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DOI: 10.1080/17415349.2021.1877585

Blood: from donation to transfusion

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ABSTRACT: Blood transfusions are becoming increasingly common in veterinary medicine and veterinary nurses play an important role in administering blood products to patients, who often present as emergency patients and can be in a critical condition. Canine blood donors are needed in order for this life-saving treatment to be possible. This article describes the progression for performing a canine blood transfusion including obtaining a suitable donor, blood collection, processing, storage and transfusion to recipients.

Keywords : transfusion; blood donation; plasma; emergency; critical care

Introduction

At the Queen Mother Hospital for Animals, (the small animal referral hospital for the Royal Veterinary College (RVC)), the Animal Care Trust (ACT) have helped to fund the non-profit Transfusion Medicine Service (TMS). This has included the purchase of a refrigerated blood centrifuge, blood refrigerator, plasma warmer, tube welder and tube sealer. These generous contributions have allowed Transfusion Medicine Service to expand and develop the component therapy it provides, which is invaluable to the patients treated by the Emergency and Critical Care (ECC), Soft Tissue Surgery, Orthopaedics, Internal Medicine and Oncology teams. In 2019, 842 canine transfusions were carried out at the RVC. This breaks down into 365 packed red blood cell (pRBC) transfusions, 304 plasma transfusions and 88 whole blood (WB) transfusions.

Blood donation

Canine blood donors are recruited from volunteer owners and must meet the following criteria (Figure 1):

- Aged between 1 and 8 years old
- Weigh over 15kg
- Be clinically healthy
- Not be on any medications or have had a recent anaesthetic
- Up-to-date on vaccinations as well as regularly receiving veterinary approved parasite control
- Not received a blood transfusion themselves
- Have a relaxed demeanour
- Not to have travelled outside the UK (Republic of Ireland is accepted).

Before each donation it is important to ensure each dog is fit to donate. Owners are required to fill out a short questionnaire, a veterinary surgeon carries out a physical examination and the dog's weight, heart rate, respiratory rate and axilla temperature are taken as described by Yagi and Bean (2016). Rectal temperatures can be distressing for some animals and therefore would hinder the stress free environment needed for a successful blood donation.

A pre-donation haemoglobin (Hb) check is carried out at each appointment. This blood sample is taken from the saphenous vein as it requires minimal restraint thereby minimising stress for the donor prior to the donation. Measurement is carried out using a Hemocue®, a haemoglobin point-of-care machine (Figure 2) or a manual PCV measurement. In order to give a blood donation, a Hb above 135 g/l or a manual packed cell volume (PCV) above 40% are considered appropriate (King & Boag, 2018).

On the donor's first visit, haematology, biochemistry and screening for babesiosis and bartonellosis are carried out and these are performed annually if the dog continues to donate. Infectious diseases are screened depending on the area the donor is from (Wardrop et al., 2016).

Jugular veins are used for the blood donation itself. The right and left veins are alternated at each donation. An area of approximately 5–10 cm^2 over the jugular is clipped and a prilocaine/lidocaine combination local anaesthetic cream (EMLA, AstraZeneca, UK) is applied at least 20–30 minutes prior to donation.

Figure 1. Canine blood donor.

Figure 2. Hemocue® – haemoglobin point-of-care machine used to check the blood donors haemoglobin levels prior to donation.

A collection bag is chosen based on bodyweight of the donor. A 250 ml bag is used for dogs weighing between 15 and 24 kg and a 450 ml for dogs over 25 kg. A multi-bag system is used so that both the collection and processing are closed to reduce the risk of bacterial contamination.

The collection bag contains an anticoagulant such as citrate-phosphate-dextrose (CPD). It is placed in a vacuum chamber on weighing scales and attached to a suction machine.

A calculation of how much blood the dog can donate in grams can be performed with the following formula:

Maximum weight of blood to be collected (g/kg) = 18 ml/kg × 1.06 g/ml

Where 1.06 g/ml corresponds to the weight of 1 ml of blood and 18 ml/kg corresponds to the maximum amount of blood that should be collected from a blood donor.

The blood to anticoagulant ratio in the bag must also be considered. If too little blood is collected, this can lead to excessive citrate in the blood product which could lead to citrate toxicity in the recipient. If too much blood is collected in the bag, there is a higher risk of it clotting and the donation may not be able to be used (Vieira et al., 2009). The correct volume of blood for a collection bag to provide the appropriate anticoagulant:blood is always on the label.

Once the local anaesthetic cream has been on for the required time, the dog is gently restrained in lateral recumbency, on the table. Owners are present throughout the donation to keep the dog calm as they are not sedated. It has now been stated by the Veterinary Medicines Directorate that dogs must not be sedated for blood donation unless for immediate use (King & Boag, 2018).

The neck is slightly extended, and forelimbs pulled caudally to expose the jugular vein. The veterinary nurse washes their hands and then prepares the skin. The venepuncture site is aseptically prepared using chlorhexidine gluconate (ChloraPrep; BD, UK) prior to venepuncture.

Once the needle enters the vein, blood begins to travel down the collection bag tubing, and then the suction machine can be turned on.

Once the desired volume is collected, the suction is turned off, the tubing is clamped off and then the needle is removed, and a light dressing is gently applied around the dog's neck. The full collection bag is gently rotated in order to mix the blood with the anticoagulant.

Following donation, the dog receives a bowl of food and plenty of attention as well as a bag of food to go home with to say thank you. The whole appointment lasts approximately one hour, and the dog can donate again after two months.

Processing and storage of blood

Transfusion medicine in veterinary medicine has developed so that component therapy is now more accessible. Whole blood (WB), fresh frozen plasma (FFP) and packed red blood cells (pRBCs) are the most common blood products used in veterinary medicine. It allows recipients to receive the component that is necessary as well as a single donation being able to help multiple patients.

Once the blood has been collected, WB can be administered immediately if required, but otherwise it is placed in the blood refrigerator for a minimum of one hour and is then ready to process into pRBCs and plasma.

The blood is filtered through a leukoreduction filter to reduce white blood cell levels which are linked to transfusion reactions. At the time of writing the RVC are currently carrying out a study on whether filtered blood products result in fewer transfusion reactions than un-filtered blood products.

The whole blood unit is weighed, balanced and spun in the refrigerated centrifuge for 15 minutes in order to separate the plasma from the red blood cells (Figure 3). The plasma is then extracted into another bag in the multi-bag system which is then sealed, separated, labelled and placed in the plasma freezer for use as FFP (Figure 4).

The pRBCs then have a nutrient rich solution added and mixed. This is called SAGM, which is composed of saline, adenine, glucose and mannitol, helping to suspend and nourish the red cells to prevent storage lesions and haemolysis (D'Amici et al., 2012).

Each unit must be labelled appropriately. This has been adapted from the guidelines for human blood donation. The label should include component details (either pRBCs, FFP etc), blood type, volume, donor identification number, veterinary nurse name and institution, date of collection and expiry and unit code (UK Parliament, 2003).

pRBCs are stored in a dedicated blood refrigerator for five weeks at 1–6 °C and plasma is frozen for one year at −32° C as FFP. As the clotting factors degrade after a year, this then becomes stored frozen plasma (SFP) which is stored for up to 5 years from collection at −32° C (King & Boag, 2018).

Large units can be split into smaller volumes in a sterile manner using a device such as Terumo TSCD®-II Sterile Tubing Welder and tube sealer, allowing units to benefit many smaller patients as well as xenotransfusions in feline patients (Figure 5).

Figure 3. Blood unit in refrigerated centrifuge.

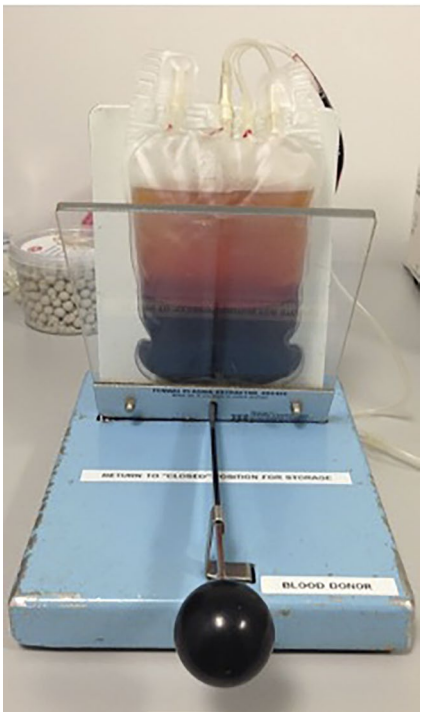

Figure 4. Plasma being extracted from the PRBCs.

Packed red blood cell transfusion

There are many indications for a blood transfusion. pRBCs are often used to treat acute bleeds during surgery, trauma patients and those with medical conditions such as immune mediated haemolytic anaemia (IMHA). FFP is used to help treat coagulopathies as well as assisting in volume resuscitation in cases with acute trauma or sepsis. WB is used for significant blood loss and platelet deficiencies (Liu & Silverstein, 2015; Prittie, 2012).

Transfusion reactions

There are different types of transfusion reactions such as acute or delayed haemolytic, and acute or delayed non-haemolytic. The main signs to monitor for are pyrexia, tachypnoea and tachycardia, vomiting, facial swelling or pruritis as well as haemoglobinuria and haemoglobinaemia. If a transfusion reaction is suspected, a blood sample can be taken from the patient to assess for haemolysis and it is important to stop the transfusion if there are any concerns that a transfusion reaction may be occurring before discussing options with the clinician.

Prior to starting a blood transfusion, it is important to carry out some simple checks to help reduce the risk of transfusion reactions.

Check the details

Firstly, it is best practice to give type specific pRBCs to dogs as the transfusion history may be unknown. Blood typing can be easily carried out using commercially available blood typing kits such as Alvedia©. It is also important to countercheck the unit of blood to be given with the type of the recipient as well as which component is required, to check for any discolouration or major clots in the product and to ensure it has not exceeded its expiry date. Cross matching is necessary in patients who have received a transfusion over five days prior to another transfusion (Odunayo et al., 2017).

Check the IV

It is important to check intravenous (IV) catheters by flushing with saline prior to giving a blood product to ensure patency, however, be aware of any medication that may be in the catheter line. Citrate from the anticoagulant in the blood products can bind with calcium in fluids such as compound sodium lactate therefore this should be temporarily stopped if giving the transfusion through the same IV catheter or a new IV catheter can be placed. Once the transfusion has finished, flush the IV catheter again before restarting any fluids or medications.

Blood products can be given intraosseously, which may be used in neonates or particularly sick patients (Li & Xu, 2015; King & Boag, 2018).

Setting up a transfusion

Any blood product must be administered through a 170-260 µm filter to reduce the risk of microclots or debris and set up in an aseptic manner using non-sterile gloves to reduce the risk of iatrogenic bacteraemia. Avoiding disconnection of the transfusion once connected also reduces this risk.

A giving set can be inserted into the unit or it can be drawn out into syringes if smaller volumes or rates are required. The blood product must be administered via an appropriate infusion pump as some may damage red blood cells (Kisielewicz & Self, 2014).

A plasma warmer, such as the SAHARA©, is usually used for defrosting the plasma but can be used to gently warm the pRBCs to combat hypothermia, especially if multiple blood product transfusions are to be given, patients are small or particularly young, if the patient is under general anaesthesia or is already hypothermic (Kisielewicz & Self, 2014; Prittie, 2003).

Figure 5. PRBC unit split being into another smaller unit using the tube welder.

Monitoring

Blood transfusions take place in the intensive care unit where the patient can be closely monitored. It is important to obtain baseline parameters prior to starting the transfusion in order to effectively monitor for any changes. Documentation of the parameters occurs at 15 minutes, 30 minutes, 1 hour and then every hour until finished.

Heart rate, respiratory rate and effort, temperature should be monitored as well as general appearance, mentation, mucous membrane colour and urine colour. Should these parameters change markedly the transfusion should be stopped temporarily and the clinician should be notified as a transfusion reaction may be occurring. The transfusion may be restarted after discussion with the clinician.

The rate and volume of the product given is decided by the clinician. It is important to start slowly, for example 1 ml/kg/hr for the first 15–30 minutes. If no changes to the patient's parameters or demeanour occur, then the rate can be increased to up to 5 ml/kg/hr or in some cases a bolus may be required (Kisielewicz & Self, 2014; Yagi, 2016).

All blood products should be transfused within four hours of being broached. Care in infusion rates should be taken for small patients and those at risk of volume overload when units may be split into several syringes or bags which can remain refrigerated for up to 24 h after broaching a unit. Using a multiparameter machine with ECG and thermometer (if tolerated by the patient) can aid nursing.

Case report

Some cases may need multiple products, such as a Labrador named Ford. He presented to the QMHA ECC service after eating a significant amount of horse food leading to gastric dilation (Figure 6).

He presented lethargic, tachycardic with weak peripheral pulses and congested mucous membranes indicating shock. He was stabilised with fluid therapy and analgesia and underwent surgery to remove the impaction. A total of 4.5 kg of material was removed!

Ford had a central venous catheter in place and required many constant rate infusions. A nasogastric tube and urinary catheter were placed by nurses, and he required multiple analgesics.

Figure 6. Ford in intensive care.

Figure 7. Ford received both PRBC and FFP.

Figure 8. Ford going home!

Ford's blood type was DEA 1 positive. During his recovery he required a unit of pRBC as well as four units of FFP in total in order to maintain his blood pressure and his PCV. The veterinary nurses played an important role in Ford's intensive care as well as monitoring the multiple blood product transfusions (Figure 7).

Ford did not show any signs of transfusion reactions. He was hospitalised at the RVC for a total of 17 days and made a full recovery (Figure 8).

Acknowledgements

Karen Humm and Charlotte Russo.

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