Identification of the most common cutaneous neoplasms in dogs and evaluation of breed and age distributions for selected neoplasms

J. Armando Villamil, DVM, PhD; Carolyn J. Henry, DVM, MS, DACVIM;
Jeffrey N. Bryan, DVM, PhD, DACVIM; Mark Ellersieck, PhD; Loren Schultz, DVM, PhD, DACVIM;
Jeff W. Tyler,† DVM, MPVM, PhD, DACVIM; Allen W. Hahn, DVM, DACVIM

Objective—To identify the most common cutaneous neoplasms in dogs and evaluate breed and age distributions for selected neoplasms.

Design—Retrospective epidemiological study.

Sample—Records available through the Veterinary Medical Database of dogs examined at veterinary teaching hospitals in North America between 1964 and 2002.

Procedures—Information on tumor type and patient breed and age was collected. Incidence and odds ratios with 95% confidence intervals were calculated.

Results—Records of 1,139,616 dogs were reviewed. Cutaneous neoplasms were diagnosed in 25,996 of these dogs; records for the remaining 1,113,620 dogs did not indicate that cutaneous neoplasms had been diagnosed, and these dogs were considered controls. The most frequent age range for dogs with cutaneous neoplasms was 10 to 15 years. Lipoma, adenoma, and mast cell tumor were the most common skin tumor types.

Conclusions and Clinical Relevance—Results supported previously reported data regarding cutaneous neoplasia in dogs but provided updated information on the most common skin tumors and on age and breed distributions. (*J Am Vet Med Assoc* 2011;239:960–965)

Over the past 40 years, hundreds of manuscripts have been written about cutaneous neoplasia in dogs. Many of these manuscripts make reference to the percentage of the total canine population affected by various types of skin tumors. Unfortunately, the references cited for these percentages are usually outdated. Most of the original references are from the 1970s, and newer studies tend to cite these earlier references. Other references consist of case series or studies with small sample populations and specific selection criteria that may misrepresent the total population.

One of the most commonly cited studies was published in 1968.[1] In a review of common indexing and abstracting services, for example, we found that this study has been cited > 298 times in published studies of mast cell tumors in dogs and has been cited at least 2 times/y in the past 32 years. The other study frequently referenced is a 1974 report,[2] which we found, in our same review of indexing and abstracting services, to have been cited at least 68 times. These are only 2 examples of how outdated references continue to be cited in the veterinary oncology literature, primarily because the literature has not been updated with newer, more accurate epidemiological studies. The problem with these studies is that the control populations are not well-defined. Dorn et al[1] used a human survey to estimate the number of dogs in Contra Costa County, and Cohen et al[2] estimated the total population from the number of cases examined each year at the University of Pennsylvania.

Abbreviations

CI	Confidence interval
OR	Odds ratio
VMDB	Veterinary Medical Database

From the Department of Veterinary Medicine and Surgery, College of Veterinary Medicine (Villamil, Henry, Schultz, Tyler, Hahn), the Agriculture Experimental Station, College of Agriculture, Food, and Natural Resources (Ellersieck), and the Hematology/Oncology Division, Department of Internal Medicine, School of Medicine (Henry), University of Missouri, Columbia, MO 65211; and the Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Washington State University, Pullman, WA 99164 (Bryan). Dr. Villamil's present address is Animal Cancer Care Clinic, 1122 NE 4th Ave, Fort Lauderdale, FL 33304.

This manuscript represents a portion of a dissertation submitted by the senior author to the University of Missouri Graduate School as partial fulfillment of the requirements for a Doctor of Philosophy degree.

Dr. Villamil was supported by a Minority Bio-Medical Researchers Training Initiative MU/NIH Science Education Partnership Award, University of Missouri. Drs. Villamil and Henry were supported by the Tom and Betty Scott Endowed Program in Veterinary Oncology, University of Missouri. Dr. Bryan was supported by the National Library of Medicine Biomedical and Health Informatics Research training grant 2-T15-LM07089.

Presented in abstract form at the 26th Annual Veterinary Cancer Society Conference, Pine Mountain, Ga, October 2006.

The authors thank Kate Anderson and Mathew Keeler for technical assistance.

Address correspondence to Dr. Villamil (drarmando@animalcancercareclinic.com).

†Deceased.

Data regarding the incidence of various tumors in dogs help veterinary oncologists better understand the etiology of these diseases and decide how to allocate the limited resources available for veterinary research. Impediments to performing the types of epidemiological studies in veterinary medicine needed to obtain this information include the lack of a representative control population and the fact that no universally accepted tumor classification system exists.[3] Many case series have large sample sizes but lack an adequate control population for calculation of risk factors or incidence. Other studies include cases from a limited geographic area,[1] necessitating that survey data and sometimes control populations be estimated.[2] A recent study[4] evaluated incidence of neoplasia among insured dogs in the United Kingdom, but the conclusions cannot be applied to the US population. As an example, dogs in the United States are more likely to have been spayed or neutered, compared with dogs in the United Kingdom, which could be expected to affect the incidence of hormone-associated tumors such as mammary gland tumors. In the UK study,[4] the incidence of mammary gland tumors was considerably higher than the rate reported in previous studies[2,5,6] from the United States. Because only a small number of dogs in the United States are insured, it would be difficult to duplicate the United Kingdom study here. In addition, most insured dogs in the United Kingdom study were young, raising concerns about whether selection bias could have affected the results, in that cancer incidence tends to increase with age. A study[7] that evaluated cancer incidence among dogs in Genoa, Italy, has similar limitations when its findings are compared with rates for dogs in the United States.

One of the most comprehensive databases of veterinary medical record information currently available is the VMDB.[a] The VMDB collects records from 27 university-based, veterinary teaching hospitals in North America. Data collection began in 1964, and the VMDB currently has records for > 1 million dogs. The purpose of the study reported here was to use data from the VMDB to identify the most common cutaneous neoplasms in dogs and evaluate breed and age distributions for selected neoplasms.

Materials and Methods

The VMDB was searched to identify all records for dogs entered between 1964 and 2002. Dogs for which a diagnosis of cutaneous neoplasia, defined in accordance with the Standard Nomenclature of Veterinary Diseases and Operations, had been entered in the record were designated as cases. Dogs in which any diagnosis other than cutaneous neoplasia had been entered in the record were designated as controls. Because each visit to the teaching hospital resulted in generation of a unique entry in the VMDB, individual dogs may have been included in the database multiple times. Therefore, all entries were first searched to identify dogs in which cutaneous neoplasia had been diagnosed during any hospital visit and to designate dogs as cases or controls. Subsequently, a single record was randomly selected to represent each individual dog in the case and control populations. This was done to minimize age bias. To ensure that each dog was represented only once in the data set, data were sorted by patient identification number and a single record was randomly selected for each dog by use of standard software[b] and all other records for that dog were deleted.

Information extracted from the records of case and control dogs included in the study consisted of age at the time of examination, year of examination, sex, breed, and diagnosis. Records for which age, year of examination, sex, breed, or diagnosis was unknown were excluded from the study.

Age was recorded on the basis of age ranges used in the VMDB (2 weeks to 2 months, > 2 to 6 months, > 6 to 12 months, > 1 to 2 years, > 2 to 4 years, > 4 to 7 years, > 7 to 10 years, > 10 to 15 years, and > 15 years). Owing to the low number of dogs ≤ 12 months old with cutaneous neoplasia, the first 3 age categories were combined into a single category (2 weeks to 12 months old).

Table 1—Skin tumor types identified in dogs (n = 25,996) examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Tumor type	No. of dogs	Percentage
Lipoma	7,133	27.44
Adenoma	3,660	14.08
Mast cell tumor	2,854	10.98
Papilloma	1,825	7.02
Histiocytoma	1,256	4.83
Hemangiopericytoma	762	2.93
Other sarcomas*	738	2.84
Melanoma	725	2.79
Adenocarcinoma	707	2.72
Lymphoma	611	2.35
Basal cell tumor	546	2.10
Hemangioma	510	1.96
Fibrosarcoma	450	1.73
Hemangiosarcoma	429	1.65
Trichoepithelioma	408	1.57
Squamous cell carcinoma	325	1.25
Fibroma	242	0.93
Carcinoma	221	0.85
Neurofibrosarcoma	135	0.52

Remaining tumor types made up < 1% of the skin tumors in the overall population.

*Other sarcomas include myxosarcoma, osteosarcoma, leiomyosarcoma, chondrosarcoma, lymphangiosarcoma, rhabdomyosarcoma, and unspecified sarcomas.

Table 2—Odds of cutaneous neoplasia among dogs grouped on the basis of age for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Age	No. of case dogs	No. of control dogs	OR	95% CI	*P* value
2 wk–12 mo	652	277,747	0.07	0.07–0.08	< 0.001
> 1–2 y	610	131,410	0.17	0.17–0.19	< 0.001
> 2–4 y	1,342	189,027	0.26	0.25–0.28	< 0.001
> 4–7 y	4,016	214,604	0.76	0.74–0.79	< 0.001
> 7–10 y	7,973	162,303	2.59	2.52–2.66	< 0.001
> 10–15 y	10,657	127,844	5.35	5.22–5.49	< 0.001
> 15 y	746	10,685	3.04	2.83–3.29	< 0.001

There were 25,996 case dogs with cutaneous neoplasia and 1,113,620 control dogs without a diagnosis of cutaneous neoplasia. The OR represents the odds of cutaneous neoplasia in the age group of interest, compared with the odds in all other dogs.

For case dogs, the type of skin tumor was determined on the basis of the diagnostic code entered in the record. Dogs with cutaneous lymphoma, lymphosarcoma, or mycosis fungoides were grouped together in a single lymphoma category. Dogs with cutaneous hemangiopericytoma, fibrosarcoma, myxosarcoma, leiomyosarcoma, rhabdomyosarcoma, neurofibrosarcoma, or undetermined sarcoma were grouped together into a soft tissue sarcoma category on the basis of similar biological behavior.

Six tumor types (hemangiosarcoma, lymphoma, mast cell tumor, melanoma, soft tissue sarcoma, and squamous cell carcinoma) were selected to be specifically characterized. Age and breed categories were evaluated for each of these tumor types owing to their clinical importance.

Distribution of case and control dogs was analyzed by decade. Percentage of dogs with skin tumors was calculated for each decade by dividing the number of dogs with skin tumors examined during that decade by the number of all dogs examined during that decade.

To determine whether age category or breed was significantly associated with development of skin tumors in general or with development of cutaneous hemangiosarcoma, lymphoma, mast cell tumor, melanoma, soft tissue sarcoma, or squamous cell carcinoma in particular, ORs and their 95% CIs were calculated. For each age category, the OR was calculated by comparing odds of each tumor type for dogs in that age category with odds for dogs in all other age categories.

Table 3—Odds of cutaneous hemangiosarcoma among dogs grouped on the basis of age and breed for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Variable	No. of case dogs	No. of control dogs	OR	95% CI	*P* value
Age					
2 wk–12 mo	4	277,747	0.01	0.00–0.03	< 0.001
> 1–2 y	6	131,410	0.05	0.02–0.11	< 0.001
> 2–4 y	48	189,027	0.26	0.20–0.35	< 0.001
> 4–7 y	158	214,604	0.85	0.72–1.01	0.315
> 7–10 y	286	162,303	2.57	2.24–2.95	< 0.001
> 10–15 y	400	127,844	5.73	5.04–6.53	< 0.001
> 15 y	36	10,685	4.12	2.95–5.75	< 0.001
Breed					
Boxer	53	13,850	4.76	3.60–6.28	< 0 .001
Greyhound	12	4,663	3.08	1.74–5.45	< 0.001
Airedale Terrier	11	4,517	2.91	1.61–5.28	0.003
Golden Retriever	88	39,712	2.80	2.25–3.49	< 0.001
English Pointer	13	6,905	2.25	1.30–3.90	0.030
American Cocker Spaniel	17	41,285	0.48	0.30–0.77	0.024
Miniature Poodle	12	35,627	0.39	0.22–0.69	0.011

There were 938 case dogs with cutaneous hemangiosarcoma and 1,113,620 control dogs without a diagnosis of cutaneous neoplasia. The OR represents the odds of cutaneous hemangiosarcoma in the age group or breed of interest, compared with the odds in all other dogs.

Table 4—Odds of cutaneous lymphoma among dogs grouped on the basis of age and breed for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Variable	No. of case dogs	No. of control dogs	OR	95% CI	*P* value
Age					
2 wk–12 mo	11	277,747	0.06	0.03–0.10	< 0.001
> 1–2 y	14	131,410	0.17	0.10–0.30	< 0.001
> 2–4 y	35	189,027	0.30	0.21–0.42	< 0.001
> 4–7 y	107	214,604	0.89	0.72–1.09	0.740
> 7–10 y	176	162,303	2.37	1.99–2.82	< 0.001
> 10–15 y	252	127,844	5.40	4.59–6.34	< 0.001
> 15 y	17	10,685	2.95	1.82–4.78	< 0.001
Breed					
Scottish Terrier	17	5,683	5.57	3.44–9.03	< 0.001
Boxer	26	14,320	3.41	2.30–5.05	< 0.001
Golden Retriever	51	41,529	2.35	1.76–3.13	< 0.001
Bulldog	12	9,528	2.32	1.31–4.11	0.032
German Shepherd Dog	20	70,665	0.50	0.32–0.78	0.021

There were 611 case dogs with cutaneous lymphoma and 1,113,620 control dogs without a diagnosis of cutaneous neoplasia. The OR represents the odds of cutaneous lymphoma in the age group or breed of interest, compared with the odds in all other dogs.

Table 5—Odds of cutaneous mast cell tumor among dogs grouped on the basis of age and breed for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Variable	No. of case dogs	No. of control dogs	OR	95% CI	*P* value
Age					
2 wk–12 mo	27	277,747	0.03	0.02–0.04	< 0.001
> 1–2 y	35	131,410	0.09	0.07–0.13	< 0.001
> 2–4 y	166	189,027	0.30	0.26–0.35	< 0.001
> 4–7 y	665	214,604	1.27	1.17–1.39	< 0.001
> 7–10 y	999	162,303	3.16	2.92–3.41	< 0.001
> 10–15 y	902	127,844	3.56	3.29–3.86	< 0.001
> 15 y	60	10,685	2.22	1.72–2.86	< 0.001
Breed					
Boxer	336	14,320	10.24	9.13–11.49	< 0.001
Rhodesian Ridgeback	19	1,470	5.07	3.22–7.98	< 0.001
Vizsla	24	1,948	4.84	3.23–7.25	< 0.001
Boston Terrier	101	9,631	4.21	3.44–5.13	< 0.001
Weimaraner	53	5,291	3.96	3.02–5.21	< 0.001
Chinese Shar-Pei	49	5,038	3.84	2.89–5.11	< 0.001
Bullmastiff	13	1,415	3.60	2.08–6.22	< 0.001
Dutch Pug	51	5,916	3.41	2.58–4.50	< 0.001
Labrador Retriever	355	66,885	2.22	1.99–2.49	< 0.001
American Staffordshire Terrier	29	5,493	2.07	1.44–2.99	0.001
Golden Retriever	210	41,529	2.05	1.78–2.36	< 0.001
English Setter	34	7,082	1.88	1.34–2.64	0.003
English Pointer	33	7,018	1.84	1.31–2.60	0.006
Mixed	622	268,591	0.88	0.80–0.96	0.038
American Cocker Spaniel	70	42,096	0.64	0.50–0.81	0.003
Dachshund	42	25,891	0.63	0.46–0.85	0.028
Doberman Pinscher	48	32,727	0.56	0.42–0.75	0.001
Great Dane	17	13,834	0.48	0.30–0.77	0.021
Rottweiler	21	17,429	0.47	0.30–0.72	0.005
Yorkshire Terrier	16	13,393	0.46	0.28–0.76	0.020
Siberian Husky	13	10,932	0.46	0.27–0.80	0.044
Miniature Poodle	39	36,035	0.41	0.30–0.57	< 0.001
Lhasa Apso	10	9,782	0.40	0.21–0.74	0.028
Chihuahua	10	12,402	0.31	0.17–0.58	0.002
Toy Poodle	9	16,746	0.21	0.11–0.40	< 0.001
Collie	12	22,441	0.21	0.12–0.36	< 0.001
German Shepherd Dog	37	70,665	0.19	0.14–0.27	< 0.001

There were 2,854 case dogs with cutaneous mast cell tumor and 1,113,620 control dogs without a diagnosis of cutaneous neoplasia. The OR represents the odds of cutaneous mast cell tumor in the age group or breed of interest, compared with the odds in all other dogs.

For each breed, the OR was calculated by comparing odds of each tumor type for dogs of that breed with odds for dogs of all other breeds. Only breeds with > 10 dogs with that specific tumor type were included in OR calculations; for each tumor type, results were reported only for those breeds for which the OR was significantly different from 1. An OR significantly > 1 was considered evidence of a predisposition in dogs of that age category or breed; an OR significantly < 1 was considered evidence that dogs of that age category or breed were protected from developing that tumor type, compared with dogs in the general population.

All analyses were performed with standard software.[b] Values of $P < 0.05$ were considered significant.

Results

After duplicate records and records with missing information were excluded, information was available for 1,139,616 dogs. Of these, 25,996 had a diagnosis of cutaneous neoplasia (case dogs) and 1,113,620 had a diagnosis other than cutaneous neoplasia (control dogs). For dogs with cutaneous neoplasia, the most common skin tumor type was lipoma, followed by adenoma and mast cell tumor (**Table 1**).

Of the 25,996 case dogs, 11,385 were spayed females, 5,866 were sexually intact males, 5,488 were castrated males, and 3,257 were sexually intact females. The most frequent age range was > 10 to 15 years (n = 10,657), followed by > 7 to 10 years (7,973), > 4 to 7 years (4,016), > 2 to 4 years (1,342), > 15 years (746), 2 weeks to 12 months (652), and > 1 to 2 years (610) (**Table 2**). Mixed-breed dogs were most common, followed by Labrador Retrievers, Golden Retrievers, Miniature Poodles, American Cocker Spaniels, German Shepherd Dogs, Doberman Pinschers, Boxers, Miniature Schnauzers, and Dachshunds.

For the 6 tumor types that were selected, case and control frequency and ORs, 95% CIs, and *P* values were summarized. Variables evaluated for each tumor were age and breed (**Tables 3–7**).

Evaluation of ORs and their 95% CIs indicated that dogs > 7 to 10 years old, > 10 to 15 years old, and > 15 years old were significantly more likely to have cutaneous hemangiosarcoma, compared with dogs in other age groups. Dogs of 5 breeds were found to be overrepresented, compared with dogs of other breeds (Table 3).

Similarly, dogs in the 3 oldest ages groups were significantly more likely to have cutaneous lymphoma than were dogs in other age groups. However, dogs of only 4 breeds were overrepresented, compared with dogs of other breeds (Table 4).

Dogs in the 3 youngest age groups were significantly less likely and dogs in the 4 oldest age groups were significantly more likely to develop cutaneous mast cell tumors, compared with dogs in other age groups. Thirteen breeds were overrepresented, and 14 were underrepresented, compared with dogs of other breeds (Table 5).

Dogs in the 3 oldest age groups were significantly more likely to have cutaneous melanoma, compared with dogs in the other age groups. Mixed-breed dogs, German Shepherd Dogs, and American Cocker Spaniels

Table 6—Odds of cutaneous melanoma among dogs grouped on the basis of age and breed for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Variable	No. of case dogs	No. of control dogs	OR	95% CI	*P* value
Age					
2 wk–12 mo	5	277,747	0.02	0.01–0.05	< 0.001
> 1–2 y	5	131,410	0.05	0.02–0.12	< 0.001
> 2–4 y	14	189,027	0.10	0.06–0.16	< 0.001
> 4–7 y	105	214,604	0.70	0.57–0.86	0.010
> 7–10 y	252	162,303	3.08	2.65–3.59	< 0.001
> 10–15 y	326	127,844	6.21	5.36–7.18	< 0.001
> 15 y	24	10,685	3.50	2.33–5.27	< 0.001
Breed					
Vizsla	21	1,896	17.34	11.21–26.83	< 0.001
Miniature Schnauzer	83	18,624	7.53	5.99–9.47	< 0.001
Chesapeake Bay Retriever	12	3,172	5.84	3.30–10.35	< 0.001
Boxer	38	13,850	4.35	3.14–6.04	< 0.001
Airedale Terrier	10	4,517	3.41	1.82–6.36	< 0.001
Scottish Terrier	11	5,519	3.07	1.69–5.57	0.002
Doberman Pinscher	60	32,015	3.02	2.32–3.93	< 0.001
Golden Retriever	64	39,712	2.59	2.01–3.35	< 0.001
Irish Setter	23	15,962	2.23	1.47–3.38	0.002
Mixed	117	259,601	0.63	0.51–0.76	< 0.001
German Shepherd Dog	22	69,430	0.47	0.31–0.71	0.005
American Cocker Spaniel	12	41,285	0.43	0.25–0.77	0.033

There were 731 case dogs with cutaneous melanoma and 1,113,620 control dogs without a diagnosis of cutaneous neoplasia. The OR represents the odds of cutaneous melanoma in the age group or breed of interest, compared with the odds in all other dogs.

Table 7—Odds of cutaneous soft tissue sarcoma (ie, cutaneous hemangiopericytoma, fibrosarcoma, myxosarcoma, leiomyosarcoma, rhabdomyosarcoma, neurofibrosarcoma, or undetermined sarcoma) among dogs grouped on the basis of age and breed for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Variable	No. of case dogs	No. of control dogs	OR	95% CI	*P* value
Age					
2 wk–12 mo	11	277,747	0.02	0.01–0.03	< 0.001
> 1–2 y	22	131,410	0.09	0.06–0.14	< 0.001
> 2–4 y	88	189,027	0.25	0.20–0.31	< 0.001
> 4–7 y	262	214,604	0.70	0.61–0.80	< 0.001
> 7–10 y	583	162,303	2.74	2.48–3.02	< 0.001
> 10–15 y	802	127,844	6.01	5.48–6.59	< 0.001
> 15 y	63	10,685	3.68	2.86–4.73	< 0.001
Breed					
Rhodesian Ridgeback	11	1,398	4.81	2.65–8.72	< 0.001
Golden Retriever	176	39,712	2.88	2.46–3.36	< 0.001
Siberian Husky	45	10,379	2.68	1.99–3.60	< 0.001
Boxer	40	13,850	1.77	1.30–2.43	0.004
Labrador Retriever	151	63,954	1.48	1.25–1.74	< 0.001
Mixed	532	259,601	1.35	1.22–1.49	< 0.001
American Cocker Spaniel	35	41,285	0.51	0.36–0.71	< 0.001
Miniature Poodle	30	35,627	0.50	0.35–0.72	0.002
Collie	17	22,013	0.46	0.29–0.75	0.016
Toy Poodle	12	16,533	0.44	0.25–0.77	0.035

There were 1,831 case dogs with cutaneous soft tissue sarcomas and 1,113,620 control dogs without a diagnosis of cutaneous neoplasia. The OR represents the odds of cutaneous soft tissue sarcoma in the age group or breed of interest, compared with the odds in all other dogs.

Table 8—Odds of cutaneous squamous cell carcinoma among dogs grouped on the basis of age and breed for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Variable	No. of case dogs	No. of control dogs	OR	95% CI	*P* value
Age					
2 wk–12 mo	3	277,747	0.03	0.01–0.09	< 0.001
> 1–2 y	8	131,410	0.19	0.09–0.38	< 0.001
> 2–4 y	22	189,027	0.35	0.23–0.55	< 0.001
> 4–7 y	63	214,604	1.00	0.76–1.32	1.000
> 7–10 y	100	162,303	2.59	2.05–3.28	< 0.001
> 10–15 y	123	127,844	4.67	3.73–5.85	< 0.001
> 15 y	7	10,685	2.27	1.07–4.79	0.184
Breed					
Dalmatian	17	8,756	6.94	4.26–11.32	< 0.001
Basset Hound	11	9,715	3.97	2.17–7.24	< 0.001

There were 326 case dogs with cutaneous squamous cell carcinoma and 1,113,620 control dogs without a diagnosis of cutaneous neoplasia. The OR represents the odds of cutaneous squamous cell carcinoma in the age group or breed of interest, compared with the odds in all other dogs.

Table 9—Change over time in percentage of dogs determined to have skin tumors for dogs examined at veterinary teaching hospitals in the United States for which records were entered in the VMDB between 1964 and 2002.

Years	No. of case dogs	No. of control dogs	Percentage of dogs with skin tumors
1964–1969	1,123	57,533	1.9%
1970–1979	5,411	296,023	1.8%
1980–1989	8,691	381,461	2.2%
1990–1999	8,504	318,324	2.6%
2000–2002	2,267	60,279	3.6%

were significantly less likely to have cutaneous melanoma than were dogs of other breeds (Table 6).

Dogs in the 4 youngest age groups were significantly less likely and dogs in the 3 oldest age groups were significantly more likely to develop cutaneous soft tissue sarcomas (ie, cutaneous hemangiopericytoma, fibrosarcoma, myxosarcoma, leiomyosarcoma, rhabdomyosarcoma, neurofibrosarcoma, or undetermined sarcoma), compared with dogs in other age groups (Table 7). Mixed-breed dogs and dogs of 5 breeds were overrepresented, compared with other dogs.

Finally, dogs > 7 to 10 years old and dogs > 10 to 15 years old were significantly more likely to have cutaneous squamous cell carcinoma, compared with dogs in other age groups, but dogs > 15 years old were not (**Table 8**). Only Dalmatians and Basset Hounds were overrepresented.

When percentages of dogs examined during each decade from 1964 through 2002 and found to have cutaneous neoplasia were calculated, the percentage of dogs with cutaneous neoplasia appeared to increase over time (**Table 9**).

Discussion

Results of the present study support previously reported data regarding cutaneous neoplasia in dogs. Many previous studies, for instance, have shown that skin tumors are more common in elderly dogs, and our results indicated a peak in the odds of developing skin tumors in dogs > 10 to 15 years of age. It has also been reported that Boxers are predisposed to develop cutaneous neoplasia,[8] and this was supported by our results. Previous studies[5,8,9] have indicated that mast cell tumors are the most common skin tumor in dogs; however, in the present study, lipomas were more common, which was in keeping with our clinical impression. In addition, there seemed to be an increase in the frequency with which skin tumors were diagnosed during the period of the present study (ie, 1964 to 2002). This may be attributable to better diagnostic testing over time, especially the increased use of immunohistochemical staining for tumor diagnosis.

There are limited reports on the incidence of skin tumors in dogs grouped by breed. A report by Goldschmidt et al[10] of surgical biopsy specimens evaluated by the Laboratory of Pathology at the University of Pennsylvania School of Veterinary Medicine is one of the few studies in which a detailed evaluation of breed distribution for specific skin tumors was completed. Data from that study[10] showed some similarities and some differences, compared with our results. When we compared breed distributions for cutaneous melanomas and mast cell tumors, both studies had similar distributions. However, the distributions for cutaneous squamous cell carcinoma and cutaneous lymphoma had striking differences between these 2 studies. Our data indicated that Dalmatians were the breed with the highest odds of developing squamous cell carcinoma, whereas Giant Schnauzers had the highest odds in the study by Goldschmidt et al.[10] Rothwell et al[11] also reported that Dalmatians were the breed with the highest odds for squamous cell carcinoma, on the basis of a study performed in Sydney, Australia. This is in keeping with the etiologic link between UV light exposure of lightly pigmented skin and the development of squamous cell carcinomas.

The present study evaluated breed distribution for cutaneous lymphoma, and results matched our clinical impression that Scottish Terriers, Boxers, and Golden Retrievers were commonly affected. In the study by Goldschmidt et al,[10] Briards, English Cocker Spaniels, and Bulldogs were the top 3 breeds.

Comparisons between results of the present study and findings reported by Goldschmidt et al[10] must take into account the very different sources from which the data were derived. Goldschmidt et al[10] used data from biopsy reports, whereas in the present study, we obtained our data from medical records. We believe that our data should be more representative of the clinical population because it is hard to estimate a total population on the basis of biopsy submissions, in that the size of the total population from which those biopsies specimens are collected is often unknown. In addition, we excluded breeds with < 10 cases for each tumor type in an attempt to report the most clinically relevant data. In contrast, the study by Goldschmidt et al[10] reported some ORs calculated on the basis of small numbers (as few as 2) of dogs of each breed; thus, previous reports of breed risks may be erroneous.

The veterinary literature frequently makes reference to the fact that mast cell tumors represent 7% to 21% of all skin tumors in dogs.[1,2,5,6] Our data support this assertion, with mast cell tumors accounting for 11% of all skin tumors in our study population.

By using the VMDB to select a documented case population and comparing it with a large control population, we have been able to identify the most frequently diagnosed skin tumors in dogs, with data specific to breed and age distribution. These data may serve as a reference for future comparative studies. Inherent flaws in the VMDB include the fact that cases are gathered from tertiary veterinary hospitals and may not be representative of the canine population as a whole and that data entry may vary in quality and reliability from site to site. However, the size of the VMDB, which includes > 1 million cases, should minimize the impact of any data entry bias. In addition, by using randomly selected records for individual dogs, we minimized any possible selection bias that may have skewed the data toward a specific tumor type, age group, or breed.

Recently, the VMDB adopted a new nomenclature system: the Systematized Nomenclature of Medicine-Clinical Terms. This new system has allowed some veterinary teaching hospitals to enter data directly from their computerized records to the VMDB, allowing them to enter data in a more timely fashion.

One important limitation of the VMDB is that the method of diagnosis is not always described in the record, and tumor diagnosis could represent anything from a histologic diagnosis to a clinical impression.

In conclusion, results of the present study supported previously reported data regarding cutaneous neoplasia in dogs but provided updated information on the most common skin tumors and on age and breed distributions.

a. Veterinary Medical Database [database online]. Urbana, Ill: Association of Veterinary Medical Data Program Participants. Available at: www.vmdb.org. Accessed Mar 24, 2006.
b. SAS for Windows, version 9.13, SAS Institute Inc, Cary, NC.

References

1. Dorn CR, Taylor DO, Schneider R, et al. Survey of animal neoplasms in Alameda and Contra Costa Counties, California. II. Cancer morbidity in dogs and cats from Alameda County. *J Natl Cancer Inst* 1968;40:307–318.
2. Cohen D, Reif JS, Brodey RS, et al. Epidemiological analysis of the most prevalent sites and types of canine neoplasia observed in a veterinary hospital. *Cancer Res* 1974;34:2859–2868.
3. Bronden LB, Flagstad A, Kristensen AT. Veterinary cancer registries in companion animal cancer: a review. *Vet Comp Oncol* 2007;5:133–144.
4. Dobson JM, Samuel S, Milstein H, et al. Canine neoplasia in the UK: estimates of incidence rates from a population of insured dogs. *J Small Anim Pract* 2002;43:240–246.
5. Brodey RS. Canine and feline neoplasia. *Adv Vet Sci Comp Med* 1970;14:309–354.
6. Kelsey JL, Moore AS, Glickman LT. Epidemiologic studies of risk factors for cancer in pet dogs. *Epidemiol Rev* 1998;20:204–217.
7. Merlo DF, Rossi L, Pellegrino C, et al. Cancer incidence in pet dogs: findings of the Animal Tumor Registry of Genoa, Italy. *J Vet Intern Med* 2008;22:976–984.
8. Bostock DE. Neoplasms of the skin and subcutaneous tissues in dogs and cats. *Br Vet J* 1986;142:1–19.
9. Larsson B. Some aspects of canine mastocytoma *Nord Vet Med* 1957;9:241–256.
10. Goldschimidt MH, Shofer FS. *Skin tumors of the dog & cat*. Oxford, England: Pergamon Press, 1992.
11. Rothwell TL, Howlett CR, Middleton DJ, et al. Skin neoplasms of dogs in Sydney. *Aust Vet J* 1987;64:161–164.

New Veterinary Biologic Products

Product name	Species and indications for use	Route of administration	Remarks
Swine Influenza Virus RNA Test Kit, Code 59A7.80 Firm 432	For detection of swine influenza virus RNA from porcine nasal swabs	NA	USDA licensed 6/23/11