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Blood Transfusion — A review of the Literature.

Patel* K.F. , M.B.B.S., D.A., F.F.A.R.C.S. (England)

and Angole+ Y.E. , M.B., Ch.B. (E.A.) D.A., F.F.A.R.C.S. (England)

Department of Anaesthesia, University Teaching Hospital, Lusaka, Zambia.

*Senior Registrar +Consultant

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SUMMARY

The dangers of using whole blood and its disadvantages are pointed out and the place of crystalloid or colloid transfusion as an adjuvant or substitute is discussed. The use of blood fractions for treatment of anaemias and clotting disorders is stressed. This means a reduction in amount of blood used for transfusion and hence reduction in cost and morbidity due to blood transfusion.

INTRODUCTION

The discovery of the blood groups,[1] and the outbreak of the first world war led to increased knowledge about blood transfusion and its greater use with beneficial results. The establishment of blood banks increased its use even more extensively and the use of voluntary blood donors even further.

In recent years, the increase in knowledge of blood transfusion, its unfavourable side effects and the resultant morbidity has led to a rationalisation of its use. This is a matter of even greater importance in developing countries, where blood is scarce and lack of proper banking facilities compromises the situation even further. In addition diseases such as malaria, syphilis and hepatitis are endemic. Further the cost of blood is often prohibitive. This has been estimated in one instance to be as much as K20 (£15.60) for 500ml. (Hussein 1977)[2]

Stored blood has other hazards such as low ionisable calcium, low temperature, increased viscosity, high potassium level and low acidity. The pulmonary microembolism due to small clots in the blood can prove fatal.

Indications for blood transfusion.

There are three categories:

1. To replace blood volume and increase the oxygen carrying capacity for example in haemorrhagic shock or operative losses.
2. Correction of anaemias.
3. Correction of bleeding and clotting disorders.

1. Volume expansion in shock "Blood for blood loss" is a widely held view and rigidly practised, often the first fluid infused into a shocked patient is whole blood. This is often done after a casual infusion of 500ml of saline or dextrose solution. Blood transfusion in shocked patients or during operation is used to maintain normal blood volume, and hence the cardiac output and perfusion of vital organs. Thus the initial use of blood is as a volume expander. The degree of shock is related to the blood volume rather than the reduced oxygen carrying capacity. Hypovolaemia is the important factor contributing to the ill effects of shock.

The blood volume is dependent on functional extracellular fluid volume (F.E.C.F.V.). Extracellular fluid is 45% of the body weight, of this 20% is the interstitial lymphwater. The plasma water and interstitial lymph water are but a single body compartment separated by a membrane and the movement of water across the capillary vasculature is regulated by the fact that a fixed partition ratio must be maintained between these spaces. Thus interstitial lymph fluid acts as a reservoir from which water and sodium can be mobilised into circulation or which will accept large amounts of water and sodium when circumstances favour extravascular filtration (Scurr and Fieldman 1970)[3].

Studies in man during haemorrhagic shock showed appreciable loss in extracellular fluid (E.C.F.).[4] Shires et al (1964)[5] showed that depletion of extracellular fluid was directly related to the blood loss. Thus any regime used to increase the blood volume must also take into consideration the extracellular fluid space.

Dogs given shed blood and ringer lactate solution showed a higher survival rate (Shires 1964)[5]. This was attributed to the alleviation of the depleted extracellular fluid. Plasma and blood alone was not effective in reducing the mortality in dogs. Administration of large amounts of isotonic sodium lactate solution resulted in the restoration of extracellular fluid to normal in man. The buffering effect of lactate is beneficial. In addition to the haemodilution so produced, it reduces the intravascular sludging and sequestration of erythrocytes which occur in microcirculation during shock. A high urine output is maintained.

The distribution of infused crystalloids between plasma and interstitial fluid space (IFS) means that the volaemic needs of the patient are higher than the losses. The crystalloid solutions are distributed within

minutes in the ratio of four litres to extracellular fluid space to one litre of plasma volume. (Moss 1969)[6]. He showed that even after eightfold infusion of crystalloid solution in haemorrhage, the hypovolaemia persisted but physiologically the cardiovascular state was stable. Splenectomised dogs survived a 75% haemorrhage if adequate volume of electrolyte solution were used for replacement. The ratio of electrolytes to blood varied from 5:1 for 36% haemorrhage to 8:1 for 75% haemorrhage.

Volume of ringer lactate equivalent to twice the blood loss may be administered instead of blood for haemorrhage involving 50% of the blood volume during operation (Boba, 1966).[7]

Patients suffering from major gastro-intestinal bleeding have been successfully treated with infusion of large amounts of crystalloids, with low mortality and incidence of complications, such as phlebitis and serum hepatitis. The postoperative course was shown to be superior when crystalloids have been used instead of blood as a sole replacement of fluid.[8,9]

The haemodilution produced as a result of transfusion of cystalloids has two fold effects:

1. Dilution of Plasma Proteins

Plasma proteins are mobilised in response to dilution and eventually find their way into the intravascular compartment. The haemodilution does not lead to gross oedema, irrespective of the very low absolute values observed for plasma proteins. The reason, for this are not clear, although protein dilution is not synonymous with tissue oedema. No significant deficit of albumin occurs as the reserves are high and the regenerative capacity in healthy adults is high – 16G per day. (Schorr and Marx 1970)[10]

2. Progressive fall in red cell content.

A progressive fall in the haematocrit value occurs in patients receiving cystalloids as opposed to blood for replacement. The lowest haematocrit level compatible with survival is difficult to define because many variables are involved.

Haemoglobin level of 4gm% corresponding to haematocrit of 9 is considered adequate for survival, provided the circulation is adequate.

Oxygen available to the body depends on cardiac output, haemoglobin and oxygen saturation and partial pressure. Thus in a normal adult with cardiac output of 5 litre per minute and 15G of haemoglobin, oxygen available will be 1L per minute. Available oxygen equals product of cardiac output x(Hbx 1.34 x saturation . x PO_2) X10. If all the other factors are kept constant and the haemoglobin is allowed to fall to say 5G, the body will have available about 330mls of oxygen per minute. This is well within the oxygen consumption in a healthy adult which is 200 to 250 ml per minute.

Thus the loss of volume from the intravascular compartment is of far more importance than the loss of haemoglobin alone. Furthermore in stored blood the oxygen dissociation curve is shifted to the left due to depleted 2, 3 diphosphoglycerate and hence is not a good supplier of oxygen to the tissues (Valtis Kennedy 1954).[11] Clinical observations confirm the fact that the replacement of lost blood with blood and crystolloid solution in amount such that the volume infused is in excess of measured loss affords a larger measure of protection against untoward circulatory or renal responses to surgical trauma.[5,12] The peripheral circulation is better maintained and improved when crystalloids are used instead of whole blood.[13] Loss of available functional sodium from the extracellular and intracellular fluids is an important factor associated with loss of plasma volume, hypotension and oliguria.

A deficit of 1milli equivalent of sodium is associated with a decrease in plasma volume of 4.2%. It is therefore important to provide sodium ions when giving crystalloids for replacements. Infusion of balanced salt solution improves the oliguria and also the haemodynamic state of the patients.[14] Sodium rich oedema fluid is found in the lung during shock. Infusion of red cells and salt solution is associated with the disappearance of the lung oedema. The use of blood alone or blood with albumin showed residual abnormalities.[15]

B. Colloids as Volume Expanders.

Plasma is a preferred volume expander where hypofibrinognaemia is apt to develop. Use of plasma is not free of dangers of transmission of viral hepatitis and hyperkalaemia. It is also expensive. The advantage of plasma is that it can be stored for a long time in the dried form and can be transported easily.

Several other colloid solutions are available such as dextrans and haemaccele. They are useful as plasma expanders in emergency situations but they are expensive and are not always available.

Care must be taken with the use of dextran, particularly the ones with higher molecular weight, as they can cause renal damage in dehydrated patients. Haemaccele does not have these disadvantages. Plasma substitutes cause no homologous serum jaundice and are preferred to plasma.

Recommendations

From the foregoing discussion a case can be made for the use of balanced salt solutions instead of or in conjunction with blood for restoration of blood volume. The dangers of blood transfusion are well known. No morbidity and mortality figures are available for developing countries and death is often attributed to shock. Gubber (1970)[16] states that 2% of preserved blood is bacterially contaminated and haemolytic reactions are increasing due to iso-immuni-

sation of recipients. The transmission of viral hepatitis is a well known danger and the incidence of this is about 10% while the non-icteric form is at least four times as common as the icteric form.

Autotransfusion is gaining popularity in several countries but it must be used with caution. Pathak and Stewart (1970)[17] pointed out that in about 40% of their patients the blood collected from the peritoneal cavity was unusuable for autotransfusion. The practice of autotransfusion must not be taken lightly and blood should be examined for evidence of haemolysis and bacterial contamination. Crytalloids used should be balanced salt solution such as Ringer's lactate which provide enough sodium for the needs of the patient. Ringer's lactate can be used to replace blood loss more than 1 litre during surgical procedure without increased mortality or morbidity of the patients.

In the majority of patients receiving massive infusion no adverse effects occur but Vietnam casualties treated with massive crystalloids solution showed a mortality of 50% if pulmonary oedema developed.[19] The monitoring of central venous pressure is of great importance in preventing overtransfusion and development of pulmonary oedema. The volume of fluids infused should be regulated by careful clinical observation, monitoring blood pressure, pulse and central venous pressure. The danger of overtransfusion with crystalloids should always be kept in mind.

2. Increasing Oxygen Carrying Capacity.

An arbitrary figure of 10G% haemoglobin is taken as the lower limit in patients for routine operations. This figure has no meaning in certain countries where haemoglobin levels of the general populace is low. Lower levels must be accepted as normal in these population. As the aim of transfusion in anaemia is to increase the red cell mass, the packed cell must be used in these cases. This is less likely to lead to congestive cardiac failure (CCF) and also the plasma thus saved can be used for other purposes.

There is no advantage of increasing the haemoglobin levels of patients to an arbitrary level, with blood transfusion a day before operation and this practice must be criticised. Alternative preparation of the patient with oral or total dose infusion of iron will preclude the use of blood routinely. Similarly postoperative hypochromic anaemia should be corrected with proper nutrition and iron therapy.

A rise in haemoglobin level at an average rate of 0.17% per day, occasionally as high as 0.25G% per day – 0.25G% on oral iron therapy can be expected.

Parentally administered doses of iron cause a rise in haemoglobin as high as 0.26G% per day [21,22] Haemoglobin values in Zambians average 15.2G% range 13.1 to 16.6G% in the male and 13.1G% range 11 to 15.2G% in the female[23].

3. Correction of clotting factors.

The deficiencies of certain clotting factors can be corrected by use of plasma fraction. The use of whole blood for treatment of haemophilia is wasteful and cryoprecipitates where available or plasma should be used.

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