HHS Public Access

Author manuscript

Ticks Tick Borne Dis. Author manuscript; available in PMC 2015 October 29.

Published in final edited form as:

Ticks Tick Borne Dis. 2014 June ; 5(4): 404–408. doi:10.1016/j.ttbdis.2014.01.008.

U.S. healthcare providers' experience with Lyme and other tick-borne diseases

Meghan E. Brett, **Alison F. Hinckley***, **Emily C. Zielinski-Gutierrez**, and **Paul S. Mead**

Division of Vector-Borne Diseases, Centers for Disease Control and Prevention, Fort Collins, CO, USA

Abstract

Surveillance indicates that tick-borne diseases are a common problem in the United States. Nevertheless, little is known regarding the experience or management practices of healthcare providers who treat these conditions. The purpose of the present study was to characterize the frequency of tick-borne diseases in clinical practice and the knowledge of healthcare providers regarding their management. Four questions about tick-borne diseases were added to the 2009 Docstyles survey, a nationally representative survey of >2000 U.S. healthcare providers. Topics included diseases encountered, management of patients with early Lyme disease (LD), provision of tick-bite prophylaxis, and sources of information on tick-borne diseases. Overall, 51.3% of practitioners had treated at least one patient for a tick-borne illness in the previous year. Among these, 75.1% had treated one type of disease, 19.0% two types of disease, and 5.9% three or more diseases. LD was encountered by 936 (46.8%) providers; Rocky Mountain spotted fever was encountered by 184 (9.2%) providers. Given a scenario involving early LD, 89% of providers would prescribe antibiotics at the first visit, with or without ordering a blood test. Tick-bite prophylaxis was prescribed by 31.0% of all practitioners, including 41.1% in high-LD-incidence states and 26.0% in low-incidence states. Tick-borne diseases are encountered frequently in clinical practice. Most providers would treat early LD promptly, suggesting they are knowledgeable regarding the limitations of laboratory testing in this setting. Conversely, providers in low-LD-incidence states frequently prescribe tick-bite prophylaxis, suggesting a need for education to reduce potential misdiagnosis and overtreatment.

Keywords

Tick-borne disease; Lyme disease; Treatment; Prophylaxis; Provider knowledge

Introduction

North American ticks transmit a diverse array of diseases with clinical features that range from mild and self-limited to fulminant and life-threatening. Lyme disease (LD), caused by *Borrelia burgdorferi*, is by far the most common with approximately 30,000 cases reported

*Corresponding author at: Centers for Disease Control and Prevention, 3156 Ram-part Road, Fort Collins, CO 80521, USA. Tel.: +1 970 266 3558; fax: +1 970 494 6631. ahinckley@cdc.gov, cue0@cdc.gov (A.F. Hinckley).

Disclosures

The authors do not have any conflicts of interest to disclose.

each year to the Centers for Disease Control and Prevention (CDC). Less common but potentially fatal is Rocky Mountain spotted fever (RMSF), caused by *Rickettsia rickettsii*. Other endemic diseases associated with ticks include anaplasmosis, babesiosis, Colorado tick fever, ehrlichiosis, Powassan encephalitis, southern tick-associated rash illness (STARI), tick-borne relapsing fever (TBRF), tularemia, tick paralysis, and recently described infections with *B. miyamotoi*, with a new ehrlichia species in Wisconsin, and a novel phlebovirus (Krause et al., 2013; McMullan et al., 2012; Pritt et al., 2011). Tick-borne diseases occur throughout the United States, although the geographic distribution of individual diseases varies.

Early detection and appropriate treatment is crucial for reducing morbidity and mortality due to tick-borne pathogens. Unfortunately, timely diagnosis and management may be hindered due to unrecognized tick bites, non-specific symptoms, or a lack of familiarity on the part of the health care provider. In addition, providers may be called upon by concerned patients to provide prophylaxis following a recognized tick bite. Prophylaxis can be effective in preventing LD; however the circumstances where this is considered beneficial are complex and require substantial knowledge on the part of the provider (Fix et al., 1998; O'Reilly et al., 2003; Warshafsky et al., 2010). There is currently no evidence that posttick bite prophylaxis is effective for preventing other tick-borne diseases.

To better characterize current provider experiences related to tick-borne diseases in the United States, questions were developed for a representative, nationwide survey of U.S. healthcare providers. Previous surveys focused on LD and were conducted in LD-endemic states (Eppes et al., 1994; Magri et al., 2002; Murray and Feder, 2001; Strickland et al., 1994). The goals were to determine how commonly providers see patients with tick-borne diseases, what they know about diagnosis and management of selected diseases, what their practices are with regard to post-tick bite prophylaxis, and where they obtain information regarding tick-borne diseases.

Methods

DocStyles is a web-based survey of physicians and nurse practitioners conducted by Porter Novelli, a public relations firm with a specialty practice in health and social marketing. Physicians are drawn from the Epocrates' Honors Panel, an opt-in panel of over 156,000 medical practitioners who are verified against the American Medical Association's (AMA) master file by name, birthdate, medical school, and graduation date. Physicians are randomly sampled from the Panel to match the proportions for age, gender, and region within AMA's master file. They are also screened for the following criteria: practice within the United States, actively seeing patients, and practicing for at least 3 years. Nurse practitioners are drawn from Epocrates' Allied Health Panel which includes over 44,500 nurse practitioners and ~1600 registered dietitians. Survey quotas were set to reach 1000 primary care physicians (Internist, Family/General practice), 250 pediatricians, 250 OB/GYNs, 250 dermatologists, 250 nurse practitioners, and 150 registered dieticians. Invitations to participate are sent electronically in numbers estimated to yield the desired quotas of completed questionnaires. Once a sampling quota for a provider type is met, the survey website prevents additional respondents in that specialty. The survey takes an estimated 30–

40 min to complete, and participants are paid an honorarium of $55–$95 for completing the survey. CDC licenses the results of DocStyles surveys from Porter Novelli. Analyses of these results were exempt from institutional review board approval because personal identifiers were not included in the data provided to CDC. Responses from dietitians were excluded as these providers are not expected to be directly involved in diagnosing infectious diseases.

The 2009 DocStyles survey was comprised of approximately 140 questions covering practices related to a wide range of health topics (e.g., tobacco use, sexually transmitted diseases, influenza vaccination, gynecologic procedures), as well as practitioner demographic information, practice characteristics, and practitioner type. Four questions regarding tick-borne diseases were dispersed among the other questions:

1. "I am knowledgeable regarding the diagnosis and clinical management of tick-borne diseases." *(Select one: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree.)*
2. "For which of the following tick-borne disease have you treated a patient in the last year?" *(Select all that apply: Lyme disease, Rocky Mountain spotted fever, ehrlichiosis or anaplasmosis, tularemia, babesiosis, southern tick-associated rash illness, tickbite prophylaxis, none of these.)*
3. "An otherwise healthy patient with no previous history of tick-borne diseases presents to your office with a large, circular, "bull's-eye" rash around a site where he had removed an engorged tick 7 days earlier. Which of the following best describes what you would do during the first visit?" *(Select one: order a blood test for Lyme disease and await the results before treating; order a blood test for Lyme disease and begin empiric antibiotics; begin empiric antibiotics without ordering a blood test; reassure the patient and have them return if symptoms do not improve; none of these.)*
4. "From which of the following sources do you get information on the management of tick-borne disease?" *(Select all that apply: CDC website, NIH website, other websites, Guidelines from the Infectious Diseases Society of America, articles by the International Lyme and Associated Diseases Society, other published materials, professional meetings, none of these, I don't treat patients with tick-borne diseases.)*

Data analysis was conducted in 2012. SAS JMP 9.0.2 (Cary, NC) was used for all analyses. Chi-square tests were used to compare practitioner characteristics of those who had and had not treated a patient with tick-borne illnesses in the previous year. If values were ≤5, Fisher's exact test was used. Variables with a p value <0.05 in the univariate analysis were included in mutivariable logistic regression model. Practitioners were also compared according to the incidence of LD in their practice area. For purposes of this analysis, 14 states (Delaware, Connecticut, New Hampshire, Massachusetts, Maine, New Jersey, Vermont, Pennsylvania, Wisconsin, Maryland, New York, Minnesota, Rhode Island, Virginia) and the District of Columbia were defined as high-LD-incidence areas based on having a reported incidence greater than the national average of 9.4 confirmed cases/

100,000 population in 2008. Collectively, these jurisdictions accounted for approximately 97% of all confirmed LD cases reported to CDC in that year.

Results

Invitations were sent to 4937 practitioners in order to obtain 2261 responses, for a response rate of 48.5%, as calculated by Porter Novelli. Fifty-seven providers did not meet inclusion criteria for active practice in the United States for at least 3 years, and 54 others did not complete the survey, yielding a total of 2150 completed surveys. After excluding registered dieticians, 2000 practitioners were included in this analysis, of which 1750 (87.5%) were physicians and 250 (12.5%) were nurse practitioners (NPs; Table 1). The median age of all practitioners was 43 years (range: 27–95 years). Providers were predominantly non-Hispanic whites (1463/2000; 73.2%). Median time in practice was 12.5 years (range: 3–46 years), and practitioners reported seeing a median of 101 patients per week (range: 10–650). Practitioners were from 49 states and the District of Columbia (Table 1). Overall, 665 (33.3%) of 2000 providers practiced in states meeting the definition of high LD incidence.

When rating their knowledge of tick-borne diseases, 1393 (69.7%) of 1999 practitioners agreed or strongly agreed that they were knowledgeable about the management of tick-borne diseases, 354 (17.7%) neither agreed nor disagreed, and 254 (12.7%) disagreed or strongly disagreed. Dermatologists were most likely to agree or strongly agree (88.8%), whereas NPs (63.2%) and OB/GYNs (31.6%) were least likely. Practitioners in high-LD-incidence states were more likely to respond that they were knowledgeable regarding tick-borne diseases than those from low-incidence states (79.0% vs. 65.0%, $p < 0.0001$). Similarly, those who saw >100 patients per week (OR = 1.3, 95% CI 1.1–1.6), were male (OR = 1.4, 95% CI 1.1–1.7), or were ≤40 years-old (OR = 1.3, 95% CI 1.0–1.5) were more likely to agree that they were knowledgeable about tick-borne diseases. All of these factors remained statistically significant in the multivariable analysis.

A total of 1025 (51.3%) of 2000 practitioners reported treating ≥1 patient with a tick-borne disease in the previous year (Table 2). Among these, 770 (75.1%) had treated only one type of tick-borne disease, 195 (19.0%) had treated 2 types of tick-borne disease, and 60 (5.9%) had encountered ≥3 types of tick-borne disease. The most common illness was LD, encountered by 936 (46.8%) providers, followed by RMSF encountered by 184 (9.2%) providers. Overall, 492 (74.0%) of 665 clinicians in high-LD-incidence states and 444 (33.3%) of 1335 practitioners in low-LD-incidence states reported treating a patient with LD. Among practitioners treating RMSF, 100 (54.3%) were from southeastern states, which account for 68% of RMSF cases reported to CDC in 2008 (CDC, 2010). Practitioners who had treated LD did not differ with regard to age, sex, race, ethnicity, practice setting, or years in practice from those who had not. In contrast, practitioners who had treated RMSF were more likely to be male (OR = 1.4, 95% CI 1.0–1.9), to treat >100 patients per week (OR = 1.5, 95% CI 1.1–2.1), and to practice in the south (OR = 2.6, 95% CI 1.9–3.6). Ninety-five (52%) of 184 providers who diagnosed RMSF also diagnosed at least one case of LD.

Thirty-one percent of all providers had prescribed tick-bite prophylaxis for one or more patients in the previous year, with a higher frequency among dermatologists (41.2%) and family practitioners (39.7%), and a lower frequency among pediatricians (22.8%) and OB/GYNs (12.0%). Overall, 273 (41.1%) of 665 practitioners in high-LD-incidence states and 347 (26.0%) of 1335 practitioners in low-incidence states provided tick-bite prophylaxis in the previous year. Clinicians in high-LD-incidence states were significantly more likely to have prescribed tick-bite prophylaxis (OR = 2.0, 95% CI 1.6–2.4), as were those who saw more than 100 patients per week (OR = 1.5, 95% CI 1.3–1.9) or had been practicing for longer than 10 years (OR = 1.3, 95% CI 1.1–1.6). Additionally, practitioners in individual practices were more likely to have prescribed prophylaxis relative to those in group practices (OR = 1.5, 95% CI 1.1–1.8) or hospital practices (OR = 2.1, 95% CI 1.1–1.8). Among the 1025 providers who treated a patient with a tick-borne disease in the past year, the proportion of practitioners who prescribed tick-bite prophylaxis was similar among those who reported treating patients for LD and those who only treated other tick-borne diseases (43.8% vs. 44.2%, $p = 0.94$).

When presented with a scenario describing a patient with a large, circular, “bull’s-eye” rash around a site where he/she had removed an engorged tick 7 days earlier, 1412 (70.6%) of 2000 providers would prescribe antibiotics and order a blood test for Lyme disease, 373 (18.7%) would begin antibiotics without ordering a blood test, 85 (4.3%) would order a test and await results, 15 (0.8%) would reassure the patient and have them return if symptoms do not improve, and 115 (5.8%) opted for none of these. Combining these responses, 1785 (89.3%) of the 2000 providers would prescribe empiric antibiotics at the time of the first visit. Empiric antibiotics were prescribed more often by providers in high-LD-incidence states (91.2% vs. 88.2%, $p < 0.05$) and by providers other than OB/GYNs (92.6% vs. 66.0%, $p < 0.001$). Excluding OB/GYNs, empiric antibiotics were provided by 93.9% of providers in high-LD-incidence states. Clinicians who had treated a patient with LD in the past year were more likely to select an option that included empiric antibiotics (OR = 3.4, 95% CI 2.5–4.8), as were providers who responded positively about their knowledge of tick-borne diseases (OR = 6.4, 95% CI 4.7–8.7). Overall, 95% of providers who responded positively about their knowledge of tick-borne diseases would prescribe antibiotics at the first visit, as compared with only 65% of providers who responded negatively. Otherwise, there were no other notable differences in the age, sex, years in practice, or practice setting between practitioners who would and would not prescribe empiric antibiotics. With respect to testing, 74.9% of all providers would order a blood test for LD, with lower rates among OBS/GYNs (67.2%) and pediatricians (68%). Providers in high-LD-incidence states were more likely to prescribe antibiotics without ordering a blood test for LD (OR = 2.2, 95% CI 1.7–2.7, $p < 0.0001$), as were pediatricians (OR = 2.2, 95% CI 1.6–2.9). OB/GYNs were least likely to prescribe antibiotics without testing (OR = 0.2, 95% CI 0.1–0.3).

Among 1775 practitioners who reported treating patients for tick bite or a tick-borne disease, 1436 (80.9%) consulted websites, 406 (22.9%) attending professional meetings, and 375 (21.1%) used guidelines and other published materials to obtain information on management of tick-borne diseases. Websites were used most commonly by OB/GYNs (93.2%) and least often by dermatologists (69.6%). There were no differences among website users by work

setting, age, number of patients per week, or years of practice. Obtaining information from professional meetings was more common among practitioners who were >40 years of age (25.5% vs. 19.1%), worked in individual practices (28.2% vs. 21.6% overall), were dermatologists (42.9% vs. 24.6% other provider types), or saw >100 patients per week (26.1% vs. 19.6%). Use of published materials was more common among practitioners who practiced in a hospital or clinic settings (31.6% vs. 18.8%), were internists (30.5% vs. 17.4% other provider types), or saw ≤100 patients per week (23.4% vs. 18.6%).

Discussion

In this representative nationwide survey of 2000 U.S. health-care providers, over 51% reported treating at least one patient for a tick-borne disease during the previous year. Because the survey concerned a wide range of topics, this result is unlikely to reflect differential participation by treating providers. Certain types of providers were more likely to treat tick-borne diseases; however, all provider types saw such patients, including nearly 20% of OB/GYNs. The proportion of providers diagnosing specific diseases generally mirrored the occurrence and ranking of these diseases as measured through national surveillance. LD, with ~30,000 cases reported annually, was diagnosed by far more providers than RMSF (~2500 reported cases), which was diagnosed by slightly more providers than anaplasmosis or ehrlichiosis (~2000 reported cases), babesiosis (~1000 reported cases), and tularemia (~150 reported cases) (CDC, 2013). Similarly, the geographic distribution of physician diagnoses is consistent with surveillance data. LD and babesiosis were diagnosed most often by providers in the Northeast, RMSF most often by providers in the Southeast.

Despite these consistencies, the absolute percentage of providers treating tick-borne disease is higher than might be expected, particularly the percentage treating patients for LD in low-incidence areas (33%). Overdiagnosis almost certainly plays a role in this finding (Ley et al., 1994; Reid et al., 1998). Given the ease of treating common tick-borne diseases with oral antimicrobials, many providers may be treating patients for infections that are suspected rather than confirmed. For LD in particular, confusion with STARI is likely in areas where *A. americanum* ticks are common (Campbell et al., 1995; Wormser et al., 2005). Nevertheless, provider's tendency to treat may not be entirely baseless. "Low-incidence areas" includes several states with large populations where LD is nevertheless endemic (e.g., California, Illinois, Ohio, and Michigan). Furthermore, ours is a highly mobile society, and providers in low-incidence areas are likely to have at least some patients with recent travel to a high risk area. In this regard, it is important to note that treating a single traveler for a suspected tick-borne disease, among hundreds or thousands of patients evaluated each year, would generate a "yes" response in this survey for treating that disease. While treatment may be out of proportion with the occurrence of true infections, this does not negate the observation that providers frequently encounter illnesses that either are or they consider to be tick-borne.

Nearly one-third of surveyed providers reported prescribing antibiotics for post-tick bite prophylaxis. Prophylaxis has been shown effective only for preventing LD. Furthermore, it is only recommended in highly specific circumstances, i.e., when it can be administered

within 72 h of removing an engorged *Ixodes scapularis* tick with a ≥20% probability of being infected (Nadelman et al., 2001; Wormser et al., 2006). The proportion of providers who prescribed tick-bite prophylaxis was greater in high-incidence areas; nevertheless, as with LD treatment, a substantial proportion (26.0%) of providers in low-incidence areas also prescribed tick-bite prophylaxis. These results suggest a need for provider education regarding the uses and the limitations of tick-bite prophylaxis. Additionally, talking points for providers may be useful to guide discussions with their patients about the reasons for and against tick-bite prophylaxis for tick-borne diseases.

This survey found that almost 90% of U.S. practitioners would treat patients with erythema migrans (EM) with empiric antibiotics at the first visit; this increased to 95% among providers who had treated a patient for LD in the past year. EM remains a clinical diagnosis based on appearance and knowledge of epidemiologic features of Lyme disease such as seasonality, endemic areas, and potential exposure to tick habitats. Guidelines emphasize the need to treat patients with EM empirically (Wormser et al., 2006) given that serologic testing can be negative early in disease (Aguero-Rosenfeld et al., 2005), and treatment may prevent complications (Feder et al., 2006). Although EM is a clinical diagnosis, approximately 75% of providers would have ordered concurrent laboratory testing for a patient with EM. Many different factors may motivate testing, including the difficulty in distinguishing EM from other rashes (Feder and Whitaker, 1995; Tibbles and Edlow, 2007), a desire to confirm the diagnosis (Kassirer, 1989), lack of knowledge regarding test characteristics in early Lyme disease (Tugwell et al., 1997), medico-legal concerns, or patient requests. Among the types of practitioners surveyed, pediatricians were less likely than most other practitioners to order blood tests, perhaps due to concerns surrounding venipuncture in children (Kennedy et al., 2008). The more limited laboratory testing by pediatricians did not influence the proportion who would provide antibiotics at the first visit or who would prescribe antibiotics without laboratory testing. In contrast, OB/GYNs were less likely to order blood tests and were less likely to treat a patient with EM at the first visit. Reticence to treat empirically may reflect concern of the use of medications during pregnancy, and OB/GYNs may be more likely to refer such patients to another provider, a management option that was not included in this survey. OB/GYNs were the least likely group in this survey to encounter patients with LD, and this may impact knowledge about current recommendations. Nevertheless, although they encounter patients with LD less commonly, they may also be the only point of contact with the healthcare system. Therefore, OB/GYN-targeted educational resources on tick-borne diseases, particularly LD, may be helpful.

Almost 70% of practitioners were confident about their knowledge of tick-borne diseases management, but this varied by practitioner type and the frequency with which they encountered any tick-borne disease. When uncertain about tick-borne diseases, providers used a wide variety of sources to obtain information, with websites being by far the most frequently used resource. This information should guide the development of educational resources for specific provider groups.

Our findings are subject to several limitations. In regard to the DocStyles survey, healthcare providers who chose not to participate may have answered the tick-borne disease questions

differently than those who did participate. These results may, therefore, not be generalizable to all U.S. healthcare providers. The answers to tick-borne disease questions are self-reported and may differ from providers' actual knowledge and practice. Additionally, the survey instrument does not lend itself to an evaluation of nuanced treatment decisions. Lastly, the DocStyles questionnaire has not been evaluated for validity or reliability. This specific study did not assess reasons for LD treatment in low-incidence areas or for ordering blood tests for patients with EM. The number of patients treated for LD by each provider was not determined, which would have allowed for better quantification of the public health burden of disease. In addition, tick-bite prophylaxis was not explicitly defined with respect to antibiotic type and duration, nor could specific diseases or disease the provider intended to prevent be determined. In future surveys, inclusion of other providers such as physician assistants and emergency medicine physicians would be valuable because they likely encounter patients with tick-borne diseases. Finally, other practice patterns such as prompt referral or consultation that may be appropriate management options were not assessed.

Tick-borne diseases, or at least clinically similar conditions, are commonly encountered by practitioners throughout the United States. Most clinicians would treat early LD appropriately with antibiotics at the first visit; however, more detailed information and resources regarding EM diagnosis, the characteristics of test results in early LD, and the need for early treatment among specific practitioner groups are suggested by this survey. Practice patterns related to tick-bite prophylaxis may help guide future provider education. Developing tick-borne diseases resources for OB/GYNs with a focus on LD might help improve early treatment for EM.

Acknowledgments

This work was funded by the Centers for Disease Control and Prevention. The views expressed in the publication are those of the authors and not necessarily those of the U.S. government.

References

Aguero-Rosenfeld ME, Wang G, Schwartz I, Wormser GP. Diagnosis of Lyme borreliosis. Clin. Microbiol. Rev. 2005; 18:484–509. [PubMed: 16020686]

Campbell GL, Paul WS, Schriefer ME, Craven RB, Robbins KE, Dennis DT. Epidemiologic and diagnostic studies of patients with suspected early Lyme disease, Missouri, 1990–1993. J. Infect. Dis. 1995; 172:470–480. [PubMed: 7622891]

CDC. Summary of notifiable diseases, United States, 2008. MMWR. 2010; 57

CDC. Summary of notifiable diseases, United States, 2011. MMWR. 2013; 60

Eppes SC, Klein JD, Caputo GM, Rose CD. Physician beliefs, attitudes, and approaches toward Lyme disease in an endemic area. Clin. Pediatr. (Phila.). 1994; 33:130–134. [PubMed: 8194286]

Feder HM Jr, Whitaker DL. Misdiagnosis of erythema migrans. Am. J. Med. 1995; 99:412–419. [PubMed: 7573098]

Feder HM Jr, Abeles M, Bernstein M, Whitaker-Worth D, Grant-Kels JM. Diagnosis, treatment, and prognosis of erythema migrans and Lyme arthritis. Clin. Dermatol. 2006; 24:509–520. [PubMed: 17113969]

Fix AD, Strickland GT, Grant J. Tick bites and Lyme disease in an endemic setting: problematic use of serologic testing and prophylactic antibiotic therapy. JAMA. 1998; 279:206–210. [PubMed: 9438740]

Kassirer JP. Our stubborn quest for diagnostic certainty. A cause of excessive testing. N. Engl. J. Med. 1989; 320:1489–1491. [PubMed: 2497349]

Kennedy RM, Luhmann J, Zempsky WT. Clinical implications of unmanaged needle-insertion pain and distress in children. Pediatrics. 2008; 122(Suppl. 3):S130–S133. [PubMed: 18978006]

Krause PJ, Narasimhan S, Wormser GP, Rollend L, Fikrig E, Lepore T, Barbour A, Fish D. Human *Borrelia miyamotoi* infection in the United States. N. Engl. J. Med. 2013; 368:291–293. [PubMed: 23323920]

Ley C, Le C, Olshen EM, Reingold AL. The use of serologic tests for Lyme disease in a prepaid health plan in California. JAMA. 1994; 271:460–463. [PubMed: 8080498]

Magri JM, Johnson MT, Herring TA, Greenblatt JF. Lyme disease knowledge, beliefs, and practices of New Hampshire primary care physicians. J. Am. Board Fam. Pract. 2002; 15:277–284. [PubMed: 12150460]

Mcmullan LK, Folk SM, Kelly AJ, Macneil A, Goldsmith CS, Metcalfe MG, Batten BC, Albarino CG, Zaki SR, Rollin PE, Nicholson WL, Nichol ST. A new phlebovirus associated with severe febrile illness in Missouri. N. Engl. J. Med. 2012; 367:834–841. [PubMed: 22931317]

Murray T, Feder HM Jr. Management of tick bites and early Lyme disease: a survey of Connecticut physicians. Pediatrics. 2001; 108:1367–1370. [PubMed: 11731662]

Nadelman RB, Nowakowski J, Fish D, Falco RC, Freeman K, Mckenna D, Welch P, Marcus R, Aguero-Rosenfeld ME, Dennis DT, Wormser GP, Tick Bite Study G. Prophylaxis with single-dose doxycycline for the prevention of Lyme disease after an *Ixodes scapularis* tick bite. N. Engl. J. Med. 2001; 345:79–84. [PubMed: 11450675]

O'Reilly M, Paddock C, Elchos B, Goddard J, Childs J, Currie M. Physician knowledge of the diagnosis and management of Rocky Mountain spotted fever: Mississippi, 2002. Ann. N.Y. Acad. Sci. 2003; 990:295–301. [PubMed: 12860642]

Pritt BS, Sloan LM, Johnson DK, Munderloh UG, Paskewitz SM, Mcelroy KM, Mcfadden JD, Binnicker MJ, Neitzel DF, Liu G, Nicholson WL, Nelson CM, Franson JJ, Martin SA, Cunningham SA, Steward CR, Bogumill K, Bjorgaard ME, Davis JP, Mcquiston JH, Warshauer DM, Wilhelm MP, Patel R, Trivedi VA, Eremeeva ME. Emergence of a new pathogenic *Ehrlichia species*, Wisconsin and Minnesota, 2009. N. Engl. J. Med. 2011; 365:422–429. [PubMed: 21812671]

Reid MC, Schoen RT, Evans J, Rosenberg JC, Horwitz RI. The consequences of overdiagnosis and overtreatment of Lyme disease: an observational study. Ann. Intern. Med. 1998; 128:354–362. [PubMed: 9490595]

Strickland GT, Caisley I, Woubeshet M, Israel E. Antibiotic therapy for Lyme disease in Maryland. Public Health Rep. 1994; 109:745–749. [PubMed: 7800782]

Tibbles CD, Edlow JA. Does this patient have erythema migrans? JAMA. 2007; 297:2617–2627. [PubMed: 17579230]

Tugwell P, Dennis DT, Weinstein A, Wells G, Shea B, Nichol G, Hayward R, Lightfoot R, Baker P, Steere AC. Laboratory evaluation in the diagnosis of Lyme disease. Ann. Intern. Med. 1997; 127:1109–1123. [PubMed: 9412316]

Warshafsky S, Lee DH, Francois LK, Nowakowski J, Nadelman RB, Wormser GP. Efficacy of antibiotic prophylaxis for the prevention of Lyme disease: an updated systematic review and meta-analysis. J. Antimicrob. Chemother. 2010; 65:1137–1144. [PubMed: 20382722]

Wormser GP, Masters E, Nowakowski J, Mckenna D, Holmgren D, Ma K, Ihde L, Cavaliere LF, Nadelman RB. Prospective clinical evaluation of patients from Missouri and New York with erythema migrans-like skin lesions. Clin. Infect. Dis. 2005; 41:958–965. [PubMed: 16142659]

Wormser GP, Dattwyler RJ, Shapiro ED, Halperin JJ, Steere AC, Klempner MS, Krause PJ, Bakken JS, Strle F, Stanek G, Bockenstedt L, Fish D, Dumler JS, Nadelman RB. The clinical assessment, treatment, and prevention of Lyme disease, human granulocytic anaplasmosis, and babesiosis: clinical practice guidelines by the Infectious Diseases Society of America. Clin. Infect. Dis. 2006; 43:1089–1134. [PubMed: 17029130]

Table 1

Characteristics of 2000 practitioners surveyed for DocStyles 2009.

Characteristics	*n*	(%)
Sex		
Male	1220	(61.0)
Female	780	(39.0)
Age		
≤40 years	803	(40.2)
>40 years	1197	(59.8)
Race		
White	1538	(76.9)
Asian	289	(14.5)
Other	96	(4.8)
Black or African American	77	(3.9)
Ethnicity		
Non-Hispanic	1902	(95.1)
Hispanic	98	(4.9)
Region		
South[a]	676	(33.8)
Northeast[b]	507	(25.4)
Midwest[c]	423	(21.2)
West[d]	394	(19.7)
LD incidence		
High-LD-incidence states	665	(33.3)
Low-LD-incidence states	1335	(66.7)
Practitioner type		
Family/general practice	609	(30.5)
Internist	391	(19.5)
Dermatologist	250	(12.5)
Nurse practitioner	250	(12.5)
Obstetrician/gynecologist	250	(12.5)
Pediatrician	250	(12.5)
Practice setting		
Group	1271	(63.6)
Hospital	367	(18.4)
Individual	362	(18.1)
Years of practice		
≤10	856	(42.8)
>10	1144	(57.2)
Patients per week		
≤100	1104	(55.2)

Characteristics	*n*	(%)
>100	896	(44.8)

[a] Southern states included: AL, AR, District of Columbia, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, and WV.

[b] Northeastern states included: CT, MA, ME, NH, NJ, NY, PA, RI, and VT.

[c] Midwestern states included: IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, and WI.

[d] Western states included: AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, and WY.

Ticks Tick Borne Dis. Author manuscript; available in PMC 2015 October 29.

Table 2

Experience with tick-borne diseases among 2000 practitioners surveyed for DocStyles 2009.

	Total (*n*)	Any tick-borne disease (%)	Lyme disease (%)	RMSF[a] (%)	Ehrlichiosis or anaplasmosis (%)	STARI[b] (%)	Babesiosis (%)	Tularemia (%)
Practitioner type								
Family/general practice (ref)	609	56.2	48.8	12.5	8.5	2.0	3.3	1.1
Internist	391	59.1	55.0	9.7	9.7	0.8	5.1	1.3
Dermatologist	250	59.6	57.6	8.4	4.4	1.6	0.8	0.4
Nurse practitioner	250	48.8	44.8	10.0	4.4	1.2	2.0	0.8
Obstetrician/gynecologist	250	19.2	18.0	1.2	0.8	0.4	0.0	0.0
Pediatrician	250	53.2	49.2	8.4	7.2	2.4	2.0	1.6
Region								
South (ref)	676	50.7	44.8	14.9	5.8	3.6	1.0	1.2
Northeast	507	75.4	74.6	4.7	11.4	0.2	7.1	0.2
Midwest	423	43.7	37.8	7.6	7.3	0.5	1.2	1.0
West	394	29.2	24.4	6.9	1.0	0.5	1.0	1.5
LD incidence								
High-incidence states (ref)	665	74.7	74.0	6.3	11.0	0.8	6.0	0.3
Low-incidence states	1335	39.6	33.3	10.6	4.4	1.8	0.9	1.3
Practice setting								
Individual (ref)	362	50.0	46.4	8.8	5.0	2.2	1.7	0.3
Group	1271	52.9	48.2	9.0	7.1	1.4	2.8	1.2
Hospital	367	46.9	42.5	9.5	6.5	0.8	3.0	0.8
Total	2000	51.3	46.8	9.2	6.6	1.5	2.6	1.0

[a] Rocky Mountain spotted fever (RMSF).

[b] Southern tick-associated rash illness (STARI).