Blood and Blood Transfusion

Year 1 Medical Student Lecture

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Aims and Objectives

This lecture was made specifically to accompany the Semester 2: PBL Case 7 ‘Giving and Receiving’

The points we will cover are:

• Blood donation and blood transfusion

• What is blood and how is it made?

• Function and structure of important blood cells and structures

• Anaemia:
  • Causes
  • Signs and symptoms
Blood Donation and Blood Transfusion
Round 1: Blood Transfusion

- A ‘blood transfusion’ on average will contain 80% red cells, 15% plasma and 5% platelets
  True or false?

- Leucodepletion takes away all risk of viral transmission via blood components
  True or false?

- The most common blood type in the UK is group O RhD positive
  True or false?

- The universal red cell donor is group O RhD negative and the universal red cell recipient is group AB RhD positive
  True or false?

- All mothers which are RhD negative require ‘anti-D’ prophylaxis after childbirth
  True or false?
Leave a blood sample to rest and it divides into its constituents.

**Blood**

- **Plasma (55%)**
  - Contains clotting factors

- **Buffy Coat (<1%)**
  - Contains white blood cells (leucocytes) and platelets

- **Red cell layer (45%)**
The Journey of Blood

Donor
Donor screening and samples for group and viral testing

NHS BT
Manufacturing of the components from whole blood

Hospital Blood Bank
Store units, cross match, designate units and label

Ward Area

Patient
Prescription, positive patient identification, monitoring
Prize question: What is this?
Blood Components

- **Whole blood donation**
  - Mix with citrate to stop clotting (CPD)

- **Plasma**
  - **Fresh Frozen Plasma**
  - **Cryoprecipitate**

- **Buffy Coat**
  - **Granulocytes**
  - **Pooled Platelets**

- **Plateletpheresis**
  - **Platelet dose**

- **Red cells**
  - **Red cell units**
    - Mix with SAG-M (preservative)
  - *Leucodepletion*
## Red Cell Groups

<table>
<thead>
<tr>
<th>Antigen(s) presents on red cell surface</th>
<th>Blood Group</th>
<th>Antibodies present in donors plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>Anti-B</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Anti-A</td>
</tr>
<tr>
<td>A and B</td>
<td>AB</td>
<td>None</td>
</tr>
<tr>
<td>None</td>
<td>O</td>
<td>Anti-A,B</td>
</tr>
</tbody>
</table>
`Forward group`
Adding patient’s red cells to the first four columns:
- Does the patient have A antigen expressed on the cell surface?
- Does the patient have B antigen expressed on the cell surface?
- Does the patient have D antigen expressed on the cell surface?

`Reverse group`
Adding patient’s plasma to the two end columns:
- Does the patient have anti-A?
- Does the patient have anti-B?
Cross Matching Cards
## Indications for Anti-D

### Appendix 2: SHOT flowchart to guide the appropriate administration of anti-D Ig


Last accessed: 15th April 2016

<table>
<thead>
<tr>
<th>Potentially Sensitising Events (PSEs) during pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gestation LESS than 12 weeks</strong></td>
</tr>
<tr>
<td>Vaginal bleeding associated with severe pain</td>
</tr>
<tr>
<td>ERPC / Instrumentation of uterus</td>
</tr>
<tr>
<td>Medical or surgical termination of pregnancy</td>
</tr>
<tr>
<td>Ectopic / Molar Pregnancy</td>
</tr>
<tr>
<td><strong>Gestation 12 to 20 weeks</strong></td>
</tr>
<tr>
<td>For any Potentially Sensitising Event (PSE)</td>
</tr>
<tr>
<td><strong>Gestation 20 weeks to term</strong></td>
</tr>
<tr>
<td>For any Potentially Sensitising Event (PSE) (Irrespective of whether RAADP has been given)</td>
</tr>
<tr>
<td>Does the Kleihauer / FMH test indicate that further anti-D Ig is required?</td>
</tr>
<tr>
<td>For continuous vaginal bleeding at least 500iu anti-D Ig should be administered at a minimum of 6-weekly intervals, irrespective of the presence of detectable anti-D, and a Kleihauer / FMH Test requested every two weeks in case more anti-D Ig is needed</td>
</tr>
</tbody>
</table>

Administer at least **250 IU** anti-D Ig within 72 hours of event. Confirm product / dose / expiry and patient ID pre administration.
## Indications for Anti-D

### Routine Antenatal Anti-D Prophylaxis (RAADP)

<table>
<thead>
<tr>
<th>For Routine Antenatal Anti-D Prophylaxis (Irrespective of whether anti-D Ig already given for PSE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take a blood sample to confirm group &amp; check antibody screen – do not wait for results before administering anti-D Ig</td>
</tr>
<tr>
<td><strong>Administer 1500 IU anti-D Ig at 28 – 30 weeks</strong></td>
</tr>
<tr>
<td><strong>OR</strong></td>
</tr>
<tr>
<td>Administer at least 500 IU anti-D Ig at 28 weeks and then administer at least 500 IU anti-D at 34 weeks</td>
</tr>
<tr>
<td>Confirm product / dose / expiry and patient ID pre administration</td>
</tr>
</tbody>
</table>

### At Delivery (or on diagnosis of Intra Uterine Death >20 weeks)

<table>
<thead>
<tr>
<th>Is the baby's group confirmed as RhD positive? OR Are cord samples not available?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request a Kleihauer Test (FMH Test)</td>
</tr>
<tr>
<td>Administer at least 500 IU anti-D Ig within 72 hours of delivery Confirm product / dose / expiry and patient ID pre administration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Does the Kleihauer / FMH test indicate that further anti-D Ig is required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administer more anti-D following discussion with laboratory</td>
</tr>
</tbody>
</table>


Last accessed: 15th April 2016
Red Cells

- Provided in leucodepleted ‘units’ measuring approximately 280ml
- Each unit of red cells rises the Hb by approximately 10g/l
- Transfused over 2-4 hours
- Patients should receive written information prior to receiving a blood transfusion including the risks of reaction and viral transmission

Storage:
- Temperature: 4°C +/- 2°C
- Shelf life: up to 35 days
Red Cells

- Provided in leucodepleted ‘units’ measuring approximately 280ml
- Each unit of red cells rises the Hb by approximately 10g/l
- Transfused over 2-4 hours
- Patients should receive written information prior to receiving a blood transfusion including the risks of reaction and viral transmission

Prize question: What is the name of the commonly used technique where a patient is given their own blood cells back?

Storage:
Temperature: 4°C +/- 2°C
Shelf life: up to 35 days
Fresh Frozen Plasma (FFP)

- FFP is prepared from anticoagulated whole blood by separating and freezing to a temperature of -30°C within 6 hours of collection.
- The volume of a typical unit: 200-250ml
- FFP contains all coagulation factors
- Sample needed for transfusion lab as group specific

Storage:
Shelf life: up to 36 months frozen (24 hours at 4°C after thawing)
Platelets

Each ‘ATD’ – adult therapeutic dose is ‘pooled’ from 4 different platelet donations

One ATD of platelets would be expected to rise the platelet count by $20-40 \times 10^9$, we can check this by doing a ‘1 hour increment’

Given over 30 minutes

Storage:
- Agitation
- Temp: 20-24°C
- Shelf life: 5 days (7 days if bacterial screening)
Risks of Transfusion

Table taken from SHOT Report: Blood transfusion reactions 1996 - 2014
## Risks of Transfusion

<table>
<thead>
<tr>
<th>Transfusion transmitted infections</th>
<th>Risk of infected donation entering blood supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis B</td>
<td>1 in 1.3 million</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>1 in 28.6 million</td>
</tr>
<tr>
<td>HIV</td>
<td>1 in 7.1 million</td>
</tr>
</tbody>
</table>

Data from SHOT presented at PBM Haematology Conference November 2014
Hepatitis E risk from blood donations

One in almost every 3,000 blood donors in England could be infected with hepatitis E, according to a new study.

Experts said that around 4,200 transfusions containing the virus are likely to be given to patients every year in England.
Prize question: Which animal is linked to the rise in hepatitis E in the UK?
Patients who refuse transfusion

Patients can refuse blood components for personal reasons, not only religious regions.

Assess the patient’s capacity to make decision and explore their reasons, ideally the patient should be alone.

Address each component in turn, explain why it may be indicated and where this product is from.

Clearly documented whether they would accept this product.

Some patients have an advanced directive.
Patients who refuse transfusion

Almost all patients refuse transfusion of whole blood products:
- Red cells, platelets, white cells and unfractionated plasma

Some patients will accept transfusion of blood derivatives:
- Albumin, cryoprecipitate, clotting factor concentrates and immunoglobulins

Most patients do not refuse:
- Intra-operative cell salvage, apheresis, haemodialysis
- Recombinant products: e.g. Epo and G-CSF
- Others: IV iron and tranexamic acid
Round 1: Blood Transfusion

- A ‘blood transfusion’ on average will contain 80% red cells, 15% plasma and 5% platelets
  False

- Leucodepletion takes away all risk of viral transmission via blood components
  False

- The most common blood type in the UK is group O RhD positive
  True

- The universal red cell donor is group O RhD negative and the universal red cell recipient is group AB RhD positive
  True

- All mothers which are RhD negative require ‘anti-D’ prophylaxis after childbirth
  False
Blood and Anaemia
Questions

Round 2: Blood

• The main type of haemoglobin in adults is HbA2
  True or false?

• In adults, haemopoiesis is limited to the pelvis
  True or false?

• Anaemic patients should be offered a blood transfusion
  True or false?

• Thrombopoietin stimulates platelet production
  True or false?

• Monocytes are the cells which are typically increased in response to bacterial infection
  True or false?
• Haemopoiesis – production of blood cells

• *Erythropoiesis* - production of *red* cells

• Blood cells are made in the bone marrow in response to stimulation by growth factors (hormones) such as:
  • G-CSF
  • Erythropoietin
  • Thrombopoietin

• Sites of production vary with age:
  • **Fetus**: Yolk sac (0-2 months), liver and spleen (2-7 months)
  • **Infants**: Bone marrow
  • **Adults**: Sacrum, pelvis, sternum, proximal femur, ribs and skull
Erythrocytes (red blood cells)

- Biconcave, anuclear cells
- Central pallor

- Carry oxygen to tissues and to take the CO$_2$ away
- Each red cell has approximately 640 million molecules of haemoglobin

**STRUCTURE OF HAEMOGLOBIN**

- Adults: Hb A
- Two alpha and two beta chains ($\alpha_2\beta_2$)
- Haem group
- Other subtypes

Erythrocytes (red blood cells)

Haemolysis (red cell breakdown)

- Haem
- Globin

Role of the spleen

Consequences of having no spleen

- Some patients can be *'functionally asplenic'*
- Reduced ability fight against encapsulate organisms (pneumococcus)
- Vaccination
- Penicillin V prophylaxis (role now controversial in adults)
Leukocytes (white blood cells)

- White cells are divided into ‘myeloid’ and ‘lymphoid’ precursors

‘Myeloid’:
- Basophils
- Eosinophils
- Neutrophils
- Monocytes

‘Lymphoid’:
- B cells
- T cell
- NK cells

‘Granulocytes’
NEUTROPHILS

• White cells which are important in the body’s response to infection, particularly bacterial

• Tissue phagocytes which engulf and kill bacteria

Nucleus: Purple and two to five lobes (>five lobes may signify folate of B12 deficiency)

Cytoplasm: Pale blue and contains multiple fine granules. If neutrophils are heavily granulated the term ‘toxic granulation’ is given and is in response to severe infection. ‘Vacculation’ of the cytoplasm can also be seen with this response
EOSINOPHILS

White cells which are important in the body’s response to allergy and to parasites

**Nucleus:** Purple and bi-lobed

**Cytoplasm:** Large, red dominant granules
BASOPHILS

White cells which are important in the body’s response to allergy and inflammation

**Nucleus:** Bi-lobed

**Cytoplasm:** Contains large, purple granules
Leukocytes (white blood cells)

MONOCYTES

White cells which are important in the body’s response to both bacterial and fungal infection

Present antigens to lymphocytes

**Nucleus:** Lobulated

**Cytoplasm:** Large amounts of greyish-blue cytoplasm. Cytoplasm may contain vacuoles
LYMPHOCYTES

Differentiated into B cells, T cells and NK cells

The body’s immune response

Small lymphocytes

Nucleus: circular and purple nucleus

Cytoplasm: small amount of pale to dark blue cytoplasm
• Made in the bone marrow from megakaryocytes

• Small discoid structures
• Adhesion and aggregation
• Formation of platelet plug to ensure haemostasis
Anaemia

- Anaemia is defined as (for adults):
  Haemoglobin < 120g/L for males
  Haemoglobin <110g/L for non-pregnant females (WHO, 2011)

CAUSES OF ANAEMIA
- **Not making enough red cells** (ineffective or inadequate haemopoiesis)
  - Bone marrow failure/infiltration
  - Nutritional deficiency (iron/B12/folate)
    - E.g. Malabsorption of needed elements
  - Chronic disease
- **Losing red blood cells** (e.g. chronic GI bleeds)
  - Iron deficiency
- **Breakdown of red blood cells** (haemolysis)
Anaemia

IRON DEFICIENCY
- Losing iron (heavy periods, chronic blood loss)
- Not eating enough iron
- Not absorbing enough iron
- Increased demand

Symptoms:
Angular cheilosis, kolionychia, glossitis, symptoms relating to underlying cause (i.e. malignancy)

B12 AND FOLATE DEFICIENCY
- Not eating enough in diet
- Not absorbing enough (including pernicious anaemia)

Symptoms:
Neurological features with B12 deficiency
If pernicious anaemia, association with other autoimmune conditions
HAEMOLYSIS
Break down of red cells either due to:

**Hereditary**
- Abnormalities with red cell membrane
- Abnormalities in red cell metabolism
- Abnormalities in haemoglobin

**Acquired**
- Immune
- Fragmentation syndromes
- Chemical

**Signs and symptoms:**
- Jaundice
- Hepatosplenomegaly
- Gallstones
- Chronic venous ulceration
Round 2: Blood

• The main type of haemoglobin in adults in HbA2
  False

• In adults, haemopoiesis is limited to the pelvis
  False

• Anaemic patients should be offered a blood transfusion
  False

• Thrombopoietin stimulates platelet production
  True

• Monocytes are the cells which are typically increased in response to bacterial infection
  False
The transfusion of blood components can be life-saving however does carry risks.

Each patient should be individually assessed regarding their need for transfusion including the presence or absence of bleeding, co-morbidities and signs and symptoms.

The cause of anaemia should be investigated and the underlying problem treated.

For a very helpful guide to diagnosis, investigation and treatment of anaemia, please follow the link below:
https://www.cmft.nhs.uk/media/499600/manchester%20anaemia%20guide.pdf
Thank you very much

Any Questions?

Interested in a career in haematology or have any further questions?

Please feel free to email me: jayne.peters@cmft.nhs.uk