

# Rabies preexposure vaccination among veterinarians and at-risk staff

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**Objective**—To measure rabies preexposure vaccination rate and identify factors potentially associated with lack of vaccination among veterinarians and at-risk staff.

**Design**—Cross-sectional survey.

**Study Population**—At-risk veterinary medical association (VMA) members, their staff members, and animal shelter and wildlife rehabilitation center personnel located in a California county.

**Procedure**—A questionnaire was mailed to VMA members and managers of animal shelters and wildlife rehabilitation centers. Respondents were requested to provide data on vaccination history and potential factors associated with vaccination status for themselves and their at-risk staff members. Vaccinated and unvaccinated individuals were compared by use of univariate and logistic regression analyses to identify factors associated with vaccination status.

**Results**—Fifty-eight percent (79/137) of persons who received questionnaires responded; 74 were eligible for the study. Respondents provided data for 47.6% (219/460) of their staff members. The vaccination rate was greater among respondents (85.1%) than among their staff members (17.5%). Among staff members, age and duration of employment were significantly associated with vaccination status.

**Conclusions and Clinical Relevance**—A large proportion of at-risk staff members working in veterinary clinics, animal shelters, and wildlife rehabilitation centers in the study area did not receive rabies preexposure vaccination per the Centers for Disease Control and Prevention's published recommendations of the Advisory Committee on Immunization Practices (ACIP). The cost of the preexposure vaccine series may be a barrier, particularly for young employees who are commonly short-term, part-time, or volunteer workers. Efforts are needed to increase awareness of the ACIP recommendations and to increase access to vaccination through agencies such as public health clinics. (*J Am Vet Med Assoc* 2000;217:1707–1710)

The Centers for Disease Control and Prevention has published the recommendations of the **Advisory Committee on Immunization Practices (ACIP)** for human rabies prevention, which indicate that rabies preexposure vaccination should be offered to persons more likely to be exposed to rabies virus than the pop-

ulation of the United States at large.<sup>1</sup> The 3-dose series of preexposure rabies vaccine, given on days 0, 7, and 21 or 28, is recommended for persons at frequent risk of rabies exposure, such as veterinarians and staff and animal control and wildlife workers in rabies-enzootic areas. In addition, serologic testing is recommended every 2 years, with a booster vaccination if the antibody titer is less than an acceptable value. This preexposure vaccination schedule permits postexposure vaccination to consist of 2 doses of vaccine on days 0 and 3 instead of 5 on days 0, 3, 7, 14, and 28 and avoids the need for postexposure administration of human rabies immune globulin.

To the author's knowledge, previous studies have not been performed among veterinarians, veterinary staff, or wildlife workers to evaluate their adherence to these recommendations, although a study among animal control officers in New Mexico found that only 37% had ever received the preexposure vaccination series.<sup>2</sup>

The purpose of the study reported here was to measure the rabies preexposure vaccination rate and identify factors potentially associated with lack of vaccination among an at-risk population, which included **veterinary medical association (VMA)** members, their staff members, and animal shelter and wildlife rehabilitation center personnel located in a California county.

## Materials and Methods

In August 1998, a cross-sectional survey was conducted by mailing a questionnaire to all VMA members and managers of animal shelters and wildlife rehabilitation centers. Respondents were asked to provide data on the following: their demographics, job title, type of facility (veterinary practice, animal shelter, or wildlife rehabilitation center), number of persons employed by the facility, animal species cared for, whether they directly handled animals, history of rabies preexposure prophylaxis, and health insurance coverage. In addition, respondents who owned veterinary practices or managed animal shelter or wildlife rehabilitation centers were asked to provide the following data for each staff member who handled animals (ie, veterinary associates, registered veterinary technicians, veterinary assistants, animal caretakers, and volunteers): demographics, job title, duration of employment, history of rabies preexposure prophylaxis, and health insurance coverage. Only at-risk individuals (ie, those who handled animals) were eligible for inclusion in the study. Respondents were not asked to provide any personal identifiers for the staff for whom they supplied data.

**Statistical analyses**—Data were entered into a software program for descriptive data analyses.<sup>a</sup> **Odds ratios (OR)** and exact 95% **confidence intervals (CI)** were calculated.<sup>b</sup> Multiple logistic regression was performed to further quantify associations between potential predictor variables and rabies vaccination status.<sup>c</sup> Outcome (vaccination status) was coded as a dichotomous variable, with vaccinated persons

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considered to be positive for the outcome ( $y = 1$ ) and unvaccinated persons considered to be negative for the outcome ( $y = 0$ ). Dummy variables were generated for categorical variables with  $> 2$  levels. Values of  $P < 0.05$  were considered to be significant.

## Results

**Survey respondents**—Questionnaires were mailed to 137 persons (132 VMA members and 5 managers of animal shelters and rehabilitation centers), of which 79 (57.7%) responded. Seventy-four persons remained eligible for the study after excluding those who were not at risk according to the ACIP criteria (3 retired veterinarians, 1 veterinarian who was not working in clinical practice, and 1 office manager). Respondents ranged in age from 28 to 78 years (median, 47 years); 54.1% of respondents were male. Eligible respondents represented 70 veterinary practices, 3 animal shelters, and 1 wildlife rehabilitation center. These facilities employed a total of 460 persons as paid or volunteer staff.

Sixty-three (85.1%) of 74 respondents had received the preexposure vaccination series. The interval from vaccination to the time of the survey ranged from 1.5 years to 45.3 years (median, 9.3 years) for the 63 vaccinated respondents. Fifty-five had received the preexposure series  $> 2$  years previously, of which 33 (60.0%) had since had their rabies titer checked and 15 (27.5%) had since received a booster. Although 73 (98.7%) respondents had health insurance, 43 (58.9%) were unsure if rabies vaccination was covered by their plan, and 42 (57.5%) were unsure if having their rabies titer checked was covered. Nine of the 11 unvaccinated respondents indicated 1 or more of the following reasons for not being vaccinated: uncertain about the recommendations ( $n = 4$ ), concern about possible adverse effects (4), cost (3), uncertain where to obtain vaccination (1), and low perceived risk (1). Because the proportion of respondents vaccinated for rabies was fairly high, and there were no factors significantly associated with vaccination status among this group (Table 1), the remainder of the analyses focused on their staff members.

**Staff members**—Respondents who were practice owners or facility managers were asked to provide data on rabies preexposure vaccination and employment history for their staff members who handled animals. Data were reported for 219 (47.6%) of the 460 total staff members at all facilities. Staff members ranged in age from 13 to 79 years (median, 35 years); 9.5% were male. The rabies vaccination status was not reported for 19 (8.7%) of the 219 staff members, and they were excluded from the subsequent analyses; 35 (17.5%) of the 200 remaining staff members had received the preexposure vaccination series.

Results of univariate analyses of data from staff members indicated that only age and duration of employment were significantly associated with rabies vaccination status (Table 2). This association was observed regardless of whether the data were analyzed as continuous or categorical variables; however, only the latter results are shown. All variables were then entered into a logistic regression model. Three variables associated with employment were highly correlated with

Table 1—Results of analysis of factors potentially associated with rabies preexposure vaccination status among survey respondents

| Factor                               | Vaccinated (n = 63) | Unvaccinated (n = 11) | OR (95% CI)               |
|--------------------------------------|---------------------|-----------------------|---------------------------|
| Gender                               |                     |                       |                           |
| Male                                 | 33                  | 7                     | 0.6 (0.1, 2.8)            |
| Female                               | 30                  | 4                     |                           |
| Facility type                        |                     |                       |                           |
| Veterinary practice                  | 61                  | 9                     | 6.8 (0.4, 100.3)          |
| Other*                               | 2                   | 2                     |                           |
| Insured                              |                     |                       |                           |
| Yes                                  | 63                  | 10                    | $\infty$ (0.1– $\infty$ ) |
| No                                   | 0                   | 1                     |                           |
| Age (y)                              |                     |                       |                           |
| 26–49                                | 42                  | 4                     | 3.5 (0.8, 17.9)           |
| $\geq 50$                            | 21                  | 7                     |                           |
| Position                             |                     |                       |                           |
| Facility manager/<br>practice owner† | 43                  | 9                     | 1                         |
| Associate veterinarian               | 17                  | 1                     | 3.6 (0.4–165)             |
| Other‡                               | 3                   | 1                     | 0.6 (0.1–36.6)            |

OR = Odds ratio. CI = Confidence interval.  
 \*Animal shelter (n = 3) and wildlife rehabilitation center (1). †Referent category. ‡Veterinary technician or assistant (n = 3) and self-employed veterinarian (1).

Table 2—Results of analysis of factors potentially associated with rabies preexposure vaccination status among at-risk staff members of veterinary practices, animal shelters, and rehabilitation centers

| Factor                   | Vaccinated (n = 35) | Unvaccinated (n = 165) | OR (95% CI)     |
|--------------------------|---------------------|------------------------|-----------------|
| Gender                   |                     |                        |                 |
| Male                     | 2                   | 17                     | 0.7 (0.1–3.1)   |
| Female                   | 20                  | 110                    |                 |
| Type of employment       |                     |                        |                 |
| Full-time                | 13                  | 78                     | 0.6 (0.2, 1.3)  |
| Part-time                | 22                  | 76                     |                 |
| Facility type            |                     |                        |                 |
| Veterinary practice      | 32                  | 151                    | 1.0 (0.3, 5.7)  |
| Other*                   | 3                   | 14                     |                 |
| Insured                  |                     |                        |                 |
| Yes                      | 14                  | 46                     | 1.8 (0.8, 4.3)  |
| No                       | 17                  | 103                    |                 |
| Employment duration (mo) |                     |                        |                 |
| 1–11†                    | 5                   | 52                     | 1               |
| 12–48                    | 16                  | 69                     | 2.4 (0.8, 8.9)  |
| $\geq 49$                | 14                  | 30                     | 4.9 (1.4, 18.7) |
| Age (y)                  |                     |                        |                 |
| 13–25†                   | 2                   | 45                     | 1               |
| 26–49                    | 26                  | 66                     | 8.9 (2.0, 79.9) |
| $\geq 50$                | 4                   | 18                     | 5.0 (0.6, 58.3) |

Complete survey data were not available for all variables. See Table 1 for key.  
 \*Animal shelters (n = 14) and wildlife rehabilitation centers (3). †Referent category.

each other: having health insurance, type of employment (full vs part-time), and duration of employment. Of these 3 variables, only duration of employment was retained in the model, because it was the only variable that was significantly associated with vaccination status. Neither gender nor type of facility were found to be associated with rabies vaccination status, and both variables were eliminated from the model. An evaluation of effect modification between gender and age or gender and duration of employment was not possible because of the small values in some cells. The final model contained age and duration of employment; the

Table 3—Results of logistic regression analysis to evaluate factors potentially associated with rabies preexposure vaccination status among at-risk staff members of veterinary practices, animal shelters, and rehabilitation centers

| Factor                      | Coefficient (SE) | P value | Odds ratio (95% CI) |
|-----------------------------|------------------|---------|---------------------|
| Duration of employment (mo) |                  |         |                     |
| 1–11*                       |                  |         | 1                   |
| 12–48                       | 0.66 (0.58)      | 0.26    | 1.93 (0.61, 6.04)   |
| ≥ 49                        | 1.32 (0.63)      | 0.04    | 3.74 (1.10, 12.77)  |
| Age (y)                     |                  |         |                     |
| 13–25*                      |                  |         | 1                   |
| 26–49                       | 1.90 (0.78)      | 0.01    | 6.71 (1.46, 30.69)  |
| ≥ 50                        | 0.86 (0.98)      | 0.38    | 2.37 (0.35, 16.06)  |
| See Table 1 for key.        |                  |         |                     |
| *Referent category.         |                  |         |                     |

age groups 13 to 25 years and ≤ 11 months were used as the reference groups for comparison, respectively (Table 3).

Data were analyzed to evaluate the association between vaccination status and duration of employment, while controlling for age as a confounder, and the association between vaccination status and age, while controlling for duration of employment as a confounder. In both instances, the relationships were confounded, although both variables remained independent risk factors after controlling for the confounding. These findings are consistent with the definition of a confounder as a factor that is associated with the exposure of interest and an independent risk factor for the outcome. According to the model, staff members who had been employed at a facility for 12 to 48 months were more likely (OR, 1.9) to have received preexposure rabies vaccination, compared with those employed ≤ 11 months, while controlling for age, although this difference was not significant (Table 3). Staff members employed by a facility for ≥ 49 months were significantly (OR, 3.7) more likely to have received preexposure vaccination than those employed ≤ 11 months, while controlling for age. There was evidence of a dose-response relationship with duration of employment. Those in the 26- to 49-year-old age group were significantly (OR, 6.7) more likely to have received preexposure vaccination than those in the 13- to 25-year-old age group, while controlling for duration of employment. Staff members who were ≥ 50 years old were also more likely (OR, 2.4) than those who were 13 to 25 years old to have received preexposure vaccination, while controlling for duration of employment, although this difference was not significant. Evaluation of effect modification between duration of employment and age was not possible because of the small values in some cells and collinearity between variables.

## Discussion

Results of the study reported here indicate that a large proportion of the at-risk staff working in veterinary clinics, animal shelters, and wildlife rehabilitation centers in the study area had not received rabies preexposure vaccination as recommended by ACIP guidelines. The guidelines classify persons who are

employed in these occupations and who work in rabies-enzootic areas such as California, with its enzootic bat and skunk rabies transmission cycles,<sup>3</sup> as being at frequent risk of exposure.<sup>1</sup> The vaccination rate was high among veterinarians, although follow-up with recommended serologic testing and boosters was low. One possible reason for the higher vaccination rate among veterinarians may be the requirement by veterinary schools that students receive rabies preexposure vaccination prior to participation in clinical activities, whereas there is no such requirement for staff working in veterinary hospitals, animal shelters, and wildlife rehabilitation centers. In addition, there are no regulatory requirements for notifying staff of the potential occupational risk of rabies and the ACIP recommendations, which may result in lower awareness among staff.

For many employees, a major barrier to obtaining the preexposure series may be the cost, which is typically \$288 for the intradermal (ID) series and \$468 for the intramuscular (IM) series.<sup>4</sup> This may be especially problematic for staff members who are volunteers, work only part-time, have no health insurance, or any combination of these factors. Health insurance policies may cover all or part of these costs, but even those in the study reported here who had coverage were often not aware of their specific benefits. Persons in our study who had been employed for a longer duration (usually older employees) were more likely to be vaccinated. Employers may be more likely to provide the means for obtaining preexposure prophylaxis, such as health insurance or reimbursement, to long-term employees, or those more experienced employees may be more likely to seek rabies preexposure prophylaxis because of heightened awareness of the rabies risk.

Some studies have been performed to explore cost-effective approaches to human rabies preexposure prophylaxis. Murray et al<sup>4</sup> examined the long-term costs associated with rabies preexposure prophylaxis among persons at frequent risk of rabies exposure and found that use of the IM route with serologic testing every 2 years, with boosters as needed, was the least expensive approach. These savings resulted from a longer duration of immunity from the IM route, compared with the ID route, and a resulting reduction in the occurrence of adverse reactions from unnecessary boosters. A comparison of outcomes after use of preexposure and postexposure prophylaxis versus postexposure prophylaxis alone reported that the 2 approaches were equally protective against human rabies after an exposure, although it is acknowledged that the latter would not protect against inapparent exposures.<sup>5</sup> The latter approach was reported to be less costly as long as the probability of rabies exposure did not exceed 20%. The probability of rabies exposure used to determine the cost effectiveness of these 2 approaches would likely vary depending on the degree of discrimination between perceived and actual rabies exposure in instances where postexposure prophylaxis is administered.

One of the limitations of this study was that data for staff members were provided indirectly by owners of veterinary practices or managers of facilities such as animal shelters or wildlife centers. As a result, a non-

random sample of staff members was obtained, which may not be representative of all at-risk staff working in this area. Similarly, because only 58% of those targeted by the survey responded, it is possible that respondents may differ in a systematic manner from nonrespondents. Unfortunately, data were not available from nonrespondents to allow a comparison. It is likely that a higher response rate was obtained for respondents who were vaccinated or had higher vaccination rates among their staff. The result would be over-representation of vaccinated individuals, implying the existence of an even lower vaccination rate than that found in our study. Furthermore, a study targeting a population that is representative of a more diverse geographic area would assist in the evaluation of factors that may be regional, such as socioeconomic status and access to health care. For instance, the availability of rabies preexposure prophylaxis through public health clinics in some counties may have a noticeable impact on the vaccination rate in these areas.

Efforts are needed to increase awareness of the ACIP recommendations for preexposure prophylaxis among staff at veterinary practices, animal shelters, and wildlife rehabilitation centers. Missionary personnel who had preexposure prophylaxis recommended to them prior to service in a rabies-endemic country were more likely to receive vaccination.<sup>6</sup> Although it may be prohibitively expensive for an employer to provide this benefit to all employees, particularly for those facilities that depend on a large numbers of volunteers, such as animal shelters

and wildlife rehabilitation centers, public health clinics may be a valuable resource for making this service more affordable and accessible. Hopefully, data from the study reported here will stimulate employers, public health professionals, and health care providers to maximize awareness and minimize the occupational risk of potential rabies exposure among those who are at risk.

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<sup>a</sup>Epi Info 6.02b, Centers for Disease Control and Prevention, Atlanta, Ga.

<sup>b</sup>PEPI 2.07a, USD, Inc/Universal Stationer, Stone Mountain, Ga.

<sup>c</sup>STATA 6.0, Stata Corp, College Station, Tex.

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