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Clinical-laboratory Manifestations of Myocarditis in Dogs

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Abstract

The leading clinical signs of myocarditis in dogs were the sudden development of signs of disease, refusal to eat, dyspnea at rest, rapid fatigue. At the diagnostic stage, the position of animals forced, lying, increased breathing speed up to 60-72 movements per minute, pale visible mucous membranes and conjunctiva, weak filling of pulse, rapid filling of capillaries, high blood pressure, increase in the number of leukocytes up to 25--27×109/l, SRS up to 15,4--17,4 mg/l, troponin up to 3,85--4,2 ng/ml. Electrocardiographic study established sinus or ectopic rhythm, heart rate 133--198 oz/min, conductivity disturbance and deceleration. ECHOKG showed moderate expansion of the left ventricle, moderate expansion of the left atrium. Sealing of the mitral valve leaves, regurgitation on the mitral valve of the first degree. Left ventricular myocardium is inhomogeneous, wall echogenicity is increased. Fraction of contractility 16--18 %. After establishment of a dietary regime and correction of conditions of the maintenance, to dogs strictly with a twelve-hour interval twice a day are appointed vedmedin (0,25 mg/kg), sotalol (1,5 mg/kg), sinulox (20 mg/kg), mexidol-vet (1 table), verospheron (1 mg/kg). As a result of four-week monitoring of patients' condition positive results were noted: lack of dyspnea, normalization of pulse rate and blood pressure, reduction of capillary filling rate up to 1 second, leukocyte concentration up to 12,6--15,7 ×109/l, SRS up to 1,3--1,4 mg/l, troponin up to 0,09--0,17 ng/ml. The electrocardiographic study showed a decrease in the height of teeth R and P, increase in the intervals P-Q and Q-T. The sinus rhythm is irregular. Echokg showed expansion of the left ventricle, moderate expansion of the left atrium. Sealing of mitral valve leaves, regurgitation on mitral valve of the first degree. Left ventricular myocardium is less heterogeneous, wall echogenicity is increased. Fraction of contractility 23--24 %. It is difficult to predict the outcome of the disease at this stage, as the age of dogs is 7--12 years, and in many respects the quality of life will be provided by their owners.

Keywords: dog, myocarditis, white blood cells, troponins, C-reactive protein, echocardiography, electrocardiography.

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1. Introduction

Animals are affected by a huge number of environmental factors, and constant technogenic pressure causes additional stress in their cardiovascular system [6, 7]. In small domestic animals, heart diseases account for about 10.0 % of all non-communicable diseases, where hereditary diseases account for one in ten cases [13]. According to A.A. Rudenko (2019), heart diseases in dogs in Germany range from 9.2 to 9.4 %, the Netherlands -- 22.2 %, Denmark -- 3.8 %, Russia -- 5.0 % of the total number of cases of internal pathology [20]. And every year there is an increase in cardiovascular diseases among dogs [27]. According to the data, male dogs are sick more often than female dogs, the first critical period of heart and vascular disease in dogs falls on the age of up to one year, the second -- from 5 to 14 years [27]. Scientists have found that dogs have cardiovascular disease in the lead: 10 % of cases of disease detect heart problems. Statistics on heart and vascular diseases in medium and small breeds of dogs are very contradictory and depend to a large extent on the popularity of a particular breed. Leaders in cardiovascular diseases are heavy breed dogs, such as German shepherd, Newfoundland, Golden Retriever, Labrador Retriever, Bulldog [11]. The leading causes of disease in large breeds of dogs are either too much exercise or hypokinesia, due to lack of movement and exercise. The development of cardiovascular pathology is not insignificant in terms of basic metabolic disorders, previously transmitted infectious diseases, genetically inherited anomalies, congenital heart disease, blood loss, severe injuries, poisoning, intoxication, emotional stress [14, 27]. 3.9 to 6.4 % of all heart and vascular diseases are myocarditis-related [8]. Myocarditis is a clinical syndrome with many possible causes and manifestations [21]. More specifically, myocarditis is a lesion of the heart muscle that is primarily inflammatory in nature, caused by direct or indirect exposure to infection, parasitic or protozoic invasion, chemical or physical factors, as well as lesions arising from allergic and autoimmune diseases, and may involve both cardiomyocytes and interstitial tissue in the inflammatory process [17, 22]. The high clinical significance of this pathology is conditioned by high morbidity, as myocarditis is considered a precursor of dilatational cardiomyopathy in connection with the development of systolic dysfunction [3, 18]. very often, an acute inflammatory process in myocardium is accompanied by blockades of the conductive heart system, including atrioventricular blockades of the 2nd and 3rd degree and blockades of the sinus node [28, 31, 34]. In dogs, myocarditis is a focal or diffuse inflammatory heart disease characterized by degeneration or necrosis of the heart muscle (myocyte) that causes inflammatory tissue infiltration [33]. Despite the rapid development of diagnostic

methods, the improvement of algorithms for prevention and treatment, heart disease remains a leading pathology in the structure of morbidity and mortality, both in human and veterinary medicine [10, 15]. The pronounced differences in clinical picture of the disease make the issues of diagnosis, classification and treatment of myocarditis extremely complex [12]. Myocarditis is one of the most diverse and difficult to recognize diseases in a clinic of internal diseases. With no particular symptom, it can mimic both the majority of common heart disease and some relatively rare forms of cardiomyopathy (1). Dogs have only isolated memories of myocarditis symptoms caused by viral, bacterial or protozoic agents [18]. Rheumatic myocarditis is thought to be the most dangerous in dogs with a tendency or disease to rheumatism [23]. The clinical picture of myocarditis in dogs can vary greatly, from cardiac arrhythmias to cardiomyopathic changes. [29].

2. Methods and Equipment

The research was carried out in 2018-2019 on the basis of the Department of Obstetrics, Surgery and Non-Communicable Diseases of Animals, in the veterinary training and research center "Vetass". The object was the dogs who entered the clinic for an appointment. The subject of the study was data from physical, laboratory and instrumental studies. General blood analysis was performed with the help of automatic hematological analyzer BCE-90Vet, biochemical (glucose, total albumin protein, urea, creatinine, bilirubin AST, ALT, alkaline phosphatase) -- on the semi-automatic BioChemBA analyzer with Diacon-vet kits, C-reactive protein -- by immuno-turbodimetry with Diasys reagent kit, troponin -- in the independent veterinary laboratory "VetUnion" (Moscow). Instrumental research -- ECG and ECG -- by the veterinary computer electrocardiograph "PoliSpectrum-8/B" (Neurosoft, Russia) and "Sonomed-500" (Spectrumed, Russia), respectively. Blood pressure was determined by means of a veterinary blood pressure monitor SnTechSet 20 (USA).

3. Results

Two dogs took part in the study: a poodle, 12 years old, a dog, the nickname Rhett and a German shepherd, 7 years old, a female dog, the nickname Justyna. Complaints of the owners were similar: rapid fatigue, rejection of food, dyspnea at rest, signs developed suddenly, within 2--3 days. In both cases, the clinical study showed that the position was forced, lying, tachypic (frequency of 60--72 breathing movements per minute), the color of visible mucous membranes and conjunctivae was pale, and the pulse was

weakly filled. Optional lungs without features. Justyna's pulse deficit, weak systolic noise on the mitral valve (1st degree), capillary filling rate (CNA) 2.5 sec, arterial pressure -- 107/75 mm Hg; Rett's arterial pressure -- 114/80 mm Hg, systolic noise on the mitral valve (1--2 degree), CNA -- 2 s.

To assess the severity of the patients' condition, we studied the morphological biochemical parameters of the blood (Tables 1 and 2).

Table 1: Blood morphology in dogs before treatment.

Indicators	Unit of measure	Reference range	Rhett, 12 years, ♂	Yustina, 7 years, ♀
WBC	$\times 10^9$/l	6,0--17,0	25,3	27,0
RBC	$\times 10^{12}$/l	5,50--8,50	5,84	6,23
HGB	g/l	110--190	124	134
HCT	%	39,0--56,0	41,3	45,3
MCV	fl	62,0--72,0	65,6	66,7
MCH	pg	20,0--25,0	21,2	23,2
MCHC	g/l	300--380	306	336
PLT	$\times 10^9$/l	117--460	394	274

As can be seen from Table 1, the leukocyte content in both dogs exceeded the upper limit of the physiological norm by 48.8--58.8 %. The analysis of biochemical parameters revealed the increase of ACT activity in patients by 50 % and more, the increase of DRR concentration by 2.57--2.9 times. Troponin levels increased 55--60 times (Table 2). the changes we found are consistent with the previously obtained data of other scientists [2, 3, 19, 26, 33], which indicates the development of acute inflammatory process of the heart muscle.

However, for the final diagnosis, instrumental studies have been performed as the most informative methods of diagnosing heart disease [3, 4, 9]. According to the electrocardiographic study of a poodle called Rhett, the rhythm is sinus, HR=133 oud/min, deceleration of intracardiac and intraventricular conduction, single ventricular extrasystoles (left ventricular), an average of 10 per 1 minute (Fig. 1). In the analysis of the results of the ECG of the German Shepherd Justyna, the rhythm was ectopic, HR=198 oz/min, paroxysmal ventricular tachycardia (left ventricular), transient intraventricular conduction disorders on the Gisa legs (Fig. 2).

A study of the ECHO-poodle results showed moderate expansion of the left ventricle, moderate expansion of the left atrium. Sealing of the mitral valve leaves, regurgitation on the mitral valve of the first degree. Right heart regions without features. Significant areas of left ventricular myocardial hypokinesia (especially of the posterior wall of the left

Table 2: Blood chemistry in dogs before treatment.

Indicators	Unit of measure	Reference range	Rhett, 12 years, ♂	Yustina, 7 years, ♀
Total protein	g/l	55--77	64,1	69,9
Albumin	g/l	25--40	35,1	32,0
Globulins	g/l	30--40	29,0	37,0
Creatinine	μMol/L	50--120	115,9	89,7
Urea	μMol/L	2,5--8,6	7,8	6,8
Glucose	μMol/L	4,4--6,5	4,6	5,0
Total bilirubin	μMol/L	0,5--10,0	4	7,5
Straight bilirubin	μMol/L		0	0
ALT	ME/l	До 70	73,4	65,6
AST	ME/l	до 75	112,8	135,7
Alkaline phosphatase	ME/l	до 160	165,2	139,2
SRB	Mg/l	0--6	15,4	17,4
Troponin	ng/ml	0,03--0,07	3,85	4,2

ventricle). Left ventricular myocardium is heterogeneous, wall echogenicity is increased. Fraction of contractility is 16 % (Fig. 3).

According to ECHOKG results, the German shepherd has a moderately enlarged left ventricle and a moderately enlarged left atrium. Sealing of the mitral valve leaves, regurgitation on the mitral valve of the first degree. Right heart regions without features. Significant areas of left ventricular myocardial hypokinesia. Left ventricular myocardium is less heterogeneous, wall echogenicity is increased. Fraction of contractility 18 % (Fig. 4).

Acute myocarditis was diagnosed on the basis of a comprehensive study of patients.

4. Discussion

Following the basic principles of therapy, the animals are recommended a gentle diet, not voluminous, easily assimilable feed, walking on demand of the animal. From medications patients were prescribed a cardiotropic drug of vermedin in a dose of 0.25 mg/kg, which has a positive inotropic effect and a pronounced vasodilating effect; preparation with antiarrhythmic action sotalol in a dose of 1.5 mg/kg, combined antibacterial preparation sinulox in a dose of 20 mg/kg, to improve metabolic processes in the heart muscle mexidol-vet 1 pill each, to control edema syndrome -- verospiron 1 mg/kg.

Figure 1: Rhett's poodle EKG before the treatment.

Figure 2: Justina's German shepherd's ECG before treatment.

Medicines were used twice a day strictly at twelve-hour intervals. A similar algorithm of drug therapy has been suggested by other authors [13, 24, 30].

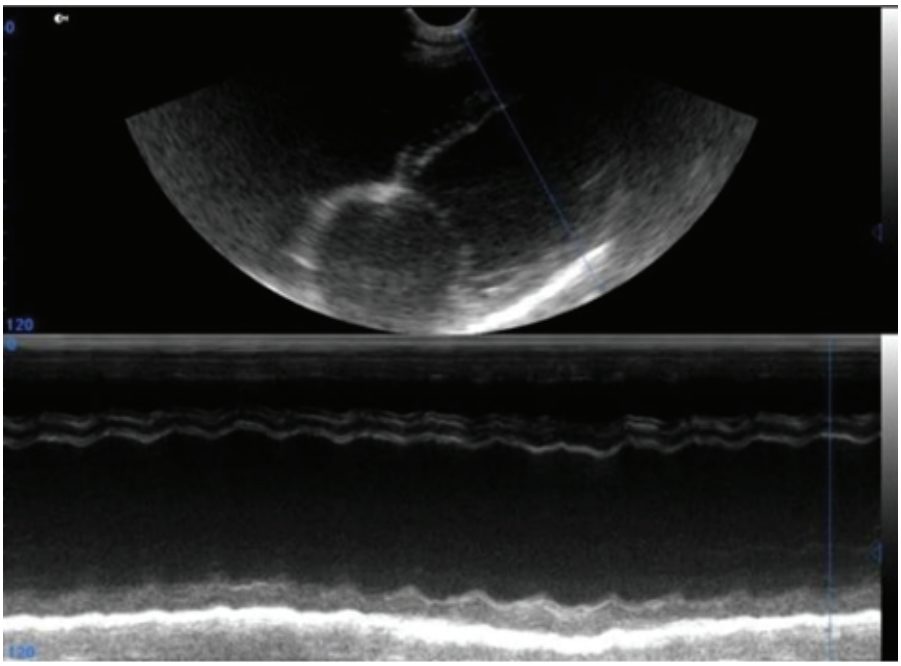

Figure 3: EHOKG, Rhett's poodle.

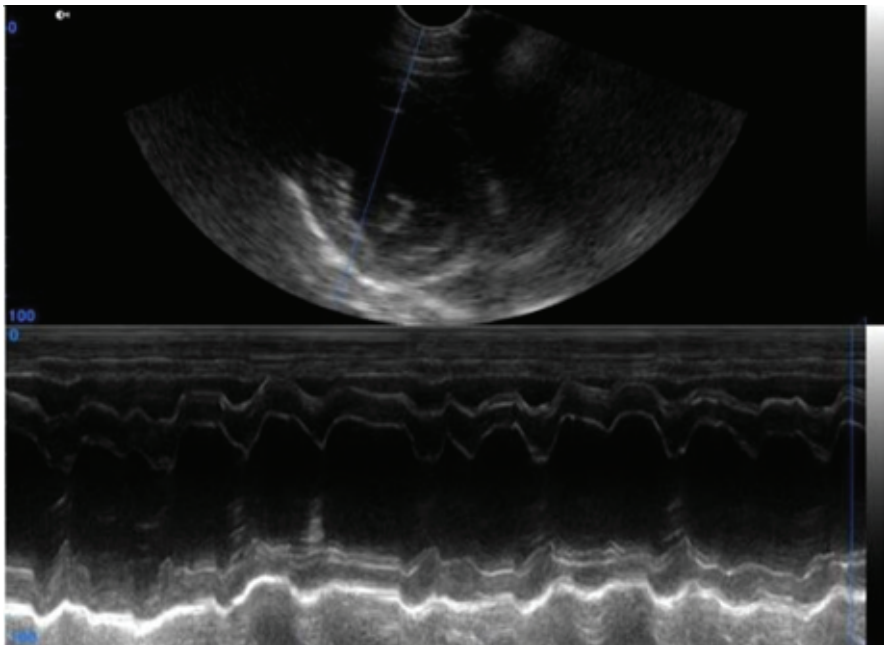

Figure 4: ECHOKG, Justina's German shepherd.

A positive response to the treatment was revealed in the course of monitoring the condition of dog patients. The repeated study was conducted 4 weeks after the start of treatment. In the poodle called Rett, we noted the recovery of blood pressure to reference values, pulse rate of 96 beats per minute. Electrocardiographic study showed a decrease in the height of R and P teeth, increase in P-Q and Q-T intervals. Sinus irregular rhythm with heart rate max. = 178 oz/min, heart rate min. = 62 l/min. Single

ventricular extrasystoles were observed, the position of the electric axis of the heart is normal (Fig. 5).

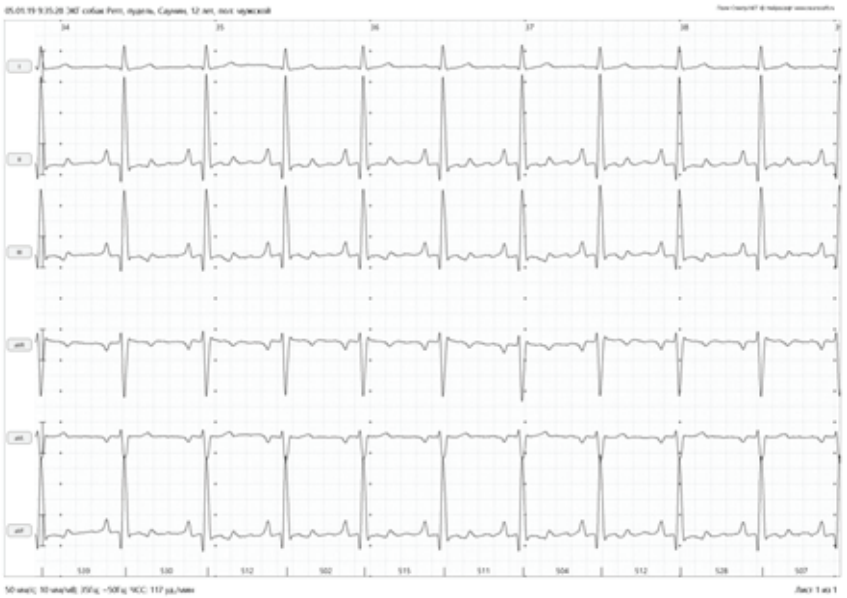

Figure 5: Rhett's poodle EKG after treatment.

The German shepherd Justina had a reduced pulse rate of up to 109 beats per minute and normalized blood pressure to physiological parameters. The ECG revealed the increase in the value of R and P teeth, the increase in P-Q intervals, reduction of QRS complex. Sinus irregular rhythm with heart rate max. = 118 oud/min, heart rate min. = 95 l/min. Position of the electric axis of the heart is normal. Slowdown of intracardiac conduction. Elevation of the S-T complex is probably myocardial hypoxia (Fig. 6).

Both dogs had stable, moderate physical activity and dyspnea after 10 minutes of physical activity. NSA was 1 sec.

ECHOKG after treatment in the poodle showed expansion of the left ventricle, moderate expansion of the left atrium. Sealing of the mitral valve leaves, regurgitation on the mitral valve of the first degree. Right parts without any peculiarities. Reduced contractility of the left ventricle posterior wall. Left ventricular myocardium is less heterogeneous, wall echogenicity is increased. Fraction of contractility 23 %.

In the German shepherd's ECHOKG study, left ventricular dilation and moderate left atrial dilation were found. Sealing of the mitral valve leaves, regurgitation on the mitral valve of the first degree. Right parts without any peculiarities. Reduced contractility of the left ventricle posterior wall. Left ventricular myocardium is less heterogeneous, wall echogenicity is increased. Fraction of contractility 24 %.

Figure 6: Justina's German shepherd's ECG after treatment.

On the background of the performed therapy the confirmation of the patients' condition improvement is the decrease of leukocyte concentration in the peripheral blood by 41,9--50,2 %, the increase of MCV and MCHC erythrocyte indexes (Table 3).

TABLE 3: Blood morphology in dogs after treatment.

Indicators	Unit of measure	Reference range	Rhett, 12 years, ♂	Yustina, 7 years, ♀
WBC	$\times 10^9$/l	6,0--17,0	12,6	15,7
RBC	$\times 10^{12}$/l	5,50--8,50	5,64	6,67
HGB	g/l	110--190	128	132
HCT	%	39,0--56,0	41,0	42,3
MCV	fl	62,0--72,0	67,6	65,3
MCH	pg	20,0--25,0	21,7	22,2
MCHC	g/l	300--380	316	341
PLT	$\times 10^9$/l	117--460	364	304

Their analysis of biochemical parameters should improve the trophic functions of the myocardium, accompanied by an increase in the content of albumins in blood serum. Decreased enzymatic activity, DRR and troponin levels confirm the leveling of inflammation in the myocardium, and the effectiveness of the therapy (Table 4).

Table 4: Blood chemistry in dogs after treatment.

Indicators	Unit of measure	Reference range	Rhett, 12 years, ♂	Yustina, 7 years, ♀
crude protein	g/l	55--77	63.3	63.4
albumen	g/l	25--40	36.1	32.2
globulin	g/l	30--40	27.2	31.2
creatinin	μMol/L	50--120	108.0	93.8
urea	μMol/L	2.5--8.6	7.8	7.0
sugar	μMol/L	4.4--6.5	5.1	5.2
total bilirubin	μMol/L	0.5--10.0	5	3.6
bilirubin	μMol/L		0	0
SGPT	ME/l	До 70	57.3	55.1
HSNP	ME/l	до 75	110.8	96.2
phosphatase	ME/l	до 160	185.3	130.6
CRP	SRB	0--6	1.4	1.3
troponins	Mg/l	0.03--0.07	0.17	0.09

5. Conclusion

The substantiated choice of diagnostic criteria and the stage of their involvement in the diagnosis of myocarditis correspond to the current trend of cardiac diagnostics [4, 5, 16, 25, 32, 33]. The effectiveness of the performed therapeutic measures is obvious: reduction of leukocytes, SRS, troponin, activity of marker enzymes accompanied by restoration of the value of P and R teeth, normalization of QRS complex. It is difficult to predict the outcome of the disease at this stage, as the age of dogs is 7--12 years, and in many respects the quality of their lives will be provided by the owners.

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Conflict of Interest

The authors have no conflict of interest to declare.

References

[1] Blagova, O.V. (2014). Not accessible. Modern myocarditis masks (from clinical syndromes to diagnosis). *Russian Cardiology Journal*, no. 5(100), pp. 13--22. Moscow: FIRMA SILICEIA LLC.

[2] *Dog and cat diseases. Complex diagnostics and therapy*. (2013). Under edition of Stekolnikova, A.A., Staroverova, S.V. 4rd ed., op. and extra. St. Petersburg: SpetsLit, 925 p.

[3] Vasilieva, V.A., Prokhorova, E.V., Kulikova, N.N., Nebaikina, L.A. (2006). Treatment of myocarditis in dogs. *Successes of modern science*, no. 1, pp. 48--49. Belgorod: Successes of modern science.

[4] Gerke, V.S. (2013). Fundamentals of cardiological examination of dogs. *Vetpharma*, no. 4, pp. 40--46. Moscow: Medical Information Agency ``MEDFORUM''.

[5] Gilyarovsky, S.R. (2008). *Myocarditis: modern approaches to diagnosis and treatment*. Moscow: Media Sphere, 324 p.

[6] Golokhvast, K.S., Panichev, A.M., Automonov, E.G. (2010). Ecological aspects of interaction between living organisms and mineral factors of the environment. *Proceedings of the II International Symposium ``Ecological problems of animals and humans''*. (Ministry of Agriculture of the Russian Federation; Novosibirsk State Agrarian University; Research Institute of Animal Husbandry; Biotechnological Institute, 29--30 October 2009). Novosibirsk, pp. 25--27.

[7] Donnik, I.M., Shkuratova, I.A. (2011). Environment and animal health. *Veterinary of Kuban, Krasnodar: Krasnodar Regional Public Veterinary Organization*, no. 2, pp. 12--13.

[8] Julikova, O.A. (2016). Monitoring of cardiovascular diseases among cats and dogs in Blagoveshchensk, Amur region. *Far Eastern Agrarian Bulletin, Blagoveshchensk: FSBEI ``Far Eastern State Agrarian University''*, no. 2(38), pp. 49--56.

[9] Ivanova, S.V., Titov, V.A., Mitrofanova, L.B., Moiseeva, O.M. (2018). Analysis of the causes of late diagnosis of myocarditis. *Translational Medicine*, no. 5(2), pp. 5--14. St. Petersburg: National Medical Research Center named after V.A. Almazov.

[10] Isakov, L.K., Tarasov, N.I., Sinkova, M.N., Vakhovskaya, I.M. (2017). Clinical case of a favorable outcome of undiagnosed myocarditis. *Fundamental and clinical medicine*, vol. 2, pp. 83--91. Kemerovo: FSBEI HEI "Kemerovo State Medical University.

[11] Kozlovskaya, N.G. (2013). Breed predisposition of dogs and cats to cardiological diseases. *RHD. MWA*, no. 6, pp. 32--35. Moscow: Logos Press.

[12] Koroleva, A.A., Zhuravkov, Y.L. *Modern approaches to diagnosis and treatment of myocarditis.* Retrieved from: file:///C:/Users/%D0%9B%D1%D1%E%D0%B4%D0%D0%BC%D0%B8%D0%B%D0%B0/Downloads/2013011410411110.pdf (assessed on 07.02.2019).

[13] Martin, V.S., Corcorin, B.M. (2004). Cardiorespiratory diseases of dogs and cats. Moscow: Aquarium-Print, 496 p.

[14] Martynov, A.N., Turkov, V.G., Kletikova, L.V., Zybina, T.N. (2016). Diabetes mellitus in cats associated with metabolic syndrome. *Successes of modern science*, vol. 3, no. 2, pp. 6--11. Belgorod.

[15] Mitkovskaya, N.P., Grigorenko, E.A., Danilova, L.I. (2008). *Heart and metabolic risk*. Minsk: Belarus. Science, 277 p.

[16] Niemand, H.G., Souter, P.F. (2001). *Dog diseases*. Practical guidelines for veterinarians (organization of a veterinary clinic, examination, diagnosis of diseases, treatment), 2rd ed. Moscow: Aquarium LTD, 816 p.

[17] Paleyev, N.R., Paleyev, F.N. (2009). Non-coronarogenic myocardial diseases and their classification. *Russian Cardiological Journal*, no. 3(77), pp. 5--9. Moscow: FIRMA SILITSEA LLC.

[18] Roberto, A. Santilli. (2017). Etiology of myocarditis. Therapeutic strategies. What we can use in clinical practice and how to interpret myocardial biopsy. *Vetpharma*, no. 3. Moscow: Agency for Medical Information MEDFORUM.

[19] Rogachev, A.S. (2015). Blood diagnostic examination for the content of cardiac troponins. *RHV. MWA*, no. 1, pp. 32--33. Moscow: Logos Press.

[20] Rudenko, A.A. *Distribution of cardiomyopathies and other cardiovascular diseases in dogs*. Retrieved from: http://xn--80abelqjzx5d.su/rasprostranenie-kardiomiopatij-i-drugih-boleznej-serdechno-sosudistoj-sistemy-u-sobak.html (accessed on 08.02.2019).

[21] Swanton, H., Harband, R.K .(2001). *Diagnostics and treatment of myocarditis*. Retrieved from: https://www.lvrach.ru/2001/07/4528851/ (accessed on 04.02.2019).

[22] Skvortsov, V.V., Tumarenko, A.V., Odintsov, V.V., Orlov, O.V., Skvortsova, E.M. (2009). *Russian Cardiology Journal*, no. 1(75), pp. 87--96. Moscow: FIRMA SILITSEA LLC.

[23] Modern course of veterinary medicine by Kirk. (2005). Moscow: Aquarium-Print, 1376 p.

[24] Starchenkov, S.V. (2001). *Dog and cat diseases*. St. Petersburg: Lan, 560 p.

[25] Storozhkov, G.I., Gorbachenkov, A.A. (2008). *Guidance on cardiology*, vol. 1. Moscow: Geotar-Media, 682 p.

[26] Suther, P., Kon, B. (2011) *Dog diseases*, 10rd ed., full reworking and rass. Moscow: Aquarium-Print, 1384 p.

[27] Khrushcheva, V.P., Shumakov, V.V., Martynov, A.N., Kletikova, L.V. (2017). Analysis of the incidence of cardiovascular pathology in small domestic animals in the period from 2012 to 2015. *Agrarian Bulletin of the Upper Volga region, FGBOU ETO Ivanovskaya SSKHA*, no. 3, pp. 25--31.

[28] Church, W.M., Sisson, D.D., Oyama, M.A., Zachary, J.F. (2007). Third degree atrioventricular block and sudden death secondary to acute myocarditis in a dog. *J. Vet. Cardiol.*, no. 9. pp. 53--57.

[29] Janus, I., Noszczyk-Nowak, A., Nowak, M. et al. (2018). Biocarditis in Dogs: Etiology, Clinical Symptoms and Histopathological Signs (Overview of 11 Clinical Cases: 2007--2013). *Modern Veterinary Medicine. Cardiology (Special Iss.)*, pp. 34--42. Moscow: Zooinform Research Center LLC.

[30] Ketal, G.D. (2005). Reduction of infarct size and postischemic inflammation from ATL-146e, a highly selective adenosine A2A receptor agonist, in reperfused canine myocardium. *Am J. Physiol Heart Circ Physiol*, vol. 288(4), pp. H1851--H1858.

[31] Kaneshige, T., Machida, N., Nakao, S., Doiguchi, O., Katsuda, S., Yamane, Y. (2007). Complete atrioventricular block associated with lymphocytic myocarditis of the atrioventricular node in two young adult dogs. *J. Comp. Path*., vol. 137, pp. 146--150.

[32] Mason, J.W., O'Connell, J.B., Nerskowitz, A. et al. (1995). A clinical trial of immunnosupressive therapy for myocarditis. *N. Engl. J. Med.* vol. 333, pp. 269--275.

[33] Silvestrini, P. et al. (2012). Serum cardiac troponin I concentrations in dogs with leishmaniasis: correlation with age and clinicopathologic abnormalities. *Vet ClinPathol Sep 12*.

[34] Woolley, R., Blundell, R., Else, R., Corcoran, B., Devine, C., French, A. (2007). Atrial myocarditis as a cause of sinus arrest in a dog. *J. Small. Anim. Pract*., no. 48, pp. 455--457.