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Distribution of blood groups in dogs of different breeds in Kyiv and Kyiv Oblast, Ukraine

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In veterinary transfusion medicine, correct identification of blood group of dogs is critical to prevent immunological complications. The most clinically significant antigen is DEA 1 (dog erythrocyte antigen 1), which can cause sensitization and development of acute hemolytic reaction in recipients of repeated transfusion of incompatible blood. Taking into account the importance of local mapping of the distribution of blood groups, the objective of this study was determining the distribution of the DEA 1 blood group in dogs of different breeds in Kyiv and Kyiv Oblast, emphasizing the analysis of breed variability and clinical significance of the results for veterinary practice. In the study, we used 493 blood samples from dogs whose owners contacted the clinic or the bank of animal blood during the period between 2018 and 2024. Blood group was identified using the immunochromatographic method with RapidVet-H Canine DEA 1 kits. All the samples were tested for the presence of DEA 1 antigen with the subsequent distribution according to breeds, calculation of the percentage ratio of DEA 1+ and DEA 1-, and also the statistical analysis with the χ^2 criterion in relation to the null hypothesis of even distribution (50/50). In general, 55.4% of the animals turned out to be DEA 1-positive, while 44.6% were found to be DEA 1-negative. We determined a significant variability in the distribution of blood groups depending on the breed. The largest share of DEA 1+ was observed in the English Cocker Spaniels, Pomeranian Dogs, and American Cocker Spaniels, while the DEA 1- blood group dominated in the German Shepherds, Belgian Shepherds, and Giant Schnauzers. The obtained results indicate a possible genetic tendency of certain breeds toward a particular blood type. The results are consistent with similar studies in other countries and can be used for designing effective programs of selecting donors in veterinary transfusion medicine. A special attention should be paid to the limited number of DEA 1- donors, which underscores the importance of pre-typing of blood before each transfusion. The study is the first large-scale analysis of the distribution of DEA 1 in dogs in Ukraine and therefore is of practical significance for the development of clinical veterinary medicine.

Keywords: dog erythrocyte antigen; immunochromatography; blood transfusion; breed variability.

Introduction

Blood transfusion is a vitally important procedure in veterinary medicine, especially in cases of acute blood loss, hemolytic anemia, or surgical interventions. Dogs, unlike people, have no natural alloantibodies, which reduces the risk of acute hemolytic reactions to first-time transfusion. However, repeated transfusion of non-matching blood, in particular DEA 1-positive to DEA 1-negative animals, can cause alloimmunization, with the development of severe clinical complications (Acierno et al., 2014; Giger et al., 2014).

Blood group in dogs is determined based on the breed-specific antibodies on the surface of erythrocytes. Currently, at least eight antigens are known, which are classified within the Dog Erythrocyte Antigen (DEA) system: DEA 1.1, 1.2, 3, 4, 5, 6, 7, and 8 (Bank et al., 2023). The most clinically significant is DEA 1. Earlier, it was divided into subtypes (DEA 1.1, 1.2, 1.3), but modern studies have proved that this is one antigen with a variable expression (Blais & Giger, 2007; Carli & Vascellari, 2017). Its expression is stably genetically determined, and antigens of other groups have lower immunogenicity.

The antigen DEA 1 is inherited as a complex autosomal-dominant feature. Erythrocytes can express different combinations of DEA antigens, which complicates the selection of donors for transfusions (Baranidharan & Medina Valentin, 2018). The presence of DEA 1-positive phenotype is considered the main risk factor of the development of reactions to blood transfusions. Despite the fact that dogs have no natural alloantibodies against DEA 1, a first-time transfusion can lead to the formation of antibodies, which may pose a risk for reactions in subsequent transfusions (Ergul Ekiz et al., 2011).

As of now, there are ongoing discussions regarding the clinical significance of alloantibodies to other DEA groups, although in most practices the identification of just DEA 1 is considered sufficient for avoiding major risks (Acierno et al., 2014). In this context, it is important to assess the prevalence of DEA 1 in populations, which allows planning donor programs.

The geographic and breed variability in the distribution of blood groups has been well documented (Euler et al., 2016). For instance, in pedigree dogs, the share of DEA 1+ can reach 91.3% (Ferreira et al., 2011), while in mixed-breed dogs it was observed to range 42.8% in Italy and Spain (Silvestre-Ferreira et al., 2024) to over 90% in Brazil (Giger et al., 1995).

To diagnose blood groups, various commercial methods are used, including immunochromatographic test with monoclonal antibodies, which is the most convenient for clinical use (Ergul Ekiz et al., 2011).

In Ukraine, the study of blood groups in cats revealed the domination of A group (86.9%), while the B group occurred in 10.4%, and the AB group was found in 2.7% of the animals (Malyuk et al., 2024). However, such data regarding dogs have been absent so far. The objectives of this study were to determine the distribution of the DEA 1 blood group in dogs of different breeds in Kyiv and Kyiv Oblast using the immunochromatographic test, and also to assess the breed variability and clinical significance of the yielded results.

Materials and methods

All the procedures with the animals were performed according to the General Ethic Principles of Experiments on Animals, adopted by the I National Congress of Bioethics of Ukraine, European Convention for the Protection of Vertebrate Animals used for Experimental

and other Scientific Purposes, and also the requirements of the Law of Ukraine on Protection of Animals from Abuse. The study was approved by the local commission of bioethics of the National University of Life and Environmental Sciences of Ukraine. When drawing blood, we minimized physical restrictions on the animals. For individuals that were frightened or stress-sensitive, we administered sedatives to help manage their behavior.

The studies were conducted in 2018–2024 at the scientific-research laboratory Bank of Animal Blood of the Department of Veterinary Surgery named after Academician I. O. Povazhenko of the National University of Life and Environmental Sciences of Ukraine, and also the scientific-research and production center Vetmedservis.

The objectives of the study were to determine the distribution of the DEA 1 blood group in dogs of different breeds, kept by their owners in the city of Kyiv and Kyiv Oblast, and also to enumerate the prevalence of DEA 1+ and DEA 1- in those animals.

The objects of the study were 493 dogs of different breeds, whose owners contacted the clinic or the blood bank to determine the blood group of their pets.

The sampling was performed by collecting 0.5–1 mL of whole blood from the vein of the forearm in test tubes with EDTA (ethylenediaminetetraacetic acid). To determine the blood group, we used the RapidVet-H Canine DEA 1 immunochromatographic test (Agrolabo SpA, Italy). This test is based on the agglutination reaction between the DEA 1 antibody on the erythrocyte membrane and mouse monoclonal antibody, lyophilized on a test strip. Before testing, the antibody was revitalized using a solvent, and then mixed with whole blood. Then, we visually observed the reaction: the presence of agglutination indicated DEA 1+, and its absence meant DEA 1-. Therefore, all the results of the study of the blood groups were united into two categories: DEA 1-positive (DEA 1+) and DEA 1-negative (DEA 1-).

All the results of blood tests were registered visually according to the manufacturer's manual. Then, the animals were grouped according to breeds, with identification of the number of DEA 1-positive and -negative animals. For the statistical assessment, we calculated expected values according to the null hypothesis (50/50) and conducted an analysis using the χ^2 criterion so as to determine statistically significant differences among the breeds.

Results

According to the results of the study, the DEA 1+ blood group was found in 273 animals, accounting for 55.4% of the total number of the examined dogs, while DEA 1- was identified in 220 animals, or 44.6% of the dogs (Table 1). Therefore, the commonest blood group in the studied region was found to be the DEA 1+ group.

Table 1
Distribution of the blood groups in dogs in Kyiv and Kyiv Oblast, Ukraine

Breed	Number of examined animals	DEA 1+(%)	DEA 1-(%)	χ^2 (50/50)	P-value
German Shepherd	58	16(27.6)	42(72.4)	11.655	0.001
Mixed-breed	56	31(55.4)	25(44.6)	0.643	0.423
Siberian Husky	47	25(23.2)	22(46.8)	0.191	0.662
Labrador Retriever	40	27(67.5)	13(32.5)	4.910	0.027
French Bulldog	20	13(65.0)	7(35.0)	1.801	0.180
Pembroke Welsh Corgi	19	11(57.9)	8(42.1)	0.474	0.491
English Cocker Spaniel	18	14(77.8)	4(22.2)	5.556	0.018
Belgian Malinois	17	4(23.5)	13(76.5)	4.765	0.029
American Staffordshire Terrier	17	12(70.6)	5(29.4)	2.882	0.090
Beagle	15	5(33.3)	10(66.7)	1.667	0.197
American Cocker Spaniel	14	10(71.4)	4(28.6)	2.571	0.109
Pomeranian	13	10(76.9)	3(23.1)	3.769	0.052
Central Asian Shepherd Dog (Alabai)	13	8(61.5)	5(38.5)	0.692	0.405
Yorkshire Terrier	10	3(30.0)	7(70.0)	1.601	0.206
Miniature Pinscher	9	6(66.7)	3(33.3)	1.000	0.317
Giant Schnauzer	8	2(25.0)	6(75.0)	2.000	0.157
Other dog breeds	119	76(63.9)	43(36.1)	9.151	0.002
Total	493	273(55.4)	220(44.6)	5.698	0.017

The greatest share of the DEA 1+ blood group was found in the English Cocker Spaniels (77.8%), Pomeranian Dogs (76.9%), and American Cocker Spaniels (71.4%). Meanwhile, the breeds with the lowest percentage of DEA 1+ were Belgian Shepherd Malinois (23.5%), Giant Schnauzer (25.0%), and German Shepherd (27.6%).

For most of the breeds, in particular English Cocker Spaniel, Labrador Retriever, Belgian Shepherd Malinois, German Shepherd, and Pomeranian Dog, the differences between the shares of DEA 1+ and DEA 1- were statistically significant ($P < 0.05$). This may point to a genetic breed tendency to inherit a certain blood group.

Discussion

The system of blood groups in dogs is represented by at least eight serologically recognized antigens, which are united under the name Dog Erythrocyte Antigen (DEA). The highest clinical significance was observed for DEA 1, because this antigen is highly immunogenic and is most often found among the well-known types. Dogs that have negative DEA 1 factor have no natural alloantibodies, but after receiving their first transfusion of blood from DEA 1+ donor they can develop an immune response that can further lead to an acute hemolytic reaction to the repeated transfusion of incompatible blood (Giger et al., 1995; Kessler et al., 2010). Therefore, it is DEA 1- dogs that are considered the best donors because this group minimizes the risk of immunologic complications in the recipients of their first transfusion and their blood can be used without the need for initial typing of the recipient (Acierno & Raj, 2008; Giger, 2011).

Besides DEA 1, other antibodies of DEA, such as DEA 3, 4, 5, 6, and 7, occur in dog populations with different frequencies and have mostly low or moderate clinical significance. For example, DEA-4 is considered almost universal (found in 98–100% of dogs) and it induces no serious reactions to blood transfusion, while DEA-7 can cause a delayed hemolytic reaction, although its clinical significance remains a subject to discussions (Hale, 1995; Ebelt et al., 2012). Of significant scientific interest are the recently identified antigens, such as Dal and Kai. The Dal antigen was mostly found in Dobermanns and Schnauzers, in which its presence can provoke an immune response to transfusion (Goulet & Blais, 2007). The antibodies Kai 1 and Kai 2 were described only in 2016, and the data pertaining to their immunogenicity and distribution are at the moment extremely limited (Kessler et al., 2016).

Considering the limited clinical significance of other antigens and absence of purchasable tests, this study focused exclusively on the DEA system, in particular the DEA 1 antigen. This corresponds to modern clinical recommendations that indicate DEA 1 as key target of blood transfusion testing (Giger, 2011; Seth et al., 2015). In the context of practical application, the table of results demonstrates the distribution of DEA 1 in the dogs of different breeds. For each breed, the general number of animals is provided, along with the number of individuals with positive (DEA 1+) and negative (DEA 1-) statuses. The general share of DEA 1+ in the sampling was 55.4%, which is a

typical value for companion dogs in various countries (Giger et al., 1995).

A subject of special interest is the analysis of breed variability. Thus, the breeds with the highest shares of DEA 1+ were English Cocker Spaniel, Pomeranian Dog, and American Cocker Spaniel (over 75% of the DEA 1-positive animals). At the same time, the breeds with the lowest share of DEA 1+ were Belgian Shepherd Malinois, Giant Schnauzer, and German Shepherd. This may suggest the genetically conditioned tendency of certain breeds to inherit certain blood groups, which is an important factor to consider when selecting donor animals.

Within the framework of the conducted analysis, we developed a comparative table (Table 2), which reflects the frequency of detecting DEA 1-positive (DEA 1+) and -negative (DEA 1-) dogs in different countries.

Table 2
Comparative table of prevalence of the DEA 1+ and DEA 1- blood groups in dogs in different countries (%)

Country	DEA 1+	DEA 1-	Source (author, year)
Ukraine (Kyiv and Kyiv Oblast)	55.4	44.6	Our study
Italy	62.0	38.0	Carli et al., 2017
Portugal	57.0	43.0	Ferreira et al., 2011
Spain	58.0	42.0	Silvestre-Ferreira et al., 2024
Switzerland	53.0	47.0	Riond et al., 2011
Brazil	61.0	39.0	Giger et al., 1995
USA	42.0	58.0	Hale, 1995
Japan	44.0	56.0	Mangiaterra & Gavazza, 2021
Turkey	64.0	36.0	Ergul Ekiz et al., 2011
India	60.0	40.0	Seth et al., 2015
South Africa	56.0	44.0	Dhliwayo et al., 2016
Germany	59.0	41.0	Kessler et al., 2010

Another important aspect is the geographic variability of the distribution of DEA 1. As known, canine blood groups differ not only across breeds, but also regionally (Ergul Ekiz et al., 2011). It should be noted that the present study was the first such analysis in Ukraine (Kyiv and Kyiv Oblast). The yielded results revealed that the share of the dogs with DEA 1+ (55.4%) corresponds to the average global data (50–65%) (Silvestre-Ferreira et al., 2024), is similar to that in Switzerland (53%) (Spada & Perego, 2016) and Brazil (61%) (Kessler et al., 2010), and is higher than that in the US (42%) (Hale, 1995) and Japan (44%) (Mangiaterra & Gavazza, 2021). The analysis we conducted also found that the distribution of blood groups in Ukraine is similar to that in other countries, in particular Japan, Brazil, South Africa, Portugal, Spain, Switzerland, and India (Riond et al., 2011; Mesa-Sanchez & Galan-Rodriguez, 2014; Seth et al., 2015; Medina Valentin et al., 2017). Another interesting observation is the share of DEA 1- in German Shepherds, which was the most represented dog in our sampling. It accounted for 72.4%, in line with the previous data (up to 81%) (Riond & Lutz, 2011; Mangiaterra & Gavazza, 2021). Similarly, the mixed-breed dogs also exhibited typical global parameters of DEA 1+ (55.4%) (Blais et al., 2007; Ferreira et al., 2011). As with sex, the data we obtained are consistent with the reports that describe somewhat higher frequency of DEA 1+ in females (Giger et al., 1995). However, other researchers found no significant sex dependence (Kessler et al., 2010; Riond & Lutz, 2011).

The results of our studies in Ukraine (Kyiv and Kyiv Oblast) demonstrated the share of DEA 1+ dogs at the level of 55.4%, which corresponds to the average global tendencies (Mangiaterra et al., 2021; Silvestre-Ferreira et al., 2024). These data are also consistent with the studies in Turkey (Ergul Ekiz et al., 2011), Spain (Mesa-Sanchez et al., 2014), and South Africa (Dhliwayo et al., 2016), indicating a similar pattern of the distribution of blood groups in European and African populations of dogs. Such results confirm the necessity of local studies of the distribution of blood groups in order to form banks of donor blood and prevent the risk of reactions to transfusions, especially to repeated transfusions. The awareness of the distribution of DEA 1+ and DEA 1- in animals is of practical significance in veterinary transfusion medicine, particularly for matching donors, planning donor programs, and minimizing the risk of immune sensitization in the recipients (Hohenhaus, 2004; Acierno et al., 2014; Giger, 2014).

From the clinical perspective, it is important to understand that DEA 1- dogs are considered universal donors (Bank et al., 2023). In our sampling, their share was relatively low, which underscores the importance of typing prior to blood transfusion and also the difficulty of selecting a donor.

The likelihood of sensitization in recipient dogs after first transfusion from a non-matching donor and the risk of acute hemolytic reaction to repeated transfusion highlight the practical importance of prior testing, as was demonstrated in Portugal (Medina Valentin et al., 2017), Turkey (Seth & Giger, 2012), and Zimbabwe (Giger et al., 1995). At the same time, although DEA 1+ antigen has a high alloimunizing potential, there are no evidences that alloimunization occurs in all cases of transfusion of incompatible blood. This requires a careful clinical approach to each case of transfusion.

Furthermore, new blood groups have been described, such as Dal and Kai. Thus, Dal-antigen was identified in Dalmatians, in which its absence can lead to alloimmunization (Dhliwayo & Tivapasi, 2016). In the US and Germany, Dal-negative dogs were found at a high rate (Symons & Bell, 1992; Hohenhaus, 2004). At the same time, most dogs in North America are Kai 1+ and Kai 2− (Ebelt & Giger, 2020). Since there is no verified relationship between the systems Kai/Dal and DEA, and also due to the lack of tests, the practical transfusiology will further focus on DEA 1 (Silvestre-Ferreira et al., 2024).

It should be noted that our study was local, had a limited selection and incomplete representation of some breeds, and therefore its results should be extrapolated to other regions with caution.

Conclusion

In Ukraine (Kyiv and Kyiv Oblast), this is the first complete study of the distribution of the DEA 1 blood group in dogs. We found that the total share of the dogs with DEA 1-positive phenotype accounted for 55.4%, which corresponds to the average global tendencies and the data from other European countries (Italy, Portugal, Spain), whereas the share of the DEA 1-negative animals measured 44.6%.

We determined the variability of the distribution of the blood groups in different breeds: Cocker Spaniels, Pomeranian Dogs, and Labradors demonstrated the prevalence of DEA 1+, while the German Shepherds, Belgian Shepherds Malinois, and Giant Schnauzers were mostly found to have DEA 1-.

The yielded results of the distribution of blood groups in dogs of different breeds in Kyiv and Kyiv Oblast are of significant clinical value for both domestic and foreign veterinary transfusion medicine and open broad perspectives for similar studies in other regions of our country and other countries around the world, which will promote a more effective selection of donor animals for blood transfusion and formation of local banks of canine blood.

The authors declare no conflict of interest regarding this study, including financial, personal, copyright, or other, which could have affected the study and its results, presented in the paper.

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