies, anti-A and anti-B, fix complement.
- symptoms include restlessness, anxiety, flushing, chest or lumbar pain, tachypnoea, tachycardia and nausea, followed by shock and renal failure.
Rh incompatibility:

- Extravascular haemolysis
- Anaemia due to destruction of red cells in the RE system
- The clinical manifestations are relatively less severe and usually consist of malaise and fever but shock and renal failure may rarely occur
Transfusion-related acute lung injury (TRALI)

- Transfusion of donor plasma containing high levels of anti-HLA antibodies which bind to leucocytes of recipient.
- Leucocytes then aggregate in pulmonary microcirculation.
- Increased vascular permeability resulting in acute pulmonary oedema.
• **Febrile reaction**: attributed to immunologic reaction against white blood cells, platelets, or IgA class immunoglobulins.

• **Graft-versus-host disease**: mediated by donor T lymphocytes
NONIMMUNE TRANSFUSION REACTIONS
Circulatory overload:
- result in pulmonary congestion and acute heart failure
- Risk factors: chronic anaemia, in infants and elderly.
- onset may be immediate, or may be delayed up to 24 hours.

Massive transfusion:
- dilutional thrombocytopenia and
- dilution of coagulation factors.
Transmission of infection:

- hepatitis (HBV, HCV),
- CMV infection,
- syphilis,
- malaria,
- toxoplasmosis,
- infectious mononucleosis,
- Brucellosis and
- AIDS (HIV infection)
Thrombophlebitis:
- associated with venesection
- if it is done in the saphenous vein of the ankle rather than the veins of the arm
- if the transfusion is continued longer than 12 hours at a single site

Transfusion haemosiderosis:
- in thalassaemia major
- liver, myocardium and endocrine glands are all damaged.
BLOOD COMPONENTS
Blood components

- packed RBCs,
- platelets,
- fresh-frozen plasma (FFP) and
- cryoprecipitate.
Collection

- The procedure consists of initial centrifugation at low speed to separate whole blood into two parts: packed RBCs and platelet-rich plasma (PRP).
- Subsequently, PRP is centrifuged at high speed to yield two parts: random donor platelets and FFP.
- Cryoprecipitates are obtained by thawing of FFP followed by centrifugation.
- Apheresis is direct collection of large excess of platelets from a single donor.
Applications

1. Packed RBCs:
   - normovolaemic patients of anaemia
   - without cardiac disease.
   - One unit of packed RBCs- raise haemoglobin by 1 g/dl

2. Platelets:
   - Patient with platelet count below 10,000/μl.
   - raise platelet count by 5,000 to 10,000/μl
3. Fresh frozen plasma:
- FFP contains plasma proteins and coagulation factors that include albumin, protein C and S and antithrombin.
- indicated in patients of coagulation failure and TTP
- Each unit of FFP raises coagulation factors by about 2%

4. Cryoprecipitate:
- plasma proteins, fibrinogen, factor VIII and vWF
- patients requiring fibrinogen, factor VIII and vWF
- Transfusion of single unit of cryoprecipitate yields about 80 IU of factor VIII
HAEMOLYTIC DISEASE OF NEWBORN

- passage of IgG antibodies from the maternal circulation across the placenta into the fetal circulation.
- HDN can occur from incompatibility of ABO or Rh blood group system.
- ABO incompatibility is much more common but the HDN in such cases is usually mild,
- Rh-D incompatibility results in more severe form of the HDN
HDN due to Rh-D incompatibility

- Rh incompatibility occurs when a Rh-negative mother is sensitised to Rh-positive blood.
- Sensitisation occurs - passage of Rh-positive foetal red cells across the placenta into the circulation of Rh-negative mother.
- Normally, during pregnancy very few foetal red cells cross the placenta but haemorrhage during parturition causes significant sensitisation of the mother.
- 95% cases of Rh-HDN are due to anti-D,
- some cases are due to combination of anti-D with other immune antibodies of the Rh system such as anti-C and anti-E, and rarely anti-c alone.
HDN due to ABO incompatibility

- Naturally-occurring anti-A and anti-B antibodies which are usually of IgM class do not cross the placenta.
- While immune anti-A and anti-B antibodies which are usually of IgG class may cross the placenta into foetal circulation and damage the foetal red cells.
CLINICAL FEATURES

- severe form may result in intrauterine death from hydrops foetalis
- Moderate disease- severe anaemia and jaundice due to unconjugated hyperbilirubinaemia.
- When the level of unconjugated bilirubin exceeds 20 mg/dl, it may result in deposition of bile pigment in the basal ganglia of the CNS called kernicterus.
- Mild disease- severe anaemia with or without jaundice.
LABORATORY FINDINGS

- Anaemia with reticulocytosis,
- Increased nucleated RBC and polychromasia
- Elevated serum bilirubin
- Positive direct Coombs’ test
- Mother’s blood - Indirect Coomb’s test - anti-D antibodies.
Treatment

- Exchange transfusion
- Phototherapy - converts unconjugated bilirubin into soluble form, that is excreted in urine.
- Infusion of bile - binds free bilirubin in plasma and thus decreases the risk of kernicterus.
Prevention

- All Rh D –ve women are given RhIg within 72 hrs of delivery of Rh +ve infant.
<table>
<thead>
<tr>
<th></th>
<th>Rh HDN</th>
<th>ABO HDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Less common</td>
<td>More common</td>
</tr>
<tr>
<td>Blood group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>Rh neg</td>
<td>O</td>
</tr>
<tr>
<td>Fetus</td>
<td>Rh positive</td>
<td>A or B</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>Usually second</td>
<td>Usually first</td>
</tr>
<tr>
<td>affected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severity</td>
<td>Severe</td>
<td>Mild</td>
</tr>
<tr>
<td>Blood smear</td>
<td>Erythroblastosis</td>
<td>Spherocytosis</td>
</tr>
<tr>
<td>DCT</td>
<td>Strongly Positive</td>
<td>Weakly positive or Negative</td>
</tr>
<tr>
<td>Prevention</td>
<td>Rh immune globulin</td>
<td>Not available</td>
</tr>
</tbody>
</table>