

Chapter 20

Transfusion, conservation of blood and blood components in dogs and cats

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Raimundo Nonato Colares Camargo Júnior

Doctor Vet. Federal Institute of Education, Science and Technology - IFPA
E-mail: camargo.jr@ifpa.edu.br

Ana Beatriz Pantoja Neves

Academic of the veterinarian course. University Center of the Amazon - Unama

Brena Peleja Vinholte

Veterinary Doctor. University Center of the Amazon - Unama

Matheus Junott Miranda

Academic of the veterinarian course. University Center of the Amazon - Unama

Edicleya Marinho Guimarães

Veterinary Doctor. University Center of the Amazon - Unama

Helder Ribeiro Batista

Veterinarian. University Center of the Amazon - Unama

Jaciara Simone Sarmento Gomes

Veterinary Doctor. Prefeitura Rurópolis City Council

Albiane Sousa de Oliveira

Veterinary Doctor. Federal University of Mato Grosso do Sul – UFMS

Anna Claudia de Sousa Lins

Academic of the veterinarian course. University Center of the Amazon - Unama

Welligton Conceição da Silva

Veterinarian. University Center of the Amazon - Unama

ABSTRACT

Transfusion therapy in veterinary medicine is a practice that is growing more and more, being used as a supportive treatment for dogs and cats, mainly with the use of whole blood, which seeks to reestablish the ability to transport oxygen to tissues, in addition to correcting other deficits, as in the case of severe anemias and blood losses. Although there are still indications for the use of whole blood, currently the bags are centrifuged for separation of blood components, favoring the more economical use of whole blood. The blood enabled to the transfusion process should be stored in plastic bags, however, during the conservation period, the blood tissue suffers increasing lesions, and these changes are known together as storage lesions. Deficiency in monitoring these changes over the preservation period may make blood use unfeasible or decrease its effectiveness after transfusion. Therefore, it is important to disseminate information about the whole process, as well as the correct use of blood components, in order to subsidize donation programs and veterinary blood banks. This chapter aims to conduct a literature review to highlight advances in transfusion medicine and the conservation of blood and blood components in dogs and cats.

Keywords: Hemotherapy, Whole blood, Pets.

1 INTRODUCTION

One of the techniques of veterinary medicine used in small animal hemopathies is blood transfusion that refers to the transfer of whole blood, or its products, from a donor individual to a recipient, in order to temporarily recover a deficiency or dysfunction (BAETA et al, 2015; PENHA et al., 2022).

Although transfusion medicine deserves recognition of its significant improvement in recent years, in Brazil, these veterinary hemotherapy services are growing more and more, since the number of research this field in educational institutions has increased (PRADO, 2011, SANTOS, et al, 2013, FLUMARI, 2017).

Although blood fractionation techniques are known to obtain its components, the conservation and

use of whole blood is still the most widespread and used form in veterinary centers (LUCAS et al., 2004; COSTA JÚNIOR, 2006; SOUSA et al., 2012).

There are a number of modifications that are known as storage injuries, which can also generate irreversible damage and reduce post-transfusal survival. This happens when the removal of the whole blood from the circulation in vitro, transfers the erythrocytes to an environment different from that found in the living organism, promoting during its preservation, a series of hematological, morphological and biochemical alterations (NEVES et al., 2021).

According to Patterson et al. (2011), acute transfusion reactions can be caused by blood bags maintained at inadequate temperatures for periods longer than one month.

Veterinarians are responsible for expanding their knowledge on the subject and correctly applying them in their routine. That said, the objective of this study was to conduct a review of the literature on advances in transfusion medicine and the conservation of blood and blood components in small animals.

2 LITERATURE REVIEW

Intravenous therapy with whole blood or blood components, as it is called transfusion, exists to combat various clinical manifestations as which includes anemia, hemorrhage, coagulopathy, pancreatitis and hypoproteinemia (GOMES, 2008), being considered key component in modern intensive therapy, since it brings improvement in the oxygen transport to tissues (HESS, 2009).

The practice took strength due to military needs during the world wars, when the practice and science of blood transfusion was stimulated, through the selection of donors, blood fractionation, the discovery and clinical applications of the "Rh system", in addition to the development of the blood bank, which is torn or possible because of the use of anticoagulants and preservatives (BOULTON; ROBERTS, 2015, BOULTON, 2017).

In the 1940s, Brazil was represented in hemotherapy in a remarkable way, with the foundation of the Blood Transfusion Service of Rio de Janeiro, as well as the emergence of other hemotherapy services such as the Blood Bank of Santa Casa de Porto Alegre and the Blood Bank of the Emergency Room of Recife (VIZZONI, 2015).

Therapy with blood components aims to: increased oxygen capacity, replacement of absent or dysfunctional hemostatic components, replacement of proteins to increase oncotic pressure, replacement of leukocytes and volume expansion to increase hydrostatic pressure (NOVAIS, 2004).

In veterinary medicine, much of the experience gained in hemotherapy in people has been used. In a similar way, donors are also recommended to be hygienic in dogs and cats. Therefore, they should be vaccinated and may not present with hemoparasites and other infectious diseases. In addition to the donor canine and feline females should be nulliparous and castrated (FIGUEIREDO et al., 2016).

In addition, it is recommended that dogs be 27kg or older, age between one and eight years, have

docile behavior in order to allow to go and facilitate containment and have no history of heart murmur or convulsions. In addition, they should not be receiving medication and should be under constant control of ectoparasites (GOMES, 2008).

The tests for recommended infectious diseases for donor dogs are Babesiosis, Leishmaniasis, Ehrlichiosis, Brucellosis, Anaplasmosis, Rickettsiosis, Trypanosomiasis and Bartonellosis.

Dogs can donate about 15 to 20% of the blood volume, having as a maximum dose to be given 18 ml/kg. They can donate every 3 or 4 weeks, as long as they receive balanced nutrition in adequate quantity (LACERDA, 2008).

Blood fractionation allows more than one patient to benefit from only one donor, because often the patient who requires a transfusion needs only one specific blood component (SOUSA et al., 2012).

Thus, it is safe to affirm that the fractionation of the blood and the use of its various components allows the most economical use of whole blood and avoids unnecessary exposure of the recipient to other components and antigens present in the total blood of the donor.

Given the importance of fractionation, it should be emphasized that the viability of stored blood is directly related to the harvesting technique used, the available anticoagulant, the storage temperature, biochemical parameters and the frequency of homogenization during storage, the latter in the case of platelet conservation (AUTHEMENT et al., 1986; HÖGMAN et al., 2002).

According to Holme (2005), for blood collection and storage, three main types of preservative solutions are used: ACD (Citrate Dextrose), CPD (Citrate Phosphate Dextrose) and CPDA-1 (Citrate Phosphate Dextrose and Adenine).

Stocked whole blood can be used to provide red blood cells, plasma proteins, and stable coagulation factors such as fibrinogen. The correction of anemia is the first indication for hemotherapy in dogs and cats, this anemia can have different causes that are divided into three main groups: anemia caused by blood loss, destruction of erythrocytes (hemolysis), or insufficient production (HELM & KNOTTENBELT 2010; HOHENHAUS, 2010).

Red blood cell porridge is indicated for patients with chronic hemorrhage, inefficient erythropoiesis, and hemolysis, i.e., they are normovolemic anemic patients. Red blood cells concentrate has an advantage over fresh or stored whole blood, as they reconstitute the same amount of red blood cells contained in the bag, but with lower volume, benefiting patients with heart disease and nephropathic (NEVES et al., 2021).

According to Gomes (2008), the primary indication of platelet concentrate is for thrombocytopenic patients. Because it is of smaller volume, when compared with whole blood and red blood cell porridges, it allows the transfusion of large amounts of platelets without simultaneous transfusion of erythrocytes or plasma, reducing the risks of transfusion reactions.

Fresh Frozen Plasma (CfP) is obtained after centrifugation and separation of whole and frozen blood within six hours, which prevents the degradation of coagulation factors. It can be kept frozen for up to one year, as long as it is stored between -18°C and -4°C , however, it is a fact that there will be degradation of

coagulation factors in two or three months after harvest (HELM; KNOTTENBELT, 2010).

Within one year of storage, the PFC contains Von Willebrand factor (vWF) and coagulation factors II, VII, VIII, IX and X. After this storage period, the PFC is reclassified as Frozen Plasma (PC) and can remain frozen for another four years (CHIARAMONTE, 2004).

The indication of PC use is the deficiency of non-lavulary coagulation factors, as in rodenticide poisoning in addition to the treatment of coagulopathies (hereditary, paraneoplastic syndromes, liver diseases, dicumarinics, disseminated intravascular coagulation), hemophilia A and B (factors VIII and IX, respectively), pancreatitis, hypoproteinemias and parvovirus (HELM & KNOTTENBELT, 2010).

Before its administration, it should be subjected to defrosting in a water bath with a plastic wrap so as not to allow water to enter the porous bag and, if not used immediately, it should be stored in a refrigerator to maintain factor VIII (GONÇALVES, 2009; NOVAIS, 2004).

After 24 hours of storage clotting factors lose their activity, some authors recommend use within a period of 4 hours (TRHALL, 2006).

The main difference is that CP loses the action of coagulation factors V, VIII and vWF and plasma proteins, but still contains the factors dependent on vitamin K, i.e., coagulation factors II, VII, IX and X (CHIARAMONTE, 2004; BRASIL, 2008).

Cryoprecipitate is composed of approximately 20% fibrinogen, 50% coagulation factor VII and 30% factors VIII, XIII and vWF. To obtain it, the PFC unit must be heated to 4°C and then centrifuged, forming a white precipitate. Like the PFC, it is ideally stocked between -18°C and -20°C for up to a year (CHIARAMONTE, 2004; HELM & KNOTTENBELT, 2010).

Preservative solutions have been developed and improved to maintain erythrocytic energy metabolism through glycolysis and ensure cell viability during blood storage (SECCHI, 2010).

Measures such as the choice of the most appropriate preservative solution, storage temperature control, packaging type and appropriate handling during the storage period aim to minimize injuries resulting from blood storage (AUTHEMENT et al., 1986).

These injuries, which occur in vitro, alter blood components and decrease the survival of erythrocytes, both during storage and after transfusion in the patient (HALE, 2006).

The bags for the conservation of whole blood used in veterinary medicine are the same as those used in human medicine, which have a conservative solution in the proportion of 63 mL to 450 mL or 70 mL to 500 mL of total blood, while the bags with additive solutions also have a solution of 100 mL to be added after collection. They can be found in the form of a single bag, or coupled forming double systems (primary bag and another satellite), triple (primary pouch, plus two satellites) or quadruple (one primary and three satellites). Satellite pockets are used to store blood components after total blood centrifugation, such as red blood cell concentrate, plasma and platelets (FELDAM; SINK, 2007).

Each constituent of the preservative solution has specific functions that help maintain blood viability for longer. Citrate is an anticoagulant that acts by chelating calcium and preventing blood coagulation, as

well as promoting the stabilization of the erythrocyte membrane, assisting in the maintenance of intracellular pH (AUTHEMENT et al., 1986; HÖGMAN et al., 2002).

Phosphate is a substrate for the production of 2,3 diphosphoglycerate (DPG) inside red blood cells (EISENBRANDT) (EISENBRANDT; SMITH, 1973; WARDROP et al., 2005). 2,3-DPG is a molecule that is present inside erythrocytes and binds to the β subunit of hemoglobin, being responsible for releasing oxygen to tissues.

The lower the levels of 2,3-DPG, the greater the affinity of hemoglobin for oxygen, and consequently less oxygen will be delivered to tissues (BOOTHE, 2001). The 2,3-DPG is directly related to blood pH and it is known that when the pH is less than 7.0, its degradation is favored, which significantly impairs the binding of O₂ by erythrocytes (HESS; GREENWALT, 2002).

Dextrose is added to the solution as an energy source, and this carbohydrate is slowly consumed by the cell when they are subjected to low temperature conditions (1 to 6°C). On the other hand, adenine promotes an increase in adenylylation, which is important for the synthesis of ATP, reducing osmotic fragility and ensuring greater survival of red blood cells (AUTHEMENT et al., 1986).

The use of solutions containing CPD/SAG-M (citrate, dextrose phosphate, adenine saline, glucose and mannitol) maintains the energy and viability of erythrocytes during storage and preserve human red blood cells for up to 42 days, the advantages are the reduction in hemolysis rate, improvement in fluidity during transfusion with decreased discomfort of the receptor, increase in the volume of recovered plasma, decreased allergic reactions to plasma proteins and, facilitating leukocyte filtration (FELDMAN, SINK, 2006; HOHENHAUS, 2007).

3 FINAL CONSIDERATIONS

Veterinary transfusion medicine has been gaining strength with advances in the techniques of collection, conservation of whole blood and blood components.

Considering that many of the chosen techniques involve the use of whole blood, this review sought to show that there are other options, which could be directed according to the need since often the clinical picture could be solved with the use of blood components thus avoid reactions caused with the use of whole blood.

In addition, it sought to describe the types of bags available on the market and the indication for each collection objective, bringing information about storage period, storage temperature, conservative solutions and how important are these factors for the maintenance of blood components.

In summary, this systematic review highlighted a theme that is still little widespread, but has the potential to be widely used with relative ease, in order to stimulate clinicians of dogs and cats to appropriate information that supports knowledge of hemotherapy and blood components.

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