Evidence Against Infection with Hantaviruses Among Forest and Park Workers in the Southwestern United States


To determine if individuals with extensive exposure to rodent habitats were infected with Sin Nombre hantavirus (SNV), we evaluated forest and park service personnel from the region of endemicity in the southwestern United States. Information about work and recreational activities, including exposure to rodents and history of recent illnesses, was obtained via a standardized questionnaire. Serum specimens were also collected. Of 140 participating workers, 84 (60%) were primarily engaged in outdoor work activities, 14 (10%) were office-based supervisors, and 42 (30%) were office workers. Of the 140 employees, 89 (64%) reported repeated exposures to rodents, rodent nests, and/or rodent droppings; 22 (16%) reported trapping or handling wild rodents. Hantavirus antibodies were not detected in any park employee. These data suggest that transmission of SNV is a rare event even among persons in the southwestern United States who have a high level of exposure to this virus. Although park employees and visitors in this region are at low risk of infection with SNV, these persons should continue to use recommended measures for risk reduction.

An investigation of a cluster of cases of adult respiratory distress syndrome that occurred in the spring of 1993 among healthy young adults living in rural areas of the southwestern United States led to the discovery of a previously unknown hantavirus, provisionally called Sin Nombre virus (SNV), and the identification of a distinct syndrome, hantavirus pulmonary syndrome (HPS) [1, 2]. The reservoir rodent species for SNV was identified as the deer mouse (Peromyscus maniculatus), a field mouse that can also inhabit human dwellings [3].

Hantaviruses other than SNV are usually transmitted to humans via inhalation of aerosolized rodent excreta; activities involving exposure to rodents can increase the risk of hantavirus infection. Occupational groups with extensive outdoor exposure to rodent habitats, such as farmers, soldiers engaged in field exercises, and foresters, are at increased risk for infection with hantaviruses other than SNV [4].

In the area of the Southwest where the initial hantavirus outbreak occurred, there were extensive public lands including national parks, state parks, and forests (herein designated generically as parks), that are visited by large numbers of campers and other tourists. Many of the employees (herein designated as park employees) working at these sites could have been exposed to rural rodent habitats; such exposure is similar to those of individuals whose occupation placed them at risk for infection due to hantaviruses other than SNV. Although none of the cases of HPS diagnosed early in the initial outbreak were in park employees, subclinical illness is common among individuals with hantavirus infection not due to SNV [4] and had not been studied in individuals with infection due to SNV.

In June 1993, serological testing demonstrated hantavirus antibodies in a tourist who had had an illness compatible with HPS in August 1992, a few weeks after the individual had engaged in outdoor recreational activities in the area where the outbreak had occurred [5]. At that time, the degree of risk associated with outdoor activities in the heavily visited parks in the area was unknown. We studied whether infection with SNV had occurred among park employees and if any observed infection could be linked to the degree of rodent exposures.

Materials and Methods

Study population. We studied park employees from seven sites: two forest service districts, two national monuments, two national historic areas, and a state park, all of which were located in northwestern New Mexico and northeastern Arizona, the area of the HPS outbreak. Our eligible study population consisted of all employees, full time or seasonal, at these sites. The study was approved by the appropriate regional administrative officers for each site. Employees were notified about the study by local supervisors; participation was voluntary.

Data and specimen collection. Ten mL of blood was drawn (for serum separation) from each study participant. Demographic data and information about work activities, hobbies, and known exposure to rodents were obtained from participants with use of a standardized, self-administered questionnaire. Written consent was obtained from each subject.

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Informed consent was obtained from all participants, and human experimentation guidelines of the Centers for Disease Control and Prevention (CDC) were followed.
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Reprints or correspondence: Dr. Charles E. Vitek, National Immunization Program, CDC, 1600 Clifton Road, Mailstop E-61, Atlanta, Georgia 30333.
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Laboratory testing. Serum samples were tested for hantavirus-specific IgM and IgG by ELISA. This assay used antigens from several hantavirus species; Seoul and Puumala viruses for IgM, and Seoul, Prospect Hill, and Puumala viruses for IgG. An ELISA titer of ≥400 was considered positive. Any positive or equivocal samples were later tested by ELISA with use of recombinant antigen from SNV [6, 7].

Results

We obtained serum specimens and questionnaires from 140 (60%) of 234 eligible park employees between 12 July 1993 and 25 July 1993. Males constituted 65.5% of the study population, and the median age of the participants was 28 years (range, 19–66 years). Eighty-four (60%) study participants were field workers with primarily outdoor work activities (including fire crews, timber surveyors, and their field supervisors), 14 (10%) were office-based supervisors, and 42 (30%) were office workers or visitor center employees (the last two categories are designated office workers herein). Serum specimens were obtained from three individuals who did not complete questionnaires. These individuals (all of whom were seronegative) were not considered participants and were not included in the analyses.

Exposure. Eighty-nine (64%) of the study participants reported repeated exposures to rodents, rodent nests, and/or rodent droppings at home, at work, or during leisure activities. Field workers (69%) and office-based supervisors (93%) were both significantly more likely to report exposure than were office workers (43%; P<.01 for both comparisons). Twenty-two participants (16%) reported trapping or handling wild rodents. Both field workers and supervisors were more likely to report this type of exposure than were office workers; however, the differences were not statistically significant.

Park employees slept outdoors a mean of 6.1 nights per year because of work and recreational activities (mean number of nights for field employees, 8.1; for supervisors, 3.5; and for office workers, 2.9). Field workers had been employed a median of 3 years (range, 0–30 years) at their present park, supervisors a median of 10 years (range, 2–16 years), and office workers a median of 2 years (range, 0–32 years).

Serological test results. None of the 143 participants had serological evidence of hantavirus infection.

Discussion

Yanagihara reviewed earlier studies that reported a low prevalence (2%) of immunofluorescent antibodies (IFA) to hantavirus among ~7,000 U.S. residents who were tested [8]. Most of these individuals with IFA reactivity had low titers of antibody to hantavirus, and few had neutralizing antibodies to hantaviruses (12% of those tested). Therefore, most of these IFA-reactive specimens probably represented false-positive results. The few individuals who had neutralizing antibodies to hantaviruses included longshoremen, mammalogists, and a research technician who worked with rodents.

One of these earlier studies examined samples from 524 U.S. Forestry Service and U.S. Geological Service personnel in Mississippi, Virginia, and Alaska and found that specimens from 11 (2.1%) had IFA reactivity when tested against a panel of hantavirus strains (i.e., Hantaan, Tchoupitoulas, Prospect Hill, and Puumala viruses) [9]. However, most of these individuals had only low titers of antibody to hantavirus, and neutralizing antibodies were not measured.

Our study participants included a convenience sample of park employees working in the area in the Southwest in which SNV was endemic. These employees, especially field workers, reported a high level of exposure to rodents and their habitats.

Our reported figures on recent exposure may underestimate the cumulative long-term rodent exposure for the study population since long-term park employees reported a trend toward working in jobs with decreasing outdoor responsibilities and toward sleeping outdoors fewer nights over the years of their employment. In addition, before their current employment, many of these employees had worked in similar occupations in other western states that have been shown to have areas in which SNV is endemic [10]. Finally, since these parks are in rural settings and the employees tend to live either in the parks or in other nearby rural areas, they may be exposed to rodents, rodent nests, and/or rodent droppings in peridomestic settings. Despite this situation, none of the park employees had serological evidence of hantavirus infection.

The lack of evidence of recent or previous hantavirus infection in our study participants could reflect limited exposure in the past because of the recent arrival of the employees or the recent appearance of the virus. However, more than one-half of the field employees had worked in their present location for more than 3 years. Long-term endemicity of SNV in the Southwest is supported by retrospective investigations that have identified cases of HPS dating back to 1978 [11] and by molecular studies of SNV genomic variability [12].

Since heterologous hantavirus antigens were used to screen for antibodies to SNV, it is possible that patients who were seropositive were missed; however, this panel of heterologous antigens was highly sensitive for SNV antibodies in past infections when compared with ELISA, which used recombinant antigen from SNV (Centers for Disease Control and Prevention, Atlanta, unpublished data).

In our study, the number of participating park employees who had been exposed to rodents or their habitats was not large enough to exclude a low level of risk. However, the size of our study population was sufficient to allow us, with 95% confidence, to exclude the possibility that ≥4% of field workers in this area were infected at the time of the survey. These results, along with those of another study [13], demonstrate that the background seroprevalence of SNV antibodies in this region is low, further strengthening the epidemiologic evidence associating SNV with HPS.
Although the absence of serological evidence of hantavirus infection in park employees suggests that transmission of SNV is rare, many of the park employees participate in activities associated with an increased risk of infection with hantaviruses and should use measures to reduce the risk of hantavirus infection [14]. The lack of infection in a population with a high level of exposure to rodent habitats also suggests that visitors to the parks in this area are at low risk of infection with hantavirus. However, a case of HPS was recently reported in a hiker with extensive exposure to rodent-infested dwellings along the Appalachian Trail [15]. Park visitors in all parts of the United States should use the recommended risk reduction measures for campers and hikers to further lower their risk of hantavirus infection [14].

References