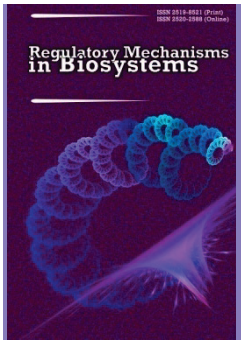

Regulatory Mechanisms in Biosystems

ISSN 2519-8521 (Print)
ISSN 2520-2588 (Online)
Regul. Mech. Biosyst.,
2024, 15(2), 207–211
doi: 10.15421/022430

Effectiveness of blood transfusion to cats suffering flea infestation

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Article info

Received 03.03.2024
Received in revised form 30.03.2024
Accepted 14.04.2024

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Malyuk, M. O., Klymchuk, V. V., Kharkevych, Y. O., Honchar, V. V., Tarnavskyi, D. V., Dovbnia, Y. Y., Holopura, S. I., & Tkachenko, V. V. (2024). Effectiveness of blood transfusion to cats suffering flea infestation. Regulatory Mechanisms in Biosystems, 15(2), 207–211. doi:10.15421/022430

Donation and transfusion of whole blood and its components in cats are relevant issues in veterinary practice. Blood transfusion to cats helps effectively treat anemia of diverse causes or at least stabilize a patient for further examinatons and searh of solutions for particular pathologies. Measures ensuring blood matching of donor and recipient cats must be conducted with the utmost care and thoroughness possible. At the very least, the blood group A/B/AB of both cats should be checked, and ideally further cross-sampling should be performed so as to detect Mik antigenes and other incompatibilities. Unlike dogs, cats have natural antibodies. Donor cats must be clinically healthy, vaccinated, 2–8 years old, weigh over 4 kg, with hematocrit over 30% (preferably more than 35%). Also, a donor cat should be examined for blood-transmitted infections, including feline leukemia virus (FeLV), feline immunodeficiency virus (FIV), and *Mycoplasma haemofelis* (pathogen of infectious feline anemia). The article presents clinical cases of using blood transfusion to treat feline anemia and results of the conducted laboratory studies, showing effectiveness of the performed medical procedures. After blood transfusion, the cats had positive dynamics in the general clinical state and increases in the main morphological blood parameters up to the norm or to values close to it. However, the issue of posthemorrhagic anemia requires more in-depth research in each separate case, particularly regarding the underlying case, since it can return the animal's state and its main morphological blood parameters to the initial level, with no recovery, or at least long remission. It was found that whole-blood transfusion to the recipient animals with flea invasion increased the number of red blood cells, hemoglobin content, and hematocrit, which positively affected blood oxygenation and redox processes in the recipient animals, and accordingly their general clinical state.

Keywords: cat; anemia; blood transfusion; hematology; red blood cells; hemoglobin; hematocrit parameter.

Introduction

Blood transfusion in dogs and cats is now carried out more and more often than in the recent past, and veterinary practitioners have an opportunity to use fresh whole blood, as well as stored blood or individual blood components (packed red blood cells and platelet concentrate, blood plasma), pre-collected from donor animals and prepared to be used. Of cource, transfusion of blood and its components is associated with insignificant risks for the recipient animals, particularly immediate or delayed side effects related to immune-conditioned mechanisms during or soon after transfusion. The severity of those reactions ranges from insignificant hyperthermia to severe responses that cause impairments of blood circulation and hemolytic crisis. Prevention of those risks is an integral part of transfusion of whole blood and its components. This paper presents description of clinical cases of blood transfusion in cats (Tocci & Ewing, 2009; Weltman et al., 2014; Spada et al., 2015; Schober et al., 2018; Tasker et al., 2018).

The commonest reasons for blood to be transfused to cats are anemia as a result of blood loss (mostly severe, more rarely chronic) and ineffective erythropoiesis or hemolysis due to intramedullary or extramedullary conditioning (Zaremba et al., 2019). Decision on whether to prescribe blood transfusion depends on the number of red blood cells, content of hemoglobin, and hematocryt parameter (Ht). Transfusion of packed red blood cells is recommended for severely ill cat patients if Ht drops below 10–15%. However, more important is the patient's general condition: such parameters as tachycardia, weak pulse, long time for capillaries to fill, lethargy, and weakness. Those are the symptoms that would indicate necessity of transfusion. If an animal suffers acute anemia or requires surgery, blood transfusion is carried out only if Ht values are high. Cats with chronic anemia are more tolerant of low Ht than those with acute anemia (Feldman & Kristensen, 1995; Euler et al., 2016; Goy-Thollot et al., 2019).

The most important system of blood groups in cats is the AB system with blood groups A, B, and AB, not immunologically associated with the AB0 system of humans. Recently, a domestic shorthair cat was found to have another erythrocyte antigen – the so-called Mik (Feldman & Kristensen, 1995).

In European and American short-haired and long-haired cats, the dominating group is A. Percentage of cats with this blood group geographically ranges 70% to 100%. In recognized breeds of cats, occurrence of blood group B varies. There are breeds where B-type cats were not recorded at all (Siamese, Birman, Russian Blue, Tonkinese) or were recorded with the occurrences of 1–10% (Maine Coon, Norwegian Forest Cat), 11–20% (Abyssinian, Birman, Persian, Somali, Sphynx, Scottish Fold), and 20–45% (exotic and British short-haired, Cornish Rex, and Devon Rex). The third group, AB, is very rare in pedigree and non-pedigree cats (up to 1%) (Feldman & Kristensen, 1995; Ravagnan et al., 2017; Marenzoni et al., 2018).

An important aspect in blood transfusion is its safety regarding infectious diseases. In addition, unlike dogs, cats have natural antibodies (alloantibodies) against the blood group they lack. Blood-group-B cats have hemagglutinine antibodies of IgM type against type-A cells, and group-A cats have weak hemolysin and hemaglutinating antibodies of IgM and IgG types against B-type cells. Kittens of both groups have no antibodies against other blood groups during the first weeks of life. Plasma of type-AB cats of various age contains no anti-A or anti-B antibodies (Feldman

& Kristensen, 1995; Reine, 2004; Proverbio et al., 2013; Nesina et al., 2015; Nentwig et al., 2018; Persichetti et al., 2018; Popov et al., 2021).

To identify blood group, there was developed a testing method that is suitable for veterinary practice (Rapid Vet®H Feline, Agrolabo Sp.A., Italy). In case of spontaneous agglutination of red blood cells of a patient, grouping of blood is possible only if agglutination does not remain after rinsing erythrocytes in physiological solution. If blood grouping is impossible, in extreme cases one can make a crossmatching test, and agglutination indicates that blood of donor and recipient animals is incompatible (Costa et al., 2016; Pennisi et al., 2017; Cole & Humm, 2019).

Anemia in cats can be caused by:

– blood losses, caused by external bleeding from wounds, intraoperative blood losses, as well as internal hemorrhages (for example from ulcers, polytraumas);

– infections: intoxications with breakdown products or endotoxins that promote ruination of red blood cells, or infections of the bone marrow (for example, viral leukocysis);

– medications: irresponsiveness of breeds to some groups of drugs (for example, paracetamol) or using incompatible groups of drugs (for example, non-steroid anti-inflammatory drugs together with corticosteroids);

– breed vulnerability (for example, Somali and Abyssinian cats suffer due to faster ruination of red blood cells);

– problems of maintenance and nutrition (deficiency of iron, chronic inflammatory processes).

Thus, the main reason animals receive blood transfusion is reduced oxygen capacity of red blood cells, which leads to tissue hypoxia. Such a pathological state is related to malfunctioning of erythrocyte formation, their ruination, and blood loss (acute or chronic) (Feldman & Kristensen, 1995; Schober et al., 2016). A number of authors noted that an ill animal having a lowered number of red blood cells, content of hemoglobin, and hematocrit parameter, undergoes impairment in blood oxygenation, while non-oxydized products of breakdown accumulate, leading to general intoxication of the body, and therefore deterioration of the clinical state of the animal. Anemia in parasite-infested cats results from intravascular and extravascular hemolysis. Extravascular hemolysis takes place in the spleen and liver phagocytes, whereas intravascular hemolysis is the result of life cycle of parasite and immune-mediated lysis of red blood cells (Tocci & Ewing, 2009).

Studies demonstrated that allogeneic transfusion of whole blood is accompanied by a cascade of complex immunologic reactions in the recipient animals. Even in cases of allogeneic transfusion of packed red blood cells to recipient rabbits, there were found typical immunologic changes afterwards, which were a consequence of progressing increase in the activity of the humoral link of immunity (Malyuk et al., 2023a, 2023b).

A perfect condition for treatment is access to a source of safe and tested blood, a local blood bank that stores blood and components that could be timely used if needed. However, it is a challenge when it comes to blood of cats, because their red blood cells can be stored only for a limited time. Another practical solution is to make a list of owners who are ready to allow using their cats as donors. This may be useful, though no perfect solution exists.

Therefore, many issues regarding blood transfusion in veterinary medicine remain unsolved and clinical use of whole blood and its components in case of feline anemia is a quite relevant topic.

Thus, our objective was analysis of efficacy of blood transfusion to recipient cats with anemia caused by flea infestation.

Materials and methods

The experiments were performed according to the requirements of the General Ethical Principles of Conducting Experiments on Animals, approved by the 1st National Congress of Bioethics, and the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes, and the Law of Ukraine on Protection of Animals from Abuse, and also a permit of the local commission of bioethics of the National University of Life and Environmental Sciences of Ukraine. The studies were conducted in 2023 at the Scientific-Research Laboratory the Bank of Animal Blood of the I. O. Povazhenko Department of Surgery and Pathophysiology of the National University of Life and Environmental Sciences of Ukraine and in the conditions of Scientific-Research and Production Center Vetmedservis.

The objects of the studies were cats suffering anemia caused by flea-infestation. Blood groups of the recipient cats were identified, and serological reactions and a large amount of crossmatching were conducted. Also, we ruled out viruses using chromatological study methods (ICA express test for antibodies to the immune-deficiency virus and antigene to feline leukosis, Quicking Biotech, manufactured by China).

Morphological analysis of blood was carried out using a Mindray BC-2800 hematological analyzer (Mindray, China, 2020) and biochemical blood analysis was conducted using a SINNOWA BS 3000M vet semi-automatic analyzer (Sinnowa, manufactured in China, 2018).

Blood groups were identified using the RapidVet-H test system (Feline) (produced by Agrolabo Sp., Italy).The analysis is based on agglutination reaction, which occurs when erythrocytes, which bear one of groups of A, B, or AB antigens on the surface of plasmalemma, interact with dried anti-serum of a specific antigen placed on the test strip.

In type-A cats, erythrocyte plasmalemma bears glycolipid antigen (NeuGc2GD3). RapidVet-H (Feline) uses mouse monoclonal antibodies that confirm specificity for this antigen, lyophilized on a test strip. Antibody molecule gives it the ability to bind and attach antigens that are specified to blood group A.

In type-B cats, erythrocyte antigens contain neuraminic acid (NeuAc2GD3), unlike erythrocytes of blood group A. A specific connecting link was found to be the lectin *Triticum vulgaris*. RapidVet-H (Feline) uses the lectin *Triticum vulgaris* to identify blood group B.

The donor cats were examined for infections that are transmitted via blood, including feline leukemia virus (FeLV), feline immunodeficiency virus, and *Mycoplasma haemofelis* (pathogen of infectious anemia in cats). Blood of the donor cats was collected from the jugular vein using the partially enclosed method, with pre-treatment of the skin region with 70% ethyl alcohol. Samples of donor blood were put in plastic containers with the CPDA anticoagulant.

Prior to blood transfusion, a test for individual compatibility of blood group (red blood cells) was obligatory and was carried out as follows: 2–3 drops of recipient's blood serum were placed on a microscope slide, to which 5 times smaller drop of donor blood was added and mixed. The glass was regularly shaken for 5 minutes and at the same time the result of reaction was observed. Absence of agglutination of donor's red blood cells indicates compatibility of donor and recipient blood group.

The patients were treated according to the following scheme: Stronghold (selamectin, 6%) in the dose of 6 mg per 1 kg of animals' body mass externally, applying directly on dry skin once; cyanocobalamin 0.02% (0.2 mg/mL) in the dose of 1 mL per animal, intramuscularly, once a day for 5 days; prednisolone (30 mg/mL) in the dose of 0.5 mg per 1 kg of body mass, subcutaneously, once a day for 3 days.

The amount of necessary blood for transfusion was estimated using the formula provided by Sackmen (1998), which takes into account the patient's body mass, necessary level of hemoglobin, and initial parameters of hemoglobin of recipient and donor.

Allogeneic transfusion of packed red blood cells was conducted after administration of the antiparasitic drug. The recipient animals were given packed red blood cells once.

Donors' packed red blood cells were stored for 10 days in a AEG-317 pharmaceutical refrigerator (AEG, Denmark, 2021) at 2–6 °C at the scientific-research laboratory the Bank of Animal Blood of the I. O. Povazhenko Department of Surgery and Pathophysiology. Microscopic studies and photographing of the cells were performed using a Sigeta Biogenic LED microscope (China) equipped with an installed camera for the Sigeta MDC-560 CCD microscope (Sigeta, China, 2020).

The clinical condition of the recipient cats must be thoroughly observed, especially at the beginning of blood transfusion so as to find unfavorable reactions. The first several milliliters of blood should be administered very slowly (for example, 1 mL/kg/h for the first 30 min), so as to detect any unsatisfactory immunologic reactions in the recipient animal.

The results were statistically analyzed with calculating mean arithmetic (x) and its mean square deviation (SD) using ANOVA and the Tukey's test with the Bonferroni's correction.

Results

During 6-month period, 26 cats were admitted to the clinic. Five cats were found to have anemia, caused by intensive invasion by external parasites (flea infestation). High intensity of flea infestation was the reason of anemia in 19.2% (5/26) of the cats. All five cats with flea-infestation-caused anemia had unrestricted outdoor access and had not been pretreated from ectoparasites. The commonest complaints of the owners of all animals with anemia were paleness, weakness, and anorexia. The cats were also observed to have other clinical signs that were not directly related to parasitic diseases. Concurrent diseases or stress factors in the cats included retroviral infection, hepatic lipidosis, pancreatitis, and myelofibrosis. The flea-infested cats were diagnosed with 2.02-fold decline in the number of red blood cells, 3.12-fold decrease in the hemoglobin content, and 2.47 decrease in hematocryt. We assume that this is how mechanical action of external parasites affects the body. This is conditioned by the fact that once a flea is on the host's skin, it immediately starts feeding and remains a permanent resident. During 36 hours, an adult female is already ready to mate, and oviposition begins 24–48 hours after the first blood meal. Taking into account clinical examination and changes in hematological indicators that pointed to anemia, the ill cats underwent allogeneic transfusion of whole blood.

After transfusion, we performed control of the clinical state of the cats, based on clinical examination, anamnesis (questioning the owners of the animals) and hematological studies on the 2nd, 5th, 10th, and also 15th days of treatment (Table 1). The general condition of the animals improved in the 2–5 days following transfusion, with the clinical manifestation of anemia dissapearing. Their appetite and locomotor activity returned to the norm in 5 days after transfusion. As with changes in the morphological blood parameters of the cats, we should note positive dynamics on the 2nd and 5nd days after transfusion of whole blood, recovering to the range of the reference values by the 10th and 15th days.

Table 1
Morphological parameters of blood of flea-infested cats (x ± SD, n = 5)

Parameter	Reference values	Initial state	Day 2	Day 5	Day 10	Day 15
Leukocytes, 10^9/L	5.5–19.5	12.55 ± 1.95^a	14.91 ± 1.96^a	24.79 ± 2.97^b	8.93 ± 0.90^c	7.48 ± 0.70^c
Lymphocytes, 10^9/L	0.8–7.0	1.66 ± 0.06^a	2.54 ± 0.24^b	1.83 ± 0.21^a	2.52 ± 0.22^b	2.23 ± 0.14^{ab}
Monocytes, 10^9/L	0.0–1.9	0.52 ± 0.08^a	0.76 ± 0.08^b	0.60 ± 0.10^{ab}	0.54 ± 0.05^a	0.54 ± 0.04^a
Granulocytes, 10^9/L	2.1–15.0	7.68 ± 0.79^a	9.12 ± 0.85^a	24.82 ± 0.83^b	5.14 ± 0.41^c	5.40 ± 0.25^c
Erythrocytes, 10^{12}/L	4.60–10.0	2.27 ± 0.27^a	3.26 ± 0.45^b	4.60 ± 0.46^c	6.94 ± 1.07^d	6.55 ± 0.49^d
Hemoglobin, g/L	93–153	29.8 ± 3.0^a	49.8 ± 3.9^b	63.2 ± 5.6^c	105.0 ± 10.7^d	123.0 ± 6.2^e
Hematocrit, %	28.0–49.0	11.3 ± 2.3^a	19.2 ± 3.9^b	27.0 ± 3.9^c	37.2 ± 2.5^d	37.4 ± 1.7^d
Mean corpuscular volume (MCV), 10^{-15} L	39.0–52.0	37.22 ± 0.59^a	41.20 ± 0.69^b	41.58 ± 0.97^b	44.62 ± 0.48^c	49.36 ± 0.58^d
Mean corpuscular hemoglobin (MCH), pg	13.0–21.0	9.24 ± 0.48^a	11.65 ± 0.78^b	12.18 ± 0.90^b	14.22 ± 1.05^c	16.72 ± 1.04^d
Mean corpuscular hemoglobin concentration (MCHC), g/dL	300–380	262.0 ± 6.4^a	281.4 ± 1.7^b	289.4 ± 3.2^c	328.8 ± 8.0^d	331.0 ± 5.5^d
Erythrocyte distribution width (EDW), %	14.0–18.0	19.46 ± 0.30^a	20.50 ± 0.29^b	22.56 ± 0.34^c	17.94 ± 0.57^d	15.76 ± 1.37^e
Platelets, 10^9/L	100–514	287.0 ± 10.7^a	424.6 ± 15.2^b	405.0 ± 10.8^b	164.8 ± 15.8^c	177.2 ± 12.4^c
Mean platelet volume (MPV), 10^{-15} L	5.0–11.8	10.44 ± 0.38^a	10.18 ± 0.58^a	8.98 ± 0.54^b	8.88 ± 0.73^b	8.42 ± 0.36^b
Platelet distribution width (PDW), %	–	13.34 ± 0.38^a	14.20 ± 0.22^b	13.82 ± 0.19^{ab}	14.40 ± 0.31^b	14.48 ± 0.23^b

Note: different letters indicate samplings that were significantly different one from another ($P < 0.05$) according to the results of the Tukey Test with Bonferroni's Correction.

The results of clinical analysis of blood on days 2, 5, 10, and 15 after transfusion confirmed regenerative anemia. On the 2nd day after blood transfusion, we observed increases compared with the initial parameters, measuring 18.8% in the number of leukocytes, 53.0% in lymphocytes, 46.1% in monocytes, 18.7% in granulocytes, 43.6% in erythrocytes, 67.1% in hemoglobin, 69.8% in hematocrit, 10.7% in the mean volume of red blood cells, 26.1% in the mean corpuscular hemoglobin, 7.4% in the mean corpuscular hemoglobin concentration, and 5.3% increase in erythrocyte distribution width. Also, there occurred 47.7% increase in the number of platelets, while mean platelet volume decreased 2.4%.

On the 5th day after blood transfusion, we observed increases compared with the initial parameters, measuring 97.5% in the number of leukocytes, 10.2% in lymphocytes, 15.4% in monocytes, 3.23-fold in granulocytes, 2.02-fold in erythrocytes, 2.12-fold in hemoglobin parameters, 2.38-fold in hematocrit percentage, 11.7% in mean corpuscular volume, or mean cell volume (MCV), 31.8% in mean corpuscular hemoglobin, 10.5% in mean corpuscular hemoglobin concentration (MCHC), and 15.9% in erythrocyte distribution width. The number of platelets increased 41.1% and mean platelet volume declined 13.9%.

On the 10th day after blood transfusion, compared with the initial parameters, we observed 28.8% decline in the number of leukocytes, 51.0% increase in the number of lymphocytes, 3.8% increase in monocytes, 33.0% decrease in the number of granulocytes, and increases measuring 3.05-fold in the number of erythrocytes, 3.52-fold in the parameters of hemoglobin, 3.28-fold in the percentage of hematocrit, 19.9% in mean corpuscular volume, 53.9% in mean corpuscular hemoglobin, 25.5% in mean corpuscular hemoglobin concentration, and also 7.8% decrease in erythrocyte distribution width. The number of platelets decreased by 42.6%, and mean platelet volume declined by 14.9%.

On the 15th day after blood transfusion, compared with the initial parameters, the number of leukocytes decreased 40.4%, number of lymphocytes increased 34.3%, monocytes increased 3.8%, and the number of granulocytes decreased 29.7%, We saw increases measuring 2.88-fold in the number of erythrocytes, 4.13-fold in hemoglobin parameters, 3.31-fold in hematocrit percentage, 32.6% in mean corpuscular volume, 80.9% in mean corpuscular hemoglobin, and 26.3% in mean corpuscular hemoglobin concentration, whereas erythrocyte distribution width declined 19.3%. The number of platelets decreased 38.3% and mean platelet volume declined 19.3%.

Table 2
Biochemical analysis of blood of flea-infested cats (x ± SD, n = 5)

Parameters	Physiological norm	Initial state (prior blood transfusion)	Day 10 after blood transfusion
Glucose, mmol/L	3.5–6.0	5.72 ± 0.60	3.69 ± 0.48**
Total protein, g/L	55–75	69.80 ± 2.84	65.44 ± 3.49
Albumin, g/L	25–40	24.14 ± 1.07	25.64 ± 1.13
Bilirubin, μmol/L	0.0–5.5	4.20 ± 1.06	1.58 ± 0.54***
Creatinine, μmol/L	80–160	97.20 ± 7.93	95.37 ± 4.09
Urea, mmol/L	4–11	7.93 ± 1.29	6.55 ± 0.43
ALT, IU/L	10–50	44.60 ± 4.24	25.14 ± 7.11***
AST, IU/L	10–30	24.78 ± 4.40	17.08 ± 2.19**
GGTP, IU/L	1–5	3.16 ± 0.71	2.19 ± 0.58
Ca, mmol/L	2.3–3.0	2.85 ± 0.20	2.52 ± 0.31
P, mmol/L	0.8–1.8	2.00 ± 0.16	1.51 ± 0.14***

Note: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ compared with the parameters of the initial state (n = 5).

Analysis of the results of biochemical studies revealed the following changes in the parameters on the 10th day against the initial state: the level of glucose decreased 35.5%, content of total protein decreased 6.2%, and albumin increased 6.2%. We saw 62.4%, 1.2%, and 17.4% decreases in the levels of bilirubin (total), creatinine, and urea, respectively. Also, we should note statistically significant decreases in the levels of activity of transaminase in blood plasma compared with their initial level, particularly, 30.7% in gamma-glutamyl transpeptidase (GGTP), 43.6% in alanine aminotransferase (ALT), and 31.1% in aspartate aminotransferase (AST). Levels of calcium and phosphorus were within the reference norm values, but on the 10th day we observed 11.5% and 24.5% decreases in their levels, respectively.

Concentrations of creatinine in blood plasma and urea in the group of ill cats was within the reference norm values, indicating no impairments in the infiltrational ability of the glomerulus.

Discussion

Over recent years, transfusion of blood and its components has become extremely relevant in veterinary medicine. At the same time, transfusion of allogeneic blood to recipient animals is followed by immune response. The most effective transfusion of blood and its components in veterinary medicine is carried out to treat amenia of various genesis (post-hemorrhagic, hemolytic, aplastic). As known, anemia in animals occurs quite often and requires immediate treatment by veterinary specialists.

Animal anemia is given attention by veterinary-medicine practitioners. However, immune-system reactions in recipients raise concerns (Callan et al., 2013; Khalak et al., 2020; Shkatula et al., 2023; Dunaievska et al., 2024). Mistakes made during blood transfusion in veterinary clinics occur when drawing blood, processsing, storing, and transfusing it. Transfusion-related complication such immune response ranges in severity from light signs to potentially lethal reactions. Most often, a recipient animal's immune system mounts a response not only to transfused erythrocytes, but also to products of cellular processes, formed during storage. While blood components are stored, pro-inflammatory cytokines develop, which can provoke acute immune reactions in animals that receive blood transfusion. Concentration of pro-inflammatory cytokines depends on duration of blood storage. Moreover, immune reactions in recipient animals after transfusion of whole blood and blood components occur due to malpractice of vetclinic personnel in identifying the blood group and performing crossmatching (the main and secondary). The results suggest that whole-blood transfusion to recipient cats can be positive. Allogeneic-blood transfusion to recipient animals caused no clinical picture of immune response: rectal temperatre, pulse, and respiratory rate remained within the physiological parameters, and also we observed no syndrome of transfusion-caused lesions of the lung tissue and disseminated intravascular blood coagulation.

Inferring from the results of the laboratory studies and clinical examination of the animals with parasitic infestation, we think that transfusion of packed red blood cells is a safe method of restoring number of erythrocytes in recipient animals. It has to be noted that recovery of erythrocytes (2.89-fold increase compared with initial values), hemoglobin content (4.12-fold increase), and hematocrit (3.31-fold increase) led to improvement of saturation of the recipients' tissues with oxygen, and as a result – decrease in the general intoxication of the organism through normalization of redox processes.

Improvement of the hematological parameters in the parasite-infested cats already on the 5th day of treatment with whole-blood transfusion was associated with the fact that the main mechanism of action of transfused blood is oxygen-forming ability. Claus et al. (2022) noted that besides the main respiratory function, red blood cells partake in blood coagulation and fibrolysis, thanks to the agent similar to factor of platelet activation, and also erythrokinase, which activates and converts profibrinolysin into fibrinolysin. The large surface of red blood cells (4,000 m^2), fast circulation of non-deposited red blood cells (45 s), and pronounced sorption ability determine their detoxicating function. According to Denysova et al. (2021), as the modern concept of component therapy suggests, red blood cells are mainly transfused with the compensating purpose. Studies by Ackerman et al. (2021) and Gul et al. (2023) demonstrated that the advantage of transfusion of erythrocyte-containing components over transfusion of stored donor blood is increased oxygen-transporting activity in a small volume of transfusion environment. Morris et al. (2021) noted that an advantage of using packed red blood cells may be absence or minimal content of sensitization factors (proteins of plasma, white blood cells, and platelets). Results of the studies by Otsuka et al. (2002) and Denysova et al. (2021) showed that this ability was especially expressed in rinsed red blood cells. Zygner et al. (2023) noted absence or minimal concentration of breakdown products and vasoactive compounds (potassium, sodium, nitrogen, serotonine, histamine) after using erythrocyte-containing blood components. Wong et al. (2022) observed that transfusion of packed red blood cells was followed by decrease in the number of microaggregates, absence of plasmatic factors of blood coagulation and significant number of platelets, and also decrease in the risk of transmissive infections.

Analysis of the results of biochemical studies revealed an array of changes in the activity of transaminases and concentration of total bilirubin in blood plasma in cases of high invasion intensity. Threfore, ill animals with severe infestation were observed to have increased total bilirubin in blood plasma, which was related to a mass breakdown of red blood cells (Pogozhykh et al., 2017) and release of a large amount of hemoglobin, which breaks down in the liver into bilirubin. On the 10th day after blood transfusion, the level of bilirubin decreased 62.4% against the initial parameters. Decreases that occurred in blood plasma – 30.7% in the activity of gamma-glutamyl transpeptidase (GGTP) (decline to the level of the norm), 43.6% in alanine aminotransferase (ALT), and 31.1% in aspartate aminotransferase (AST) – can suggest high hepatoxicity of this disease and additional loading on the hepato-biliary and cardiovascular systems. Concentrations of creatinine and urea in blood plasma of the ill cats were within the reference values of the norm, indicating absence of malfunctions of the filtrating ability of the glomerulus, and the 17.4% decline in the urea level indicated improvement in metabolic processes in the organism and moderately expressed desintoxicating action. Other parameters were within the reference values of the norm. The glucose level in blood plasma, collected from patients on an empty stomach, was within the norm throughout the treatment, though on day 10 after transfusion it decreased 35.5% to the lower threshold of the norm, which may indicate improved endocrine functionality of the pancreas.

Conclusion

On day 15 after allogeneic-blood transfusion to anemia-suffering cats, compared with the initial parameters, we observed statistically significant increases in the values of morphological blood parameters, particularly, 2.89-fold in the number of erythrocytes, 4.12-fold in the hemoglobin parameters, and 3.31-fold in the percentage of hematocryt. There were also 32.6%, 80.9%, and 26.3% increases in mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration, respectively.

On the 10th day after blood transfusion, there were seen significant changes in the parameters of biochemical parameters of blood: compared with the initial parameters, there were decreases measuring 62.4% in the bilirubin level, 30.7% in the activity of gamma-glutamyl transpeptidase (decline down to the level of the norm), 43.6% in alanine aminotransferase, and 31.1% in aspartate aminotransferase.

Thus, transfusion of whole blood to the recipient animals can heighten the number of erythrocytes, hemoglobin, parameters of hematocrit, thereby positively influencing blood oxygenation, redox process in the recipient animals, as indicated by decline in the levels of transaminases and urea in the blood serum and improvement in the general clinical state of the animals.

The study was financed by the Ministry of Education and Science of Ukraine (No. 0122U001642 "Scientific-experimental study of action mechanisms of donor blood in veterinary medicine in case of pathologies of various genesis").

The authors declare no conflict of interests.

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