# Canine and feline blood transfusions in practice

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## INTRODUCTION

The first canine blood transfusion was undertaken in 1665 at Oxford University; however, it was not until much later, in the 1950s, that the use of veterinary transfusion medicine became more prominent. In 2007, the Pet Blood Bank in the UK was launched and, prior to this, many similar blood banks in North America were also established. These banks offer some clear advantages to the veterinary surgeon, patient and donor in terms of both convenience and the ability to tailor blood products to an individual patient's needs, thereby maximising the benefits and minimising the risk of complications associated with transfusion. Blood banking systems also ensure there is appropriate donor screening and typing, and increase the products available for an individual patient. In some circumstances, such as where there is an urgent requirement or where there are financial constraints, obtaining blood from an 'in-house' donor is necessary. In addition, feline blood banking is still uncommon. Ireland currently has neither a canine nor feline blood bank, therefore blood is always obtained from a donor animal at the local level – although this may change in the future. However, even in the absence of a commercial pet blood bank, if practitioners are willing to dedicate time to adequate planning and to ensuring a sensible approach to obtaining blood from suitable blood donors, then the process is relatively straightforward.

## A SUITABLE BLOOD DONOR?

To ensure that a blood transfusion is safe for both the donor and recipient the guidelines below should be followed. A good place to start is the selection of an appropriate blood donor. Table 1 outlines the general guidelines for the selection of an appropriate canine and feline blood donor.

**Table 1: Selection of appropriate donor.**

| |
|---|
| Healthy, fully vaccinated (according to regional guidelines) |
| Normal physical examination findings and lack of ectoparasites |
| Cats should be negative for viruses (FeLV, FIV) |
| No history of travel |
| Good temperament |
| Dogs > 25kg; cats > 4.5kg (ideally > 5kg) |
| Normal PCV (> 35 per cent) |
| > 6 weeks since last donation |
| Ideally, DEA 1.1, 1.2 and 7 negative (dogs) |

Prior to blood collection, a full history and careful clinical examination should be carried out in the donor animal.

In ideal circumstances, donors should have blood typing (see below), a complete blood count and biochemistry panel. However, a minimal database of blood type and a measurement of haematocrit (HCT) or packed cell volume (PCV) would suffice in an emergency.

In human medicine, individual blood units are screened for infectious diseases, however this is not usually logistically or financially viable in veterinary medicine. It is appropriate to check feline blood donors for feline leukaemia virus (FeLV) and feline immunodeficiency virus (FIV) before they donate; if possible, performance of a polymerase chain reaction (PCR) test for *Mycoplasma haemofelis* and *Candidatus Mycoplasma haemominutum* is also recommended (especially considering the risk of transmitted *M haemofelis* to the cats that are recipients of blood transfusions). Testing for infectious disease depends on geographic location. Suggestions are listed in Table 2.

**Table 2: Tests for infectious disease.**

| Canine blood donors | Feline blood donors |
|---|---|
| ***Bartonella spp*** | **FeLV** |
| ***Mycoplasma haemocanis*** | **FIV** |
| **Heart worm (*D immitis*) antigen (geographic)** | ***Mycoplasma haemofelis* (+/- *Candidatus Mycoplasma haemominutum*)** |
| ***Babesia spp* (geographic)** | ***Bartonella spp*** |
| ***Ehrlichia spp* (geographic)** | ***Ehrlichia spp* (geographic)** |
| ***Neorickettsia spp* (geographic)** | ***Anaplasma spp* (geographic)** |
| ***Leishmania spp* (geographic)** | ***Neorickettsia spp* (geographic)** |
| ***Trypanosoma cruzi* (geographic)** | ***Cytauxzoon felis* (geographic)** |
| ***Brucella canis* (breeding animals)** | |

## SAFE COLLECTION OF BLOOD FROM A DONOR

Whole blood can be safely collected in practice. In advance of the procedure, collection bags, catheters and anticoagulants should be ordered. Equipment that may be needed to obtain blood from a donor is listed below:

- Three members of staff (one experienced in phlebotomy)
- Sterile scrub solution, EMLA cream and clippers
- Sedation for cats (if required for dogs)
- Ideally, pre-place an intravenous (cephalic) catheter in the donor in case of problems
- Dogs – human blood collection bag pre-filled with anticoagulant, scales for weighing the blood unit
- Cats – sandbag or small cushion to place under the

donor's neck, 19-21 gauge butterfly needle, three 20ml syringes prefilled with 2ml of anticoagulant (acid citrate dextrose or citrate phosphate dextrose). Note that heparin is not advised as it can affect platelet function and inhibit coagulation factors, although it may be used in an emergency situation.

A quiet and calm part of the practice should be equipped for the collection to take place and staff taking part should be briefed on the following technique. Blood may be collected from donor dogs without sedation, especially given that most commonly used sedatives can cause hypotension and should be avoided unless absolutely necessary. Therefore, if a donor is very agitated, aggressive and difficult to handle, heavy sedation should be avoided and a more suitable donor should be used. In the first instance, an opioid such as butorphanol (0.1-0.3mg/kg IM or IV) may be enough to reduce anxiety in a nervous donor. Acepromazine should be avoided, given that it may affect platelet function.

Ideally, blood is collected from the jugular vein with the dog either sitting or in lateral recumbency. The jugular vein should be clipped and aseptically prepared. The application of a local anaesthetic gel (for instance, EMLA 5 per cent cream) will minimise discomfort during collection; this should be applied 45 to 60 minutes prior to venopuncture. Collection of blood from the cephalic vein in larger dogs is possible but less desirable, given that flow rates will be slower, increasing the risk of the development of microthrombi and venous thrombosis/needle occlusion. Donation volume for dogs is usually 15-20ml/kg.

In cats, blood should always be collected from the jugular vein, since flow rates are too slow if blood is collected from peripheral veins. Most donor cats require sedation or anaesthesia to ensure proper restraint, before being positioned in lateral recumbency. Placing some padding under the cat's neck often improves access to the jugular vein during collection. There are minimal published prospective studies examining the optimal sedation/anaesthesia protocols for blood donation in cats. Some of the problems associated with commonly used sedative drugs and successful blood collection are listed below:[1]

- Alpha-2-agonist – adverse cardiovascular side-effects, difficult phlebotomy as a result of vasoconstriction (avoid)
- Propofol – high incidence of mortality and morbidity (ACVIM discussion list) and expense
- Ketamine has been associated with prolonged recoveries and altered behaviour post-anaesthesia.

A sedative combination such as ketamine, midazolam (or diazepam) and butorphanol is preferred (see Appendix for suggested doses). Mask administration of sevoflurane is a suitable alternative. The usual donation volume for cats is 11ml/kg (10-15ml/kg lean body weight) over five to 10 minutes. An acceptable fluid therapy protocol is to give 90ml of saline subcutaneously immediately before donation, then to infuse 60-90ml saline over 15 to 20 minutes starting halfway through donation (this equates to two-to-four times the volume collected).

During collection, the needle should be held as still as possible and a second person should gently mix the bag or syringe to ensure that the anticoagulant is thoroughly mixed with the blood; in dogs the bag should be weighed periodically until the target weight is obtained. Under optimal circumstances, to ensure a donation goes smoothly, three members of staff should be available, enabling one person to restrain the donor, another to hold the needle in place and a third to weigh and gently mix the donation bag or apply suction and mix the syringe. A skilled phlebotomist is preferred to minimise stress to the patient, aid blood flow and prevent complications, such as microthrombi at the site of venopuncture.

Canine blood is normally collected directly into a 'closed' human blood collection bag which contains an appropriate volume of anticoagulant (acid citrate dextrose [ACD] or citrate phosphate dextrose [CPD]). The use of ACD or CPD as anticoagulant allows the blood to be stored for up to three-to-four weeks without significant loss of red blood cell viability, provided it is kept at 4-5°C.[2]

Since smaller volumes of feline blood are collected and the flow rate is much slower, collection directly into human blood bags is inappropriate. Feline blood is therefore routinely collected into an 'open system' consisting of individual components, such as three 20ml syringes or a 50ml syringe attached to a butterfly needle or catheter. Although heparin can be added to the syringe, ACD or CPD are preferred since the blood can then be stored for up to four weeks after collection, provided it is kept refrigerated and they do not affect platelet or coagulation factor function. Note that blood cannot be stored in a syringe long term; for long-term storage a sealed sterile gas-diffusible bag should be used. The syringe should contain 1ml ACD or CPD (withdrawn from a human blood collection bag) per 9ml of blood to be collected.[3] Blood must be stored in a sterile fashion as bacterial contamination of blood can result in a severe transfusion reaction.

The equipment required for blood donation and collection (eg. in-line filters, blood collection bags) can be obtained directly from the UK Pet Blood Bank (www.petbloodbankuk.org) or from individual veterinary suppliers.

## BLOOD TYPING AND CROSS–MATCHING

See Table 3 for key points.

**Table 3: Blood typing.**

| |
|---|
| **Blood typing of the recipient and donor is recommended before all transfusions in dogs and cats** |
| **Cats must always be blood typed prior to transfusion** |
| **Cross-matching should be performed prior to all transfusions to test for reactions to newly discovered blood groups such as Mik in cats or the Dal in dogs. This is rarely practical in practice, however cross-matching should be performed in all cases if the recipient has had a previous transfusion (> 4 days previously). However, in an emergency:**<br>○ **DEA 1.1 negative blood can be given to a dog of unknown type safely**<br>○ **Or dogs can receive untyped blood if they have never received a prior blood transfusion, given the absence of significant naturally occurring alloantibodies to the DEA 1 system**<br>○ **Or dogs can receive untyped blood if they are within a 72-hour window from a previous blood transfusion, given the absence of significant naturally occurring alloantibodies to the DEA 1 system.** |

Specific blood antigens have been described in dogs since 1910 and antigen groups since the 1940s. Dogs may belong to 13 groups, however only the following six dog erythrocyte antigen (DEA) groups can be easily identified during routine typing: 1.1, 1.2, 3, 4, 5 and 7. The Dal antigen has been recently recognised and is common in most dogs, but is absent in some Dalmatians – it is independent from the known DEAs.

In dogs a true universal donor would be negative for DEA 1.1, 1.2, 3, 5 and 7 but positive for DEA 4. To identify universal donors, blood needs to be submitted to a commercial laboratory for testing with polyclonal antibodies via a tube agglutination method.

DEA 1.1 is the most common blood type in dogs and, although naturally occurring antibodies to DEA 1.1 are rare, the determination of the DEA 1.1 antigen is strongly recommended as this antigen is highly immunogenic and will result in antibody formation. In-house typing kits are available: the Alvedia CHROM technique (Figure 1); and the card system (Figure 2) are both readily available for typing in practice; they are both easy to use and accurate. However, given that both tests can give false positives and negatives, it is strongly recommended that blood donors be typed in an external laboratory, where possible.[3]

Cats can belong to the A, B or AB blood groups, where A is the most common. Blood type in cats varies by geographical location and also by breed. The rarer B blood type is more common in some exotic cat breeds such as the Devon Rex (41 per cent type B), Cornish Rex (31 per cent type B), British Shorthair (36 per cent type B), Exotic Shorthair (27 per cent type B), Scottish fold (19 per cent type B) and non-purebred Australian cats. The recent discovery of the Mik antigen should also be noted, which is present in most cats.[4] In contrast to dogs, cats need to be blood typed before their first transfusion and they should be administered the correct (matched) blood type with every transfusion. There is no universal blood donor for cats. See below for the consequences of a mis-matched transfusion in cats.

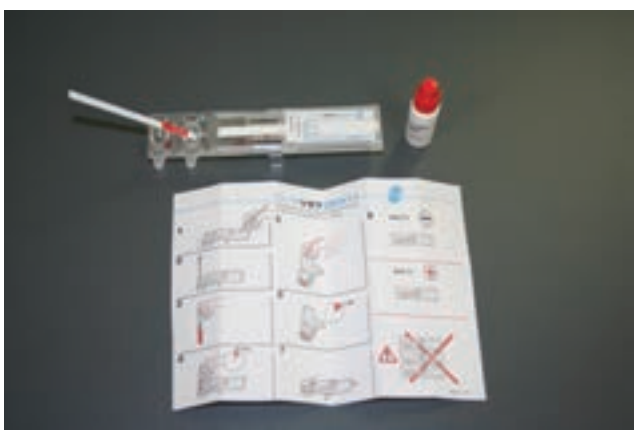

**Figure 1: Alvedia CHROM technique.**

**Figure 2: Card system.**

**Table 4: Consequences of mis-matched transfusion in cats.**

| Recipient / Donor | A | B | AB |
|---|---|---|---|
| A | OK | Fatal | Reaction (preferable over type B) |
| B | Reaction | OK | Reaction |
| AB | Reaction | Fatal | OK |

Once a blood transfusion has been administered it is impossible to determine the recipient's true blood type, therefore typing must be performed prior to transfusions in dogs and cats.

## CROSS–MATCHING

In-house cross-matching can be used when blood typing is unavailable, or blood typing and cross-matching may be combined before administration of a blood transfusion. Cross-matching assesses the effect that recipient serum antibodies will have on the donor cells (major cross-match) and the effect that donor serum will have on recipient cells (minor cross-match). Since the main aim of a blood transfusion is to provide the recipient with red blood cells it is most important that the recipient's serum antibodies do not destroy these cells and in so doing evoke a transfusion reaction. The minor cross-match assesses the risk of recipient cell destruction by the donor serum, a much smaller risk because the volume of transfused serum will comprise only a small volume of the recipient's total serum. To perform both major and minor cross-matches, blood collected in both heparin and EDTA anticoagulants must be obtained from both the donor and the recipient. The technique is as follows, but this process can be time consuming and interpretation is operator dependent. Commercial gel cross-matching kits are now available and they have the advantages of requiring less blood per sample (compared to the method described below), easier interpretation and they can be used in patients that are auto-agglutinating.

In dogs, cross-matching is only required if transfusion history is unknown, if a previous haemolytic transfusion reaction has occurred, if more than four days have elapsed between transfusions, or if DEA 7 type is unknown. Historically, cross-matching was recommended in dogs that had previous pregnancies; however, recent literature suggests that pregnancy does not sensitise dogs to red blood cell antigens.[5]

In cats, both cross-matching as well as blood typing is recommended prior to administration of a transfusion. The additional step of cross-matching is because of the presence of naturally occurring Mik antibiotics in some cats[4] and also because of the potential for fatal transfusion reactions (for example, if type A blood is mistakenly given to a type B cat), however this is not always practical (see Table 3 for advice).

## WHEN SHOULD WE USE TRANSFUSIONS?

Blood transfusions can benefit patients with a broad spectrum of disease. Most commonly, they are used to provide support for patients with anaemia and/or coagulopathies.

Patients with a debilitating non-regenerative anaemia benefit greatly from red cell transfusions to provide support while underlying aetiologies are investigated and addressed.

There is neither a specific 'transfusion trigger' nor a particular figure when a blood transfusion should be administered. Instead, it is important to look at the patient as a whole. A transfusion should be considered if a patient's clinical examination findings are consistent with an inability to cope with the anaemia or coagulopathy (this may be an increase in heart rate, weakness, lethargy, for example).

## BLOOD ADMINISTRATION

Ideally, blood should be given into a peripheral (or central-jugular) vein via an intravenous catheter (> 22 gauge, whenever possible). Blood and blood products can be administered safely via certain types of infusion pump or syringe driver. However, some infusion pumps have pumping mechanisms which will damage red cells so, before using them to administer blood products, it is important to check the manufacturer's guidelines. Administration of damaged red cells will reduce the benefit of the transfusion and increase the risk of a transfusion reaction.

Blood should be administered through filtered giving sets specifically designed for blood products (Figure 3), which will remove the cellular aggregates and microthrombi which can cause systemic problems (such as thrombosis). The filters present in standard giving sets will tend to clog when blood is administered through them because they are too small. Blood should not be administered concurrently (ie. through the same catheter) with intravenous fluids containing calcium or glucose, or with lactated Ringer's solution (Hartmann's). No medications or solutions should be added or infused through the same tubing with blood products, except 0.9 per cent sodium chloride or species-specific plasma.

**Figure 3: Blood should be administered via sets designed for blood products.**

Any red cell transfusion should be gently warmed to 37°C before administration in order to reduce blood viscosity, prevent patient chilling and minimise vasoconstriction. Do not use a microwave oven! If blood is over-heated, clotting and haemolysis can occur. The unit should be at room temperature before administration (ie. between 21°C and 37°C). Once any bag has been warmed it must be used within 24 hours as the warming process will promote bacterial growth within the product. If leakage occurs at any stage in the warming process the entire contents must be discarded.

The 'dose' of transfusion is usually calculated based on the formula below[6] (where k = 90 for dogs and 60 for cats). This is assuming a stable blood volume.

**Table 5: 'Dose' of transfusion formula.**

$$\text{Required volume of blood} = k \times \text{body weight} \times \frac{\text{(desired PCV-recipient PCV)}}{\text{donor PCV}}$$

The rate of administration is based upon the condition of the patient. Transfusions are often started slowly to monitor for any adverse reactions (see below). All transfusions should be given within four hours (to prevent bacterial contamination)[7] and patients should always be monitored closely throughout (practices should make sure that they have specific blood transfusion monitoring sheets available; Figure 4).

As a rule of thumb, a maximum volume to administer would be 22ml/kg.

Examples of appropriate rates are listed below:

- First 15-30 minutes – 0.5-1ml/kg/hr
- Normovolaemic patients with no adverse reaction – 5-10ml/kg/hr
- Patients with compromised heart/kidney function – 4ml/kg/hr max
- Hypovolaemic patients with no adverse reaction – 20ml/kg/hr.

### Haemoglobin-based, oxygen-carrying solutions (Oxyglobin)

Oxyglobin is a sterile haemoglobin-based oxygen-carrying solution made from bovine haemoglobin. It is useful when a blood transfusion is not available. Oxyglobin is only licensed for the provision of oxygen-carrying support in dogs with anaemia, but its use in cats has been reported. Information about administration and management of patients who have received Oxyglobin is available elsewhere.[7]

### Auto-transfusion

Auto-transfusion is the collection and re-transfusion of a cat's or dog's own blood. It is only possible when patients bleed into body cavities (such as the thorax or abdomen), and it can be useful in emergency situations. Blood should not be used if there is the potential for it to be contaminated with bacteria, tumour cells, urine or bile. Blood is collected from the body cavity in a sterile manner and is re-transfused, after addition of an anticoagulant, through a filter (as would be done with any other blood product – see above).

## TRANSFUSION REACTIONS

Transfusion reactions are adverse events occurring following the administration of blood or blood products. Their effects can be fatal, in some cases, or may merely result in the transfusion giving limited benefits to the recipient. Reactions that occur within 24 hours of administration are termed 'acute reactions' and those occurring more than 24 hours post-transfusion are termed 'delayed reactions'. Transfusions are monitored closely and started slowly to minimise the impact of any reactions. In all transfusions, the clinician should weigh up the benefits versus the potential risk of reaction. Of course, careful attention to correct donor selection, in addition to matching of the donor and recipient blood types (including undertaking a cross-match where possible) will minimise the risk of any reactions.

Types of potential transfusion reaction are shown in Table 6. Non-haemolytic febrile reactions (defined as a rise in body temperature of 1-2°C within one to two hours of a transfusion) and transfusion-associated circulatory overload (TACO) are the most common reactions reported in cats and dogs.

**Table 6.**

| Non-immune-mediated | Immune-mediated |
|---|---|
| Bacterial contamination of blood/sepsis | Acute hypersensitivity |
| Hypocalcaemia (citrate toxicity) | Haemolysis |
| Volume overload (transfusion-associated circulatory overload [TACO]) | Pyrexia |
| Transmission of infectious diseases | Anaphylaxis |
| Electrolyte changes (increased K+, NH3, decreased P) | Transfusion-associated lung injury (TRALI) |
| | Decreased red blood cell survival |

If a reaction is suspected then the transfusion should be stopped, and supportive care should be administered as required. Records should be taken to record the volume infused, and the rate of infusion. The blood product and line should be kept for testing (such as bacterial culture, a repeat cross-match and blood type), the blood and patient should be examined for signs of haemolysis. Depending on the nature of the reaction, the transfusion may be restarted after the reaction has been managed. However, remember

**Figure 4: Practices should have blood transfusion monitoring sheets available.**

that once a transfusion has been started it should be administered over four hours maximum.

Examples of the clinical signs associated with adverse reactions are listed below:

- Tachycardia or bradycardia
- Dyspnoea, tachypnoea or coughing
- Pyrexia
- Depression
- Vocalisation
- Vomiting
- Urticaria, erythema, pruritus
- Shock
- Tremors and convulsions
- Cardiopulmonary arrest
- Jaundice, haemoglobinuria and anorexia (delayed).

## SUMMARY

In summary, ensuring a safe blood transfusion involves making sure that integrity is maintained throughout the whole process. This begins with choosing a suitable donor, through safe collection and administration of the donor blood, including post-transfusion evaluation for any reactions that may have occurred. The commercial availability of point-of-care blood typing and cross-matching kits should enable veterinary practitioners to administer appropriate transfusions with minimal risk of elucidating an immune-mediated transfusion reaction.

## REFERENCES


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