PERIOPERATIVE BLOOD TRANSFUSION

By Abeer Al-tamimi
Concepts

• EBV & ABL
• preparation
• Hx of blood transfusion
• Blood groups, compatibility, cross match
• Components and production of blood component by centrifugation
• Preservative & storage
EBV & ABL

• **Estimated Blood Volume (EBV)** average: Men 75 ml / kg ➢ Women 65 ml / kg ➢ Infants 80 ml / kg ➢ Neonates 85 ml / kg
• ➢ EBV = weight (kg) * Average blood volume

• **Allowable Blood Loss (ABL)**
• ➢ Allowable Blood Loss = \([\text{EBV} \times (\text{Hi} - \text{Hf})]/\text{Hi}\)
• ➢ Where:
• ➢ EBV=Estimated Blood Volume ➢ Hi= initial hemoglobin (Hct) ➢ Hf= final hemoglobin (Hct)
• Why we use EBV & ABL? To decide to transfuse blood or not

  Replacing Blood Loss: “Ideally, blood loss should be replaced with crystalloid or colloid solutions to maintain intravascular volume (normovolemia) until the danger of anemia outweighs the risks of transfusion. For most patients, that point corresponds to a hemoglobin between 7 and 10 g/dL (or a hematocrit of 21-30%). Below a hemoglobin concentration of 7 g/dL, the resting cardiac output has to increase greatly to maintain normal oxygen delivery”

• Example

  Q: Before surgery is to take place, what is the EBV of a female patient weighing 50 kg? Also, what is the ABL of this patient if her Hct is 45?

  EBV = 50kg x 65 = 3250, The final lowest acceptable Hct (Hf) = 30%

  (3250 x (45 – 30))/45 = 1083 Using this rough estimate, the patient in this example could lose 1083 mL of blood without needing a transfusion.
Blood Products

- Whole blood
- Packed Red Blood Cells
- Platelets
- Fresh Frozen Plasma
- Cryoprecipitate
- Human Albumin

Have you ever donated blood?????
• Preparation of Blood Components

• **How to prepare a blood component unite?**

1. Blood donors: Each donor is interviewed for medical **history** of known infectious diseases

2. Each unit is screened for antibodies to:
   - Syphilis, **what's the causative agent?**
   - Hepatitis B and C
   - HIV 1 and 2

3. Centrifugation of blood to its components then add preservative and store it

3. Blood Bank has tests to compare the blood of the donor to the blood of the recipient before the transfusion. So you must know the **blood groups**
• Red Blood Cell Groups

• At least 20 separate blood group antigen systems are known; fortunately, only the ABO and the Rh systems are important in the majority of blood transfusions.

• Other systems include the Lewis, P, Li, MNS, Kidd, Kell, Duffy, Lutheran, Xg, Sid, Cartright, YK, and Chido Rodgers antigens.

• The Rh System

• The Rh system is encoded by two genes located on chromosome 1. There are about 46 Rh-related antigens, but in most clinical settings, the five principal antigens (D, C, c, E, and e).
Hx of blood transfusion

- **Important dates**:
  - In 1665: first recorded transfusion, between dogs
  - In 1667: blood transfusion from sheep to male
  - In 1795: first human to human transfusion
  - In 1901: description of blood groups
  - World War I: development of blood banks
  - In 1960-1970: methods to separate whole blood, prevent antibody formation, detect infections
• **The ABO System**

  Simply speaking, the chromosomal locus for this system produces two alleles: A and B. Each represents an enzyme that modifies a cell surface protein.

  Almost all individuals not having A or B antigen “naturally” produce antibodies, **HOW?** mainly immunoglobulin (Ig) M, against those missing antigens within the first year of life.
The Rh System

- The Rh system is encoded by two genes located on chromosome 1. There are about 46 Rh-related antigens, but in most clinical settings, the five principal antigens (D, C, c, E, and e).

- Approximately 85% of the white population has the D antigen, and individuals lacking this antigen are called Rh-negative.

- In contrast to the ABO groups, Rh-negative patients usually develop antibodies against the D antigen only after a Rh-positive transfusion or with pregnancy, in the situation of an Rh-negative mother delivering an Rh-positive baby.

  - the universal recipient?
  - the universal donor?
Compatibility Testing, purpose? To prevent AG-AB

• **ABO-Rh Testing (Group and Save)**
  - The patient's RCs are tested with serum known to have **anti A and anti B antibodies to determine blood type**. Confirmation of blood type is then made by testing the patient's serum against RCs with a known antigen type.
  - The patient's RCs are also tested with **anti-D antibodies** to determine Rh.

• **Crossmatching**
  - Mimics transfusion: donor cells are mixed with recipient serum.
    - (1) confirms ABO and Rh typing (<5 min)
    - (2) detects antibodies to the other blood group systems (45 min)
    - (3) detects antibodies in low titers or those that do not agglutinate easily (45 min)
Ok, let's take an e.g.? If the recipient is ... It's not a random process!!!
• Centrifugation

• Collect 500 mL whole blood
• Divert the first 40 mL to reduce risk of bacterial contamination from donor skin
• The 40 mL are used for donor unit testing

• Blood is centrifuged and separated into 3 parts:
  ◆ Red Blood Cells
  ◆ Plasma
  ◆ Buffy coat
• Separated of blood components by **1 unit** of Whole blood:

  • [PRBCS](hematocrit 70%): [250 mL of PRBC]+saline preservative=350 mL. 1–6°C.

• **A preservative:**

  • anticoagulant solution is added. The most commonly used solution is [CPDA-1]:
    - Citrate as an anticoagulant (by binding calcium)
  
  • Phosphate as a buffer [Dextrose as a RC energy source [Adenosine as a precursor for ATP synthesis.

• 35 days

• AS-1 (Adsol) or AS-3 (Nutrice) extends the shelf-life to 6 weeks. ADSOL (Adenine, glucose, mannitol and sodium chloride) NUTRICE (Adenine, glucose, citrate, phosphate and NaCl)
Blood component storage

optimal utilization of blood bank resources

<table>
<thead>
<tr>
<th>Blood Component</th>
<th>Storage Temperature</th>
<th>Precaution</th>
<th>Shelf Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRBC</td>
<td>2–6 ºC</td>
<td>ABO&amp;Rh incompatibility</td>
<td>Red cells: 42 days</td>
</tr>
<tr>
<td>Platelets</td>
<td>20–24 ºC</td>
<td>ABO</td>
<td>5 days</td>
</tr>
<tr>
<td>Fresh frozen plasma(FFP)</td>
<td>At or below –25 ºC</td>
<td>ABO</td>
<td>12 months</td>
</tr>
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**Fresh frozen plasma (FFP):** it is rich in clotting factors & other proteins, it’s a plasma removed from fresh blood & then stored rapidly at –28°C
• Blood transfusions should be given as PRBCs.

  1. severe anemia less than 8 gm
  2. class 3&4 hemo

• Surgical patients require: volume as well as red cells, and
crystalloid or colloid can be infused simultaneously through
(a second intravenous line for volume replacement.)

• Prior to transfusion, each unit should be carefully checked
  1. against the blood bank slip and the recipient’s identity
  2. The transfusion tubing should contain a 170-μm filter to trap any clots or debris
  3. Blood for intraoperative transfusion should be warmed to 37°C during infusion,
     particularly when more than 2–3 units, why? Lt shift of hb O2 curve leads to hypoxia
Fresh frozen plasma (FFP) contains all plasma proteins, including most clotting factors.

Transfusions of FFP are indicated in the treatment of:
1. isolated factor deficiencies PT > 18 sec/PTT > 60 sec
2. the reversal of warfarin therapy INR > 2
3. and the correction of coagulopathy associated with liver disease.

Each unit of FFP generally increases the level of each clotting factor by 2–3% in adults.

The initial therapeutic dose is usually 10–15 mL/kg. The goal is to achieve 30% of the normal coagulation factor concentration.