Epidemiology of Atrial Fibrillation in the Dog

Jessica Westling, BA, DVM[1]
Wendy Westling, MS, MPH[2]
R. Lee Pyle, VMD, MS[3]

[1]*Virginia-Maryland Regional College of Veterinary Medicine*
Virginia Tech
Blacksburg, Virginia, USA
[2]*Mission Hospitals*
Heart Research
Asheville, North Carolina, USA
[3]*CorVet*
Blacksburg, Virginia, USA

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ABSTRACT

A retrospective, statistical review of atrial fibrillation (AF) in the dog was done using information submitted to the Veterinary Medical Data Base from 1969-2007. A total of 3,542 cases were identified with a general increase in the prevalence of AF over the study period. Giant breed dogs were at higher risk to develop AF, large breed dogs varied in susceptibility to AF, and small breed dogs were at low risk to develop AF. In all 3 groups, affected males outnumbered affected females. Large breed spayed females with AF lived longer than affected intact large breed females.

INTRODUCTION

Atrial fibrillation (AF) in dogs is a common cardiac arrhythmia that can occur in otherwise healthy dogs (lone AF) but is most often associated with dilated cardiomyopathy in large and giant breed dogs and acquired mitral valve disease in the smaller breeds.[1] Small epidemiologic studies have revealed that AF in dogs is associated with a high mortality and is overrepresented in large and giant breeds.[2-4] Dogs with lone AF generally live longer than dogs that have other accompanying heart disease.[5]

Although previous studies have revealed important information about AF; it was decided to review AF using the Veterinary Medical Data Base (VMDB)[6] to allow statistical analysis of a larger sample size than has been done in the past.

METHODS

Data Source

The VMDB was developed by the National Cancer Institute in 1964 and includes nearly 7 million records from 26 participating colleges of veterinary medicine. The original VMDB records were encoded using Standard Nomenclature of Veterinary Diseases and Operations (SNVDO). In 1999, a second database was developed using the Systematized Nomenclature of Medicine (SNOMED). SNOMED is a comprehensive clinical terminology developed by the College of American Pathologists and is provided to users by the National Library of Medicine. Presently, 8 colleges of veterinary medicine participate in the SNOMED-coded VMDB, which contains almost 300,000 records. SNVDO and the SNOMED VMDBs were searched for canine cases that presented with an initial diagnosis of AF. The search resulted in 3,542 (3,281 SNVDO and 261 SNOMED) cases (2,549 males/977 females/16 not specified) from a population of

2,352,633 (2,174,002 SNVDO and 178,631 SNOMED) dogs. In addition, we requested all other diagnoses for the 3,542 cases that were generated prior to, during, and after the initial AF diagnosis. This resulted in 34,841 additional diagnoses.

Data Analysis

SAS statistical analysis software (version 8.2) was used to complete all data analysis.[7] Incidence and odds ratios were calculated for 28 breeds that had 5 or more cases of AF. Kaplan-Meier estimators were used to estimate the survival functions for the 28 breeds using time to death or last institution visit. Because there were too few deaths in many individual breeds, the breeds were combined into groups by the senior author based on size: small, large, and giant. Kaplan-Meier survival analysis was used to compare survival among the groups.

As disease status at first presentation may vary by breed group, all additional diagnoses (up to 24) per patient during the initial AF visit were analyzed and categorized by disease status as AF alone (AF), AF with heart disease (AFHD), or AF with heart failure (AFHF). Kaplan-Meier estimators were calculated using these categories. Differences in survival functions for breed groups and disease status (AF, AFHD, and AFHF) were tested with the log-rank test.

A multivariate analysis of the data included the development of Cox regression models. However, the SNVDO and SNOMED data elements are not easily combined due to different data element definitions. Furthermore, the SNOMED database is relatively new so there were too few deaths to use this alone in developing a Cox regression model. Consequently, Cox regression models were developed using only the SNVDO database. The independent variables in the model included gender (male/female), spay/neuter (yes/no), heart failure status (yes/no), and an interaction term between gender and spay/neuter. The Cox regression analysis was stratified by breed group.

RESULTS

The prevalence of AF diagnosed in dogs increased over time from 5.07 per 10,000 canine admissions in 1969 to 23.31 per 10,000 canine admissions in 2007. The number of admissions for AF by geographic area showed the highest diagnosis rate in the Midwest at 16.26 and lowest in the Southeast at 12.66 per 10,000 canine admissions over this same time period. The prevalence of AF in males over females was highly significant in all breed groups ($P < 0.0001$).

The overall prevalence of AF was 0.15% ranging from 5.84% in Irish Wolfhounds to 0.04% in the Miniature Poodle. Odds ratios for the 28 breeds are listed in Table 1. All giant breeds had significant odds ratios >1 ranging from 41.65 for the Irish Wolfhound to 2.36 for the Great Pyrenees. The large breed group was mixed with 37.5% of the breeds having increased odds, 37.5% having an odds ratio not significantly different from one, and 25% of the breeds having decreased odds of developing AF. All small breeds had odds ratios <1 ranging from 0.50 to 0.28. The results of the Kaplan-Meier survival analysis by breed group did not show a statistically significant difference of survival time between the groups with a median survival time for giant breeds of 20 months, 21 months for large breeds, and 15 months for small breeds. The distribution of age at initial AF diagnosis by breed group revealed that giant breed dogs developed AF early in life while small breed dogs were diagnosed later in life.

A chi-square test confirmed that when small breeds present with their first diagnosis of AF, they had more advanced stage of heart disease ($P < 0.0001$). This finding was further supported with a Kaplan-Meier survival analysis by heart disease status to test whether survival functions differed by disease status. The log-rank test was significant, thus rejecting the null hypothesis that the survival functions were the same for all disease groups ($P < 0.0001$) with the median survival time of 19 months for AF, 24 months for AF with AFHD, and 12

Table 1. Odd ratios and prevalence by breed.

	Odds Ratio	Lower Confidence Limits	Upper Confidence Limits	Chi-Square *P*-value	AF Cases	Total Dogs in Registries	Prevalence
Giant Breed							
Irish Wolfhound	41.65	36.74	47.22	<0.0001	248	4,245	5.84%
Great Dane	12.25	11.06	13.55	<0.0001	416	25,292	1.64%
Newfoundland	11.60	9.86	13.63	<0.0001	151	9,000	1.68%
Mastiff	8.34	6.47	10.73	<0.0001	61	4,932	1.24%
Saint Bernard	5.67	4.80	6.70	<0.0001	144	16,875	0.85%
Great Pyrenees	2.36	1.45	3.85	0.0004	16	4,515	0.35%
Large Breed							
Doberman	5.66	5.13	6.26	<0.0001	448	59,001	0.76%
Bull Mastiff	3.86	2.43	6.13	<0.0001	18	3,107	0.58%
Bouvier	3.81	2.53	5.74	<0.0001	23	4,024	0.57%
Afghan Hound	3.01	2.19	4.14	<0.0001	38	8,456	0.45%
Old English Sheepdog	3.00	2.30	3.90	<0.0001	56	12,542	0.45%
Rottweiler	1.99	1.62	2.45	<0.0001	93	31,387	0.30%
Boxer	1.83	1.47	2.28	<0.0001	81	29,717	0.27%
Bulldog	1.64	1.19	2.24	0.0020	39	15,904	0.25%
Weimaraner	1.38	0.91	2.07	0.1258	23	11,128	0.21%
German Shepherd	1.00	0.87	1.15	0.9819	205	135,954	0.15%
Golden Retriever	0.86	0.72	1.03	0.1074	122	93,454	0.13%
Standard Poodle	0.85	0.59	1.24	0.3992	28	21,788	0.13%
German Shorthaired Pointer	0.81	0.52	1.25	0.3300	20	16,474	0.12%
Irish Setter	0.80	0.59	1.10	0.1689	40	32,955	0.12%
Labrador	0.68	0.58	0.80	<0.0001	152	145,198	0.10%
English Springer Spaniel	0.49	0.31	0.75	0.0010	20	27,222	0.07%
Collie	0.47	0.33	0.67	<0.0001	31	43,240	0.07%
Small Breed							
Basset Hound	0.50	0.30	0.84	0.0070	15	19,665	0.08%
Cocker Spaniel	0.40	0.31	0.52	<0.0001	54	87,668	0.06%
Shetland Sheepdog	0.37	0.24	0.58	0.0001	20	5,418	0.06%
Beagle	0.36	0.24	0.56	<0.0001	21	37,985	0.06%
Miniature Poodle	0.28	0.19	0.39	<0.0001	31	72,872	0.04%

months and AF with AFHF. The AF and AFHD survival functions crossed around 25 months, suggesting no statistically significance survival difference between these groups. Therefore, the AF and AFHD groups were combined before proceeding with the development of Cox regression models.

The Cox regression model for the giant breed group was significant with only AFHF being significantly associated with survival time ($P < 0.01$). The AFHF variable had a hazard ratio of 1.44 (chi-square = 0.03, confidence interval = 1.032-2.013). The Cox regression for the large breed group was

Table 2. Large breed Cox regression results.

Variable	Hazard Ratio	95% Confidence Interval	Statistical Significance
Heart failure	1.278	1.049-1.556	0.0148
Gender	0.692	0.520-0.922	0.0120
Spay/neuter	0.564	0.399-0.796	0.0011
Interaction	1.776	1.164-2.708	0.0077

Likelihood ratio = 0.0042.

significant with a chi-square of .004 with all predictor variables including the interaction term between gender and spay/neuter being significant (Table 2). The small breed group was not significant.

To further explore the interaction between gender and spay/neuter, a survival function for large breed females by spay status was developed. The results showed a median time of survival of 18 months if spayed versus only 10 months if not. The model for large breed males was not significant.

DISCUSSION

Atrial fibrillation is a common arrhythmia in the dog that can present as an isolated "lone" problem, but most often occurs secondary to dilated cardiomyopathy in large and giant breeds. In small breeds, the initiating cause is degenerative disease of the atrioventricular valves, particularly the mitral valve. The establishment and maintenance of AF is apparently related to the mass and of the atria; therefore, the larger the dog the greater the predisposition to develop AF.[2,3] This study supports that concept by identifying markedly increased odds ratios in the giant breeds, mixed ratios in the large breeds, and decreased ratios in the small breeds.

The general increase in the number of recorded cases of AF from 1969 to 2007 is likely related to better diagnostic tools and improved recognition of AF; however, fluctuation in the popularity of breeds predisposed to AF could be a factor.

The preponderance of males with AF in this study is consistent with findings in other studies. The basis for this gender difference is not known; however, the generally larger size of males could be a factor. In the large breed group, there was great variation in breed predisposition to AF suggesting that other factors are involved in the development of AF.

The increased longevity of spayed females in the affected large breed group was an unexpected finding. The reason for this protective effect is not apparent.

Weaknesses in this study primarily relate to the accuracy of both the diagnoses and the VMDB entries. Identifying structural heart disease prior to the advent of echocardiography and other imaging modalities were probably subject to greater error than cases managed in more recent times. Entries into the VMDB could also be a source of error. Incomplete, inaccurate entries as well as the switch to a new coding system could have introduced error into the VMDB; however, it is unlikely that these weaknesses would be of such magnitude to reduce the validity of this study. A second weakness was the arbitrary assignment of the dogs to 3 groups based on size. Slight variations in the assignment could occur, but it is likely that any effect on the outcome would have been minor.

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