

CANINE BLOOD TRANSFUSION IN MY PRACTICE: IS IT REALISTIC?

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In the last decade, the demand for veterinary blood products has grown tremendously. The goal of transfusion medicine is ultimately to avoid transfusion reactions by having a high-quality blood product. The purpose of this presentation is to, using a case-based approach, demystify blood transfusions by emphasizing the selection of the appropriate blood product and its proper administration.

1. Careful selection of healthy blood donors

The ideal canine blood donor is a healthy large breed dog (> 25 kg) to allow the collection of a standard blood volume (450-500 ml depending on collection bag). Ideally, the donor should have a docile temperament to permit blood collection without sedation. Contrary to what is often reported in the veterinary literature, pregnancy does not sensitize bitches to erythrocyte antigens.(1) Depending on the geographical location, blood donors must be tested for different infectious agents transmitted via a blood transfusion (ex: Babesia, Ehrlichia, Anaplasma). To this end, an updated ACVIM Consensus has been published in 2016, which proposes optimal and minimal standards.(2)

2. Proper techniques for collecting and storing blood products

Blood is collected via the jugular vein using either gravity or a suction system, and using a 16G needle connected to closed collection system. The site should be shaved and prepared aseptically. Citrate-phosphate-dextrose-adenine (CPDA), with or without additive solution, is commonly used as an anticoagulant. In an emergency situation, heparin or sodium citrate may also be used for immediate transfusion purpose (not for storage).

Given the financial and time investment required to identify, test and collect blood donors, the purchase of high-quality blood products through a commercial blood bank is likely advantageous for most clinics.

Blood can be separated into different compounds (packed RBC (pRBC), fresh frozen plasma, etc.). Although centrifugation accelerates the process of separation of red blood cells and plasma, gravity can certainly allow adequate sedimentation.

Whole blood and RBC concentrate are stored at 4°C in a dedicated refrigerator and should be gently rocked daily. When used alone, CPDA-1 allows storage of RBC for up to 20 days. Preservatives (e.g. Adsol or Nutrisol) added to canine pRBC increase storage time to 35-37 days. Plasma products should be kept at -20°C (or colder) and has a shelf life of about one year.

The advantages of blood components therapy are:

- Limits the risk of transfusion reaction by limiting the transfusion of non-essential blood elements
- Limits the risk of vascular overload
- One unit of blood can be used for more than one patient
- Coagulation factors are maintained active in FFP (decrease in factor V, VIII and vWF at 8 hours post-storage; does not appear to be as dramatic as initially believed).

3. Appropriate administration of blood products

There are numerous indications to administer blood products, some more clinically appropriate than others (Table 1).

Table 1. Clinical indications for specific blood products

Indications	Blood products
Oxygen transport capacity	- Whole blood (fresh or stored) - RBC concentrate
Oncotic pressure and hypoalbuminemia* (limited efficacy)	- Whole blood (fresh or stored) - Fresh frozen plasma (FFP)* - Frozen plasma* - Cryo-poor plasma* - Human Albumin
Platelets*	- Fresh Whole Blood - Platelet rich plasma - Platelet concentrate
von Willebrand Factor	- Fresh Whole Blood - FFP - Cryoprecipitate (ideal)
Coagulation factors (including factors VIII et vWF)	- Fresh Whole Blood - FFP
Coagulations factors vitamin-K dependant	- Whole Blood (fresh or stored_ - FFP - Frozen plasma - Cryo-poor plasma*
Immunoglobulins (unproven efficacy)	- FFP - Stored plasma

* *To be considered in small animals only*

** *See limitations in fresh frozen plasma*

PACKEC RBC (pRBC)

Increasing the oxygen transport capacity of an anemic patient is obviously the main reason to use pRBC. It is particularly ideal in normovolemic dogs, e.g. in immune-mediated hemolytic anemia (IMHA).

- Total recommended volume: 6 to 10 ml / kg

The following formula can be used once the PCV on the unit is verify (usually around 60-70%), which will also allow to check for hemolysis secondary to storage/transportation.

- Volume administered (ml) =

$$\frac{\text{Weight (kg)} \times 90 \text{ (dog)} \times (\text{Desired PCV} - \text{PCV of recipient})}{\text{PCV of blood unit}}$$

FRESH FROZEN PLASMA (FFP)

FFP contains all coagulation factors and are indicated in numerous cases of coagulopathy (hepatic insufficiency, rodenticide poisoning, von Willebrand disease, hemophilia, DIC, etc.). Since plasma contains globulins, its use has been suggested in puppies which did not have access to maternal colostrum or with parvovirus, but its benefit remains unproven. Plasma is not ideal as the sole treatment of hypoproteinemia, since approximately 45 ml/kg of plasma is required to increase serum albumin by 10 g/L (unrealistic volume for large dogs). Finally, since FFP also contains α -macroglobulins, its use is often advocated during pancreatitis, but its efficacy remains unproven.(3) Before administration, FFP should gradually be warmed to 20-37 °C; overly aggressive warming can lead to inactivation of clotting factors and denaturation of plasma proteins, in addition to promoting bacterial growth.

- Total recommended volume: 10-15 ml / kg (repeated as needed)

The decision to administer a blood product should be based on the patient clinical signs. Indications for RBC transfusion in an anemic patient includes: weakness, exercise intolerance, tachycardia, tachypnea, weak pulse. Signs of coagulopathy may include petechiae, ecchymosis, hematomas, bleeding at venipuncture sites. Prolongation of clotting times may justify the use of blood products if a

procedure that may lead to significant bleeding is planned (ex.: surgery, liver biopsy) or in actively bleeding patients.

Blood products must be examined prior to administration (expiration date, brownish discoloration (suggestive of bacterial contamination), microhematocrit to verify if hemolysis is present). Transfusion of RBC requires a catheter > 22 G, as smaller catheters may cause hemolysis. The use of volume-appropriate filters is essential. Only approved pumps for transfusion purpose should be used. In fact, administration by gravity seems ideal; indeed, a recent study in dogs has shown that even approved pumps can lead to significant hemolysis.(4)

A slower transfusion rate (0.25 ml/kg/hr) is initially recommended. It is essential to closely monitor the patient regardless of the transfused blood product. The animal's mental state, temperature, heart rate, respiratory rate, mucosal color and capillary refill time should be noted before starting the transfusion, and then 15 minutes after it starts. If vital parameters are stable, the transfusion rate can be increased to 5-10 ml/kg/hr. Monitoring of vital parameters should be done at 20-30 minutes throughout the transfusion. The animal should also be monitored for signs of vomiting, diarrhea, angioedema, urticaria and hemoglobinuria.

In general, transfusions are better tolerated at slower rate, while respecting a 4-hour window (maximum time a unit should be kept at room temperature to limit risk of bacterial growth). In case of severe acute hemorrhage, the administration can be done much faster. In opposition, cardiac patients may receive their transfusion over two successive 4 hour-periods, while the rest of the unit is in the refrigerator. A hematocrit measurement should be taken 1 to 2 hours after the end of the transfusion.

4. Principles of blood compatibility: blood typing and crossmatch

It is strongly advised to determine the DEA 1 status of our donors and patients, since it is recognized has the most immunogenic and therefore most clinically significant blood group. Simple, fast and inexpensive blood typing methods are commercially available for DEA 1 blood typing, which are either based on agglutination reaction (RapidVet-H®) or immunochromatography technology (Alvedia®). Note that more extensive blood typing (other DEA, Dal antigen) can only be performed by certain specialized laboratories (eg Animal Blood Resources International, Inc.; University of Montreal).(5)

A crossmatch, which identifies circulating antibodies in the plasma, should be performed in dogs that have already received a blood transfusion (> 4 days previously). Although laborious, the crossmatch can be done in clinic with very little equipment. A major crossmatch, which is of up-most importance, consists in incubating a solution of washed RBC (blood donor) with the plasma (or serum) of the recipient. Commercial crossmatch kits based on a gel reaction (RapidVetH-Crossmatch) or immunochromatography (Alvedia Canine Crossmatch test) are now available and may facilitate interpretation.

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