JENNIFER H. MCQUISTON, DVM MS ■ ROBERT C. HOLMAN, MS
AMY V. GROOM, MPH ■ STEPHEN F. KAUFMAN, MS ■ JAMES E.
CHEEK, MD MPH ■ JAMES E. CHILDS, ScD

Incidence of Rocky Mountain Spotted Fever among American Indians in Oklahoma

Dr. McQuiston, Mr. Holman, and Dr. Childs are with the Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta. Drs. McQuiston and Childs are with the Viral and Rickettsial Zoonoses Branch. Dr. McQuiston is an Epidemiologist, and Dr. Childs is Branch Chief; at the time of this study, Dr. McQuiston was an Epidemic Intelligence Service Officer. Mr. Holman is a Senior Mathematical Statistician, Office of the Division Director. Ms. Groom, Mr. Kaufman, and Dr. Cheek are with the Indian Health Service. Ms. Groom is an Epidemiologist with the Office of Epidemiology, Albuquerque, New Mexico; Mr. Kaufman is a Statistician, Office of Public Health, Rockville, Maryland; and Dr. Cheek is a Communicable Disease Consultant, Office of Epidemiology, Albuquerque.

SYNOPSIS

Objective. Although the state of Oklahoma has traditionally reported very high incidence rates of Rocky Mountain spotted fever (RMSF) cases, the incidence of RMSF among the American Indian population of the state has not been studied. The authors used data from several sources to estimate the incidence of RMSF among American Indians in Oklahoma.

Methods. The authors retrospectively reviewed an Indian Health Service (IHS) hospital discharge database for 1980–1996 and available medical charts from four IHS hospitals. The authors also reviewed RMSF case report forms submitted to the Centers for Disease Control and Prevention (CDC) for 1981–1996.

Results. The study data show that American Indians in the IHS Oklahoma City Area were hospitalized with RMSF at an annual rate of 48.2 per million population, compared with an estimated hospitalization rate of 16.9 per million Oklahoma residents. The majority of cases in the IHS database (69%) were diagnosed based on clinical suspicion rather than laboratory confirmation. The incidence of RMSF for Oklahoma American Indians as reported to the CDC was 37.4 cases per million, compared with 21.6 per million for all Oklahoma residents (RR 1.7, 95% confidence interval [CI] 1.5, 2.1).

Conclusions. Rates derived from the IHS database may not be comparable to state and national rates because of differences in case inclusion criteria. However, an analysis of case report forms indicates that American Indians in Oklahoma have a significantly higher incidence of RMSF than that of the overall Oklahoma population. Oklahoma American Indians may benefit from educational campaigns emphasizing prevention of tick bites and exposure to tick habitats.

Address correspondence to:
Dr. McQuiston, CDC, MS G-13, 1600 Clifton Rd., Atlanta GA 30333; tel. 404-639-0041; fax 404-639-2778; e-mail <fzh7@cdc.gov>.

Rocky Mountain spotted fever (RMSF), a potentially fatal illness caused by the rickettsial agent *Rickettsia rickettsii*, is transmitted to humans through tick bites. RMSF is endemic throughout the southeastern and south central United States, and people residing in these areas are at high risk for infection.[1] Clinical signs and symptoms of RMSF include fever with acute onset, headache, myalgia, and rash, often on the palms and soles.[1] Severe RMSF infection may be characterized by respiratory distress, renal failure, bleeding disorders, myocarditis, and encephalitis.[2] With appropriate antibiotic treatment, case-fatality ratios in the range of 2% and 10% are expected; fatality ratios as high as 30% were observed prior to the late 1940s, when broad-spectrum antibiotics became available.[1]

The Centers for Disease Control and Prevention (CDC) collects national data on RMSF using two distinct reporting systems: the National Electronic Telecommunications System for Surveillance (NETSS) and case report forms (CRFs) submitted by state health departments. State health departments electronically submit numbers of laboratory-confirmed cases to the CDC on a weekly basis through NETSS. In addition, state health departments are encouraged to submit completed CRFs on RMSF cases; these forms provide useful data on patient demographics, laboratory test results, and case outcomes.

National annual incidence rates for RMSF are calculated using NETSS data, and generally range from 2 cases per million population to 5 cases per million population.[1,3] Oklahoma has traditionally reported very high RMSF incidence rates; cases from this state accounted for more than 11% of all NETSS cases for 1980–1996.[1,3] Although American Indians make up an estimated 8% of the Oklahoma population,[4] the incidence of RMSF in this population has not been evaluated. American Indians in Oklahoma may be at particular risk for RMSF infection because many live in rural environments and are involved in occupational or recreational activities that could increase their risk for tick bites.

Comprehensive health care is available to people of American Indian descent who are members of federally recognized tribes through the Indian Health Service (IHS), an agency of the US Department of Health and Human Services. Treatment is offered at designated IHS- or tribally run clinics and hospitals, or through private contractual arrangements. Approximately 20% of American Indians who use IHS health care services reside in the Oklahoma City area,[5] one of 12 IHS Areas across the nation. The Oklahoma City Area, which spans the entire state of Oklahoma, part of Kansas, and part of Texas, is home to 37 different federally recognized tribes; inpatient services are provided by a total of seven IHS tribally run or contract facilities. Although the Oklahoma City Area serves some people who reside in Kansas and Texas, they make up a relatively small percentage (<3%) of the IHS user population in the Oklahoma City Area (Personal communication, Dan Cameron, PhD, Statistical Services, Oklahoma City Area, IHS, October 11, 2000).

For the present study, we estimated RMSF incidence rates for American Indians in Oklahoma according to two different reporting mechanisms. We first examined hospital discharge records for 1980–1996 for the seven Oklahoma City Area IHS inpatient facilities to estimate RMSF hospitalization rates for the Oklahoma American Indian population. We then compared these rates to estimated state and national hospitalization rates derived from NETSS data.

We evaluated the accuracy of the IHS hospital discharge reporting system for RMSF by conducting medical chart reviews of available records of RMSF cases from four IHS hospitals.

We also analyzed RMSF CRFs submitted to the CDC for 1981–1996 to compare the incidence of RMSF for Oklahoma American Indians to that for the general Oklahoma and US populations.

METHODS

IHS hospital discharge data. We obtained hospital discharge data reported to the IHS from the Oklahoma City Area for calendar years 1980 through 1996[6] (Personal communication, Yolinda Cadman, Information Technology Support Center, IHS, February 26, 1999, for October–December 1996 data). These data consisted of patient discharge records obtained from all seven of the IHS-operated, tribally operated, and contracted community hospitals in the Oklahoma City area that provided care to eligible American Indians.[7]

The hospital discharge data provided information on individuals who were hospitalized at IHS inpatient facilities. These data did not include information on people treated as outpatients, or information on American Indians who may have obtained health care services at non-IHS facilities. In addition, no data were included on

American Indians who were not members of federally recognized tribes, because these individuals do not have access to IHS health care services.

We selected the first hospital discharge record with a diagnosis of RMSF for each person, defined as a hospitalization for which the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)[8] code 082.0 was listed as one of up to six diagnoses on the IHS patient record. Six patients had a second hospitalization with a diagnosis of RMSF (ICD-9-CM 082.0) or unspecified rickettsioses (ICD-9-CM 082.9) within five days of their first discharge; for these cases, we considered both hospitalizations part of the same event.

We estimated the annual RMSF hospitalization rate for Oklahoma American Indians by calculating the number of hospitalized cases per million Oklahoma City Area IHS users. The number of Oklahoma City Area IHS users was determined for each year from 1980 through 1996 by using the 1996 IHS estimate of the Area's user population and adjusting backward for annual changes based on annual percentage changes in the size of the Area's IHS service population.[5]

Estimated state and national hospitalization rates. To obtain Oklahoma state and national estimates of RMSF hospitalization rates, we first multiplied the annual numbers of NETSS-reported RMSF cases by the expected frequencies of hospitalization calculated from CRF data for 1981–1996. The expected frequency of hospitalization for laboratory-confirmed RMSF cases for this period averaged 68.9% for the United States and 63.6% for Oklahoma (Unpublished data, Viral and Rickettsial Zoonoses Branch, CDC). We defined national and state RMSF hospitalization rates as the estimated number of hospitalized RMSF cases per million persons per year.[9]

Risk ratios (RRs) with 95% confidence intervals (CIs) were calculated using Poisson regression analysis.[10]

Medical chart review. Prior to the medical chart review, the project was reviewed and approved by human subject review boards of the IHS, the Oklahoma City IHS Area, and appropriate tribal councils.

We reviewed available medical charts containing RMSF diagnoses from four Oklahoma City Area IHS hospitals, collecting additional information on clinical signs, disease severity, and how the diagnosis of RMSF was made. The four hospitals accounted for more than 75% of the 186 reported cases, and charts were available for 78 of the 141 RMSF-related hospitalizations at these four facilities.

We defined cases of RMSF according to national reporting guidelines.[11] Specifically, a confirmed case of RMSF required laboratory evidence of disease in an individual with a compatible clinical illness. Laboratory confirmation consisted of any of the following: a fourfold change in antibody titer measured by immunofluorescence (IFA), complement fixation (CF), latex agglutination (LA), microagglutination (MA), or indirect hemagglutination antibody (IHA) tests of paired acute- and convalescent-phase serum samples; a positive polymerase chain reaction (PCR) assay; a positive immunohistochemistry; isolation of *R. rickettsii* from a clinical specimen; a single IFA titer ≥64, a single CF titer ≥16; a fourfold change in *Proteus* OX2/19/K titer or a single titer ≥320; or a single LA, IHA, or MA titer ≥128.[11] We classified clinically compatible cases that did not meet the definition of a confirmed case as suspected cases.

We compared confirmed cases with suspected cases with respect to patient age and length of hospital stay using the Wilcoxon rank-sum test.[12] RRs with 95% CIs were calculated for dichotomous variables.

CRF data submitted to CDC. We calculated average annual incidence rates for RMSF using the CRFs submitted to the CDC for 1981–1996. Only laboratory-confirmed RMSF cases were included in the analysis of these data.

Incidence was calculated as the total number of laboratory-confirmed RMSF cases per million population, using intercensal population estimates for each year from 1981 through 1996 as denominators.[9] If the record listed a race/ethnicity classification of American Indian/Alaska Native and Oklahoma residence, we considered the patient an Oklahoma American Indian for the purposes of the present study.

We compared rates of CRF-reported RMSF cases across racial/ethnic groups for the state of Oklahoma for 1981–1996. RRs with 95% CIs were calculated using Poisson regression analysis.[10]

RESULTS

IHS hospital discharge data. For 1980–1996, 186 cases of RMSF were reported to the IHS from seven IHS inpatient facilities in the Oklahoma City Area. The

estimated average annual RMSF hospitalization rate for Oklahoma American Indians based on these data was 48.2 cases per million population.

Two of the Oklahoma City Area IHS patients with RMSF died, for a case-fatality ratio of 1.1%. Of the 186 cases reported to the IHS from the Oklahoma City Area, 146 (78.5%) had a primary diagnosis of RMSF. Other ICD-9-CM codes that were frequently listed as co-diagnoses included 275.5 (volume depletion; 9.7% of patients), 287.5 (thrombocytopenia; 7.5%), 780.6 (fever; 6.5%), 079.9 (unspecified viral or chlamydial infection; 3.2%), and 288.0 (agranulocytosis; 2.7%).

Estimated state and national hospitalization rates. Using NETSS data, we calculated an average estimated RMSF hospitalization rate for Oklahoma of 16.9 cases per million population (including the American Indian population) and an average rate for the United States of only 2.1 cases per million population (see Figure 1).

Figure 1. Estimated average annual Rocky Mountain spotted fever hospitalization rates, 1980–1996, according to discharge records from Indian Health Service (IHS) Oklahoma City Area inpatient facilities and the National Electronic Telecommunications System for Surveillance (NETSS)

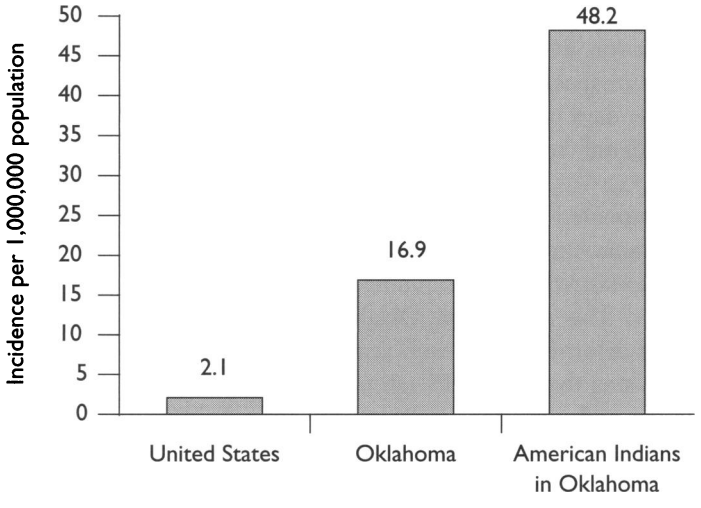
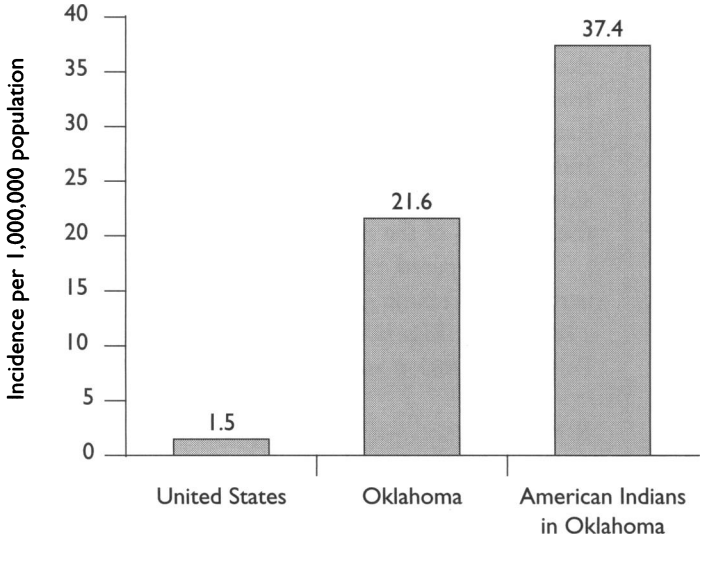


Figure 2. Average annual incidence of Rocky Mountain spotted fever, Oklahoma, 1981–1996, according to Case Report Forms submitted to the Centers for Disease Control and Prevention



RMSF hospitalization rates were significantly higher for Oklahoma American Indians than for all Oklahoma residents (RR = 2.9; 95% CI 2.4, 3.3).

Medical chart review. We reviewed medical charts for 78 of the 186 RMSF hospitalizations in the Oklahoma City Area for 1980–1996. Of these 78 patients, only 24 (30.8%) met the definition for laboratory-confirmed RMSF. In the remaining 54 cases, RMSF was suspected on the basis of clinical signs but was never shown to be the cause of illness by laboratory tests. Cases of laboratory-confirmed RMSF did not differ appreciably from suspected cases with respect to the length of hospital stay (median of 4 days for laboratory-confirmed and median of 3 days for suspected) or the sex of the patient. Median patient age was lower for laboratory-confirmed cases (10.5 years) than for suspected cases (22 years), although not significantly ($P = 0.36$).

Table. Clinical history associated with cases of Rocky Mountain spotted fever among Oklahoma City Area American Indians, 1980–1996, according to inpatient medical charts from four Indian Health Service hospitals (*N* = 78 cases)

	Confirmed cases n = 24		Suspected cases n = 54			
Clinical signs and symptoms	Number	Percent	Number	Percent	Risk ratio	95% CI
Tick bite within 2 weeks	15	62.5	38	70.4	0.9	0.6, 1.3
Fever	21	87.5	52	96.3	0.9	0.8, 1.1
Headache	17	70.8	37	68.5	1.1	0.8, 1.5
Myalgia	16	66.7	36	66.7	1.0	0.7, 1.4
Rash anywhere on body	15	62.5	33	61.1	1.0	0.7, 1.5
Rash on palms and soles	11	45.8	11	25.6	2.3	1.1, 4.5
Severe disease	6	25.0	4	7.4	3.4	1.1, 10.9

CI = confidence interval

The frequencies of specific clinical signs (see Table) indicate that the clinical characteristics in laboratory-confirmed cases of RMSF were in many instances similar to those in suspected cases. However, in confirmed cases, patients were significantly more likely to have a history of rash on the palms and soles and severe disease, characterized by respiratory distress, encephalitis or meningitis, or coagulopathy.

In 15 (27.8%) of the 54 suspected RMSF cases, we found no record of any diagnostic test being conducted during the course of clinical illness. In 20 cases (37.0%), we found a record of a single negative antibody test for RMSF, and in 19 cases (35.2%) there were records of negative serologic tests on both acute- and convalescent-phase serum samples.

CRF surveillance data submitted to CDC. Information on patient race/ethnicity was available for 1,113 confirmed cases of RMSF reported in Oklahoma for 1981–1996. Of these, 140 cases (12.6%) occurred in people described on the CRF form as American Indians. Oklahoma American Indians had a significantly higher risk for RMSF (37.4 cases per million population) than residents of the state of Oklahoma (21.6 cases per million; RR = 1.7; 95% CI 1.5, 2.1) or of the United States (1.5 cases per million) (Figure 2).

In 75 (56.0%) of the 134 Oklahoma American Indian cases for which hospitalization status was known, patients were hospitalized during the clinical course of illness. American Indians in Oklahoma were hospitalized when diagnosed with RMSF at a slightly lower rate than members of other racial/ethnic groups in Oklahoma (RR = 0.9; 95% CI 0.7, 1.0), although this difference was not significant. Fatal outcomes were reported for 181 US residents (including Oklahoma residents) (case-fatality ratio = 3.4%) and 27 Oklahoma residents (case-fatality ratio = 2.4%) in 1981–1996. Only one of the people who died in Oklahoma was an American Indian; the case-fatality ratio of 0.7% was not significantly different from that for other racial/ethnic groups in Oklahoma.

DISCUSSION

The average annual RMSF hospitalization rate for American Indians in Oklahoma based on IHS hospital discharge summaries was higher than NETSS-based estimated hospitalization rates for the general populations of Oklahoma and the United States. These findings provide suggestive evidence that Oklahoma American Indians experience an RMSF rate higher than that of the general Oklahoma population. However, our review of hospital medical charts indicated that many RMSF cases identified through IHS hospital discharge records did not meet the criteria for laboratory confirmation. Thus, rates derived from these data may not be comparable to rates derived from NETSS data due to differences in case inclusion criteria.

An analysis of data from a second reporting system, CRF forms submitted to the CDC by state health departments, provided additional evidence that reported rates of confirmed RMSF were significantly higher among Oklahoma American Indians than among the general Oklahoma population.

The data reported here are subject to some limitations. Some case patients may have been non-residents of the state of Oklahoma. Some RMSF cases may have been missed in the IHS hospital discharge records due to underreporting or incomplete hospital records. Furthermore, the IHS hospital discharge records may not have included all American Indians diagnosed with RMSF, because some individuals may have sought care at non-IHS hospitals. In addition, the IHS hospital database only provided information on hospitalized cases and therefore did not include RMSF cases treated on an outpatient basis.

Another limitation of our study is the possibility of underreporting of RMSF cases by physicians or state health departments, due to the inevitable problems with passive surveillance or due to difficulties in meeting the case definition for confirmed cases. Because people who present with RMSF frequently do not have detectable antibody titers to *R. rickettsii* during the first 10 days of their illness, some physicians may not routinely use laboratory tests to aid their diagnostic and treatment decisions.[13,14] In the present study, the IHS hospital discharge records showed that nearly 45% of the patients with a reported diagnosis of RMSF either had no serum tested or had only a single serum sample submitted for testing. Another complicating factor is that within the last decade additional tickborne agents that are either endemic (*Ehrlichia chaffeensis*) or likely to be endemic (*E. ewingii*) to Oklahoma have been identified as human pathogens that cause diseases similar to RMSF.[15–17] Serologic tests for these agents were not widely available before 1992, and as of 1999, the human ehrlichioses had not been assigned unique ICD-9-CM designations.

The finding that many American Indians in the Oklahoma City Area with suspected RMSF presented with an illness similar to, but less severe than, those with confirmed RMSF further highlights the interesting possibility that another tickborne illness, such as ehrlichiosis, may be contributing to disease in this population. A study in North Carolina (a state that reports rates of RMSF and ehrlichiosis similar to those seen in Oklahoma[1,3,16]) found that febrile patients with a history of tick bites were as likely to show serologic evidence of exposure to ehrlichial agents as to RMSF.[18] Support for this hypothesis is found in the high percentage of suspected RMSF cases for which tick bite was reported in the two weeks preceding illness (70%) in the present study. Furthermore, confirmed cases of RMSF were more than three times as likely as suspected cases to be associated with severe disease, characterized by encephalitis, respiratory distress, or coagulopathy. Patients in laboratory-confirmed cases were also younger on average than those in suspected cases, although not significantly, and were more than two times as likely to report a rash on the palms or soles. In contrast to RMSF, ehrlichiosis is typically a less serious illness; it affects older age groups more frequently than children; it has a lower rate of complications; it less frequently causes a rash; and when present, the rash is not typically found on the palms or soles.[19,20]

Our results suggest that American Indians in Oklahoma have a higher rate of RMSF than the overall Oklahoma population. If true, this may be due to differences in frequency of exposure to ticks. Ticks infected with RMSF may sometimes be highly concentrated in focal geographic areas, and may thus contribute to high rates of transmission of rickettsiae in these areas.[21,22] Although there are no Indian reservations in Oklahoma, people with cultural ties to specific tribes may live close to each other. Because our study also indicated that other tickborne diseases, such as ehrlichiosis, may be contributing to RMSF-like illness among this population, American Indians in Oklahoma may benefit from educational campaigns emphasizing prevention of tick bites and avoiding exposure to tick habitats. Efforts to identify the etiologic cause(s) of disease in people who present with symptoms similar to those of RMSF should include requests for testing against ehrlichial antigens as well as *Rickettsia rickettsiae*.

The authors thank John O'Conner for editorial assistance; Aaron Curns for technical assistance; Chris Paddock for manuscript review; Yolinda Cadman, Glenn Melton, and Dan Cameron, PhD, for access to IHS data; and the staff members of the Oklahoma Area IHS hospitals we visited. The views expressed are the authors' and do not necessarily represent those of the Indian Health Service or the other agencies with which the authors are affiliated.

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