# EVALUATION OF A CANINE RABIES VACCINATION CAMPAIGN AND CHARACTERIZATION OF OWNED-DOG POPULATIONS IN THE PHILIPPINES

Laura E Robinson[1], Mary Elizabeth Miranda[2], Noel L Miranda[2] and James E Childs[1]

[1]Viral and Rickettsial Zoonoses Branch, Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia 30333 USA; [2]Research Institute for Tropical Medicine, Department of Health, Alabang, Muntinlupa, Metro Manila, Philippines 1770

**Abstract.** A mass canine rabies vaccination campaign in Sorsogon Province, the Republic of the Philippines, was conducted in April and May 1993. From 1 to 14 days following visits by vaccination teams to 30 selected villages (barangays), survey teams revisited the barangays to assess vaccine coverage. Modified cluster survey methods were used to gather information about vaccine coverage in the owned-dog population (210 households) and about characteristics of owned-dogs and factors influencing owner willingness to participate in the campaign. Vaccinated dogs were identified by asking owners about receipt of certificates given by the vaccinating teams and examining each animal for a special collar or paint mark placed on the animal at the time of vaccination.

Survey results indicated that 73% (178/243) of eligible dogs were vaccinated and 82% of vaccinated dogs were marked with a collar or paint. Dogs were owned by 69% of households and ranged in age from 3 days to 13 years (median = 1 year), and the ratio of male to femles dogs was 1 : 1. The dog-to-human ratio was 1 : 3.8, with an average of 1.4 dogs per household or 2.1 dogs per dog-owning household. Most dogs were kept as guards (83%) and most were free-ranging (85%). The most common reasons dogs were not vaccinated included they could not be restrained (11/64), the owner was not home (10/64), and fear of injury resulting from vaccination (10/64). The owners of 20% of vaccinated dogs reported some adverse reaction in their pet. Improved vaccine coverage was significantly associated with restrained dogs kept primarily for guard functions by owners who received information about the vaccination campaign from multiple sources. Vaccine coverage was sufficiently high to potentially control rabies transmission among dogs through herd immunity and indicated a successful vaccine campaign.

## INTRODUCTION

Most human deaths from rabies worldwide occur in developing countries with endemic canine rabies (WHO, 1992). Rabies control programs have shown that vaccination of 60% to 80% of dogs can eliminate dog-to-dog transmission of virus and prevent human rabies cases in these areas (Chomel *et al*, 1988; Beran, 1982). In Lima, Peru, a single administration of a tissue culture derived vaccine delivered to 270,000 dogs over a period of 1 month was sufficient to eliminate canine rabies for a period of 6 years (Chomel *et al*, 1988). In the Philippines, a country with one of the highest incidences of human rabies in the world (6 per $10^6$ population) (Miranda and Miranda, 1993), elimination of rabies through vaccination is an achievable goal because the only rabies reservoir in that country is the domestic dog (Beran *et al*, 1972; Arambulo and Escudero, 1971; Beran, 1982). Approximately 98% of the laboratory-confirmed animal rabies cases are in dogs (Miranda and Miranda, 1993). The island geography of the Philippines, which acts as a barrier to unrestricted movement of animals, is an additional factor that would facilitate the control and elimination of rabies (Miranda and Miranda, 1993; Fishbein *et al*, 1991).

Mass canine rabies vaccination campaigns have been used effectively in many areas to increase the number of vaccinated dogs and to educate the public about the importance of rabies control measures (Chomel *et al*, 1988; Fishbein *et al*, 1992). To adequately plan a vaccination campaign, information is required about the number of dogs in the

Correspondence: Dr James E Childs, Viral and Rickettsial Zoonoses Branch, Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia, 30333 USA.

population, the accessibility of these dogs, and the cultural, social, or economic factors that might influence an owner's decision to allow their dog to be vaccinated (Wandeler *et al*, 1988; Chomel, 1993). Although most efforts and resources have focused on the planning and implementation of the campaign itself, postcampaign assessment is necessary to determine if the targeted percentage of dogs was vaccinated. Evaluation of vaccination campaigns should measure the effectiveness of precampaign advertisements designed to encourage participation and determine vaccination coverage in the owned and stray dog populations.

During April and May 1993, dogs from one Philippine province were vaccinated as a pilot study for a comprehensive rabies elimination program for the Republic of the Philippines. This report summarizes attempts to evaluate the effectiveness of this program in terms of vaccination coverage among owned dogs, to characterize the owned-dog population, and to describe factors affecting community participation in the rabies vaccination campaigns.

## MATERIALS AND METHODS

### Vaccination campaign

Vaccination of dogs was accomplished through the deployment of two-person teams made up of veterinarians and veterinary students, Department of Health sanitarians, Department of Agriculture animal technicians, and other community volunteers. Vaccination occurred at preannounced, centralized locations in large urban centers or by house-to-house visits in small villages (barangays). Starting 1 month prior to the vaccination campaign, repeated educational announcements were made in schools, churches, community assemblies, and through public service broadcasts on local radio stations. Vaccination dates were posted 1 week prior to the campaign, and leaflets with this information were distributed door to door 2 days before the campaign. Posters and pamphlets advertising the campaign were posted or made available in barangay halls, health stations, and other selected locations. Vaccine was an inactivated tissue culture product administered intramuscularly and had a duration of immunity of 3 years. The majority of barangays had fewer than 1,000 residents. The presurvey estimate of the owned-dog population used a dog-to-human ratio of 1 : 5 to plan team logistics; most barangays could be covered by three to ten teams of vaccinators in 1 day.

Vaccination certificates for individual dogs were issued to each dog's owner. In addition, to assess the feasibility for additional studies using mark-recapture methods and to estimate vaccination coverage in the total (owned and stray) dog population, each dog was marked with a special plastic collar and/or a nontoxic paint mark. Dogs were considered eligible for vaccination if they were healthy, 1 month of age or older, and had not been vaccinated for rabies within the last 6 months.

### Cluster survey

The modified WHO Expanded Program on Immunization (EPI) cluster survey technique (Henderson and Sundaresan, 1982; Lemeshow and Stroh Jr, 1988) was used to assess dog ownership, vaccination coverage of owned dogs, and characteristics of the dog population. Thirty clusters were selected from among eligible barangays in Sorsogon Province according to WHO EPI cluster survey recommendations. After the barangays were listed alphabetically, cumulative population subtotals were calculated for each barangay, using the 1990 human population census, and the sampling interval was determined by dividing the total population of the barangays in the study by 30. A barangay was selected if a multiple of the sampling interval fell within its listed cumulative population subtotal. Barangays were visited between 1 day and 2 weeks following their visitation by personnel vaccinating dogs. One barangay selected for inclusion required substitution due to safety concerns related to possible civil unrest in the area.

Two separate surveys were conducted within each cluster: a household survey to determine dog population and household characteristics, and a dog survey to estimate vaccination coverage and collect descriptive data. Household questionnaires were administered to seven households; the index household was randomly selected and subsequent households were selected by their proximity to the index household. Questionnaires collecting dog-specific information were administered to the household owners of the first seven dogs. If fewer than seven dogs were found after completing the seventh household interview, additional dog-own-

ing households were visited until information on at least seven dogs was collected. If the household owning the seventh dog owned additional dogs, information was collected on all dogs in the household.

In addition to household size and composition [adults (> 15 years of age) *vs* children], the household questionnaire asked about the number of dogs owned, and how vaccination campaign information was obtained by the household. Dog questionnaires included questions about the dog's age, sex, length of ownership, source, function within the household, and free-ranging status. If a dog's exact age was unknown, the owner was asked to estimate it to be nearest month for dogs 1 year of age and younger, and to the nearest year for dogs older than 1 year of age. Dog onwers were asked if they had received vaccination certificates, and the presence or absence of vaccination collar and vaccination paint mark was noted on each questionnaire. Owners of vaccinated dogs were asked whether they had noted their dog having any adverse reaction to the vaccine. For dogs that were unvaccinated, owners were asked to provide the reason the dog had not been vaccinated.

**Data analysis**

Data were compiled and coded on standardized forms and entered into an IBM-compatible computer database before analysis. Data from the cluster surveys were analyzed using Epi Info Cluster Sampling Analysis software to calculate the vaccination coverage and odds ratios (OR), as well as 95% confidence intervals (CI) for each variable (Dean *et al*, 1990).

## RESULTS

The 210 households selected were inhabited by 1,131 persons (641 adults and 490 children), and household size ranged from 1 to 14 members (median = 5). A total of 297 dogs were owned by 144 (69%) households, giving an average of 1.4 dogs per household or 2.1 dogs per dog-owning household (range 1 to 9 dogs, median 2 dogs, dog-to-human ratio 1 : 3.8). Households with fewer than five members were less likely to own a dog than were larger households (OR = 0.404, 95% CI 0.22, 0.75). Of the households that did not own a dog at the time of the survey, 89% (59/66) had previously owned a dog and only 7 households had never owned a dog.

Dog population and demographic data were obtained for 256 dogs (Table 1). Dogs' ages ranged from 3 days to 13 years, with a median age of 1 year; 88% were ≤ 4 years of age and 43% were between 3 and 14 months of age. Length of ownership was roughly equivalent to the dog's age since most dogs had been obtained as puppies. The male-to-female dog ratio was approximately 1 : 1. Only 7 of 247 dogs (3%) were reported to have been obtained from a different province and transported to Sorsogon.

Dogs were kept primarily as guard animals (83%), and most dogs were allowed to roam free during the day (85%) and night (84%). Forty-nine percent of dogs had been given to the household, and 38% had been born in the households.

Of the 243 dogs eligible for vaccination, 178 (73%, 95% CI 61.8, 83.1) were reported by their owner as being vaccinated during this campaign. This figure compared very favorably to the estimate of vaccine coverage (75%) generated using the 1 : 5 dog-to-human ratio (estimated 8,224 dogs for the barangays surveyed) and the actually of vaccinated dogs (6,128). However, the concordance of these figures is misleading, since in two barangays the number of vaccinated dogs exceeded the estimated dog population and the estimated vaccine coverage ranged from 26% to 220%. Among the survey dogs, 25% of the vaccinated dogs had only a vaccination collar, 31% had only a paint mark, and 26% had both; 18% (32/178) of vaccinated dogs had not been marked (Table 1). One unvaccinated dog had a vaccination collar. Some marker (collar and/or paint mark) of vaccination status was present on > 90% of the dogs through day 5 postvaccination (Fig 1). Five percent (13/256) of the dogs in the survey were ineligible for vaccination: 9 were less than 1 month of age, 2 had been vaccinated within the last 6 months, 1 was sick, and 1 was acquired during the interval between the vaccination campaign and the assessment.

The owners of 20% (35/178) of the vaccinated dogs reported that their dogs had adverse reactions to vaccination, most commonly lethargy (19 dogs), but also anorexia (6 dogs), both anorexia and lethargy (6 dogs), increased aggression (4 dogs), and

Table 1

Characteristics of dogs selected by the cluster survey.

| Variable | All dogs No.[b](%)[c] | Vaccinated[a] No.(%) | Unvaccinated No.(%) |
|---|---|---|---|
| **Age** | | | |
| Total dogs | 256 | 178 | 65 |
| Median (months) | 12 | 12 | 12 |
| Minimum-maximum (months) | 0.1-156 | 1-156 | 1-84 |
| **Time in current household** | | | |
| Total dogs | 256 | 177 | 65 |
| Median (months) | 12 | 12 | 12 |
| Minimum-maximum (months) | 0.1-156 | 0.25-156 | 0.5-84 |
| **Sex** | | | |
| Male | 129 (51.2) | 96 (53.1) | 29 (46.3) |
| Female | 123 (48.8) | 82 (46.9) | 36 (53.7) |
| **Source** | | | |
| Given | 126 (49.4) | 92 (51.6) | 31 (50.1) |
| Born in household | 96 (37.6) | 66 (36.3) | 20 (28.8) |
| Bought | 26 (10.2) | 16 (10.5) | 10 (14.2) |
| Traded | 5 (2.0) | 3 (1.7) | 2 (3.1) |
| Found | 2 (0.8) | 0 | 2 (3.7) |
| **Function** | | | |
| Guard | 178 (70.6) | 140 (79.2) | 36 (58.0) |
| Pet | 39 (15.5) | 20 (11.1) | 13 (17.1) |
| Food | 4 (1.6) | 0 | 4 (5.6) |
| Guard and pet | 10 (3.9) | 6 (3.6) | 4 (5.9) |
| Guard and food | 10 (3.9) | 3 (1.5) | 7 (11.4) |
| Guard, pet and food | 11 (4.4) | 9 (4.6) | 1 (2.0) |
| **Restraint during day** | | | |
| Free-ranging | 218 (85.2) | 150 (84.6) | 59 (89.6) |
| On premises | 13 (5.1) | 4 (2.4) | 5 (8.6) |
| Leashed | 21 (8.2) | 20 (11.5) | 1 (1.7) |
| Panned | 4 (1.6) | 4 (1.4) | 0 |
| **Restraint during night** | | | |
| Free-ranging | 215 (84.0) | 147 (83.2) | 59 (89.6) |
| On premises | 18 (7.0) | 9 (5.1) | 5 (8.6) |
| Leashed | 19 (7.4) | 18 (10.4) | 1 (1.7) |
| Penned | 4 (1.6) | 4 (1.4) | 0 |
| **Vaccination marker** | | | |
| Collar | 47 (18.4) | 46 (25.3) | 1 (1.5) |
| Paint mark | 58 (22.7) | 58 (31.1) | 0 |
| Collar and paint mark | 42 (16.4) | 42 (25.9) | 0 |
| None | 109 (42.6) | 32 (17.7) | 64 (98.5) |

[a] Includes 243 eligible dogs only
[b] Sample size varies with each variable because of missing data
[c] Percentages vary due to weighting in cluster sample analysis and rounding

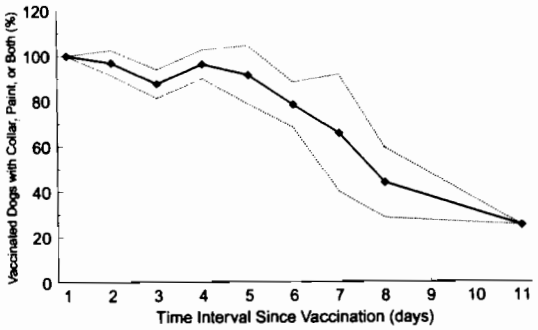


Fig 1–Percentage of dogs reported by their owners to be vaccinated and identified by the survey with either a paint mark, a collar, or both. Paint marks and collars were placed on dogs during the vaccination campaign. The interval between the campaign and assessment survey is shown on the X-axis. Dotted lines indicate 95% confidence intervals when more than one barangay was sampled at the interval.

dehydration (1 dog). Reasons given for not vaccinating dogs were obtained for 64 of the 65 unvaccinated dogs: 11 dogs could not be caught or restrained, 11 dogs were not home when the vaccination team arrived, 10 dogs' owners were not home when the vaccination team arrived, 10 dogs' owners did not want to cause injury to the dog from the vaccination, 9 dogs were believed to be too young to be vaccinated, 7 dogs were for slaughter or consumption and owners feared vaccination would affect the meat, 4 dogs were pregnant, and the owner of 2 dogs was unaware of the vaccination campaign and refused to participate.

Seventy-four percent (105/142) of the dog-owning households vaccinated at least one household dog. The most common sources of information about the rabies vaccination campaign for dog-owning households were barangay officials (58%), posters (16%), radio announcements (16%), and health officials (7%), although most households reported more than one source of information.

Dogs were more likely to be vaccinated if they were restrained (either leashed or penned during the day OR = 9.97, p = 0.006; or night OR = 9.03, p = 0.01), if they were kept as guards rather than pets (OR = 2.56, p = 0.016), or if their household had received vaccination campaign information from more than one source (OR = 4.45, p = 0.04). Dogs were less likely to be vaccinated if they were kept for food (OR = 0.32, p = 0.006) or if their household had learned of the campaign primarily through posters (OR = 0.30, p = 0.015).

## DISCUSSION

In the last century, a central component of the strategy for preventing human rabies has been the successful interruption of dog-to-dog transmission of rabies virus through vaccination and stray animal control (Steele and Fernandez, 1991; Steele, 1988; Turner, 1976). A single, mass vaccination campaign combined with ongoing control efforts can interrupt rabies transmission among dogs and from dogs to humans for a period of years (Tierkel *et al*, 1950; Chomel *et al*, 1988).

The WHO EPI cluster survey, although designed to measure immunization coverage among children (Henderson and Sundaresan, 1982), adapts readily to a number of public health applications (Lemeshow and Stroh Jr, 1988). The cluster survey is more rapid and logistically simple than other household surveys that use random samples selected from a population. However, this sampling is based on households and it is necessary for the characteristic being evaluated to be associated with households. Studies have shown this was the situation in the Philippines where, due to economic and cultural factors, there are very few unowned dogs except in urban settings (Beran, 1982). Similarly, studies from Nepal (Bogel and Joshi, 1990) and other locations generally indicate that fewer than 15% of dogs are inaccessible for vaccination (WHO, 1994). In other countries, the cluster survey method may be less useful for assessing dog populations because unowned (Stray or feral) dogs will not be evaluated. For this reason, we also assessed the feasibility of using mark-release methods by attempting to mark vaccinated dogs, which would then mix with the free-ranging canine population consisting of both stray and owned dogs. A number of studies have used variations of mark-capture techniques for estimating dog populations (Anvik *et al*, 1974; Heussner *et al*, 1978; Beck, 1973).

The vaccination coverage estimated by the cluster survey was above the level of 70% reported as being necessary to eliminate the spread of rabies among dogs (Baer and Wandeler, 1987). In previous control efforts in the Philippines, vaccine

coverage of 80% of dogs was achieved and readily brought rabies under control (Beran, 1982). The use of volunteers proved to be an effective approach for this mass vaccination campaign. Efforts to advertise the goals of the campaign and the dates vacinating teams would visit selected barangays helped prepare the population and ensured a high percentage of homeowners who were home and willing to participate.

The dog-to-human population ratio estimated in this study, 1 : 3.8, indicated a greater population of dogs than some previous estimates from the Philippines (dog-to-human ratios of 1 : 6 to 1 : 8) (Beran, 1982). The current estimate was also substantially different from the presurvey estimate of 1 : 5 and resulted in additional time requirements for vaccination teams and additional vaccine costs. The region was predominantly rural, and dog-to-human ratios of 1 : 3 to 1 : 6 have been reported from rural mountain areas of the Philippines (Beran, 1982). The ratio in this study was similar to the 1 : 3.4 reported from surveys in rural Mexico (Fishbein *et al,* 1992), but gives higher population estimates than the 1 : 6 to 1 : 10 ratio reported for American and European countries (Baer and Wandeler, 1987).

The ability to mark vaccinated dogs with collars and paint could provide a means of assessing vaccine coverage among all dogs, both owned and stray, although the inability to apply markers to all vaccinated animals and the loss of the markers over time will result in coverage being underestimated. Data obtained by mark-recapture methods will help address the requirement for supplemental vaccination campaigns or use of methods, such as oral vaccine distributed in baits (Matter *et al*, 1995), to target unowned and free-ranging dog populations (WHO, 1994). In countries where few stray dogs exist, such as in non-urban Philippine communities, such methods may not be required.

These estimates of vaccination coverage were an important measures of the success of this campaign and helped generate continued support for future vaccination efforts in the Philippines. The surveys also provided information on dog ecology and factors associated with non-participation in the campaign, and these insights will be helpful for planning and implementing future vaccination campaigns. Finally, the availability of different methods for estimating vaccination coverage for different populations of dogs will help in selecting inexpensive, reliable approaches for future post-campaign evaluations of vaccination coverage.

## ACKNOWLEDGEMENTS

We thank Dr Daria Llenaresas, Mr Edwin Nuñez, Dr Grace F. Galpo, and Dr Enrique Espiritu, Research Institute for Tropical Medicine, Department of Health, Manila, Philippines; Dr Daniel B Fishbein and Ms Nancy Barker, Epidemiology Program Office, Centers for Disease Control and Prevention, Atlanta, Georgia; Dr David W Dreesen, College of Veterinary Medicine, University of Georgia, Athens, Georgia. Mr John O'Conner provided valuable editorial assistance.

## REFERENCES

Anvik JO, Hague AE, Rahaman A. A method of estimating urban dog populations and its application to the assessment of canine fecal pollution and endoparasitism in Saskatchewan. *Can Vet J* 1974; 15 : 219-23.

Arambulo PV, Escudero SH. Rabies in the Republic of the Philippines: its epidemiology, control, and eradication. *J Phil Med* 1971; 47 : 206-21.

Baer GM, Wandeler AI. Rabies virus. In: Appel MJ, ed. Virus Infections of Carnivores, New York: Elsevier, 1987: pp 167-82.

Beck AM. The Ecology of Stray Dogs. Baltimore: York Press. 1973.

Beran GW, Nocete AP, Elviña O, *et al.* Epidemiological and control studies on rabies in the Philippines. *Southeast Asian J Trop Med Public Health* 1972; 3 : 433-45.

Beran GW. Ecology of dogs in the central Philippines in relation to rabies control efforts. *Comp Immunol Microbiol Infect Dis* 1982; 5 : 265-70.

Bogel K, Joshi DD. Accessibility of dog populations for rabies control in Kathmandu valley, Nepal. *Bull WHO* 1990; 68 : 611-7.

Chomel BB, Chappuis G, Bullon F, Cardenas E, de Beublain TD, Lombard M, Giambruno E. Mass vaccination campaign against rabies: are dogs correctly protected? The Peruvian experience. *Rev Infect Dis* 1988; 10 (Suppl 4) : S697-702.

Chomel BB. The modern epidemiological aspects of rabies in the world. *Comp Immunol Microbiol Infect Dis* 1993; 16 : 11-20.

Dean AG, Dean JA, Burton AH, Dicker RC. Epi Info, Version 5: a Word Processing, Database, and Statistics Program for Epidemiology on Microcomputers, Stone Mountain, GA, USD, Incorporated 1990.

Fishbein DB, Miranda NJ, Merrill P, *et al.* Rabies control in the Republic of the Philippines: benefits and costs of elimination. *Vaccine* 1991; 9 : 581-7.

Fishbein DB, Frontini MG, Dobbins JG, *et al.* Prevention of canine rabies in rural Mexico: an epidemiologic study of vaccination campaigns. *Am J Trop Med Hyg* 1992; 47 : 317-27.

Henderson RH, Sundaresan T. Cluster sampling to assess immunization coverage: a review of experience with a simplified sampling method. *Bull WHO* 1982; 60 : 253-60.

Heussner JC, Flowers AI, Williams JD, Silvy NJ. Estimating dog and cat populations in an urban area. *Anim Reg Stud* 1978; 1 : 203-12.

Lemeshow S, Stroh G Jr. Sampling techniques for evaluating health parameters in developing countries, Washington, DC: National Academy Press 1988.

Matter HC, Kharmachi H, Haddad N, *et al.* Test of three bait types for oral immunization of dogs against rabies in Tunisia. *Am J Trop Med Hyg* 1995; 52 : 489-95.

Miranda N, Miranda M. Country report: Philippines. In: Proceedings of the Symposium on Rabies Control in Asia. Lyon: Foundation Marcel Merieux, 1993; p 39.

Steele JH. Rabies in the Americas and remarks on global aspects. *Rev Infect Dis* 1988; 10 (Suppl 4) : S585-97.

Steele JH, Fernandez PJ. History of rabies and global aspects. In: Baer GM, ed. The Natural History of Rabies. Boca Raton: CRC Press, 1991; pp 1-24.

Tierkel ES, Graves LM, Tuggle HG, Wadley SL. Effective control of an outbreak of rabies in Memphis and Shelby County, Tenessee. *Am J Public Health* 1950; 40 : 1084-8.

Turner GS. A review of the world epidemiology of rabies. *Trans R Soc Trop Med Hyg* 1976; 70 : 175-8.

Wandeler AI, Budde A, Capt S, Kappeler A, Matter H. Dog ecology and dog rabies control. *Rev Infect Dis* 1988; 10 (Suppl 4) : S684-8.

WHO. Expert committee on rabies. Eighth report, Geneva, World Health Organization 1992.

WHO. Report of the 5th consultation on oral immunization of dogs against rabies. Geneva, World Health Organization 1994.