Blood transfusion

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Abstract

The term 'blood transfusion' generally refers to the therapeutic use of blood and components (red cells, platelets, fresh frozen plasma and cryoprecipitate). Careful donor selection and stringent testing by the blood service is required to ensure a safe blood supply. Blood transfusion may be essential for many clinical treatments where it can be life saving. However, donated blood is a limited resource and hospital blood transfusion practice must focus on ensuring safe and appropriate use. Clinical guidelines are essential in all specialities using blood and components supported by education and training with regular audit of practice. Particular emphasis is required on accurate patient identification through the whole transfusion process from taking the initial blood sample, laboratory testing and transfer of blood to clinical areas to the final bedside check prior to transfusion to minimize errors. The reporting and monitoring of all adverse events in relation to blood transfusion via national haemovigilance schemes has highlighted key areas for action resulting in improved transfusion safety. Transfusion medicine must be practiced within a strict regulatory framework and, in particular, the European Union (EU) blood directives have had far-reaching implications for the UK blood services and for hospital transfusion laboratories.

Keywords blood components; Better Blood Transfusion initiatives; EU Blood Directive; haemovigilance; transfusion

Transfusion medicine has evolved over recent years with several scientific and clinical advances. Within the blood service, the introduction of more advanced serological and molecular techniques for microbiological testing coupled with stricter criteria for selection of donors has greatly reduced the risks of transfusion transmitted infection. Additional steps during processing of blood and components including leuco-depletion and viral inactivation where feasible further improve safety.

The key priorities for clinical transfusion practice include avoidance of unnecessary transfusion and reducing avoidable transfusion errors wherever possible. A robust clinical governance infrastructure within a hospital including an active Hospital Transfusion Team and Hospital Transfusion Committee is essential for implementing key activities to ensure safe transfusion practice and appropriate use of blood.

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Blood donation and processing

Blood donation

All donors in the UK are voluntary and unpaid. They are carefully selected using a donor health questionnaire to ensure that they are safe to donate and to exclude anyone at risk of transmitting infection. Donors can give around 450 ml of whole blood up to three times a year, which is separated into red cells, platelets and plasma. These individual components can also be collected by separate component donation using a process known as apheresis.

UK plasma is no longer used for fractionation for manufacture of blood products such as albumin, intravenous immunoglobulin, Anti-D or factor concentrates (see below).

Testing of donor blood

Transfusion transmitted infection: the epidemiology of infection in the population of a particular country can help guide the testing required to maximize safety of the blood supply. In the UK, all donations are tested for syphilis, hepatitis B, hepatitis C, HTLV1 and HIV. The tests used and the current estimated risk are summarized in Table 1.[1]

Some donations are also tested for cytomegalovirus (CMV) antibody to help provide CMV-negative blood for particular patient groups such as neonates or patients undergoing bone marrow transplantation.

Variant Creutzfeldt-Jakob disease (vCJD): to date, there have been four cases in the UK where blood transfusion may have been implicated in transmission of new vCJD. There is no blood test at present readily available for detecting prions, although considerable international research is being undertaken in this field. The full risk of vCJD in the UK population remains uncertain and accordingly the UK blood services have taken a number of precautionary measures to reduce the potential risk of transmission of prions by blood, plasma and blood products, the latter requiring fractionation of very large volumes of plasma. These include:

- universal leuco-depletion (removal of white cells) of all blood donations since 1998
- importation of plasma for countries other than the UK for fractionation to manufacture plasma products
- importation of fresh frozen plasma for use in children born after January 1996
- exclusion of blood donors who have received a transfusion in the UK since 1980.

Processing of blood

Donor blood is collected into plastic packs containing citric phosphate dextrose, which acts as an anticoagulant and helps support red cell metabolism. All units are then transported without delay to the blood centre for processing, with initial leucodepletion to remove white cells. Further processing is then undertaken to produce red cells, platelets and plasma under stringent standards of quality control.

The standard unit of red cells available in the UK has most of the plasma removed and replaced by a saline solution containing saline, adenine, glucose and mannitol (SAGM), also known as optimal additive solution. Red cells are stored at 4 °C with a shelf-life of 35 days.

Transfusion transmitted infection in UK

Test	Testing introduced	Examples of testing methods used	Risk of infection 2008[1]
Syphilis	1940s	Antibody	
Hepatitis B	1970 onwards	Surface antigen (HBsAg)	1 in 850,000
HIV	1985/2002 onwards	Antibody/Nucleic acid testing	1 in 5 million
HCV	1991/1999 onwards	Antibody/Nucleic acid testing	1 in 51 million
HTLV	2002	Antibody	1 in 11 million

Table 1

A unit of platelets can either be produced by single donor apheresis or by centrifugation of whole blood followed by separation and pooling of the platelet rich layer from four donations. Platelets can be stored for 5 days at 20–24 °C with constant agitation to maintain optimal platelet function.

Fresh frozen plasma (FFP) is a source of coagulation factors and is produced by separation and freezing of plasma at –30 °C.

In the UK, single donation units, sourced from the USA and treated with methylene blue to reduce microbial activity, are indicated for all children born after 1996.

Solvent detergent plasma is prepared commercially from pools of 300–5000 plasma donations that have been sourced from non-UK donors and treated with solvent and detergent to reduce the risk of viral transmission.

Cryoprecipitate is prepared by the blood service by undertaking controlled thawing of frozen plasma to precipitate high molecular weight proteins including Factor VIII, von Willebrand factor and fibrinogen.

Blood transfusion regulation and the EU blood directives

The EU Blood Directive on blood safety set standards of quality and safety for the collection, testing, processing, storage and distribution of human blood and components. This was written into English Law as the UK Blood Safety and Quality Regulations and was implemented in 2005.

In the UK, the 'competent authority' overseeing the implementation of these regulations is the Medicines and Healthcare Products Regulatory Agency (MHRA), which is responsible for assessing compliance within hospital transfusion laboratories and for inspection and licensing of blood services (also known as 'blood establishments').[3]

Impact of blood safety and quality regulations in hospitals

The chief executive of each hospital with a transfusion laboratory needs to submit a formal annual statement of compliance to the MHRA. Hospital transfusion laboratories can be inspected by the MHRA and in the event of significant deficiencies can be given the order to 'cease and desist from activities'. The key requirements for hospitals include:

- a comprehensive quality management system based on the principles of 'good practice', including stringent requirements for storage and distribution of blood and components, with emphasis on 'cold chain' management
- traceability, requiring all hospitals to trace the fate of each unit of blood/blood component (including name and patient ID) with records being kept for 30 years
- education and training of staff involved in blood transfusion, with maintenance of all training records
- haemovigilance, with reporting of all adverse events (see below).

Hospital transfusion laboratories undertaking any processing activities such as irradiation must have a license from the MHRA indicating blood establishment status.

Better blood transfusion

Although not a regulation, 'Better Blood Transfusion' health service circulars published in 1998, 2002 and 2007 provide strong recommendations for promoting safe transfusion practice within hospitals with particular emphasis on the appropriate use of blood and components in all clinical areas.

All hospitals must have Hospital Transfusion Committees (HTCs), with multi-disciplinary representation. These committees are responsible for overseeing implementation of guidelines, and the audit and training of all staff involved in transfusion. The HTC has an essential role within the hospital clinical governance framework and must be accountable to the chief executive.

The smaller Hospital Transfusion Team (HTT), including the transfusion nurse specialist, transfusion laboratory manager and consultant haematologist in transfusion, undertakes various activities on a day-to-day basis to achieve the objectives of the HTC.

Laboratory transfusion

Blood group serology – ABO groups

There are four different ABO blood groups, which are determined by whether or not an individual's red cells have the A antigen (Group A), the B Antigen (Group B), both A and B antigens (Group AB) or neither (Group O).

Depending on the ABO group, individuals produce anti-A or anti-B antibodies in early life that are mainly IgM and can rapidly attack and destroy incompatible cells with activation of the full complement pathway, resulting in intravascular haemolysis (acute haemolytic reaction). It is therefore essential that only red cells of a compatible ABO group are transfused.[5]

RhD group and antibodies

Individuals who lack the RhD antigen are called RhD negative and account for about 15% of the population, with the majority who do have the RhD antigen called RhD positive. RhD negative individuals can become 'sensitized' and develop Anti D after being exposed to RhD positive cells following transfusion or pregnancy.

The clinical complications include haemolytic disease of the newborn (HDN) the risk of which can be minimized by use of anti D