How to Approach Whole Blood Transfusions in Horses

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The collection process of whole blood has become more streamlined today than in the past. The availability of the high flow blood collection set and administration set has made it easier for the practitioner to administer whole blood transfusions in an emergency situation. Authors' address: Hagyard-Davidson-Mcgee Associates, P.S.C. 4250 Iron Works Pike, Lexington, KY 40511. © 2001 AAEP.

1. Introduction

Whole blood transfusions are indicated when there are concomitant deficits of oxygen-carrying capacity, blood volume, and coagulation factors. Compensatory mechanisms for augmenting oxygen delivery to tissues allow patients to tolerate modest degrees of anemia. These mechanisms include increasing cardiac output by raising stroke volume or heart rate; redistributing blood to areas requiring more oxygen; enhancing oxygen extractions by tissues; and increasing coronary artery blood flow, ventilatory volume, and respiratory rates.

In the absence of cardiopulmonary dysfunction, otherwise healthy patients usually do not have signs or symptoms of anemia at rest when the hemoglobin concentration is greater than 7–8 g/dl. However, dyspnea on exertion occurred at this level. Weakness occurs at a hemoglobin of 6 g/dl, dyspnea at rest occurs when the hemoglobin concentration falls to 3 g/dl, and the risk of heart failure is significant when the hemoglobin is less than 2.5 g/dl. The objective of whole blood transfusion is to help improve the oxygen delivery to the tissues during anemia; however, it is only considered a temporary lifesaving procedure that should be used only as needed. The majority of transfused erythrocytes remain in the circulation for an average of 5 days (after cross-match), which is why the bone marrow response to the anemic crisis is very important to the overall recovery. The short life span of transfused cells is likely due to minor antigenic incompatibilities that could have been detected if blood-typing of the donor and recipient had been performed. Over 30 different erythrocyte antigens (alloantigens) constituting seven blood groups have been identified in horses, accounting for more than 400,000 phenotypes. The possibility of identifying a completely compatible recipient is nearly impossible, but cross matching can help prevent severe transfusion reactions. Following first exposure to foreign alloantigens, antibodies are produced within 5 to 7 days. Repeated exposure to the same alloantigens results in a rapid anamnestic response with erythrocyte destruction.

An important decision in the management of anemia, blood loss, and coagulopathies in the patient is determining whether a blood transfusion is indicated. Blood transfusions should be considered in patients with a packed cell volume (PCV) < 12% and...
who are considered unstable; hemoglobin concentrations less than 8 g/dl, acute loss of 30–40% of the blood volume, and blood loss is associated with collapse or ongoing hemorrhage is present.1,4–6

2. Materials and Methods

Donors

Typing and crossmatching a blood sample helps confirm which antigens appear on the patient’s red blood cells. All horses kept specifically as donors should have blood types performed. Alloantigens Aa of the A system and Qa of the Q system are the most immunogenic of the equine alloantigens and are highly prevalent among light breed horses. Transfusion of blood from a donor positive with these alloantigens will result in the development of a high alloantibody titer in the recipient that can cause severe hemolysis upon subsequent exposure. Donors lacking those alloantigens are considered safe blood donors. Suitable donors can be found among Standardbreds and Quarter Horses since both breeds have a low prevalence of Aa, and Standardbreds rarely possess Qa.

Crossmatching should be performed before any blood transfusion administration. Crossmatch stimulates, in vitro, the response of a recipient to a transfusion of a type specific donor red cells plus some donor plasma. The full crossmatch consists of a major and minor part. The major part is the crossmatching of donor red cells with the recipient serum (plasma). The minor part is the crossmatching of recipient red blood cells with the donor serum (or plasma). Incompatibilities are seen either as agglutinations or hemolysins only noted after the addition of exogenous complement to the reaction mixture. If an immediate transfusion is needed to sustain life, then administer without delay. Initial transfusions rarely are associated with adverse reactions because horses infrequently produce strongly reactive natural erythrocyte alloantibodies.

Hagyard-Davidson-McGee Internal Medicine Department houses and owns 7 blood donors; 2 that are considered universal donors (Aa and Qa negative). Access to a third universal donor and 6 additional blood donors are made available by previous arrangements with owners of these horses. All the donors are blood-typed and up-to-date with the following vaccinations of rhinopneumonitis, tetanus toxoid, eastern and western encephalitis, botulism toxoid, and rabies toxoid. They are also tested annually for EIA and EVA.

We use geldings rather than mares because of the possibility that the mares obtained may have had a subsequent pregnancy and therefore increase the likelihood of having more erythrocyte alloantibodies.

Blood Collection

Once the decision has been made to collect whole blood, preparation of supplies is done before the donor is brought up and placed into the stocks or stall. The materials that we use at our clinic consists of a 500-ml (with ACD)9 or 2-l evacuated glass containerb (Fig. 1), 500-ml Bag Acid-Citrate-Dextrose,c blood collection set, high flow blood collection setd (Fig. 2), high flow fluid/blood delivery set, e or normal blood delivery set.

To prepare the bottle for collection we use a blood collection set to add ACD to the 2-l bottle to provide a ratio of 1:9 with blood (add 200 ml ACD per 2000 ml bottle). Remove the metal top on the bottle and save. Place the short, wide bore needle of the collection set into the ACD bag, and the long, narrow bore needle into the bottle gently. Be very careful—only puncture the bottle once, and do not lose the vacuum in the bottle. Fill with the appropriate amount of ACD, remove needle from vacuum bottle first, replace the metal cap on top of the bottle, and rock the bottle to coat the entire inside with ACD solution.

Either a 10-gauge catheter or 14-gauge needle is then inserted into the jugular vein. The high flow blood collection set’s swivel luer lock is then secured on to either the catheter or needle, when the blood
reaches the end of the collection set the collection spike is inserted where the ACD was added to prevent loss of the vacuum. Continue to hold off the vein during the entire process. Gently rock the bottle continuously and completely during the collection process. Do not shake (this can destroy red blood cells). We collect a maximum of 15–18 ml kg body weight of blood at one time with no adverse effects noted with our donors.

Amount of Blood to Transfuse
The blood deficit can be approximately estimated by the following formula (assuming normal blood volume is at 8%).

\[ \text{Liters of blood lost} = \frac{(\text{normal PCV} - \text{patient PCV})/\text{normal PCV} \times (0.08 \times \text{patient weight in kg})}{0.08 \times \text{patient weight in kg}} \]

Another method of estimating the amount of blood required for transfusion is provided by the crude formula that assumes a PCV of 40% for the donor animal:

2.2 ml of whole blood/kg body weight

will increase the PCV by 1%

Replacing 30–40% of the calculated blood loss is sufficient to maintain life until the bone marrow can respond.\(^2\)

Sample Calculation
A 500-kg Thoroughbred broodmare with uterine hemorrhage and a PCV of 10%.

Liters of blood lost

\[ = \frac{(35 - 10)}{35} \times (0.08 \times 500 \text{ kg}) \]

\[ = 25/35 \times 40 \]

\[ = 28.5 \text{ liters} \]

We typically would like to replace 30–40% of the calculated blood loss

\[ 28.5 \text{ L} \times 0.30 = 8.5 \text{ liters of whole blood} \]

A 600-kg blood donor could provide this volume of blood without complications.

Transfusion Technique
The speed of whole blood administration is patient-based. If immediate transfusion is needed, then we use the high flow fluid/blood delivery set to administer the blood. The high flow administration set has a port with a filter that allows one the capability to attach a pressure bulb to aid in the pressurization of the bottle for rapid delivery (Fig. 3). We have been able to administer 8 l as fast as 40 min. The high flow administration set has a 0.22 μm in-line filter to remove fibrin and debris. If administration of blood is not needed immediately then we proceed at an initial drip rate of 0.1 ml/kg body weight for the first 10 min using the standard blood delivery sets. Vital signs and temperature fluctuation are monitored every 2 min. If temperature and vital signs do not change then the transfusion is continued at a rate of 20–30 ml/kg/hr. The recipient is monitored continuously during the transfusion and the transfusion stopped if the recipient has any change in vital signs.

Fig. 3. The use of the high flow blood administration set. Note the pressure bulb attached to the filter port to allow pressurization of the bottle.
Potential Complications

Anaphylactic reactions occur more commonly and are more severe when repeated transfusions from one donor are given more than 1 week after the initial transfusion. Sensitization to the blood of a particular donor may persist for more than 1 year. Intravenous epinephrine 1:1000 5 ml/500 kg horse given SQ or IM and solu-delta-cortef 0.5–1 mg/kg of weight are available during every blood transfusion.

3. Results

We have treated over 20 severe blood loss cases over the past year with the use of the high flow blood collection set and the high flow fluid/blood delivery set without complications. One mare received a total of 30 l of blood over a 5-day period for her post foaling uterine hemorrhage. We have not seen any adverse affects of rapid removal of whole blood from any of our donors. We typically do not administer crystalloid fluids to our donors unless more than 10 l of whole blood is collected. We feel that the use of the high flow delivery set has saved the lives of many patients.

4. Discussion

The collection process of whole blood has become more streamlined today than in the past. Keeping at least 1–2 donors available and in close proximity saves time. Once the decision has been made to administer whole blood to a patient, the donor is selected from a list kept up-to-date with past whole-blood collections, the amount drawn from the donor, and date collected. In the past, blood collection of 8 l could take up to 1.5 h or more to complete with a standard blood collection set. With the high flow blood collection set that same process takes only 20 min. The donors tolerate this process well and usually are not sedated. After collection, they are placed in a stall for a few hours and fed hay and grain for a short rest period before being turned back out again.

The rapid administration of whole blood is still controversial. We feel that the benefits of rapid transfusion outweigh the potential complications when one is dealing with an active hemorrhaging animal. We have not noted any signs of transfusion reactions in any of the horses that were exhibiting active hemorrhage when administered the whole blood transfusion rapidly. We do not recommend the use of rapid transfusions to an animal that is not associated with ongoing hemorrhage and acute loss of blood volume. It must be understood that the glass bottles containing ACD inactivates platelets almost immediately. Therefore, if one were considering a whole blood transfusion for a thrombocytopenic animal it would be recommended to collect the whole blood into plastic bags using ACD.

References and Footnotes


*aMetrix Company, Dubuque, IA 52002.
*bBaxter Health Care Corporation, Deerfield, IL 60015 Code # 1A8506.
*cBaxter Anticoagulant Citrate Dextrose Solution USP (ACD), Formula B, Baxter Health Care Corporation, Deerfield, IL 60015 Code # 487899.
*dMila International Inc., 7604 Dixie Hwy., Florence, KY 41042. Order # 175484 1-888-MILA-INT.
*eMila International Inc., 7604 Dixie Hwy., Florence, KY 41042. Order # 175484 1-888-MILA-INT.