Praca oryginalna *Original paper*

Congenital heart defects in dogs: A retrospective study of 301 dogs

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Received 30.05.2017 *Accepted 20.07.2017*

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Summary

The aim of the study was to assess the frequency of congenital heart defects in a population of dogs in Poland and to determine which breeds were affected by particular defects. A retrospective study of the medical records of cardiologically examined dogs revealed 301 cases of echocardiographically confirmed congenital heart defects. Dogs with congenital heart defects made up 2.7% of the dogs that underwent a cardiologic examination. The age at diagnosis ranged from 2 weeks to 190 months. Mixed breeds (33 dogs, 11%), Bull Terriers (31, 10%), Boxers (28, 9%), German Shepherds (17, 6%), Yorkshire Terriers (17, 6%), and French Bulldogs (16, 5%) were the most frequently affected breeds. Subaortic stenosis (120 cases, 33.9%), pulmonic stenosis (64, 18.1%), patent ductus arteriosus (59, 16.7%), mitral valve dysplasia (56, 15.8%), ventricular septal defect (24, 6.8%) and tricuspid valve dysplasia (17, 4.8%) were the most frequent congenital heart defects recognized in this study. Isolated congenital heart disease occurred in 258 dogs (86%), while multiple heart defects were noted in 43 dogs (14%). Most (60%) congenital heart defects were recognized in dogs older than 1 year. Early recognition of congenital heart defects is important for better patient care. Collecting information on the frequency of congenital heart defects in particular breeds will be useful in educating breeders and thus in improving the overall health of the breed.

Keywords: congenital heart defects, dogs

The prevalence of congenital heart defects (CHD) varies depending on breed popularity in different parts of the world (11, 13, 21). It is essential to recognize the presence of heart defects in order to decide on the best possible treatment plan for each patient, to assess prognosis, and, in the case of purebred animals, to exclude affected animals from breeding programs. The most common CHD in canine patients include aortic stenosis (AS), pulmonic stenosis (PS), patent ductus arteriosus (PDA), ventricular septal defects (VSD), mitral valve dysplasia (MD), tricuspid valve dysplasia (TD), and tetralogy of Fallot (TF) (1, 11, 13, 14, 21), with the first three usually predominating (3, 18). The order of prevalence of these defects is related to the dog breed population in a particular geographical region. Publications in Poland have described single cases of CHD (6, 7), prevalence of aortic stenosis (15), tricuspid dysplasia (17), and tetralogy of Fallot (16), and a description of treatment of pulmonic stenosis (19). A large-scale study of the number and types of congenital heart defects in Poland has not been published to date. The aim of this study was to ascertain which congenital heart defects occurred most often in the population of dogs in and around Warsaw, Poland, and which breeds were most affected by particular defects.

Material and methods

Medical records of 11,015 dogs that underwent a cardiovascular examination by one of three veterinarians at the Faculty of Veterinary Medicine, Warsaw University of Life Sciences between January 1, 2006, and May 9, 2017, were retrospectively reviewed and analyzed. An echocardiographic diagnosis of a congenital heart defect was obtained in 301 dogs. Only dogs with a full clinical chart (history, signalment, physical examination, and echocardiography) were included in the study, but for the purposes of this report further descriptive analyses were performed with respect to breed, sex, and the number of congenital defects. This study complies with national and institutional guidelines on the use of animals in clinical research according to the Polish

legal act of January 21, 2005, concerning experiments performed on client-owned animals.

Transthoracic echocardiographic examinations were performed without the use of chemical restraint by means of the following ultrasound machines: SC300 PANDION with mechanical transducers ranging from 2.5 to 7 MHz, Mindray M7 with phase array transducers ranging from 2 to 12 MHz, and Aloka 4000 or Esaote MyLabClassCVet with 2.5-7 MHz electronic transducers. Patients were placed in right and left lateral recumbency according to accepted guidelines (20) and in some cases in a standing position. Diagnoses of congenital heart defects were based on two-dimensional interrogation in combination with color and spectral Doppler interrogation. The severity of PS and AS was evaluated on the basis of spectral Doppler pressure gradients calculated from flow velocities of the respective great vessels according to published guidelines (3). Both AS and PS were classified as mild with pressure gradients of 20-49 mmHg, moderate with gradients of 50-80 mmHg and severe with gradients above 80 mmHg.

Descriptive statistics were performed using Microsoft Excel.

Results and discussion

Dogs with CHD made up 2.7% of all the examined dogs. Of these 301 dogs with CHD, 145 (48.2%)

Tab. 1. The number of dogs of various breeds with congenital heart defects and the types of the defects

Breed	n	Congenital heart defect
Mixed breed	32	PDA (11), PS (8), SAS (3), VSD (2), PS + VSD (1), SAS + PS (2), SAS + PS + VSD (1), PLCVC (1), MD (2), Ebstein's anomaly (1)
Bull Terrier	30	MD (11), SAS (11), SAS + PS (2), SAS + PS + MD (2), SAS + MD (4)
Boxer	28	MD (1), PS (3), SAS (23), SAS + PS (1)
Golden Retriever	27	SAS (15), MD (6), TD (2), MD + TD (1), SAS + MD (1), PS (1), PDA (1)
German Shepherd	17	PDA (9), MD (4), SAS (2), ASD + PDA (1), MD + TD (1)
French Bulldog	16	PS (8), VSD (3), TD (2), SAS (1), SAS + VSD + PS (1), SAS + VSD (1)
Yorkshire Terrier	16	PDA (6), PS (6), VSD (2), VSD + MD (1), SAS + PS (1)
American Stafforshire Terrier	9	MD (1), PS (2), SAS (6)
Miniature Bull Terrier	8	SAS (4), MD (3), SAS + PS + MD (1)
Great Dane	7	SAS
Labrador Retriever	6	TD (3), TD + PDA (1), SAS (2)
Maltese	6	PDA (4), SAS (1), SAS + MS + PDA + PLCVC (1)
West Highland White Terrier	6	PS (3), SAS (2), VSD (1)
English Bulldog	5	PS (4), MD (1)
Miniature Schnauzer	5	PDA (3), PS + SAS (2)
Border Collie	4	PDA (2), VSD (2)
Polish Lowland Sheepdog	4	PDA (3), VSD (1)
Wire Fox Terrier	4	VSD, VSD + SAS + MD, VSD + PDA, VSD + PDA + PS
Weimaraner	4	MD (3), TD + CTD + QA (1)
Jack Russell Terrier	3	PDA (2), PS (1)
Australian Sheepdog	2	MD
Belgian Sheepdog	2	PDA, MD
Bullmastiff	2	TD (2)
Cane corso	2	SAS (1), TF (1)
Chihuahua	2	PDA (1), TF (1)
Cocker spaniel	2	PDA, PS + TD
Dog de Bordeaux	2	MD, SAS
Giant Schnauzer	2	SAS + PS (1), SAS + PDA (1)
Irish Setter	2	PDA + MD, SAS + PS
Manchester Terrier	2	PS, SAS
Miniature Pincher	2	PS
Rottweiler	2	SAS, SAS + PS
Airdale Terrier Bernese Mountain Dog Nova Scotia Ducktolling Retriever Springer Spaniel	1	MD
Bavarian Mountain Hound Cavalier King Charles Spaniel Dachshund Griffon Bruxellois Leonberger Rhodesian Ridgeback Rough Collie	1	PDA
Ca de Bou Chinese Crested Dog Clumber Spaniel Dalmation Dogo Argentino English Mastiff Hovawart Neapolitan Mastiff Newfoundland Old English Sheepdog Staffordshire Bull Terrier	1	SAS
Shetland Sheepdog Shih-tzu Welsh Terrier	1	PS
Flat Coated Retriever Papillion Siberian Husky	1	VSD
Pekinese	1	TF
Central Asian Shepherd Dog Pembroke Welsh Corgi	1	MD + TD
Entlebucher	1	SAS + PS
Polish Hunting Dog	1	VSD + MD
Samoyed	1	PS + TD

Explanations: ASD – atrial septal defect, CTD – cor triatriatum dextrum, MD – mitral valve dysplasia, MS – mitral valve stenosis, PDA – patent ductus arteriosus, PLCVC – persistent left cranial vena cava, PS – pulmonic stenosis, QA – quadricuspid aortic valve, SAS – subaortic stenosis, TD – tricuspid valve dysplasia, TF – tetralogy of Fallot, VSD – ventricular septal defect

were female and 156 (51.8%) were male. Their age at diagnosis ranged from 2 weeks to 15.8 years. CHD were diagnosed in 187 dogs aged less than 3 years (62% of all dogs with CHD), 72 dogs aged 3-8 years (24%), and 42 dogs aged more than 8 years (14%). Various dog breeds were represented. Tab. 1 shows the various dog breeds represented and the congenital heart defects recognized in each breed. The most frequent dog breeds were mixed breeds (33 dogs, 11%), Bull Terriers (31 dogs, 10%), Boxers (28 dogs, 9%), German Shepherds (17 dogs, 6%), Yorkshire Terriers (17 dogs, 6%), and French Bulldogs (16 dogs, 5%).

The most frequent congenital heart defects recognized in this study were SAS, PS, PDA, MD, VSD, and TD. Their numbers are presented in Tab. 6 along with those of other, less frequent defects. The breed distributions of the four most frequent heart defects, SAS, PS, PDA, and MD, are shown in Tab. 2-5.

Isolated heart defects. Isolated CHD occurred in 258 dogs (86%). Subvalvular aortic stenosis (SAS) was the most frequent single defect (93 dogs). Mild SAS occurred in 68 dogs (73.1% of SAS), moderate in 14 dogs (15.1% of SAS), and severe SAS occurred in 11 dogs (11.8% of SAS, 4.3%). There was no available information on the severity of SAS in one dog. No valvular or supravalvular AS was seen.

PDA was diagnosed in 52 dogs, only two (3.9%) of which had a right to left shunt, while the remaining (96.1%) had a left to right shunt.

PS was seen in 41 dogs, the majority of which had a valvular stenosis. One dog (2.4%) had a hypoplastic pulmonary artery (with severe stenosis), and one dog (2.4%) had a supravalvular stenosis (mild). In 4 cases, no information on the severity of PS was available. In the remaining dogs, PS was severe in 14 (34.1%) animals, moderate in 11 (26.8%), and mild in 10 (24.3%).

MD was diagnosed in 40 dogs, VSD in 15 dogs (all of which had

Tab. 2. Breed distribution of subaortic stenosis

Breed	n	%
Boxer	24	20.00
Bull Terrier	20	16.67
Golden Retriever	16	13.33
Great Dane	7	5.83
American Staffordshire Terrier Mixed	6	5.00
Miniature Bull Terrier	5	4.17
French Bulldog	3	2.50
German Shepherd Giant Schnauzer Labrador Retriever Maltese Miniature Schnauzer Rottweiler West Highland White Terrier	2	1.67
Cane Corso Chinese Crested Dog Clumber Spaniel Dalmation Dog de Bordeaux Dogo Argentino Etlebucher Hovawart Manchester Terrier English Mastiff Neapolitan Mastiff Newfoundland Old English Sheepdog Ca De Bou Rhodesian Ridgeback Irish Setter Staffordshire Bull Terrier Wire Fox Terrier Yorkshire Terrier	1	0.83
Total	120	100

Tab. 4. Breed distribution of patent ductus arteriosus

Breed	n	%
Mixed breed	11	18.64
German Shepherd	10	16.95
Yorkshire Terrier	7	11.86
Maltese	5	8.47
Miniature Schnauzer Polish Lowland Sheepdog	3	5.08
Border Collie Irish Setter Jack Russel Terrier Wire Fox Terrier	2	3.39
Bavarian Mountain Hound Belgian Shepherd Cavalier King Charles Spaniel Chichuachua Cocker Spaniel Dachshund Giant Schnauzer Golden Retriever Griffon Bruxellois Labrador Retriever Leonberger Rough Collie	1	1.69
Total	59	100

Tab. 3. Breed distribution of pulmonic stenosis

Breed	n	%
Mixed breed	12	18.75
French Bulldog	9	14.06
Yorkshire Terrier	7	10.94
Boxer Bull Terrier English Bulldog	4	6.25
West Highland White Terrier	3	4.69
Miniature Pincher American Staffordshire Terrier Miniature Schnauzer	2	3.13
Miniature Bull Terrier Cocker Spaniel Entlebucher Giant Schnauzer Golden Retriever Irish Setter Jack Russel Terrier Manchester Terrier Neapolitan Mastiff Shetland Sheepdog Rottweiler Samoyed Shih-tzu Welsh Terrier Wire Fox Terrier	1	1.56
Total	64	100

Tab. 5. Breed distribution of mitral valve dysplasia

Breed	n	%
Bull Terrier	17	30.36
Golden Retriever	8	14.29
German Shepherd	5	8.93
Miniature Bull Terrier	4	7.14
Weimaraner	3	5.36
Mixed breed Australian Shepherd	2	3.57
Airdale Terrier American Staffordshire Terrier Bernese Mountain Dog Boxer English Bulldog Dog de Bordeaux Polish Hunting Dog Nova Scotia Duck Tolling Retriever Belgian Shepherd Central Asian Shepherd Dog Irish Setter Springer Spaniel Welsh Corgi Pembroke Wire Fox Terrier Yorkshire Terrier	1	1.79
Total	56	100

Tab. 6. Isolated and associated congenital heart defect distribution

Defect	n (%)	Isolated	Associated	Male	Female	Age at first diagnosis (months): median (range)
SAS	120 (33.9%)	93 (77.5%)	27 (22.5%)	57 (47.5%)	63 (52.5%)	26.5 (2-177)
PS	64 (18.1%)	41 (64.0%)	23 (36.0%)	47 (73%)	17 (27%)	36 (2-169)
PDA	59 (16.7%)	52 (88.1%)	7 (11.9%)	20 (34%)	39 (66%)	15 (1-180)
MD	56 (15.8%)	40 (71.4%)	16 (28.6%)	30 (54%)	26 (46%)	22.5 (0.5-144)
VSD	24 (6.8%)	15 (62.5%)	9 (37.5%)	14 (58%)	10 (42%)	9 (1-130)
TD	17 (4.8%)	9 (53.0%)	8 (47.0%)	11 (65%)	6 (35%)	17 (0.5-140)
PLCVC	6 (1.7%)	4 (66.7%)	2 (33.3%)	3 (50%)	3 (50%)	120.5 (2-190)
TF	3 (0.9%)	3 (100%)	0 (0%)	1 (33%)	2 (67%)	10 (3-10)
EbA	1 (0.3%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	6
ASD	1 (0.3%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	24
CorT	1 (0.3%)	0 (0%)	1 (100%)	1 (100%)	0 (0%)	17
MS	1 (0.3%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)	2
QA	1 (0.3%)	0 (0%)	1 (100%)	1 (100%)	0 (0%)	17
Total	354 (100%)					

Explanations: SAS – subaortic stenosis, PS – pulmonic stenosis, PDA – patent ductus arteriosus, VSD – ventricular septal defect, TD – tricuspid valve dysplasia, PLCVC – persistent left cranial vena cava, TF – tetralogy of Fallot, EbA – Ebstein's anomaly, ASD – atrial septal defect, CorT – cor triatiratum dexter, MS – mitral stenosis, QA – quadricuspid aortic valve

a L-R shunt), TD in 9 dogs, PLCVC in 4 dogs, and TF in 3 dogs. EbA was seen in only one dog.

Multiple heart defects. Multiple CHD occurred in 43 dogs (14%). One dog had four separate abnormalities, 8 dogs had a combination of 3 defects, while 33 dogs had two separate defects. The most frequent combination of congenital heart defects was SAS and PS. MD also occurred often in association with SAS and PS (3 dogs), SAS alone (5 dogs), and TD (4 dogs).

Tab. 6 shows the percentage distribution of particular single and multiple congenital heart defects. Tab. 7 shows the exact combinations of multiple heart defects and the breeds in which they were recognized.

The most frequent congenital heart defects in this study were SAS, PS, and PDA. These findings are consistent with many previous reports (1, 2, 13, 18, 21). Most studies recognized VSD as the 3rd or 4th most frequent defect (1, 13, 21), but in the present study MD took the 4th place, possibly because of the overrepresentation of Bull Terriers (the most frequent breed with MD). Bull Terriers have become a popular breed recently, and many owners/breeders choose to perform voluntary heart checks to rule out heart disease. This might account for the increased number of examinations and therefore recognized defects in otherwise asymptomatic dogs.

The occurrence of CHD was nearly equal in males and females, but females were more often affected with PDA (66% females) and TF (67%), while males more often suffered from PS (73%) and TD (65%). This is similar to what another study has shown (13), with the exception of TD, which in that study was evenly distributed. There was an earlier study, which showed that males were more often affected with TD (21), as in the present study. The differences may be attributed to breed distribution in different countries.

Most studies do not look at the age of dogs at diagnosis. Oliveira et al (13) showed that the average age at diagnosis was over 2 years and justifiably underline the importance of early diagnosis. In the present study, only 91 (30%) dogs were 1 year or younger, which is the best time to identify CHD. Most dogs were diagnosed as adults. This most probably results from the fact that mild disease is asymptomatic and the owners are not inclined to bring their pets in for heart testing when the dogs appear healthy. In addition, congenital heart defects sometimes do not present with heart murmurs, and therefore further heart testing does not seem warranted.

The present study showed a similar predisposition to SAS as previous reports in Boxers, Golden Retrievers, German Shepherds, mixed breeds (2, 4, 12, 13, 15), and Bull Terriers (15). This study showed two more breeds, Great Danes and Miniature Bull Terriers, that have not been previously reported. Miniature Bull Terriers may be overrepresented due to their increased popularity and a high number of voluntary heart examinations in Poland. There was no apparent difference in the number of male or female dogs with SAS, which is similar to one study (21), but not another (13), which showed a male predisposition. These discrepancies may simply be due to the popularity of different breeds in each country, such as Sweden (21) and Italy (13), and Poland in this study.

A high number of mixed breeds, French Bulldogs, and Yorkshire Terriers were diagnosed with PS. These breeds have previously been described as predisposed to this defect (2, 9, 13, 21). Other breeds that have also

Tab. 7. Various combinations of multiple congenital heart defects in 43 dogs

Combination of defects	Number of dogs	Dog breeds
4 defects		
SAS + MS +PDA + PLCVC	1	Maltese (F)
3 defects		
SAS + PS + MD	3	Bullterrier (2 F, 1 M)
SAS + VSD + PS	2	Mixed breed (F) French Bulldog (F)
SAS + VSD + MD	1	Smooth Fox Terrier (M)
TD + CTD + QA	1	Weimaraner (M)
PDA + PS + VSD	1	Smooth Fox Terrier (M)
2 defects		
PS + SAS	13	Miniature Schnauzer (2, both M) Mixed breed (2, both F) Boxer (M) Giant Schnauzer (M) Irish Setter (M) Rottweiler (M) Entlebucher (M) Bullterrier (1 M, 1 F) Yorkshire Terrier (F) Neapolitan Mastiff (M)
SAS + MD	5	Bullterier (3 F, 1 M) Golden Retriever (M)
MD + TD	4	Central Asian Shepherd Dog (F) German Shepherd (M) Pembroke Welsh Corgi (F) Golden Retriever (F)
PS + TD	2	Samoyed (M) English Cocker Spaniel (M)
VSD + MD	2	Yorkshire Terrier (M) Polish Hunting Dog (M)
PDA + MD	1	Irish setter (M)
PDA + TD	1	Labrador Retriever (F)
PDA + VSD	1	Smooth Fox Terrier (M)
PDA + ASD	1	German Shepherd (F)
PDA + SAS	1	Giant Schnauzer (M)
PS + VSD	1	Mixed breed (M)
PS + PLCVC	1	American Staffordshire Terrier
SAS + VSD	1	French Bulldog (F)
Total number of dogs	43	

Explanations: ASD – atrial septal defect, CTD – cor triatriatum dextrum, MD – mitral valve dysplasia, MS – mitral valve stenosis, PDA – patent ductus arteriosus, PLCVC – persistent left cranial vena cava, PS – pulmonic stenosis, QA – quadricuspid aortic valve, SAS – subaortic stenosis, TD – tricuspid valve dysplasia, VSD – ventricular septal defect

been described as predisposed did not show up in this study in comparable numbers, including Boxers, which are often seen as one of the breeds most predisposed to PS (2, 11, 13). Although not one of the most common breeds, Bull Terriers were relatively highly represented in this study, but only one study mentions a minimally increased frequency of PS in this breed (5). The increased incidence in this study may once again result from screening for heart disease before inclusion into a breeding program.

PDA occurs with different frequencies, depending on the geographical location. It has been named the 1st (2), 2nd (10), 3rd (13), and 4th (1, 21) most common CHD. This study showed PDA to be the third most frequent defect, as in the California population (10). It occurred most often in mixed breed dogs, German Shepherds, Yorkshire Terriers, and Maltese, all breeds classified as predisposed in previous reports (2, 10, 13, 21). The Miniature Schnauzer is also described as being at increased risk for PDA (2), but in this study only 3 (5%) dogs were affected. Similarly, 3 (5%) Polish Lowland Sheepdogs were diagnosed with PDA, but this breed has not previously been reported to have a predisposition.

The frequency of MD cases was much higher (15.8%) in this study than the previously reported 1.9% (13), 8.0% (21), and 1.7% (2). This may partly be due to the increased number of Bull Terriers presented to the examiners for heart examinations for breeding purposes. At present, there is only anecdotal information on the predisposition of Bull Terriers to MD (2). The present study did show that 11 (35.5%) of the 31 Bull Terriers with CHD had MD. Of all the dogs with MD, Bull Terriers were the most frequent (17 dogs, i.e. 30% of dogs with MD), followed by Golden Retrievers (8 dogs, 14%), German Shepherds (5 dogs, 9%), Miniature Bull Terriers (4 dogs, 7%), and Weimaraners (3 dogs, 5%). Of these breeds, only the German Shepherds and Golden Retrievers have previously been described as having MD (2, 21).

Although VSD was the 5th most common defect in this study, the percentage of affected dogs was similar to that reported in previous studies, with 7.5% in one study (13) and 9.8% in another (1). Two other studies have shown a greater frequency of this defect, with 14.4% in one study (1) and 12.3% in another (21), but in both those studies VSD was the 3rd most frequent congenital heart defect. VSD was most often recognized in French Bulldogs, mixed breeds, Wire Fox Terriers, Yorkshire Terriers, and Border Collies, but only the first two of these breeds have previously been described as predisposed to VSD (2, 13). Flat-coated retrievers have previously been described (21), but in the present study only one dog (4%) of this breed was diagnosed with VSD.

TD was most frequently seen in Labrador Retrievers and Golden Retrievers, which is consistent with a previous study on TD in Poland (17) and other reports (2, 13). The other breeds reported in this study have not previously been described (i.e. French Bulldog and Bullmastiff).

PLCVC has not been previously reported in an analysis of a larger population of dogs. It is mostly considered an incidental finding and therefore receives little attention. In this study, it occurred concomitantly

with other defects in 2 (33.3%) cases, but not in the same combination (1 PS, 1 SAS + MS + PDA), so this was probably not a significant finding.

Multiple defects were clearly less frequent compared to isolated CHD. The results of the present study, in which multiple defects were twice as frequent as in previous studies (1, 21), are similar to those reported by Oliveira et at. (13). The combination of SAS and PS was the most frequent, accounting for 30% of all multiple defects, which confirms previous studies showing the same tendency (4, 8, 13, 21). Kander et al. (8) showed a somewhat different breed distribution, with Boxers being affected more often than in this study, in which a variety of breeds were represented (Tab. 7).

This study shows the frequency of different CHD in Poland, the breeds most affected, and tendencies relatively similar to those in other such studies in different geographical areas. The most common defects are SAS and PS, as in other reports. The order of the remaining defects differs somewhat from those reported in previous studies, with PDA being the 3rd, MD the 4th, VSD the 5th, and TD the 6th most common defect in this study. Several breeds that have not previously been mentioned as predisposed to CHD are reported in this study, including Great Danes and Miniature Bull Terriers with SAS, Bull Terriers with PS, Polish Lowland Sheepdogs with PDA, Bull Terriers, Miniature Bull Terriers, and Weimaraners with MD, Wire Fox Terriers, Yorkshire Terriers, and Border Collies with VSD, and French Bulldogs and Bullmastiffs with TD. To the authors' best knowledge, this is the first report to include the frequency of PLCVC. The relatively high incidence of multiple CHD underlines the importance of a complete echocardiographic examination, even when one defect has already been recognized. The veterinary profession should strive to recognize CHD early in the dog's life, which would give breeders information about the presence of a possible genetically based CHD. This, along with the education of breeders on breed susceptibility to CHD, would allow them to make medically sound decisions regarding their breeding stock, as well as allow for early interventional treatment when possible, and provide information about the disease prognosis.

List of abbreviations

AS – aortic stenosis
ASD – atrial septal defect,
CHD – congenital heart defect
CTD – cor triatriatum dextrum,
EbA – Ebstein's anomaly,
MD – mitral valve dysplasia,
MS – mitral valve stenosis,
PDA – patent ductus arteriosus,
PLCVC – persistent left cranial vena cava,
PS – pulmonic stenosis,
QA – quadricuspid aortic valve,
SAS – subaortic stenosis,
TD – tricuspid valve dysplasia,
TF – tetralogy of Fallot,
VSD – ventricular septal defect.

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