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Updated guidelines for protection of mammalogists and wildlife researchers from hantavirus pulmonary syndrome (HPS)

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The American Society of Mammalogists herein provides revised guidelines for personnel working with rodents potentially infected with viruses that cause hantavirus pulmonary syndrome (HPS) in humans. We also clarify that previously published guidelines, including those of the United States Centers for Disease Control and Prevention (CDC), were not intended to apply to field-workers conducting nonviral-based research on rodents. Unfortunately, institutional animal care and use committees and other safety officers have assumed that current CDC recommendations are requirements for conducting safe field research. They then have misapplied the original CDC recommendations to field researchers conducting behavioral, ecological, taxonomic, and other research, making field research increasingly and unnecessarily difficult. Herein, we provide guidelines that have been modified from those published by the CDC to incorporate new information about HPS risk and to better match the level of personal protection to the level of risk associated with a wider array of field activities. DOI: 10.1644/10-MAMM-A-306.1.

Key words: deer mice, disease, field research, guidelines, *Hantavirus*, hantavirus pulmonary syndrome, HPS, *Peromyscus*, Sin Nombre virus, zoonoses

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Hantavirus pulmonary syndrome (HPS) emerged in May 1993 when an outbreak of this previously unknown disease occurred in the “Four Corners” region of the southwestern United States (<http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/history.htm>, accessed 10 August 2010). With an initial mortality rate >90%, the United States Centers for Disease Control and Prevention (CDC) promptly initiated a vigorous investigation into the etiology of this disease and into factors contributing to human susceptibility. One product of this early burst of efforts was a set of guidelines for workers exposed to rodents potentially infected with viruses that cause HPS. These included two Morbidity and Mortality Weekly Reports (CDC 1993; Mills et al. 2002), an online guide (Mills 1995a), and 1 summary contribution in this journal (Mills et al. 1995b). Recommendations included use of disposable shoe coverings and coveralls or surgeon’s gowns, 2 pairs of latex or nitrile gloves, eye protection, and a negative-pressure or

powered air-purifying respirator fitted with high-efficiency particulate air (HEPA) filters; traps being disinfected after every capture (e.g., using Lysol [Reckitt Benckiser, Berkshire, United Kingdom] or dilute bleach) and both washed and disinfected after every trapping session; and traps containing rodents being handled with heavy rubber gloves, placed in doubled plastic bags (tied closed), and processed at a central processing station. These initial guidelines were established with a conservative goal of protection but were developed during a time when this disease was only beginning to be understood. Knowledge of the biology and etiology of HPS has improved greatly in the past 1.5 decades, however, such that updated guidelines intended for field biologists not involved in disease-related studies are now warranted. The absence of guidelines that reflect more accurately the actual low risks for a field researcher of contracting HPS has been considered a hindrance to field biology and is a serious threat to field mammalogy and the training of young mammalogists

¹ Established in 2007, this ad hoc committee included (in alphabetical order) Joseph A. Cook, Brent J. Danielson, Mark S. Hafner, Christine Hice, Douglas A. Kelt (Chair), Suzanne B. McLaren, and Dirk H. Van Vuren.



(Hafner 2007). Institutional animal care and use committees and other safety officers routinely treat CDC recommendations as mandates, and the threat of litigation and punitive damages is a serious consideration in an increasingly litigious age. Given these threats to field mammalogy and to the training of young mammalogists, the President of the American Society of Mammalogists (ASM), Robert Timm, in 2007 appointed an ad hoc committee to draft a set of more specific guidelines relevant to field mammalogists not involved in disease-related studies. These guidelines were presented to the Board of Directors of the ASM in June 2008 and subsequently presented to the Director of the CDC in the form of a letter from ASM President Sue McLaren. The Board of Directors, at the 90th annual meeting (Laramie, Wyoming, 2010) of the ASM, charged the ad hoc Committee with converting these guidelines into a formal contribution to the *Journal of Mammalogy*.

Rationale for updated guidelines.—Field mammalogists and wildlife researchers (hereafter “field researchers”) interact with rodents in ways that are fundamentally different from those of other categories of workers mentioned in the above-referenced CDC document (i.e., pest-control workers, farm and domestic workers, building and fire inspectors). Contact between field researchers and rodents occurs in open environments, not inside dwellings or other structures where evidence shows that exposure to aerosolized hantavirus particles is much more likely (Mills et al. 2002). Contact between field researchers and rodents is not accidental, nor is it incidental to their work; field researchers approach rodents deliberately and with a carefully planned research protocol. Because field researchers have control of the encounter and are able to identify the rodent species at hand, they know when to be especially cautious of possible exposure to hantaviruses. Because their encounters with rodents are deliberate, field researchers are constantly aware of the possibility of hantavirus exposure and therefore remain vigilant for symptoms of HPS following periods of fieldwork. Evidence shows that early diagnosis of HPS significantly increases the likelihood of successful treatment.

Results of serological surveys of field mammalogists and wildlife researchers published subsequent to the recommendations of Mills et al. (1995a, 1995b, 2002) show that the risk of contracting HPS is exceedingly low in researchers who handle rodents regularly. Fulhorst et al. (2007) and Kelt et al. (2007) documented that of 1,412 people with occupational exposure to deer mice and tested for antibodies to Sin Nombre virus (SNV), the causative agent of HPS, only 1 (i.e., 0.071%) had been hospitalized with symptoms of HPS, and only 4 (0.212%) had antibodies to SNV. Fulhorst et al. (2007) noted that more than two-thirds of their subjects ($n = 757$) rarely or never used any protective equipment; indeed, their research reported on samples collected in 1994 at several national conferences (including the annual ASM meeting in Washington, DC), well before widespread awareness of HPS, and it is likely that most subjects had never used protective equipment designed to prevent exposure to hantaviruses (Kelt et al.

2007). This new evidence, coupled with the degree of contact between field researchers and rodents varying from minimal (e.g., capture and release) to intimate (e.g., invasive procedures such as dissection or tissue sampling), suggests that the complex procedures recommended for HPS risk reduction in Mills et al. (1995a, 1995b, 2002) likely are overly conservative for the many field researchers who typically are well informed about HPS risk and take reasonable precaution when handling rodents. Additionally, overprescription of HPS preventative measures can have unintended negative consequences, including heat prostration from extra layers of protective gear, difficulty breathing when using negative pressure respirators at high elevation, and snake bites, falling, and other physical injuries due to restricted visibility when using full-coverage face masks.

The ASM supports and encourages responsible field research on mammals (e.g., Gannon et al. 2007), and we endorse all recommendations and regulations that ensure the health and safety of mammalogists in the field. Because the mortality rate of HPS remains high (30–35%), we believe that efforts must be made to minimize contact with hantaviruses. However, the widespread fear of HPS that has developed over the past 1.5 decades, both in the mammalogical community and in the broader academic environment in which most mammalogists are employed, has had a chilling effect on field research involving rodents and currently threatens our ability to attract new students into this discipline (Hafner 2007). With the recognition that the risk of contracting HPS is exceedingly low (Kelt et al. 2007), even by field researchers who handle rodents regularly, the ASM believes that now is an appropriate time to adjust the level of protection against HPS to fit the level of risk.

Updated HPS guidelines.—The following guidelines for HPS risk reduction have been modified from those published by the CDC (Mills et al. 1995a, 1995b, 2002) to incorporate new information about HPS risk. These include various levels of protection against HPS designed to meet various degrees of risk associated with different kinds of field activities and focus on field researchers who work with rodent species known to transmit hantaviruses that cause HPS. In North America these species are primarily sigmodontine and neotomine rodents, including white-footed and deer mice (*Peromyscus leucopus* and *P. maniculatus*), harvest mice (*Reithrodontomys*), rice rats (*Oryzomys*), cotton rats (*Sigmodon*), and certain arvicoline rodents such as voles (*Microtus*). Because transmission of hantaviruses to humans is believed to result primarily from inhalation of aerosolized excreta, egesta, or saliva from infected mice in mouse-infested structures (cabins, sheds, etc.), our recommendations begin with an admonition to avoid such structures whenever possible while in the field. Detection of high viral titers in the saliva of deer mice suggests that transmission via a bite from an infected mouse also is a probable means of transmission. Fresh feces and urine in and on traps, although not easily aerosolized, still have the potential for transmission via scratches or contact with the mouth or eyes via the hands. Guidelines provided herein

include ways to reduce the risk of these kinds of viral transmission.

We recommend that field researchers directly involved in disease ecology studies follow the CDC guidelines for sampling small mammals for virologic testing (Mills et al. 1995a). We consider the following to comprise reasonable guidelines for field biologists not working on disease-related studies but who nevertheless might come into contact with small mammals potentially infected with viruses that cause HPS.

1. Field workers should not use a cabin or field bunkhouse that shows evidence of current or prior occupation by rodents until the structure is thoroughly cleaned. Because feces and other sign of rodents known to transmit hantaviruses can be difficult to distinguish from those of nonhantavirus-transmitting species, workers should be conservative and assume that small feces and other rodent signs pertain to hantavirus-transmitting species. Because *Hantavirus* infection is thought to be acquired primarily by inhalation, efforts should be made to minimize aerosolization of dust inside the dwelling; we suggest that workers spray surfaces with disinfectant, use a mop rather than a broom, and use HEPA respirators during initial cleaning if dust is likely to be aerosolized. Once the dwelling is cleaned, workers should maintain a program of removal of small mammals from the structure by live or kill trapping, following the recommendations below. Hantaviruses are readily killed by contact with common disinfectants (e.g., 10% bleach, 3% Lysol) or exposure (≥ 30 min) to direct sunlight or heat $>60^{\circ}\text{C}$.
2. All handling of rodents known to transmit viruses that cause HPS should be done in the open air with the rodent (or trap containing the rodent) held away from the face and positioned such that direct wind (and wind vortices) do not blow aerosolized particles from the rodent toward the investigator.
3. Live traps containing rodents known to transmit viruses that cause HPS should not be transported within a vehicle unless they are securely isolated in intact plastic bags (e.g., large garden bags) or otherwise placed in an area in which air circulation is separate from that of the driver and any passengers.
4. Mammalogists should avoid direct contact with urine, feces, saliva, blood, and internal organs of rodent species associated with HPS. Eye protection and rubber, latex, vinyl, or nitrile gloves are recommended when handling or doing invasive procedures with rodents that potentially transmit *Hantavirus*.
5. Appropriate training should prioritize safe and secure handling of small mammals to avoid being bitten or scratched. Rodents can be anesthetized or euthanized by placing the trap containing the rodent inside a disposable plastic bag containing the anesthetic agent. For mark-and-release studies smaller rodents (<100 g) can be removed from traps using disposable plastic or washable cloth bags

and handled safely and securely by grasping them firmly at the nape of the neck.

6. In the unlikely event that a field researcher is bitten, scratched, or comes into direct contact with the fluids of rodents that potentially transmit *Hantavirus*, the affected area should be washed thoroughly with soap and water, then disinfected with an alcohol-based hand sanitizer or similar disinfectant, such as Lysol or Clorox (Clorox, Oakland, California) hand wipes.
7. All mammalogists should be fully aware of the symptoms of HPS, which include severe muscle aches, fever, and headaches. If these flu-like symptoms appear within 6 weeks after fieldwork, the person should see a physician immediately and report that he or she might have been exposed to *Hantavirus*.
8. All field mammalogists should visit the CDC website regularly to get updates on hantaviruses (<http://www.cdc.gov/ncidod/diseases/hanta/hps/index.htm>), HPS, and other rodent-borne diseases (<http://www.cdc.gov/rodents/diseases/>).

These updated guidelines have been prepared in response to our belief that the level of protection against HPS should match the level of risk of exposure associated with field activities. We recognize the threat of HPS, and we urge field researchers to avoid exposure. We emphasize, however, that the probability of field-workers contracting HPS is exceedingly small, and normal activities of field research in mammalogy should not engender unreasonable fear of contamination.

RESUMEN

La American Society of Mammalogists presenta aquí directrices revisadas para la manipulación de roedores potencialmente infectados con virus que causan el síndrome pulmonar hantavirus (SPH) en humanos. Estas nuevas directrices clarifican aquellas previamente publicadas por el U. S. Centers for Disease Control and Prevention (CDC) que no estaban destinadas a ser aplicadas a trabajadores de campo cuyas investigaciones con roedores no están basadas en los virus. Desafortunadamente, los comités de cuidado y uso animal institucionales, así como otros agentes de seguridad, han utilizado las directrices del CDC asumiendo que estas constituyen, de hecho, reglamentaciones para conducir investigaciones de campo de un modo seguro. Así, han aplicado erróneamente las recomendaciones originales del CDC para investigadores de campo que conducen investigaciones comportamentales, ecológicas, taxonómicas y de otro tipo, haciendo innecesariamente dificultoso el trabajo de campo. Ofrecemos aquí nuevas directrices que han sido modificadas con respecto a aquellas publicadas por el CDC para incorporar nueva información sobre el riesgo de SPH y para ajustar mejor el nivel de protección personal al nivel de riesgo asociado a una amplia variedad de actividades de campo.

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These guidelines are the product of a 3-year gestation that has now spanned the tenure of 3 ASM Presidents. We recognize ASM past-President Bob Timm for his leadership in establishing this ad hoc committee in 2007 and for his many insights throughout the process of crafting these recommendations. His tenure was followed by that of Sue McLaren, who was instrumental in shepherding this through numerous drafts and for managing the mutually respectful correspondence with CDC in 2008. Current ASM President Michael Mares has been a strong proponent of these recommendations from the outset, and his drive and determination helped to move this to the present format. Two colleagues in CDC, Darin Carroll and Jim Mills, provided critical insight that helped us understand goals and constraints at CDC. Karl M. Johnson, formerly with CDC, reviewed earlier versions of this document and provided additional feedback that helped make this a productive contribution toward management of risk in field mammalogy. Finally, we thank Michael A. Mares for providing the Resumen.

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