

Community rabies knowledge and pet vaccination practices after a skunk rabies outbreak in Eddy County, New Mexico

Carrie S. McNeil, DVM, MPH; Samantha Nagy; Catherine Moonan; Ryan M. Wallace, DVM, MPH; Neil M. Vora, MD; Jessie L. Dyer, MSPH; Jesse D. Blanton, MPH; Tina Dorado; Mark L. Heinrich, DVM, MS; Robin Sankey, DVM; Samantha Uhrig, DVM, MS; Angela Cary; Woods Houghton; Paul Ettestad, DVM, MS

Objective—To determine percentages of domestic cats and dogs vaccinated against rabies, identify barriers to vaccination, and assess knowledge about rabies in a semirural New Mexico community after a skunk rabies outbreak.

Design—Cross-sectional, door-to-door, bilingual, community-based participatory survey.

Sample—366 residential properties in Eddy County, NM.

Procedures—The New Mexico Department of Health and CDC administered surveys and analyzed data.

Results—Individuals at 247 of the 366 residential properties participated in the survey. One hundred eighty of the 247 (73%) households owned a dog ($n = 292$) or cat (163). Cats were more likely than dogs to not have an up-to-date rabies vaccination status (prevalence ratio, 3.2; 95% confidence interval, 2.3 to 4.4). Cost and time or scheduling were the most frequently identified barriers to vaccination. One hundred sixty (65%) respondents did not know livestock can transmit rabies, 78 (32%) did not know rabies is fatal, and 89 (36%) did not know a bat scratching a person can be an exposure. Only 187 (76%) respondents indicated they would contact animal control if they saw a sick skunk, and only 166 (67%) indicated they would contact animal control if bitten by a dog they did not own.

Conclusions and Clinical Relevance—Findings indicated that rabies vaccination prevalence among pet dogs and cats was low, despite the fact that the region had experienced a skunk rabies outbreak during the previous 2 years. In addition, substantial percentages of respondents did not have correct knowledge of rabies or rabies exposure. (*J Am Vet Med Assoc* 2015;246:1242–1247)

In 2011 and 2012, Eddy County, NM, experienced an unprecedented skunk rabies outbreak, with 41 skunks, 1 horse, 2 raccoons, 4 foxes, 3 bats, and 2 dogs testing positive for rabies during this period. In con-

From the Epidemic Intelligence Service (McNeil, Wallace, Vora), Public Health Associate Program (Nagy, Moonan), and Poxvirus and Rabies Branch (Dyer, Blanton), CDC, 1600 Clifton Rd, Atlanta, GA 30333; City of Carlsbad Animal Control, 602 W Mermod St, Carlsbad, NM 88220 (Dorado); Carlsbad Animal Clinic, 103 E Blodgett St, Carlsbad, NM 88220 (Heinrich); Animal Care Center, 1302 Canal St, Carlsbad, NM 88220 (Sankey); Desert Willow Veterinary Services, 512 E Fiesta Dr, Carlsbad, NM 88220 (Uhrig); Noah's Ark Animal Shelter, 5217 Buena Vista Dr, Carlsbad, NM 88220 (Cary); Eddy County Agriculture Extension Agent, 1304 W Stevens, Carlsbad, NM 88220 (Houghton); and New Mexico Department of Health, 1190 St Francis Dr, Santa Fe, NM 87505 (Ettestad). Dr. Sankey's present address is Animal Ophthalmology Clinic, 4444 Trinity Mills Rd, Ste 201, Dallas, TX 75287. Dr. Dyer's present address is Department of Anthropology, University of Georgia, Athens, GA 30602.

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Address correspondence to Dr. McNeil (mcneilca@yahoo.com).

ABBREVIATIONS

CI	Confidence interval
PR	Prevalence ratio

trast to the 41 rabid skunks identified during 2011 and 2012, only 28 skunks from Eddy County tested positive for rabies during the entire 45-year period prior to the 2011–2012 skunk rabies outbreak. Most of these animals were tested because of a potential human or domestic pet exposure, and in this region, wild animals were typically tested only in response to an exposure, not as a routine surveillance mechanism.

Most of the rabid skunks identified during the 2011–2012 outbreak had been killed by or fought with family-owned pets in or around household yards. During these years, at least 85 cats and 49 dogs were euthanized after exposure to animals suspected to be rabid because the exposed cats and dogs did not have a current rabies vaccination status and the owners elected not to have them subjected to a 6-month quarantine. Also during the outbreak, 29 county residents received postexposure prophylaxis, the direct costs of which exceeded \$100,000 as estimated by the New Mexico Department of Health. Animal control calls increased substantially during the outbreak, with the 3 animal control officers for the city of Carlsbad, NM, respond-

ing to approximately 400 to 500 calls each month during the outbreak.

Under state law in New Mexico, dogs and cats are required to be vaccinated against rabies at 12 weeks of age, 1 year after initial vaccination, and then every 3 years.¹ Carlsbad requires dogs and cats to be licensed annually, granting licenses only to pet owners with certification of current rabies vaccination.² Eddy County does not require dogs and cats to be licensed, but requires owners to keep copies of rabies vaccination certificates for their dogs and cats and to affix a rabies tag to their pets when they leave the owner's property.³ Two small animal hospitals and 1 large animal practice provide veterinary services for the area. The local shelter provides a reduced-cost voucher for spaying or neutering and rabies vaccination of animals adopted from the shelter; an estimated 80% of vouchers are redeemed. Despite these policies and available services, the outbreak demonstrated that substantial numbers of pets lacked an up-to-date rabies vaccination status. Maintenance of an up-to-date vaccination status in compliance with state requirements would have minimized the risk of rabies transmission from unvaccinated domestic pets to humans, prevented the necessity of euthanizing animals after exposure to potentially rabid wildlife, and lessened the burden on local animal control and public health agencies that facilitated administration of postexposure prophylaxis. Pet vaccination would not, however, have decreased the risk to residents associated with exposure to wildlife.

A limited number of studies have evaluated rabies vaccination prevalence through pet owner interviews. A 2009 mailed survey of pet owners in Flagstaff, Ariz, found that 96% of dogs, 90% of outdoor cats, and 76% of indoor cats had been vaccinated.⁴ A Brazos County, Tex, telephone survey conducted during the same year found that dogs aged 4 to 15 months were less likely to be vaccinated against rabies.⁵ That study⁵ also found an increase in vaccination prevalence after the state implemented a 3-year rabies vaccine policy. Community knowledge about rabies exposure has varied in previous studies. An Arizona study⁴ found that 97% of both pet owners and individuals who did not own pets knew that rabies was transmitted through bites, 74% knew that it was transmitted through contact with saliva, and 73% knew that it was transmitted through scratches. However, fewer persons indicated they were likely to seek medical care if bitten by a domestic animal than if they were bitten by a wild animal. Most also reported they would contact animal control or other agencies if bitten or scratched. A study⁶ in Texas found that 86% of all respondents would report being bitten by a dog they did not know. Women, persons living within city limits, and persons > 65 years old were more likely to report a dog bite; dog ownership, however, did not change the percentage of persons reporting a bite. In the Arizona survey⁴ of both dog owners and individuals who did not own pets, only 59% knew that rabies can lead to death without treatment.

The 2011–2012 Eddy County skunk rabies outbreak highlighted the need to systematically assess vaccination prevalence and to more fully understand community knowledge about rabies. The present study

was designed to elicit collaboration among community stakeholders (animal control officials, city and county policymakers, agricultural extension personnel, animal shelter staff members, health department officials, and local veterinarians) in addressing these concerns. While many stakeholders were pet owners, pet owners were not separately represented in the stakeholder group. Specifically, the purposes of the study reported here were to determine percentages of domestic dogs and cats within the Carlsbad Soil and Water Conservation District (the area within Eddy County where the 2011–2012 rabies outbreak occurred) that had been vaccinated against rabies, identify barriers to vaccination, and assess the level of knowledge about rabies among adult residents living within the Carlsbad Soil and Water Conservation District.

Materials and Methods

At the time of the study, Eddy County was 90% rangeland and had a population of 54,419 (5.0 persons/km²). However, most residents (26,296 persons; 356.2 persons/km²) lived in the city of Carlsbad.

The study used a community-based participatory research protocol, which requires community partnership from study design through interpretation of results.⁷ Community stakeholders identified the need for this project, assisted in designing survey questions, and provided guidance in survey administration. Stakeholders included staff from the city of Carlsbad, Eddy County Animal Control, the local agricultural extension office, the local animal shelter, the Carlsbad office of the New Mexico Department of Health, and the 3 local veterinary practices.

With the aid of statistical analysis software,^a 366 residential properties were randomly selected from the 11,976 residential addresses within the Carlsbad Soil and Water Conservation District, the area in Eddy County where the 2011–2012 rabies outbreak had occurred (Figure 1). Sample size was determined on the basis of the likelihood of detecting a 7% difference in proportions between dichotomous categories with 95% confidence and a design effect of 1, assuming, on the basis of local stakeholder estimates, that 80% of residents owned pets and that 70% would respond to the survey. To increase response rate, a presurvey outreach campaign was conducted from December 2012 through January 2013. This campaign consisted of strategically posting flyers, mailing notices with the city water bill, and messaging through local media and stakeholder social media. The survey was pilot tested in conversational Spanish and English before administration.

From January 23 through February 2, 2013, after completion of standardized training, staff from the New Mexico Department of Health and the CDC conducted a read-aloud, door-to-door, 31-question survey. After learning from stakeholders that a substantial number of persons in the community worked alternate shifts in oil fields, mines, and ranches, a goal was made to visit each residence up to 6 times at different times of the day and different days of the week. The Carlsbad Police Department provided insight with regard to homes unsafe to visit. Bilingual notices about the survey were

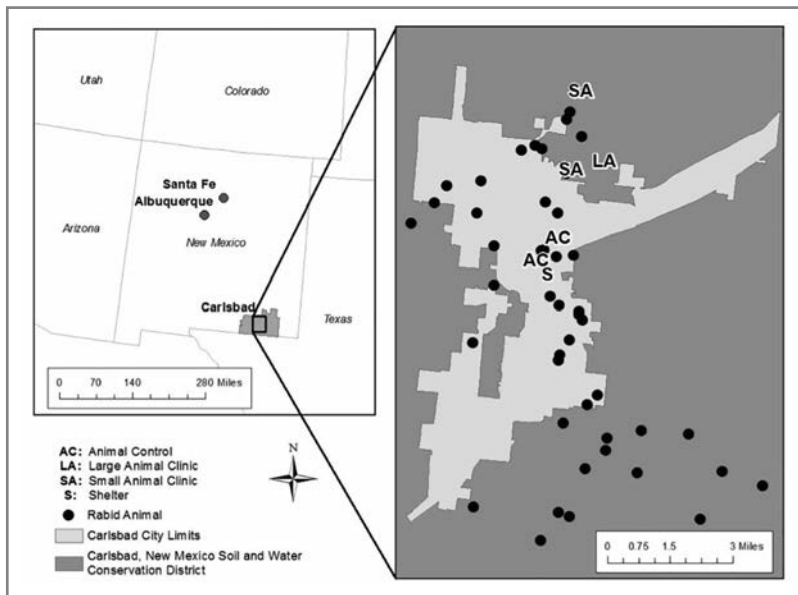


Figure 1—Map of the Carlsbad Soil and Water Conservation District, which experienced a skunk rabies outbreak during 2011–2012, showing location of rabid animals identified during the outbreak.

left when no one was home. Household members aged < 18 years and persons who were not full-time residents were excluded from participating. An information card, including rabies facts and contact information for animal control personnel, veterinarians, and the local animal shelter, was provided to respondents after survey completion. For survey questions asking about pets' rabies vaccination status, up-to-date rabies vaccination status was defined as having received a rabies vaccine within the previous 3 years, regardless of the pet's age or history of receiving an initial booster vaccination at 1 year of age.

Prevalence ratios were calculated to measure the strength of associations. Qualitative data were collected in writing by interviewers in response to an open-ended question asking respondents to share additional comments about rabies in the community, and were evaluated by categorizing comments according to topics. Consistent with community-based participatory research protocols, results were presented to stakeholders for interpretation and development of locally appropriate, community-based recommendations. Because human subjects were involved, the study protocol was reviewed by the CDC but was considered to be public health practice rather than human subjects research.

Results

Individuals were contacted at 277 of the 366 (76%) residential properties selected for inclusion in the study. Of the 277 individuals who were contacted, 247 (89%) completed the survey, 2 (1%) were disqualified because they were nonresidents, and 28 (10%) declined to participate.

Fifty-six percent (138/246) of respondents were women. Median age of the respondents was 50 years (interquartile [25th to 75th percentile] range, 17 years; range, 18 to 97 years), and 74% (184/247) lived in Carls-

bad. Sixty-eight percent (167/247) of respondents did not have a college degree, 31% (77/247) were Hispanic, 58% (144/247) were non-Hispanic white, and 73% (180/247) were pet owners. Of the 89 residential properties for which contact was not made, 68 (76%) were households at which no one answered the door, 17 (19%) were unoccupied houses, and 4 (4%) were houses that were not contacted because of police-identified safety risks.

Vaccination prevalence and barriers to vaccination—Among the 180 pet-owning households responding to the survey, 52 (29%) reported that not all pets had an up-to-date rabies vaccination status. Pet-owning respondents without a college degree (119/180 [66%]) were significantly more likely (PR, 2.0; 95% CI, 1.1 to 3.6) to have pets without an up-to-date vaccination status, compared with pet-owning respondents with a college degree or higher (61/180 [34%]).

A higher percentage of households with dogs for pets (133/160 [83%]) had an up-to-date rabies vaccination status, compared with households with cats for pets (28/62 [45%]) and households with dogs and cats for pets (20/42 [48%]). Only 43% (18/42) of households leaving food outside overnight for their own pets and 36% (12/33) leaving food out for strays or wildlife reported that all of their pets had an up-to-date rabies vaccination status.

Overall, 292 dogs and 163 cats were owned by the 180 pet-owning households that responded to the survey. Of the 455 dogs and cats, 116 (25%) were reported to not have an up-to-date vaccination status. Cats (74/163 [45%]) were significantly more likely than dogs (42/292 [14%]) to not have an up-to-date vaccination status (PR, 3.2; 95% CI, 2.3 to 4.4; Table 1). Vaccination prevalence was not significantly different between urban (ie, within the city of Carlsbad) and rural (ie, within unincorporated portions of the county) pets (PR, 1.0; 95% CI, 0.7 to 1.4).

Pets allowed to roam freely were more likely (PR, 2.7; 95% CI, 2.0 to 3.7; Table 1) to not have an up-to-date vaccination status than were pets that were not allowed to roam, and pets housed primarily outside were more likely (PR, 1.4; 95% CI, 1.1 to 2.1) to not have an up-to-date vaccination status than were pets housed primarily inside. Sexually intact pets were more likely (PR, 4.5; 95% CI, 3.0 to 6.7) to not have an up-to-date vaccination status than were neutered pets.

Respondents most frequently identified cost (81/245 [33%]) and time or scheduling (52/246 [21%]) as barriers that prevented themselves or their neighbors from vaccinating pets against rabies; 14% (35/245) did not believe any barriers to obtaining rabies vaccinations were encountered. Analysis of qualitative data suggested that time and scheduling posed unique challenges for rural residents, who often had to drive as much as an hour each way to a veterinary clinic. Even though rural residents may have made routine trips to the city, those trips may not have coincided with clinic hours.

Table 1—Factors associated with pet dogs and cats in Eddy County, NM, not having an up-to-date rabies vaccination status.

Variable	No. (%) of animals not up-to-date	PR (95% CI)
Species		
Cat (n = 163)	74 (45)	3.2 (2.3–4.4)*
Dog (n = 292)	42 (14)	Referent
Roaming		
Roams freely (n = 114)	55 (48)	2.7 (2.0–3.7)*
Not allowed to roam (n = 340)	60 (18)	Referent
Housing		
Outside (n = 255)	76 (30)	1.4 (1.1–2.1)*
Primarily inside (n = 200)	40 (20)	Referent
Neuter status		
Not spayed or neutered (n = 132)	59 (45)	4.5 (3.0–6.7)*
Spayed or neutered (n = 295)	30 (10)	Referent
Residency		
Unincorporated county (n = 157)	41 (26)	1.0 (0.7–1.4)
City of Carlsbad (n = 298)	75 (25)	Referent

*Prevalence ratio was significantly ($P < 0.05$) different from 1 (ie, the 95% CI did not include 1).

Data were obtained through a survey administered to residents (n = 245) of Eddy County, NM, which had experienced a skunk rabies outbreak during the preceding 2 years; not all respondents answered all questions. Up-to-date rabies vaccination status was defined as having received a rabies vaccine within the previous 3 years, regardless of the pet's age or history of receiving an initial booster vaccination at 1 year of age.

Knowledge of and attitudes about rabies, rabies vaccination, and wild animal exposure—Of the 247 respondents, 222 (90%) correctly identified raccoons, skunks, cats, dogs, coyotes, and foxes as species capable of transmitting rabies. However, 161 (65%) did not know horses and cattle can also transmit rabies. A total of 226 of 245 (92%) respondents knew that unvaccinated pets can contract rabies. However, 79 of 246 (32%) respondents did not know that rabies vaccination was required by law, 89 (36%) did not know a bat scratching a person can be an exposure, 45 (18%) did not know a dog playing with a bat can be an exposure, and 106 (43%) did not correctly identify both of these as exposures. Overall, 78 of 245 (32%) respondents did not know rabies is fatal.

Of the 247 respondents, 169 (68%) had heard about the rabies outbreak through 1 or more sources (multiple answers allowed). Respondents cited newspapers (100/169 [59%]), television (38/169 [22%]), and family or friends (31/169 [18%]) as the most common sources. Among the 9 of 169 (5%) respondents who had learned about rabies through the radio, almost all lived in unincorporated rural areas. When asked which sources were the most trusted to learn about rabies (multiple answers allowed), respondents identified veterinarians (210/246 [85%]) as the most trusted, followed by animal control officials (140/246 [57%]), public health officials (124/246 [50%]), television (120/246 [49%]), newspaper (119/246 [48%]), radio (91/246 [37%]), and the Internet (90/246 [37%]). Pet owners (94/180 [52%]) were significantly less likely than those not owning pets (46/67 [69%]) to list animal control officials as a most trusted source.

Fewer than half of pet owners (79/180 [44%]) but most non-pet owners (47/67 [70%]) stated the top reason for vaccinating pets was because people might get rabies. A significantly higher percentage of pet owners

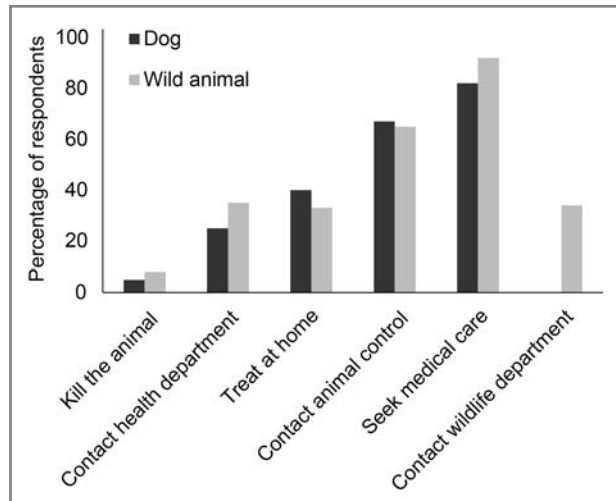


Figure 2—Actions respondents (n = 245) to a survey about rabies knowledge would take in response to a bite by a wild animal (gray bars) or a dog they did not own (black bars; multiple answers were allowed); the survey was administered to residents of Eddy County, NM, which had experienced a skunk rabies outbreak during the preceding 2 years.

(70/180 [39%]) than non-pet owners (10/67 [15%]) answered that the top reason was concern that a dog might get rabies. The primary reason given by other respondents for vaccinating included legal requirements (18/180 [10%] pet owners and 9/67 [13%] non-pet owners) and veterinarian recommendation (5/180 [3%] pet owners).

Respondents were asked to indicate what actions they would take if bitten by a wild animal or a dog they did not own (multiple answers were allowed). Most indicated that they would seek medical treatment and contact animal control officials (Figure 2). Some respondents stated they would kill the animal as a write-in response. Qualitative data revealed a substantial number of respondents who answered that they would seek medical treatment knew that doctors were required to report animal bites to animal control.

Respondents were allowed only 1 answer when asked how they might respond to finding a sick bat or a sick skunk. The most common answers were to contact animal control (187/246 [76%] for a sick skunk and 170/246 [69%] for a sick bat) and to kill it (46/246 [19%] for a sick skunk and 46/246 [19%] for a sick bat). Limited qualitative responses suggested that respondents who would kill a sick skunk or bat would usually not contact animal control.

Discussion

In the present study, only 75% (339/455) of pet dogs and cats had a current rabies vaccination status (ie, had received a rabies vaccine within the past 3 years), and all pets had a current rabies vaccination status in only 71% (128/180) of pet-owning households. This was despite the fact that the study was conducted in an area that had just experienced a 2-year outbreak of skunk rabies during which dozens of unvaccinated pets were euthanized after potential exposures. This was well below the postoutbreak rabies vaccination

prevalence of 90% in a Flagstaff, Ariz, study⁴ and indicated a need for increased education about the benefits of rabies vaccination of pet dogs and cats. Several factors (ie, pet species [cat vs dog], allowing pets to roam freely, housing pets outdoors, and not having pets spayed or neutered) were associated with a lower rabies vaccination prevalence, and households that left food outside overnight for pets, strays, or wildlife were more likely to have 1 or more pets that were not up-to-date on their rabies vaccinations.

Similar to findings of a previous study,⁴ only 68% (167/245) of respondents in the present study knew that rabies is fatal. Individuals who are not aware of the serious consequences of rabies might not call about possible exposures or seek medical care. Although the community generally was knowledgeable about species of animals that can transmit rabies, a substantial percentage of respondents were unaware that livestock can transmit rabies. Increasing awareness regarding rabies transmission among livestock owners is important, not only for herd protection but also to protect persons working with livestock.

In New Mexico, potential rabies exposures are addressed when animal control is contacted by an exposed person, a medical provider caring for an exposed person, or a veterinarian caring for an exposed pet. We found certain exposures can go unreported, including bat scratches to persons, dogs playing with bats, dog bites, wild animal bites, and sightings of sick skunks and sick bats. More respondents reported that they would seek medical care rather than contact animal control after a dog bite exposure; therefore, reporting by medical providers is critical for exposure identification.

The study had several findings unique to a rural community. Certain residents were accustomed to depredation practices and shared that they would kill suspect animals without calling animal control. Because of the distances across the county, waiting multiple hours for animal control to kill a sick skunk or bat that is interacting with pets or livestock is often not a viable option. We identified a need for public education to ensure persons contact animal control, even if they kill the suspected rabid animal, to allow animal control personnel to determine whether an exposure occurred and whether the animal needs to be tested for rabies.

Limitations of the study included that vaccine rates and pet details were based on owner recall and might have been subject to social desirability bias. Additionally, 24% (59/247) of respondents did not provide income data, and consequently, education level was the only socioeconomic status variable included in analyses. Selection bias was possible owing to the presurvey outreach that was done; however, it was difficult to discern the impact of any bias, given that presurvey outreach was bilingual and through general public information sources. During the random selection of residential parcels, no multiunit properties were selected; therefore, our findings reflect rabies knowledge and vaccination practices of single-family households and not of apartments or mobile home park households. The percentage of respondents who did not know rabies is fatal might be inaccurate because the question did not specify that we were asking about rabies with-

out postexposure prophylaxis treatment. While many stakeholders were pet owners, the solutions developed by the stakeholder team may have been limited by not including additional pet owner representation.

The community-based participatory research approach we used provided a unique opportunity for stakeholders to work together to interpret the findings and identify an action plan to strategically approach gaps that were identified. To increase rabies vaccination prevalence, community stakeholder partners subsequently implemented measures to improve rabies vaccination rates in the community. For example, small animal practices required that dogs and cats have an up-to-date rabies vaccination status before any procedures were performed; the local animal shelter provided free rabies vaccination vouchers for adopted dogs and cats that could be redeemed at local veterinary clinics after adoption; stakeholders agreed to develop an annual multiagency outreach campaign highlighting the importance of vaccinating both dogs and cats against rabies at 12 weeks of age, 1 year, and then every 3 years; and the 3 veterinary clinics agreed to collaborate on an annual vaccination clinic for the community.

To address knowledge gaps associated with rabies in the community, stakeholders began conducting outreach through their own agencies and education programs in local schools in April 2013. To ensure correct responses to potential rabies exposure and accurate dissemination of public rabies information, stakeholders recommended ensuring animal control and wildlife field personnel receive appropriate training on these topics. In addition, the stakeholders designated an annual rabies awareness month, with plans to distribute educational messages through billboards, stickers on pet food bags in stores, and social media messaging during the month and to promote increased media attention to the importance of dog and cat rabies vaccination. Consensus messaging was developed by the group to ensure that key knowledge gaps were addressed across all constituent groups.

We believe that the community-based participatory research approach used in the present study helped us identify how the community can best reduce future exposure risk through increased vaccination prevalence, can expand awareness of what constitutes an exposure and how to best address exposures, and can enhance knowledge about the risks of rabies. We recommend future evaluation of rabies knowledge and vaccination practices to understand how effective the action steps and outreach campaign planned by the community stakeholder group have been.

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From this month's *AJVR*

Serotonin concentrations in plasma and serum and associated with activated platelets in Cavalier King Charles Spaniels with myxomatous mitral valve disease

Signe E. Cremer et al

Objective—To investigate serum and plasma serotonin concentrations, percentage of serotonin-positive platelets, level of surface-bound platelet serotonin (mean fluorescence intensity [MFI]), and platelet activation (CD62 expression) in platelet-rich plasma from Cavalier King Charles Spaniels with myxomatous mitral valve disease (MMVD).

Animals—Healthy dogs (n = 15) and dogs with mild MMVD (18), moderate-severe MMVD (19), or severe MMVD with congestive heart failure (CHF; 10).

Procedures—Blood samples were collected from each dog. Serum and plasma serotonin concentrations were measured with an ELISA and platelet surface-bound serotonin concentration and platelet activation were determined by flow cytometry.

Results—Dogs with mild MMVD had higher median serum (746 ng/mL) and plasma (33.3 ng/mL) serotonin concentrations, compared with MMVD-affected dogs with CHF (388 ng/mL and 9.9 ng/mL, respectively), but no other group differences were found. Among disease groups, no differences in surface-bound serotonin concentration or platelet activation were found. Thrombocytopenic dogs had lower serum serotonin concentrations (482 ng/mL) than nonthrombocytopenic dogs (731 ng/mL). In 26 dogs, a flow cytometry scatterplot subpopulation (FSSP) of platelets was identified; dogs with an FSSP had a higher percentage of serotonin-positive platelets (11.0%), higher serotonin-binding level (MFI, 32,068), and higher platelet-activation level (MFI, 2,363) than dogs without an FSSP (5.7%, 1,230, and 1,165, respectively). An FSSP was present in 93.8% of thrombocytopenic dogs and in 29.5% of nonthrombocytopenic dogs.

Conclusions and Clinical Relevance—A substantive influence of circulating serotonin on MMVD stages prior to CHF development in Cavalier King Charles Spaniels was not supported by the study findings. An FSSP of highly activated platelets with pronounced serotonin binding was strongly associated with thrombocytopenia but not MMVD. (*Am J Vet Res* 2015;76:520–531)



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