

# Descriptive Data on Trends Among Patients Hospitalized With Lyme Disease in Southwest Michigan, 2017–2021

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This retrospective chart review identifies hospitalizations for Lyme disease at two southwest Michigan hospital systems, 2017–2021. Lyme admissions increased sharply, while admissions for Lyme carditis and neuroborreliosis increased in parallel. Southwest Michigan is becoming an endemic area for Lyme disease.

**Keywords.** Lyme carditis; Lyme disease; Michigan; neuroborreliosis.

## BACKGROUND

Lyme disease is the most common vector-borne disease in the United States, affecting somewhere between 30 000 and 475 000 Americans annually [1–3]. In 2020, the most recent year for which data are available online, the state of Michigan reported 468 cases, continuing a statewide increase in reported cases over the past decade [3]. The Michigan Department of Health and Human Services reported 864 cases in 2021 and describes the disease as “endemic and expanding” [4]. The early/localized stage of Lyme disease usually manifests as erythema migrans (EM) skin lesion(s), whereas once the condition progresses to the disseminated stage it may cause severe illness through complications that include carditis and central nervous system involvement (neuroborreliosis). Lyme carditis most frequently manifests as cardiac conduction disease, with myopericarditis and dilated cardiomyopathy also both observed occasionally [1, 5]. Neuroborreliosis may cause a variety of neurologic manifestations that include facial palsy,

meningitis, and a syndrome of painful subacute radiculitis that is often associated with lymphocytic pleocytosis and the aforementioned facial palsy (Bannwarth syndrome) [6]. The complications of Lyme disease noted above sometimes merit hospitalization and treatment with intravenous antibiotics [1].

Lyme disease is a mandatory reportable disease in the United States, which allows for estimates of prevalence on a statewide and national level [2]. Between 2008 and 2015, the reported case rate increased in some lower-incidence states, including Michigan [2]. Concurrent with this, Lantos et al [7] note that although Lyme was quite rare in Michigan’s Lower Peninsula through the 20th century, reported cases began to increase in 2005. During this time, according to this study, the southwestern portion of the state was a major focus of geographic spread of the disease, with the tick vector of the disease first being reported in Kalamazoo County in 2007. The western Lower Peninsula including Kalamazoo County is currently reported to have among the highest tick *Borrelia burgdorferi* infection level in the state [4].

Estimates of carditis rates among US Lyme inpatients are between 5% and 11% [5, 8, 9]. A single-center pediatric study [8] in Pennsylvania identified Lyme meningitis in 38% of pediatric patients hospitalized for Lyme disease from 2007 to 2014; I am not aware of similar data in US adults. In general, Lyme hospitalizations in the United States appear to be increasing [5]. The premise that Lyme carditis is increasing in incidence in the United States has been proposed in a pediatric setting [9]. These investigators concluded that increases in Lyme carditis rates were caused by an increase in the total infectious burden of Lyme disease, rather than by any difference in its tropism or mechanism. The increases were significant in the subgroup of hospital network data from the subregion that included the state of Michigan. In adults, a survey of Lyme carditis between 2003 and 2014 through the National Inpatient Sample database also demonstrated a significant increase in both total Lyme hospitalizations and Lyme carditis [5].

This retrospective chart review study provides descriptive data with regard to hospitalization with Lyme disease. I hypothesized that both Lyme disease case numbers and reports of Lyme complications would increase in parallel over the course of the study period.

## METHODS

This study was designed as a retrospective chart review of patients hospitalized at the Bronson Healthcare Group in southwestern Michigan (sites in Kalamazoo, Battle Creek, and Paw Paw), as well as at Ascension Borgess Medical Center in Kalamazoo. An initial list of candidate patients was generated

Received 20 September 2022; editorial decision 29 November 2022; accepted 05 December 2022; published online 7 December 2022

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<https://doi.org/10.1093/ofid/ofac658>

via a data audit of the electronic medical record based around the following search strategy: Admission date January 1, 2017 through December 31, 2021 AND (either) Any positive testing for Lyme disease (serum total antibody, serum immunoglobulin [Ig]M, serum IgM, serum *B burgdorferi* polymerase chain reaction testing, cerebrospinal fluid Lyme total IgG, or antibody index) OR Any of the following *International Classification of Diseases* (ICD)-10 diagnostic codes: Lyme disease, unspecified (A69.20), meningitis due to Lyme disease (69.21), arthritis due to Lyme disease (A69.23), other conditions associated with Lyme disease (A69.29), other neurologic disorders in Lyme disease (A69.22).

One hundred seven charts were identified by these means. All charts were reviewed for appropriateness for inclusion in the study, so as to include only those for whom Lyme disease or its symptomatic manifestations were the reason for admission. Fifty-four patients (49 adult, 5 pediatric) were eligible for analysis. Thirty-five patients in this cohort, including all pediatric patients, were male, whereas 19 were female.

Each chart was reviewed in greater detail to classify the diagnosis and to determine whether there was clinical evidence of EM, Lyme carditis, and neuroborreliosis. Lyme cases were classified based upon US Centers for Disease Control and Prevention criteria [3]. “Laboratory evidence” of Lyme disease was thus defined as a positive “two tier” test (positive enzyme immunoassay followed by a positive confirmatory IgM or IgG). “Confirmed” Lyme disease was defined as a combination of a typical clinical manifestation of Lyme disease—clinical EM, neuroborreliosis, Lyme carditis, or inflammatory arthritis—together with laboratory evidence of infection. Cases without the above specific clinical manifestations but with positive testing and high clinical suspicion, or cases with a Lyme-like presentation (eg, EM) with laboratory testing absent or negative were define as “suspected” Lyme. We defined a case as Lyme carditis if a patient with Lyme disease had atrioventricular heart block on electrocardiographic monitoring or any form of myopericarditis. We defined a case as neuroborreliosis if a patient with Lyme disease had clinical signs of central nervous system or cranial nerve involvement (specifically meningitis or

encephalitis, facial palsy, cranial neuritis, or radiculoneuropathy) attributed to Lyme disease by clinical providers. A positive antibody index for intrathecal Lyme antibody production was also considered to represent neuroborreliosis. Headache, fatigue, paresthesia, or stiff neck in the absence of the symptoms and testing above were not sufficient to classify a patient as having neuroborreliosis.

#### Patient Consent Statement

The project involved collection of existing clinical data with no additional contact with subjects. Consent was waived by the Western Michigan University Homer Stryker MD School of Medicine Institutional Review Board per the US Department of Health and Human Services regulation 45 CFR Part 46.101(d) under category 4 (iii).

## RESULTS AND DISCUSSION

Descriptive data on the patients hospitalized with Lyme disease are shown in [Table 1](#). Of the 54 inpatients, 34 had confirmed Lyme disease, whereas 20 had suspected Lyme disease. Thirteen (24.1%) had Lyme carditis, whereas 16 (29.6%) had neuroborreliosis. Of the 5 pediatric patients hospitalized for Lyme disease, 4 had carditis and none had neuroborreliosis. Additional data on reasons for hospitalization and testing results are shown in [Table 2](#).

The most striking finding of this study was that the raw number of patients hospitalized with Lyme disease in our area hospitals increased sharply over the years studied, progressively rising to 24 inpatients in 2021. Lyme admissions rose despite fewer total admissions in 2020 and 2021 compared to prior years. However, the proportion of inpatients with Lyme carditis or neuroborreliosis did not show any clear variation between years, nor did the distribution of confirmed versus suspected cases. The years of 2020 and 2021 were marked by not only higher total Lyme admissions than 2017–2018 but also a similar proportion that represented confirmed Lyme and its complications. These findings are consistent with the premise that the incidence of hospitalization for Lyme disease in southwest

**Table 1. Lyme Disease Cases by Year<sup>a</sup>**

Patients	2017	2018	2019	2020	2021	Total
Total Medical Admissions to Study Hospitals	50 534	52 492	52 308	46 888	49 010	...
All Lyme-related admissions	4	4	11	11	24	54
Confirmed Lyme	2 (50)	4 (100)	5 (45)	9 (82)	14 (58)	34 (63)
Suspected Lyme	2 (50)	0	6 (54)	2 (18)	10 (58)	20 (37)
Clinical erythema migrans	3 (75)	1 (25)	4 (36)	5 (45)	9 (38)	22 (41)
Lyme carditis	1 (25)	1 (25)	1 (9)	3 (27)	7 (29)	13 (24)
Neuroborreliosis	1 (25)	2 (50)	1 (9)	5 (45)	7 (29)	16 (30)

<sup>a</sup>Values in the second row indicate all patients hospitalized for Lyme disease in a given calendar year. Numbers given in rows below represent raw number of admissions (percentage of Lyme admissions from that year with this diagnosis, rounded to nearest full percentage). Confirmed/suspected Lyme disease were defined using US Centers for Disease Control and Prevention criteria as summarized under Methods.

**Table 2. Admission Indications and Diagnostic Tests<sup>a</sup>**

Reason for Admission	Meningitis Concern	Other Neurologic	Cardiac	Expedited Workup	Concern for Sepsis or Acute Bacterial Infection	Other or Unrelated Condition
Confirmed	7	9	12	2	3	1
Suspected	3	0	1	3	8	5
Testing Method	Total antibody testing with positive confirmatory IgM	Total antibody testing with positive confirmatory IgM + IgG	None or negative testing	CSF IgG and antibody index without serology	...	...
Confirmed	22	11	0	1	...	...
Suspected	6	1	13	...	...	...

Abbreviations: CSF, cerebrospinal fluid; Ig, immunoglobulin.

<sup>a</sup>Patients admitted with Lyme disease are sorted based on reason for the decision to admit as extracted from the electronic medical record, as well as by the testing method used to make the diagnosis of Lyme disease. "Meningitis" refers to patients for whom providers' notes on admission indicate strong concern for acute bacterial meningitis. "Other neurologic" includes suspected stroke, acute weakness, and facial palsy with suspicion for neuroborreliosis. "Cardiac" indicates that cardiovascular manifestations led to the decision to admit to the hospital, and it includes heart block, troponin elevation, or other manifestations of myopericarditis. Patients who were clinically stable but were believed to need workup of an ongoing issue refractory to outpatient management—usually fever—were coded as "expedited workup." Patients who were admitted due to concern at time of admission for an acute bacterial process such as sepsis or cellulitis that would merit admission are collectively coded as "concern for sepsis." Some patients were admitted for reasons that do not fit any of the above categories or had a principal reason for admission unrelated to their acute Lyme disease.

Michigan is increasing, and that the higher numbers of Lyme carditis and neuroborreliosis reflect an increase in overall disease prevalence rather than a change in the nature of the condition. Despite Michigan's status as a "low incidence" state, accumulating data indicate that southwest Michigan is now one of the more affected regions of the state [4, 7]. I suspect that Lyme burden has further increased in our region such that it is now an endemic area.

The admittedly limited and narrowly focused data presented here provide the only available description of patients hospitalized with Lyme disease since 2017 in southwest Michigan. Of note, these case data were individually reviewed by the author; the importance of this step is highlighted by studies demonstrating that the sensitivity and specificity of ICD coding are inadequate for providing an accurate assessment of Lyme cases [10, 11]; indeed, only half of the patients identified by the initial electronic screen were actually appropriate for analysis in the present study. The results represent an early warning suggesting that Lyme disease, including its severe complications, will increasingly be a major medical issue in regions not traditionally viewed as high incidence such as the lower Midwest. Ongoing surveillance is indicated to assess whether this trend will continue, fluctuate, or reverse, as multiple European countries for which Lyme is a mandatory reportable disease have shown reported declines in neuroborreliosis diagnoses after a period of increase [12]. This study will be extended through 2023 at minimum, both to continue monitoring of this worrisome trend and to gather more data to allow for statistical analysis. The numbers presented here would gain valuable context if compared with quality outpatient data on local Lyme prevalence that could shed light on whether the proportion of hospitalizations is also remaining constant. Investigations of provider practices and attitudes, particularly regarding the decision to test for and treat for Lyme

disease, could also provide a parallel marker of the endemicity of Lyme in an area in which Lyme was once considered rare.

### Acknowledgments

I acknowledge the assistance throughout this project of Theresa McGoff (Department of Biomedical Informatics) who acted as the Data Manager, with the assistance of Anita Bell. Daphne York was the Research Coordinator and facilitated communication among staff involved. Dr. Thomas Flynn, Dr. Mireya del Carmen Diaz Insua, and Maureen Owens also provided valuable advice during discussions of project design. I am indebted to 2 reviewers at *Open Forum Infectious Diseases* for their invaluable input and advice on a prior version of this article.

**Potential conflicts of interest.** All authors: No reported conflicts of interest.

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