Blood Component Transfusion

Learning Outcomes

1. **Decision to Transfuse** -by the end of this module you will:
    a. Understand transfusion issues
    b. Be able to identify the blood components available and know the indications for their use
    c. Have an understanding of the available alternatives to transfusion
    d. Know the expected benefits, risks and anticipated outcomes of transfusion
    e. Understand the importance and the factors considered as part of undertaking an effective patient assessment
    f. Understand the importance of providing and documenting the reason for transfusion
    g. Understand the importance of providing patients with the required information to enable the patient's understanding for blood transfusion and respond to their concerns
    h. Understand the importance of and know the procedure for obtaining and documenting informed consent for blood transfusion
    i. Know the processes required for the safe and appropriate ordering of blood components including special requirements
    j. Know where local policies are available
    k. Know the processes to authorise (prescribe) blood components

2. **Blood Sampling** – by the end of this module you will:
    a. Know which equipment and materials are needed for blood sampling including protective clothing for yourself and/or individual
    b. Understand the importance of obtaining positive confirmation of individuals' identity and consent before starting the procedure – and effective ways of getting positive identification
    c. Know the processes required for obtaining and labelling a transfusion sample
    d. Understand the importance of correctly completing a transfusion request with all relevant clinical information
    e. Identify the possible consequences of confusing samples or incorrect labelling
    f. Know the procedure for safe disposal of equipment and material used
    g. Understand the importance of communication with the transfusion laboratory for urgent requests
    h. Know where local policies are available

3. **Collection of Blood Components from Storage and Delivery to the Clinical Area** – at the end of this module you will:
    a. Be able to identify the common errors related to the collection of blood components and know how to reduce the potential risks
    b. Know the correct checking procedures and understand the rationale underpinning them
    c. Understand the importance of obtaining positive confirmation of patient identity before starting the procedures – and effective ways of getting positive identification

d. Understand the importance of clear documentation and communication and be aware of the information required to collect blood components
e. Understand and know the correct procedures, conditions and documentation required for receiving/delivering or returning blood components
f. Know where local policies are available

4. **Administration of Blood Components** – by the end of this module you will:
    a. be able to identify the common errors related to the administration of blood transfusion and know how to reduce the potential risks
    b. understand the importance of obtaining positive confirmation of patient identity before starting the blood transfusion procedure – and effective ways of getting positive identification
    c. understand the importance of informed consent and indication of blood transfusion
    d. know the procedure for correct blood component checks prior to administration and understand the rationale underpinning them
    e. know the frequency and importance of patient monitoring, transfusion rates and relevant documentation of transfusion episodes
    f. know how and where blood components are stored
    g. understand the importance and legal implications of traceability for blood components
    h. know, recognise and understand the potential common complications of blood transfusion together with the appropriate management
    i. know the process for management of massive blood loss
    j. know how to raise concerns or report incidents / regarding the administration of components
    k. know the procedure for safe use and disposal of equipment and materials
    l. know where local policies are available

The main purpose of this learning pack is that the **right blood product is given to the right patient at the right time.**

PLEASE NOTE THAT THE PROCEDURES IN THIS WORKBOOK ARE FOR GUIDANCE ONLY – YOU ARE RESPONSIBLE FOR CHECKING THE LOCAL PROCEDURE FOR THE TRUST IN WHICH YOU ARE WORKING.

The Blood Safety and Quality (amendment) Regulations 2006/2013 (BSQR) set legally binding standards for quality and safety in the collection, testing, processing, storage and distribution of human blood components.

The regulations affect both the blood services and hospital blood banks. For the latter, the provisions include the requirement to show the existence of a comprehensive quality system and the provision of appropriate training for blood bank staff.

A record must be maintained of the final fate of each blood component pack, i.e. whether it is transfused to a named recipient, discarded or returned to the supplying blood establishment.

Hospital must submit reports of serious adverse reactions and events to the Medicines and Healthcare Products Regulatory Agency (MHRA) and/or the Serious Hazards of Transfusion (SHOT) scheme using the SABRE inline reporting system (www.shotuk.org).

The National Haemovigilance Office states that blood components and products are life-saving and when used appropriately they will improve the quality of life in a large range of clinical conditions. However, it is also widely recognised, that as in any other clinical intervention, there are a number of risks associated with this therapy, transfusion transmitted infections (TTI) and human error.

Safe Transfusion Practice relies on collaborative teamwork, as blood transfusion is a complex, high risk and multi-step procedure. The Transfusion Process crosses several professional boundaries and involves many individuals. There are at least 23 stages between taking a pre-transfusion compatibility blood samples, the recipient receiving their transfusion and the completion of the transfusion. Six different professional groups intervene at different stages of the process and with each stage there is the potential of error.

In 2005 when the European directive for blood was transcribed into British criminal law as the Blood Safety and Quality Regulations (2005)3 it became a legal requirement that every unit issued for transfusion had to be fully traceable from donor to recipient, vein to vein traceability.

The health professional responsible for communicating the final fate of every unit in the clinical area is the responsibility of the nurse as they are invariably the ones that administer he transfusions on the wards.

To make this process easier most hospitals, if they have not already, are in the process of implementing an electronic tracking system to meet the above requirements. The laborious paper systems, which might be still in use in some hospitals, are unreliable and few have achieved 100% traceability as they rely heavily on the health professional remembering to sign, date and return the traceability slip.

Despite this change from paper to electronic systems the transfusion process will remain the same and the same safety steps will need to be followed.

With the transcription of the EU Directive on Blood Safety and Quality Regulation in to British criminal law also came a new Haemo-vililance scheme which is monitored by the MHRA (Medicines and Healthcare Products Regulatory Agency) known as S.A.B.R.E (Serious Adverse Blood Reactions & Events) This new scheme works alongside SHOT.

What is Blood?

Your body carries around four to six litres (7 to 10.5 pints) of blood. Blood is made up of red blood cells, white blood cells and platelets in a liquid called plasma.

Plasma is about 90% water, but also contains proteins, nutrients, hormones and waste products. Blood is made up of about 60% plasma and 40% blood cells.

Each type of blood cell has a specific role to play:

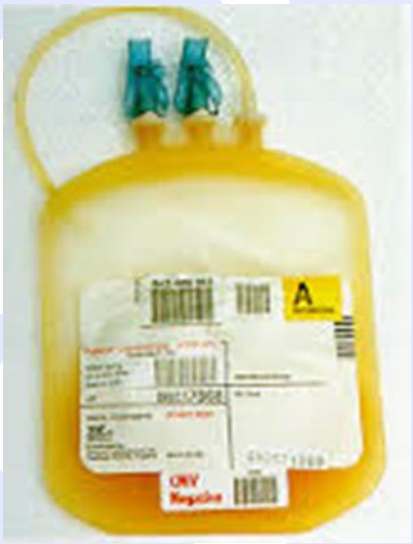
- Red blood cells carry oxygen around the body and remove carbon dioxide and other waste products; they give blood its red colour
- White blood cells are part of the immune system (the body's natural defence mechanism) and help fight infection
- Platelets help the blood clot (thicken) to stop bleeding

Whole Blood contains:

- Red blood cells 45%
- WBC and Platelets <1%
- Plasma 55%

Fresh Frozen Plasma

Packed red blood cells



Platelets

Blood Groups

There are four main blood groups (types of blood): A, B, AB and O. Your blood group is determined by the genes you inherit from your parents.

Each group can be either RhD positive or RhD negative, which means your blood group can be one of the eight types.

Antigens and Antibodies

Your blood group is identified by antigens and antibodies in the blood. Antibodies are part of your body's natural defences against invading substances such as germs.

Antigens are protein molecules found on the surface of red blood cells. Antibodies are proteins found in plasma. Antibodies recognise anything foreign in your body and alert your immune system to destroy it.

The ABO System

There are four main blood groups defined by the ABO system:

- **Blood group A** has A antigens on the red blood cells with anti-B antibodies in the plasma
- **Blood group B** has B antigens with anti-A antibodies in the plasma
- **Blood group O** has no antigens, but both anti-A and anti-B antibodies in the plasma
- **Blood group AB** has both A and B antigens, but no antibodies

Almost half (48%) of the UK population has blood group O, making this the most common blood group.
Receiving blood from the wrong ABO group can be life threatening. For example, the anti-A antibodies in a recipient with group B blood will attack the group A cells if transfused to them. This is why group A blood must never be given to a group B person.

As group O red blood cells don't have any A or B antigens, it can safely be given to any other group.

The Rh System

Red blood cells sometimes have another antigen, a protein known as the RhD antigen. If this is present, your blood group is RhD positive. If it's absent, your blood group is RhD negative. This means you can be one of eight blood groups:

- A RhD positive (A+)
- A RhD negative (A-)
- B RhD positive (B+)
- B RhD negative (B-)
- RhD positive (O+)
- RhD negative (O-)
- AB RhD positive (AB+)
- AB RhD negative (AB-)

Blood Group Test

To work out a blood group, the red cells are mixed with different antibody solutions. If, for example, the solution contains anti-B antibodies and there is B antigens on the cells (it is blood group B), it will clump together.

If the blood doesn't react to any of the anti-A or anti-B antibodies, it's blood group O. A series of tests with different types of antibody can be used to identify your blood group.

The patient's pre-transfusion blood sample is tested to determine the ABO and RhD groups and the plasma is screened for the presence of red cell alloantibodies capable of causing transfusion reactions. Antibody screening is performed using a panel of red cells that contains examples of the clinically important blood groups most often seen in practice.

Almost all hospital laboratories carry out blood grouping and antibody screening using automated analysers with computer control of specimen identification and result allocation. This is much safer than traditional manual techniques and eliminates most transcription and interpretation errors.

ABO grouping is the single most important test performed on pre-transfusion samples and the sensitivity and security of testing systems must never be compromised. Robust identification procedures outside the laboratory at patient blood sampling, collection of blood from the blood bank and administration of blood at the bedside are vital.

The current British Committee for Standards in Haematology (BCSH) guideline for pre-transfusion compatibility procedures (2012) recommends that a second sample should be requested for confirmation of the ABO group of a first-time transfused patient provided this does not impede the delivery of urgent red cells or components.

Pregnancy

Pregnant women are always given a blood group test. This is because if the mother is RhD negative but the child has inherited RhD-positive blood from the father, it could cause complications if left untreated.

RhD-negative women of child-bearing age should always only receive RhD-negative blood.

Donating Blood

Most people are able to give blood, but only 4% actually do.

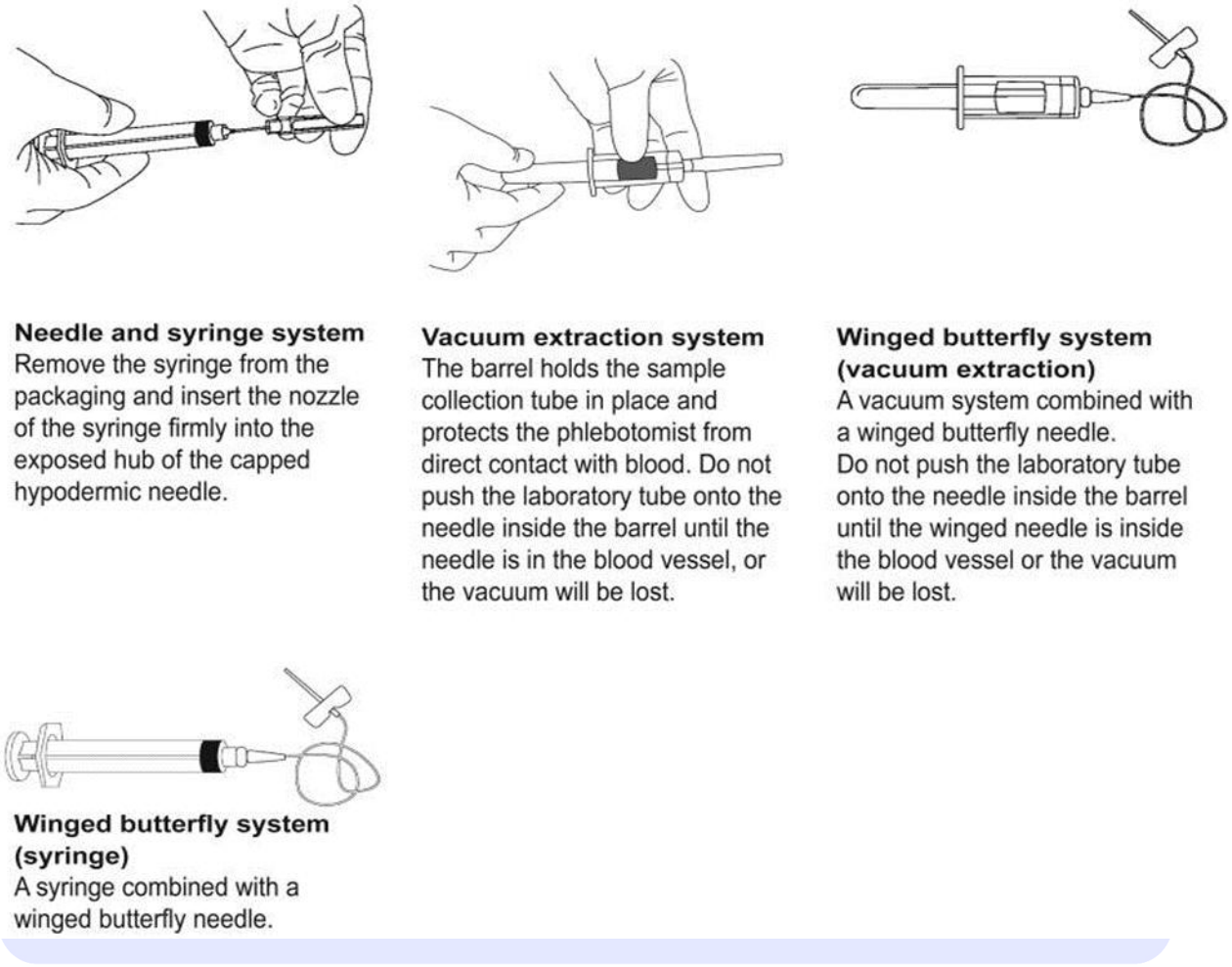
All donated blood is tested for:

- Human T-call lymphotropic Virus (HTLV)
- Hepatitis B and C
- HIV & AIDS
- Syphilis

Blood Sampling

Prior to receiving a blood transfusion, a sample of blood will be taken from the patient to ensure they are receiving blood that is completable. All patients being sampled must be positively identified.

Infection prevention and control is priority at all times. You should always work in a clean, well-lit area and take all practicable steps to assure the quality of your work. Make sure that you have been properly trained and practically assessed by a suitable person before undertaking blood sampling. Assemble all the necessary equipment.



Needle and syringe system
Remove the syringe from the packaging and insert the nozzle of the syringe firmly into the exposed hub of the capped hypodermic needle.

Vacuum extraction system
The barrel holds the sample collection tube in place and protects the phlebotomist from direct contact with blood. Do not push the laboratory tube onto the needle inside the barrel until the needle is in the blood vessel, or the vacuum will be lost.

Winged butterfly system (vacuum extraction)
A vacuum system combined with a winged butterfly needle.
Do not push the laboratory tube onto the needle inside the barrel until the winged needle is inside the blood vessel or the vacuum will be lost.

Winged butterfly system (syringe)
A syringe combined with a winged butterfly needle.

The above picture has been taken from the World Health Organisation.

Make sure that this equipment is placed close to you, so you can easily reach it, but not so close to the patient that it may be knocked over.

- Ensure that the bottles and are correctly labelled and attached to the correct laboratory request form. Check to ensure any instructions from the laboratory regarding inverting tubes or not depending on the additives contained within them.

- You should record the details of the sample you have taken, the time and date, and the information provided to the laboratory, on the patient's record to ensure that there is no

confusion in the future.

- Never try and take blood samples from more than one patient at a time. Always stop after taking the sample to label this and dispatch it, along with the laboratory request form, straight away before taking the next sample. This will help to reduce the risk of samples becoming confused or mis-labelled.

- Incorrect or inaccurate information on the sample blood can lead to the patient being incorrectly matched to donor blood or components which can have very serious consequences.

Labelling System for Blood and Blood Components

The Base Label – This is the label applied to the blood pack by the manufacturer
The Donation Number Label – This is the unique ISBT 128 identification number with a bar code and eye readable equivalent which cross references blood components and samples taken at the time of donation.
The Batch Identification Label - This is the unique ISBT 128 identification number with a bar code and eye readable equivalent which identifies pooled components.
The Blood Group Label - This is the unique ISBT 128 identification number with a bar code and eye readable equivalent which identifies the blood group, expiry date and blood characteristics.
The Component Label – This provides the component specific information.

Labels must be:

- Water resistant
- Resistant to alcohol and humidity
- Self-adhesive with non-invasive biocompatible adhesive
- Not rub off
- Readable
- Tamper-evident
- Smear-resistant
- Able to withstand temperatures of -80°C to +56°C after application
- Not slip during use in temperature change

Storage of Blood Components

Units of blood must be stored in a fridge, often referred to as the 'blood bank'.

- When storing **Whole Blood and Red Cell** the temperature must be between 2°C to 6°C. This is to minimise bacterial growth but prevent haemolysis.

- **Platelets** should be stored between 20°C to 24°C. Platelets should never be stored in the fridge as they lose their blood clotting capacity at low temperatures. Also, platelets should be transfused as soon as possible.
- **Frozen Plasma and Cryoprecipitate** should be stored at -25°C or cooler until it is thawed for use. If the Fresh Frozen Plasma is not used immediately it should be stored in the fridge at temperatures between 2°C to 6°C and transfused within 24 hours.

Removal of Blood Components

When removing the blood or blood components for transfusion the correct documentation must be completed. Either electronically or blood register, the following should be recorded:

- Date
- Time
- Signature

You should inform the person requesting the blood immediately of it arrival.

Why a Blood Transfusion is Necessary

There are several different types of blood transfusion. Whether it is needed depends on a number of factors.

These include:

- The health of the patient
- The patients' medical history
- The type of operation the patient is having
- The seriousness of the patient's condition

Common Reasons for Blood Transfusions are:

- To treat anaemia if other treatments have failed
- To treat blood disorders
- To replace blood loss, for example, during surgery

Hyponatremia

Hyponatremia is a condition where the sodium levels within a person's blood is too low. Sodium disorders are the most common electrolyte abnormalities seen in hospital. Normal sodium level is between 135 and 145 milliequivalents per litre (mEq/l) of sodium. Hyponatremia occurs when the sodium level is below 135. When sodium levels in the body are low, fluid enters the cells causing them to swell. When this occurs in the brain, known as cerebral oedema it can cause brain damage due to the increased pressure within the skull.

Symptoms of Hyponatremia:

- Headache
- Restlessness
- Muscle cramps or spasms
- Weakness
- Lethargy
- Seizures
- Confusion
- Nausea
- Vomiting
- Altered mental state
- Decreased consciousness levels

Common causes of Hyponatremia

Excessive fluid in the body, common causes:

- Kidney failure
- SIADH – Syndrome of inappropriate anti-diuretic hormone
- Congestive heart failure

Loss of fluid in the body, common causes:

- Prolonged and excessive sweating
- Severe vomiting
- Severe diarrhoea

Medical Conditions, common causes:

- Adrenal insufficiency
- Hypothyroidism
- Cirrhosis of the liver
- Anorexia

Medication, common causes:

- Diuretics
- Desmopressin
- Sulfonylureas
- Indapamide
- Sertraline
- Amiloride/hydrochlorothiazide
- Carbamazepine
- Furosemide
- Fluoxetine

Treatment

Treatment will depend on whether it is chronic or acute hyponatremia. A person with chronic hyponatremia will have likely made appropriate compensatory changes. Therefore, slow sodium correction will be safer. In contrast, a person with acute hyponatremia will require a faster sodium correction partially if experiencing neurological symptoms.

The Different Types of Blood Transfusions

Red blood cell transfusions

The main reason for a red blood cell transfusion is to treat anaemia. Anaemia occurs when the body doesn't have enough red, oxygen-carrying blood cells, which means the body's tissues and cells aren't getting enough oxygen.

Anaemia can develop as a result of severe blood loss – for example, as a complication during childbirth or as a result of injury or surgery. **Anaemia can also be caused by:**

- Health conditions in which red blood cells are produced at a reduced rate – for example, in anaemia due to lack of iron, vitamin B12 or folate (usually treated without the need for blood transfusion), and some types of cancers, such as acute myeloid leukaemia and lymphoma
- Health conditions that disrupt the normal production of red blood cells – such as sickle cell anaemia and thalassaemia

- Conditions or factors that lead to red blood cells being destroyed – for example, in some types of infections such as malaria, the use of certain medicines, toxins such as alcohol or lead poisoning, or as a result of the immune system mistakenly attacking healthy red blood cells

Platelets

A platelet transfusion is used to treat people who have very low levels of platelet cells in their blood. This is known as thrombocytopenia.

A patient with thrombocytopenia is at risk of excessive bleeding, either through a minor accident, cut or graze, or as a result of surgery or dental work.

Causes of thrombocytopenia that may require treatment with a platelet transfusion include:

- Cancers – such as leukaemia or lymphoma
- Chemotherapy or bone marrow transplantation – which reduces the production of platelets
- Chronic liver disease or cirrhosis (scarring of the liver, which has many causes, including alcohol abuse)
- Sepsis or severe infection – this can cause abnormal clotting and low platelets

Plasma

Plasma is the fluid in the blood containing proteins that help the blood to clot. A transfusion of plasma may be needed if there's severe bleeding, such as after surgery, trauma or childbirth. A transfusion may also be needed in conditions (such as liver disease) that affect the production of clotting proteins.

Granulocytes

Granulocytes are a type of white blood cell that help to fight infection. Granulocyte transfusions aren't commonly used, but may be needed if there's a severe infection that's not responding to antibiotics after chemotherapy or bone marrow transplantation.

Safe Blood Transfusions

Pre- Collection Checks

Is the transfusion necessary for this patient? If so, ensure it is the:

- Right blood
- Right patient
- Right time
- Right place

Data from the UK Serious Hazards of Transfusion (SHOT) initiative show that around 1 in 13000 blood units are administered to the wrong patient with occasional fatal outcomes. 'Wrong blood into patient' incidents are preventable and nearly always caused by human error.

Safe blood administration (from the BCSH Guideline on Administration of Blood Components, 2009)

Positive patient identification

Positive patient identification at all stages of the transfusion process is essential. Minimum patient identifiers are:

- Last name, first name, date of birth, unique identification number.
- Whenever possible ask patients to state their full name and date of birth. For patients who are unable to identify themselves (paediatric, unconscious, confused or language barrier) seek verification of identity from a parent or carer at the bedside. This must exactly match the information on the identity band (or equivalent).
- All paperwork relating to the patient must include, and be identical in every detail, to the minimum patient identifiers on the identity band.

In emergency situations or where the patient cannot be immediately identified at least one unique identifier, such as A&E or trauma number, and patient gender should be used.

Identification of patients, samples and blood components throughout the transfusion process can be enhanced by the use of electronic transfusion management systems using barcodes on ID bands and blood components and hand-held scanners linked to the laboratory information systems. Most UK hospitals still use manual ID checks at the bedside although electronic 'blood-tracking' systems to control access to blood refrigerators are in more widespread use.

Blood Component Integrity

Check the blood unit for:

- Bag integrity
- Haemolysis in the plasma
- Clots in the blood

Patient information and consent for transfusion

Where possible, patients (and for children, those with parental responsibility) should have the risks, benefits and alternatives to transfusion explained to them in a timely and understandable manner and any questions answered. Standardised patient information, such as national patient information leaflets, should be used wherever possible.

As with any emergency treatment, the need for consent must not prevent or delay essential urgent transfusion, but the presence of a valid Advance Decision Document declining transfusion should always be respected. Patients transfused when it is not possible to obtain prior consent should be provided with information retrospectively.

This is important, as transfused patients are no longer eligible to act as blood donors. For the same reason, patients who have given consent for possible transfusion during surgery should be informed if they actually received blood while under anaesthesia.

Patients needing long-term transfusion support should have a modified form of consent (e.g. annual review and re-consent) and this should be specified in local policies.

Pre-transfusion documentation

Minimum dataset in patient's clinical record:

- Reason for transfusion (clinical and laboratory data).
- Summary of information provided to patient (benefits, risks, alternatives) and patient consent.

Prescription (authorisation)

The transfusion 'prescription' must contain the minimum patient identifiers and specify:

- Components to be transfused
- Date of transfusion
- Volume/number of units to be transfused and the rate or duration of transfusion
- Special requirements (e.g. irradiated, CMV negative).

Requests for transfusion

Must include:

- Minimum patient identifiers and gender
- Diagnosis, any significant co-morbidities and reason for transfusion
- Component required, volume/number of units and special requirements
- Time and location of transfusion
- Name and contact number of requester.

Collection and delivery of blood component to clinical area

- Before collection, ensure the patient (and staff) is ready to start transfusion and there is good venous access.
- Only trained and competent staff should collect blood from transfusion laboratory or satellite refrigerator.

- Authorised documentation with minimum patient identifiers must be checked against label on blood component.
- Minimum patient identifiers, date and time of collection and staff member ID must be recorded.
- Deliver to clinical area without delay.

Administration to the Patient

- Blood components must be administered by registered practitioners who are trained and competent according to local policies.
- The final check must take place next to the patient, not at the nursing station or another remote area.
- Transfusion must only go ahead if the details on the patient identity band (positively confirmed by the patient if possible), the laboratory-generated label attached to the component pack and the transfusion prescription are an exact match. Any discrepancy must immediately be reported to the transfusion laboratory.
- Check the expiry date of the component and ensure the donation number and blood group on the pack matches that on the laboratory-generated label attached to the pack.
- Any special requirements on the transfusion prescription, such as irradiated component, must be checked against the label on the pack.
- Inspect the component pack for signs of leakage, discoloration or clumps.
- The prescription and other associated paperwork should be signed by the person administering the component and the component donation number, date, time of starting and stopping the transfusion, dose/volume of component transfused and name of the administering practitioner should be recorded in the clinical record.
- To reduce the risk of bacterial transmission, blood component transfusions should be completed within 4 hours of removal from a controlled temperature environment.
- Non-essential overnight transfusion of blood should be avoided, except in adequately staffed specialist clinical areas, because of the increased risk of errors.
- All components must be given through a blood administration set (170–200 µm integral mesh filter).

Monitoring the Patient

Patients should be under regular visual observation and, for every unit transfused, minimum monitoring should include:

- Pre-transfusion pulse (P), blood pressure (BP), temperature (T) and respiratory rate (RR).
- P, BP and T 15 minutes after start of transfusion – if significant change, check RR as well.
- If there are any symptoms or signs of a possible reaction – monitor and record P, BP, T and RR and take appropriate action.
- Post-transfusion P, BP and T – not more than 60 minutes after transfusion completed.
- Inpatients observed over next 24 hours and outpatients advised to report late symptoms (24-hour access to clinical advice).

Completion of transfusion episode

- If further units are prescribed, repeat the administration/identity check with each unit.
- If no further units are prescribed, remove the blood administration set and ensure all transfusion documentation is completed.

Documentation

The documentation required at each stage of the transfusion process should be kept to an essential minimum and, whether hard copy or electronic, be 'user-friendly' to encourage compliance by busy clinical teams.

Combined transfusion prescription and monitoring charts or care pathways can be used to record the information and provide a clear audit trail. The development of standardised transfusion documentation in the UK has the potential to reduce errors by clinical staff moving between hospitals. All transfusion documentation should include the minimum patient identifiers. Documentation in the clinical record should include:

Pre-transfusion:

- The reason for transfusion, including relevant clinical and laboratory data.
- The risks, benefits and alternatives to transfusion that have been discussed with the patient and documentation of consent (see below).
- The components to be transfused and their dose/volume and rate.
- Any special requirements, such as irradiated components.

During transfusion:

- Details of staff members starting the transfusion.
- Date and time transfusion started and completed.
- Donation number of the blood component.
- Record of observations made before, during and after transfusion.

Post-transfusion:

- Management and outcome of any transfusion reactions or other adverse events.
- Whether the transfusion achieved the desired outcome (e.g. improvement in symptoms, Hb increment).

Technical Aspects of Transfusion

Intravenous access

Blood components can be transfused through most peripheral or central venous catheters, although the flow rate is reduced by narrow lumen catheters and long peripherally inserted central catheters (PICC lines).

They should be transfused through an administration set with a 170–200 µm integral mesh filter. Although special platelet administration sets are available, it is safe to use a standard blood administration set, but platelets should not be transfused through a set previously used for red cells as some platelet loss will occur. It is not necessary to prime or flush blood administration sets with physiological (0.9%) saline but a new administration set should be used if blood components are followed by another infusion fluid.

Although there is little evidence, current guidelines recommend changing blood administration sets at least every 12 hours to reduce the risk of bacterial infection.

Blood and other solutions can be infused through the separate lumens of multi-lumen central venous catheters as rapid dilution occurs in the bloodstream. Where possible, one lumen should be reserved for the administration of blood components.

Infusion devices

There are two main types: gravity delivered or infusion pumps. The device should be monitored regularly during transfusion to ensure the correct volume is being delivered at the correct rate.

Blood warmers

Rapid infusion of red cells recently removed from the refrigerator may cause hypothermia. Concerns include impaired coagulation in surgical or trauma patients and cardiac arrhythmias if cold blood is transfused rapidly into a central catheter or in neonates and small infants having large-volume transfusions. The National Institute for Health and Care Excellence (NICE) in England recommends that, in all patients undergoing elective or emergency surgery, 'intravenous fluids (500 mL or more) and blood products should be warmed to 37°C'.

Compatible Intravenous Fluids

It is good practice to avoid the co-administration of any intravenous fluid through the same line used for blood components, unless a multi-lumen central venous catheter is used. Solutions containing calcium (e.g. Ringer's lactate) or calcium-containing colloids (e.g. Haemaccel™or Gelofusine™) antagonise citrate anticoagulant and may allow clots to form if mixed in the same infusion line. Hypotonic solutions, such as 5% dextrose in water, can cause haemolysis of red cells in laboratory experiments but the clinical significance of this is uncertain and no clinical adverse events have been reported.

Co-Administration of Intravenous Drugs and Blood

Drugs should never be added to a blood component bag. Wherever possible, intravenous drugs should be administered between transfusions or administered through a second venous access device (or the separate lumen of a multi-lumen central venous catheter). If this is not possible, the

transfusion should be temporarily stopped and the line flushed with 0.9% saline before and after administration of the drug.

Transfusion of Blood Components

Red cells in additive solution

- Transfusions must be completed within 4 hours of removal from controlled temperature storage.
- Many patients can be safely transfused over 90–120 minutes per unit.
- A dose of 4 mL/kg raises Hb concentration by approximately 10 g/L. Note: The common belief that one red cell pack = 10 g/L increment only applies to patients around 70 kg weight – the risk of transfusion-associated circulatory overload (TACO) is reduced by careful pre-transfusion clinical assessment and use of single-unit transfusions, or prescription in millilitres, for elderly or small, frail adults where appropriate.
- During major haemorrhage, very rapid transfusion (each unit over 5–10 minutes) may be required.

Platelets

- One adult therapeutic dose (ATD) (pool of four units derived from whole blood donations or single-donor apheresis unit) typically raises the platelet count by 20–40×109/L.
- Usually transfused over 30–60 minutes per ATD.
- Platelets should not be transfused through a giving-set already used for other blood components.
- Start transfusion as soon as possible after component arrives in the clinical area.

Fresh frozen plasma (FFP)

- Dose typically 12–15 mL/kg, determined by clinical indication, pre-transfusion and post-transfusion coagulation tests and clinical response.
- Infusion rate typically 10–20 mL/kg/hour, although more rapid transfusion may be appropriate when treating coagulopathy in major haemorrhage.
- Because of the high volumes required to produce a haemostatic benefit, patients receiving FFP must have careful haemodynamic monitoring to prevent TACO (Transfusion Associated Circulatory Overload).
- FFP should not be used to reverse warfarin (prothrombin complex is a specific and effective antidote).

Adverse Effects of Transfusion

Acute transfusion reactions

Acute transfusion reactions (ATRs) present within 24 hours of transfusion and vary in severity from mild febrile or allergic reactions to life-threatening events. **They include:**

- Febrile non-haemolytic transfusion reactions – usually clinically mild.

- Allergic transfusion reactions – ranging from mild urticaria to life-threatening angio-oedema or anaphylaxis.
- Acute haemolytic transfusion reactions – e.g. ABO incompatibility.
- Bacterial contamination of blood unit – range from mild pyrexial reactions to rapidly lethal septic shock depending on species.
- Transfusion-associated circulatory overload (TACO).
- Transfusion-related acute lung injury (TRALI).

Key principles in the management of ATR include:

- Transfusing patients in clinical areas where they can be directly observed by appropriately trained staff (including the emergency management of anaphylaxis)
- Ensuring that the recognition and immediate management of ATR are incorporated into local transfusion policies and the training of clinical and laboratory staff.

Acute Haemolytic Reactions

The most serious reactions are caused by transfusion of ABO-incompatible red cells which react with the patient's anti-A or anti-B antibodies. There is rapid destruction of the transfused red cells in the circulation (intravascular haemolysis) and the release of inflammatory cytokines. The patient often quickly becomes shocked and may develop acute renal failure and disseminated intravascular coagulation (DIC).

The first indication of a reaction may be tachycardia, hypotension and bleeding into the skin or from needle wounds, emphasising the importance of careful monitoring of vital signs.

Transfusion of a blood component contaminated by bacteria

Although rare, this more often occurs with platelet components (which are stored at 22–24°C) than with red cells refrigerated at 2–6°C and can rapidly be fatal. Typical symptoms and signs include rigors, fever (usually >2°C above baseline), hypotension, tachycardia, pale cold clammy skin and rapidly developing shock and impaired consciousness.

Blood cultures should be taken from the patient and treatment immediately started with an intravenous broad spectrum antibiotic combination covering gram negative and gram-positive bacteria.

Anaphylactic reactions

Shock or severe hypotension associated with wheeze (bronchospasm), stridor from laryngeal oedema or swelling of face, limbs or mucous membranes (angioedema) is strongly suggestive of anaphylaxis – an acute, life-threatening emergency.

Other skin changes may include flushing and urticaria ('nettle rash' or hives) that also occur in less severe allergic reactions.

UK Resuscitation Council (UKRC) guidelines (2010 update) recommend the urgent administration of intramuscular (IM) epinephrine to treat anaphylaxis (adult dose 0.5 mL of 1:1000 (500 µg)).

Transfusion-related acute lung injury (TRALI)

Classical TRALI is caused by antibodies in the donor blood reacting with the patient's neutrophils, monocytes or pulmonary endothelium. Inflammatory cells are sequestered in the lungs, causing leakage of plasma into the alveolar spaces (non-cardiogenic pulmonary oedema).

Most cases present within 2 hours of transfusion (maximum 6 hours) with severe breathlessness and cough productive of frothy pink sputum. It is often associated with hypotension (due to loss of plasma volume), fever and rigors and transient peripheral blood neutropenia or monocytopenia. Treatment is supportive, with high-concentration oxygen therapy and ventilatory support if required.

Transfusion-associated circulatory overload (TACO)

TACO is defined as acute or worsening pulmonary oedema within 6 hours of transfusion. Typical features include acute respiratory distress, tachycardia, raised blood pressure and evidence of positive fluid balance. It has probably been significantly under-reported in the past and may now be the most common cause of transfusion-related death in developed countries.

The treatment of TACO involves stopping the transfusion and administering oxygen and diuretic therapy with careful monitoring and critical care support if required.

Mild allergic reactions

Symptoms are confined to itching (pruritus) and/or skin rash ('nettle rash' or hives) with no change in vital signs. They are most common in patients receiving plasma-rich components such as FFP or platelets.

Symptoms often improve if the transfusion is slowed and an antihistamine is administered orally or intravenously. The patient must be monitored closely for development of a more severe reaction, in which case the transfusion must be stopped.

Viral infections

With modern donor selection and testing, hepatitis B, hepatitis C and HIV transmission are now very rare in the UK. The current risk of an infectious donation entering the UK blood supply is now <1 in 1.2 million donations for hepatitis B, <1 in 7 million for HIV and <1 in 28 million for hepatitis C.

Variant Creutzfeldt–Jakob disease (vCJD)

This is a rare fatal neurological disease, due to the same agent (abnormal variant of prion protein) as bovine spongioform encephalopathy (BSE) in cattle and caused by eating beef from affected animals, was first identified in the UK in 1996.

As a precaution, blood donors who have received a blood transfusion in the UK since 1980 (2004) will be excluded from donating blood to reduce the risk of transmitting of vCJD.

Alternatives to Blood Transfusion

Drugs – that can manage or prevent blood loss

- Tranexamic acid (antifibrinolytic) is inexpensive, safe and reduces mortality in traumatic haemorrhage. It reduces bleeding and transfusion in many surgical procedures and may be effective in obstetric and gastrointestinal haemorrhage.
- Novo Seven is used to treat or prevent bleeding problems such as haemophilia A or B acquired haemophilia, or congenital FVII deficiency.
- Erythropoiesis stimulating agents (ESAs) are standard therapy in renal anaemia and can support blood conservation in some cancer chemotherapy patients and autologous blood donation programmes.
- Fibrin Sealants provide sustained haemostasis for bleeding that may be addressed intraoperatively
- Plasma (volume) expanders are used for the treatment of circulatory shock. Can be used to provide volume for the circulatory system.
- Iron Treatment used to treat the underlying cause of bleeding.

Intraoperative cell salvage (ICS)

This is the collection and reinfusion of blood spilled during surgery. Commercially available, largely automated devices are available for ICS and are now widely used in hospitals for both elective and emergency surgery with significant blood loss and in the management of major traumatic or obstetric haemorrhage. The machines must always be used and maintained according to the manufacturer's instructions by appropriately trained staff.

Blood lost into the surgical field is filtered to remove particulate matter and aspirated into a collection reservoir where it is anticoagulated with heparin or citrate. If sufficient blood is collected and the patient loses sufficient blood to require transfusion, the salvaged blood can be centrifuged and washed in a closed, automated system. Red cells suspended in sterile saline solution are produced, which must be transfused to the patient within 4 hours of processing

Management of Patients Who Do Not Accept Transfusion

In all circumstances, the essentials are:

- Respect the values, beliefs and cultural backgrounds of all patients.
- Anxiety about the risks of transfusion can be allayed by frank and sympathetic discussion with a well-informed clinician.
- Blood Transfusion Services provide a range of quality assured information resources for patients, parents and their families.
- Jehovah's Witnesses decline transfusion of specific blood products, usually whole blood and primary blood components. Individuals vary in their choice and it is important to clearly establish the preference of each patient.
- Advance Decision Documents must be respected.
- No one can give consent on behalf of a patient with mental capacity.
- Emergency or critically ill patients with temporary incapacity must be given life-saving transfusion unless there is clear evidence of prior refusal such as a valid Advance Decision Document.

- Where the parents or legal guardians of a child under 16 refuse essential blood transfusion a Specific Issue Order (or national equivalent) can be rapidly obtained from a court.

Every patient has the right to be treated with respect and staff must be sensitive to their individual needs, acknowledging their values, beliefs and cultural background.

Some patients, their family members or friends are very worried about the risks of blood transfusion, especially transfusion-transmitted infection, based on reports in the media or anecdotal experience. Others decline transfusion of certain blood products based on their religious beliefs.

Reference

- JPAC – Joint United Kingdom (UK) Blood Transfusion and Tissue Transplantations Service Professional Advisory Committee
- SHOT Annual Report 2014
- NHS Choice

Glossary

Additive Solution -Solution designed to maintain viability of cellular components during storage.
Adult Therapeutic Dose (ATD) - Usually used in reference to platelet transfusions. Refers to the amount usually transfused to an adult in a single dose.
Allogeneic Blood Products - Blood and blood components collected from an individual and intended for transfusion to another individual, for use in medical devices or as starting material or raw material for manufacturing into medicinal products.
Allogeneic Donation - Blood donated by another person.
Anti-D Immunoglobulin - Human IgG preparation containing a high level of antibody to the RhD antigen.
Apheresis - A process in which whole blood is collected from a donor and separated into components. Some of these are retained and the remainder is returned to the donor.
Artificial Colloid Solutions - See colloid solutions.
Autologous Blood Transfusion - Transfusion to an individual of blood collected from him- or herself.
Blood Component - A therapeutic constituent of human blood (red cells, white cells, platelets, plasma, cryoprecipitate).
Blood establishment - Organisation responsible for any aspect of the collection and testing of human blood or blood components, whatever their intended purpose, and for their processing, storage and distribution when intended for transfusion. Excludes hospital blood banks (EU Directive 2002/98/EC definition).
Blood Product - Any therapeutic product derived from human whole blood or plasma donations.
Bovine Spongiform Encephalopathy (BSE) - A neurological disease of cattle which is generally thought to have caused the epidemic of vCJD in humans.

Buffy Coat - The granulocyte and platelet layer that forms between red cells and plasma when a pack of whole blood is centrifuged under suitable conditions.

Citrate Phosphate Dextrose (CPD) - An anticoagulant used for the storage of donated blood.

Colloid Solutions - Gelatin, dextran, starch preparations (artificial colloids) that are used as plasma expanders.

Cryoprecipitate - Precipitate produced after freezing and thawing fresh frozen plasma to precipitate high-molecular-weight proteins including Factor VIII and fibrinogen.

Crystalloid Solutions

Aqueous solutions of electrolytes, minerals or other water-soluble molecules for intravenous administration. Examples include physiological saline (0.9%) and Ringer's lactate solution.

Cytomegalovirus (CMV)

A type of herpes virus which is transmissible via transfusion and can cause infection in immunosuppressed patients.

Direct antiglobulin test (DAT)

Also known as the direct Coombs' test, it is a sensitive method to detect red-cell-bound antibody.

Electronic issue

A safe and rapid method for issuing compatible blood. Compatible units are selected by laboratory computer without serological crossmatch.

Epoetin

Approved name for recombinant human erythropoietin.

Erythropoietin

A hormone produced by the kidney that stimulates red cell production by bone marrow.

Fresh frozen plasma (FFP)

Plasma that is frozen within a specific time period after collection and stored in the frozen state until thawed for transfusion.

Graft-versus-host disease (GvHD)

A serious condition in which allogeneic lymphocytes attack the tissues of the individual to whom they have been transplanted or transfused.

Granulocytes

Phagocytic white blood cells. Therapeutic blood component can be produced by apheresis of a donor or from donor buffy coats. Efficacy is uncertain.

Haemolytic disease of the fetus and newborn (HDFN)

A condition in which fetal red cells are destroyed by maternal antibody, usually anti-D.

Haemovigilance

The systematic surveillance of adverse reactions and adverse events related to transfusion.

Hepatitis B surface antigen (HBsAg)

The presence or absence of this surface antigen is used to determine whether blood is infected with hepatitis B virus.

Hospital blood bank

Any unit within a hospital which stores and distributes, and may perform compatibility tests on, blood and blood components exclusively for use within hospital facilities, including hospital-based transfusion activities.

Human parvovirus B19

A non-enveloped virus transmissible by blood products. May cause transient red cell aplasia in haemolytic anaemias or hydrops fetalis in fetuses.

Intraoperative cell salvage

The collection and re-infusion of blood spilt during surgery.

Irradiated (blood component)

Cellular blood component treated with 25 gray (Gy) gamma or X irradiation to inactivate lymphocytes that could cause graft-versus-host disease in a recipient.

Kleihauer test

A method for counting fetal cells in maternal blood.

Leucodepleted

Blood component from which white cells have been removed by filtration or another method.

massive transfusion

Variously defined as the replacement of one blood volume within 24 hours, or of 50% blood volume loss within 3 hours, or a rate of loss of 150 mL per minute in adults. In children it is usually defined as the loss of one blood volume within 24 hours, or 50% blood volume within 3 hours, or a rate of loss of 2–3 mL/kg per minute.

Maximum surgical blood order schedule/surgical blood order (MSBOS/SBO)

Schedule of the normal quantities of blood ordered by type of surgical procedure, set at hospital level.

Methylene blue treated fresh frozen plasma (MB-FFP)

Pathogen-inactivated single donor component produced from imported plasma. Indicated for all patients born on or after 1 January 1996.

Pathogen reduction

Additional manufacturing step in making blood products, validated to remove or substantially reduce infectivity for infectious agents. Includes light-activated chemicals (e.g. methylene blue, psoralens) and solvent detergent treatment. Some non-enveloped viruses may not be reliably inactivated by current methods.

Plasma

The liquid portion of the blood in which the cells are suspended. Plasma may be separated from the cellular portion of a whole blood collection for therapeutic use as fresh frozen plasma or further processed to cryoprecipitate and cryoprecipitate-depleted plasma for transfusion. It may be used for the manufacture of medicinal products derived from human blood and human plasma, or used in the preparation of pooled platelets, or pooled leucocyte-depleted platelets. It may also be used for resuspension of red cell preparations for exchange transfusion or perinatal transfusion.

Plasma derivative

Licensed pharmaceutical product containing partially purified human plasma protein for therapeutic use. Prepared from pooled human plasma under pharmaceutical manufacturing conditions, e.g. coagulation factors, immunoglobulins, albumin.

Platelets, apheresis, leucocyte-depleted

A concentrated suspension of blood platelets, obtained by apheresis, from which leucocytes are removed.

Platelets, recovered, pooled, leucocyte-depleted

A concentrated suspension of blood platelets, obtained by the processing of whole blood units and pooling the platelets from the units during or after separation, and from which leucocytes are removed.

Postoperative cell salvage

Collection and re-infusion of blood from wound drains. Mainly used in orthopaedic surgery.

Post-transfusion purpura (PTP)
Immunologically mediated thrombocytopenia following transfusion.
Red cells
In this handbook, the term is used for any red cell component unless otherwise stated.
Red cells in additive solution
The red cells from a single whole blood donation, with a large proportion of the plasma from the donation removed. A nutrient or preservative solution is added (e.g. SAG-M).

Routine antenatal anti-D prophylaxis (RAADP)
A programme established to further reduce the incidence of HDFN by administering one or two doses of anti-D Ig in late pregnancy.
Saline
Sodium chloride intravenous infusion (0.9%).
Serious adverse event
Any untoward occurrence associated with the collection, testing, processing, storage and distribution of blood or blood components that might lead to death or life-threatening, disabling or incapacitating conditions for patients or which results in, or prolongs, hospitalisation or morbidity.
Serious adverse reaction
An unintended response in a donor or in a patient associated with the collection or transfusion of blood or blood components that is fatal, life-threatening, disabling, or which results in or prolongs hospitalisation or morbidity.
Serious Hazards of Transfusion (SHOT)
UK-wide reporting system for adverse transfusion events and 'near misses'.
Solvent detergent treated plasma (SD-FFP)
A commercially available pooled plasma product pathogen-inactivated by the solvent detergent method (Octaplas®)
Thrombocytopenia
An abnormally low platelet count which may indicate a bleeding risk.
Traceability
The facility to trace each individual unit of blood or blood component derived thereof from the donor to its final destination, whether this is a recipient, a manufacturer of medicinal products or disposal, and vice versa (European Commission Directives on haemovigilance/traceability).
Tranexamic acid
An antifibrinolytic drug that reduces bleeding and mortality in traumatic haemorrhage and reduces transfusion in a range of surgical procedures.
Transfusion-associated graft-versus-host disease (TA-GvHD)
A fatal complication of blood transfusion where allogeneic lymphocytes proliferate in the recipient causing severe marrow aplasia.
Transfusion-related acute lung injury (TRALI)
Acute lung injury within 6 hours of a transfusion (non-cardiogenic pulmonary oedema).
United Kingdom Blood Transfusion Services (UKBTS)
This comprises the NHS Blood and Transplant (NHSBT), the Northern Ireland Blood Transfusion Service (NIBTS), the Scottish National Blood Transfusion Service (SNBTS) and the Welsh Blood Service (WBS).
Variant Creutzfeldt–Jakob disease (vCJD)

A fatal disease which may be transmissible through prions transferred during transfusion of blood products from an infected donor. It is believed to be linked to BSE and affects much younger adults than CJD.

Viral inactivation

See pathogen reduction.

Whole blood

Blood collected from a donor before separation into red cells, platelets and plasma.