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Technical Article

Theoretical and Practical Approach for Blood Transfusion in Bovines and Canines

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Introduction:

Blood transfusion has been successfully used since the 20th century to save the life of animals, which were in the stage of severe anemia and hemorrhage. It involves the transfer of blood consisting of plasma, red blood cells, white blood cells and platelets. Experts in veterinary field have done blood transfusion in various animals, and also contributed a lot to transfusion medicine. They have even hinted the possibility of separating the whole blood into its fraction for most efficient use. The ability to separate the blood into fractions has helped improve the storage period and to specifically use the blood constituents depending on the requisite. Advanced screening facilities, testing blood groups, cross-matching of blood had made the process accurate. Due to the several antigenic combinations in blood groups of animals, probably there may not be any universal donors in animals. Although there are plenty of advantages of blood transfusion, it still poses several risk factors that need to be studied. The rapid advancement of Blood Transfusion in veterinary practice.

Fresh Whole Blood:

Fresh Whole Blood that is less than 8 hours old and has not been refrigerated and has all cellular and fluid components of blood. Stored Whole Blood is blood that is more than 8 hrs. old. It can be stored at 33.8-42.8°F (1 - 6 °C) for a maximum of 28-35 days.

- Treatment for anemia with thrombopathy or severe thrombocytopenia and disseminated intravascular coagulation
- Animals with severe trauma requiring massive transfusion
- Animals suffering from blood-related protozoal diseases like Anaplasmosis, Babesiosis
- Animals suffering from anaemia with hypoproteinemia
- For intravascular volume expansion and oxygen support

Packed RBCs:

Contains concentrated RBCs with a PCV of 80% depending on the anticoagulant used, it can be stored for 28 – 35 days.

- a. Animals with symptomatic anemia including anemia due to hemorrhage, hemolysis, renal disease and decreased production of RBCs (bone marrow suppression)
- b. Helps to increase RBC concentration in animals that require oxygen support

Platelet Rich Plasma (Platelet concentrate):

Obtained by centrifuging fresh blood at a rate slower than that used for production of packed cell volume and plasma. Difficult to store. Can be used within 48 hrs if kept away from light at room temperature. Should not be refrigerated.

- a) Consistently administered to animals with life-threatening hemorrhage due to marked thrombocytopenia
- b) To animals with hemorrhage secondary to congenital or acquired thrombopathy.

Fresh Frozen Plasma:

Can be stored at -4 to -22 °F (-20 to -30 °C) for a period of 1 year without harming the coagulation factors. Thaw the plasma carefully to 98.6 °F (37 °C) before use.

- a) For treating burns.
- b) In cases of anticoagulant rodenticide intoxication.
- c) It is used in coagulopathy due to factors II, VII, IX, X, XI, X, fibrinogen and anti-thrombin III.

Cryoprecipitate:

Cryoprecipitate is the cold, insoluble portion of plasma that precipitates after Fresh Frozen Plasma has been thawed slowly in the refrigerator at 33.8 to 42.8 °F (1 – 6 °C). It has a slushy consistency. It can be stored at -4 to -22 °F (-20 to -30 °C).

Blood and Blood Volumes of Animals:

Blood is the vascular connective tissue composed of fluid parts termed plasma and of corpuscles viz - erythrocytes or red blood cells, leucocytes or white blood cells and platelets. The shape and size of red blood cells vary in different animals e.g. Dog's RBC is a typical biconcave disk, whereas the Goat's RBC is more spherical. RBC shape in Camel is elliptical; in Deer it is sickle shaped. Humans and animals have blood volumes of 7% to 9% of their body weight. When there is a reduction in the blood volume, transfusion is generally required.

Animals	Blood volume (ml/kg)	Average body wt. (kg)	Total Blood Volume (ml)
<i>Cattle</i>	55	300	16500
<i>Goat</i>	66	20	1320
<i>Sheep</i>	66	35	2310
<i>Dog</i>	86	25	2150
<i>Cat</i>	55	5	275
<i>Pig</i>	65	60	3900
<i>Horse</i>	76	450	34200

Blood Types:

Every species has specific cell surface antigens on its RBC which differ leading to the development of the blood groups in animals. In animals, there is a combination of blood factors leading to the terminology of Blood grouping system rather than blood groups. Blood groups are produced by the presence of species-specific antigens on the cell membrane of red blood cells. These factors cause a devastating role in causing adverse-systemic reactions following transfusion. Antigens can also get adsorbed onto the leucocytes, platelets, and plasma protein failing transfusion. When these antigens encounter other organisms either by transfusion or through transplacental exposure, it induces the production of antibodies in the young ones and even causes neonatal isoerythrolysis in certain species in puppies, kittens and foals.

Species	No. of Blood Group	Description
<i>Cattle</i>	11	A, B, C, F, J, L, M, R, S, T, Z
<i>Sheep</i>	8	A, B, C, D, M, R, X
<i>Goat</i>	6	A, B, C, M, J
<i>Horse</i>	8	A, C, D, K, P, Q, U, T
<i>Pig</i>	15	A-O, C, F, G, H, I, J, K, L, N, O
<i>Dog</i>	9	DEA1.1, 1.2, 3,4,5,6,7,8, Dal antigen
<i>Cat</i>	4	A, B, AB, Milk antigen
<i>Chicken</i>	13	A, B, C, D, E, H, I, J, K, L, N, P, R

Mandatory Blood Typing and Cross-Matching:

Blood Typing:

It is a technique by which the surface antigen of the erythrocytes can be identified. It works well to screen the blood donors of the animals before crossmatching and transfusion. They are determined in the laboratory and even blood-typing kits like card-based agglutination assay, immunochromatographic cartridge and gel column diffuse assay are available in the market. These cards are available for both felines and canine's blood- typing and can detect DEA 1.1 and felines type A, B, and AB. In samples of canine blood that is potentially DEA 1.1 – negative, the laboratory can also type the blood or DEA 1.2 to confirm that RBCs are negative for both DEA 1 alleles which could mean that dog is a Universal donor.

Cross-matching:

Performing the cross match is an intimidating but simple procedure, once all the equipment is

assembled. Not all protocols recommended the use of phosphate buffered saline, other have an additional step at the end using species specific Combs reagent to the test sensitivity and some recommend that tubes be incubated at 4^o C, 37^o C, and 42^o C.

The following is protocols that are uses

1. Obtain EDTA anticoagulated blood from the recipient and the potential donor or the tube segments of blood from the units being considered for blood transfusion.
2. Centrifuge both donor and recipient blood for 5 minutes at 1000 rpm.
3. Using pipettes, remove the plasma and save in separate labeled tubes.
4. Wash the red blood cells by adding phosphate buffered saline to the red cells to fill the tube. Resuspend the red cells in the saline by tapping the bottom of the tube with a finger.
5. Centrifuge the red cells and saline for 5 minutes at 1000 rpm. Pipette off saline and discard.
6. Repeat steps 4 and 5 twice.
7. After third washing of the red cells in saline, resuspend the red cells to a 3% to 5 % solution. It will appear bright cherry red.
8. For each potential donor, mix two drops of recipient plasma and one drop of donor red cell suspension for the **major cross match**. Mix gently.
9. For each potential donor, mix the two drops of donor plasma and one drop of recipient red cell suspension for the **minor cross match**. Mix gently.
10. For recipient control, mix two drops of recipient plasma and one drop of recipient red cell suspension. Mix gently.
11. Incubate the tubes at room temperature for 15 minutes.
12. Centrifuge the tubes for 15 seconds at 1000 rpm.
13. Observe the plasma for hemolysis.
14. Resuspend the centrifuged cell by shaking gently.
15. Observe the red blood cells for agglutination.
 - Major cross matching = Recipient's Plasma + Donor's RBC
 - Minor cross matching = Recipient's RBC + Donor's Plasma
 - Recipient's control = Recipient's Plasma + Recipient's RBC

Blood Bags Availability for Animals:

Blood bags 150 ml, 350 ml and 1.5 litre available in India. Commercially available Collection Bag of different sizes, e.g. 1.5 Liter Bag for Large animals (Bovine and Equine) and 350 ml Bag for Small animals (Such as Dog, Cat, Sheep and Goat) and 150 ml for pets.

Donor Selection and Screening:

To ensure safe and effective animal blood transfusion, donor animals whether canine, feline, or

livestock must meet the following criteria:

A. General Health and Suitability:

- Must be clinically healthy with no signs of systemic illness.
- Free from tick-borne and vector-borne diseases
- Should be docile and temperamentally suitable for handling during donation.
- Not under any ongoing medication or treatment.

Restoration of blood volume and its components occur within 2 weeks of blood withdrawal in healthy animals. Though volume is often replaced within 24 hrs., two to four weeks may be required to replace all blood constituents. As a general principle, sample volumes and number of samples should be kept to a minimum.

B. Age and Weight Requirements:

- **Dogs:** Age 1–8 years, minimum body weight 5-7 kg (small breeds), 15-20 Kg (medium breeds) and 25 kg (large breeds)
- **Cats:** Age ideally 1–5 years, minimum body weight 4 kg, not obese.
- **Livestock:** Healthy adults selected based on species-specific clinical norms.

C. Vaccination and Reproductive Health:

- Donors must be vaccinated against major infectious diseases, especially against rabies. Must have a thorough vaccination history.
- Should be regularly dewormed.
- Female animals must not be pregnant or recently lactating

D. Donation Frequency:

- **Dogs:** Eligible for donation every 4–6 weeks.
- **Cats:** Eligible every 8–12 weeks.
- A minimum 30-day interval between successive donations is mandatory.

E. Mandatory Pre-Donation Screening:

- A clinical examination and history review must be conducted before every donation.
- Laboratory parameters to be assessed:
 - a) Packed Cell Volume (PCV): $\geq 35\%$
 - b) Hemoglobin (Hb): ≥ 10 g/dL, Platelet count: $> 200,000/\mu\text{L}$
 - c) Total protein: Within species-specific normal limits

F. Infectious Disease Screening:

Donors must, at a minimum, test negative for transfusion-transmissible infections:

- **Dogs:** Hemoprotozoan infections (e.g., Babesia, Ehrlichia), and von Willebrand factor levels (if indicated)

- **Cats:** FeLV, FIP (Feline Infectious Peritonitis), Haemoplasma, and optionally Bartonella spp.
- **Livestock:** Should be free from Brucellosis, trypanosomiasis, babesiosis, and theileriosis

Blood Collection and Processing:

Blood collection must follow species-specific protocols to ensure donor welfare, maintain blood quality, and minimize transfusion risks. The jugular vein is the preferred site across species due to its size and accessibility. Aseptic preparation of the collection site is mandatory in all cases.

A. General Principles:

- Closed collection systems are recommended for dogs and livestock to prevent contamination and ensure sterility.
- Open systems may be used for cats, but only when a closed system is not feasible.
- Anticoagulants must be used appropriately based on species and collection volume (Table 1).
- Blood collection must be performed by trained personnel under veterinary supervision.

B. Blood Volume Guidelines and Anticoagulants:

Table 1: Quantity of blood that can be collected from the animal

Species	Safe Blood Volume	Recommended Anticoagulant	Anticoagulant-to-Blood Ratio
<i>Dog</i>	10-15 ml/kg body weight	CPDA-1	1 mL per 9 ml of blood
<i>Cat</i>	10-12 ml/kg body weight	CPDA-1 or ACD	1 ml per 9 ml (CPDA-1); 50 ml per 450 ml (ACD)
<i>Cattle/Buffalo</i>	Up to 1.6% of body weight (max ~6-8 L)	Sodium Citrate or ACD	100 ml /L (sodium citrate); 50 ml per 450 ml (ACD)
<i>Horse</i>	6-8 liters	CPDA-1 or ACD	Species-specific; veterinary discretion

Table 2: Blood Collection details in Dogs and Cats

Species	Donated Volume of blood	Needle gauge (G)	System of blood collection
<i>Dog</i>	10%	16-18	Closed
<i>Cat</i>	60 ml at a time	19-21	Open

C. Collection Protocol:

- Use sealed bags compatible with anticoagulants for collection and storage.
- In livestock, use specially designed 1.5-liter blood collection kits pre-loaded with anticoagulants.
- Gentle continuous shaking of the blood bag is necessary during collection to prevent clotting.
- Blood volume collected should be based on:
 - a) Donor's body weight
 - b) Expected packed cell volume (PCV) required for the recipient

Administration Route:

- Preferred route is intravenous via the jugular or cephalic vein.
- For neonates or critical patients, intraosseous access may be used when venous access is not possible.

Rate and Duration of Transfusion:

- **Start slow:** 0.5–1 mL/kg/hr for the first 15–30 minutes to monitor for adverse reactions.
- **Dogs and Cats:** Total transfusion must be completed within 2 hours.
- **Farm Animals:**
 - a) Begin gradually for the first 30 minutes.
 - b) Transfusion rate gradually increases at the rate of 1-5 ml/kg/hr
 - c) Total transfusion time should not exceed 4 hours.

Equipment and Asepsis:

- Blood should be warmed to body temperature (37°C) before transfusion if blood store in refrigerator.
- Use non-heparinised saline to prime the IV line (never mix with calcium-containing fluids).
- Employ blood administration sets with inline filters (170–260 µm) to remove clots and debris.
- Use extension lines connected from the fluid pump to the catheter to maintain sterility.
- Ensure sterile technique during all handling of blood products.

Methods of Blood Collection:**A. Open System:**

It refers to the system where the microbial-free environment is not guaranteed and so the shelf life of blood is spontaneously reduced. It is preferred in cats since only a small amount of blood is generally transfused and can be collected by syringe.

B. Closed System:

In this system, the sterility of the blood is maintained. This is suitable for processing and storage of blood and blood products. It holds well in case of canines.

Procedure Of Blood Transfusion:**A. Farm Animals:**

- a) The blood transfusion kit consists of a blood collection bag having a capacity of 2 liters with an anticoagulant.
- b) Anticoagulants like Sodium citrate (100ml/L of blood), Acid citrate dextrose (50ml/450ml of blood) can be used in preserving blood.
- c) Cattles can donate blood up to 1.6% of its body weight.
- d) Once everything is prepared, Blood can be collected from the donor by jugular venipuncture. Collect blood with anticoagulants and slowly shake it.
- e) Transfusion should be done carefully by noticing the adverse reaction even though the effect is less during the first transfusion.
- f) The transfusion reactions include increased respiratory rate, tachycardia, sweating, violent movements.

- g) It is advised to transfer the blood into the recipient gradually for the first 30 minutes. Importantly, the process should not exceed more than 4 hours.
- h) Do not administer calcium or hypotonic fluids immediately after blood transfusion, as it may lead to hemolysis.

B. Dogs and Cats:

- a) Identify the transfusion recipient.
- b) Blood transfusion can commence after Typing / Cross-match of blood is done.
- c) Collect blood aseptically from the jugular vein.
- d) Dogs can safely donate 15-20ml/kg, whereas cats can donate 10-12ml/kg body weight.
- e) Blood should be collected into sealed, gas diffusible blood bags with the use of an anticoagulant (CPDA-1 at a ratio of 1 ml of anticoagulant per 9ml of blood).
- f) The amount transfused to the animal is calculated based on the bodyweight and Packed Cell Volume.
- g) Precautions to be followed:
 - Warm the unit of blood to be administered, to body temperature
 - Suitable IV catheter should be used to render RBCs undamaged. To prime the line, a non heparinised saline is used.
 - Blood filter is commonly used to remove clots, that may have formed during the collection and storage process. From the fluid pump, extension lines are placed to comfortably reach the patients and are attached to the part on the IV catheter.
 - Initial stages of transfusion should be done slowly to monitor for an acute reaction
 - Vital signs should be checked every 15 minutes during the first 30 minutes and every 15 to 30 minutes thereafter.
 - All transfusions should be administered within 4 hours to prevent the risk of contamination.
 - After completion, a post-transfusion PCV is performed to assess the patient.

Monitoring and Reaction Management:**A. Monitoring Schedule:****• During Transfusion:**

- a) First hour: Monitor vital signs every 15 minutes.
- b) Subsequent period: Monitor every 30–60 minutes.

• Post-transfusion:

- a) Evaluate Packed Cell Volume (PCV) 2–4 hours after transfusion to assess efficacy.
- b) Continue clinical observation for at least 2 hours post-transfusion.

B. Common Signs of Acute Transfusion Reaction:

- a) In farm animals: Increased respiratory rate, tachycardia, sweating, muscular tremors, violent movements.
- b) In dogs and cats: Fever, vomiting, facial swelling, restlessness, panting, urticaria, or collapse.

C. Emergency Response Protocol:

- a) Stop transfusion immediately if any acute reaction is suspected.
- b) Administer appropriate supportive care: Antihistamines (e.g., diphenhydramine), Corticosteroids, IV fluids if required—but avoid hypotonic or calcium-containing solutions immediately after transfusion due to the risk of hemolysis

Summary:

Blood transfusions can be life-saving in a number of clinical situations. Used prudently, with forethought and adequate preparation, the risks associated can be minimized.

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***“Veterinary Officer and Assistant Commissioner of Animal Husbandry
are involved in Blood Transfusion in different field condition”***