EQUINE VETERINARY EDUCATION
Equine vet. Educ. (1996) **8** (1) 8-12

Satellite Article

Blood and plasma transfusion in the horse

A. E. DURHAM
The Equine Veterinary Hospital, Forest Mere, Liphook, Hampshire GU30 7JG, UK.

Introduction

Blood and plasma transfusions are procedures which, although uncommonly employed, have important applications in the therapeutic and prophylactic management of conditions encountered in equine practice. **The techniques are not difficult, expensive specialised equipment is not necessary and the appropriate use of transfusion can be a major factor in the survival of potentially fatal cases.**

Immunohaematology and donor selection

An ideal blood donor (**Table 1**) will yield an adequate quantity of blood to have a beneficial influence on the condition of the recipient, without significant risk of harm to the donor or the recipient. The donor should be free from infectious blood borne agents (e.g. equine infectious anaemia virus, *Babesia* spp) and should have normal erythrocyte indices and plasma protein concentrations. Immunological considerations of blood transfusion are broadly divisible into the possible existence of anti-erythrocyte antibodies in donor and/or recipient blood and antigenic differences between donor and recipient blood.

Naturally occurring anti-erythrocyte antibodies are found in some horses in the absence of known prior exposure to foreign erythrocytes but have weak, if any, haemolytic activity and are unlikely to pose a clinical problem (Suzuki *et al.* 1975). Previously sensitised individuals, however, are more likely to be carrying pathogenic anti-erythrocyte antibodies. Therefore horses with a history of pregnancy, parturition or transfusion should be avoided as blood donors and are potentially high risk recipients. **There are particular risks when horses lacking the Aa erythrocyte antigen (Aa^-) are carrying anti-Aa antibodies which are highly pathogenic to individuals possessing the Aa erythrocyte antigen (Aa^+).** Nevertheless, a single blood transfusion between 2 previously unsensitised individuals is unlikely to present immunological problems and is generally considered to be safe (Morris 1989). The safety of subsequent transfusions between the same donor and recipient depends upon antigenic differences between their respective erythrocytes.

With more than 30 different equine erythrocyte antigens, which may occur in several hundred thousand different combinations (Stormont 1982), it is extremely improbable that a donor and recipient would be selected with identical erythrocyte phenotypes. In practice this is usually unimportant as the majority of equine erythrocyte antigens are only weakly immunogenic and multiple transfusions are required to raise significant antibody titres against them (Hata and Sonoda 1974; Wong *et al.* 1986). **The important exception to this concerns the Aa erythrocyte antigen, where highly haemolytic antibodies may appear as early as a few days following a single transfusion of Aa^+ blood into an Aa^- horse** (Hata and Sonoda 1974; Wong *et al.* 1986). However, even in this worst case scenario of Aa incompatibility, repeated transfusions within a few days of the first are unlikely to be a problem. In many situations it may not be practical to determine the Aa phenotype of donors and recipients, but in cases where blood typing records are available (e.g. many Thoroughbreds, Shire horses etc), the information may be made available from data held at various laboratories, such as, the Animal Health Trust (Newmarket, Suffolk, UK) enabling matching of Aa phenotypes of donor and recipient.

Donor selection for the treatment of haemolysis in foals suffering from neonatal isoerythrolysis differs from other situations in that the **red cell donor of choice is the dam of the affected foal** (Scott and Jeffcott 1978). This is because one can be certain that the maternal colostrum derived anti-erythrocyte antibodies, which the foal has absorbed, will not attack transfused maternal erythrocytes but they probably would attack erythrocytes from other horses.

Cross match testing

Cross match tests aim to detect harmful pre-existing anti-

TABLE 1: Ideal characteristics of an equine blood donor (NB exception to this description is in the treatment of neonatal isoerythrolysis in which the dam of the affected foal is the donor of choice - see text) (PCV: packed cell volume)

Large body mass	- greater volumes of blood can be taken safely
Young	- history more accurately known
Healthy	- no transmissible diseases, normal PCV, serum albumin, globulin etc
Same Aa phenotype as recipient	- lower risk of severe immunological transfusion reactions
Male	- lower risk of previous sensitisation against homologous blood

erythrocyte antibodies in the plasma of donors or recipients. However, **there are problems associated with cross match tests in horses** (see also Van Heerden p 3). Firstly, the only cross match test of realistic practicality is the saline agglutination test. However, most pathogenic anti-erythrocyte antibodies in horses act more strongly as haemolysins than as haemagglutinins and transfusion reactions may occur in the absence of detectable agglutinating antibody (Hata and Sonoda 1974; Stormont 1975). **Secondly**, even when theoretically more appropriate cross match tests are used (e.g. haemolysin assay and Coombs antiglobulin tests) there are reported examples of both false negative and false positive results (Kallfelz *et al.* 1978).

Given the apparent unreliability of cross match tests in equine haematology, it would seem that a more appropriate pre-transfusion test may be the rather crude method of transfusing a small volume of donor blood (e.g. 50 ml) into the recipient and monitoring the recipient's vital signs (e.g. pulse rate, respiratory rate, rectal temperature) before proceeding further. As little as 200 ml of transfused blood has been reported to provoke a fatal transfusion reaction (Kallfelz *et al.* 1978).

Technique of blood transfusion

Collection

After selection of the donor as described above, a 12 gauge i.v. catheter is placed into the donor's jugular vein in a sterile manner and sterile collection bags containing anticoagulant are then filled by gravity (**Figs 1** and **2**). Collection of 6 l whole blood can be completed in about 30–40 min. Both of the donor's jugular veins can be catheterised and, in urgent situations, 2 collection bags filled simultaneously. It is safe to collect approximately 20–25% of the donor's blood volume (1.5–2% bwt or 6–9 litres from a Thoroughbred) at intervals of 2–4 weeks (Byars and Divers 1981).

Separation

If separation of cells and plasma is required, centrifugation or plasmapheresis are the most effective methods. Few practices can justify the cost of owning a centrifuge large enough to receive blood collection bags, but most human hospitals are willing to offer their services to separate blood although the charges for this service are often considerable.

In most practices, separation of cells and plasma is achieved by sedimentation under gravity. After collection from the donor, the blood bags should be placed with the giving-set portals uppermost in the refrigerator or ice bucket. Although reasonable sedimentation has occurred within 2 h there will still be considerable erythrocyte contamination at this time and overnight settlement would be preferable if time allows. When sedimented out, the plasma is decanted off by applying external pressure to the collection bag. In the case of 450 ml Fenwal bags, the plasma passes through a giving set with in-line filter into another Fenwal bag. The Arnold's plasma collection kit has an in-built connecting tube leading to a collection bag which facilitates the separation procedure. A homemade or purchased plasma extractor (**Fig 3**) or a board against a wall makes the application of pressure to the collection bag much easier. Following separation, if only the plasma is required then the cellular fraction can be resuspended in normal saline (calcium-containing fluids are likely to cause coagulation) and transfused back into the donor.

Storage

All blood-derived products are best used fresh although storage of most blood components is possible if desired. Erythrocytes remain viable (although significantly inferior to fresh cells) in anticoagulant containing dextrose for up to 3–4 weeks in a refrigerator. If plasma is frozen promptly following collection, clotting factors will remain stable for about 2 months and albumin and globulin for at least a year (Crawford and Perryman 1980; Cotter 1991).

Administration

The recipient's jugular vein is clipped, surgically prepared and a catheter placed i.v. in a sterile manner (mature subjects 12–16 gauge, foals 16–20 gauge). Bags containing the transfusion are connected through a giving set with in-line 170 µm filter (e.g. Aquafarm Veterinary Blood Administration Set[3]) (**Fig 4**). As a precaution against transfusion reaction, a 50 ml 'test dose' of blood/plasma should be administered as described above. If no problems are encountered then the transfusion may proceed at a rate of 10–20 ml/kg/h in mature subjects (5–10 l/h for a 500 kg bwt horse) and the recipient continuously monitored for adverse signs (e.g. tachycardia, tachypnoea, discomfort). Foals may safely receive transfusions at a faster rate of 40 ml/kg/h (1 litre in 20–30 min for a 50 kg foal), but if more than 1 litre is to be transfused into a foal then the rate should be slowed to 20 ml/kg/h for the second litre (1 litre/h for a 50 kg foal) (Morris 1981). Clearly, if ongoing losses of blood or plasma volume are occurring, then flow rates may be increased judiciously.

Indications for blood transfusion

Compatible transfused equine erythrocytes are entirely lost from the recipient's circulation within a few days of transfusion (Gimlette 1978; Kallfelz *et al.* 1978). The short-lived transfused erythrocytes may be adequate to stabilise a case of acute haemorrhage or haemolysis but would be unlikely to be of real benefit in chronically anaemic horses.

Severe haemorrhage

Up to 30–40% blood volume (e.g. 12–16 l from a 500 kg bwt horse) can be lost before shock occurs (Byars and Divers 1981). Although it may seem logical that transfusion of whole blood is indicated in cases of acute haemorrhage,

Fig 1a: *Fenwal single blood-pack unit[1] (450 ml collection bag containing citrate phosphate dextrose adenine formula 1 anticoagulant).*

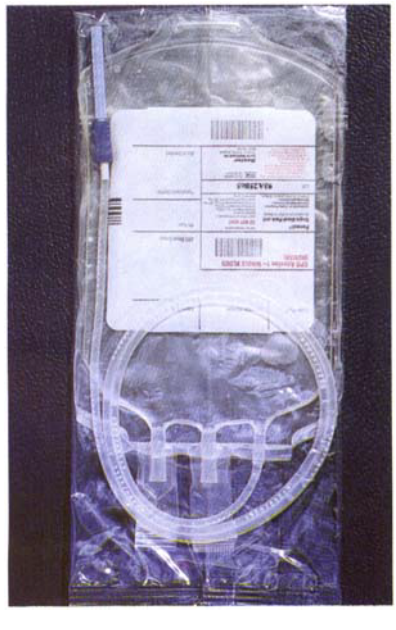

Fig 1b: *Plasma Collection Kit[2] (3 l collection bag connected to 2 l plasma transfer bag and acid citrate phosphate dextrose formula A anticoagulant).*

resuspended packed red cells may in fact be more beneficial (Cotter 1991). However, in a practical situation, where time is of the essence, then fresh whole blood is to be preferred.

Probably the most common indication for transfusion associated with severe blood loss in equine practice is the intra-operative transfusion of

Fig 2: *Collection of blood from a young gelding using Arnold's Plasma Collection Kit.*

Fig 3: *Homemade plasma extractor to apply pressure to collection bag containing separated blood.*

Fig 4: *Mare suffering from autoimmune haemolytic anaemia receiving a transfusion of resuspended packed red cells.*

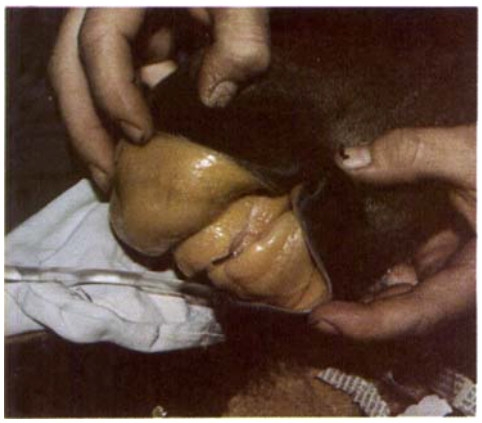

Fig 5: Icteric oral mucosae in a foal suffering from neonatal isoerythrolysis.

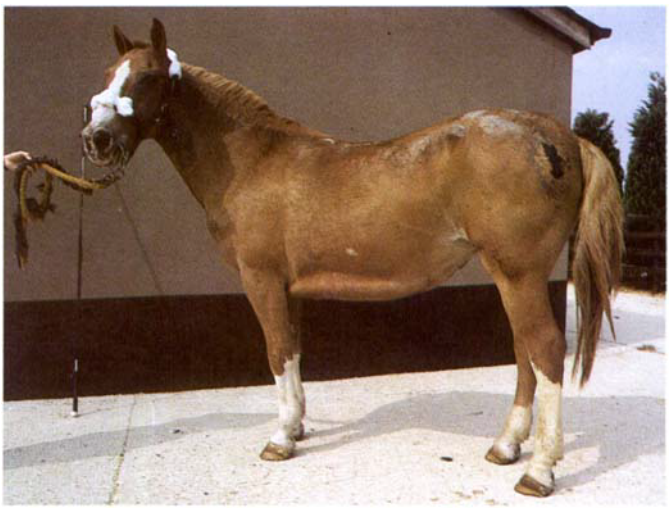

Fig 6: Ventral oedema in a hypoalbuminaemic horse subsequent to severe thermal burns.

horses subject to sinus surgery (e.g. progressive ethmoidal haematoma). The blood loss is predictable and transfusions can be prepared in advance of the surgery (either autologous blood taken a few weeks previously or homologous blood taken shortly before surgery).

It is a matter of careful clinical judgement whether or not transfusion of an actively haemorrhaging conscious horse (e.g. guttural pouch mycosis or post partum uterine haemorrhage) is genuinely beneficial. The excitement and stress of the procedure may potentiate the haemorrhage and, furthermore, the rate of blood loss may be considerably greater than practical flow rates of transfusion. Therefore attempts to administer the transfusion may sometimes be at best ineffectual and, at worst, positively harmful. Leaving the horse alone in a dark quiet box may be preferable in many circumstances.

Haemolysis

When dealing with most haemolytic diseases (e.g. autoimmune haemolytic anaemia, babesiosis (see Van Heerden p 3), toxic haemolysis) the cell-rich bottom half of a sedimented blood bag can be transfused into the recipient after resuspending in saline. Plasma is unneccesary and whole blood transfusion is not, therefore, indicated.

In cases of neonatal isoerythrolysis (**Fig 5**), maternal erythrocytes must be repeatedly resuspended (3 or 4 times) in normal saline to remove all traces of plasma. This 'washing' procedure is a difficult and time consuming task without the use of a centrifuge and arrangements with a local hospital should, therefore, be made and the costs discussed fully with the owner.

Hypoalbuminaemia

Hypoalbuminaemic horses commonly present with signs of diarrhoea, subcutaneous oedema and/or pleural/peritoneal effusions (**Fig 6**). Albumin provides a large percentage of the plasma oncotic pressure and isotonic fluid therapy in hypoalbuminaemic subjects tends, therefore, only to potentiate oedema, diarrhoea or effusion. There can be dramatic clinical responses to plasma transfusion as long as the underlying cause of protein loss is under control and large volumes of plasma are available (6 litres plasma transfusion would be the minimal requirement for an hypoalbuminaemic horse). The main indications for albumin transfusions in practice include some cases of protein losing enteropathy (e.g. acute larval cyathostomiasis) and high protein effusions (e.g. pleuropneumonia).

There is usually a rather disappointing rise (and sometimes even a fall) in plasma albumin concentrations following plasma transfusion of hypoalbuminaemic horses. This is due partly to possible ongoing losses and also because over half of the transfused albumin will exit the vasculature to replace depleted interstitial albumin (Cotter 1991). Following a transfusion of 6 litres plasma into a hypoalbuminaemic horse, it would be unusual to raise the recipient's plasma albumin concentration by more than 1 or 2 g/l. Nevertheless, in many cases there is a dramatic clinical response, despite little or no improvement in plasma albumin.

Hypogammaglobulinaemia

Probably the main use of transfusion in practice is prophylaxis of foals for failure of transfer of passive immunity. This is a very common occurrence with perhaps around a third of foals having plasma immunoglobulin G concentrations of less than 8 g/l (Stoneham *et al.* 1991). Recognition of the condition by routine blood testing of foals and prophylactic transfusion may prevent costly and frequently fatal sequelae such as septicaemia and infectious arthritis. Equine plasma separated by apheresis is commercially available for this purpose in situations where practitioners do not wish to prepare plasma transfusions themselves (e.g. Polymune[4]).

Transfusion reactions

Transfusion reactions are very rare events which may be caused by nonimmunological as well as immunological factors (**Table 2**). Clinical signs (**Table 3**)

TABLE 2: Potential causes of transfusion reactions in horses

Immunological causes of transfusion reactions	Nonimmunological causes of transfusion reactions
erythrocyte antigens	volume overload (rapid administration)
leucocyte antigens	hypocalcaemia (excess citrate)
platelet antigens	hyperkalaemia (stored blood)
histocompatibility antigens	infection (from donor or poor technique)
plasma protein isotypes	haemolysed blood (poor technique)
immunosuppression	microaggregates (stored blood)

may develop early on during the transfusion or may appear a few hours or days later (Hata and Sonoda 1974; Cotter 1991). The signs may imply the cause of the reaction and, therefore, the appropriate treatment. It is good practice to have drugs and their dose rates readily available in case of transfusion reaction. Cases of massive acute haemolysis or anaphylactic shock may benefit from rapid infusion of isotonic or hypertonic saline along with adrenaline (4 or 5 ml 1:1000 solution sub. cut., i.m.) and corticosteroids (e.g. dexamethasone 0.05–0.1 mg/kg bwt i.v.). Less severe reactions showing signs of discomfort or colic may respond to analgesics (e.g. phenylbutazone 2.2–4.4 mg/kg bwt i.v.) and corticosteroids (e.g. dexamethasone 0.05 mg/kg bwt i.m. or i.v.) as will mild immunological reactions manifesting as urticaria or pyrexia. Volume overload may cause pulmonary oedema manifesting as dyspnoea and moist lung sounds and requires cessation of the transfusion and possibly diuretics (e.g. frusemide 1 mg/kg bwt i.v.) and intranasal oxygen (15 l/min).

Conclusion

Blood and plasma transfusions are easily performed in practice. In addition to the beneficial effects of replenishment of erythrocytes, leucocytes, platelets, clotting factors, albumin, globulins and other more minor components, transfusions are potentially harmful requiring careful selection of donors and good technique to minimise the risks of adverse reactions.

Manufacturers addresses

[1]Baxter Healthcare, Thetford, Norfolk, UK.
[2]Arnold's Veterinary Products, Shrewsbury, Shropshire, UK.
[3]Animalcare Ltd, Dunnington, York, UK.
[4]Veterinary Dynamics Ltd, Penrith, Cumbria, UK.

TABLE 3: Clinical signs of transfusion reactions

Tachypnoea	Cardiac arrhythmias
Tachycardia	Pyrexia
Collapse	Urticaria
Dyspnoea	Pruritus
Colic	Icterus
Defaecation/urination	Haemoglobinuria

References

Byars, T.D. and Divers, T.J. (1981) Clinical use of blood transfusions. *Calif. Vet.* **1**, 14-16.

Cotter, S.M. (1991) Clinical transfusion medicine. *Adv. vet. Sci. comp. Med.* **36**, 187-223.

Crawford, T.B. and Perryman, L.E. (1980) Diagnosis and treatment of failure of passive transfer in the foal. *Equine Pract.* **2**, 17-23.

Gimlette, T.M.D. (1978) Transfusion of autologous and allogeneic chromium-51 labelled red cells in ponies. *J. Roy. Soc. Med.* **71**, 576-581.

Hata, R. and Sonoda, M. (1974) Clinical and hematological observations on repeated experimental blood transfusions in horses. *Exp. Rep. Equine Hlth. Lab.* **11**, 133-151.

Kallfelz, F.A., Whitlock, R.H. and Schultz, R.D. (1978) Survival of 59Fe-labelled erythrocytes in cross transfused equine blood. *Am. J. vet. Res.* **89**, 617-620.

Morris, D.D. (1989) Review of anaemia in horses, part II: pathophysiologic mechanisms, specific diseases and treatment. *Equine Pract.* **11**, 34-46.

Morris, P. (1981) Blood transfusions. *Proc. Am. Ass. equine Practnrs.* **27**, 331-338.

Scott, A.M. and Jeffcott, L.B. (1978) Haemolytic disease of the newborn foal. *Vet. Rec.* **103**, 71-74.

Stoneham, S.J., Wingfield Digby, N.J. and Ricketts, S.W. (1991) Failure of passive transfer of colostral immunity in the foal: incidence, and the effect of stud management and plasma transfusions. *Vet. Rec.* **128**, 416-419.

Stormont, C.J. (1975) Neonatal isoerythrolysis in domestic animals: a comparative review. *Adv. vet. Sci. comp. Med.* **19**, 23-45.

Stormont, C.J. (1982) Blood groups in animals. *J. Am. vet. med. Ass.* **181**, 1120-1124.

Suzuki, Y., Stormont, C. and Trommerhausen-Smith, A. (1975) Alloantibodies: the blood groups they define. In: *Proceedings of the 1st International Symposium on Equine Haematology.* Eds: H. Kitchen and J.D. Krehbiel. American Association of Equine Practitioners. pp 34-41.

Van Heerden, J. (1996) Equine babesiosis in South Africa: a report of two cases. *Equine vet. Educ.* **8**, 3-5.

Wong, P.L., Nickel, L.S., Bowling, A.T. and Steffey, E.P. (1986) Clinical survey of antibodies against red blood cells in horses after homologous blood transfusion. *Am. J. vet. Res.* **47**, 2566-2571.