Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 65 / No. 21
June 3, 2016

Human Rabies — Wyoming and Utah, 2015

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In September 2015, a Wyoming woman was admitted to a local hospital with a 5-day history of progressive weakness, ataxia, dysarthria, and dysphagia. Because of respiratory failure, she was transferred to a referral hospital in Utah, where she developed progressive encephalitis. On day 8 of hospitalization, the patient's family told clinicians they recalled that, 1 month before admission, the woman had found a bat on her neck upon waking, but had not sought medical care. The patient's husband subsequently had contacted county invasive species authorities about the incident, but he was not advised to seek health care for evaluation of his wife's risk for rabies. On October 2, CDC confirmed the patient was infected with a rabies virus variant that was enzootic to the silver-haired bat (*Lasionycteris noctivagans*). The patient died on October 3. Public understanding of rabies risk from bat contact needs to be improved; cooperation among public health and other agencies can aid in referring persons with possible bat exposure for assessment of rabies risk.

Case Report

On September 22, 2015, a Wyoming woman aged 77 years with a history of mild dementia was evaluated at a local emergency department with a 5-day history of progressive weakness and ataxia after a fall. On examination, she had slurred speech, could not swallow water, and could not stand without assistance. Initial blood tests did not indicate any specific abnormalities; lumbar puncture was not performed. Urinalysis suggested urinary tract infection, and intravenous ceftriaxone was started; urine culture subsequently grew pan-sensitive *Escherichia coli*. Magnetic resonance imaging (MRI) of the brain and spine revealed no acute pathology.

During the first 2 days of hospitalization, the patient's weakness, dysarthria, and dysphagia progressed. She became increasingly confused and dyspneic and positive pressure ventilation was started. Lumbar puncture was performed on September 24; cerebrospinal fluid (CSF) had elevated protein of 64 mg/dL (normal = 15–45 mg/dL) and a white blood cell count of 7 cells/μL (normal = 0–5 cells/μL) with 72% polymorphonuclear leukocytes and 28% lymphocytes. Electromyography and nerve conduction studies suggested a demyelinating process. A presumptive diagnosis of Guillain-Barré syndrome was made, and intravenous immunoglobulin (Ig) therapy was initiated.

On September 26, the patient required endotracheal intubation for worsening respiratory failure, and on September 27,

INSIDE

534 Cigarette Smoking Among Urban American Indian Adults — Hennepin and Ramsey Counties, Minnesota, 2011
538 Public Confidence in the Health Care System 1 Year After the Start of the Ebola Virus Disease Outbreak — Sierra Leone, July 2015
543 Interim Guidance for Interpretation of Zika Virus Antibody Test Results
547 Notes from the Field: Investigation of Hepatitis C Virus Transmission Associated with Injection Therapy for Chronic Pain — California, 2015
550 Notes from the Field: Increase in *Neisseria meningitidis*–Associated Urethritis Among Men at Two Sentinel Clinics — Columbus, Ohio, and Oakland County, Michigan, 2015
553 QuickStats

Continuing Education examination available at http://www.cdc.gov/mmwr/cme/conted_info.html#weekly.

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she was transferred to a referral hospital in Utah. Examination on arrival revealed near complete quadriplegia and spontaneous myoclonus. During the next 5 days the woman became comatose. Repeat brain and spine MRI revealed new enhancement of the dura, trigeminal nerve, and cauda equina, indicative of a central infiltrative process. Tests of blood and CSF for infectious, oncologic, and autoimmune etiologies were unrevealing.

On September 30 (13 days after initial symptom onset and day 8 of hospitalization), family members reported that on August 22, 2015, the patient awoke at night in her home with a bat on her neck, which she swatted away with her hand (Figure). She immediately washed her hand with soap and water; her husband examined her for bite wounds and found none. She did not seek medical attention. Her husband captured the bat with gloved hands and released it outside.

On October 1, the Utah Department of Health coordinated the collection and shipment of specimens to CDC for rabies virus diagnostic evaluation. Rabies virus RNA was detected in nuchal skin biopsy and saliva by reverse transcription–polymerase chain reaction. Rabies virus antigens were found in nuchal skin biopsy by direct fluorescent antibody testing, and rabies IgM and IgG were detected in CSF and serum by indirect fluorescent-antibody assay, and confirmed by the rapid fluorescent focus inhibition test. The rabies virus variant was identified as one enzootic to the silver-haired bat (*Lasionycteris noctivagans*). The woman died on October 3, 2015. She was the first Wyoming resident with confirmed rabies virus infection since the state began documenting reportable infectious diseases in 1911.

Public Health Investigation

After rabies infection was confirmed on October 2, Salt Lake County Health Department and Wyoming Department of Health (WDH) personnel interviewed 15 family members and community contacts to assess rabies exposure risk from contact with the patient and from bat encounters in the patient's home. The patient's husband and one other family member required postexposure prophylaxis (PEP) because of potential contact with the woman's saliva through kissing or sharing of food and drinks during the woman's infectious period. Because rabies virus can be shed in saliva and tears 2 weeks before symptom onset, the infectious period began on September 4, 2015, 2 weeks before she fell at home on September 18 (Figure). The patient's husband also required PEP because of his potential bat exposure on August 22. Two other contacts chose to receive PEP although they did not report exposures that would constitute increased risk for acquiring rabies (Table) (*1*).

WDH worked with the Wyoming hospital to assess rabies exposure risk among the patient's health care providers. The employee health department at the Utah hospital instructed personnel with potential exposure of nonintact skin or mucous membranes to the patient's saliva, tears, respiratory tract secretions, CSF, or nuchal biopsy specimens to discuss PEP with the employee health medical director. Between the Wyoming and Utah hospitals, 100 health care providers had cared for the patient; 22 (22%) received PEP (Table).

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2016;65:[inclusive page numbers].

FIGURE. Timeline of events involving a woman patient with fatal rabies virus infection — Wyoming and Utah, August–October 2015

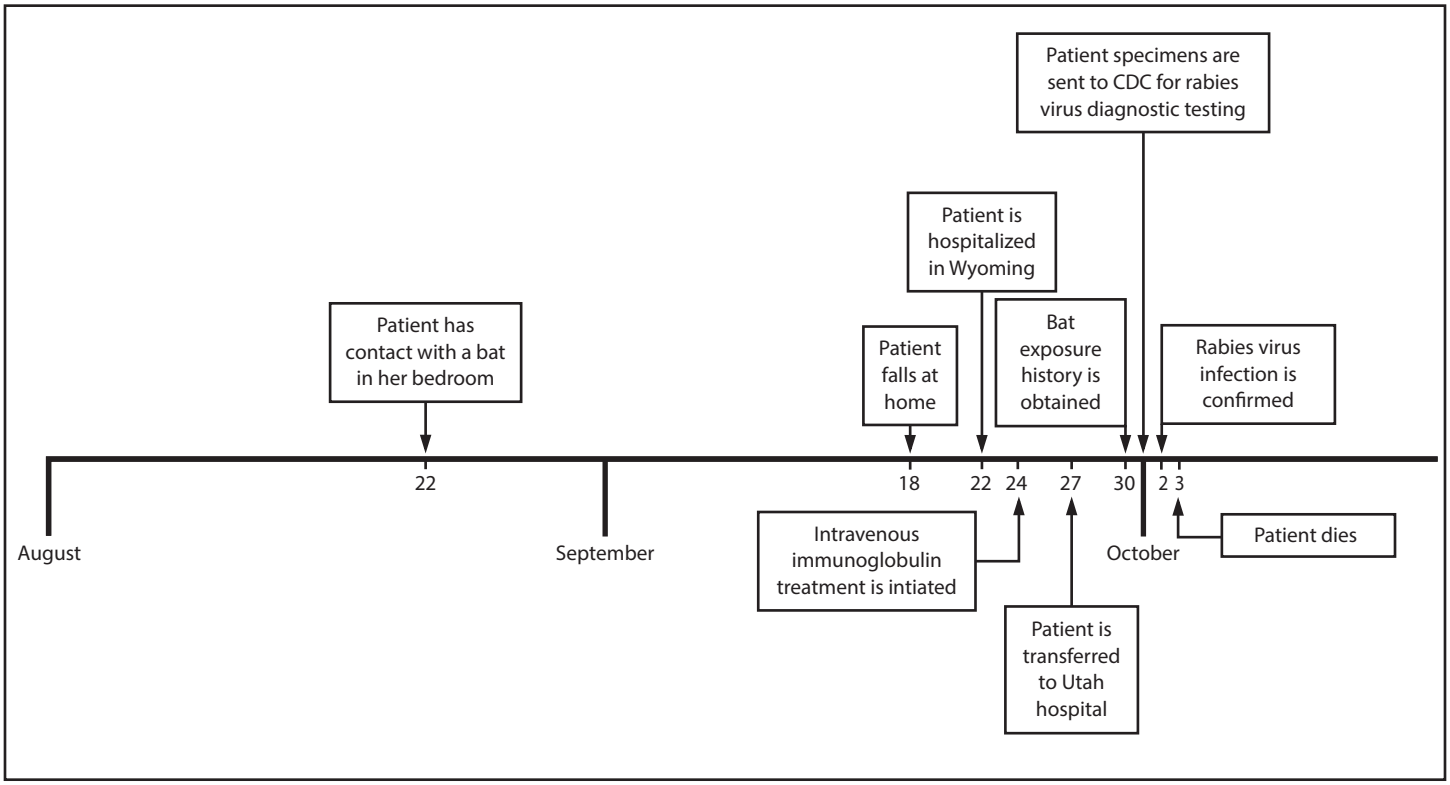

TABLE. Reported reasons for receipt of rabies postexposure prophylaxis (PEP) among 100 hospital care providers and 15 family members and community contacts of a woman patient with fatal rabies virus infection — Wyoming and Utah, 2015

Reason for receiving PEP	Hospital care providers No. (%)	Family members and community contacts No. (%)
Possible exposure to patient saliva, sputum, or tears		
Nonintact skin	3 (3)	0 (—)
Mucous membranes	4 (4)	2 (13)*
Both nonintact skin and mucous membranes	3 (3)	0 (—)
Intact skin†	2 (2)	0 (—)
Bat contact at the patient's home	**N/A**	**1 (7)***
No reported exposure but chose to receive PEP	**10 (10)**	**2 (13)**
Total	**22 (22)**	**4 (27)**

Abbreviation: N/A = not applicable.

* The patient's husband had both possible mucous membrane exposure to patient saliva, sputum, or tears, and possible bat contact at the patient's home.

† Not considered an exposure requiring PEP by the Advisory Committee on Immunization Practices. CDC. Human rabies prevention—United States, 2008: recommendations of the Advisory Committee on Immunization Practices. MMWR Recomm Rep 2008;57(No. RR-3).

During further interviews with the patient's family, local public health workers and WDH learned that the patient's husband had consulted a county weed and invasive species authority about the bat incident during the week after it occurred, but he was neither informed about the risk for rabies exposure nor referred to medical or public health officials. The family also reported that during the multiple years they had owned their home, they had often seen bats outside and under the eaves of the home, and that the patient and her husband had occasionally encountered bats inside the home. They reported having contacted multiple authorities from local wildlife, invasive species, and health agencies about bat removal over the years, but said they had never received information concerning rabies.

On October 2, 2015, WDH issued a press release with recommendations for preventing rabies, including when to seek medical attention for possible rabies exposure. WDH staff members also contacted county authorities to provide information regarding rabies risk and ensure that correct referrals to public health agencies would be made in the future.

Discussion

Rabies is a nearly universally fatal zoonotic disease caused by infection with viruses of the genus *Lyssavirus* and characterized by acute progressive encephalitis (*2*). Rabies virus is usually transmitted by an animal bite, and is preventable if exposed persons receive appropriate PEP, which includes thorough wound cleansing, human rabies immunoglobulin, and 4 doses of inactivated rabies vaccine on days 0, 3, 7, and 14 (*3*).

Human rabies presents a diagnostic challenge because of its rare occurrence in the United States and varied clinical

presentations; symptoms can be difficult to distinguish from Guillain-Barré syndrome (*2*). Although the patient had prominent dysphagia, a symptom that is rare in other etiologies of encephalitis (*4*), diagnosis was complicated by her preexisting dementia and acute urinary tract infection, both of which might have explained some of her symptoms. In this case, the history of bat exposure was critical in leading clinicians to consider a diagnosis of rabies; however, because a history of animal bite cannot be documented in the majority of rabies cases in the United States (*5*), clinicians should consider a diagnosis of rabies infection in any patient with acute unexplained encephalitis (*6*).

The prolonged hospitalization of the patient described in this report raised concerns about possible exposures among health care providers. PEP is only indicated for health care providers who have mucous membrane or open skin contact with saliva, tears, or nervous tissue (*1*). Consistent adherence to standard precautions among providers could have reduced the need for PEP (*1*,*6*,*7*). The Hospital Infection Control Practices Advisory Committee recommends standard precautions for all hospitalized patients, including situations in which a transmissible infectious disease is not initially suspected (*7*).

The patient described in this report likely acquired rabies through the reported bat exposure in the home. During recent decades, most domestically acquired human rabies cases have been associated with bat exposures, either by history of bat contact or infection with bat-associated rabies virus variants (*6*,*8*); however, in the majority of these cases, no bite was reported (*5*,*8*). Because bat bites can cause limited injury and therefore can be difficult to detect (*9*), the Advisory Committee on Immunization Practices recommends that any person with direct bat contact or who might be unaware of bat contact (e.g., awakening with a bat in the room) undergo evaluation for rabies virus exposure (*1*).

In this case, the patient and her husband, her primary caregiver, were unaware of the risk for rabies in the absence of a visible bite wound, did not seek medical evaluation, and did not receive PEP. The reported multiple past telephone calls by the patient's family to local authorities regarding bats represent missed opportunities to provide rabies education. Similar missed opportunities were reported in a previous human rabies case in the United States (*10*). These cases indicate the need to not only increase public awareness of rabies transmission risk from bat exposure, but also the need to educate public agencies outside of the public health domain to ensure that they can provide accurate information and proper referrals.

Summary

What is already known about this topic?

Rabies is a nearly universally fatal zoonotic disease, but is preventable if exposed persons receive postexposure prophylaxis (PEP). During recent decades, most domestically acquired human rabies cases in the United States have been associated with bat exposures; however, in the majority of these cases, no bite was reported.

What is added by this report?

In 2015, a Wyoming woman aged 77 years died from infection with a rabies virus variant enzootic to the silver-haired bat. The patient had contact with a bat while sleeping, but she and her husband, her primary caregiver, were unaware of the risk for rabies in the absence of a visible bite wound; they did not seek medical evaluation or receive PEP after the incident. The patient's family had reportedly contacted several local agencies about bats near their home over multiple years, but had not been informed about the risk for rabies.

What are the implications for public health practice?

Public understanding of rabies exposure risk from bat contact needs to be improved. Cooperation among public health and other agencies can aid in referring persons with potential bat exposure for rabies risk assessment.

Acknowledgments

Cindy Herrera, Julie Twist, Fremont County Health Department, Wyoming.

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Cigarette Smoking Among Urban American Indian Adults — Hennepin and Ramsey Counties, Minnesota, 2011

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In 2013, it was estimated that the prevalence of cigarette smoking among American Indians was 36.5%, the highest of all racial/ethnic groups in the continental United States (*1*). Among American Indians, considerable cultural and geographic variation in cigarette smoking exists. Smoking prevalence among American Indians is lowest in the Southwest and highest in the Upper Midwest/Northern Plains (*2*). Little information is available about tobacco use among urban American Indians, who might not have ever lived on a reservation or be enrolled in or affiliated with a tribe. In Minnesota, a significant proportion of American Indians reside in urban areas. Among Minnesota's residents who identify as American Indian alone or in combination with another race, 30% live in Hennepin County and Ramsey County, which encompass Minneapolis and St. Paul, respectively (collectively known as the Twin Cities). The predominant tribes (Ojibwe [Chippewa] and Dakota/Lakota/Nakota [Sioux]) traditionally have used locally grown tobacco (*Nicotiana rustica*), red willow, and other plants for religious ceremonies, although nonceremonial tobacco is often substituted for traditional plants. To assess prevalence of cigarette smoking among this population, it is important to distinguish ceremonial tobacco use (smoked or used in other ways) from nonceremonial tobacco use. To obtain estimates of cigarette smoking prevalence among American Indians in Hennepin and Ramsey counties, the American Indian Adult Tobacco Survey was administered to 964 American Indian residents in 2011, using respondent-driven sampling. Among all participants, 59% were current smokers, 19% were former smokers, and 22% had never smoked. Approximately 40% of employed participants reported that someone smoked in their workplace area during the preceding week. High prevalences of cigarette smoking and secondhand smoke exposure among urban American Indians in Minnesota underscores the need for a comprehensive and culturally appropriate approach to reducing nonceremonial tobacco use.

Because no lists of eligible respondents existed, the study sample was generated using respondent-driven sampling (*3*). Using this sampling scheme, identified respondents referred persons they knew, who in turn referred persons they knew. A mathematical model weighted the sample to compensate for the fact that it was collected in a nonrandom way. Each participant, beginning with the initial five respondents (called seeds) chosen by investigators, was given three coupons with unique identification numbers to give to other eligible participants. This process continued through 12 rounds of recruitment to produce a sufficient sample for prevalence estimates with a reasonable margin of error. Eligible participants were aged ≥18 years, self-identified as American Indian (alone or in combination with other races), and resided in Hennepin or Ramsey counties. Only one respondent per household was eligible. Data were collected in community settings through face-to-face interviews by American Indian interviewers who received training in interviewing and human subject protection. Participants received a $15 gift card for participating in the survey and a $10 gift card for each of their participating coupon recipients. This study was approved by the University of Minnesota Institutional Review Board (IRB), the Fond du Lac Reservation IRB, and the Indian Health Service IRB.

The survey was conducted during March–May, 2011, and was based on the American Indian Adult Tobacco Survey (*4*). It included questions about spiritual, ceremonial, nonceremonial, and smokeless tobacco use, including information on initiation and quitting; secondhand smoke exposure; attitudes and knowledge about nonceremonial tobacco, including harms and social acceptability; and participant demographics, including age, sex, education level, and household income. To determine cigarette-smoking status, participants were asked the following question: "Not including ceremonial or sacred use…in your entire life have you smoked at least 100 cigarettes?" Respondents who answered "yes" were asked, "Do you usually now smoke cigarettes every day, some days, or not at all?" Current smokers were defined as participants who had ever smoked at least 100 cigarettes and at the time of the survey smoked every day or some days. Former smokers were defined as persons who had smoked at least 100 cigarettes and at the time of the survey did not smoke at all, and never smokers were defined as participants who had not smoked 100 cigarettes in their lifetimes. Smokers were asked about willingness to use various smoking cessation aids or methods, including nicotine replacement therapy, buproprion or varenicline products, various quit smoking modalities, and traditional tribal practices. Participants were asked if, during the previous week, anyone had smoked tobacco around them in their house, in a car, where they work, or somewhere else, other than for ceremonial or sacred purposes. Raw data were adjusted for network size using weights generated by the RDS Analysis Tool.* Data were further weighted by gender, age, and county of residence distribution

* RDS = respondent-driven sampling. RDS Analysis Tool v5.6 user manual (http://www.respondentdrivensampling.org/reports/RDSAT_56_Manual.pdf).

of American Indians (alone or in combination with other races) from the U.S. Census. Data were compared with data from the 2010 Minnesota Adult Tobacco Survey (*5*).

The target sample size was 1,000 participants, based on estimates of detectable differences in smoking rates by demographic categories. The survey was administered to 964 persons, and yielded 940 usable responses. The unweighted sample closely matched the age distribution for American Indians from the 2010 U.S. Census, but women and Hennepin County residents were overrepresented. Most respondents (87%) were enrolled[†] in a tribe (65% Ojibwe, 20% Dakota/Lakota, 2% other). Sixty-four percent of participants were female; 18% were aged 18–24 years, 45% were aged 25–44 years, 32% were aged 45–64 years, and 5% were aged ≥65 years.

The estimated prevalences of current smoking, former smoking, and never smoking in this population were 59.3%, 18.5%, and 22.1%, respectively (Table 1). The estimated current smoking prevalence among women (55.8%) was lower than among men (63.7%); estimated prevalence of current smoking was highest among persons aged 25–44 years (72.4%) and lowest among persons aged ≥65 years (28.8%). The estimated prevalence of never having smoked was highest among persons aged 18–24 years (41.6%). No association of smoking status with educational level was evident. The largest percentage of smokers in this sample (39.4%) smoked ≤5 cigarettes on days they smoked, but 70.5% reported that they had smoked at least 20 days during the previous month. Regular filtered cigarettes (48.3%) and menthol cigarettes (42.1%) were predominantly reported to be the type of cigarette usually smoked (Table 2).

Among persons who had ever smoked, 23.8% reported that they had quit smoking. Two thirds (67.6%) of current smokers indicated that they wanted to quit, and approximately half (57.2%) had tried quitting during the previous year. When asked about willingness to use various smoking cessation aids or methods, a large proportion (42.9%) said they would use nicotine replacement therapies. However, other medications like varenicline (a prescription nicotine agonist) or buproprion (a prescription antidepressant medication used as a smoking cessation aid) were less acceptable (16.6%). A relatively small percentage (14.7%) of current smokers were open to telephone support such as quit lines; individual or group support for cessation was more acceptable (36.9% and 25.4% respectively). One third of participants (33.4%) knew of a stop-smoking program, most often located in a local American Indian health clinic.

Survey participants reported a higher prevalence of secondhand smoke exposure in homes (41.5%), cars (64.3%), workplaces (40.8%), and other places (69.8%) than did residents of Minnesota as a whole in the 2010 Minnesota Adult Tobacco Survey (Figure) (*5*). Most (97%) employed respondents reported working in a location other than a reservation.

[†] Membership in a tribe based on tribally determined criteria, such as ancestry and tribal blood quantum.

TABLE 1. Estimates of smoking status* of American Indians aged ≥18 years — Hennepin and Ramsey Counties, Minnesota, 2011

Characteristic	Current smokers[†] % (95% CI)	Former smokers[§] % (95% CI)	Never smokers[¶] % (95% CI)
Overall	**59.3 (56.7–61.9)**	**18.5 (16.5–20.5)**	**22.1 (19.9–24.3)**
Gender			
Men	63.7 (59.4–68.0)	17.2 (13.9–20.5)	19.2 (15.8–22.6)
Women	55.8 (52.6–59.0)	19.6 (17.1–22.1)	24.6 (21.8–27.4)
Age group (yrs)			
18–24	52.0 (46.4–57.6)	6.4 (3.9–8.9)	41.6 (35.9–47.3)
25–44	72.4 (68.4–76.4)	12.8 (9.6–16.0)	14.6 (11.9–17.7)
45–64	51.5 (47.4–55.6)	28.9 (25.1–32.7)	19.6 (16.1–23.1)
≥65	28.8 (20.7–36.9)	48.1 (39.1–57.1)	23.1 (15.3–30.9)
Education			
No high school diploma	56.3 (51.0–61.6)	19.0 (14.4–23.6)	24.7 (20.6–28.8)
High school diploma or GED	65.3 (61.3–69.3)	16.1 (13.4–18.8)	18.6 (15.3–21.9)
Postsecondary	56.0 (51.6–60.8)	20.9 (17.7–24.1)	23.1 (19.1–27.1)

Abbreviations: CI = confidence interval; GED = General Educational Development.

* Based on weighted sample of 940 residents of Hennepin and Ramsey Counties aged ≥18 years.

[†] Smoked ≥100 cigarettes in lifetime; currently smokes every day or some days.

[§] Smoked ≥100 cigarettes in lifetime; currently does not smoke at all.

[¶] Never smoked 100 cigarettes in lifetime.

Discussion

The prevalence of cigarette smoking among American Indians aged ≥18 years in the urban area of the Twin Cities was 59%, approximately four times greater than that of the overall Minnesota population estimate of 16% (*5*). Few comparable estimates of cigarette smoking among American Indians in the Twin Cities are available. Previous analyses reported a cigarette smoking prevalence of 36.6% for American Indians in Hennepin and Ramsey counties based on Behavioral Risk Factor Surveillance System data during 2005–2010 (*6*). A 2007 study based on a convenience sample of 300 American Indians in Minneapolis reported a smoking prevalence of 62% (*7*). Precision and validity of Behavioral Risk Factor Surveillance System-based data and other surveillance estimates are limited by small sample size, culturally inappropriate data collection methods (e.g., use of telephone instead of face-to-face interviews), lack of attention to ceremonial tobacco use, and exclusion of American Indians who indicate more than one race. This study was able to produce estimates of cigarette smoking prevalence among Twin Cities American Indians by using culturally appropriate methods.

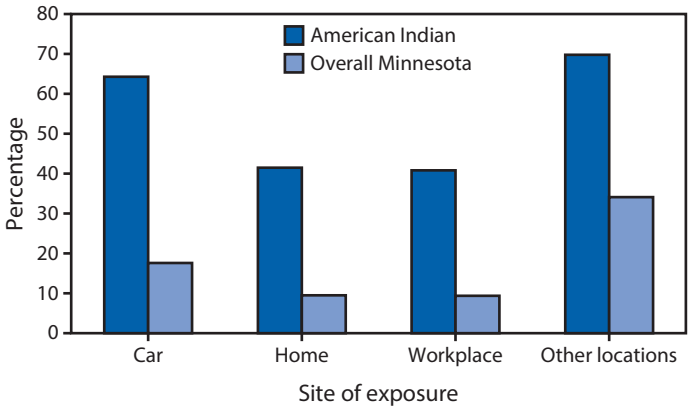
Although smoking prevalence in the general population follows a strong education gradient (*8*) this gradient was not observed in this population. The cigarette smoking prevalence among persons aged 25–44 years (72%) is particularly

TABLE 2. Estimated smoking patterns of current smokers* among American Indians aged ≥18 years — Hennepin and Ramsey Counties, Minnesota, 2011†

Characteristic	Smokers % (95% CI)
No. days smoked, past 30 days	
1–5	6.6 (5.2–8.0)
6–10	11.2 (7.9–14.5)
11–19	10.4 (8.0–12.8)
≥20	70.5 (66.8–74.2)
No. cigarettes smoked on days smoked	
≤5	39.4 (35.8–43.0)
6–10	28.6 (25.5–31.7)
11–20	25.9 (22.8–29.0)
≥21	5.5 (4.3–6.7)
Usual type of cigarettes	
Regular filtered	48.3 (44.7–51.9)
Menthol	42.1 (38.5–45.7)
Light/Ultra-light	6.9 (5.5–8.3)
Regular unfiltered	1.6 (0.9–2.3)
Natural (no additives)	1.0 (0.5–1.5)

Abbreviation: CI = confidence interval.
* Have smoked ≥100 cigarettes in lifetime; currently smokes every day or some days.
† Based on weighted sample of 940 residents of Hennepin and Ramsey Counties aged ≥18 years.

FIGURE. Percentage of persons who reported secondhand smoke exposure during the previous week, among urban* American Indians, 2011, and overall Minnesota, 2010†



* Residing in Hennepin and Ramsey Counties, Minnesota.
† Overall data reported from 2010 Minnesota Adult Tobacco Survey.

concerning in light of the effect of adult smoking on youth behavior and on secondhand smoke exposure of youth (*8*). Participants reported much higher prevalences of secondhand smoke exposure, including at their workplace and at other places than did the general Minnesota population (*5*). The Minnesota state law that prohibits smoking in all indoor workplaces, restaurants, and bars does not apply on reservations; however, almost all of the employed respondents reported working in a non-reservation location, so most of the reported worksite secondhand smoke exposure represents potential noncompliance with Minnesota law. Most smokers have made quit attempts, but few have been successful. Food and Drug Administration-approved medications for smoking cessation and quit lines (the universally available method) were less well accepted among the participants than the other methods surveyed.

The findings in this report are subject to at least three limitations. First, data were self-reported, and neither smoking status nor secondhand smoke exposure were verified biochemically. However, self-reported smoking status has been shown to correlate highly with serum cotinine levels (*9*). Second, the unweighted sample overrepresents women and Hennepin County residents. For that reason, the data were weighted to the population distribution in the represented counties. Finally, response bias could have been introduced by respondent-driven sampling methods. However, the sampling and weighting procedures followed as part of respondent-driven sampling methods have been found to produce asymptotically unbiased estimates (*3*).

Nonceremonial tobacco use is the most widespread and serious risk factor for chronic disease among the Minnesota American Indian population; such use contributes to the considerably elevated mortality from lung cancer, heart disease, diabetes and stroke in this population compared with the general population (*10*). Comprehensive tobacco prevention and control efforts, including increasing the price of cigarettes, implementing comprehensive smoke-free laws, conducting mass media campaigns to educate the public about the harmful effects of smoking and secondhand smoke exposure, and making evidence-based cessation treatments available, are effective in reducing tobacco use in the general population. However, these strategies could be adapted to be more culturally appropriate to American Indians to address disparities in nonceremonial tobacco use. In addition, approaches such as engaging traditional healers and respected elders, fostering respect for traditional ceremonial use of tobacco as a reason for not smoking recreationally, and addressing tobacco addiction in the context of social determinants of health specific to American Indians should be considered. A need exists for surveys that are specific to subpopulations and that use culturally appropriate methods to obtain valid data and inform public health intervention priorities.

Acknowledgments

Lisa Skjefte, Amanda Corbett, School of Public Health, University of Minnesota; Nancy Bennett, Great Lakes Inter-tribal Epidemiology Center, Lac du Flambeau, Wisconsin.

Summary

What is already known about this topic?

Smoking prevalence among American Indians in the Upper Midwest is the highest among all American Indians, and considerably higher than the smoking prevalence of the general population. Little is known about nonceremonial tobacco use among urban American Indians, and surveillance estimates are limited by small sample size, culturally inappropriate data collection methods, lack of attention to ceremonial tobacco use, and exclusion of American Indians who indicate more than one race.

What is added by this report?

Among American Indians surveyed in Hennepin and Ramsey counties, Minnesota, 59% were current smokers, and 19% were former smokers. Smoking was most common among persons aged 25–44 years (72%). Reports of secondhand smoke exposure were high, including 42% who reported exposure in the workplace.

What are the implications for public health practice?

Cigarette smoking is a substantial public health problem in this subpopulation. Culturally specific adaptations of strategies that have produced U.S. population-wide declines are needed. These could include engaging traditional healers and respected elders, fostering respect for traditional ceremonial use of tobacco as a reason for not smoking recreationally, and addressing tobacco addiction in the context of social determinants of health specific to American Indians.

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Public Confidence in the Health Care System 1 Year After the Start of the Ebola Virus Disease Outbreak — Sierra Leone, July 2015

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Ensuring confidence in the health care system has been a challenge to Ebola virus disease (Ebola) response and recovery efforts in Sierra Leone (*1*). A national multistage cluster-sampled household survey to assess knowledge, attitudes, and practices (KAP) related to Sierra Leone's health care system was conducted in July 2015. Among 3,564 respondents, 93% were confident that a health care facility could treat suspected Ebola cases, and approximately 90% had confidence in the health system's ability to provide non-Ebola services, including immunizations, antenatal care, and maternity care. Respondents in districts with ongoing Ebola transmission ("active districts") and respondents with higher educational levels reported more confidence in the health care system than did respondents in nonactive districts and respondents with less education. Active districts were the focus of the Ebola response; these districts implemented intensified social mobilization and communication efforts, and established district response centers, Ebola-specific health care facilities, and ambulances. Greater infrastructure and response capacity might have resulted in higher confidence in the health care system in these areas. Respondents ranked Ebola and malaria as the country's most important health issues. Health system recovery efforts in Sierra Leone can build on existing public confidence in the health system.

The 2014–2015 Ebola outbreak in Guinea, Liberia, and Sierra Leone exposed many of the public health challenges these countries face, particularly the need for and lack of a strong health infrastructure (*2*). Ebola control efforts were hampered by lack of understanding about Ebola transmission, mistrust and fear of health facilities and providers (*3*), delays in seeking care, or refusal to seek care (*4*). Sierra Leone's Ebola recovery and health security strengthening efforts depend upon willingness of a population to seek care and trust in that care. An assessment of public attitudes can help develop interventions to address these barriers and build public trust in the health care system. To better understand health care–seeking practices and perceptions of the health care system in Sierra Leone during the Ebola outbreak, the Sierra Leone Ministry of Health and Sanitation and CDC partnered with FOCUS 1000, a Sierra Leone-based nongovernmental organization,* and other stakeholders to conduct the KAP survey in July 2015.

The national cross-sectional household survey used multistaged cluster sampling, with probability of selection of primary sampling units (clusters) proportional to their size. Ninety-one clusters were sampled, and 20 households were selected from each cluster using systematic random sampling. Because of their influential role in household decisions and practices, heads of households were prioritized for interviewing. Anticipating that a majority of the household heads would be older men, interviewers randomly selected a second survey participant from each household (either a woman of any age or any other person aged 15–24 years). To ensure reliable district-level estimates, active districts† (areas in which a confirmed Ebola case had been reported during the preceding 42 days) were oversampled. A weighting factor was applied to each record to adjust for selection probability at the district level.

Trained data collectors used an open source application for digital data collection (OpenDataKit§) installed on WiFi/4G-enabled tablet computers. The survey included open-ended questions about participants' expectations regarding a health care facility's treatment of suspected Ebola cases. Participants' free responses were coded into predetermined response categories. Participants were also asked to rate their confidence regarding Ebola care, non-Ebola illness care, immunization services, and antenatal and maternity care using a 3-point Likert scale with 0 representing "not at all confident" and 2 representing "very confident." Confidence in the health care system was quantified by summarizing frequency, mean score, and standard deviation. Two questions asked about health care–seeking behaviors (willingness to take an ambulance if feeling ill today [yes/no] and willingness to take an ambulance if feeling ill after the outbreak is declared to be over [yes/no]). Participants rated how important it was for their health care system to treat and prevent certain diseases, using a 5-point Likert scale, with 1 representing "not important at all" and 5 representing "very important."

Data were stored on a secure web hosting server and imported into SPSS version 22 for analysis. Results were stratified by demographics, and analysis of variance (ANOVA)

* http://focus1000.org.

† Active districts were Western Urban Area (including the capital of Freetown), Western Rural Area, and Kambia and Port Loko districts (both in the Northern Province); Nonactive districts included Bombali, Koinadugu, Tonkolili, Kailahun, Kenema, Kono, Bo, Bonthe, Moyamba, and Pujehun districts.

§ https://opendatakit.org/.

testing was used to examine group differences. Mean scores and standard deviations for importance were calculated for each health issue. Because participants' ratings on importance of treating and preventing each health issue were all >3 on a 5-point Likert scale, the responses resulted in a negative skewed distribution; the data were normalized before conducting parametric statistical analysis. Repeated measure ANOVA was conducted to examine the differences in ratings for each health issue. Least significant difference posthoc analysis was conducted to examine the pairwise differences and rank importance levels.

Among the 3,640 persons approached by data collectors, 3,564 (98%) participants from 1,782 households consented to take part in the survey (two participants per household). The final survey included 1,774 (49.8%) males and 1,790 (50.2%) females; the participants' average age was 35 years (standard deviation = 15).

Overall, the majority of participants had positive responses about their expectations of a health care facility's treatment of suspected Ebola cases: 69.8% believed that patients suspected of having Ebola would receive care, and 56.0% believed that the health care facility could definitely cure a patient's Ebola (Table 1). The proportion of participants who reported they would ride in an ambulance today if they felt ill (63.3%) was similar to the proportion who said they would do so once the Ebola outbreak was declared over (65.8%) (Table 1).

The majority of the participants were either "very confident" or "somewhat confident" about the health care system's ability to treat Ebola, to treat non-Ebola diseases, to provide children with immunizations safely, and to provide antenatal and maternity care (Table 2). Respondents who resided in active districts expressed more confidence in the health care system than did respondents in nonactive districts. Respondents who had secondary or higher education also reported more confidence about Ebola treatment and child immunization (Table 2) than did respondents with primary school or lower education.

TABLE 1. Expectations of treatment of Ebola virus disease (Ebola) in health care facilities — National Knowledge, Attitudes, and Practices Survey, Sierra Leone, July 2015 (N = 3,564)

Expectations of treatment at health care facilities*	No. (%)
They will take care of him/her (rehydrate, give medicines/ food, and monitor status)	2,488 (69.8)
They will definitely cure the person from Ebola	1,996 (56.0)
I don't know/not sure/no response	161 (4.5)
Others	59 (1.7)
They will find a way to kill the patient so that he/she doesn't spread Ebola to others	37 (1.0)
They won't be able to do anything for him/her and he/ she may die there	36 (1.0)
They will be turned away	5 (0.1)
Health care–seeking behavior	
Willing to ride in an ambulance if feeling ill today	2,257 (63.3)
Willing to ride in an ambulance if feeling ill when Ebola was declared over	2,344 (65.8)

* Open-ended question that was back-coded into predetermined responses.

A repeated measure ANOVA identified significant differences among ranking the importance of health issues in Sierra Leone, ($p<0.000$). A follow-up pairwise comparison indicated the rank of importance as follows: Ebola (mean Likert score = 4.40), malaria (3.92), diarrheal disease (3.74), tuberculosis (3.45), and pneumonia (3.43).

Discussion

In 2010, before the start of the 2014–2015 Ebola outbreak, Sierra Leone was making progress toward its Millennium Development Goals, including stabilization of human immunodeficiency virus prevalence at 1.5% and reductions in child and maternal mortality compared with 2000–2005 levels (*5*). However, the protracted Ebola epidemic might have negatively affected some of those gains. For example, reported measles vaccination coverage declined from 99% in January 2014 to 76% in July 2014, just 2 months into the outbreak (*6*). By July 2015, Ebola incidence in Sierra Leone had declined significantly since peaking in November 2014; at the time of this survey, there was widespread expectation that the country's Ebola case count would soon reach zero. Approximately 90% of respondents reported at least some level of confidence in the health care system, and approximately half reported being very confident in Ebola care, non-Ebola care, immunization services, and antenatal and maternity services. Although much remains to be done to strengthen the health care system in Sierra Leone, these findings suggest public confidence in the system. Building on this confidence through community engagement and communication could complement and accelerate health care system recovery efforts. Strengthening the health care system's infrastructure and building capacity, including increasing the number of health workers, might help ensure that increases in demand for services are met (*7*).

Although the majority of survey participants had at least some level of confidence in the health care system, confidence level varied by geographic location and education. For example, confidence of participants from Eastern Province, where the first case of Ebola was identified, and Western Area, where the largest number of Ebola cases occurred, was higher than in other regions. Kailahun and Kenema districts in Eastern Province were the initial epicenters of the outbreak and had the first two treatment centers in the country. Witnessing Ebola patients being treated and surviving might have contributed to higher levels of confidence among residents in Eastern Province. During January–July 2015, Western Area, Kambia, and Port Loko (the active districts)

TABLE 2. Level of confidence in health care capacity, by province/area and level of education — National Knowledge, Attitudes, and Practices Survey, Sierra Leone, July 2015

Characteristic	No.	Not at all confident % (95% CI)	Somewhat confident % (95% CI)	Very confident % (95% CI)	Confidence level scores M/SD	p-value
Capacity to treat Ebola						
Province/Area*						
Western	798	6.0 (5.3–8.2)	35.0 (31.5–38.4)	59.0 (55.5–62.6)	1.53/0.61	<0.000
Northern	1,740	6.7 (3.0–5.9)	44.1 (41.3–46.9)	49.1 (46.3–51.9)	1.42/0.62	
Eastern	471	4.4(8.4–12.7)	37.5 (34.1–40.8)	58.1 (54.7–61.5)	1.54/0.59	
Southern	555	10.5 (6.1–7.8)	44.4 (41–47.8)	45.0 (41.6–48.5)	1.34/0.62	
District type†						
Active	1,237	6.8 (5.4–8.2)	35.0 (32.3–37.7)	58.2 (55.9–60.9)	1.51/0.62	0.000
Nonactive	2,327	7.0 (6.0–8.0)	43.9 (41.9–45.9)	49.1 (47.1–51.1)	1.42/0.60	
Education						
None	1,303	7.9 (6.4–9.4)	42.1 (39.4–44.7)	50.0 (47.3–52.8)	1.42/0.63	0.008
Primary	734	6.3 (4.5–8.0)	43.4 (39.8–47.0)	50.3 (46.7–54.0)	1.44/0.61	
≥Secondary	1,519	6.3 (5.1–7.5)	38.4 (36.0–40.9)	55.3 (52.8–57.8)	1.49/0.61	
Total	**3,564**	**6.9 (6.1–7.7)**	**40.8 (39.2–42.4)**	**52.3 (50.7–54.0)**	**1.45/0.62**	—
Capacity to treat non-Ebola illness						
Province/Area*						
Western	798	5.3 (3.7–7.0)	24.0 (20.9–27.1)	70.6 (67.3–73.9)	1.65/0.58	<0.000
Northern	1,740	5.4 (4.2–6.7)	33.3 (30.6–35.9)	61.3 (58.6–64.1)	1.56/0.60	
Eastern	471	3.7 (2.4–5.0)	30.4 (27.2–33.5)	65.9 (62.7–69.2)	1.62/0.56	
Southern	555	6.1 (4.4–7.7)	39.2 (35.8–42.6)	54.7 (51.3–58.2)	1.49/0.61	
District type†						
Active	1,237	5.0 (3.8–6.2)	26.3 (23.8–28.8)	68.7 (66.1–71.3)	1.64/0.58	0.000
Nonactive	2,327	4.1 (3.3–4.9)	37.7 (35.7–39.7)	58.2 (60.2–35.3)	1.54/0.58	
Education						
None	1,303	5.7 (4.4–6.9)	32.9 (30.4–35.5)	61.4 (58.8–64.0)	1.56/0.60	0.278
Primary	734	4.8 (3.2–6.3)	32.1 (28.7–35.4)	63.2 (59.7–66.7)	1.58/0.58	
≥Secondary	1,519	4.8 (3.7–5.9)	31.1 (28.8–33.5)	64.1 (61.6–66.5)	1.59/0.58	
Total	**3,564**	**5.1 (4.4–5.8)**	**32.0 (30.4–33.5)**	**62.9 (61.3–64.5)**	**1.58/.59**	—
Capacity to safely provide children with immunizations						
Province/Area*						
West	798	3.6 (2.2–4.9)	22.5 (19.5–25.6)	73.9 (70.7–77.1)	1.70/0.53	0.000
North	1,740	5.7 (4.4–7.0)	34.7 (32.0–37.3)	59.7 (56.9–62.4)	1.54/0.60	
East	471	1.7 (0.8–2.6)	28.3 (25.2–31.4)	70.0 (66.8–73.2)	1.68/0.50	
South	555	6.2 (4.5–7.9)	47.8 (44.4–51.3)	46.0 (42.5–49.4)	1.40/0.60	
District type†						
Active	1,237	5.4 (4.1–6.7)	25.9 (23.5–28.3)	68.6 (66.0–71.2)	1.63/0.58	0.000
Nonactive	2,327	4.2 (3.4–5.0)	38.5 (36.5–40.5)	57.3 (55.3–59.3)	1.53/0.58	
Education						
None	1,303	5.4 (4.2–6.7)	34.2 (31.7–36.8)	60.3 (57.7–63.0)	1.55/0.60	0.023
Primary	734	4.2 (2.8–5.7)	34.2 (30.8–37.6)	61.6 (58.1–65.1)	1.57/0.57	
≥Secondary	1,519	3.6 (2.7–4.6)	32.8 (30.4–35.1)	63.6 (61.2–66.0)	1.60/0.56	
Total	**3,564**	**4.4 (3.7–5.1)**	**33.6 (32.1–35.2)**	**62.0 (60.4–63.6)**	**1.58/0.58**	—

See table footnotes on next page.

experienced intensified social mobilization, enhanced surveillance, and scale-up of treatment facilities; this more developed infrastructure and capacity to respond to Ebola in the active districts might have engendered higher levels of confidence in those areas. Another possible reason for higher confidence in the active districts might be related to the strengthened infection prevention and control efforts aimed at decreasing the high rate of Ebola infection among health care workers early in the epidemic (*8*). The higher levels of confidence in the health care system to treat Ebola and provide childhood immunizations among participants with higher education levels might be a consequence of their having more knowledge and fewer misconceptions about available services. In addition, participants with higher levels of education might have better access to health service information, because radio discussions about health care messages are sometimes conducted in English rather than local languages, which might exclude persons with less education. A 2014 KAP survey in Nigeria also found education level to be positively related to the participant's knowledge, attitudes, and practices regarding Ebola (*9*).

TABLE 2. (*Continued*) Level of confidence in health care capacity, by province/area and level of education — National Knowledge, Attitudes, and Practices Survey, Sierra Leone, July 2015

Characteristic	No.	Not at all confident % (95% CI)	Somewhat confident % (95% CI)	Very confident % (95% CI)	Confidence level scores M/SD	p-value
Capacity to provide ante-natal and child birthing care						
Province/Area*						
West	798	3.8 (2.4–5.2)	23.9 (20.8–27)	72.3 (69.0–75.5)	1.69/0.54	0.000
North	1,740	6.1 (4.7–7.4)	34.3 (31.7–37)	59.6 (56.8–62.3)	1.54/0.61	
East	471	2.1 (1.1–3.1)	30.4 (27.2–33.5)	67.5 (64.3–70.8)	1.65/0.52	
South	555	5.7 (4.1–7.3)	47.0 (43.6–50.5)	47.3 (43.8–50.7)	1.42/0.60	
District type†						
Active	1,237	6.2 (4.9–7.5)	26.0 (23.6–28.4)	67.8 (65.2–70.4)	1.62/0.60	0.003
Nonactive	2,327	4.6 (3.7–5.5)	35.3 (33.4–37.2)	60.1 (58.1–62.1)	1.55/0.58	
Education						
None	1,303	5.8 (4.5–7.0)	33.6 (31.0–36.2)	60.6 (58.0–63.3)	1.55/0.60	0.251
Primary	734	4.1 (2.7–5.5)	34.9 (31.5–38.4)	61.0 (57.5–64.5)	1.57/0.57	
≥Secondary	1,519	3.9 (2.9–4.9)	33.9 (31.5–36.3)	62.2 (59.7–64.6)	1.58/0.57	
Total	**3,564**	**4.6 (3.9–5.3)**	**34.0 (32.5–35.6)**	**61.4 (59.8–63.0)**	**1.57/0.58**	—

Abbreviations: CI = confidence interval; Ebola = Ebola virus disease; M = mean; SD = standard deviation.

* Western Area includes Western Rural and Western Urban districts; Northern Province includes Bombali, Kambia, Koinadugu, and Port Loko, and Tonkolili districts; Eastern Province includes Kailahun, Kenema, and Kono districts; Southern Province includes Bo, Bonthe, Moyamba, and Pujehun districts.

† Active districts: districts with active Ebola cases (Western Areas, and Kambia and Port Loko in Northern Province). Nonactive districts: districts with no Ebola active cases (Bombali, Koinadugu, Tonkolili, Kailahun, Kenema, Kono, Bo, Bonthe, Moyamba, and Pujehun districts).

The Ebola epidemic overwhelmed an already fragile health care delivery system (*4*) and reduced the availability of services for endemic health concerns such as malaria and diarrhea (*10*). Scientific models have suggested that untreated malaria cases resulting from overwhelmed health care systems could have contributed to >10,000 additional malaria-attributable deaths in West Africa during the Ebola epidemic (*10*). Survey participants recognized malaria as the most important health concern after Ebola, underscoring the importance of interventions to mitigate malaria morbidity and mortality during future Ebola response and recovery activities.

The findings in this report are subject to at least four limitations. First, responses were self-reported and could be subject to social desirability bias. Second, the survey was conducted at a time when Ebola response capabilities and infection rates varied by geographic area; areas with stronger Ebola response capabilities might have generated higher confidence in the health care system. Third, the survey measured confidence levels in the health care system using a 3-point Likert scale, whereas a 5-point Likert scale was used to measure importance levels of treating and preventing different diseases. Using the same scale to measure confidence levels and importance levels in the survey would be preferred. Finally, there was no baseline assessment for confidence levels in the health care system and importance levels of treating and preventing different diseases before the Ebola epidemic, so differences in confidence by geographic area and education cannot be attributed to the Ebola outbreak.

Summary

What is already known about this topic?

Public mistrust and fear based on misconceptions regarding health care system facilities and providers increased during the Ebola virus disease (Ebola) epidemic in Sierra Leone, and health care system usage rates declined sharply. Sierra Leone's Ebola recovery and global health security strengthening efforts require willingness of citizens to seek care and place trust in that care.

What is added by this report?

A majority of participants in a knowledge, attitudes, and practices survey conducted after approximately 15 months of an Ebola epidemic in Sierra Leone expressed at least some confidence in the health care system's ability to treat patients suspected to have Ebola, and >90% reported confidence that the health care system could also provide non-Ebola services, including immunizations, antenatal care, and maternity care. Respondents from areas with active Ebola transmission had higher confidence in the health care system, as did respondents with higher education levels. Respondents ranked Ebola and malaria as the most important health issues for Sierra Leone.

What are the implications for public health practice?

Understanding factors contributing to public confidence in the health care system can help develop education and health promotion campaigns. Public confidence in the health care system to deliver basic services provides a foundation on which to build a restored and improved post-Ebola health system in Sierra Leone.

Understanding the public's confidence in the health care system can help develop public education and health promotion campaigns. The public's base of confidence provides a foundation on which to build a restored and improved health system in Sierra Leone.

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Interim Guidance for Interpretation of Zika Virus Antibody Test Results

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On May 31, 2016, this report was posted as an MMWR *Early Release on the* MMWR *website (http://www.cdc.gov/mmwr).*

Zika virus is a single-stranded RNA virus in the genus *Flavivirus* and is closely related to dengue, West Nile, Japanese encephalitis, and yellow fever viruses (*1*,*2*). Among flaviviruses, Zika and dengue virus share similar symptoms of infection, transmission cycles, and geographic distribution. Diagnostic testing for Zika virus infection can be accomplished using both molecular and serologic methods. For persons with suspected Zika virus disease, a positive real-time reverse transcription–polymerase chain reaction (rRT-PCR) result confirms Zika virus infection, but a negative rRT-PCR result does not exclude infection (*3*–*7*). In these cases, immunoglobulin (Ig) M and neutralizing antibody testing can identify additional recent Zika virus infections (*6*,*7*). However, Zika virus antibody test results can be difficult to interpret because of cross-reactivity with other flaviviruses, which can preclude identification of the specific infecting virus, especially when the person previously was infected with or vaccinated against a related flavivirus (*8*). This is important because the results of Zika and dengue virus testing will guide clinical management. Pregnant women with laboratory evidence of Zika virus infection should be evaluated and managed for possible adverse pregnancy outcomes and be reported to the U.S. Zika Pregnancy Registry or the Puerto Rico Zika Active Pregnancy Surveillance System for clinical follow-up (*9*,*10*). All patients with clinically suspected dengue should have proper management to reduce the risk for hemorrhage and shock (*11*). If serologic testing indicates recent flavivirus infection that could be caused by either Zika or dengue virus, patients should be clinically managed for both infections because they might have been infected with either virus.

Zika Virus Infection and Immune Response

Most Zika virus infections are asymptomatic (*12*). Viremia is expected to occur from several days before illness onset until a week after illness onset (*6*,*13*,*14*). Zika virus–specific IgM antibodies develop during the first week of illness (*5*,*6*). Data on duration of IgM antibody persistence following Zika virus infection are limited. However, IgM antibodies against West Nile virus, a closely related flavivirus, have been detected in asymptomatic, infected blood donors for at least 3 months after their viremic donation, and almost half of tested patients with West Nile virus neuroinvasive disease had detectable serum IgM antibodies >1 year after illness onset (*15*,*16*). Neutralizing antibodies to Zika virus develop shortly after IgM antibodies and consist primarily of IgG antibodies. Neutralizing antibodies are expected to persist for many years after flavivirus infections and are believed to confer prolonged, possibly lifelong, immunity (*17*–*19*). In persons previously infected with a flavivirus or vaccinated against yellow fever, Japanese encephalitis, or tick-borne encephalitis, subsequent exposure to a related flavivirus can result in a rapid and brisk rise in neutralizing antibodies against multiple flaviviruses (*20*). In addition, the neutralizing antibody titer against a flavivirus to which the person previously was exposed might be higher than the titer against the virus with which they were most recently infected (*20*). For example, a person who was previously infected with dengue virus or who received yellow fever vaccine might respond with high levels of neutralizing antibodies against those viruses when later infected with Zika or West Nile viruses. When performing serologic testing, the presence of these neutralizing antibodies against multiple flaviviruses can preclude conclusive determination of which flavivirus was responsible for the recent infection.

Zika Virus Antibody Testing

An enzyme-linked immunosorbent assay (ELISA) can be used to detect anti-Zika virus IgM antibodies in serum or cerebrospinal fluid; however, the Zika virus IgM ELISA can provide false-positive results because of cross-reacting IgM antibodies against related flaviviruses or nonspecific reactivity. The plaque reduction neutralization test (PRNT) measures virus-specific neutralizing antibody titers and should be performed against various related flaviviruses to rule out false-positive ELISA results. In primary flavivirus infections (i.e., the first time a person is infected with a flavivirus), PRNT also can be used to identify the infecting virus. Usually, this is determined with a neutralizing antibody titer ≥4-fold higher than titers against cross-reacting flaviviruses. Based on earlier flavivirus research and limited preliminary data specific to Zika virus, the historical use of a 4-fold higher titer by PRNT might not discriminate between anti-Zika virus antibodies and cross-reacting antibodies in all persons who have been previously infected with or vaccinated against a related flavivirus (i.e., secondary flavivirus infection) (*20*,*21*). Because of the importance of appropriate clinical management of Zika and dengue virus infections, and

the risk for adverse pregnancy outcomes in women infected with Zika virus during pregnancy, a conservative approach to the interpretation of antibody test results is now recommended to reduce the possibility of missing the diagnosis of either infection (*9*,*11*).

CDC Zika Virus Diagnostic Tests

The Food and Drug Administration (FDA) has issued an Emergency Use Authorization for the CDC Zika IgM Antibody Capture Enzyme-Linked Immunosorbent Assay (Zika MAC-ELISA) for antibody testing (*3*). This assay has been introduced and is being used in qualified public health and Department of Defense laboratories in the United States. The Zika MAC-ELISA is used for the qualitative detection of Zika virus IgM antibodies in serum or cerebrospinal fluid collected from persons meeting the clinical and epidemiologic criteria for suspected Zika virus disease (*3*,*22*). Results are reported as positive (termed "presumptive positive" to denote the need to perform a confirmatory PRNT), equivocal, negative, or inconclusive (i.e., results uninterpretable because of high background optical density). To resolve false-positive results that might be caused by cross-reactivity or nonspecific reactivity, presumptive positive results should be confirmed with PRNT against Zika, dengue, and other flaviviruses to which the person might have been exposed (*3*,*23*). In addition, equivocal and inconclusive results that are not resolved by retesting also should have PRNT performed to rule out a false-positive result.

Interpretation of Zika Virus Testing Results

For persons with suspected Zika virus disease, a positive rRT-PCR result confirms Zika virus infection, and no antibody testing is indicated (*3*,*4*,*7*). However, because of the decline in the level of viremia over time and possible inaccuracy in reporting of dates of illness onset, a negative rRT-PCR result does not exclude Zika virus infection. Therefore, serum IgM antibody testing for Zika and dengue virus infections should be performed if rRT-PCR is negative. For serum specimens collected <7 days after onset of symptoms, the combination of a negative rRT-PCR result and negative IgM antibody testing suggests that there was no recent infection. However, a negative IgM antibody test, in the absence of rRT-PCR testing, might reflect specimen collection before development of detectable antibodies and does not rule out infection with the viruses for which testing was performed. For specimens collected from 7 days to 12 weeks after onset of symptoms, a negative IgM antibody result to both Zika and dengue viruses rules out recent infection with either virus.

Summary

What is already known about this topic?

Zika virus is a mosquito-borne flavivirus closely related to dengue, West Nile, Japanese encephalitis, and yellow fever viruses. Diagnostic testing for Zika virus infection can be accomplished using both molecular and serologic methods. However, results of Zika virus antibody testing can be difficult to interpret because of cross-reactivity with related flaviviruses, which can preclude identification of the specific infecting virus, especially when the person previously was infected with or vaccinated against a related flavivirus.

What is added by this report?

For persons with suspected Zika virus disease, a positive real-time reverse transcription–polymerase chain reaction (rRT-PCR) result confirms Zika virus infection, but a negative result does not exclude infection. In these cases, antibody testing can identify additional recent Zika virus infections. If immunoglobulin (Ig) M test results are positive, equivocal, or inconclusive, performing a plaque reduction neutralization test (PRNT) is needed to confirm the diagnosis. However, recent evidence suggests that a 4-fold higher titer by PRNT might not discriminate between anti-Zika virus antibodies and cross-reacting antibodies in all persons who have been previously infected with or vaccinated against a related flavivirus. Thus, a more conservative approach to interpreting PRNT results is now recommended to reduce the possibility of missing the diagnosis of either Zika or dengue virus infection.

What are the implications for public health practice?

All patients with clinically suspected dengue should receive appropriate management to reduce the risk for hemorrhagic medical complications. Pregnant women with laboratory evidence of a recent Zika virus infection or flavivirus infection should be evaluated and managed for possible adverse pregnancy outcomes and reported to the appropriate Zika virus pregnancy registry. Health care providers should consult with state or local public health authorities for assistance in interpreting test results.

If either the Zika or dengue virus IgM antibody testing yields positive, equivocal, or inconclusive results, PRNTs against Zika and dengue viruses (or other flaviviruses endemic to the region where exposure occurred) should be performed. A PRNT using a 90% cutoff value with a titer ≥10 (the typical starting serum dilution used to establish the presence of virus-specific neutralizing antibodies) against Zika virus, together with negative PRNTs (i.e., <10) against other flaviviruses is confirmatory for recent infection with Zika virus (Table). A PRNT titer ≥10 for both Zika and dengue virus (or another flavivirus) provides evidence of a recent infection with a flavivirus but precludes identification of the specific infecting virus. A negative PRNT against Zika virus in a specimen that is collected >7 days after illness onset rules out Zika virus infection. For specimens collected <7 days after onset of symptoms, the combination of a

TABLE. Interpretation of results of antibody testing for suspected Zika virus infection*,†,§,¶, — United States, 2016**

Zika virus and dengue virus IgM ELISA	Zika virus PRNT	Dengue virus PRNT	Interpretation
Positive or equivocal (either assay)	≥10	<10	Recent Zika virus infection
Positive or equivocal (either assay)	<10	≥10	Recent dengue virus infection
Positive or equivocal (either assay)	≥10	≥10	Recent flavivirus infection; specific virus cannot be identified
Inconclusive in one assay AND inconclusive or negative in the other	≥10	<10	Evidence of Zika virus infection; timing cannot be determined
Inconclusive in one assay AND inconclusive or negative in the other	<10	≥10	Evidence of dengue virus infection; timing cannot be determined
Inconclusive in one assay AND inconclusive or negative in the other	≥10	≥10	Evidence of flavivirus infection; specific virus and timing cannot be determined
Any result (either or both assays)	<10	<10	No evidence of Zika virus or dengue virus infection
Positive for Zika virus AND negative for dengue virus	Not yet performed		Presumptive recent Zika virus infection
Positive for dengue virus AND negative for Zika virus	Not yet performed		Presumptive recent dengue virus infection
Positive for Zika virus AND positive for dengue virus	Not yet performed		Presumptive recent flavivirus virus infection
Equivocal (either or both assays)	Not yet performed		Equivocal results
Inconclusive in one assay AND inconclusive or negative in the other	Not yet performed		Inconclusive results
Negative for Zika virus AND negative for dengue virus	Not indicated		No evidence of recent Zika virus or dengue virus infection

Abbreviations: ELISA = enzyme-linked immunosorbent assay; IgM = immunoglobulin M antibodies; PRNT = plaque reduction neutralization test.

* For persons with suspected Zika virus disease, Zika virus real-time reverse transcription–polymerase chain reaction (rRT-PCR) should be performed on serum specimens collected <7 days after onset of symptoms, and on urine specimens collect <14 days after onset of symptoms.

† In the absence of rRT-PCR testing, negative IgM or neutralizing antibody testing in specimens collected <7 days after illness onset might reflect collection before development of detectable antibodies and does not rule out infection with the virus for which testing was conducted.

§ Zika IgM positive result is reported as "presumptive positive" to denote the need to perform confirmatory PRNT.

¶ Report any positive or equivocal IgM Zika or dengue results to state or local health department.

** To resolve false-positive results that might be caused by cross-reactivity or nonspecific reactivity, presumptive positive Zika IgM results should be confirmed with PRNT titers against Zika, dengue, and other flaviviruses to which the person might have been exposed. In addition, equivocal and inconclusive results that are not resolved by retesting also should have PRNT titers performed to rule out a false-positive result.

negative rRT-PCR and a PRNT titer <10 suggests that there was no infection with Zika virus. However, in the absence of rRT-PCR testing, a PRNT titer <10 might reflect specimen collection before development of detectable neutralizing antibodies and does not rule out infection with the viruses for which testing was conducted. Without confirmatory PRNTs, it is not possible to determine whether a presumptive positive IgM antibody result against Zika virus reflects recent flavivirus infection or a false-positive result.

For asymptomatic pregnant women residing in an area with local Zika virus transmission, IgM testing should be performed upon initiation of prenatal care, mid-second trimester, and if any fetal abnormalities are detected during ultrasound evaluation (*9*). For asymptomatic pregnant women with a history of travel to areas where ongoing Zika virus transmission is occurring, Zika virus antibody testing should be performed on specimens collected 2–12 weeks post travel (*9*). Results are interpreted as for symptomatic persons. If a serum specimen was collected >12 weeks after travel, although IgM might still be present, it is possible that antibody levels have dropped below the detectable limit. Performing routine PRNTs for women in this group is not recommended because any result other than a PRNT titer <10 for Zika virus could represent infection with or vaccination against a flavivirus at any time in the past and does not provide specific evidence of Zika virus exposure during pregnancy.

Management of Persons with Suspected Zika or Dengue Virus Infection

All patients with clinically suspected dengue virus infection should receive appropriate management to reduce the risk for hemorrhagic complications (*11*). Symptomatic and asymptomatic pregnant women with serologic or molecular evidence of recent Zika virus infection should be evaluated and managed for possible adverse pregnancy outcomes and reported to the U.S. Zika Pregnancy Registry or the Puerto Rico Zika Active Pregnancy Surveillance System (*9*,*10*). Among persons for whom serologic testing is unable to determine the most recent infecting flavivirus, an epidemiologic link to a laboratory-confirmed case of dengue or Zika virus disease can be considered in determining the most likely infecting virus (*22*). In addition, data on the epidemiology of viruses known to be circulating at the location of exposure and clinical features of these viral infections should be considered. If serologic testing is inconclusive or there is evidence of recent infection with either Zika or dengue virus, patients should be clinically managed for both infections because they might have been infected with either virus. Health care providers with questions about test result interpretation should consult with state or local public health authorities for assistance.

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Notes from the Field

Investigation of Hepatitis C Virus Transmission Associated with Injection Therapy for Chronic Pain — California, 2015

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On November 26, 2014, the California Department of Public Health (CDPH) contacted CDC concerning a report from the Santa Barbara County Public Health Department (SBPHD) regarding acute hepatitis C virus (HCV) infection in a repeat blood donor. The patient, who was asymptomatic, was first alerted of the infection by the blood bank and had no traditional risk factors for HCV infection. The donor had a negative HCV nucleic acid test (NAT) 56 days before the first positive NAT test, and an investigation into the donor's health care exposures and other potential risk factors, including injection drug use, incarceration, and long-term hemodialysis within this narrow exposure window, was conducted by SBPHD.

One such exposure occurred at a doctor's office (clinic A) where the blood donor received an injection procedure as part of prolotherapy. Prolotherapy, also known as regenerative injection therapy, is an increasingly popular, injection-based complementary and alternative medical therapy used to treat chronic musculoskeletal pain (*1*). Common substances injected include hypertonic dextrose, phenol-glycerine-glucose, and morrhuate sodium, a mixture of saturated and unsaturated fatty acids from cod liver oil (*1*). In addition, some patients also received platelet rich plasma therapy, a method of prolotherapy that involves injection of autologous blood with a high platelet-to-plasma ratio (*2*). No formal practice guidelines have been established for prolotherapy treatment, and no formal training is required to deliver this service. The initial investigation into clinic A revealed infection control breaches that included reentering multidose medication vials with a used syringe, use of single-dose medication vials for multiple patients, poor hand hygiene and inconsistent glove use, and lack of aseptic technique when handling injection equipment and medication. Clinic A was advised to stop these practices, and staff members were educated on bloodborne pathogen transmission. A subsequent visit to clinic A revealed ongoing poor infection control practices by staff members. After this visit, the county health officer issued an order to close clinic A immediately. A joint investigation into clinic A by SBPHD, CDPH, and CDC was initiated to identify additional cases and determine the source of transmission.

Patients who visited clinic A during the preceding 10 months (n = 400) were notified through mailed letters about their potential exposure to HCV, hepatitis B virus (HBV), and human immunodeficiency virus (HIV). SBPHD coordinated free testing through a local laboratory. Case-finding activities included review of medical records for patients who visited clinic A, review of state hepatitis surveillance records and cross-matching with clinic A records, and serologic HCV and HBV testing of staff members. Patients subsequently identified as having HCV infection were interviewed, and a blood specimen was sent to CDC for HCV genotype and phylogenetic testing.

In addition to the index patient, six other patients who received injections at clinic A were determined to have HCV infection by serologic testing. Among these six patients, five were unaware of their HCV infection status. Four of the patients without a prior HCV diagnosis or risk factors for HCV had injection procedures performed in clinic A on the same day as the index patient. A common injected substance used in all the infected patients was not identified through medical chart review, although documentation of injected local anesthesia was inconsistent. No new HBV or HIV infections were found.

Identification of a case of acute HCV infection in a frequent blood donor without other risk factors should be considered a sentinel event and should prompt public health investigation, because this could indicate a possible health care–associated infection (*3*). HCV transmission from health care exposures has been documented previously (Table) (*4*,*5*). Many of these outbreaks are attributable to the same unsafe injection practices observed in clinic A, namely reuse of syringes to access medications used for multiple patients (*5*). Although hospitals have established infection control education, resources, and oversight, health care settings where complementary and alternative medical therapies are administered, especially those that involve injections, might benefit from infection control training and inclusion in health care–associated infection surveillance networks, such as CDC's National Healthcare Safety Network (*6*). All health care settings, including complementary medical settings where injections occur, should follow guidelines for safe injection practices (*7*).

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TABLE. Health care–associated hepatitis C virus outbreaks reported to CDC, by setting — 2008–2015

Setting	Year	State	Persons notified for screening*	Outbreak-associated infections†	Known or suspected mode of transmission§
Outpatient					
Prolotherapy clinic	2015	CA	<1,500	5	Syringe reuse
Insulin infusion clinic	2015	CA	92	9	Fingerstick device (lancet holder) designed for personal use was reused on other patients; inadequate cleaning and disinfection of glucometer before reuse
Pain management clinic	2015	MI	122	2	Syringe reuse
Cardiology clinic	2015	WV	>2,000	5	Use of single-dose vials for >1 patient
Hematology oncology clinic	2012	MI	>300	10	Specific lapses in infection control not identified
Pain management clinic	2011	NY	466	2	Suspected syringe reuse
Pain management clinic	2010	CA	2,293	2	Syringe reuse
Clinic	2010	FL	3,929	5	Drug diversion
Alternative medicine clinic	2009	FL	163	9	Syringe reuse
Endoscopy clinics	2009	NY	3,287	2	Suspected syringe reuse
Ambulatory surgical centers (single-purpose endoscopy clinics) (n = 2)	2008	NV	>60,000	9	Syringe reuse
Cardiology clinic	2008	NC	1,200	5	Syringe reuse
Total	—	—	**>75,000**	**65**	—
Long-term care					
Skilled nursing	2013	ND	>500	46	Epidemiologic analysis suggested podiatry care, phlebotomy, and nail care
Hospital					
Hospital	2015	UT	7,217	>7	Drug diversion
Hospital	2012	AZ, GA, KS, MD, MI, NH, NY, PA	>11,000	45	Drug diversion¶
Hospital-based surgery service	2009	CO	>8,000	26	Drug diversion
Total	—	—	**>26,217**	**>78**	—
Hemodialysis facility					
Outpatient	2015	NJ	237	2	Multiple lapses in infection control identified, including hand hygiene and glove use, vascular access care, medication preparation, cleaning, and disinfection
Outpatient	2015	NJ	84	2	Multiple lapses in infection control identified, vascular access care, medication preparation, cleaning, and disinfection
Outpatient	2015	NJ	98	2	Multiple lapses in infection control identified, including hand hygiene and glove use, vascular access care, medication preparation, cleaning, and disinfection
Outpatient	2015	PA	115	3	Multiple lapses in infection control identified, medication preparation close to treatment area
Outpatient	2015	PA	130	3	Multiple lapses in infection control identified, medication preparation close to treatment area
Outpatient	2015	PA	97	2	Multiple lapses in infection control identified, medication preparation close to treatment area, use of single-dose vials for one patient, no separation of dirty and clean areas

See table footnotes on next page.

TABLE. (*Continued*) Health care–associated hepatitis C virus outbreaks reported to CDC, by setting — 2008–2015

Setting	Year	State	Persons notified for screening*	Outbreak-associated infections†	Known or suspected mode of transmission§
Outpatient	2015	CA	28	3	Breaches in environmental cleaning and disinfection practices
Outpatient	2014	WA	186	3	Breaches in environmental cleaning and disinfection practices
Outpatient	2014	TN	62	2	Breaches in environmental cleaning and disinfection practices
Outpatient	2014	NJ	69	4	Breaches in environmental cleaning and disinfection practices
Outpatient	2014	NJ	97	2	Breaches in environmental cleaning and disinfection practices
Outpatient	2012	PA	66	18	Multiple lapses in infection control identified, including hand hygiene and glove use, vascular access care, medication preparation, cleaning, and disinfection
Outpatient	2012	CA	42	4	Specific lapses in infection control not identified
Outpatient	2011	GA	89	6	Failure to maintain separation between clean and contaminated workspaces
Outpatient	2010	TX	171	2	Specific lapses in infection control not identified
Outpatient	2009	MD	250	8	Breaches in medication preparation and administration practices Breaches in environmental cleaning and disinfection practices
Hospital-based	2009	NJ	144	21	Breaches in medication preparation and administration practices Breaches in environmental cleaning and disinfection practices
Outpatient	2008	NY	657	9	Failure to consistently change gloves and perform hand hygiene between patients; breaches in environmental cleaning and disinfection practices
Total	—	—	**2,622**	**96**	—

Abbreviations: HBV = hepatitis B virus; HCV = hepatitis C virus.

* The number of persons notified for screening is dependent upon information and resources available at the time of investigation and might underestimate the total number of persons at risk.

† Outbreak-associated HBV and HCV infections are defined as those with epidemiologic evidence supporting health care–related transmission and include patients/residents identified with acute infection, or previously undiagnosed chronic infections with epidemiologic evidence indicating that these were likely outbreak-related incident cases that progressed from acute to chronic. Patients/residents identified as likely (previously infected) sources for transmission are not included. In the outbreak investigation setting, case definitions are based on laboratory profile and clinical evidence rather than CDC surveillance case definitions, which might omit asymptomatic cases. Acute HBV is typically defined as having a positive hepatitis B surface antigen and positive IgM core antibody, or positive surface antigen and negative total core antibody (early infection). Chronic HBV is typically defined as having a positive hepatitis B surface antigen, positive total core antibody and negative IgM core antibody. There are no serologic markers to differentiate between acute and chronic HCV infection; defining an infection as possible health care transmission is dependent upon epidemiologic evidence along with a new finding of hepatitis C antibody and/or RNA positivity in a person not previously known positive (whether or not symptoms or alanine aminotransferase elevation are present).

§ All modes of transmission are patient-to-patient unless otherwise indicated.

¶ Drug diversion is the shift of a prescribed substance, typically opioids, from the individual for whom it was prescribed to another person for illicit use.

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Notes from the Field

Increase in *Neisseria meningitidis*–Associated Urethritis Among Men at Two Sentinel Clinics — Columbus, Ohio, and Oakland County, Michigan, 2015

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Neisseria meningitidis (*Nm*) urogenital infections, although less common than infections caused by *Neisseria gonorrhoeae* (*Ng*), have been associated with urethritis, cervicitis, proctitis, and pelvic inflammatory disease. *Nm* can appear similar to *Ng* on Gram stain analysis (gram-negative intracellular diplococci) (*1*–*5*). Because *Nm* colonizes the nasopharynx, men who receive oral sex (fellatio) can acquire urethral *Nm* infections (*1*,*3*,*5*). This report describes an increase in *Nm*-associated urethritis in men attending sexual health clinics in Columbus, Ohio, and Oakland County, Michigan.

The Columbus and Oakland County clinics are two of the sites participating in CDC's Gonococcal Isolate Surveillance Project,* through which urethral isolates from the first 25 men evaluated each month with *Ng* urethritis undergo antibiotic susceptibility testing. At both clinics, staff members obtain urethral swabs from men for Gram stain and culture, and urine for nucleic acid amplification testing (NAAT) for *Ng*. During January–November 2014, Columbus documented no cases of presumed *Nm* urethritis (i.e., urethral gram-negative intracellular diplococci, growth of oxidase-positive bacterial colonies on modified Thayer-Martin media, and negative urine NAAT for *Ng*). However, two presumed cases occurred in December 2014. During January–September 2015, a total of 52 cases of urethritis were confirmed to be caused by *Nm* by Analytic Profile Index *Neisseria-Haemophilus* (API NH) (BioMérieux) testing and *sodC* polymerase chain reaction (PCR). Using the same criteria, Oakland County had documented two cases of *Nm* urethritis in 2013, eight cases in 2014, and 15 cases during January–October 2015.

Fifty-two urethral *Nm* isolates from Columbus and 12 from Oakland County were sent to CDC for molecular characterization. All Columbus isolates were non-groupable by slide agglutination serogrouping and serogroup specific PCR. Multilocus sequence typing demonstrated that all isolates were ST-11 and part of the CC-11/ET-37 clonal complex. Eleven of the 12 Oakland County isolates exhibited the same genetic profile as the Columbus isolates.

Demographic characteristics of the Columbus and Oakland County patients were similar (Table). Median age of the Columbus patients was 30.0 years (interquartile range = 24.5–39.0 years); median age of the Oakland County patients was 29.0 years (interquartile range = 18.0–47.0 years). Among all patients, 99% reported heterosexual orientation, and 97% had symptomatic urethritis. Oral sex was reported by 100% of Columbus patients (data on receipt of fellatio was not available) and 93% of Oakland County patients (100% received fellatio). Among Columbus patients, 84% reported two or more sex partners in the preceding 90 days, whereas 56% of Oakland County patients reported two or more partners in the preceding 60 days. Five Columbus patients reported out of state travel during the preceding 60 days, including to New York, Chicago, Miami, Philadelphia, and West Virginia. Travel information was unavailable for Oakland County patients. Based on urethral Gram stain results, 90% of patients were treated for presumed *Ng* infection with the CDC-recommended regimen (*6*), which is also appropriate treatment for *Nm* urethritis. Vaccination data for the patients were incomplete, but meningococcal vaccination was documented in five Columbus patients (received during 2007–2012) and three Oakland County patients (received during 2007–2009).

Cases of urethritis caused by a clonal strain of *Nm* (non-groupable, ST-11 and CC-11/ET-37) are occurring among primarily heterosexual men seeking sexual health services in Columbus, Ohio, and Oakland County, Michigan. Because the strain appears to be spreading sexually, increased awareness is warranted. Clinicians should treat *Nm* urethritis as they would treat *Ng* urethritis (a single 250-mg dose of intramuscular ceftriaxone plus a single 1-g oral dose of azithromycin) (*6*). Until more data are available on transmission and sequelae, sex partners of patients with *Nm* urethritis should be treated as they would be for exposure to urogenital *Ng*. Increases in *Nm* urethritis cases above baseline should be reported to CDC via e-mail, nmurethritis@cdc.gov (protected health information should not be sent to this e-mail).

* https://www.cdc.gov/std/gisp/gisp-protocol-may-2016.pdf.

TABLE. Characteristics of men with confirmed urethral *Neisseria meningitidis* infection at two sentinel clinics — Gonococcal Isolate Surveillance Project, Columbus, Ohio, and Oakland County, Michigan, 2015

	Columbus (N = 52)	Oakland County (N = 15)
Characteristic	**No. (%)**	**No. (%)**
Race		
White	7 (13)	0 (—)
Black	44 (85)	15 (100)
Asian	0 (—)	0 (—)
Other	1 (2)	0 (—)
Ethnicity		
Non-Hispanic	52 (100)	15 (100)
Hispanic	0 (—)	0 (—)
Sexual orientation		
Heterosexual	52 (100)	14 (93)
Homosexual	0 (—)	0 (—)
Bisexual	0 (—)	1 (7)
Symptoms		
Discharge and/or dysuria	51 (98)	14 (93)
No discharge or dysuria	1 (2)	0 (—)
Balanitis	0 (—)	1 (7)
History of self-reported or confirmed episode of previous *Neisseria gonorrhoeae* infection (lifetime)		
Yes	27 (52)	5 (33)
No	25 (48)	10 (67)
No. of confirmed episodes of *N. gonorrhoeae* infection (preceding12 months)		
One	14 (27)	1 (7)
Two	2 (4)	0 (—)
Three or more	1 (2)	0 (—)
No documented previous episodes	34 (65)	14 (93)
Unknown	1 (2)	0 (—)
Most recent HIV status		
Positive (documented or self-reported)	1 (2)	0 (—)
Negative (documented in preceding 3 months)	51 (98)	15 (100)
Exchange sex for drugs or money*		
Yes	8 (15)	0 (—)
No	43 (83)	15 (100)
Unknown	1 (2)	0 (—)
Any injection drug use*		
Yes	1 (2)	0 (—)
No	48 (92)	15 (100)
Unknown	3 (6)	0 (—)
Any noninjection recreational drug use, excluding alcohol (preceding 60 days)†		
Yes	20 (38)	10 (67)
No	29 (56)	5 (33)
Unknown	3 (6)	0 (—)
Any antibiotic use (preceding 60 days)		
Yes	2 (4)	NC
No	42 (81)	NC
Unknown	8 (15)	NC
Treatment provided§		
Ceftriaxone plus azithromycin	47 (90)	13 (87)
Ceftriaxone plus doxycycline	2 (4)	1 (7)
Ceftriaxone alone	0 (—)	0 (—)
Azithromycin alone	2 (4)	1 (7)
Unknown	1 (2)	0 (—)
Urethral coinfection with *Chlamydia trachomatis* by NAAT		
Positive	10 (19)	0 (—)
Negative	42 (81)	15 (100)

Abbreviations: HIV = human immunodeficiency virus; NAAT = nucleic acid amplification testing; NC = not collected.
* During the preceding 60 days for Columbus cases and preceding 12 months for Oakland County cases.
† Might include drugs such as ecstasy, methamphetamines, crack, cocaine, marijuana, and poppers.
§ Primary treatment for presumed *N. gonorrhoeae* infection.

Acknowledgments

Baderinwa Offutt, Tamayo Barnes, Emory University School of Medicine, Atlanta, Georgia; Patricia DiNinno, Public Health Laboratory, Columbus Public Health, Columbus, Ohio; Kathy Cowen, MS, Elizabeth Koch, MD, Center for Epidemiology, Preparedness and Response, Columbus Public Health, Columbus, Ohio; James B. Kent, MS, Bureau of Epidemiology, Michigan Department of Health and Human Services; James T. Rudrik, PhD, Marty Soehnlen, PhD, Bureau of Laboratories, Michigan Department of Health and Human Services; Elizabeth A. Torrone, PhD, Virginia B. Bowen, PhD, Division of STD Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, CDC.

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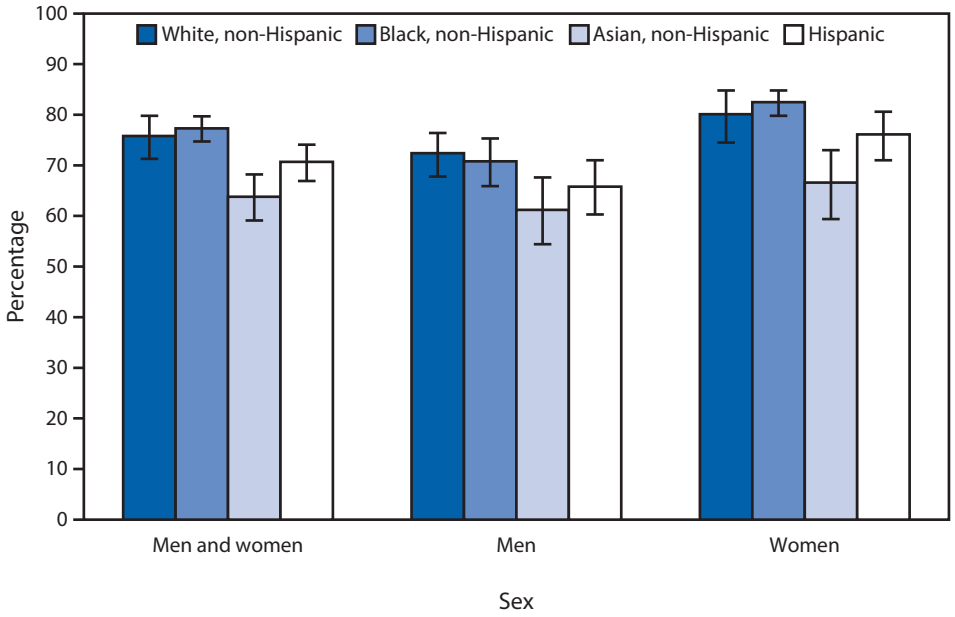
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Prevalence*,† of Hypertension Treatment§ Among Adults Aged ≥18 Years with Hypertension,¶ by Sex and Race/Ethnicity — National Health and Nutrition Examination Survey, United States, 2011–2014



* With 95% confidence intervals indicated with error bars.
† Age-adjusted using the subpopulation of persons aged ≥18 years with hypertension during 2007–2008.
§ Respondents with hypertension who responded "yes" to the following two questions: "Because of your high blood pressure/hypertension, have you ever been told to take prescribed medicine?" and "Are you now following this advice to take prescribed medicine?"
¶ Respondents were defined as having hypertension if their systolic blood pressure was ≥140 mm Hg or their diastolic blood pressure was ≥90 mm Hg, or they were currently taking medication to lower high blood pressure.

During 2011–2014, 74.6% of adults aged ≥18 years with hypertension reported taking antihypertensive medication. Overall, a smaller percentage of non-Hispanic Asian adults (63.8%) with hypertension reported taking antihypertensive medication compared with non-Hispanic white (75.8%), non-Hispanic black (77.3%), and Hispanic (70.7%) adults with hypertension. This pattern was found for both men and women with one exception: the difference between non-Hispanic Asian men and Hispanic men was not significant. A larger percentage of non-Hispanic white, non-Hispanic black, and Hispanic women reported taking antihypertensive medication than did their male counterparts.

Sources: Nwankwo, T, Yoon SS, Burt V, Gu Q. Hypertension among adults in the United States: National Health and Nutrition Examination Survey, 2011–2012. NCHS data brief no. 133; 2013. http://www.cdc.gov/nchs/data/databriefs/db133.htm.

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ISSN: 0149-2195 (Print)