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Using data to understand periodontal disease risk

By Elizabeth Lund, DVM, MPH, PhD
Contributing Author

Diseases of the oral cavity are the most prevalent ailments diagnosed in both cats and dogs.[1] Many of these oral diseases, such as periodontal disease, present an excellent client education opportunity for veterinarians. And because of the suspected links between periodontal disease and certain systemic diseases,[2] practitioners have a great potential to positively impact the quality of life for Pets and their families.

In Pets, just as in people, plaque accumulation on the teeth leads to gingival inflammation, swelling and halitosis. In its early stages, periodontal disease progression can be reversed with dental cleaning. However, left unchecked, the disease can progress to gingival recession with permanent damage to supporting bone and ligaments. Human studies have reported links between periodontal disease and systemic disorders, such as diabetes mellitus and cardiovascular disease.[3,4] Although the exact nature of these associations has not been elucidated, similar population results for Pets could provide compelling evidence for client communication to support preventive and treatment strategies.

Are dogs with periodontal disease at risk for the same concurrent diseases that are linked to human periodontitis? The analysis in this issue uses the Banfield medical database to determine the risk factors for canine periodontal disease, especially concurrent disease diagnoses. This exploration is important not only for use in communicating with clients, but also in setting the stage for future studies, such as

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Odds ratio: A measure of the degree of association (also known as a cross-product ratio or relative odds); for example, the odds of exposure among the cases compared with the odds of exposure among the controls. Both the odds ratio and the relative risk compare the relative likelihood of an event occurring between two distinct groups. Some study designs, however, prevent the calculation of the relative risk, and the odds ratio is used instead to estimate risk.

Confounding: Confounding occurs when one risk factor for a disease is also associated with the risk factor being studied. Age, breed and gender are often confounding risk factors *(e.g.*, age is related to both neuter status and risk for disease).

Matching: A process used in the design phase of a study to ensure the comparability of groups on a factor that is known to be related to the outcome. Frequency matching balances the factor with similar proportions by group.

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DataSavant's mission is to:
- Explore the health and well-being of Pet populations
- Evaluate new clinical treatments
- Monitor Pets as sentinels of zoonotic disease in family environments
- Transform Pet medical data into knowledge, *i.e.*, open new windows into Pet health care using the Banfield medical caseload and database.

examining the temporal relationship between periodontal disease and cardiovascular health–and ultimately leading to the understanding of the biologic mechanism involved.

Methods of analysis

For our population analyses, we selected a series of purebred canine in-patients (cases) seen in 2006 that were any age and had one or more of the following diagnoses:

- Gingivitis
- Periodontal disease, not otherwise specified
- Periodontal disease, Grade 1
- Periodontal disease, Grade 2
- Periodontal disease, Grade 3
- Periodontal disease, Grade 4
- Periodontal pockets
- Subgingival calculus.

We compared these patients with periodontal disease to a set of purebred canine in-patients (controls) that were frequency matched by age group, had been seen in 2006 and were without any of the periodontal disease diagnoses above. We matched participants by age to help make the groups more comparable in their potential for concurrent disease diagnosis. Periodontal disease grades were defined as follows:

- Grade 1: Inflammation
- Grade 2: Inflammation, swollen gums and early bone loss
- Grade 3: Inflammation, swelling, bone loss and loose teeth
- Grade 4: Inflammation, swelling, pus, bone loss and loose teeth.

Chi-square analyses were used to look at potential risk factors one variable at a time before using multivariate methods. Logistic regression was then used to determine which group of risk factors was most important in predicting which dogs were most likely to be afflicted with periodontal disease. Logistic regression is a technique for assessing risk when the outcome is dichotomous (*i.e.*, yes or no). In this analysis, the outcome under consideration is periodontal disease. The potential risk factors included in the model were age, breed, gender and concurrent diagnoses (*e.g.*, cardiomyopathy [dilated, congestive]; diabetes mellitus; endocarditis; acute hepatic failure; chronic hepatic failure; hepatitis; hepatopathy; acute renal failure; chronic renal failure). Logistic regression helps reduce the effects of confounding variables on the estimates of disease risk–each factor found to be significantly associated with the outcome can be interpreted as an independent predictor of disease risk for a population.

To quantify risk, we estimated the relative risk (RR) using the odds ratio (OR)[5] for the association between age, breed (75 most common breeds), gender, selected concurrent diagnoses and periodontal disease. A relative risk greater than 1 suggests a positive association between an outcome and a factor, whereas a relative risk less than 1 suggests an inverse relationship between a factor under study and a disease outcome. A relative risk equal to 1 reflects no association.

For our analysis, we required a P-value of ≤ 0.05 to determine statistical significance for our hypotheses. The P-value represents the probability that the association between the outcome (periodontal disease) and factor under consideration is at least as great as that generated by logistic regression, assuming the result happened by chance alone. Confidence intervals were estimated for each odds ratio (relative risk). The confidence interval represents the range in the

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Table 1: Prevalence of Specific Diagnoses for Dogs with Periodontal Disease—2006 Banfield Population

Disease	Case population (n=57,134)
Dental calculus	38.8%
Periodontal disease, Grade 1	29.0%
Periodontal disease, Grade 2	28.1%
Periodontal disease, NOS*	18.2%
Periodontal disease, Grade 3	16.4%
Gingivitis	15.1%
Periodontal disease, Grade 4	5.5%
Periodontal pockets	0.5%
Subgingival calculus	0.2%

*Not otherwise specified

Table 2: Purebred Breeds at Risk for Periodontal Disease—2006 Banfield Population

Common breed	Relative risk (odds ratio**)	Confidence interval
Toy Poodle	3.8	3.6, 4.2
Yorkshire Terrier	3.8	3.6, 4.0
Maltese	3.6	3.4, 3.8
Pomeranian	3.3	3.1, 3.5
Shetland Sheepdog	3.3	3.0, 3.6
Cavalier King Charles Spaniel	3.0	2.6, 3.6
Papillion	2.9	2.4, 3.3
Standard Poodle	2.6	2.5, 2.8
Dachshund	2.6	2.4, 2.7
Havanese	2.6	1.9, 3.6
Bichon Frise	2.5	2.4, 2.7
Beagle	2.5	2.3, 2.6
West Highland White Terrier	2.5	2.2, 2.7
Collie	2.4	2.1, 2.8
Miniature Schnauzer	2.3	2.2, 2.5
American Cocker Spaniel	2.3	2.2, 2.4
Basset Hound	2.2	2.1, 2.6
Cock-A-Poo	2.2	1.9, 2.4
Chihuahua	2.0	1.9, 2.0
Welsh Corgi	2.0	1.8, 2.3
Rat Terrier	1.9	1.7, 2.1
Lhasa Apso	1.9	1.7, 2.0
Fox Terrier	1.8	1.7, 2.0
Jack Russell Terrier	1.8	1.7, 1.9
Miniature Pinscher	1.7	1.6, 1.9
Pekingese	1.7	1.5, 1.9
Shih Tzu	1.6	1.5, 1.7
American Eskimo	1.5	1.4, 1.6

*Pets seen at Banfield hospitals during 2006
**Multivariate model

risk estimate variability if the population were sampled numerous times.

Results

We identified 891,994 purebred in-patient dogs from the 2006 U.S. Banfield hospital records. Periodontal disease was diagnosed in 57,134 dogs from this population, a prevalence of 6.4 percent. Dental calculus was diagnosed in nearly 39 percent of these dogs with periodontal disease *(Table 1)*. The mean age of the case group was 6.7 years, while the mean age of the control population (n=213,340) was 3.7 years. Independent of age, neutered dogs had an almost two-fold greater risk for periodontal disease compared with intact canines (RR=1.7). There was no increase in risk for periodontal disease by gender (male or female).

Despite matching for age, differences still existed between age in the case and control groups. Increasing age was also a risk factor for disease (RR=1.2). Risk increases by 20 percent for each year of age difference when comparing two dogs–one with and one without periodontal disease (all other factors were equal).

Table 2 details the breed risk for breeds with a common estimated relative risk (RR)

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Table 3: Relative Risk and Prevalence of Concurrent Diagnoses for Dogs with (Cases) and without (Controls) Periodontal Disease—2006 Banfield population

Disease	Cases (n=57,134)	Controls (n=213,340)	Relative risk (odds ratio*)	Confidence interval
Endocarditis	0.05%	0.002%	5.1	1.9, 14.3
Hepatopathy	0.6%	0.1%	3.0	2.5, 3.6
Hepatitis	0.08%	0.03%	1.6	1.1, 2.4
Chronic renal failure	0.5%	0.1%	1.3	1.1, 1.6

*Multivariate model

of 1.5 or greater (with confidence intervals) for periodontal disease. The 10 purebred breeds (RR) at highest risk for the disease are Toy Poodle, Yorkshire Terrier, Maltese, Pomeranian, Shetland Sheepdog, Cavalier King Charles Spaniel, Papillion, Standard Poodle, Dachshund and Havanese.

For concurrent diagnoses significantly associated with periodontal disease, *Table 3* details prevalence by diagnosis for case and control groups and the relative risk estimate (with confidence intervals). Although diabetes mellitus was significantly associated with periodontal disease in the univariate analysis, it did not remain a predictor in the multivariate model.

Discussion

Overall prevalence of periodontal disease in purebred dog breeds seen in 2006 was 6.4 percent; about one in 15 purebred dogs seen in the Banfield population had some degree of periodontal disease. Based on our multivariate analysis, risk for periodontal disease increases with age and is more likely to afflict spayed or neutered Pets. Risk for periodontal disease can also be predicted by breed type with Toy Poodle, Yorkshire Terrier, Maltese, Pomeranian, Shetland Sheepdog, Cavalier King Charles Spaniel, Papillion, Standard Poodle, Dachshund and Havanese breeds topping the list. Independent of age, breed or neuter status, these purebred canines are also more likely to be concurrently diagnosed with endocarditis, liver disease (hepatopathy or hepatitis) or chronic renal failure.

Client education for the prevention of periodontal disease can be made more compelling with the associations of cardiovascular, hepatic and renal disease found in our analysis. Knowing the odds that a Pet with periodontal disease is five times more likely to be diagnosed with endocarditis, for example, supports the veterinarian's recommendations about routine prophylaxis, as well as new prevention strategies like immunization (Porphyromonas Denticanis-Gulae-Salivosa Bacterin–Pfizer Animal Health). However, although the associations found in our analysis are important for future study hypotheses and as tools for client communication about risk, it is important to highlight that these results cannot be used to establish whether periodontal disease was caused by a particular concurrent disease or vice versa. Future studies will be important to explore the temporal relationship and the pathophysiology of the association. In addition, there may be unmeasured confounders or other factors important for study, such as body condition score and diet. Nonetheless, veterinarians can use these results as evidence to provide compelling rationale for client education recommendations for preventive care strategies.

We don't have to understand the exact immune or inflammatory processes that may be involved to make a difference in a Pet's health. Using results from epidemiologic studies, veterinarians can present prevention and treatment strategies, as well as build strong client relationships. Using such data to communicate a Pet's risk establishes trust and respect and helps the client make informed medical decisions.

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Elizabeth Lund, DVM, MPH, PhD, joined Banfield in 2006 as senior director of research for DataSavant. As an epidemiologist, Dr. Lund's professional experience over the last 18 years has included research in academia, industry and public health. She also has a master's degree in public health and a PhD in epidemiology/informatics. Dr. Lund and her husband, Jim, have four children (Jessica, Alyssa, Will and Nick) and four Pets.