A Guide To Safe Blood Transfusion Practice

Introduction To Blood Components (including storage conditions)

Marie Browett, Pavlina Sharp, Fiona Waller, Hafiz Qureshi, Malcolm Chambers
(on behalf of the UHL Blood Transfusion Team)
This Module Is For The Following Staff:

- Biomedical Scientists
- Medical Staff
- Midwives
- Operating Department Practitioners
- Perfusionists
- Registered Nurses
Contents

• Red cells
• Platelets
• Plasma components – FFP, Cryoprecipitate
• Granulocytes
• Other fractionated plasma products
• Summary of correct storage conditions
Aims and Objectives

Aims:
• Increase staff awareness and knowledge of different blood components and thus increase blood transfusion safety.

Objectives:
• To acquire knowledge of different blood components.
• Understand storage conditions for different blood component products.
• To identify compatibility (crossmatch) procedures required for each product.
• To gain a basic understanding of the suitable selection of ABO and RhD groups for patients.
Introduction

Human blood consists of plasma and cellular components:

- Red cells (erythrocytes)
- White blood cells (leucocytes, granulocytes, lymphocytes)
- Platelets (thrombocytes)
- The plasma also contains other specialised substances, which are important for blood clot formation e.g. clotting factors
Introduction

Each unit of donated blood is subjected to rigorous tests and further processing:

- **Testing:** all donations are screened for HIV, Hepatitis B, Hepatitis C, HTLV (Human T-Cell Lymphotropic Virus), and Syphilis

- **Leucodepletion:** removal of white cells – all blood components are now leucodepleted to reduce the risk of various transfusion reactions

- **Centrifugation:** to separate the red cells, platelets and plasma – in order to process whole blood into various blood components
**Special Requirements**

*Does the patient require CMV Negative and/or Irradiated Components?*

- Prior to prescribing/administering blood components, it is important to determine the patient's individual requirements with regard to the above issues.
- You must address the questions listed above the prescription section on the ICP in full to identify any special requirements.

Go through these Yes/No answer questions to identify any special requirements for your patient with regard to Red Cells and Platelets *well in advance* of the transfusion.

The prescriber MUST circle either Yes or No for each question.
Red Cells

<table>
<thead>
<tr>
<th>Storage:</th>
<th>Red cells must be stored in a specifically designated, temperature controlled, and suitably alarmed fridge (2-6°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelf life:</td>
<td>35 days from date of donation. Each bag of blood has an expiry date – expires at midnight on the date shown</td>
</tr>
<tr>
<td>Administration Time:</td>
<td>Red cell Administration must be completed within 4 hours of removal from the blood fridge</td>
</tr>
<tr>
<td>Volume (ml):</td>
<td>280 ± 60ml</td>
</tr>
<tr>
<td>Red cells in additive solution:</td>
<td>NB: ‘Paedipacks’ are also available</td>
</tr>
<tr>
<td>Compatibility testing requirement:</td>
<td>Red cells must be compatible with the recipient / patient (ABO and RhD type). This testing is performed by hospital transfusion laboratory (blood bank)</td>
</tr>
</tbody>
</table>

**RED CELLS SHOULD NEVER BE STORED IN ANY FRIDGE OTHER THAN THE DESIGNATED BLOOD FRIDGES.**

**NB: If temperature falls below 2°C cells may haemolyse.**

**If temperature exceeds 6°C it may lead to a higher risk of proliferation of bacteria and cause metabolic activity that can lead to deterioration in function.**
Red Cells

The following table shows red cell compatibilities according to the ABO system:

<table>
<thead>
<tr>
<th>Patient ABO Blood Group</th>
<th>Antigens on red cells</th>
<th>Antibodies in plasma</th>
<th>Compatible with donors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>Anti-B</td>
<td>A and O</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Anti-A</td>
<td>B and O</td>
</tr>
<tr>
<td>AB</td>
<td>AB</td>
<td>None</td>
<td>A, B, AB and O</td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td>Anti-A and Anti-B</td>
<td>O</td>
</tr>
</tbody>
</table>

Anti-A attacks red cells of group A (or AB)

Anti-B attacks red cells of group B (or AB)
# Red Cells Compatibility Chart

**Compatible** 😊 **Incompatible** 😞

<table>
<thead>
<tr>
<th>Patient’s Blood Group</th>
<th>A</th>
<th>B</th>
<th>AB</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>😊</td>
<td>😞</td>
<td>😞</td>
<td>😊</td>
</tr>
<tr>
<td>B</td>
<td>😞</td>
<td>😊</td>
<td>😞</td>
<td>😊</td>
</tr>
<tr>
<td>AB</td>
<td>😊</td>
<td>😊</td>
<td>😊</td>
<td>😊</td>
</tr>
<tr>
<td>O</td>
<td>😞</td>
<td>😞</td>
<td>😞</td>
<td>😊</td>
</tr>
</tbody>
</table>

- The transfusion of only a FEW mls of incompatible ABO group blood can trigger a massive immune response, leading to shock and Disseminated Intravascular Coagulation (DIC).
- Patients may DIE from circulatory collapse, severe bleeding or renal failure within a few hours.

**Remember: “BLOOD IS A LIQUID TRANSPLANT”**
Red Cells

The following table shows suitable RhD compatibilities for red cells:

<table>
<thead>
<tr>
<th>Patient RhD Blood Group</th>
<th>1\textsuperscript{st} choice of Donor group</th>
<th>2\textsuperscript{nd} choice of Donor group</th>
</tr>
</thead>
<tbody>
<tr>
<td>RhD Positive</td>
<td>RhD Positive</td>
<td>RhD Negative</td>
</tr>
<tr>
<td>RhD Negative</td>
<td>RhD Negative</td>
<td>None</td>
</tr>
<tr>
<td>Female &lt;50 years old</td>
<td>RhD Negative</td>
<td>RhD Positive</td>
</tr>
<tr>
<td>Male &lt;16 years old</td>
<td>RhD Negative</td>
<td>RhD Positive</td>
</tr>
<tr>
<td>Female &gt;50 years old</td>
<td>RhD Negative</td>
<td>RhD Positive</td>
</tr>
<tr>
<td>Male &gt;16 years old</td>
<td>RhD Negative</td>
<td>RhD Positive</td>
</tr>
</tbody>
</table>

NOTE: RhD positive cells should only be given to an RhD negative patient in an acute emergency situation or if severe shortages of RhD negative cells have occurred.

NOTE: RhD positive cells should never be given to a recipient positive for the antibody Anti-D.
Red cell transfusions are required to increase the oxygen carrying capacity of the blood by raising the haemoglobin concentration of patients with acute or chronic anaemia.

Practice **must** be based on an assessment of patients’ clinical state, transfusion thresholds and target haemoglobin levels that are set by local guidelines.
Usage Guidelines – Red Cell Transfusions

Where the patient is stable, is NOT bleeding and further major bleeding is NOT anticipated:

Patients without cardiovascular disease, and especially younger patients:

- Transfusion is likely to be appropriate to maintain haemoglobin levels in the range of **70-90g/l (grams/litre)**
- Transfusion is unlikely to be appropriate at haemoglobin levels above **90g/l**

Patients known to have or are likely to have cardiovascular disease:

- Transfusion is likely to be appropriate to maintain haemoglobin in the range of **90-100g/l**

**The indications/reason for the transfusion should always be recorded in the patient’s notes.**

NOTE: In an actively bleeding patient, a higher haemoglobin level may be indicated.
Platelets

Platelets can either be:

**Pooled:** Donated whole blood is centrifuged to separate the red cells, platelets and plasma. Four donations of platelets are then ‘pooled’ to produce one adult unit of platelets.

**Apheresis:** Platelets (suspended in plasma) are specially collected from one donor using a process called Apheresis. This is done in the National Blood Service Donor Centres. Therefore, using this process, one unit of platelets is collected from one donor, thereby reducing donor exposure.

**NOTE:**
Each bag of platelets will state whether it is ‘Pooled’ or ‘Apheresis’.
# Platelets

<table>
<thead>
<tr>
<th>Storage:</th>
<th>Controlled room temperature (20-24°C). Platelets must be stored on a special agitator rack to prevent them aggregating.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelf life:</td>
<td>7 days from date of donation. Each bag of platelets has an expiry date – expires at midnight of the date shown</td>
</tr>
<tr>
<td>Administration Time:</td>
<td>Platelets should be administered over at least 30mins and no more than 4hours</td>
</tr>
<tr>
<td>Volume (ml):</td>
<td>Locally defined nominal volume range</td>
</tr>
<tr>
<td>Pooled / Apheresis:</td>
<td>Mean volume 310ml / mean volume 220ml</td>
</tr>
<tr>
<td></td>
<td>NB: ‘Neonatal’ packs available – mean volume 55ml</td>
</tr>
<tr>
<td>Compatibility testing requirement:</td>
<td>Preferably ABO identical with the recipient / patient</td>
</tr>
<tr>
<td></td>
<td>Rhesus negative females under the age of 45 years should be given RhD negative platelets</td>
</tr>
</tbody>
</table>

**NB:** Platelets must *Never* be refrigerated as this may cause them to irreversibly aggregate.

*Platelets must be kept away from direct heat or sunlight as temperatures above the recommended range may cause rapid proliferation of bacteria.*
Platelets

The following table shows locally recommended issuing of platelets:

<table>
<thead>
<tr>
<th>Patient ABO Blood Group</th>
<th>1\textsuperscript{st} choice of donor group</th>
<th>2\textsuperscript{nd} choice of donor group</th>
<th>3\textsuperscript{rd} choice of donor group</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>B**</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>B (HT)</td>
<td>O (HT)</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>A (HT)</td>
<td>O (HT)</td>
</tr>
<tr>
<td>AB*</td>
<td>B</td>
<td>A</td>
<td>-</td>
</tr>
</tbody>
</table>

**Key:**

HT = High Titre

** = Group B platelets are not always available

* = At present no AB platelets are produced by the National Blood Service
Usage Guidelines - Platelets

• Generally, platelet transfusions are indicated for the prevention and treatment of haemorrhage in patients with thrombocytopenia or platelet defects.

• Platelets are not indicated in all cases and may be contraindicated in some, such as Thrombotic Thrombocytopenic Purpura (TTP) and Heparin Induced Thrombocytopenia (HIT).

• Risks include all those associated with transfusion. However, allergic reactions, bacterial infections, Transfusion Related Acute Lung Injury (TRALI) and platelet refractoriness due to allo-immunisation are more common complications of platelet transfusions.
Usage Guidelines - Platelets

Guidelines for dosage:

**Adults:** 1 pack = 1 adult therapeutic dose (patient >20kg)

**Small children:** 10-15ml / kg up to the adult dose of one platelet concentrate is used

**Older children:** An adult dose of platelets should be used

**NOTE:** the dose of platelets can be calculated in more detail if required, using the desired platelet increment, the patients’ blood volume in litres and a correction factor.

A post platelet transfusion count must be taken to measure the response to the transfusion of platelets.

For further details, please refer to BCSH guidelines: Guidelines For The Use of Platelet Transfusions (2003)
Plasma Components

Plasma components commonly used include:

- Fresh Frozen Plasma (FFP)
- Cryoprecipitate
**Fresh Frozen Plasma (FFP)**

**FFP is available as:**

- **Standard FFP**
  From UK donors

- **Overseas Sourced (MB) FFP**
  Available only for children under 16 years of age – the FFP is sourced from Austria as a precaution against vCJD and is ‘virus inactivated’ using Methylene Blue (MB) treatment

- **Solvent Detergent (DS) FFP**
  From non-UK donors – pools of up to 1500 donations – the FFP is ‘virus inactivated’ using Solvent Detergent treatment
**Fresh Frozen Plasma (FFP)**

<table>
<thead>
<tr>
<th>Storage:</th>
<th>Frozen (temperature controlled) -30°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelf life:</td>
<td>24 months (frozen)</td>
</tr>
<tr>
<td>Administration Time:</td>
<td>– controlled thawing process of 20 minutes duration</td>
</tr>
<tr>
<td></td>
<td>Must be transfused within 4 hours of thawing</td>
</tr>
<tr>
<td></td>
<td>Once thawed: as directed by hospital blood bank</td>
</tr>
<tr>
<td>Volume (ml):</td>
<td>Locally defined nominal volume range</td>
</tr>
<tr>
<td>Standard FFP:</td>
<td>Mean volume 273ml</td>
</tr>
<tr>
<td>MB FFP:</td>
<td>Mean volume 233ml (also 50ml paediatric size)</td>
</tr>
<tr>
<td>SD FFP:</td>
<td>200ml (no paediatric size)</td>
</tr>
<tr>
<td>Compatibility testing requirement:</td>
<td>See ‘selection of FFP packs by blood group’ below. RhD matching not required – see ‘RhD blood group compatibility’ below.</td>
</tr>
</tbody>
</table>

- FFP is rapidly thawed at 37°C using specially designed thawers, which provide conditions that minimise contamination and protein damage.
- Once thawed, FFP must not be re-frozen and should be transfused as soon as possible – any post-thaw storage will result in a decline in the content of labile coagulation factors
  - For products kept at 22°C post thawing, the transfusion must be completed within 4 hours of thawing
  - For products stored at 4°C post thawing, the transfusion must be completed within 24 hours of thawing
- If the product is collected from the laboratory but then not required, seek advice from the laboratory as soon as this is known. The advice given could prevent wastage of the product.
**Fresh Frozen Plasma (FFP)**

**FFP may be indicated:**

- Multiple coagulation deficiencies associated with severe bleeding and / or Disseminated Intravascular Coagulation (DIC)
- Single factor deficiencies for which there is no recombinant or virus-safe fractionated product
- Thrombotic Thrombocytopenic Purpura (TTP)
- Reversal of warfarin over anticoagulation associated with significant bleeding – **ONLY IF** prothrombin complex concentrate is not available or not indicated
- Massive transfusion if the coagulation tests are significantly prolonged (PT or APTT) > 1.5 x normal) and the patient is bleeding
- Liver disease with significant coagulopathy to support treatment of bleeding or prior to surgery
Fresh Frozen Plasma (FFP)

**FFP is not indicated:**

- Reversal of warfarin anticoagulation when there is no evidence of severe bleeding
- Plasma exchange (except TTP)
- Polycythaemia in infancy
- Routine correction of abnormal coagulation screen in ITU patients, most of whom require vitamin K replacement
- Volume replacement
- Nutritional support
- Sepsis
Selection of FFP by ABO Blood Group

ABO Compatibility:

• Group O FFP should only be given to group O patients

• For patients of group A, B or AB, FFP of the patient’s own ABO group should be the first choice

• If this is not possible, FFP of a different group may be acceptable if it does not possess ‘high-titre’ anti-A or anti-B antibodies

• Infants or neonates who are not group O may be particularly susceptible to haemolysis from the group O FFP because of the relatively high volumes required
Selection of FFP Principles

Principles of Selection of FFP According to Donor and Recipient Blood Group (BCSH Guidelines Erratum 2005)

<table>
<thead>
<tr>
<th>Recipient Group</th>
<th>O</th>
<th>A</th>
<th>B</th>
<th>AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st choice</td>
<td>O</td>
<td>A</td>
<td>B</td>
<td>AB**</td>
</tr>
<tr>
<td>2nd choice</td>
<td>A</td>
<td>AB**</td>
<td>AB**</td>
<td>A*</td>
</tr>
<tr>
<td>3rd choice</td>
<td>B</td>
<td>B*</td>
<td>A*</td>
<td>B*</td>
</tr>
<tr>
<td>4th choice</td>
<td>AB**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Group O should only be given to group O recipients
AB** plasma, though haemolysin free and suitable for patients of any ABO group, is often in short supply

* = Tested and negative for high-titre antibodies
**Usage Guidelines – Plasma Products**

- The indications for transfusing FFP, Cryoprecipitate and Cryosupernatant are very limited.
- The risks of transmitting infection are similar to those of other components. Of particular concern are allergic reactions, TRALI and haemolysis from transfused antibodies.

**Guidelines for dosage:**
- **FFP:** 10-15ml / kg
- **Cryoprecipitate:** typical adult dose is two pools of 5 (equivalent to 10 single donor units), or one unit per 5-10kg body weight.
- **Cryosupernatant:** only used as a replacement fluid during plasma exchange in some patients with Thrombotic Thrombocytopenic Purpura (TTP).
Cryoprecipitate

- This product contains cryoproteins (clotting factors) such as factor VIII, fibrinogen and factor XIII.
- The selected units should be ABO plasma compatible as for FFP.

<table>
<thead>
<tr>
<th>Storage:</th>
<th>Frozen (temperature controlled) -30°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelf life:</td>
<td>24 months (frozen)</td>
</tr>
<tr>
<td>Administration Time:</td>
<td>– controlled thawing process of 20 minutes duration</td>
</tr>
<tr>
<td></td>
<td><strong>Must be transfused within 4 hours of thawing</strong></td>
</tr>
<tr>
<td></td>
<td>Once thawed: as directed by hospital blood bank</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Volume (ml):</th>
<th>Locally defined nominal volume range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single units (paediatric):</td>
<td>Mean volume 35ml</td>
</tr>
<tr>
<td>Pooled (pool of 5):</td>
<td>100-250ml (mean volume 152ml)</td>
</tr>
</tbody>
</table>

| Compatibility testing requirement: | As for FFP |

- Cryoprecipitate is rapidly thawed at 37°C using specially designed thawers, which provide conditions that minimise contamination and protein damage.
- Once thawed, cryoprecipitate must not be re-frozen and should be transfused as soon as possible – any post-thaw storage will result in a decline in the content of labile coagulation factors. If delay is unavoidable, the component should be stored at ambient temperature and used with 4 hours.
- If the product is collected from the laboratory but then not required, seek advice from the laboratory as soon as this is known. The advice given could prevent wastage of the product.
Rh Blood Group Compatibility for Plasma Components

• Although FFP, Cryoprecipitate and Cryosupernatant may contain small amounts of red cell stroma, sensitisation following the administration of RhD positive FFP to RhD negative patients is most unlikely as stroma is less immunogenic than intact red cells.

• BCSH (2004) Recommendations: Fresh Frozen Plasma, MBFFP and SDFFP of any Rh type may be given regardless of the Rh status of the recipient. No anti-D prophylaxis is required if RhD negative patients receive RhD positive FFP.
Granulocytes

- Rarely used – sometimes used for severely neutropaenic patients
- Granulocytes may be prepared by apheresis for children (single donor). Larger children and adults receive granulocytes prepared by ‘buffy coats’ (pooled)
- The dose is approximately one buffy coat per 10kg

<table>
<thead>
<tr>
<th>Storage:</th>
<th>Should be used as soon as possible after preparation (if necessary, can be stored at a core temperature of 22°C +/- 2°C and used within 24 hours of collection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelf life:</td>
<td>As above</td>
</tr>
<tr>
<td>Volume (ml):</td>
<td>According to local product specification</td>
</tr>
<tr>
<td>Compatibility testing requirement:</td>
<td>Red cell crossmatch should be performed due to possible red cell contamination. Granulocytes should be irradiated</td>
</tr>
</tbody>
</table>
Other ‘Fractionated’ Products of Blood

- Fractionated products are pharmaceutical products produced by ‘pooling’ large numbers of plasma units.
- The ‘pool’ is then virucidally inactivated and fractionated into different products.
- These products may be stored and issued either from your hospital blood bank or hospital pharmacy.
- They include:
  - Anti-D Immunoglobulin
  - Fibrin Sealant
  - Recombinant Factor VII
  - Factor IX
  - Factor VII
  - Human Albumin Solution
  - Prothrombin Complex Concentrate
  - Antithrombin 3
  - Recombinant Factor VIIa (rFVIIa)
  - Factor VIII
  - Human Immunoglobulins (VIg’s)
# A Summary of Blood and Blood Component Storage Conditions

<table>
<thead>
<tr>
<th>Product</th>
<th>Storage temperature</th>
<th>Points to note</th>
</tr>
</thead>
<tbody>
<tr>
<td>All red cells</td>
<td>2-6°C</td>
<td>Temperature controlled blood bank fridges only</td>
</tr>
<tr>
<td>Platelets</td>
<td>20-24°C</td>
<td>On agitator</td>
</tr>
<tr>
<td>Fresh Frozen Plasma</td>
<td>-30°C</td>
<td>Thawed at 37°C for use</td>
</tr>
<tr>
<td>Cryoprecipitate</td>
<td>-30°C</td>
<td>Thawed at 37°C for use</td>
</tr>
<tr>
<td>Cryosupernatant</td>
<td>-30°C</td>
<td>Thawed at 37°C for use</td>
</tr>
</tbody>
</table>
Monitoring Storage Facilities

- All blood/blood component storage and issue fridges/freezers should be connected to a temperature alarm system.
- If the temperature is outside the established range for the product the alarms will ring.
- All alarms sounds are audible locally and at a remote site. This remote site must be somewhere that is manned 24 hours a day – e.g. hospital switchboard. Many fridges are also fitted with ‘door open’ alarms.
- Blood should not be stored in Haematology Day Ward or Cardiac Theatre Fridges overnight as these are not manned 24 hours a day.
- For best practice, a designated member of staff / blood bank staff must monitor these storage facilities. Temperature recording charts should be checked daily and changed weekly, with the task recorded.
- If the alarms ring, you must notify blood bank staff immediately.
Administration of Blood Components

• Only Blood Administration giving sets must be used for the administration of blood components these contain a 170-200micron filter

• These must be changed after **8 hours** or **2 units** depending on the nature of the transfusion

• No other fluid should be mixed in the same giving set as a blood component i.e. Hartmann’s etc

• If the blood component changes, so should the giving set!