Knowledge, Attitudes, and Practices Regarding Rocky Mountain Spotted Fever among Healthcare Providers, Tennessee, 2009

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Abstract. Tennessee has a high incidence of Rocky Mountain spotted fever (RMSF), the most severe tick-borne rickettsial illness in the United States. Some regions in Tennessee have reported increased illness severity and death. Healthcare providers in all regions of Tennessee were surveyed to assess knowledge, attitudes, and perceptions regarding RMSF. Providers were sent a questionnaire regarding knowledge of treatment, diagnosis, and public health reporting awareness. Responses were compared by region of practice within the state, specialty, and degree. A high proportion of respondents were unaware that doxycycline is the treatment of choice in children ≤ 8 years of age. Physicians practicing in emergency medicine, internal medicine, and family medicine; and nurse practitioners, physician assistants, and providers practicing for < 20 years demonstrated less knowledge regarding RMSF. The gaps in knowledge identified between specialties, designations, and years of experience can help target education regarding RMSF.

INTRODUCTION

Rocky Mountain spotted fever (RMSF), which is caused by the bacteria *Rickettsia rickettsii*, is the most severe tick-borne rickettsial illness in the United States. The highest incidence of RMSF is reported from the southeastern and south-central regions. In 2008, Tennessee had the fourth highest number of reported cases in the United States.¹ The rate of reported RMSF was 3.75 cases/100,000 population in Tennessee, nearly 4.5 times the nationally reported rate of 0.84 cases/100,000 population.¹ Spatial clusters of increased illness severity and death were also identified among persons with RMSF in western Tennessee in a study of 2001–2005 national surveillance data.²

Rickettsia rickettsii is transmitted by the American dog tick, *Dermacentor variabilis*, which is common in the southeastern United States. Symptoms commonly include fever, headache, myalgia, and rash. Although patients occasionally present on the first day of symptoms with an influenza-like illness accompanied by various rashes, the distinguishing maculopapular to petechial rash often is not apparent until several days after symptom onset. Notably, 10–20% of patients have no rash.^{3–5} The early nonspecific presentation can cause delays in diagnosis and treatment. The median delay between first visiting a health care provider and starting antibiotics has been reported to be five days.⁶ This delay in treatment can result in severe outcomes, including death or long-term neurologic deficits.⁷ Treatment with inappropriate antibiotics also increases the risk of death.^{8,9} Doxycycline is the recommended treatment of children and adults. The American Academy of Pediatrics (AAP) describes doxycycline as a first-line treatment of suspected RMSF in children of all ages (Figure 1).¹⁰

Provider knowledge and clinical suspicion of tick-borne disease is important for timely diagnosis, treatment, and prevention of severe outcomes related to RMSF. We report findings from a survey of Tennessee healthcare providers assessing knowledge, attitudes and perceptions of RMSF diagnosis and treatment.

METHODS

Medical providers including physicians (Doctors of Medicine [MDs] and Doctors of Osteopathic Medicine [DO]), nurse practitioners (NPs), and physician assistants (PAs) in primary care specialties (family medicine, internal medicine, pediatrics, emergency medicine/ urgent care, and other primary care) listed by the medical licensing board of Tennessee were sent a questionnaire. If an e-mail address was available, a link to an online survey was sent to providers. Paper forms were mailed only if no e-mail address was available. Questions regarding the frequency of RMSF diagnosis, knowledge about diagnosis and treatment, and awareness of public health reporting were included. Responses from various regions of the state, specialties, practice settings, and educational degrees were compared by using chi-square statistics. Knowledge score was determined by summing correct answers from eight factual questions regarding RMSF (Table 1).

Univariate general linear models were created for knowledge score with each of the following explanatory variables: provider specialty, years in practice, practice setting, academic degree, and geographic region. Models were adjusted for multiple comparisons by using the Tukey correction.

RESULTS

Of 8,049 providers contacted, 1,139 (14.2%) responded and 986 (12.2%) reported currently practicing and were included in the data analysis. Seven hundred sixteen responded by e-mail, and 270 responded by paper mail. Sixty percent were MDs, 33% were NPs, and 7% were PAs. The small number of DOs that responded were combined with MDs. Characteristics of providers included in the analysis are shown in Table 2.

Of the respondents, 828 (84.0%) of 986 correctly responded that RMSF occurs in the geographic area where they practice. Five hundred fifty-six (56.4%) reported having ever diagnosed a case of RMSF on the basis of either history and clinical signs or laboratory testing. Of those reporting ever having diagnosed RMSF, 540 (97.1%) of 556 reported that they had diagnosed ≤ 5 cases during the previous year. Providers estimated that they had diagnosed between 392 and

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- Doxycycline is the drug of choice for children and adults
- Treatment is most effective if started in the first few days of symptoms and delays in treatment are associated with severe disease and poor outcomes.
- Estimated case fatality rates of untreated RMSF range from 20% – 80% and the median time to death is 8 days.
- Incubation period is approximately 1 week (2-14 days).
- Mortality is highest in patients aged 50 years and above, children from 5 to 9 years of age, and people with no recognized tick bite or attachment.
- Approximately half of pediatric RMSF cases have no recall of a tick bite.
- A confirmed diagnosis can be made with a fourfold or greater change in immunoglobulin G-specific antibody titer between acute and convalescent serum specimens obtained two to three weeks apart.

FIGURE 1. Quick Facts from the 2012 American Academy of Pediatricians Red Book, Report of the Committee on Infectious Diseases, Rocky Mountain Spotted Fever (RMSF).

1,500 cases during March 2008–March 2009. In contrast, only 235 confirmed and probable cases were reported through the state health department reporting system during the same period. Most providers (314 of 556, 56.5%) who reported having ever diagnosed RMSF indicated that fewer than half of their patients presented with the classic clinical triad of fever, rash, and history of tick bite.

Correctly answering factual knowledge questions varied widely among providers (Table 3). Two hundred seventeen providers (22%) incorrectly responded that they thought later treatment of RMSF (> 5 days after symptom onset) would be effective or were unsure of treatment timing. Nearly all respondents (915, 92.8%) correctly responded that they would treat adults with suspected RMSF with doxycycline, but only 385 (39.0%) correctly responded that doxycycline was the first choice of treatment in children < 8 years of age. The percentage of providers who answered that they use doxycycline as a first choice of treatment in children with RMSF was < 50% for all specialties other than pediatrics and infectious disease.

TABLE 2

Rocky Mountain spotted fever survey sample characteristics of healthcare providers, Tennessee

Characteristic	No. (%)
Provider type	
Pediatric	182 (18.5)
Family medicine	389 (39.5)
Internal medicine	206 (20.9)
Emergency/urgent care	138 (14.0)
Infectious disease	18 (1.8)
Other	48 (4.9)
No response	5 (0.5)
Years of practice	
< 20	643 (65.2)
≥ 20	340 (34.5)
No response	3 (0.3)
Professional designation	
Physician/doctor of osteopathic medicine	588 (59.6)
Nurse practitioner	326 (33.1)
Physician assistant	68 (6.9)
No response	4 (0.4)
Region of Tennessee	
Western	208 (21.1)
Central	473 (48.0)
Eastern	277 (28.1)
No response	28 (2.8)

Only 418 providers (42.4%) correctly identified the case-fatality rate of untreated RMSF as between 20% and 30%. The average incubation period was recognized as 2–14 days by 730 providers (71.3%), and 941 (95.4%) properly reported that they would not rule out RMSF in the absence of a history of tick bite. Also, 809 providers (82%) appropriately answered that they would treat for RMSF even in patients who presented without a rash.

Of all providers responding, infectious disease specialists (n = 18) most often answered RMSF diagnosis and treatment questions correctly and had a mean score of 90.3%. Pediatric providers had a mean score of 82.1%, which was not significantly different from infectious disease specialists (95% confidence interval [CI] difference = -0.4 to 16.8). Mean scores of family medicine providers (69.5%), internal medicine providers (73.7%), and emergency medicine providers (74.3%) differed

TABLE 1

Rocky Mountain spotted fever survey questions and answer choices among healthcare providers, Tennessee*

	TMP/SMX	Doxycycline	Chloramphenicol	Azithromycin	Other
1. Which antibiotic is your first choice for treatment of RMSF in adults and children ≥ 8 years of age?	TMP/SMX	Doxycycline	Chloramphenicol	Azithromycin	Other
2. Which antibiotic is your first choice for treatment of RMSF in children < 8 years of age?	TMP/SMX	Doxycycline	Chloramphenicol	Azithromycin	Other
3. When do you think antibiotic treatment of RMSF is most effective?	Within 3 days of symptom onset	Within 5 days of symptom onset	Within 5–10 days after symptom onset	Within 2 weeks after symptom onset	Not sure
4. What do you think is the fatality rate of untreated RMSF?	Untreated RMSF is not fatal	< 10%	20–30%	> 50%	
5. What do you consider the average incubation period to be for RMSF?	24–36 hours	2–14 days	14–21 days	Not sure	
6. Antibiotic treatment should not be initiated before a rash develops.	Agree	Disagree	Not sure		
7. RMSF can be ruled out if the patient has no recollection of a tick bite.	Agree	Disagree	Not sure		
8. Does RMSF occur in the region of Tennessee where you practice?	Yes	No	Unsure		

* RMSF = Rocky Mountain spotted fever; TMP/SMX = trimethoprim/sulfamethoxazole. Response data is reported in Table 3.

TABLE 3
Rocky Mountain spotted fever knowledge and reported practices survey responses of healthcare providers, Tennessee*

Characteristic	No.	Use doxycycline in adults, no. (%)	Use doxycycline in children, no. (%)	Treat within recommended time frame, no. (%)	Aware of RMSF case-fatality rate, no. (%)	History of tick bite unnecessary for diagnosis, no. (%)	Aware of RMSF incubation period, no. (%)	Treat RMSF with or without a rash present, no. (%)
Total	986	915 (92.8)	385 (39.0)	755 (76.6)	418 (42.4)	941 (95.4)	703 (71.3)	809 (82.0)
Provider type	981	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P = 0.0001$	$P = 0.685$	$P < 0.0001$	$P = 0.0001$
Pediatric	182	175 (96.1)	128 (70.3)	150 (82.4)	93 (51.1)	175 (96.1)	147 (80.8)	165 (90.7)
Family medicine	389	360 (92.5)	126 (32.4)	288 (74.0)	135 (34.7)	367 (94.3)	255 (65.5)	312 (80.2)
Internal medicine	206	197 (95.6)	52 (25.2)	165 (80.1)	104 (50.5)	199 (96.6)	150 (72.8)	174 (84.5)
Emergency/urgent care	138	134 (97.1)	52 (37.7)	107 (77.5)	55 (39.9)	132 (95.6)	106 (76.8)	111 (80.4)
Infectious disease	18	18 (100)	12 (66.7)	18 (100)	12 (66.7)	18 (100)	17 (94.4)	17 (94.4)
Other	48	26 (54.2)	12 (25.0)	23 (47.9)	19 (39.6)	45 (93.7)	26 (54.2)	25 (52.1)
Years of practice	983	$P = 0.508$	$P = 0.948$	$P < 0.0001$	$P = 0.384$	$P = 0.1431$	$P < 0.0001$	$P < 0.0001$
< 20	643	594 (92.4)	251 (39.0)	465 (72.3)	267 (41.5)	609 (94.7)	425 (66.1)	501 (77.9)
≥ 20	340	318 (93.5)	132 (38.8)	287 (84.4)	151 (44.4)	329 (96.8)	276 (81.2)	305 (89.7)
Professional designation	979	$P < 0.0001$	$P = 0.003$	$P < 0.0001$	$P = 0.001$	$P = 0.0004$	$P < 0.0001$	$P < 0.0001$
Physician/DO	585	564 (96.4)	253 (43.2)	491 (83.9)	277 (47.3)	570 (97.4)	467 (79.8)	520 (88.9)
Nurse practitioner	326	281 (86.2)	109 (33.4)	208 (63.8)	116 (35.6)	299 (91.7)	186 (57.1)	229 (70.2)
Physician assistant	68	64 (94.1)	20 (29.4)	50 (73.5)	24 (35.3)	65 (95.6)	45 (66.2)	54 (79.4)
Region of Tennessee	958	$P = 0.001$	$P = 0.117$	$P = 0.518$	$P = 0.533$	$P = 0.0003$	$P = 0.120$	$P = 0.078$
Western	208	194 (93.3)	89 (42.8)	154 (74.0)	85 (40.9)	189 (90.9)	137 (65.9)	173 (83.2)
Central	473	452 (95.6)	192 (40.6)	369 (78.0)	209 (44.2)	462 (97.7)	348 (73.6)	401 (84.8)
Eastern	277	245 (88.5)	95 (34.3)	211 (76.2)	112 (40.4)	266 (96.0)	199 (71.8)	217 (78.3)

*RMSF = Rocky Mountain spotted fever; DO = doctor of osteopathic medicine. Non-responses to knowledge and practice questions were considered as incorrect responses and included in the denominators. Table 1 lists the answer choices for each question. The non-response rate per question ranged from 0.8% to 14.1%, with an average non-response rate of 3.9%; P values are for chi-square test² or Fisher's exact test.

significantly from scores of infectious disease specialists and pediatricians (differences between means 7.8%–20.8%, 95% CI range = 3.8–11.8, 12.1–29.5). Doctors of Medicine, providers in academic medicine, and providers with > 20 years of experience also answered a significantly higher proportion of questions correctly compared with persons with other degrees, practice settings, and years of practice. Treatment and diagnostic knowledge of RMSF were significantly different (95% CI difference = 0.5–7.5) between Central Tennessee (mean score = 75.0%) and East Tennessee (mean score = 71.0%). Knowledge in Central Tennessee and East Tennessee were not significantly different from that in West Tennessee (mean score = 71.5%).

Providers varied in their understanding of public health reporting requirements. Eight hundred sixteen providers (82.8%) correctly responded that RMSF was reportable. Those who did not consider RMSF to be reportable also demonstrated less factual knowledge regarding diagnosis and treatment (mean score 62.2% versus 75.2%; $P < 0.0001$).

Although the appropriate diagnosis of RMSF requires laboratory testing, 258 providers (26.2%) answered that they always or almost always treat without ordering laboratory tests. Among those who reported ordering laboratory tests, 684 (80.6%) responded to the question regarding frequency of using paired serologic samples, and 424 (62.0%) answered that they always order paired serologic samples to confirm RMSF diagnosis. Four hundred ninety-seven (58.5%) responded to the question regarding frequency of using a single serologic sample, and 198 (39.8%) answered that they always order a single serologic sample. Despite these reports of frequent use of paired serologic samples, fewer than 20% of RMSF cases reported to the state health department during 2008 included a convalescent-phase serologic result. Knowledge score was not related to laboratory test-ordering practices.

Despite the documented gaps in knowledge, most providers who practiced in pediatrics (163 of 182, 89.6%), emergency

medicine (124 of 138, 90.0%), and infectious diseases (18 of 18, 100%) agreed or strongly agreed that they understood the transmission, presentation, and treatment of RMSF. Seventy-seven percent of all providers agreed or strongly agreed that continuing medical education on the diagnosis and treatment of RMSF would be beneficial to their practice.

DISCUSSION

Although Tennessee has one of the highest state-specific incidence rates of RMSF in the country, knowledge regarding the disease appears to vary widely among Tennessee healthcare providers. The early, non-specific presentation of RMSF makes it beneficial for providers to have knowledge of epidemiologic risk factors for tick-borne disease when assessing clinical history. Rocky Mountain spotted fever is endemic throughout Tennessee, and most of the providers we surveyed correctly acknowledged that RMSF occurs in their region. In addition, nearly all providers properly recognized that RMSF should still be considered in patients with no recollection of a tick bite, which is an important facet of early and appropriate treatment of RMSF.

Providers demonstrating higher scores on an RMSF knowledge test were more likely to know about required public health reporting practices, but the estimated number of cases providers recalled diagnosing exceeded the number of RMSF cases reported to the state health department. Public health reporting of RMSF provides information regarding geographic spread, incidence, and severity of the disease, enabling patients and providers to recognize the risks of tick-borne disease in their area. The data from this survey suggest that substantial underreporting of RMSF occurs in Tennessee, although the finding is difficult to quantitate. Because providers were not instructed to review records while participating, inaccuracies in recall may account for some of the discrepancy. Increasing

provider knowledge of RMSF in a targeted manner may aid in timely diagnosis and treatment and increase the accuracy of state reporting.

We observed important differences in RMSF knowledge between specialties, degree, and years of practice. In our study, pediatricians and infectious disease physicians demonstrated a higher level of knowledge than other primary care providers. Family medicine physicians, emergency medicine physicians, internal medicine physicians, NPs, PAs, and providers with < 20 years of experience demonstrated less RMSF knowledge. This finding suggests that education and experience contribute positively to the RMSF knowledge base of a provider, which likely translates into improved patient care. Groups such as NPs and PAs; family, emergency, and internal medicine practitioners; and those with less experience might benefit from targeted educational campaigns. Although a significant difference in provider scores was seen between East Tennessee and Central Tennessee, the magnitude of the difference between scores was small (4%).

One of the notable gaps observed in providers' knowledge base was related to treatment of suspected RMSF in children. Fewer than half of providers correctly identified doxycycline as the treatment of choice in children < 8 years of age, despite the fact that nearly all providers indicated they would choose doxycycline to treat an adult with suspected RMSF. This finding suggests a lack of awareness of current AAP guidelines recommending doxycycline use in children to treat rickettsial infections irrespective of age.¹⁰ This difference was particularly pronounced among family medicine and emergency medicine providers, which is a concern given that these providers likely see and treat children with regularity.

Past studies have also indicated a reluctance of physicians to use doxycycline in children. In a 2002 survey of 84 providers in Mississippi, only a small percentage of family medicine and emergency medicine physicians reported prescribing doxycycline for suspected pediatric RMSF.¹¹ Concerns regarding teeth staining by tetracyclines may influence some provider's choice of treatment. However, studies of doxycycline as treatment of RMSF in children demonstrate minimal risk of teeth staining.¹² The AAP recommendation for pediatric treatment of RMSF provides several reasons for promoting the use of doxycycline in children, noting that teeth staining is related to cumulative dose of tetracyclines (and the recommended treatment of RMSF is short in duration), that doxycycline is less likely to cause staining compared with other drugs in the same class, and that doxycycline is also the recommended treatment of ehrlichiosis, which is clinically similar to RMSF and endemic to Tennessee.¹⁰ Provider awareness of these recommendations is essential to the prevention of adverse outcomes in pediatric RMSF cases.

The most compelling reason to choose doxycycline as a first-line therapeutic agent is that other broad spectrum antibiotics are ineffective against *R. rickettsii*. The only other antibiotic with known efficacy against *R. rickettsii* is chloramphenicol, but its use has been associated with an increased rate of fatal outcome compared with doxycycline.⁹ Chloramphenicol use also carries a risk for other potential severe side effects such as aplastic anemia, and is therefore indicated only in the case of documented life-threatening hypersensitivity to tetracyclines or concerns about early pregnancy.

Physician hesitancy to use tetracyclines in children with suspected RMSF may be contributing to unnecessary and

preventable deaths in the United States. A recent national surveillance summary spanning 2000–2007 showed a much higher case-fatality rate among children < 1–9 years of age compared with adults.¹³ In particular, children 5–9 years of age showed a case-fatality rate of 2.6%, compared with a rate of only 0.5% across all age groups. The disproportionate burden of fatal disease among pediatric patients may be influenced by the continuing provider reluctance to prescribe doxycycline as a first-line antibiotic for suspected RMSF cases.

Numerous studies support the necessity of starting early empiric antibiotic treatment with a tetracycline in patients with suspected RMSF.⁷ Increased fatalities associated with delays in treatment, particularly five days beyond symptom onset, has been well documented.^{14,15} In addition to confusion over the appropriate antibiotic to use in children, in our study, nearly one-fourth of participating providers thought treatment would be effective any time within two weeks of symptom onset or were unsure of treatment timing. Almost 20% indicated a preference to wait until a rash developed before initiating treatment. Because the rash may not appear until 3–5 days after illness onset and will be absent in 10–20% of patients, waiting for rash appearance leads to unnecessary delays in treatment. Most providers were also unaware of the high case-fatality rate of untreated RMSF. Although the national case-fatality rate for RMSF is only 0.5%, this rate is against a background of effective treatment; fatal outcome is much higher when treatment is not initiated.¹³ The severity of outcomes after delayed treatment and the fatality rate of untreated RMSF should be emphasized.

In our study, nearly one-third of providers reported that they usually treated suspected RMSF cases without submitting specimens for laboratory testing. Diagnoses made without laboratory evidence may have contributed to the discrepancy between recalled and reported cases of RMSF because many providers rely on laboratories to communicate reportable diseases to public health departments. Of those who order serologic testing, many reported that they requested determination of only a single, acute-phase titer. Acute-phase serologic results for RMSF are often negative, and diagnoses can only be confirmed through an increased titer in follow-up testing. Although treatment should be initiated immediately upon suspicion of RMSF, confirmation of the diagnosis through laboratory testing is important for providers and patients to understand the geography and risk patterns of the disease.

This study was limited by a low response rate and may not be representative of all providers in Tennessee or the United States. Results may have been biased by those with more interest in RMSF. Despite this limitation, the survey was a large sample of providers and included providers of various specialties, degrees, levels of experience, and regions. Unfortunately, the response rates by healthcare profession (MDs, DOs, NPs and PAs) were not able to be documented at the time of data collection. Substantial differences in response rates by profession could have affected the generalizability of our results to all providers.

Early diagnosis and treatment of RMSF is essential to avoiding severe outcomes. As demonstrated in our survey of healthcare providers, continuing education regarding RMSF diagnosis and treatment is critical, given the potential severity of infection and the fact that providers frequently see patients without the classic triad of fever, rash, and history of tick-bite. Tennessee has attempted to raise awareness of RMSF among

physicians by including articles on RMSF in our quarterly epidemiology newsletter (which is sent electronically to providers across the state by using the e-mail addresses of providers obtained from the state Board of Medical Examiners) and by sending an RMSF specific letter from the Health Commissioner to healthcare providers. In addition to improving diagnosis and treatment, increased awareness of RMSF may enhance public health reporting. Continuing education should be targeted to enhance knowledge among NPs, family medicine practitioners, internal medicine practitioners, and those who have been practicing for < 20 years.

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