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6

Alternatives to allogeneic blood transfusions

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Inherent risks and increasing costs of allogeneic transfusions underline the socioeconomic relevance of safe and effective alternatives to banked blood. The safety limits of a restrictive transfusion policy are given by a patient's individual tolerance of acute normovolaemic anaemia. Iatrogenic attempts to increase tolerance of anaemia are helpful in avoiding premature blood transfusions while at the same time maintaining adequate tissue oxygenation. Autologous transfusion techniques include preoperative autologous blood donation (PAD), acute normovolaemic haemodilution (ANH), and intraoperative cell salvage (ICS). The efficacy of PAD and ANH can be augmented by supplemental iron and/or erythropoietin. PAD is only cost-effective when based on a meticulous donation/transfusion plan calculated for the individual patient, and still carries the risk of mistransfusion (clerical error). In contrast, ANH has almost no risks and is more cost-effective. A significant reduction in allogeneic blood transfusions can also be achieved by ICS. Currently, some controversy regarding contraindications of ICS needs to be resolved. Artificial oxygen carriers based on perfluorocarbon (PFC) or haemoglobin (haemoglobin-based oxygen carriers, HBOCs) are attractive alternatives to allogeneic red blood cells. Nevertheless, to date no artificial oxygen carrier is available for routine clinical use, and further studies are needed to show the safety and efficacy of these substances.

Key words: blood; transfusion; alternatives; anaemia tolerance; donation; haemodilution; cell salvage; artificial O_2 carriers; blood substitutes.

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Table 1. Incidences of potential risks associated with allogeneic blood transfusions.

Risk factor		Incidence
Mistransfusion	Acute haemolytic reaction	1:6000–1:33,000
	Delayed haemolytic reaction	1:2000–1:11,000
Infections (viral)	HIV	1:20 million
	Hepatitis A	1:1 million
	Hepatitis B	1:63,000–1:320,000
	Hepatitis C	1:1.2–1:11 million
	Cytomegalovirus (CMV)	1:10–1:30
	Epstein–Barr virus (EBV)	1:200
Infections (Bacterial)	*Yersinia enterocolica*, *Serratia marcescens*, *Pseudomonas*, enterobacteria	1:200,000–1:4.8 million
Immunological	Transfusion-related lung injury (TRALI)	1:4000
	Alloimmunization	1:16,000
	Immunosuppression	1:1
	Allergic transfusion reaction	1:2000

Although safer than ever before, the transfusion of allogeneic blood is still associated with risks for the recipient (cf. Table 1), the most serious of which are allergic reactions, transfusion-related lung-injury (TRALI), accidental mistransfusions ('clerical error'), and the transmission of viral and bacterial infections (hepatitis, HIV, cytomegalovirus, Epstein–Barr virus).[1,2] Indeed, the results of several prospective clinical studies indicate that a restrictive transfusion regimen is associated with lower morbidity and mortality than a liberal transfusion policy.[3–7]

Moreover, public health systems are facing a cost explosion resulting from transfusion-related morbidity as well as from continuously rising costs of the blood products themselves; because of the growing imbalance between the decreasing rate of blood donation and the continuously increasing demand, the costs of blood products are expected to double until 2030.[8,9]

To control both the inherent risks as well as the increasing costs, allogeneic blood transfusions should be either completely avoided or at least reduced to an absolute minimum during surgical procedures.

This chapter reviews the following topics in connection with alternatives to allogeneic blood transfusions: (1) the tolerance of acute normovolaemic anaemia, including the acceptance of low intraoperative haemoglobin (Hb) concentrations; (2) the employment of autologous transfusion techniques, including supportive administration of erythropoietin; and (3) the potential of artificial oxygen carriers as substitutes for allogeneic red blood cells (RBCs).

TOLERANCE OF ACUTE NORMOVOLAEMIC ANAEMIA

The initial treatment of intraoperative blood loss always consists in the maintenance of normovolaemia by the infusion of crystalloid (3:1) and colloidal solutions (1:1). This acellular fluid replacement implies the dilution of the cell mass remaining in the vasculature (haemodilution), resulting in a dilutional anaemia (acute normovolaemic anaemia).