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Autologous transfusion and reducing allogeneic blood exposure

Autologous transfusion in childhood

Allogeneic blood will continue to be the only form of replacement therapy available to the vast majority of patients requiring blood transfusion. Although the blood supply has never been safer in countries such as the UK, many clinicians now question the need for transfusion of patients with moderately low concentrations of haemoglobin as there is no evidence that mild anaemia will contribute to perioperative morbidity.¹ Some will consider autologous transfusion or other alternatives to donor blood. Autologous blood transfusion is not a new idea but has been little used in children in the UK as opposed to some centres in the USA where it has been widely used, often eliminating the need for allogeneic blood transfusion. There are three methods of autologous transfusion that can be used singly or in combination: (i) predeposit, (ii) acute normovolaemic haemodilution, and (iii) intraoperative or postoperative red cell salvage. Whether there is a good case for any of these procedures before or during paediatric elective surgery is debatable. The advantages are that infection cannot be transmitted from donor to patient, that alloimmunisation is completely avoided, and that there is no risk of immune modulation by transfusion. The disadvantages are largely practical and include limited availability of small blood collection sets and salvage equipment, the necessity for good venous access, and cooperative patients. Also, facilities or expertise for the collection of autologous blood or for normovolaemic haemodilution in children are not always available and the cost of predeposit autologous donation exceeds that of blood from the national blood supply.²

Potential benefits of minimising allogeneic transfusion

Awareness of the risk of transfusion transmitted disease has heightened with the advent of HIV and this is usually the underlying reason for a request for autologous blood transfusion. Every effort is made by the National Blood Transfusion Service (NBTS) to minimise the risk of harm arising from transfusion. All blood and plasma donations are screened for antibodies to HIV-1 and HIV-2, hepatitis C, syphilis, and hepatitis B surface antigen. Additionally, selection criteria are applied to exclude donors who admit to activities which render them at higher risk of having infections transmissible by blood transfusion.³

The 'window period' between a viral infection and detectable seroconversion does, however, allow a donation

taken during the early phase of infection to remain undetected. Donated red blood cells and platelets cannot, at present, undergo viral inactivation and remain viable. There is, therefore, a real but very small risk of viral transmission; for HIV, this has been estimated in the UK as approximately one in 3 000 000 units transfused. The risk of post-transfusion hepatitis B has been calculated as approximately one in 20 000 and, with the recognition and screening for antibodies to hepatitis C, the risk of hepatitis C virus transmission has decreased to less than one in 13 000 units transfused (J A Barbara, M Contreras; personal observations).

Transfusions of donor blood may stimulate the formation of alloantibodies against red cell, platelet, white cell, or plasma protein antigens.⁴ Although this is undesirable at any age, it is particularly unwelcome in children who may encounter subsequent difficulties in relation to pregnancies or further transfusion. Transfusion related acute lung injury (TRALI) is a rare complication of transfusion in which donor antileucocyte antibodies cause severe pulmonary damage in a transfusion recipient.⁵ Use of autologous blood avoids all these complications.

Some reports have suggested that the rate of postoperative bacterial infection distant from the site of operation is lower in recipients of autologous blood than in patients who have received allogeneic blood.⁶⁻⁸ Most of these studies are small and further evidence is required before this can be regarded as proved.

Alternatives to allogeneic blood transfusion

(A) REDEFINING THE 'TRANSFUSION TRIGGER'

Surgeons and anaesthetists should consider whether it is justifiable to routinely return the packed cell volume to preoperative values when it is known that a packed cell volume of 25-30% decreases blood viscosity and maintains adequate tissue oxygenation as long as the blood volume remains normal. Several eloquent examples of the very low packed cell volume values that can be tolerated by children have been published.⁹⁻¹¹ On the other hand, in newborn infants undergoing surgery, a higher packed cell volume is desirable because of their predominantly fetal haemoglobin.

Hypotensive anaesthesia, in expert hands, is well tolerated in children who have no problems of coronary artery perfusion; it can prevent the need for transfusion of allogeneic blood.¹²

(B) PHARMACOLOGICAL APPROACHES

Strategies that have been shown to reduce exposure to blood transfusion include desmopressin to avoid the need for factor VIII in mild to moderate haemophilia, recombinant erythropoietin to treat anaemia of prematurity or to increase the possibility of predeposit autologous donation, and fibrin sealant in thoracic, plastic, and ear, nose, and throat surgery.¹³ Aprotinin does not seem to be as effective in paediatric cardiac surgery as it is in adults.¹⁴

(C) INTRAOPERATIVE AND POSTOPERATIVE SALVAGE

These are seldom used in small children because of the relatively small volumes of blood lost. Salvage machines have been designed for adults and the small volumes of blood lost by children are wasted in the dead spaces of the machines. For older children, there are 125 ml capacity bowls suitable for spinal and cardiac surgery and for liver transplantation.

(D) ACUTE NORMOVOLAEMIC HAEMODILUTION (ANH)

ANH consists of removing a predetermined and appropriately calculated relatively large volume of blood from the patient in the immediate preoperative period, that is, during induction of anaesthesia, and substituting this by the same volume of colloid or by three times the volume of a crystalloid solution. When blood loss starts during surgery, a relatively smaller volume of red cells is lost for a given volume of blood loss and this is replaced by the collected fresh autologous blood which is kept in theatre. The procedure is used for children in whom expected blood loss exceeds half of the estimated blood volume, as in the repair of congenital cyanotic heart disease, spinal fusion, hepatectomy, and removal of large haemangiomas. The decreased blood viscosity leads to improved tissue perfusion by reducing the peripheral vascular resistance and allows improved cardiac output due mainly to an increase in stroke volume. ANH has been used routinely by some experienced anaesthetists in paediatric surgery in the USA since the 1970s.^{15 16}

(E) PREDEPOSIT AUTOLOGOUS DONATION

Blood donation by children over the age of 7 years is straightforward if the child has adequate antecubital veins and is cooperative.^{17 18} In the UK, the risks of receiving donor blood are not sufficiently large to undertake this procedure in a frightened unwilling child. If persuasion fails, the child should not be forced to undergo a procedure that would increase fear of the planned surgery and engender increased difficulties during and after the child's hospital admission.

A standard multidisciplinary procedure, involving surgeons, anaesthetists, paediatricians and haematologists, must be in place, covering all aspects of patient selection, blood collection, documentation, testing, storage, issue, and transfusion in accordance with national guidelines.¹⁹

Parental informed consent and explanation to the child is mandatory. A child should donate only if there is a reasonable expectation that blood transfusion may be needed. The number of units collected should be in accordance with the locally agreed maximum surgical blood ordering scheme.²⁰ Blood stored at 4°C lasts between 28 and 35 days. Donation must, therefore, start and finish within this interval, allowing at least four days between the last bleed and surgery. A week is usually allowed between donations for some haematological recovery and oral iron supplements should be prescribed.

The procedure should be undertaken with the collaboration of a paediatrician and patients should not donate more than 12% of their blood volume at any one time. Older children, weighing more than 50 kg, may be bled into standard adult blood packs (450 ml). Children weighing between 20 and 50 kg should be bled into a 250 ml paediatric blood pack (for example, Pedipak, Baxter Healthcare). At present, smaller packs for children weighing less than 20 kg are not available and alteration of the volume of anticoagulant in a pack is not recommended (unfortunately all blood packs have an attached 16 gauge needle). The donation should be weighed during collection to ensure that an accurate volume is collected.

Potential disadvantages of autologous donations are few. These include cost and inconvenience. Risks of donation include vasovagal reactions, thrombophlebitis, haematoma formation, and arterial puncture.

Vasovagal reactions are more common in children and young adults than in older donors.²¹ Cowell and Swickard reported such reactions in 32 of 352 donations by patients aged 7–20 years but complete faints occurred in only three children.²² In a series of 180 children aged 8–18 years undergoing predeposit autologous donation, the rate of reactions was the same as that in adult first time donors. In 85% of these children, the full blood transfusion requirements were met with autologous blood.¹⁷ When predeposited donation and intraoperative salvage were combined in children aged 8–16, autologous blood accounted for 94% of the blood used.¹⁸

Availability

In some countries there is a legal requirement for provision of an autologous programme. This is not the case in the UK and facilities for autologous donation are not uniformly available. Where available, these may be provided by either the regional transfusion centre or by the hospital.

Cost

It has been estimated that predeposited autologous blood is approximately twice as expensive as allogeneic blood when collected by a regional transfusion centre.² This relates to higher collection and clerical costs compared with donor blood. Collection of blood from children can be a time and patience consuming activity.

Surgery for which predeposit autologous donation may be appropriate

Autologous donation may be undertaken before any elective surgery in which it is likely that blood may be transfused providing that the child is sufficiently fit, willing, and able. If the donation would delay surgery and that delay would be harmful, it is clearly not advisable.

It is usual practice to obtain autologous blood donations from children who are donating bone marrow for a sibling. The blood is returned to the donor at the time of bone marrow harvest.

Autologous donation is feasible before elective orthopaedic surgery and is of particular value for children who are likely to undergo repeated surgery with transfusion when the risks of alloimmunisation and/or infection multiply. Cowell and Swickard reported a series of 203 elective orthopaedic procedures in children who participated in an autologous donation programme in 1974.²² They concluded 'Although autotransfusion may be inconvenient in some instances, it is not reasonable to deny its many benefits to paediatric patients'.

Risks of autologous transfusion

As all blood donations carry some health risks as well as administrative costs, autologous blood should not be collected or reinfused indiscriminately. Perhaps the most important risk shared with allogeneic transfusion, is misidentification of units collected either as predeposit or for haemodilution, with the potential for an ABO incompatible transfusion. Predeposit transfusion programmes also carry the risks of (a) dilutional coagulopathy when several units are collected and blood is stored as whole blood; (b) bacterial contamination of stored blood with the potential risk of septic or endotoxic shock; (c) improper storage; (d) liberation of cytokines during storage; and (e) overtransfusion 'because it is there'.

Directed donation

Requests that relatives might donate for children are not unusual but should be refused except when the relative is the only compatible donor. There is no evidence that such donations are safer than blood provided by the NBTS. Indeed, a relative who has infection risk factors and who has been asked to donate for a child might find it difficult to avoid doing so. In addition, sharing of HLA haplotypes between donor and recipient increases the risk of transfusion associated graft versus host disease and blood from relatives should always be irradiated.²³

Conclusions

Although in countries such as the UK, the blood supply has never been safer, transfusion of allogeneic blood must be limited wherever possible. A simple but effective method of limiting such exposure is to ask the question 'Is this transfusion really necessary?' before any transfusion. Preoperative autologous donation is an effective method of limiting the exposure of children to some of the hazards of unavoidable transfusion. The procedure is feasible in many older children but requires forward planning and is more costly than blood from the national blood supply. Acute normovolaemic haemodilution at all ages and intra-operative and postoperative red cell salvage in older children are additional means of limiting allogeneic exposure. In general, it is recommended that blood conservation measures are used in combination. Nevertheless, we should not lose sight of the fact that a high proportion of children requiring blood transfusion do not qualify for autologous transfusion and unrealistic fears of transfusion

transmitted infection should not prevent the administration of necessary allogeneic blood transfusion.

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