Journal of Animal Research: v.15 n.01, p. 15-20. February 2025

DOI: 10.30954/2277-940X.01.2025.3

Therapeutic Efficacy of Whole Blood Therapy in Anaemic Dogs: A Detailed Study

Tarun Kumar[1], Sunil Punia[2], Ankit Kumar[3]*, Vivek Attri[4], Shivika Gupta[5], Maneesh Sharma[1], Divya Agnihotri[4] and Neelesh Sindhu[1]

[1]Department of Veterinary Clinical Complex, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar, Haryana, INDIA
[2]College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Rampura Phul, Punjab, India
[3]Haryana Pashu Vigyan Kendra, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Uchani, Karnal, Haryana, INDIA
[4]Department of Veterinary Medicine, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar, Haryana, INDIA
[5]Department of Veterinary Medicine, Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura, Uttar Pradesh, INDIA

[*]Corresponding author: A Kumar; E-mail: drankitkumar813@gmail.com

Received: 02 Nov., 2024 **Revised:** 10 Jan., 2025 **Accepted:** 16 Jan., 2025

ABSTRACT

Blood transfusion has been used as an emergency and life-saving step, since many years in human as well as animals medicine. The objective of this study was to demonstrate the effectiveness of whole blood transfusion in treatment of anaemic dogs. A total of ten anaemic dogs were given whole blood transfusion as part of therapy. Four dogs were suffering from hemolytic anaemia, three were suffering from severe haemorrhagic gastroenteritis and etiology was not known in three cases. Donors selected were overall healthy, negative for haemoprotozoan parasite on blood smear examination, between the ages of 1-6 years with no history of recent disease and are not currently on any medications. Major and minor cross matching tests were done between donor and recipient. Amount of blood to be transfused was calculated by formula 90 ml × kg body weight (BW) × ([desired packed cell volume (PCV) - patient PCV]/ PCV of donor blood). Rate of transfusion was 1ml/kg/hour at start for the first 30 minutes and then 3 ml/kg/hour for the rest duration of the transfusion. Transfusion was completed within 4-6 hours. There was significant improvement in mean haemoglobin and PCV values before and after treatment. Nine dogs survived after blood transfusion without any adverse reactions while one collapsed after 4 days of transfusion from severe clinical complications.

HIGHLIGHTS

- Whole blood transfusion proved to be having great therapeutic efficacy in critical care medicine.
- By carefully selecting the blood donors and testing recipients prior to transfusion, risk of adverse reactions may be minimized
- With limited investment, intensive care can be provided to anaemic patients.

Keywords: Whole Blood Transfusion, Anaemia, Haemoglobin, Packed Cell Volume

Blood is a fluid connective tissue that transports oxygen and nutrients to the cells and carries away carbon dioxide and other waste products. Blood transfusion has been used as an emergency and life-saving step, since many years in human as well as animals medicine (Davidow, 2013). It is a process of transfer of homogenous blood from a healthy individual to one who is in urgent need of same species. The first successful blood transfusion in canines

How to cite this article: Kumar, T., Punia, S., Kumar, A., Attri, V., Gupta, S., Sharma, M., Agnihotri, D. and Sindhu, N. (2025). Therapeutic Efficacy of Whole Blood Therapy in Anaemic Dogs: A Detailed Study. *J. Anim. Res.,* **15**(01): 15-20.

Source of Support: None; **Conflict of Interest:** None

was done by Lower (1666), although he emphasized the importance of cross matching prior to transfusion. Blood transfusion became more common practice in 19th century to save critically ill patients having low blood parameters. Transfused red blood cells (RBCs) provide three beneficial effects: Circulatory (volume-related), rheological (viscosity-related) and oxygen carriage (Shander *et al.,* 2013). So, blood transfusion sustains life of anaemic patients by improving the reduced cellular components like erythrocytes, leukocytes, platelets and non-cellular components like albumin, fibrinogen and plasma component. With improvement in blood collection and transfusion procedure and advancement in storage facilities for whole blood and blood constituents, blood transfusion has gradually become more feasible in veterinary medicine, but there is substantial risk associated with allogeneic transfusion of live cells. Zuck (1990) described blood transfusion as "unavoidably, unsafe and inherently dangerous" procedure. There are numerous factors which affects blood transfusion like type of anaemia, animal body weight, blood volume according to body weight percentage of that species, blood group and haematological parameters.

Blood transfusion is indicated in anaemia due to various etiologies like acute or chronic haemorrhage, bleeding disorders due to thrombocytopenia, coagulopathies, warfarin poisoning. Fresh whole blood transfusion is still a favored approach when platelets are not available because of various advantages (Edward, 2021). In the case of dogs, urgent need of blood transfusion is required when packed cell volume is 15% or less and haemoglobin is 5g per dl or less (Perman and Schall, 1983). Blood grouping in dogs is done on basis of dog erythrocyte antigen system (DEA). DEA 1.1, 1.2, 3, 4, 5, 6, 7 and 8 are recognized blood groups among dogs (Hale, 1995; Hohenhaus, 2004). A decade ago, the erythrocytic *Dal* antigen was discovered after an anaemic Dalmatian dog was accidentally sensitized by a DEA 1 matched transfusion (Blais *et al.,* 2007). In dogs, DEA 1.1 and 1.2 are the most important clinically, and DEA 1.1, 1.2 and 7 are the most antigenic blood group types (Tocci, 2010). In South Korea, two nobel blood types known as *Kai 1* and *Kai 2* were discovered (Euler *et al*., 2016). The most common adverse transfusion reactions, which occur immediately or during transfusion, are acute haemolytic reaction, anaphylactic or allergic reactions. Some complications are seen later such as delayed haemolytic reaction, immunogenic or non-immunogenic reactions, hypothermia, citrate toxicity and heart failure (Lanevschi and Wardrop, 2001). As a result of increased knowledge and availability of blood and blood products, blood transfusion has achieved significant advances in veterinary medicine in recent years.

MATERIALS AND METHODS

A total of ten anaemic dogs from the University Veterinary Clinical Complex were selected for this study, in which blood transfusion was used as part of the therapy. Dogs having PCV less than 15% and haemoglobin less than 5g/dl were recruited as anaemic dogs in the present study. Four dogs were suffering from haemolytic anaemia, three were suffering from severe haemorrhagic gastroenteritis and etiology was not known in three cases. On basis of Mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) type of anaemia was determined. Haemolytic anaemia was diagnosed on basis of hyperbilirubinemia with increased level of direct bilirubin. Clinical signs of anaemia were recorded in a predesigned performa.

STATISTICAL ANALYSIS

Student t-test (unpaired) was used to compare the parameters between the post - treatment and pre-treatment group.

Cross Matching

Major and minor cross matching of recipient and donor blood was performed before each transfusion to minimize risk of transfusion reaction. The major crossing was done using RBCs of donor and serum of recipient and minor cross was done using RBCs of recipient and serum of donor. Incompatibility was noticed as haemolysis or agglutination (Lanevschi and Wardrop, 2001).

Selection of Donor

Donor for blood transfusion, were brought by owners themselves. Donors were of age group between 1 to 6 years, healthy on complete physical examination, with proper history of deworming and vaccination. After cross matching donors were screened for presence of

any haemoprotozoan infection (*Babesia, Ehrlichia, Anaplasma, Hepatozoon*) by examination of blood smear. Complete haematological examination was performed to check for any abnormality in donor dogs. The haemoglobin and PCV of donor dogs were more than 12 g/dl and 35%, respectively.

Blood collection

Amount of blood to be transfused was calculated by formula 90 ml × kg BW × ([desired PCV- patient PCV]/ PCV of donor blood) (Slatter, 2003). Whole blood was collected for transfusion in blood bags having Citrate Phosphate Dextrose Adenine Solution (CPDA) as anticoagulant (1ml of anticoagulant per 7ml blood). For blood collection, donors were positioned in lateral recumbency on blood donation table. Hairs are clipped off from venipuncture site (jugular vein) and the site was prepared aseptically by surgical scrub to minimize the chances of bacterial contamination. A maximum of 20 mL/ kg blood was collected from donors. After collecting the blood, the blood collection line was clipped and donors were examined for signs of hypotension and weakness.

Transfusion and Transfusion reactions

After placing proper size intravenous catheter, transfusion was started using a commercial blood infusion set that had in-line microfilter for any clot. Rate of transfusion was 1ml/kg/hour at start for the first 30 minutes to check for any immediate transfusion reaction and then 3 ml/kg/hour for the complete duration of the transfusion. Transfusion was completed within 4 hours in every case. Vital parameters like heart rate, pulse rate, respiration rate was recorded regularly during transfusion and also on every visit till recovery or death to take care of any immediate or delayed transfusion reaction.

RESULTS AND DISCUSSION

A total of ten anaemic dogs were included in the study showing clinical signs like pale mucus membrane, prolonged capillary refill time, tachycardia, tachypnea, weak pulse, lethargy, weakness, and respiratory distress. Haematological findings suggested that seven dogs were suffering from normocytic hypochromic anaemia and three dogs were suffering from microcytic hypochromic anaemia. Anaemia in four dogs was because of haemolytic anaemia, three were suffering from severe haemorrhagic gastroenteritis leading to anaemia and etiology of anaemia in three cases was not known. Level of Alanine aminotransferase (ALT) was found to be within normal range. Haemoglobin (mean) values before and 2 days after treatment were 3.01 ± 0.44 g/dl and 5.46 ± 0.39 g/dl with significant increase in haemoglobin in all the cases (Fig. 1A). Kisielewicz *et al*. (2014) showed a mean increase of 3.6 ± 2.1g/dl after transfusion in 30 transfusion cases. The mean of packed cell volume before and after transfusion of all dogs was 10.93 ± 1.32% and 21.9 ± 1.26%, respectively with significant increase in the PCV (Fig. 1B). In transfusion of whole blood by Ognean *et al*. (2015) in a mean volume of 7.5 mL/kg, determined the increase of the haematocrit with 10.43%, whereas Chiaramonte (2004) reported a 10% increase after transfusion of a mean volume 20 ml/kg of blood. A more important increase of the haematocrit value (15.2%) was obtained by Sukullaya and Anuchai (2006), after transfusing a mean volume of 29 ml whole blood/kg. Among the pre- and post-transfusion haematocrits, the mean variation was of 9.0% in dogs and 6.5% in cats (Dias *et al.,* 2022). The desired final PCV value, according to Godinho-Cunha *et al.* (2011), is 10% higher than the initial value. The above goal was achieved in all the clinical cases of present study. Similarly, Kisielewicz *et al*. (2014) achieved 10.8 ± 6.0 increase in PCV values after transfusion. Mean corpuscular haemoglobin concentration was 27.67 ± 0.91 g/dl and 30.14 ± 0.55 g/dl before and after treatment respectively (Fig. 1C). The Total erythrocyte count before treatment was 1.71 ± 0.35 million per µL which increased to 3.79 ± 0.42 million per µL after treatment (Fig. 1D). So, there was significant improvement in mean haemoglobin, PCV, TEC and MCHC values before and after treatment in the present studied cases. Similar improvement in TEC from 1.54 ± 0.41 million/µl to 2.92 ± 0.5 million/µl has been reported by Pereira *et al*. (2021).

Haematological examination revealed mean TLC to be 19.613 ± 7.516 thousand per µL. Leukocytosis was present in four cases and leukopenia was seen in one case. Lymphocytosis and neutrophilia were seen in two and three cases respectively while neutropenia was present in one case. Mean corpuscular volume did not show any statistically significant change. Nine dogs survived after whole blood transfusion while one collapsed 4 days post

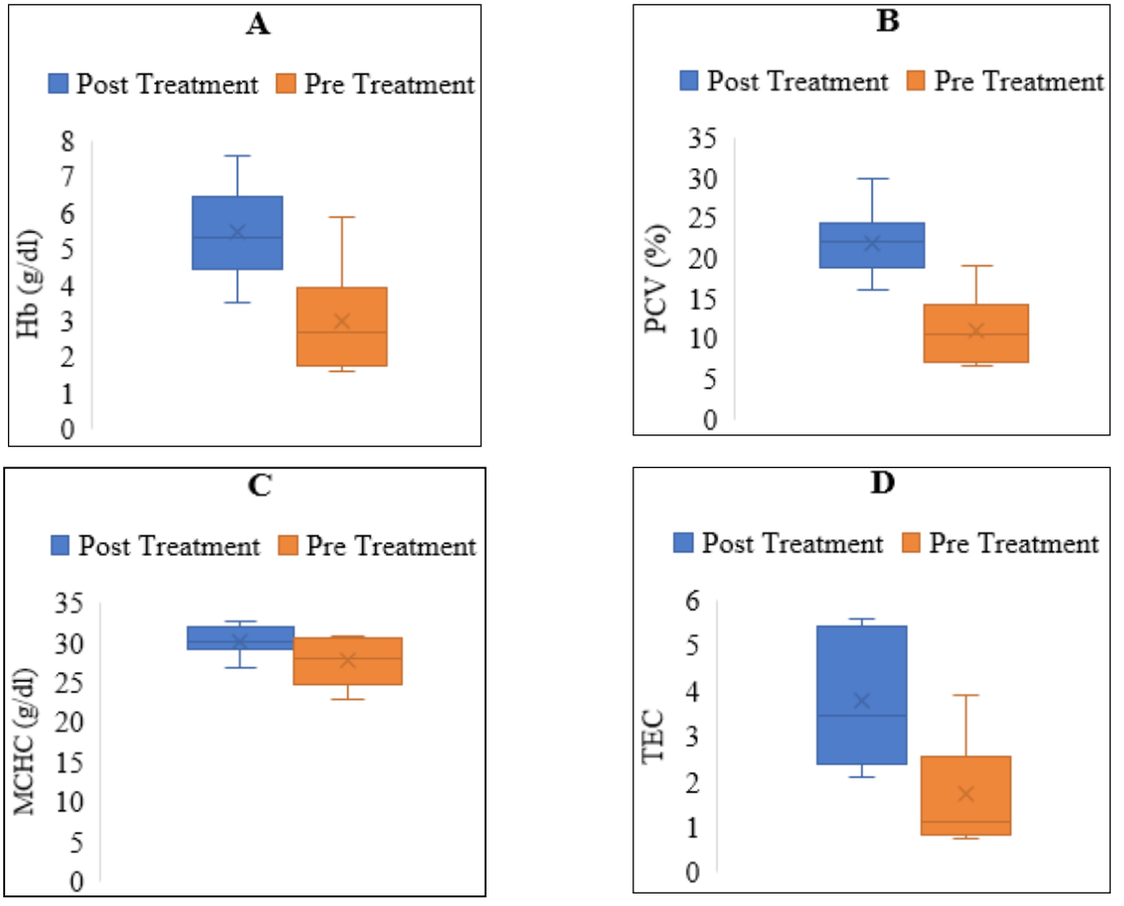

Fig. 1: Hematological changes before and after treatment. **(A)** Haemoglobin; **(B)** Packed Cell Volume; **(C)** Mean Corpuscular Haemoglobin Concentration; **(D)** Total Erythrocyte Count between Post - Treatment and Pre - Treatment group

Table 1: Pre and post transfusion haematological values (n=10)

Parameters	Pre – Treatment Mean ± SEM	Post – Treatment Mean ± SEM	95% CI	p value
Hb (g/dl)	3.01 ± 0.44	5.46 ± 0.39**	1.193 - 3.707	0.0007
PCV (%)	10.93 ± 1.32	21.9 ± 1.26**	7.130 - 14.810	0.0001
MCV (fl)	58.45 ± 2.73	59.69 ± 2.34 ^{NS}	-6.331 - 8.811	0.7348
MCHC (g/dl)	27.67 ± 0.91	30.14 ± 0.55*	0.2074 - 4.7246	0.0340
TEC ($\times 10^6/\mu L$)	1.71 ± 0.35	3.79 ± 0.42*	0.9098 - 3.2362	0.0015

*Significant ($p < 0.05$); **Significant ($p < 0.01$); Hb = haemoglobin; PCV = packed cell volume; MCV = mean corpuscular volume; MCHC = mean corpuscular haemoglobin concentration; TEC = total erythrocyte count.

transfusion. Patients presented improvement of the general state within 24 hours and a significant improvement of the mucous membranes color and general demeanor. Change in various parameters has been depicted in Table 1. No adverse reaction of blood transfusion was seen in any of the presented case. Nine dogs survived after blood transfusion while one collapsed 4 days post transfusion because of severe clinical complications. Present study showed greater recovery rate (90%) of dogs in clinically critical state in comparison to previous reports (Kerl and Hohenhaus, 1993; Callan *et al.,* 1996; Weingart *et al.,* 2004; Klaser *et al*., 2005; Roux *et al.,* 2008; Godinho-cunha *et al.,* 2011). In many countries, despite all the progress realized in veterinary transfusion medicine, blood transfusion therapy in dogs is still non-implemented or sporadic, due to limited economic and information possibilities. There are also many clinicians who avoid this therapeutic procedure, arguing that it involves high costs, inherent risks or limited therapeutic efficacy (McDevitt *et al*., 2011). Whole blood (WB) transfusion is advantageous over other blood products as there are no RBC or platelet additive solutions, and therefore WB is less dilute with a higher concentration of coagulation factors and a higher haematocrit than can be achieved by combining component products (Armand *et al*., 2003), moreover whole blood transfusion doesn't require advanced tools to separate the components and can easily be done in primary care centers.

CONCLUSION

Whole blood transfusion proved to be having great therapeutic efficacy in critical care medicine. By carefully selecting the blood donors and testing recipients prior to transfusion, risk of adverse reactions may be minimized and with limited investment, intensive care can be provided to anaemic patients. Anaemic recipients are carefully assessed before the transfusion to determine the course of treatment, co-therapies along with blood transfusion, and establish baselines for monitoring purposes. The purpose of this study is to encourage veterinarians to use whole blood transfusion as a routine treatment option for anaemic dogs.

ACKNOWLEDGEMENTS

Authors are thankful to the Directorate of Research LUVAS and HOD, VCC for their support in carrying out this research work.

REFERENCES

Armand, R. Hess, J.R. 2003. Treating coagulopathy in trauma patients. *Transfus. Med. Rev*., **17**: 223 - 231.

Blais, M.C., Berman, L., Oakley, D.A. and Giger, U. 2007. Canine Dal blood type: a red cell antigen lacking in some Dalmatians. *J. Vet. Intern. Med.,* **21**: 281 - 286.

Callan, M.B., Oakley, D.A., Shofer, F.S. and Giger, U. 1996. Canine red blood cell transfusion practice. *J. Am. Anim. Hosp. Assoc.,* **32**: 303 - 311.

Chiaramonte, D. 2004. Blood-component therapy: selection, administration and monitoring. *Clin. Tech. Small Anim. Pract.,* **19**: 63 – 67.

Davidow, B. 2013. Transfusion medicine in small animals. *Vet. Clin. Small Ani. Pract.,* **43**: 735 – 756.

Dias, L., Vilhena, H., Carolino, N., Freire, A., Moura, M., Aleixo, R., Silvestre-Ferreira, A. and Duarte, S. 2022. Blood transfusions in dogs and cats from Portugal: a retrospective study. *J. Hellenic Vet. Med. Soc.,* **73**(3): 4289 – 4294.

Edwards, T.H., Pusateri, A.E., Mays, E.L., Bynum, J.A. and Cap, A.P. 2021. Lessons Learned From the Battlefield and Applicability to Veterinary Medicine – Part 2: Transfusion Advances. *Front. Vet. Sci.,* **8**: 571370.

Euler, C.C., Lee, J.H., Kim, H.Y., Raj, K., Mizukami, K. and Giger, U. 2016. Survey of two new (*Kai* 1 and *Kai* 2) and other blood groups in dogs of North America. *J. Vet. Int. Med.,* **30**: 1642 - 1647.

Godinho-Cunha, L.F., Ferreira, R.M. and Silvestre-Ferreira, A.C. 2011. Whole blood transfusion in small animals: indications and effects. *An. Acad. Bras. Cienc.,* **83**(2): 611 - 617.

Hale, A.S. 1995. Canine blood groups and their importance in veterinary medicine. *Vet. Clin. North Am.,* **25**: 1323 - 1333.

Hohenhaus, A.E. 2004. Importance of blood groups and blood group antibodies in companion animal. *Transfus. Med. Rev.,* **18**: 117 - 126.

Kisielewicz, C., Self, I. and Bell, R. 2014. Assessment of clinical and laboratory variables as a guide to packed red blood cell transfusion of euvolemic anaemic dogs. *J. Vet. Intern. Med.,* 28: 576 - 582.

Kerl, M.E. and Hohenhaus, A.E. 1993. Packed red blood cell transfusions in dogs: 131 cases. *J. Am. Vet. Med. Assoc.,* **202**: 1495 - 1499.

Klaser, D.A., Reine, N.J, and Hohenhaus, A.E. 2005. Red blood cell transfusions in cats: 126 cases. *J. Am. Vet. Med. Assoc.,* **226**: 920 - 923.

Lanevschi, A. and Wardrop, K.J. 2001. Principles of transfusion medicine in small animals. *Can. Vet. J.*, **42**: 447.

Lower, R. 1666 The success of the experiment of transfusing the blood of one animal into another. *Philos. Trans. R. Soc. B.,* 1: 352.

McDevitt, R.I., Ruaux, C.G. and Baltzer, W.I. 2011. Influence of transfusion technique on survival of autologous red blood cells in the dog. *J. Vet. Emerg. Crit. Care.,* **21**(3): 209 - 216.

Ognean, L., Chiurciu, V., Stefanut, C., Oana, L., Morar, I. and Barabasi, I. 2015. Transfusion triggers and therapeutic efficacy in a group of dogs that underwent whole blood therapy. *Agric, Sci. Procedia.,* **6**: 363 - 369.

Pereira, M.E., Canei, D.H., Trevisan, Y.P.A., Zorzo, C., Mendonça, A.J., Konrad, J. and Sousa, V.R.F. 2021. Clinical, Hematological, Blood Gasometric and Electrolytic Changes in Dogs Receiving Whole Blood Transfusions. *Acta Sci. Vet.,* **49**: 1816.

Perman, V. and Schall, W.D. 1983. Diseases of the red blood cells. *In:* Text book of Veterinary Internal medicine. Diseases of the Dog and Cat. 2nd edn. W.B. Saunders Company, Philadelphia; 1964 -1967.

Roux, F.A., Deschamps, J.Y., Blais, M.C., Welsh, D.M., Delaforcade-buress, A.M. and Rozanski, E.A. 2008. Multiple red cell transfusions in 27 cats (2003-2006): indications, complications and outcomes. *J. Feline Med. Surg.,* **10**: 213 - 218.

Shander, A., Gross, I., Hill, S., Javidroozi, M. and Sledge, S. 2013. College of American Pathologists. A new perspective on best transfusion practices. *Blood Transfus.*, **11**: 193 - 202.

Slatter, D.H. 2003. Textbook of small animal surgery. Elsevier Health Sciences. 3rd ed.; 1.

Sukullaya, A. and Anuchai, N.A. 2006 retrospective study of blood transfusion in dogs from a veterinary hospital in Bangkok, Thailand. *Comp. Clin. Path.,* **15**: 191 - 194.

Tocci, L.J. 2010. Transfusion medicine in small animal practice. *Vet. Clin. Small Anim. Pract.,* 40: 485 - 494.

Weingart, C., Giger, U. and Kohn, B. 2004. Whole blood transfusions in 91 cats: a clinical evaluation. *J. Feline Med. Surg.,* **6**: 139 - 148.

Zuck, T.F. 1990. Legal liability for transfusion injury in the acquired immunodeficiency syndrome era. *Arch. Pathol. Lab. Med.,* **114**: 309 - 315.