Canine Blood Transfusions

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Abstract
Blood transfusions in canine have become increasingly common and are an integral part of lifesaving and advanced treatment of the critically ill patients. Total blood volume in dogs is approximately 90 ml/kg body weight. The dogs have at least thirteen different blood groups but there are currently eight internationally serologically recognized blood group antigens labeled as DEA 1 to 8. Although transfusions are beneficial but they are also associated with adverse events that can be themselves life threatening.

Keywords: Blood; Canine; Transfusion

Introduction
Blood transfusions in canine have become increasingly more common and are an integral part of lifesaving and advanced treatment of the critically ill patients where restoration of oxygen carrying capacity of blood, volume replacement and coagulation factors replacement are required (Pichler and Turnwald, 1985), white blood cells and very rarely non-hemostatic proteins ( Cotter, 1988). There is a lack of blood typing reagents, suitable donors and commercial blood banks. This situation is beginning to change and this review article focuses on practical and accessible transfusion methods for dogs.

Donor
Donor animals should be fit and healthy enough before making a blood donation to minimize the risks of donation. Donor dogs should be 25 kg or more, aged between 1-8 years and should be calm and easily restrainable and able to stay still for about ten minutes. Furthermore, he has up-to-date vaccinations, worm preventative and should never have had a blood transfusion. The bitch should neither be pregnant nor produced a litter previously. The donor should be negative for Ehrlichia canis, Babesia canis, Haemobartonella canis, brucella canis and for microfilaria of Dirofilaria immitis (Sackman, 1998). For transfusion in neonatal animals, the dam of the recipient is usually the most suitable donor. In case of hemorrhagic disease affecting more than one dog, a donor from other region should be sought.

Although either sex can be blood donor but male donor should be given preference than female donor because of high haematocrit and hemoglobin levels along with heavier body weight. Clinically healthy, fully vaccinated dog having a PCV more than 40 %, hemoglobin not less than 13% and ideally negative for DEA 1, 1.3 and 7 with normal concentration of Von Willebrand's factor (vWF), is the best donor and if possible donor should be of same breed. Cross-species (heterologous) transfusion is contraindicated because it can cause adverse reaction to foreign cells or proteins in recipients (Gordan, 1987). With adequate husbandry and nutritional support 20-25 ml/kg body wt. blood can be routinely withdrawn every three weeks.

Blood Collection
Small amount of blood (up to 75 ml) can easily be drawn into plastic syringe containing anticoagulants. Large amount of blood is usually taken into standard human blood bags that contain anti-coagulant. Several 2 ml aliquots of blood or packed cell can be attached to
commercial blood bags for later use in cross matching without entering the main unit container (Authement et al., 1987). The blood bag is gently agitated during collection to ensure thorough mixing with anticoagulant. Ideally, the blood is collected aseptically from the jugular vein or carotid artery (Sackman, 1998). Total blood volume in dogs is approximately 90 ml/kg body weight (Turnwald and Pichler, 1985) and they can donate 10 per cent of their total blood volume with no adverse effects. When over 10 per cent of a donor’s blood volume is to be collected intravenously fluids should ideally be administered in order to prevent hypovolemia (Sackman, 1998). Crystalloid solution should be given at twice or thrice the volume of blood to be collected, as they will be redistributed throughout both the intravascular and extravascular spaces. A standard blood donation in the dog is 450 ml (‘one canine unit’) and this can safely be obtained from a 25 kg dog. Smaller amounts may be obtained from smaller dogs.

Blood types
Blood groups are determined by genetically controlled, polymorphic, antigenic components of the RBC membrane. The allelic products of a particular genetic locus are classified as a blood group system. The dog has at least 13 different blood groups but there are currently 8 internationally serologically recognized blood group antigens labeled as DEA 1 to 8. There are two alternate alleles at the DEA locus. Dogs have either DEA 1.1 or DEA 1.2 antigen on the surface of RBCs are designated DEA positive or A+. About 60% of total dogs are A+ and rest are A negative (A-) (Doods and Bull, 1979). An old classification system used letters to name the antigens. The new classification system is called the Dog Erythrocyte Antigen (DEA) system (Table-1). Normally, an individual does not have antibodies against any of the antigens present on its own RBC or against other blood group antigens of that species’ systems unless they have been induced by transfusion, pregnancy, or immunization. Therefore, crossmatching in dogs does not need to be done on the first transfusion.

The major antigens are DEA 1.1 and DEA 1.2. Acute hemoiytic transfusion reactions only occur in DEA 1.1 and 1.2 negative dogs. A true universal donor for dogs is negative for DEA 1.1, 1.2 and 7. In practice, many clinicians use dogs that are dog erythrocyte antigen 1.1 and 1.2 negative as universal donors (Kerwin and Mauldin, 2003).

Cross-matching
Crossmatch detects the presence of pre-existing antibodies that produce an immediate hemolytic reaction (Doods and Bull, 1979). The crossmatch tests only for antibodies to red blood cells and not to white blood cells or platelets; therefore, immunogenic transfusion reaction are still possible (Harrell and Kristensen, 1995). Dogs that have not been previously sensitized usually have no problems after receiving uncross matched blood during their first transfusion (Feldman and Kristensen, 1995).

Crossmatching procedure
Anticoagulated blood and serum are collected from donor and recipient. RBC are washed in 0.9% saline solution and prepared 5-10% RBC suspension. In major crossmatch, 2 drops of donor cells and 2 drops of recipient serum are put and mixed. In minor crossmatch, 2 drops of recipient cell and donor serum are put. Controls are set with serum and cells of donor and recipient separately. It is incubated for 30 min at room temperature, centrifuged for 1 min at 1000 rpm. The tubes are examined for hemolysis, the tubes are shaken to resuspend cells and check for hemagglutination microscopically. Incompatibility in minor crossmatch can be used if other compatible donor is not available. Crossmatch is repeated if more than 4 days elapsed between transfusions. Crossmatching is not required if platelets or cryoprecipitate is to be transfused.

Recipient
The most important factor in determining the need of transfusion is the clinical condition of the patient. The recipients may be in need of replacement of red blood cells as in cases of blood loss anaemia, non-regenerative anaemia, hemolytic anaemia or animals requiring replacement of haemostatic proteins in conditions like hemophilia A and B, Von Willebrand’s disease, hepatic dysfunction, Vitamin-K deficiency in rodenticide poisoning. The transfusion automatically is performed
Table 1: Classification of blood with their transfusion significance in dogs

<table>
<thead>
<tr>
<th>DEA Group</th>
<th>Old name</th>
<th>Natural antibody</th>
<th>Transfusion significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>A1</td>
<td>No</td>
<td>Clinically significant antibody - can cause an acute hemolytic transfusion reaction</td>
</tr>
<tr>
<td>1.2</td>
<td>A2</td>
<td>No</td>
<td>Clinically significant antibody - can cause an acute hemolytic transfusion reaction</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>Yes</td>
<td>Possible delayed reaction. No hemolytic transfusion reaction.</td>
</tr>
<tr>
<td>4</td>
<td>C</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>D</td>
<td>Yes</td>
<td>Possible delayed reaction. No hemolytic transfusion reaction</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>7</td>
<td>Tr</td>
<td>Yes</td>
<td>Possible delayed reaction. No hemolytic transfusion reaction. Usually reacts only at colder temperatures.</td>
</tr>
<tr>
<td>8</td>
<td>He</td>
<td>No</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

whenever a patient’s PCV drops below 20 per cent (Pichler and Tumwald, 1985). Usually a post transfusion PCV of 25-30 per cent in dogs will be sufficient to reverse the signs of anemia without significantly damping the regenerative response. The required blood volume by the recipient is calculated by using the following equation (Pichler and Tumwald, 1985).

**Blood volume to be transfused (ml) = Required PCV-Recipient PCV / PCV of Donor x 90 x b. wt. in kgs**

The dose is calculated on the basis of hemoglobin content of recipient and the percentage to which it has to be increased. Since an animal contains 40 ml of blood per pound body weight. The formula used in calculating the dose:

\[
\text{ml of blood required to rise the Hb level by 1 percent} = 40 \times \text{b. wt. in pounds} / 100
\]

In dogs with anemia, 2 ml of whole blood per kilogram will raise the PCV by 1% when the PCV of donor blood is 0.41 l/l. If packed cells are used, 1 ml/kg will raise the PCV by 1% (Sackman, 1998).

**Storage**

Donor blood and blood products can be stored for different time intervals. Citrate phosphate dextrose adenine (CPDA) and acid citrate dextrose (ACD) @ 15 ml/100 ml of blood are two best solutions for prolonged storage (Doods and Bull, 1979). Citrate in these solutions acts as by inhibiting the calcium dependent steps of clotting cascade. The other additive acts as buffer and energy source for red blood cells. Heparin is another common anti-coagulant; which is not recommended for dogs, as it activates platelets due to its longer half-life in recipients (Cotter, 1988). Collected blood, mixed with CPDA, can be stored at 4 °C, for 4 weeks while with ACD for 3 weeks (Authement et al., 1987). Plasma can be removed from the blood for prolonged storage. Plasma should be frozen at -20 to -30 °C within 6 hours of separation, which ensure its quality and is usable for 1 year (Greene and Beck, 1980). Bacterial contamination of blood will result in a severe transfusion reaction; hence blood must be stored in a sterile fashion. Blood for thrombocytopenic patients must be used within 8-12 hours of collection as platelets will rapidly clump and become dysfunctional (Sibinga, 1987).

**Canine Blood Bank in India**

Initially, veterinarians were mostly using either in
**Canine Blood Transfusions**

### Table 2: Blood component and their uses in canine practice.

<table>
<thead>
<tr>
<th>Indication</th>
<th>First Choice</th>
<th>Second Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemia</td>
<td>Red Cell Concentrate</td>
<td>Whole Blood</td>
</tr>
<tr>
<td>Warfarin poisoning, Parvovirus infection, Anti Vitamin-K intoxication, Hemophilia B, Hemophilia C (Factor XI deficiency), Factor VII deficiency,</td>
<td>Factor X deficiency, Plasma</td>
<td>Fresh Frozen Plasma (FFP)</td>
</tr>
<tr>
<td>Von Willebrand's, DIC, Hemophilia A, Prothrombin Deficiency, Disfibrinogenemia, Hypofibrinogenemia</td>
<td>Cryoprecipitate</td>
<td>Fresh Frozen Plasma (FFP)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>Cryosupernatant Plasma</td>
<td>Plasma</td>
</tr>
<tr>
<td>Hypoproteinemia (Renal Disease, Malnutrition, Liver Disease)</td>
<td>Intravenous colloid</td>
<td>Plasma</td>
</tr>
<tr>
<td>Immune Mediated Thrombocytopenia</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

### Table 3: Guideline for transfusing blood product (Brooks, 1992)

<table>
<thead>
<tr>
<th>Blood product</th>
<th>Rate ml/min</th>
<th>Volume to transfuse ml/kg</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product that supply red blood cells</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh whole blood</td>
<td>6</td>
<td>12-25</td>
<td>Every 24 hours</td>
</tr>
<tr>
<td>Stored whole blood</td>
<td>6</td>
<td>12-25</td>
<td>Every 24 hours</td>
</tr>
<tr>
<td>Packed red cells</td>
<td>6</td>
<td>6-10</td>
<td>Every 24 hours</td>
</tr>
<tr>
<td>Product that supply platelets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh whole blood</td>
<td>6</td>
<td>12-25</td>
<td>Every 24 hours</td>
</tr>
<tr>
<td>Fresh/fresh frozen plasma</td>
<td>6</td>
<td>6-10</td>
<td>Every 24 hours</td>
</tr>
<tr>
<td>Cryoprecipitate*</td>
<td>10</td>
<td>1 unit/ 10 kg</td>
<td>Every 8-12 hours</td>
</tr>
<tr>
<td>Cryosupernatant **</td>
<td>10</td>
<td>6-10</td>
<td>Every 8-12 hours</td>
</tr>
<tr>
<td>Platelet-rich plasma</td>
<td>6</td>
<td>6-10</td>
<td>Every 8-12 hours</td>
</tr>
<tr>
<td>Platelet concentrate*</td>
<td>10</td>
<td>1 unit/10 kg</td>
<td>Every 8-12 hours</td>
</tr>
</tbody>
</table>

For treating hemorrhagic shock maximum dosage and rate= 22 ml/kg/hr

* Cryoprecipitate supplies active factor VII, WVF and fibrinogen. One unit of cryoprecipitate is derived from 150 ml of plasma.

** Cryosupernatant supplies active prothrombin group factors, albumin and globulin.

# One unit of platelet concentrate id derived from 500 ml of whole blood.

House blood donors kept at veterinary clinics or borrowed dogs owned by client or staff. Recently, commercial canine blood banks and community voluntary donor programme became available. Currently canine blood banks are available in India at

- Bombay Veterinary College, MAFSU, Mumbai
- Bangalore Veterinary College, KVAFSU, Bangalore
- Madras Veterinary College, TANUVAS, Chennai

**Transfusion**

The blood bags should be inverted gently several times to resuspend the red cells but should not be shaken violently. When required, it is thawed or warmed, connected to an intravenous catheter and slowly transfused into a jugular or cephalic vein of the recipient. In severely hypotensive or
paediatric patients, the blood can be transfused into the bone marrow cavity of proximal femur using an 18-20 gauge intravenous needle or a spinal needle placed in the trochanteric fossa. Cold blood should not be infused as it is more viscous and therefore takes longer time to be transfused; it provokes vasoconstriction, lowers body temperature and may also produce cardiac arrhythmias. Dogs that require repeat transfusions are at higher risk of developing a sensitization to blood types and so must be cross-matched with the donor blood every time they receive a transfusion. Initially the infusion should be slow and the patient be watched carefully for any sign of transfusion reactions. If after 20-30 minutes there are no problems the rate of transfusion may then be increased.

**Blood Components**

Blood component and their uses in canine practice are presented in Table-2. Blood component therapy has many advantages like more efficient utilization of each unit of blood by taking the advantage of differential storage properties of various elements, reduces exposure of patients to unnecessary cellular elements and plasma proteins, minimizes bacterial contamination and eliminates risk of various non-immunogenic reactions like circulatory overload (Turnwald and Pichler, 1985). Guideline for transfusing of various blood components are presented in Table 3.

**Blood Substitutes**

An ideal substitute should carry and deliver oxygen like red cells, be easy to produce in large quantities, be non-antigenic, and persist in the circulation at least long enough for resuscitation. One hemoglobin-based oxygen carrier of bovine origin is currently licensed for use in dogs but not available in India (Oxyglobin ®, Biopure Corporation, Cambridge, MA).

**Risks of Transfusion**

Adverse reactions can be life threatening. If symptoms associated with a potential transfusion reaction are observed, following steps should be used:

1. Stop the transfusion
2. Determine the type of reaction
3. Initiate appropriate treatment (administer an antihistaminic and glucocorticoids)

There are two types of blood transfusion reactions, first one is immune reaction i.e. acute hemolytic reaction, delayed hemolytic reaction, febrile reaction, anaphylactic reaction while second type is non-immune reactions i.e. disease transmission, septicemia, air embolism, citrate toxicity, circulatory overload, hypercalcemia, hemorrhagic diathesis. During transfusion of blood, vital signs are usually monitored at every 15-minute intervals. Urticaria, erythema or pruritus, vomiting, vocalization, pyrexia, dyspnea, tachypnea, coughing, tachycardia or Bradycardia, tremors or convulsions, shock, cardiopulmonary arrest, anorexia and jaundice are important clinical signs of potential transfusion reactions. If there are any adverse reactions to the transfusion, such as an elevated temperature or hives, the transfusion should be halted and treatments of adverse reaction should start immediately (Gahlot, 2012).

**References**


Canine Blood Transfusions


Andhra Pradesh Veterinarian’s honoured

Dr. C. Krishna Rao Endorsement Trust facilitated Dr. K. Gunasekhara Pillai and Dr. M. Prabhakar, working at Assistant Director's, Department of Animal Husbandry, Andhra Pradesh with Best Field Veterinarian's Award.

Dr. M. Prabhakar was awarded with Sri. M.P. Seshaih Award for his efforts towards fodder conservation, improving fodder production and introduction of new varieties of fodder for improvisation of farming livelihood in Chittor division.

Dr. K. Gunasekhara Pillai is currently working at Rayachoti division of Kapapa district and was honoured with late Dr. B. Sudhakara Reddy Medal and late B. Ananth Reddy Medal for his 15 years of professional career and efforts towards educating farmers on adoption of newer managerial practices towards improving milk and fodder production, control of mastitis and protozoan diseases and drought mitigation programs.

The awards were conferred by Dr. V. Prabhakar Rao, Vice Chancellor, SVVU and Dr. Rishender Verma, Joint Director, CADRAD. Dr. Pillai and Dr. Rao have set up examples for other field Veterinarians to follow. We on behalf of the veterinary community, congratulate them for their untiring efforts towards the profession and improvement of the status of our stakeholders.