Bleeding, blood products and transfusion reactions

TABLE 1
ESTIMATED FLUID AND BLOOD LOSSES[1]
Based on Patient's Initial Presentation

	Class I	Class II	Class III	Class IV
Blood Loss (mL)	Up to 750	750–1500	1500–2000	>2000
Blood Loss (% Blood Volume)	Up to 15%	15%–30%	30%–40%	>40%
Pulse Rate	<100	>100	>120	>140
Blood Pressure	Normal	Normal	Decreased	Decreased
Pulse Pressure (mm Hg)	Normal or increased	Decreased	Decreased	Decreased
Respiratory Rate	14–20	20–30	30–40	>35
Urine Output (mL/hr)	>30	20–30	5–15	Negligible
CNS/Mental Status	Slightly anxious	Mildly anxious	Anxious, confused	Confused, lethargic
Fluid Replacement (3:1 Rule)	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood

[1] For a 70-kg man.

The guidelines in Table 1 are based on the "3-for-1" rule. This rule derives from the empiric observation that most patients in hemorrhagic shock require as much as 300 mL of electrolyte solution for each 100 mL of blood loss. Applied blindly, these guidelines can result in excessive or inadequate fluid administration. For example, a patient with a crush injury to the extremity may have hypotension out of proportion to his or her blood loss and requires fluids in excess of the 3:1 guidelines. In contrast, a patient whose ongoing blood loss is being replaced by blood transfusion requires less than 3:1. The use of bolus therapy with careful monitoring of the patient's response can moderate these extremes.

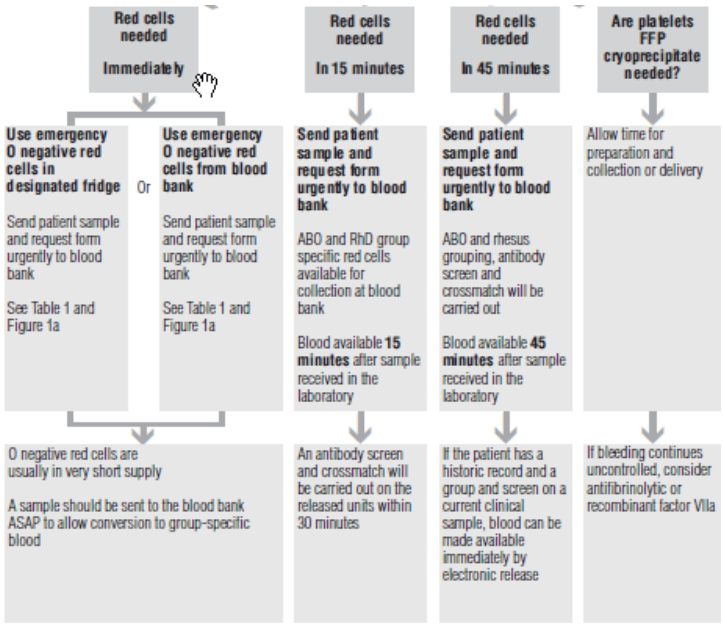

Figure 1b Example of a transfusion management guideline for major haemorrhage

Objective	Action	Notes
Control the bleeding	Early intervention – surgical, endoscopic, radiological	Upper GI tract procedures Interventional radiology
Restore circulating volume In patients with major vessel or cardiac injury, it may be appropriate to restrict volume replacement after discussion with surgical team	Insert wide-bore peripheral cannulae Give adequate volumes of crystalloid/blood Aim to maintain normal blood pressure and urine output > 30 ml/hr in adults (or 0.5 ml/kg/hour)	Blood loss is often underestimated Refer to local guidelines for the resuscitation of trauma patients and for red cell transfusion Monitor arterial pressure and CVP if unstable
Avoid exacerbating coagulation problems	Keep the patient warm	
Use laboratory data to guide management	*Request laboratory investigations* FBC, PT, APTT, fibrinogen, blood bank sample, biochemical profile, blood gases Repeat FBC, PT, APTT, fibrinogen every 4 hrs, or after 1/3 blood volume replacement, or after infusion of FFP	Colloid solutions can prolong clotting times Take samples early FFP and platelets may be required before results are available
Have blood components available when needed	*Request red cells* Pack volumes range from 180 to 350 ml	RhD positive blood may be used for male or post-menopausal female in emergency Use blood warmer Consider cell salvage
	Platelets needed? Anticipate platelet count < 50 × 10^9/l after 1.5–2 × blood volume replacement *Dose:* 10 ml/kg body weight for a neonate or small child; otherwise one 'adult therapeutic dose' (one pack)	Target platelet count: > 100 × 10^9/l for multiple/CNS trauma > 75 × 10^9/l for other situations
	FFP needed? Anticipate coagulation factor deficiency after blood loss of 1–1.5 × blood volume Aim for PT and APTT < 1.5 × mean control and fibrinogen > 1.0 g/l Allow for 30 minutes thawing time Dose: 12–15 ml/kg body weight = 1 litre or 4 units for an adult	PT and APTT > 1.5 × mean control correlates with increased surgical bleeding May need to use FFP before laboratory results are available – take sample for PT, APTT, fibrinogen before FFP transfused
	Cryoprecipitate needed? To replace fibrinogen and FVIII Aim for fibrinogen > 1.0 g/l Allow for 30 minutes thawing time *Dose:* 2 × 5 donation pools for mid-sized adult	Fibrinogen < 0.5 strongly associated with microvascular bleeding Low fibrinogen prolongs all clotting times (PT and APTT)
Recognise and act on complications	Suspect DIC Treat underlying cause	Shock, hypothermia and acidosis increase the risk of haemostatic problems, and are associated with worse outcomes
Manage intractable non-surgical bleeding	Consider the use of recombinant factor VIIa	Obtain and use according to local protocol NovoSeven® is not licensed for this indication

Blood products

450 ml blood donation up to 3 x per year

Routine testing for HBV, HIV, HTLV, HCV and syphyllis

Table 2 Red cells in additive solution

	mean	sd	95%CI	range
Volume ml	282	± 32	284–285	180–350
Haemoglobin g per pack	55	± 8	58–59	35–72
Haematocrit %	57	± 3	54.6–55.1	
Red cells ml per pack	161	± 25		
Plasma ml per pack	17	± 10		4–25
Anticoagulant CPDA1 ml	4			
Additive solution SAGM ml	100			
Storage	Up to 35 days at +2°C to +6°C			
Compatibility requirement	Must be compatible with recipient's ABO (and usually RhD type): page 16			
Dosing guide	Dose of 4 ml/kg (one pack to 70 kg adult) typically raises venous Hb concentration by about 10 g/l Paediatric use (page 54)			
Administration	Use blood administration set; complete the infusion within four hours of removal from controlled temperature storage (page 20)			
Variants	CMV negative (page 42) Irradiated (page 42)			
Cautions	Risks to recipients (page 59)			

CPDA = citrate (anticoagulant), phosphate, dextrose and adenine

SAGM = Saline, adenine, glucose and mannitol

Table 3 Platelets

From whole blood donations: platelets from 4 or 5 donations constitute an adult therapeutic dose (ATD)
From apheresis: 1 donor collection provides 1 to 3 adult ATDs

From whole blood (pool of 4 donations is 1 adult dose)	**mean**	**sd**	**95% CI**	**range**
Number of donors	4			
Volume ml	310	± 33	317–321	250–400
Platelets × 10^9 (at least 240 × 10^9)	330	± 50	329–332	180–400
Plasma ml	250			
Anticoagulant ml	60			
White cells per unit	0.3 × 10^6 per pack			
From apheresis	**mean**	**sd**	**95% CI**	**range**
Number of donors	1			
Volume ml	215	± 53	206–207	180–300
Platelets × 10^9	290	± 45	289–291	180–400
Plasma ml	180			
Anticoagulant ml	35			
White cells per unit	0.3 × 10^6 per pack			
Storage	5 days at 22 ± 2°C on a special agitator rack (may be extended to 7 days if system is validated and in conjunction with bacterial testing)			
Compatibility requirement	Preferably ABO and RhD identical with patient			
Dosing guide	For a 70 kg adult, 1 adult dose typically gives an immediate rise in platelet count of 20–40 × 10^9 ml			
Administration	Infuse through a standard blood administration set or a platelet infusion set – use a fresh set when administering each infusion of platelets			
Cautions	RhD negative females with potential for childbearing must be given RhD negative platelets to avoid risk of Rh sensitisation (page 17) Plasma in the platelets can cause an ABO incompatibility reaction (page 16), TRALI (page 60) or allergic reaction (page 60)			

Table 4 Fresh frozen plasma, SDFFP, MBFFP and cryoprecipitate

Fresh frozen plasma	mean	sd	95% CI	range
Number of donors per pack	1			
Volume ml	273	± 17	277–279	240–300
Plasma ml	220			
Anticoagulant ml	50			
Fibrinogen g/l	20–50			
Fibrinogen mg per pack estimated			554–1395	
Factor VIII c IU/ml (in > 75% packs)	> 0.7		1.03–1.06	
Other coagulation factors	variable			
Other plasma proteins	< normal plasma			
Storage	2 years at -30°C			
Methylene blue plasma[1]				
Number of donors per pack	1			
Volume ml	232	± 18		
Plasma ml	220			
Anticoagulant ml	50			
Factor VIII c IU/ml (in > 75% packs)	> 0.7			
Storage	2 years at -30°C			
Solvent–detergent plasma[1]				
Number of donors per pack	380–2500			
Volume ml	200			
Fibrinogen g/l	27			
Factor VIII c IU/ml (in > 75% packs)	> 0.5			
Storage	1 year at -30°C			

Compatibility	FFP should be ABO compatible to avoid risk of haemolysis caused by donor anti A or anti B FFP does not need to be RhD matched
Dosing guide	12–15 ml/kg would typically increase fibrinogen levels by about 1 g/l
Administration	Use standard blood administration set Rapid infusion may increase risk of acute reactions
Cautions	Risk of volume overload Rapid infusion may increase risk of adverse reaction
Infection risk	Pathogen reduction should reduce any risk due to micro-organisms Non-UK plasma should reduce risk of vCJD

Blood transfusion reactions

Divided into early (<24 hrs) or late (>24 hrs), immunological or non-immunological

Early (< 24 hrs)

Immunological

Haemolytic transfusion reaction *	ABO incompatibility
Febrile non-haemolytic transfusion reaction	Host AB vs. donor leucocytes
Urticarial transfusion reaction	Host AB vs. plasma proteins (FFP, platelets)
Anaphylactic transfusion reaction*	Re-exposure to specific Ag (IgA etc)
Transfusion related lung injury (TRALI)*	Donor Ab vs. host leucocytes

Non-immunological

Bacterial contamination *	more common with platelets
Fluid overload*	
Hypocalcaemia	
Hyperkalaemia	
Hypothermia	
DIC*	

Late (> 24 hrs)

Immunological

Delayed haemolytic transfusion reaction	Host AB vs. lesser Ag (Rhesus, Kidd etc.) 1-14 days after; fever, jaundice, falling Hb
Graft vs. Host disease*	Donor leucocytes vs. host
Post-transfusion purpura	Anti-platelet AB – thrombocytopenia 5-9 days after tranfusion

Non-immunological

Infections	HIV 1 in 4.5 million donations HCV 1 in 20 million donations HBV 1 in 450,000 donations
Iron overload	

* Severe, potentially life-threatening

People who are group A have anti-B antibody in their plasma.

People who are group B have anti-A antibody.

People who are group O have anti-A and anti-B antibodies.

People who are group AB have neither of these antibodies.

Patient's ABO blood group	Patient's plasma contains	Red cell units that are compatible
O	Anti A + B	O
A	Anti B	A O
B	Anti A	B O
AB	Neither	A B AB O

Figure 10 Acute transfusion reactions