From Donor To Door
Aim

To provide basic knowledge on the processing, testing and issue of blood donations by NHSBT

At the end of this session you will be aware of:

• The stages of processing, testing and issue of blood

• NHSBT’s range of blood components

• The storage specifications of those blood components
Taking the whole blood

450ml +/- 45ml into 63ml anticoagulant (CPD) within 15 minutes
Whole Blood Donation

• Different blood pack types

• 450 ±45mL blood into 63mL of CPD anticoagulant (target volume typically 470mL)

• At least 3 blood samples taken - bar code labelled, together with the blood packs
Multiple blood pack system

Clips

Needle
Donated Whole Blood – ready to be processed

What happens next?
Processing, Testing and Issue

Processing (> Manufacturing)
• Very few units are used as whole blood
• Reduces wastage

Testing
• Every donation no matter how often the donor has given

Issue
• Includes validation, storage and despatch
Advantages

Provides a concentrated form of a clinically effective product for the patient:

• Specific treatment for a specific deficiency
• Enables correct therapeutic dose to be administered in relatively small volumes
• Product stored at optimal temperature / conditions e.g. red cells at 4° C
But.....

• Patient may be exposed to more donors (especially pooled products) - increases potential risk of disease transmission

• Manufacturing costs

• Practical problems of supply and demand for ‘off-the-shelf’ products - wastage due to expiry
‘Manufacturing’ Department

What they do:
• Blood component “processing”
• Monitor the quality of the components
• Product storage

Licensed by MHRA
• Subject to Good Manufacturing Practice (GMP)

Produce:
• Red cell donations
• Platelet concentrates
• Fresh Frozen Plasma
• Cryoprecipitate
• (Granulocytes)
Fresh Frozen Plasma

Cryoprecipitate

Red cells

Platelets

(Granulocytes)
Multiple Blood Pack System
Leucodepletion

• All products are routinely leucocyte depleted by filtration (WBC count of $<5 \times 10^6$/unit)

• Timing is dependant on the component produced (whole blood pre-processing or component post-processing)
Mandatory:- Minimise risk of Creutzfeldt–Jakob disease (vCJD) transmission
Basic Methodology
Centrifugation of the donation
Post-centrifugation:

- Blood
- Buffy coat
- Plasma layers
Under pressure the components are expressed into different satellite bags.

Bag separation by heat sealing.
Product labelling - all critical stages of processing are under computer control
Red Cell Products

General

Types

• Most Red cells in SAGM

Storage:

• Time: 35 days
• Temperature: 4 °C ± 2°C
• Storage monitored
Red Cell Products
Specialist

- Red cells, thawed and washed (rare phenotypes)
- Washed red cells (history of severe allergic / febrile reactions to transfusion)

Neonatal / infant components

- Red cells in SAGM for large volume transfusion (not exchange) a.k.a. “LVT”
- Red cells in SAGM for neonatal transfusion (LVT split into 6 equal components)
- Red cells for neonatal exchange transfusion (in plasma)
- Red cells for intra-uterine transfusion (IUT) (in plasma but higher haematocrit)
Platelet Concentrate Products

- Automated Component Donation
- Pooled
Platelets

• Routinely produced : ‘off-the-shelf’ products

• ABO identical blood group transfused where possible

• RhD negative products for RhD negative women

• CMV negative and / or irradiated where appropriate
Component Donation (Apheresis)

- Donor blood passes through centrifuge
- Separates components
- 2-3 Adult Therapeutic Doses (ATD)
- 12 ‘baby’ doses
- Red cells are returned
- Can donate more frequently
- Takes about 90 minutes
Automated Component Donation

Can be used also for provision of directed platelet products

**Advantages:**
- Amount collected
- Frequency of donation
- Increased reliability / control
- Single donor exposure / unit

**Disadvantages:**
- Time consuming for donors
- Expensive
Apheresis Platelet Concentrate: Split For Neonatal / Paediatric Patients

One adult dose is ‘split’ into four smaller packs
Making A Platelet Pool

‘Buffy coat’ extracted by centrifugation

Four units connected with sterile connecting device
The platelets are expressed through a filter into the special platelet pack
Platelet Storage

• Maintained / recorded temperature of $22^\circ C \pm 2^\circ C$

• Up to 7 days (if bacterial monitoring)

• Constantly mixed
Plasma Products

Fresh-Frozen plasma

• Processed and frozen to below \(-25\)°C within 8 hrs

• Shelf life: 3 years at below \(-25\)°C

• ABO group specific FFP transfused

• Methylene Blue treated imported plasma for under 16’s

WHY?
Plasma Products

Cryoprecipitate

• Preparation: ‘Cryoglobulin’ fraction produced by controlled thawing of FFP at 4°C ± 2°C

• Contains various coagulation factors e.g. Fibrinogen, Factor VIII

• Isolated, resuspended in a small volume of plasma and re-frozen (<2 hours)

• Processed and frozen immediately to below -30°C

• Shelf life: 3 years at -25°C or colder
Pooled Granulocytes

• Supportive therapy for patients with life threatening bacterial / fungal infection due to:
  – Bone marrow failure
  – Neutrophil dysfunction

• Clinically effective adult dose: $\sim 2 \times 10^{10}$ cells
  – 2 pooled components
  – Derived from 20 whole blood donations

• Prepared for individual patients (must be discussed with an NHSBT Consultant before ordering)

• Use: ASAP expires midnight on day 1
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STORAGE TIME</th>
<th>STORAGE TEMP</th>
<th>STORAGE NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED CELLS</td>
<td>35 days</td>
<td>4°C +/- 2°C</td>
<td>Air temp: 2°C - 8°C</td>
</tr>
<tr>
<td>PLATELETS</td>
<td>7 days</td>
<td>22°C +/- 2°C</td>
<td>Gently mixed</td>
</tr>
<tr>
<td>PLATELETS</td>
<td></td>
<td>Bacterial Monitored</td>
<td></td>
</tr>
<tr>
<td>FFP / CRYO</td>
<td>3 years</td>
<td>below -25°C</td>
<td>Use within 4 hrs of thawing</td>
</tr>
<tr>
<td>GRANULOCYTE</td>
<td>&lt; 24 hrs</td>
<td>22°C +/- 2°C</td>
<td>Not agitated Use within 24hrs</td>
</tr>
</tbody>
</table>
Finished Components awaiting ‘Validation’
Quality Monitoring

Selection of each component type sampled to ensure stated specifications are met (‘Red Book’) 

- Checks volume, white cell contamination, clotting factors, platelet counts
- Also includes various in-process controls, worker assessment, equipment monitoring and reagent controls
- Sample 1% of products
- >75% must meet specification
Testing

Grouping and Transfusion Microbiology
Testing

- Responsible for all mandatory testing of donations
- Mandatory tests required for every donation
- 2 Testing Departments nationally. Between them they test over 9000 samples /day
- Responsible for non-mandatory testing of donations (selected donations)
- Responsible for investigating discrepancies
“Grouping” Tests

The following tests are performed on every donation:

- ABO and RhD (mandatory)
  - New donors tested twice before release
- Antibody screen (mandatory)
- High Titre ABO antibodies
- Extended phenotype (c, C, e, E, K)
The system:-

• Automated blood grouping system:- PK series (all UK Blood Centres)

• Positive sample ID, machine interpretation of results, electronic transfer of results to Pulse

• Nationally approved settings (NHSBT)

• Centrally produced reagents

• National monitoring of performance
Grouping
Discretionary Tests

• Phenotyped Units
  – Used to provide antigen negative blood for patients with pre-formed antibodies
  – Patients with antibodies to several antigens may be particularly challenging
  – Example = requirement for up to 10 units/week of O RhD pos E- S- K- Fya- Jkb- CMV-

• Enhanced antibody screen for neonatal use

• Sickle (HbS) testing
Mandatory Transfusion microbiology:-

Mandatory testing

- HBsAg
- Anti-HIV1 and 2
- Anti-HCV
- Syphilis antibodies (Olympus)
- Anti-HTLV I/II
- HCV RNA (NAT lab)
- “Bacterial Monitoring” (for 7 day platelets)
Microbiology
What types of tests?

Serological tests
• Detect antigens and/or antibodies
• Performed in testing departments

Nucleic acid tests
• Detect viral nucleic acid
• Performed in specialised NAT laboratories
Abbott Prism Test system

• Same principles as ELISA but uses Chemiluminescence instead of enzyme

• Easy system to run
Nucleic Acid Technology

• Direct detection of virus nucleic acid

• Allows reduction in window period
  – 40-60 days for HCV
  – 5-7 days for HIV
  – 7-14 days for HBV

• Currently only mandatory for HCV on blood donations with expiry >24hrs

• Current test detects HCV, HIV, HBV

• Very sensitive:- allows use of pools

• Mini-pools allows resolution to individual donation
Bacterial Screening of Platelets

• 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
  – 100% testing established by March 2011

• Increases shelf-life to 7 days
Bacterial Monitoring of platelets

In addition to arm cleansing and donation diversion pouch

- BactALERT automated test system
- All platelets now tested
- Platelets tested up to expiry
- 7 day expiry (increased from 5 days)
Bacterial Monitoring of platelets

• All platelets sampled into a pouch using sterile docking
• Sampled from pouch in laminar flow cabinet
• Tested Aerobically and Anaerobically at 36°C
• After 6 hrs results downloaded to PULSE
• Monitoring continues until expiry of product, not removed until Day 8
Hospital Services
Responsible for:

• All post-production handling of product
  – validation
  – stock control
  – receipt, issue, despatch of orders
  – reconciliation

• Daily contact with hospitals

• Inter-site stock transfers
Product Validation

- PULSE computers system links donation testing and blood pack labelling
- The system depends upon the use of machine-readable barcode labels
Ready to go
Dealing with orders

• Trained staff
  – Orders by Online Blood Ordering System (OBOS)
  – Fax back-up and phone for an emergency
  – Stock Control and first in first out to minimise wastage

• Annual issues (National 2014/15)
  – Red cells 1,651,237
  – Platelets 229,589
  – FFP 181,841
  – Cryo 27,409

• Distribution
  – Daily routine deliveries
  – Ad hoc
  – Emergency
Blood Supply Distribution Structure (2017)

Key

Testing and Manufacturing and SHU Centres
- Manchester
- Filton

Manufacturing and SHU Centres
- Colindale

Stock Holding Units (SHU)
- Lancaster
- Leeds
- Liverpool
- Newcastle
- Sheffield
- Birmingham
- Oxford
- Southampton
- Plymouth
- Tooting
- Brentwood
- Cambridge
Aim

To provide basic knowledge on the processing, testing and issue of blood donations by NHSBT

Further information:

- NHSBT Portfolio of Blood Components (via our “Hospitals & Science” website)
- Guidelines for the Blood Transfusion Services in the United Kingdom (“Red Book”)
- Your hospital’s blood bank
- robin.coupe@nhsbt.nhs.uk