Blood transfusion: a practical guide

Introduction

Over 2 million units of red cells are transfused in the UK every year, half of which are used for surgical patients. A successful transfusion is the appropriate provision of blood cells or other blood components in a safe and timely manner. This article gives a practical guide to transfusion medicine.

Blood groups

The most important blood group is the ABO system because of the natural expression of antibodies to A and B in individuals who do not have these antigens (*Table 1*). If an individual receives cells with antigens recognized by the recipients' antibodies (e.g. group B recipient receiving group A red cells) these donor cells are identified as foreign and attacked, resulting in a severe haemolytic transfusion reaction.

Donor selection

Stringent criteria are in place to limit the chance of a donor with a transmissible infection giving blood. Each unit is screened for evidence of infection with syphilis, hepatitis B and C, the human immunodeficiency virus (HIV) 1 and 2, human T-cell lymphotropic viruses 1 and 2 and in some instances cytomegalovirus, malaria, West Nile virus and *Trypanosoma cruzi*.

Ordering blood: the practicalities

As severe reactions result from human error, great care must be taken to ensure the correct blood reaches the right patient, including labelling of blood samples sent to the laboratory. A group and save involves determining the patient's ABO blood group and screening serum for the presence of antibodies to common red cell antigens that can cause transfusion reactions.

In addition to this, crossmatching involves the mixing of samples from donor blood units with the patient's blood to see if any abnormal reaction occurs. A group and save should be ordered if the patient is unlikely to need a blood transfusion but it will reduce the time required for crossmatched blood, should the patient subsequently need it. If the patient needs blood, you should crossmatch the number of units they will need. As a general rule, one unit of blood raises the haemoglobin by 1 g/dl in the non-bleeding adult patient.

For elective surgery, the case should be discussed with the anaesthetist and surgeon, who will take into account the preoperative haemoglobin, the likely blood loss and the patient's tolerance for anaemia. In an emergency, liaise with the transfusion laboratory early: each hospital will have its own policy for crossmatching and treatment of major haemorrhage (*Table 2*).

As there are more than 12 blood group systems (e.g. ABO, Rhesus, Kell, Duffy Kidd, Diego MNS) it takes about 40 minutes to determine an individual's blood group (group and save) and 40 minutes to crossmatch (issue) blood. This may take longer for people with rarer blood groups, people who have received many transfusions or who have developed antibodies. In emergencies ABO-group specific blood (12 minutes to issue) or group O blood (which has neither A nor B antigens) may be necessary.

Table 1. ABO blood group characteristics

ABO blood group and UK incidence	Antigens on RBCs	Antibodies in serum	Notes
A (42%)	A	Anti-B	
B (8%)	B	Anti-A	
AB (3%)	A and B	Neither	'Universal recipient'
O (47%)	Neither	Anti-A and anti-B	'Universal donor'

RBC = red blood cells

Blood components, indications and guidelines

All blood components produced in the UK are filtered to remove white cells.

Whole blood

This is very rarely used.

Red cells

Each 250–350 ml bag has a haematocrit (% of cells) of 0.6. There are no platelets, very few white cells and 2,3-diphospoglycerate (2,3 DPG) levels remain normal for up to 14 days, allowing relatively normal oxygen uptake and release by haemoglobin. Red cell preparations may be stored for 42 days with SAGM (saline, adenine, glucose, mannitol) solution at 40°C but must be used within 6 hours at room temperature. Current guidelines suggest a haemoglobin transfusion threshold in stable patients of 8 g/dl, or 10 g/dl in patients with cardiorespiratory disease.

Platelets

In the UK, platelets either come from pooling of the platelet component from four units of whole donated blood, called random donor platelets, or by plasmapharesis from a single donor. The platelets are suspended in 200–300 ml of plasma and may be stored for up to 4 days in the transfusion laboratory where they are continually agitated at 22°C to preserve function. One adult platelet pool raises the normal platelet

Table 2. Suggested blood requirements for elective surgical procedures

Need for transfusion	Approximate blood loss	Suggested action	Surgery
Unlikely	<1000 ml	Group and save	Appendicectomy, ERPC, varicose veins, thyroidectomy
Probably	1000–2000 ml	XM 2 units	Colectomy, TURP, laparotomy, hip arthroplasty
Definite	<3000 ml	XM 4 units	Total gastrectomy, nephrectomy, oesophagectomy
	>3000 ml	XM 6+ units	Cystectomy, elective AAA repair

AAA = abdominal aortic aneurysm; ERPC = evacuation of retained products of conception; TURP = transurethral resection of the prostate; XM = cross match

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Table 3. Indication for platelet transfusion

Threshold	Indication
Absolute number not important	Bleeding in a patient with impaired platelet function (e.g. aspirin therapy)
Platelets $<10x10^9$/litre	In a clinically stable patient
Platelets $<50x10^9$/litre	Critically ill patient, coagulopathy, undergoing invasive procedure, bleeding

count (150–450 platelets x 10^9/litre) by 5–10 platelets x 10^9/litre (*Table 3*).

ABO identical or compatible platelets are preferred but not necessary in adults; but rhesus compatibility is required in recipients who are children and women of childbearing age to prevent haemolytic disease of the newborn.

Fresh frozen plasma

Fresh frozen plasma (FFP) is produced from centrifugation of whole donated blood, or plasmapheresis. Each 150 ml bag contains all clotting factors, albumin and antibodies. FFP must be used immediately after thawing and must be ABO compatible. The usual starting dose is 10–15 ml/kg, equivalent to three or four packs of FFP for a 70 kg person (*Table 4*). Because of the potential risk of variant Creutzfeldt–Jakob disease (vCJD) in UK donors, FFP for children born after 1995 is derived from unpaid USA donors.

Cryoprecipitate

Cryoprecipitate is precipitated from FFP, and contains high levels of factor VIII, fibrinogen and von Willebrand factor. Each unit contains 20–40 ml (although larger bags may be available) and should be ABO compatible with the patient. The main indication for cryoprecipitate is hypofibrinogenaemia, either as a result of massive transfusion or disseminated intravascular coagulation (DIC). Treatment is considered if the plasma fibrinogen is <0.8–1 g/litre; ten units of cryoprecipitate should increase fibrinogen level by 1 g/litre.

Table 4. Indications for fresh frozen plasma

Severe traumatic or surgical bleeding with large packed red cell requirement
Plasma exchange
Single or multiple factor deficiency in the absence of a recombinant alternative
Disseminated intravascular coagulation with bleeding
Warfarin overdose with severe bleeding
Liver disease with a prolonged prothrombin time

Hazards of transfusion

Acute hazards

Serious or life-threatening reactions to transfusion are very rare. However, new symptoms or signs that arise during a transfusion must be taken seriously. Over half of serious transfusion reactions are caused by administrative errors: patients being transfused blood that had been intended for another patient. Other common acute effects include less severe immune reactions, fluid overload, transfusion associated lung injury (TRALI), and transfusion of bacterially infected components.

Severe immune transfusion reactions

This includes acute haemolytic transfusion reactions (such as ABO incompatibility) and immune reactions to other blood components such as platelets and white cells. ABO incompatibility can destroy red cells in the circulation, cause circulatory and respiratory collapse, initiate acute renal failure and cause DIC. It has been suggested that a single practitioner taking overall responsibility for checking the blood and patient before transfusion is safer than two practitioners checking. If red cells are mistakenly administered to the wrong patient, the chance of ABO incompatibility is about 1 in 3. Even a few drops of ABO incompatible blood may cause local symptoms within seconds, which is why patients should be closely observed at the start of each transfusion (*Tables 5* and *6*).

Since it may be impossible to identify immediately the cause of a severe reaction, the initial management is supportive.

Bacterial contamination of blood components

This is the commonest infective hazard of blood component transfusion. Clinically it causes a rapid onset of sepis: fever, tachycardia, hypotension, rigors and collapse.

Transfusion-related acute lung injury

TRALI is related to the presence of antibodies in donor plasma to the recipient's leucocytes. It is most common in individuals who have had large doses of FFP. Clinically, transfusion is followed by rapid onset of hypoxia, respiratory difficulties and a non-productive cough. The chest X-ray characteristically shows bilateral infil-

Table 5. Signs and symptoms of severe immune transfusion reactions

Symptoms	Feeling of apprehension or 'something wrong'
	Flushing
	Pain at venepuncture site
	Pain in abdomen or chest
Signs	Fever
	Hypotension
	Generalized oozing from wounds or puncture sites
	Haemoglobinuria
	Respiratory distress

Table 6. Initial management of suspected acute transfusion reaction

Stop the transfusion – keep the IV line open with saline or Hartmann's solution
Recheck the blood/patient compatibility
Check the patient's temperature, blood pressure, pulse, respiratory rate: if these are abnormal check the arterial blood gases and oxygen saturation
Give paracetamol 1 g iv/po for fever and antihistamine (e.g. chlorpheniramine 10 mg iv) for urticaria
Adrenaline (0.3–0.5 mg im) may be needed for circulatory collapse
Notify blood bank; keep blood bag
If reaction is mild, slowly re-commence transfusion
If severe: call for senior help, and consider referral to intensive care

IM= intramuscular; IV = intravascular; PO= oral

Table 7. Complications of massive blood transfusion

Impaired oxygen delivery as a result of lack of 2,3-diphosphoglycerate
Hypothermia
Coagulopathy
Transfusion-related acute lung injury
Hypocalcaemia
Hyperkalaemia
Acidosis

trates. The treatment is that for adult respiratory distress syndrome. Most authorities believe this condition, which has a mortality of up to 30%, is under-recognized.

Fluid overload

Excess or over-rapid transfusion may result in acute left ventricular failure, with signs of pulmonary oedema. The transfusion should be stopped and steps to relieve the pulmonary oedema should be given, including diuretics and oxygen. Massive blood transfusion is the acute administration of more than 1.5 times the patient's blood volume, or replacement of the patient's total blood volume within 24 hours.

Long-term hazards

Risk of infectious disease

Because of donor selection and screening techniques, the risk of transmission of infectious disease is very rare for red cell, FFP and cryoprecipitate transfusions (*Table 8*). A figure for platelet transfusions is more difficult as single platelet donors are more regularly tested, whereas platelet pools are derived from four donors.

Two cases of vCJD transmission by blood transfusion have been reported in the UK along with another of vCJD 'infectivity': the recipient died of other causes but had evidence of abnormal prion protein at post mortem.

Table 8. Approximate incidence of viral infection after transfusion in UK

Infection	Risk
Human immunodeficiency virus	1 in 5 million
Hepatitis B	2 in 1 million
Hepatitis C	1 in 30 million

Table 9. Alternatives to transfusion

Technique	Description
Reduction in blood loss	Induced hypotension, improved haemostasis during surgery
Autologous blood transfusion	The patient receiving their own blood, donated weeks before surgery
Cell salvage	Machine that collects, 'cleans' and re-infuses the patient's blood during and/or after surgery
Erythropoetin	Recombinant hormone that promotes red cell production
Purified haemoglobin	Expired or animal blood and/or red cell membrane substitute, e.g. a liposome
Recombinant haemoglobin	From bacteria
Perfluorocarbons	Inert oxygen-carrying chemicals

Iron overload

Repeated transfusions for chronic anaemia, for example thalassaemia, may result in iron deposition in the tissues and organ injury. This is treated by prophylaxis with the iron binding agent desferrioxamine.

Immunosuppression

There is some evidence that transfusion around the time of surgery may be associated with a greater risk of postoperative infections and tumour recurrence in cancer patients, but this is controversial.

Alternatives to allogenic blood transfusion

The expense and side-effects of transfusion has led to the search for alternatives, some of which are clinically established and some still in development (*Table 9*). Many of these are only appropriate for elective, planned surgery.

Social implications of blood transfusion

A blood transfusion is a procedure with potential complications: many patients would prefer not to be transfused if at all possible. Jehovah's witnesses refuse all blood products, but may allow blood to be re-transfused if it has not lost contact with the circulation such as during cardiopulmonary bypass.

It is advisable to obtain and record a patient's consent for blood transfusion, especially if they may receive blood while under anaesthetic.

Conclusions

Blood transfusion is an essential part of acute medical care, but it has side effects. Modern practise emphasizes the rationalization of transfusion according to guidelines at a national and local level. Where possible, transfusion practice should be audited, and transfusion-avoidance strategies used. BJHM

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Further reading

Hebert PC (1998) Transfusion requirements in critical care (TRICC): a multicentre, randomized, controlled clinical study. Transfusion Requirements in Critical Care Investigators and the Canadian Critical care Trials Group. *Br J Anaesth* **81** (Suppl 1): 25–33

Murphy MF, Wallington TB, Kelsey P et al (2001) Guidelines for the clinical use of red cell transfusions. *Br J Haematol* **113:** 24–31

Internet resources

British Blood Transfusion Society: www.bbts.org.uk
National Blood Service: www.blood.co.uk
Serious Hazards of Transfusion (SHOT): www.shotuk.org
UK Blood Transfusion and Tissue Transplantation Services: www.transfusionguidelines.org.uk

KEY POINTS

- All blood product component transfusions have risks.
- Great care should be taken to ensure the correct blood reaches the right patient.
- Modern evidence suggests a transfusion trigger of haemoglobin <8 g/dl in most patients.
- Blood products components such as fresh frozen plasma and cryoprecipitate have limited indications.
- Blood use should be audited at a local and national level.
- There are many established and experimental strategies to minimize the need for transfusion.