Blood Components

Constituents of Blood
Manufacturing – How do we collect prepare and store blood and blood components?

Lianne Rounding – Training Co-ordinator

Transfusion Medicine for Nurses and Midwives
Learning Objectives

• List the components manufactured from whole blood
• Identify the specification requirements of blood components
• Differentiate between routine and specialised transfusion components
• Look at the future of blood components!
The Components of Blood

- Platelets
- White cells (Leucocytes)
- Plasma
- Red Cells
- DONOR
Activity

What Transfusion medicines can be prepared from Blood Donations?
Blood Components and Products

- Plasma
  - Clotting or Coagulation factors
  - Albumin
  - Antibodies

- Buffy Coat
  - Platelets
  - White cells or Leucocytes

- Red Blood Cells
Bio Products Laboratory

• Take Donated Plasma and process it into usable products;
  – Clotting or Coagulation factors
  – Albumin
  – Antibodies (Immunoglobulin)
Routine Components manufactured in NHSBT Centres

1. Red cells
   - Packed/ Concentrated in additive solution (SAG-M)
     - Saline Adenine Glucose - Manitol
   - (Whole blood available by special request only)

2. Platelets
   - Pooled; 4 donors to make 1 ‘adult therapeutic dose’
   - ‘Automated component donation’: single donor

3. Plasma
   - Male only where possible (~90%)

4. Cryoprecipitate
Donor blood passes through a centrifuge which separates different components

- Mainly used for platelets
- Can also be used for ‘double-dose’ red cells & granulocytes
- Collect 2-3 adult doses / 12 ‘baby’ doses from a single donor
- The red cells are returned back to the donor
- The donor can donate more frequently
  - minimum 2 weeks
- Takes about 90 minutes
Whole Blood – ready to be processed
Activity: discussion points

- Why don’t we give them whole blood?
- How do we separate the different cells in blood?
- Do we want all the different cells and constituents we separate?
- Is there an advantage to separate the different parts of blood
Manufacturing (Processing) of Blood Donations
What Manufacturing is required?

• All products are leucodepleted (except for granulocytes)
• Collection pack varies depending on what products are required
  – Pooled platelets (BAT pack: Bottom and Top)
  – Cryoprecipitate (TAT pack: Top and Top)
• Decided on current stock levels and donor availability
Bottom And Top (BAT) pack
– for red cells, plasma & pooled platelets

Donation Pack
Ouch!

Satellite packs
How does this sample pouch make the finished components safer?
Diversion Pouch  Whole Blood  Needle

Test tube collection  To the lab!
Centrifugation

Fairground ride spun at 10 times a minute

Blood centrifuge spins at between 3600 and 4200 times a minute!
Plasma

Buffy Coat left behind

Additive Solution for Red cells
Scientific & Clinical Development

Nurses Study Day

Buffy Coat

Leucodepletion filter

Press

Additive solution

NHS Blood and Transplant
Leucodepletion filter

FFP

Additive solution

Red cells in SAGM
Buffy Coat contains the platelets

You need at least 4 buffy coats to make one adult dose – this requires further processing to pool them together.
Sterile Docking Process

Buffy coat & Plasma

3 Buffy coats

Sterile Docking Machines

Leucodepletion Filter

Final Platelet Pack
Joined together & sealed
4 buffy coats, 1 plasma, LD filter & final platelet pack

Gravity does the work
The pool of 4 buffy coats plus 1 plasma is now centrifuged to
- Concentrate the platelets
- Remove any last remaining red cells

The top layer will contain platelet rich plasma

This is ‘pressed-off’ & leucodepleted into the final bag ready for labelling & issues

The new unit number for this pooled platelet contains the information on the original 4 separate donors – allows traceability
Blood Components Produced by NHSBT
Blood Components
Produced by NHSBT

SPECIFICATION SPN223/5.4
NHSBT Portfolio of Blood Components and Guidance for their Clinical Use

Introduction.........................................................3
Quality Standards..................................................3
Quality monitoring of blood components.........................3
Release of components not conforming to specified requirements on occasion..................3
Donor Assessment..................................................3
Sensitival and Microbiological Testing..........................4
Additional Testing..................................................4
Irradiation..........................................................4
Administration......................................................4
Blood Component development....................................5
Feedback.............................................................5
Communication......................................................5
Responsibilities of NHSBT and Hospital..........................5
Standard Red Cell Components - General Information........6
Red Cells in additive solution...................................7
Red cells, washed..................................................7
Red cells, leukodepleted..........................................7
Red cells, thawed and washed...................................7
Autologous Blood...................................................7
Red Cells, Leucocytes Depleted, in Additive Solution.........8
Red Cells, Leucocytes depleted section.........................11
Red Cells Thawed and Washed section..........................16
Standard Platelet Components - General Information........19
HLA and HPA Selected Platelets................................20
Platelets, suspended in additive solution.......................21
Platelets, Apheresis, Leucocyte Depleted section...........22
Platelets, Pool, Buffy Coat Derived, Leucocyte Depleted section..............................................27
Plasma Components - General Information...................22
Fresh Frozen Plasma..............................................22
Plasma Cryo Depleted............................................24
Fresh Frozen Plasma, Methylen Blue Treated (MBT) and removed................................................24
Fresh Frozen Plasma IgG deficient................................24
Cryoprecipitate.....................................................24
Fresh Frozen Plasma section....................................26
Cryoprecipitate section...........................................26
Components for Intravenous, Neonatal or Pediatric Use - General Information..................42
Red Cells for Neonatal / Pediatric Use section..............45
Plasma Products for Neonatal / Pediatric Use section....52
Platelets for Neonatal / Pediatric Use section...............56
Granulocytes Components - General Information (see appendix 4 for update).................60
References........................................................63
Useful Websites....................................................64
NHSBT Components Clinical Team................................64
Appendix 1 Anticoagulants and additive solutions..............65
Appendix 2 Material Safety Data Sheets for Blood Components.................................................66
Appendix 3 NHS Component Barcodes routinely manufactured.................................................69
Appendix 4 Blood Component Development and Non Routine Components..............................76

Purpose
To provide details of the therapeutic blood components currently supplied to Hospitals

Definitions
NHSBT – NHS Blood and Transplant
Portfolio - NHSBT Portfolio of Blood Components
Component donation – Collection of blood components by apheresis
HT – High titre anti-A,B antibodies

Applicable Documents

http://hospital.blood.co.uk/library/pdf/components/SPN223_5_4.pdf
Donation of Red cells
Standard red cells: £123.31

**Adults**
1 unit of red cells raises the adult Hb by 0.7-1.0 g/dl

**Children**
Volume required in ml is calculated depending on the required increase in Hb

**Storage and handling**
Store at 4°C +/- 2°C
Should be infused within 4 hours of leaving the fridge
Red Cell Components

- Standard red cells
- Neonatal red cells
- Frozen Red cells, thawed and washed
- Red cells for exchange transfusion
- Red cells for intrauterine transfusion
- Large volume neonates and infants
- Red cells, Added value services
  - CMV negative
  - Irradiated
  - washed
Donation of Platelets
One Adult Therapeutic Dose: £209.30

Shelf-life of 7 days
Constantly agitated

Bacterial screening

Stored at 22°C - risk of bacterial contamination

Platelet transfusions are much less common than red cell transfusions but their use is increasing
Platelets – Bacterial Screening

- Sample each platelet unit for bacterial growth
- SHOT reported 28 cases in 12 years (8 fatal)
- Bacterial screening of platelet components implemented in January 2011 and 100% by March 2011
- Increases shelf-life to 7 days
- Expiry date of 5 days without bacterial screening
Platelet Components

- Platelets (one adult therapeutic dose)
- Neonatal platelets
- Platelets for intrauterine transfusion (IUT)
- Buffy Coats

- Platelet, Added value services
  - CMV negative
  - Irradiated
  - Washed then in additive solution
  - HLA selected platelets
  - HPA selected platelets
Automated component donation platelets: split for pediatric patients

One adult dose is ‘split’ into four smaller packs
Plasma Components
Fresh Frozen Plasma £27.60
Cryoprecipitate £31.70

- Clinical FFP (250/300mls)
- Paediatric Neonatal methylene blue treated FFP (MBFFP) (non UK source)
- Cryo-depleted plasma
- Cryoprecipitate
- Methylene blue Cryoprecipitate – neonatal (non-UK source)
Fresh Frozen Plasma (FFP)

- **Single unit:**
  - Processed and frozen to -25°C within 8 hrs
  - Shelf life: 2 years at -25°C or colder
  - ABO group specific FFP transfused
  - Methylene blue treated for anyone born after 1st January 1996
Methylene Blue (MB) Treatment

- Blue dye which inactivates viruses by binding to the virus DNA
- MB added to single unit plasma then exposed to white light for 30-60 mins.
- Cannot be used for red cell components as light energy is absorbed by red cells
- MB removed by filtration
- Fibrinogen and Factor VIII recovery is lower

Cost
- £48.20 per neonatal pack of 65mls.
- £171.54 per paediatric pack of 275mls
Cryoprecipitate

- Preparation: a precipitate that forms by controlled thawing of Fresh Frozen Plasma at 4°C
- Processed and frozen immediately to -25°C
- Shelf life: 2 years at min. -25°C
- It contains coagulation factors e.g. Factor VIII, von Willibrand factor, fibrinogen, Factor XIII and fibronectin
- Pools of 5 units Cost – approx £190.00
- MB-treated cryoprecipitate also available for neonates
Granulocytes
Pooled buffy coat derived: £1041.10

- Supportive therapy for patients who have or are at risk of developing life threatening bacterial or fungal infection which has resulted from bone marrow failure or white cell dysfunction
- Irradiated
- Store at 22°C / not agitated
- Use: within 24 hours of collection
- Their use is not without risk of significant adverse events
- See INF 276

For more information
## Routine Blood Component – Quality & Storage

<table>
<thead>
<tr>
<th>Component</th>
<th>Quality parameters</th>
<th>Temp</th>
<th>Shelf-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red cells in SAG-M</td>
<td>Volume 280ml ± 60ml&lt;br&gt;<strong>Hb &gt;40g/unit</strong></td>
<td>4°C ± 2°C</td>
<td>35 days</td>
</tr>
<tr>
<td>Platelets (pooled or CD)</td>
<td>Volume ~220ml pooled/&lt;br&gt;~310ml CD&lt;br&gt;<strong>Platelets ≥240 x10⁹/unit</strong></td>
<td>22°C ± 2°C&lt;br&gt;with cont. agitation</td>
<td>7 days with bacterial screening</td>
</tr>
<tr>
<td>FFP</td>
<td>Volume ~270ml&lt;br&gt;<strong>FVIII ≥0.7 IU/ml</strong></td>
<td>&lt; -25°C</td>
<td>24 months</td>
</tr>
<tr>
<td>Cryo (single)</td>
<td>Volume ~40ml&lt;br&gt;<strong>FVIII ≥70 IU/unit</strong>&lt;br&gt;<strong>Fibrinogen ≥140 mg/unit</strong></td>
<td>&lt; -25°C</td>
<td>24 months</td>
</tr>
<tr>
<td>Cryo (pooled)</td>
<td>Volume 100-250 ml&lt;br&gt;<strong>FVIII ≥350 IU/unit</strong>&lt;br&gt;<strong>Fibrinogen ≥700 mg/unit</strong></td>
<td>&lt; -25°C</td>
<td>24 months</td>
</tr>
</tbody>
</table>
Specialist Red Blood Cell Components

- **Exchange red blood cells**
  - Process of patient blood removal and transfusion replacement
  - used to treat babies with excessive toxicity due to red blood cell debris

- **Intrauterine Transfusion (IUT)**
  - Transfusion replacement *in utero (i.e. in the womb)*
  - used to treat babies with excessive anaemia

- **Blood compatible – Phenotyped**
Specialist Platelet Components

- **Matched platelets**
  - Component donation platelets
  - used to treat patients with specific immune antibodies that have previously caused an incompatibility

- **Hyper concentrated platelets (IUT)**
  - Used for babies whose platelets are affected by an antibody mum has produced
More Specialist Components
by special arrangement only

• **Washed cells**
  – Red cells or platelets have all plasma removed using saline solution or platelet additive.
  – Used for patients who might have allergic reaction

• **Granulocytes (white cells)**
  – Collected by component donation or from buffy coats.
  – Used for patients with low white cell count and unable to fight off infections (such as post chemotherapy)
Future Developments

Required for patient safety!
Changes required for recipient safety

- **SaBTO – Safety of Blood, Tissues & Organs**
  - Independent advisory committee
  - Make recommendations to government

- **Department of Health**
  - Acts on recommendations
  - Instructs Blood Services to implement changes

- **vCJD screening**
  - No test licensed yet
  - Still in development & trial phases
  - Safety measures in place include:
    - Deferral of anyone transfused since 1st January 1980
    - Leucodepletion: removes 50% of prion activity
    - Non UK plasma for anyone born after 1st January 1996
Current & Future Developments

- **All products** – vCJD screening test
- **Red cells**
  - Prion filtration – currently under assessment in UK. Patient safety trials. (will lead to 6g of Hb lost)
  - Importation – to remove CJD risk
  - Double red cells – reduces patient exposure
- **Platelets**
  - Bacterial screening (since January 2011)
  - Pathogen inactivation – costly / may damage product
  - >80% from component donation: met - recommendation changing
- **Plasma/ Cryo**
  - Import all: initially considered by SABTO but recommended against in March 2012
  - Fibrinogen concentrate (to replace Cryo) Not licensed yet
Learning Objectives – have we met them today?

Can you

• List the components manufactured from whole blood?
• Identify the specification requirements of blood components?
• Differentiate between routine and specialised transfusion components?
• See the future of blood components?
Over to you – any questions or comments?