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Assessment of Occupational Risk for Hantavirus Infection in Arizona and New Mexico

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Abstract

Differentiating occupational exposure from other potential domestic or recreational exposure(s) for Sin Nombre virus (SNV) infection is an epidemiologic challenge. Interviews on work-related activities were conducted, and serum specimens were obtained from 494 workers in Arizona and New Mexico. These workers may have been exposed to rodents and rodent excreta at work, but their primary occupation did not require rodent contact (National Park Service [n = 193]; Navajo Agricultural Product Industry [n = 65], utility companies [n = 169] and plumbing and heating contractors [n = 67]). Within each occupational group (farm workers [n = 457], laborers [n = 20], professionals [n = 70], repairers [n = 211], service industry workers [n = 83], and technicians [n = 53]), the majority of workers reported working in areas that had rodent droppings (range, 75 to 95%); 70% of laborers and 64% of service industry workers reported handling rodents. More than 60% of workers in each group, except technicians, reported reopening and cleaning or working in closed spaces. Approximately 90% of laborers, repairers, and farm workers reported hand-plowing. Although the risk for occupationally related SNV infection appears to be low, workers frequently performed risk activities associated with hantavirus pulmonary syndrome (HPS). All workers were seronegative for SNV by enzyme-linked immunoassay or Western blot testing. These findings, the known occupational exposure of some HPS cases, and the high HPS case-fatality rate (52%) support the need for recommendations to reduce human contact with rodents in the workplace. Increased understanding of hantavirus transmission to humans will help focus future recommendations to minimize human exposures effectively.

The Sin Nombre virus (SNV) has been identified as the etiologic agent of hantavirus pulmonary syndrome (HPS).^{1,2} Through July 1995, 113 cases of HPS had been identified in 23 states (Centers for Disease Control and Prevention [CDC], unpublished data). Hantaviruses are transmitted to humans primarily by inhalation of aerosolized rodent urine, feces, or saliva or by particulates contaminated by rodent excreta. Differentiating the potential occupational, household, and recreational exposure(s) associated with transmission of SNV and development of HPS remains an epidemiologic challenge.

A case-control study of HPS patients during the 1993 hantavirus outbreak in the southwestern United States identified a larger number of small rodents at case households, contact with rodents (eg, trapping rodents), agricultural activities (eg, hand-plowing and planting), and peridomestic cleaning activities (eg, cleaning food storage areas in residences and cleaning outbuildings in which animals were maintained) as associated with increased risk for HPS.³ A concurrent case-control study of household environmental factors did not identify any unique characteristics associated with developing HPS other than an increased rodent density.⁴ Serosurveys conducted during the 1993 HPS outbreak identified a SNV seroprevalence of 1 to 2% among persons living in Arizona and New Mexico.^{3,5,6}

In studies of hantaviruses in other parts of the world, occupational activities identified as risk factors for hemorrhagic fever with renal syndrome (HFRS) included agricultural work (eg, planting, harvesting, and threshing), forestry, laboratory work with infected rodents, military field assignments in endemic areas, and herding.⁷ Seroprevalence studies conducted in northern Africa and Europe demonstrated hantavirus antibodies in persons engaged in agricultural activities (eg, farmers, woodcutters, forest workers, mammalogists) and villagers in rural areas. In these studies, the seroprevalence in healthy

persons ranged from 2 to 4%.^{8,9}

In the United States, several studies have been conducted recently to assess the risk for exposure to hantaviruses to persons who have varying degrees of exposure to rodents. In studies of mammalogists and rodent control workers whose occupations involve frequent contact with known hantavirus hosts, seropositivity was 1.4 to 2.0%.^{10,11} A study of health care workers (eg, physicians, nurses, pathology assistants, and respiratory technicians) who had been exposed to HPS patients but who had limited or no occupational exposure to rodents identified no seropositive persons.¹²

The objectives of this study were (1) to establish the prevalence of hantavirus antibodies in persons with potential occupational exposure to hantaviruses, and (2) to determine the prevalence of potential risk activities performed by various occupational groups whose work environments could expose them to rodents, rodents nests, or aerosolized rodent excreta but whose primary occupation does not require rodent contact.

Methods

Sampling and Data Collection

During May through August 1994, a cross-sectional survey of persons at risk of occupational exposure to hantavirus-infected rodents was conducted in the region where the 1993 SNV outbreak occurred. Survey participants were identified through convenience sampling by industry:

1. Government and concession park service workers at the Grand Canyon National Park (south Rim and north Rim), Arizona;
2. Agriculture workers at the Navajo Agriculture Product Industry, Navajo Nation; and
3. Utility company workers and plumbing/heating contractors in New Mexico.

Consenting participants had 10 ml of blood collected and completed a self-administered questionnaire that requested the following information: demographics, industry, occupation, job title, five most important work activities, location of work, and known SNV risk factors. The questionnaire was translated verbally into Spanish and Native American languages as needed.

Occupational Coding and Statistical Analysis

Data were used to assign an occupational group according to the 1990 Census of Population and Housing, Alphabetical Index of Industries and Occupations.¹³ Staff at the CDC's National Institute of Occupational Safety and Health (NIOSH) coded participants into the following occupational groups:

1. 1. Farm workers (farm workers, gardeners, hunters, and trappers);
2. 2. Laborers (machine operators, assemblers, inspectors, equipment cleaners);
3. 3. Professionals (executive, administrative, managerial occupations, professional specialty occupations [eg, natural scientists]);
4. 4. Repairers (precision production; craft; repair occupations such as machine, automobile, electrical, and HVAC repair; and construction trades);
5. 5. Service occupations (firefighters, law enforcement officers, rangers, and food service and building cleaning workers);
6. 6. Technicians (technicians and related support occupations [eg, supervisors and administrative support personnel]).

Prevalence of risk activities, categorized as ever/never, were analyzed by occupational group and demographic characteristics, including age, sex, race, ethnicity, and years of education. All analyses were conducted using SAS(R) statistical software (SAS Institute Inc, Cary, NC).

Laboratory Testing

All serum specimens were tested at the CDC for SNV-specific immunoglobulin G (IgG) by enzyme-linked immunoassay (ELISA) using a recombinant SNV nucleocapsid protein as the antigen.^{1,14} An ELISA reciprocal titer of >400 was considered positive for SNV. A subset of samples (411 of 494, 83%) were also tested at the University of New Mexico School of Medicine for the presence of SNV antibodies by a recombinant Western blot assay, using methods described previously.¹⁵

Results

Demographic and Employment Characteristics

Study participants (n = 494) were classified by occupational group (Table 1). The majority of study participants were male (77%). The median age of study participants was 40 years (range, 18 to 68 years). Most of the farm and forestry workers and laborers were Native American and had a high school education level or less. The majority of workers in the other occupational groups were white and had more than high school education.

The majority of workers in all groups (81 to 100%) started working in their current position before or during the 1993 HPS outbreak. On average, participants had worked in their current job for 12 years (range,

Occupational performance of hantavirus-associated risk activities. Within each NIOSH-coded occupational group, the majority of workers reported working in areas that had rodent droppings (range, 75 to 95%). Seventy percent of laborers and 64% of service industry workers reported handling rodents (Table 3). More than 60% of workers in each group, except technicians, reported reopening and cleaning or working in closed spaces.

In univariate analysis, significant differences were found between prevalence of

performing each risk activity by sex, race, years of education, and age. Men were more likely than women to work outdoors > 5 hours per week, to work in outbuildings, to reopen closed spaces, to dig or hand-plow, or to handle rodents/rodent nests (P 5 hours per week, to work in outbuildings, and to trap rodents (P 40 years of age were more likely to reopen or work in closed spaces (P

Serologic studies. All study participants were seronegative for SNV using the ELISA method. The subset of participants tested using a recombinant Western blot assay were also seronegative.

Discussion

Since the identification of SNV in 1993, persons living and working in the southwestern United States, and, to a lesser extent, elsewhere in the country, who have contact with rodents or rodent feces/urine or who perform known SNV risk activities, have been presumed to be at increased risk for developing HPS.¹⁶ This investigation assesses the potential occupational risk of persons who are exposed to rodents and rodent environments but whose primary occupation does not require rodent contact.

The majority of study participants had contact with rodents or rodent droppings, worked in closed spaces such as outbuildings, and/or performed hand-plowing. Also, the majority of participants reported working in their occupation before or during the 1993 HPS outbreak. These findings indicate that workers had potential contact with hantavirus-infected rodents, therefore they may be at risk for acquiring SNV infection.

The actual exposure of these workers to SNV-infected rodents is unknown because rodents were not trapped and tested for SNV infection at the study sites.

Serologic testing of rodents trapped in Arizona and New Mexico during 1993-1995 have shown large variations in SNV seropositivity (range, 0 to 40%) by geographic area (CDC, personal communication).

Detailed exposure information has been collected for 83 of the 113 known HPS cases. Occupational exposure, without peridomestic or recreational exposure, was reported for six (7%) of these 83 patients, including a grain farmer, an agricultural extension livestock specialist, a steel metal worker, and a bridge worker. In 19% (16 of 83) of the remaining cases, workers reported both occupational and peridomestic exposures to rodents, rodent nests, or rodent excreta; these workers included four agricultural workers, two field biologists, a construction worker, a landscaper, a mill worker, and an electric company operator. Overall, 22 of the 83 patients who had HPS had had some occupational exposure, suggesting a need to consider occupational risk for hantavirus infection (CDC, unpublished data.)

The concordant seronegative findings by ELISA and Western blots methods suggest a low prevalence of false-positive results using both methods. The fact that seropositive persons were not identified in this study is not surprising because HPS and subclinical SNV infection appear to be rare.^{3,5,6,12} Although the overall sample size may have provided sufficient power to identify SNV seroprevalence of

This study may also be limited by potential selection biases. The convenience sampling methods, for example, may have been less likely to recruit national park workers who worked at remote sites and who may also have had the greatest risk for rodent exposure. In addition, more than 50% of HPS cases identified thus far have been fatal, and infected persons who died would have been omitted from the study.

Although the results of this study indicate that the risk for occupationally related SNV infection is low, workers frequently performed activities associated with rodent exposure. These findings, the previously identified HPS patients who had known occupational exposure to rodents or rodent excreta, and the high mortality of HPS support the necessity for occupational precautions to reduce human contact with rodents.¹⁶ Because we cannot predict which rodents are SNV-infected during occupational exposure, an increased understanding of hantavirus transmission to humans will help focus future recommendations to more effectively maximize human protection.

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Risky Business

Teach your teenager not to take unnecessary risks, shows a survey by the US Centers for Disease Control and Prevention. It found that nearly 9% of high school students had attempted suicide, 25% had smoked marijuana, 52% had drunk

alcohol in the previous month, and 39% had ridden in the last month with a driver who had been drinking alcohol. Also, about 40% said they had had sexual intercourse in the last month, and of those, 46% said they did not use a condom.

-From Schogol M. Personal briefing, Philadelphia Inquirer October 2, 1996, p D3.
