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Blood transfusions in the dog and cat

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ABSTRACT: The initial section of this article discusses the indications for blood transfusions, cross-matching and blood typing in dogs and cats. The second part explains blood collection, including volumes, and illustrates common calculation formulae used in blood product therapy, rates of administration, correct handling and warming of blood components, likely causes of transfusion reactions plus clinical signs and treatment.

Established in 2007, Pet Blood Bank (PBB) was the first UK charity to collect, process, store and distribute canine blood products to veterinary practitioners throughout Britain. PBB collects blood from donors at organised collection sessions across a range of national locations. The donated blood is processed into red cell and plasma components, before being stored in preparation to be supplied to veterinary practices nationwide.

Feline blood products are currently unobtainable from PBB, although it is hoped that the organisation will be able to provide them in the near future. Presently, veterinary practices are reliant on in-house feline emergency donors belonging to staff members and clientele, which will ideally have been pre-blood typed and screened. Feline patients are subsequently restricted to the option of fresh whole blood.

Alternatively – or in addition to this – veterinary practices may choose to register with www.animalbloodregister.com in order to obtain a contact list of local donors within their area.

Blood transfusion indications

The most common indication for blood component transfusions in dogs and cats is anaemia necessitating the treatment or prevention of hypoxia resulting from a reduction in haemoglobin and subsequent tissue and/or organ ischaemia. Blood-product transfusions are also indicated in the management of hypovolaemia, coagulopathy, hypoproteinaemia and thrombocytopenia.

Patients with rapidly progressive anaemia are usually transfused once their packed cell volume (PCV) falls to approximately 20 - 25 per cent. In cases of acute haemorrhage, exceeding 20 per cent of blood volume, a transfusion may be required in addition to initial intravenous fluid shock therapy.

Note: in cases of peracute blood loss, a decline in PCV will not be observed for several hours following haemorrhage, until inter-compartmental fluid shifts occur or fluid therapy is instituted.

Other parameters, such as mucous membrane colour, capillary refill time, heart rate, blood pressure and possibly blood lactate levels, must, therefore, be monitored to determine if a transfusion is required.

The disease process determines the type of blood product required for treatment, such as packed red blood cells (PRBCs), fresh whole blood (FWB), stored whole blood (SWB), fresh frozen plasma (FFP) or frozen plasma (FP).

Cross-matching and blood typing

Blood typing and cross-matching are implemented in both donors and recipients to ensure compatibility. This reduces the risk of potentially fatal transfusion reactions, and decreases the likelihood of sensitising recipients that have no naturally occurring *alloantibodies* should future transfusions be necessary.

Also known as *isoantibodies*, alloantibodies are naturally occurring antibodies to tissues of other members of the same species. It is also important to screen for infectious diseases, such as feline immunodeficiency virus (FIV) and feline leukaemia virus (FeLV).

Cross-matching is performed to analyse the serological incompatibility between an individual donor and recipient. Although it does not identify blood type, it does indicate whether a reaction will occur under the patient's current medical condition. If no typed blood is available, a sample may be obtained from a prospective donor and tested against the recipient's blood to determine the suitability of commencing with a transfusion.

Canine patients rarely acquire naturally occurring alloantibodies and so, generally, tolerate an initial unmatched blood transfusion. Nevertheless, the antibodies produced following an incompatible transfusion will prevent further unmatched transfusions being administered. Blood-group determination is, however, always critical in feline patients, as an unmatched transfusion is likely to result in a fatal systemic anaphylactic reaction.

Blood group identification is recommended whenever red blood cells are to be administered to ensure that the correct type is given. Blood typing patients at a non-critical time can assist with future emergency situations.

Cat and dogs have species-specific blood types, which are determined by the presence or absence of aminosaccharide molecules on erythrocyte membranes. These aminosaccharide molecules have slight variations in their structure, which provide antigenic properties.

Despite only minor differences occurring between one or two amino acids, the immune system responds to the slightest inconsistency.

Dogs

Canine blood types are classified according to a numeric system referring to the specific antigens located on erythrocyte surfaces, termed dog erythrocyte antigens (DEAs). The eight major antigens that form the common blood groups are DEA 1.1, 1.2, 3, 4, 5, 6, 7 and 8. Of these, the most common antigenic blood type and, therefore, most significant in relation to acute immunological transfusion reaction, is DEA 1.1 followed by 1.2 and 7.

In comparison to cats, there is no evidence that dogs have any clinically significant, naturally occurring antibodies to other blood types. The low incidence of DEA 1.1, 1.2 and 7 across all common blood groups and the deficiency of naturally occurring antibodies have two vital clinical implications.

First, cross-matching will not detect any alloantibodies if neither donor nor recipient has received a transfusion, even if the individual blood samples are of two different blood types. Second, a random, first-time transfusion is unlikely to result in an immediate incompatibility reaction, as four to14 days are required for the recipient to produce antibodies against donor cells.

Certain breeds, such as greyhounds, have a low frequency of DEA 1.1, 1.2 and 7 antigens. In addition, members of this breed have a higher PCV and are, therefore, particularly suitable donors. Other blood types cause minimal antigenic stimulation in unsensitised members of this breed, and they are, therefore, considered as 'universal donors'.

Approximately 70 per cent of all dogs are DEA 1.1 positive and 30 per cent DEA 1.1 negative. It is, therefore, often challenging obtaining negative donors, and consequently difficult to ensure a constant supply of negative blood. This is further complicated by the fact that negative blood may be administered to DEA 1.1 positive blood type dogs.

Thus, to ensure that an adequate supply of blood is available for those that can only accept negative blood, patients should always be blood typed and transfused accordingly. If positive patients were only given positive blood, it would help with the supply of negative blood for those that can only receive this blood type.

Cats

Feline blood groups are inherited, consist of two antigens and are described as Type A or Type B. A Type AB has also been identified, although this combination is rare.

Feline blood-group incidence varies between breeds and according to geographical location. However, the most frequent blood type is A. Unlike dogs, Type A and B cats develop naturally occurring alloantibodies to other blood groups within the first few months of life; although AB Type cats do not.

Testing

In-house blood-typing kits are available for routine testing to classify dogs as DEA 1.1 positive (1.1 antigen is present on the erythrocyte surface) or negative (1.1 antigen is not present on the erythrocyte surface).

Cats are simply classified as Type A, Type B or Type AB.

Blood collection

The ideal canine donor is/has:

- friendly
- at least 25 kg in body weight
- aged between one and eight years
- clinically normal
- of known blood type, compatible to the recipient
- a current vaccination status but has not been vaccinated within the previous 10 - 14 days
- nulliparous (females only)
- free from parasites and blood-borne diseases
- not travelled outside the UK and Ireland
- not receiving any medication at the time of donation
- not received any blood product transfusions themselves
- a high PCV if the transfusion is for red blood cells
- a lower PCV if platelet and plasma products are required.

The ideal feline donor is:

- as above but weighs over 5 kg
- is negative for feline infectious diseases.

The maximum canine donation volume is 16 - 18ml/kg. A standard donation (unit) for whole blood is approximately 450ml or 200ml for packed red blood cells; a typical feline whole blood unit is 45ml or 20ml for packed red blood cells.

Collection is usually from a jugular vein; however, peripheral veins may be used

in larger patients. Aseptic preparation and collection methods must be strictly adhered to in order to minimise the incidence of infection.

Anaemia is a concern when repeated blood donations are made in a relatively short time period, and should, therefore, be avoided unless absolutely necessary. Ideally, animals should not donate blood more regularly than once every three months. Their nutritional status must be monitored if donating more often than this.

Blood can be collected from conscious animals if they are cooperative. However, where possible, donors should be starved for eight hours prior to donation to allow for sedation, if required. In emergency donation, post-prandial lipaemia seems to have no effect on the transfused product.

Feline blood may be collected into a syringe that contains a pre-measured amount of an appropriate anticoagulant, such as heparin (for immediate use only). The solution should then be gently agitated to ensure adequate mixing of the anticoagulant and blood.

Blood volume

Healthy, conscious animals readily tolerate blood loss of up to 40 per cent. Under general anaesthesia, patients can generally endure blood loss up to 20 per cent. Note: blood donors regularly provide 20ml/kg every three months without detrimental effect.

A patient's blood volume should be calculated to determine the consequence of any lost fluids in the perioperative period and to anticipate the necessary volume of fluid replacement required. Blood volume is generally calculated as 9 per cent of body weight (90 ml/kg) in dogs and 6 - 7 per cent of body weight (60 - 70 ml/kg in cats).

Patients can tolerate a lower haematocrit when conscious or if anaemia is of chronic duration. For these patients, a PCV of 18 - 20 per cent is often well accepted. However, when general anaesthesia is necessary, blood products are required earlier owing to an increase in fluid demand during surgery.

Haematocrits below 25 - 27 per cent may limit oxygen delivery, and thus delay healing. Therefore, depending on the length of anaesthesia and the invasiveness of the surgical procedure, the pre-anaesthetic PCV value is recommended to be at least 30 - 34 per cent in dogs and 25 - 29 per cent in cats.

Blood volume is critical for homeostasis and, obviously, decreases during haemorrhage. Nonetheless, it may also decline with conditions such as hypoproteinaemia, owing to a decrease in intravascular oncotic pressure. Initially, blood volume can be restored with either crystalloid or colloid fluid therapy. However, two points should be considered in deciding whether blood therapy is indicated:

- the rate of blood loss
- the haemoglobin content of the patient's blood.

Blood loss and replacement volume

Blood loss volume

It is important to establish blood loss volume as a percentage in order for the correct fluid type to be administered. For this use the following formula:

blood loss volume (%) = blood loss (ml) ÷ total blood volume (ml) × 100

For example, to correct a 100 ml blood loss in a 10 kg dog:

100 ÷ 90 ×10 = 11% blood loss

Replacement fluid

Fluid type to use under general anaesthesia, based on blood-loss volume

- 10-15% = crystalloids
- 15-20% = colloids
- >20% = blood or haemoglobin based oxygen carrier (HBOC)

Whole blood replacement

To calculate whole blood replacement volume,

2.2 ml/kg of whole donor blood (approximate PCV of 40%) will increase the recipient's PCV by 1%.

For example, in order to increase a 20 kg dog's PCV by 15%, 660 ml of whole blood would be required:

2.2 (ml whole blood) × 20 (kg body weight) × 15(%) = 660 ml whole blood required

Red blood cell replacement

1 ml/kg of donor packed red blood cells (usually washed with saline and re-suspended in minimal saline so the approximate final PCV value is 80-90%) will increase the recipient's PCV by 1% **(Figure 1)**.

For example, in order to increase a 12 kg canine's PCV by 10%, 120 ml of packed red blood cells would be required.

12 (kg body weight) x 10 (% increase required) = 120 ml packed red cells required

Figure 1. Packed red blood cells

Administration

Handling and warming

Blood is an excellent medium for bacterial growth and it is, therefore, vital that it is handled correctly to avoid contamination.

Blood-product transfusion giving sets include filters that prevent microthrombi and/or large contaminants from entering the blood stream, and must always be used. Infusion pumps that administer blood are designed not to damage the red blood cells.

Plasma products are very brittle when frozen, and must be handled carefully and thawed slowly. Prior to administration, blood products that have been stored in the refrigerator may be actively warmed by immersing the bag in a fluid-warming bath to room temperature (37°C).

Care must, however, be taken to ensure that the product is not warmed above 38°C, because of the risk of haemolysis and potassium release. Hot water should be avoided, as haemolysis of red blood cells and destruction of proteins will occur. (Note: potassium also escapes from cold cells).

The product should be protected in a zip-lock bag to prevent contamination of the ports.

Currently, there is some debate in clinical practice as to whether it is necessary to warm blood products prior to

administration, because they should have attained room temperature anyway by the time they reach the patient. In addition, the patient's thermodynamics will warm the blood once it reaches the circulation.

However, in the author's opinion, additional measures (heat pads or a Bair Hugger) should be employed if the patient is hypothermic and she would warm the blood prior to administration for her own peace of mind.

Blood products should ideally be administered through a wide-bore peripheral or central venous catheter. However, if venous access cannot be achieved, intra-osseous or intra-peritoneal administration can be used. (Note: the latter can take up to 24 hours for absorption.)

Care must be taken when administering additional fluids simultaneously: solutions containing calcium, such as compound sodium lactate, cause *precipitation* of the citrate in the anticoagulant, and those containing dextrose will result in *haemolysis*.

Rate

The rate at which blood products are administered depends on the patient's condition; generally, initial administration should be extremely slow (0.25 - 0.5mg/kg for the first 15 - 30 minutes). If no acute reaction is observed, the infusion rate should be calculated to ensure the transfusion is complete within four hours (4 - 20 ml/kg/h).

There is a heightened risk of bacterial contamination when blood products are kept at room temperature for longer than this time frame. If the procedure is to take longer than this, it may be preferable to divide the blood product and refrigerate the remainder until required. The maximum rate of infusion should be 22 ml/kg/h and must only be used in an emergency situation. Any remaining product should be discarded 24 hours after opening or if leakage is apparent.

Transfusion reactions and patient monitoring

An immediate or delayed reaction may occur with incompatible blood types. If a cross-match is unavailable and the donor's and recipient's blood types are incompatible, the recipient patient is likely to destroy the donor red blood cells as antibodies develop.

Cats are at a greater risk of this by approximately 36 per cent.

Dogs

The majority of reactions occur when DEA 1.1 positive blood is given to a DEA 1.1 negative recipient. Less severe reactions occur when DEA 1.2 is mismatched.

DEA 1.1 negative patients must only receive 1.1 negative blood. However, DEA 1.1 positive patients may receive DEA 1.1 *positive or negative blood.* Administering an unmatched red blood cell transfusion will result in premature destruction of the transfused cells and may induce acute hypersensitivity or anaphylactic reaction.

The ideal blood groups to be transfused in dogs are, therefore, DEA 1.1 and 1.2 negative.

Cats

Type A cats have low naturally occurring anti-B antibodies in their serum; whereas Type B cats usually have high naturally occurring anti-A antibodies in their serum. Therefore, if a Type B cat is transfused with Type A blood an immediate anaphylactic reaction will occur owing to the high level of naturally occurring anti-A antibody.

A Type A cat, transfused with Type B blood, will display a less severe reaction, because of the lower level of anti-B antibody. Type AB felines have no alloantibodies to either Type A or Type B. However, as this blood type is rare, donors are difficult to find.

Transfusion reactions

Transfusion reactions can occur even if the correct blood type has been used. The majority of reactions occur within a short time of the transfusion commencing, although a reaction can occur hours or even days following the therapy.

Reactions can be categorised into immunological and non-immunological.

Immunological reactions (acute or delayed) can lead to an acute haemolytic crisis caused by:

- incompatibility reactions
- reactions to white blood cells and platelets.

Non-immunological reactions (acute or delayed) can occur from excessive volumes or rates being used or from changes to the donated product occurring during storage, these include:

- anaphylactic reactions which usually occur as a consequence of a fast transfusion rate
- circulatory overload, which is more common in small animals or patients with concurrent cardiac or renal failure
- microbial contamination that can lead to transfusion-associated sepsis
- poor storage or administration resulting in hyperkalaemia owing to RBCs leaking potassium during storage
- pre-transfusion haemolysis owing to contamination, poor storage, rough handling and overheating.

Prior to commencing with a blood-product transfusion, a temperature, pulse and respiratory rate (TPR) base reading should be obtained for comparison at each observation, and the slightest change should be identified and noted. Monitoring must include evaluating a patient's response to the therapy and close observation for signs of an acute transfusion reaction.

Clinical signs that may indicate a transfusion reaction include:

- pyrexia (this can be as little as a 0.2°C increase)
- tachycardia
- bradycardia
- dyspnoea
- tachypnoea
- altered capillary refill time
- tremors
- agitation
- urination
- vomiting
- diarrhoea
- peripheral oedema
- pruritus
- weakness
- collapse
- seizures.

Treatment of transfusion reactions

If even mild hyperthermia occurs up to four to five hours after transfusion, the most likely cause is incompatibility

between donor white blood cells and recipient antigens.

For any reaction, treatment involves stopping the transfusion immediately and providing supportive care.

If the reaction is mild and signs abate within five minutes, the transfusion may be reinstated at a slower rate. The administration of dexamethasone (1mg/kg) intravenously and/or chlorphenamine (0.5mg/kg) subcutaneously, intramuscularly or intravenously, depending on the preparation, should be considered. If signs recur, the transfusion should be discontinued altogether.

If severe signs, such as collapse, cardiac arrhythmia, pyrexia or urticaria appear, the transfusion should be stopped and, if necessary, intravenous adrenaline (0.01mg/kg) corticosteroids and saline can be administered.

These drugs should always be readily available for emergency administration under the guidance of a veterinary surgeon.

Conclusion

With blood products now being widely available and, therefore, routinely administered to treat a range of conditions in veterinary patients, it is vital to ensure that transfusions are carried out safely and effectively.

As veterinary nurses, we are responsible for the appropriate preparation, administration and management of blood transfusions. We must be able to identify potential complications quickly, through regular vigilant observations and be ready to respond accordingly. vn

Suggested reading

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NEWS REVIEW by Jean Turner

Congratulations to Alice

Alice Priddy is a Student Veterinary Nurse who has just run a 5km military style obstacle course (The Major Series North) to raise money for the BVNA Charity of the Year, Nowzad. She raised £151 for them!

Alice before and after completing the course!

Evidence-based veterinary medicine conference

RCVS Knowledge has announced the 1st International EBVM Network Conference for 2014, which will be held at Beaumont House, Windsor, on 23 - 24 October.

There are 30 bursaries being offered of £500 each for (a) students in full or part-time education, (b) veterinary nurses registered with an accredited body and (c) veterinary professionals based in low or middle/lower income economies.

The deadline for these bursaries is 1 May 2014.

The first EBVM all-day meeting was held in October 2012 and sold out completely and so quickly that another larger venue had to be booked. For further information about the 2014 conference, contact www.rcvsknowledge.org

Neutering of cats

At this time of the year, many young cats presented for spaying are actually in early pregnancy. Charities, such as Cat Protection, emphasise the need for neutering all cats not intended for breeding, so the resources of all rescue organisations are not stretched to the limit.

Concise, practical guidance provided on practice notice boards and newsletters can help with preventing unwanted pregnancies and thereby reduce the numbers of unwanted kittens needing homes. It is suggested that neutering earlier may help, i.e. before the females become pregnant.

The biggest problem is a lack of knowledge of the reproduction process – many owners believing that a litter is required before neutering or that cats cannot become pregnant before 12 months of age!

Research commissioned by the RSPCA in 2012 revealed that 14% of first litters are born to cats less than six months old, 85% of litters are unplanned, and there is confusion about when a cat can become pregnant and when to neuter.