Evaluation of risk factors for bite wounds inflicted on caregivers by dogs and cats in a veterinary teaching hospital

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Objective—To identify factors associated with increased risk of being bitten by a dog or cat in a veterinary teaching hospital.

Study population—207 animal caregivers.

Procedure—Case subjects (n = 75) were any caregiver that reported being bitten by a dog or cat. Control subjects (n = 132) were randomly selected from a list of all caregivers interacting with dogs or cats. Information on the characteristics of the caregivers, characteristics of the dogs and cats, and the nature of the interaction between the dog or cat and the caregiver was obtained by use of self-administered questionnaires.

Results—Caregivers were more likely to be bitten by dogs or cats that had warning signs on their cages indicating the potential to bite or that were considered difficult to handle. Caregivers interacting with cats or with older dogs and cats were more likely to be bitten. Only 37 to 55% of dogs and cats that had characteristics traditionally associated with biting or were considered likely to bite were muzzled.

Conclusions and Clinical Relevance—Muzzling dogs and cats should be considered more frequently. Dogs and cats considered to have the propensity to bite frequently do bite, and precautions, such as muzzling, should be taken if the medical condition or conformation of the dog or cat is amenable to this type of restraint. (J Am Vet Med Assoc 2003;223:312–316)

It is estimated that 4.7 million humans are bitten by animals each year.1 Of those who are bitten by dogs, only 17 to 18% seek medical attention,2 and approximately 42% of those seek medical attention in emergency departments. Direct costs related to animal bite injuries are large. Insurance companies estimate that > $1 billion annually in homeowners’ liability claims are related to dog bites.1 Emergency department visits related to dog bites are estimated to cost $102.4 million/y.4 These costs do not take into account medical insurance claims, workmen’s compensation claims, lost wages, and sick-leave-associated business costs. In addition, the physical and emotional damage to the individuals and their families can be severe.5–9 Dog bites are a major public health problem, and for this reason, the epidemiologic features of dog bites in the general public have been extensively evaluated and recently reviewed.1

The epidemiologic features of animal bites among particular professions have received less comprehensive attention. A recent report10 on a community approach to preventing dog bites indicates that bites have been well tolerated as an occupational hazard for utility and postal workers; however, it does not mention this hazard for the veterinary medical community. Animal control workers are 500 times more likely to be bitten, compared with the general population.11 In a survey of veterinarians from Minnesota and Wisconsin, 92.3 and 81.0% reported being bitten by dogs and cats, respectively.12 Despite the high risk of being bitten, to the authors’ knowledge, there are no studies that assess risk factors for bite wounds in humans in the veterinary profession. The effects of bite wounds may result in hours or days lost from work and cause pain, infection, hospitalization, scarring, and potential psychologic injury. It is important to determine whether certain tasks, behaviors, or occupations within a veterinary teaching hospital put caregivers at increased risk for bites from cats and dogs. An understanding of risk factors for bite wounds may lead to training programs and other preventive procedures that will lessen the occurrence. We hypothesized that dogs and cats that were easy to handle and not expected to bite would bite and that the incidence of dog and cat bites would depend on the amount of time the caregiver was in direct contact with dogs and cats on a daily basis and how rushed in their responsibilities caregivers believed they were during the interaction. The purpose of the study reported here was to identify factors associated with increased risk of being bitten by a dog or cat in a veterinary teaching hospital.

Materials and Methods

Selection of case and control subjects—This study was approved by the Institutional Review Board of the University of Pennsylvania. Case and control subjects were chosen from caregivers who, as part of their primary responsibilities, interacted with dogs and cats in a veterinary teaching hospital such as faculty, residents, interns, students, nurses (veterinary technicians), nurse assistants, nurse volunteers, and nurse trainees. Case subjects were caregivers who were bitten (defined as any bite that broke the skin) by a dog or cat and reported the incident to the hospital’s bite wound coordinator from July 1, 2000, through June 30, 2001. Random selec-
tion of control subjects was achieved by enumerating all caregivers who worked at the veterinary teaching hospital. A random number generated by a computer software program was used to select control subjects. Two control subjects were selected for each case subject soon after each bite wound report was received. We hypothesized that being bitten was the result of a sudden incident that was more likely to be dependent on the immediate circumstances than on long-term characteristics of the caregiver who was bitten. Therefore, criteria for selection of control subjects were such that we did not reject caregivers who had been bitten during the study period (or case subjects who had been selected as control subjects).

Questionnaires—Case and control subjects completed self-administered questionnaires that focused on 3 main data sets including characteristics of the caregiver, characteristics of the dog or cat, and the nature of the interaction between the dog or cat and the caregiver. Case subjects answered questions regarding the bite wound. Control subjects answered questions regarding a randomly selected interaction with a dog or cat. To select the interaction, control subjects were asked to enumerate all interactions with dogs or cats they had on the day the questionnaire was given to them. The interaction was randomly selected from this enumerated list. Pretesting indicated that the questionnaires could be completed within 10 minutes.

Questions in the first data set included demographic details and the caregiver's experience with and attitude toward dogs and cats. Caregivers were asked to describe 3 warning signs that may indicate a dog or cat was likely to bite. They were also asked if they had been bitten in the past and how often, at what age, and by what species.

Questions in the second data set included details of species, breed, age, sex, and disposition of the dog or cat. Reasons for hospitalization, whether the dog or cat had signs of pain, and whether analgesics had been administered were recorded.

Questions in the third data set included the caregiver's workload, the percentage of a typical day that the caregiver had contact with dogs and cats, the duration of the interaction, location (floor, table, or cage) and type of procedure being performed, the duration of the restraint of the dog or cat, and whether a muzzle was available and used. Questions regarding the severity (mild, moderate, or severe) and location of the bite wound and whether the caregiver had received medical attention were also included. Bite wounds were described on the questionnaire as mild (minor skin break), moderate (deep puncture wound with swelling), and severe (deep puncture wound with swelling, bruising, and severe pain).

Statistical analyses—Answers to questionnaires were coded and stored in a database. All statistical analyses were performed by use of a statistical software program. Descriptive statistics for categoric variables are expressed as proportions with the 95% confidence interval (CI), whereas means (with 95% CI) or medians (range) are used for continuous variables, depending on data distribution.

The primary purpose of the analyses was to test the hypothesis that there was no association between 1 or more of the putative risk factors and increased occurrence of bites. The first step in the analysis was to select those independent variables that would be included in the preliminary multivariable logistic regression models. A univariable logistic regression model was used to determine the association between individual variables and the occurrence of bites. Variables were included in the multivariable model if the value of P was ≤ 0.2 for the likelihood ratio χ² statistic (LRCS) for the univariable model. This P value was chosen to avoid an excessively rigorous initial selection among variables.

Because of the large number of variables that met the initial univariable analysis criterion, 5 exploratory models were first developed on the basis of general topic areas. Model 1 included variables concerning muzzling and workload of the caregiver. Model 2 included circumstances surrounding the interaction including variables associated with the dog or cat, the procedure, and the caregiver. Model 3 included all warnings associated with the dog or cat. Model 4 included all variables associated with the general characteristics of the caregiver, and model 5 included variables associated with the general characteristics of the dog or cat. Variables identified as significant (P < 0.05) in the 5 exploratory models were pooled and used to develop the final main-effects model. For each model development, individual variables were deleted stepwise by a backward selection technique.

The null hypothesis for each variable was that the corresponding regression coefficient equaled zero. Plausible interaction terms were defined and included in the main-effects model. Individual interaction terms were deleted stepwise from the model by use of the backward selection method. The fit of the final model was tested by use of the Hosmer-Lemeshow goodness-of-fit statistic.

Before the study, we calculated that a sample size of 115 cases with a 2:1 control-to-case subject ratio would detect an odds ratio (OR) of ≥ 2.0 if the proportion of caregivers exposed in the control population ranged from 0.3 to 0.6. We also performed a post hoc power analysis because the sample size of cases was less than expected. The post hoc power analysis revealed that our sample size had a power of approximately 0.6 to detect a univariate odds ratio of 2.0 if the proportion of caregivers exposed in the control population ranged from 0.3 to 0.6.

Results There were 207 caregivers (132 control and 75 case subjects); 158 (76%) were female and 49 (24%) were male. Among case subjects, there were more females (60 [80%]) than males (15 [20%]); however, this was not significantly different from the gender ratio of control subjects. Demographic characteristics such as age, marital status, ethnic background, level of education, years of experience in veterinary medicine, years working in the teaching hospital, and household income did not differ significantly between case and control subjects. Duration from the interaction between the caregiver and the dog or cat to completion of the questionnaire was significantly (P < 0.001) longer for case subjects (median, 6 days; range, 0 to 96 days), compared with control subjects (median, 0 days; range, 0 to 65 days).

Case subjects were bitten most frequently on the hand or finger (n = 62 [83%]), followed by wrist (7 [10%]), face (3 [4%]), and arm (1 [1%]). Two case subjects (3%) did not report the location of the bite. Bite wounds were rated as mild (n = 30 [42%]), moderate (33 [41%]), and severe (12 [17%]). Sixty-nine percent of case subjects received medical attention for the bite wound. The percentage of case subjects that received medical attention was dependent on severity of the bite wound (mild [53%], moderate [79%], and severe [83%]). The percentage of a typical day that a caregiver was in direct contact with dogs and cats was significantly (P = 0.004) greater for case subjects (median, 72.5%; range, 3 to 100%), compared with control subjects (median, 50%; range, 0 to 100%). The univariable
OR of being bitten for each 1% increase in time caregivers were in direct contact with dogs and cats was 1.01 (95% CI, 1.00 to 1.02). Nurses, nurse assistants, nurse volunteers, and nurse trainees were in direct contact significantly (P < 0.001) more often with dogs and cats (median, 80%; range, 5 to 100%), compared with caregivers who were not in this category (median, 50%; range, 0 to 100%).

The majority (61%; 95% CI, 54 to 68%) of caregivers had been previously bitten by cats. Sixty-five percent (95% CI, 58 to 71%) of caregivers had been previously bitten by dogs. The percentage of veterinarians who had been previously bitten by a dog or cat was 75 (95% CI, 60 to 87%) and 80 (95% CI, 65 to 90%), respectively. There was no significant difference regarding previous bites by either species between case and control subjects. The median number of previous cat and dog bites for case and control subjects was 1 (range, 0 to 50 and 0 to 12, respectively), with no significant difference between case and control subjects. Seventy-one percent of the caregivers (95% CI, 63 to 78%) were adults when bitten. The age of the caregiver when previously bitten was not significantly different between case and control subjects.

Overall, there were 126 (61%) dogs (53 breeds) and 81 (39%) cats (7 breeds). The frequency distribution of breeds of dog did not differ between case and control subjects. Nineteen breeds of dog were identified by case subjects and included mixed breed (7), American Staffordshire Terrier (2), Dachshund (2), German Shepherd Dog (2), Golden Retriever (2), Siberian Husky (2), Lhasa Apso (2), Miniature Poodle (2), and 1 each of 11 other breeds. Thirty-four breeds were identified by control subjects and included mixed breed (13), Labrador Retriever (7), Golden Retriever (4), German Shepherd Dog (4), Beagle (3), Dachshund (3), Doberman Pinscher (3), and Mastiff (3). There were 2 dogs each of 8 other breeds and 1 each of 18 other breeds.

Six breeds of cat were identified by case subjects including domestic shorthair (35), domestic longhair (2), Maine Coon (2), Siamese (1), Himalayan (1), and an unidentified purebred (1). Six breeds of cat were identified by control subjects and included domestic shorthair (34) and 1 each of 5 other breeds.

The multiplicity of reported procedures that were being performed on dogs and cats rendered any comparison between case and control subjects impractical. The most common procedures reported by case subjects were physical examination (n = 8 [11%]), restraint (8 [11%]), feeding (6 [8%]), placing a muzzle (5 [7%]), giving a pill (5 [7%]), putting into or removing from a cage (4 [5%]), lifting the dog or cat (4 [5%]), and taking radiographs (4 [5%]). The most common procedures reported by control subjects included physical examination (n = 36 [27%]), venipuncture (22 [17%]), abdominal ultrasonography (17 [13%]), taking radiographs (10 [8%]), and inducting anesthesia (5 [4%]).

Although only 29% (95% CI, 20 to 39%) of dogs and cats that seemed anxious were muzzled during the interaction with the caregiver, this percentage was significantly higher than that for dogs or cats that were not considered anxious (9%; 95% CI, 5 to 17%). Only 30 to 53% of dogs and cats described as aggressive, difficult to handle, high strung, or having a warning sign on their cage indicating the potential to bite were muzzled, compared with only 12 to 14% of those not having these characteristics. Of dogs and cats considered likely to beite, only 47% (95% CI, 34 to 61%) were muzzled, even though an appropriate muzzle was available.

Univariable analysis—Twenty-one variables were identified as significant from results of the univariable analysis. Variables with OR < 1.0 were considered protective against being bitten, and variables with OR ≥ 1.0 were considered risk factors for being bitten. Nurses and nursing assistants were more likely to be bitten than veterinarians (OR, 2.2; 95% CI, 1.2 to 4.02); however, this OR decreased to 1.8 (95% CI, 0.74 to 4.6) when adjusted for the percentage of a typical day the caregiver was in direct contact with dogs and cats. Case subjects were significantly (P < 0.001) more likely to have interacted with cats than dogs (OR, 3.0; 95% CI, 1.61 to 5.71). More male (OR, 1.31; 95% CI, 0.81 to 2.82) dogs and cats than females bit caregivers, but this difference was not significant (P = 0.167). Case subjects were more likely to be interacting with a neutered dog or cat (OR, 2.14; 95% CI, 1.02 to 4.73; P = 0.032) and less likely to be interacting with a purebred dog or cat (OR, 0.4; 95% CI, 0.2 to 0.7; P = 0.002).

Case subjects interacted with significantly (P = 0.006) older dogs and cats (median, 9 years; range, 0.33 to 16 years), compared with control subjects (median, 6 years; range, 0.17 to 18 years). The OR for each year increase in age was 1.09 (95% CI, 1.02 to 1.17, P = 0.009).

Case subjects were more likely to have been interacting with dogs and cats that appeared aggressive (OR, 6.5; 95% CI, 2.6 to 16.9), anxious (OR, 3.0; 95% CI, 1.6 to 5.8), or high strung (OR, 2.7; 95% CI, 1.3 to 5.6).

Case subjects were more likely to believe that the dog or cat had the potential to bite (OR, 4.2; 95% CI, 2.1 to 8.2) or believed they were rushed in their responsibilities (OR, 2.2; 95% CI, 1.0 to 4.7). The median number of hours (4.5 hours; range, 0.25 to 17.5 hours) case subjects worked during the day before the interaction was significantly (P = 0.001) greater, compared with control subjects (3.0 hours; range, 3 to 17 hours). Case subjects believed their workload was heavy (OR, 1.8; 95% CI, 0.99 to 4.7), compared with control subjects; however, the difference was not significant (P = 0.05).

There was a significant association between case subjects and whether the dog or cat had ever been muzzled during its hospitalization (OR, 2.9; 95% CI, 1.3 to 6.6). Fifty-five percent (95% CI, 36 to 72%) of dogs and cats that appeared aggressive, 33% (95% CI, 19 to 48%) that appeared high strung, 29% (95% CI, 20 to 39%) that appeared anxious, 37% (95% CI, 24 to 52%) that were difficult to handle, and 47% (95% CI, 34 to 61%) that the caregiver believed might bite were muzzled. Case subjects indicated more frequently that a dog or cat was difficult to handle (OR, 5.9; 95% CI, 2.8 to 12.7) and had signs indicating that it might bite (OR, 4.9; 95% CI, 2.4 to 9.8).
There was a significant association between case subjects and whether someone else knew that a dog or cat had the propensity to bite (OR, 5.46; 95% CI, 2.62 to 11.50; *P* < 0.001) or had a warning sign in the medical record indicating the propensity to bite (OR, 2.88; 95% CI, 1.08 to 7.80; *P* = 0.016). There was a significant (*P* < 0.001) association between case subjects and a warning sign on the cage indicating the propensity to bite (OR, 7.19; 95% CI, 2.83 to 19.71). There was no significant association between case subjects and whether the owner had warned that the dog or cat might bite (OR, 2.48; 95% CI, 0.85 to 7.33), although this association approached significance (*P* = 0.057).

There were 7 variables regarding the procedure that was being performed during the interaction between case subjects and dogs and cats, and there was no significant association between case subjects and most of these variables. There was no significant association between case subjects and whether the procedure was 1 of multiple painful procedures that had been performed on the dog or cat (OR, 2.07; 95% CI, 0.91 to 4.65), although this association approached significance (*P* = 0.054). There was a significant (OR = 0.026) association between case subjects and whether the procedure was performed on a caged dog or cat (OR, 2.16; 95% CI, 1.02 to 4.54).

Duration of restraint of the dog or cat was significantly (*P* < 0.001) shorter for case subjects (median, 4 minutes; range, 0.5 to 90 minutes) than for control subjects (median, 10 minutes; range, 0.5 to 270 minutes). Case subjects were not more likely than control subjects to be associated with dogs and cats that were not restrained, although the difference between these 2 groups approached significance (OR, 2.0; 95% CI, 0.94 to 4.0).

Multivariable analysis—Forty-one variables met the criteria from the univariable analyses for initial inclusion in the final multivariable model. Only 4 variables were retained in the final model (Table 1). None of the plausible interaction terms that considered all combinations of 2 variables met the criteria for inclusion. The final model was determined by 194 observations. The overall *χ*² test statistic of the model was 49.87 (4 df; *P* < 0.001). The Hosmer-Lemeshow goodness-of-fit *χ*² test statistic was 9.22 (8 df; *P* = 0.324) indicating an adequate fit to the data.

The odds of being bitten by a dog or cat that had a warning sign on its cage indicating the propensity to bite were 5.0 times greater than the odds of being bitten by a dog or cat (with respect to the other covariates in the model) without a warning sign. The odds of being bitten increased with age of the dog or cat.

There were 7 instances in which the same caregiver was included as a case and control subject. Therefore, the analyses were performed twice, including and excluding these 7 caregivers. Excluding the 7 caregivers resulted in inclusion of a variable in the initial analysis of the multivariable model. However, the backward selection process excluded this variable and the variable concerning age of the dog or cat from the final model.

### Discussion

Typically, there are from 80 to 115 bite wounds reported each year at our veterinary teaching hospital, and many bites may be unreported. Occupational exposure to bite wounds in our study population accounts for the anatomic distribution of bite wounds and is different from that of the general population or for children. In our study, most (93%) bite wounds were on the hand, finger, or wrist. In the general population, most (43%) bite wounds involve the lower extremities, whereas in children, most (60%) bite wounds involve the face, head, and neck. Occupational exposure explains why caregivers in our study reported being bitten more frequently as adults than as children. In the general population, male children are most often bitten. We had several hypotheses about risk factors for bite wounds in our study population. Of these, only the percentage of a typical day the caregiver was in direct contact with dogs and cats was significant, but only in the univariable analysis. The loss of this variable and others that were significant from the univariable analysis does not necessarily indicate that these variables may not be independently associated with being bitten. The number of case subjects that were included in our study was lower than the initial sample size analysis. The post hoc power analysis revealed a power of 0.6 to detect an odds ratio of 2.0 if the exposure proportion in the control population ranged from 0.3 to 0.6. The lower power in our study makes interpretation of the findings more difficult.

Four variables were significantly associated with being bitten in the multivariable analysis: species (dog or cat), age of the dog or cat, a warning sign on the cage, and the dog or cat being difficult to handle. Case subjects were more likely to be interacting with cats than dogs. However, veterinarians in small animal practice report being bitten more often by dogs than by cats. The reason for the difference is unknown.

The risk of a dog or cat biting increased with age. For each 1-year increase in age, there was a 10% greater chance of biting. There is little information regarding the association of a dog’s age and its propensity to bite. Most dogs with a behavioral diagnosis of dominance aggression are socially mature; however, this may vary between male and females, with females having dominance aggression at a younger age (range, 8 weeks to 11 months).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted odds ratio</th>
<th>95% CI</th>
</tr>
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<tbody>
<tr>
<td>Difficult to handle</td>
<td>3.9</td>
<td>1.8, 8.5</td>
</tr>
<tr>
<td>Age of dog or cat</td>
<td>1.1</td>
<td>1.0, 1.2</td>
</tr>
<tr>
<td>Species (cats)</td>
<td>2.4</td>
<td>1.2, 4.8</td>
</tr>
<tr>
<td>Warning sign on cage</td>
<td>5.0</td>
<td>1.3, 13.8</td>
</tr>
</tbody>
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Cl = Confidence interval.
and cats that subject cases interacted with was 9 years, which is greater than the age of the dogs when the initial diagnosis of dominance aggression was made.

A warning sign on the cage indicating the potential to bite was 1 of the strongest variables in the multivariable analysis. There are different ways to interpret why a warning sign on a cage would be more likely to be associated with a caregiver being bitten. Dogs and cats that were considered the most likely to bite were more likely to have signs placed on their cages. Alternatively, the warning sign may change the behavior of the caregiver toward the dog or cat. Warniness or anxiety of the caregiver may increase the risk of being bitten, or it could be a combination of these factors.

Dogs and cats that were difficult to handle were also more likely to be associated with case subjects. We believed that caregivers would take more precautions, such as muzzling, when handling these dogs and cats; however, only 37% were muzzled. Failure to muzzle dogs and cats with characteristics traditionally associated with the propensity to bite was a consistent finding in our study. The questionnaire asked caregivers to answer questions regarding the animal’s propensity to bite before they were bitten; therefore, it was difficult to prevent the outcome from influencing the answers and causing bias. Nevertheless, our study found that dogs and cats that appear likely to bite are the ones that bite.

There were 7 caregivers who were included in the study as case and control subjects. Initially, we hypothesized that a bite incident was a sudden event determined by the immediate circumstances. Nevertheless, we did obtain information on certain long-term characteristics of the caregivers such as whether they liked cats or dogs, ethnicity, household income, gender, and age, and including in the analysis those caregivers that were both case and control subjects would introduce a bias for these variables. For this reason, the analyses were performed with and without the 7 caregivers that were in both groups. There was no change with respect to our conclusions concerning the long-term characteristics of the caregiver. However, age of the dog or cat was removed from the final model when the 7 caregivers were not included. This may have been a consequence of loss of statistical power, and for that reason, we chose to leave this variable in the final model.

There were limitations in our study. First, case subjects were derived from caregivers who reported bite wounds. There may have been caregivers who were bitten during the study period who did not report the bite incident. There may have been common characteristics with the caregivers or interactions with dogs or cats that may have caused caregivers to not report the incident. This may have resulted in a biased population of case subjects that may have affected our results and conclusions; however, it was difficult to determine which direction this bias may have taken.

Although we believed that being bitten was the result of a sudden interaction more likely to be dependent on the immediate circumstances, long-term characteristics of caregivers cannot be disregarded. Although we did not find a significant difference between case and control subjects regarding duration of their experience in veterinary medicine and at the teaching hospital, questions regarding type and quality of experience of the caregivers in animal handling were not included on the questionnaire and may have influenced the outcome.

Studies involving questionnaires are subject to recall bias. It is likely that case subjects would remember the interaction. However, we were unable to detect recall bias and are unwilling to speculate about the direction of recall bias if it were noticed, particularly given that the duration between the interaction and completing the questionnaire for the case subjects was greater than for control subjects.

References