

Lyme Carditis in Hospitalized Children and Adults, a Case Series

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Background. Lyme carditis is an uncommon manifestation of Lyme disease. This report compares Lyme carditis presentation, management, and outcomes in pediatric and adult populations.

Methods. Charts of pediatric and adult patients with heart block (PR interval >300 ms) and positive Lyme serologies hospitalized in Portland, Maine, between January 2010 and December 2018 were analyzed. Data on medical history, presentation, treatment, and outcomes are described.

Results. Ten children and 20 adults were admitted for Lyme carditis between June and October. Ninety percent were male, and 87% had no prior cardiac history. Seventeen had outpatient evaluation before admission. Of these, a minority (41%) had Lyme disease suspected in the outpatient setting, and fewer (12%) were initiated on Lyme disease treatment. The most common alternate diagnoses were viral illness and erythema multiforme. More children than adults had disseminated erythema migrans and fever. First-degree heart block was more prevalent in children, and Mobitz type 2 heart block was more prevalent in adults. Ten patients presented with syncope. Proportionately more adults needed temporary pacing. Children had shorter antibiotic durations compared with adults. Of the 30 cases, 27 had improved heart block, while 3 adults required a pacemaker at discharge. Nine children and 14 adults were discharged with a PR 200–300 ms. There was a single death in this series.

Conclusions. Cases tended to be younger males. Most patients had some heart block on discharge. Of patients evaluated as outpatients, Lyme disease was suspected in 41%. Improved early recognition and treatment of Lyme disease may decrease Lyme carditis.

Keywords. adult; carditis; Lyme; outcomes; pediatric.

Lyme disease is a tickborne infection increasingly endemic in many parts of the United States. Cardiac manifestations of Lyme disease, predominantly conduction disturbances, were initially described in 1980 and occur in about 1% of cases, though earlier estimates ranged from 4% to 10% [1–5]. Lyme carditis is usually a self-limited inflammatory process with a good prognosis [6, 7]. Cases range from asymptomatic, especially with first-degree heart block, to more symptomatic and potentially fatal advanced heart blocks. Additionally, there have been case reports of sudden cardiac deaths associated with this entity [8–10], and also rarely irreversible heart block [11].

Clinical observations of Lyme carditis consist of case reports, case series, and 1 autopsy series [3]. The largest published cases series in children (n = 33) includes only 14 with advanced heart block [2]. Our study compares pediatric and adult Lyme carditis

cases in Maine, a high-incidence state for Lyme disease. This adds to the literature and data currently available for a relatively common disease with uncommon, but potentially serious, cardiac manifestations [12].

METHODS

We defined Lyme carditis cases as having recent onset heart block and meeting Centers for Disease Control and Prevention (CDC) serologic criteria for Lyme disease. In 1990, the CDC suggested a standard reporting case definition for Lyme carditis that included patients with “acute onset of high-grade atrioventricular conduction defects that resolve in days to weeks and are sometimes associated with myocarditis” [13]. In our series, we also included patients who met Lyme disease diagnostic criteria [14] with first-degree atrioventricular (AV) conduction delay of >300 ms. Pediatric and adult patients hospitalized at Maine Medical Center between January 2010 and December 2018 with a diagnosis of Lyme carditis were included. Chart review and data extraction utilized the electronic medical record. Approval was obtained from MaineHealth’s Institutional Review Board.

We collected data on demographics, medical history including prior cardiac history and drug use, disease presentation, Lyme disease diagnostic testing, and testing for other tickborne illness (*Anaplasma* spp., *Babesia* spp., and *Borrelia miyamotoi*). When available, data regarding outpatient evaluations before

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hospital admission were collected. We also collected data on hospitalization characteristics, cardiac evaluations, antibiotic use, and pacemaker use. Outcomes examined included antibiotic days needed for PR interval improvement to <300 ms, degree of heart block at discharge, and mortality within 1 month of discharge.

Means and medians were calculated for continuous data, and percentages for categorical data. Statistical analysis comparing adult and pediatric cases was performed using the Fisher exact test or the Student *t* test, where applicable.

RESULTS

At Maine Medical Center, from 2010 to 2018, 10 children (age range, 7–17 years; mean age, 12.4 years) and 20 adults (age range, 22–81 years; mean age, 41.4 years) met our study definition of Lyme carditis. Twenty-seven (90%) were male, and all 30 were White and non-Hispanic. All cases presented between June and October. Time between onset of illness and admission was not specified in most cases. Of the 13 cases who noted symptom onset, 10 (76%) presented within 3 weeks of illness. Previous known cardiac and drug use history, as well as incidence of fever, rash, presyncope, syncope, and other signs and symptoms, is found in [Table 1](#). There was no statistical difference in the rates of any of these signs or symptoms between age groups. All cases had reactive Lyme serologic screening assays and positive Western blots by CDC criteria. Sixteen (53%) had only IgM band positivity, and 9 (30%) had both IgM and IgG band positivity. One (3%) case was reported to have prior Lyme disease and only had IgG band positivity. In 4 cases, positive Western blot results were reported from outside laboratories. In the 18 cases tested for co-infections, none were encountered.

Seventeen (57%) cases had outpatient primary care or urgent care evaluation before admission. Of those evaluated as outpatients, 7 (42%) were diagnosed or suspected to have Lyme disease, but only 2 (12%) had appropriate therapy prescribed on initial encounter. Alternate diagnoses to Lyme disease and further information pertaining to outpatient evaluations and treatment can be found in [Table 2](#).

The most commonly seen heart block was second-degree Mobitz type 2 in 14 (47%) cases. Other cardiac complications or findings included 1 (3%) documented myocarditis and 1 (3%) pericardial effusion. There was no statistical difference between pediatric and adult cases with regards to heart block type or other cardiac complications. However, the most common heart block in pediatric cases was first-degree (40%) vs second-degree Mobitz type 2 in adult cases (55%). Eleven (37%) needed temporary pacing, and 3 (10%) had a permanent pacemaker placed. Adults were more likely to be paced, with 12 (60%) adult cases needing pacing, vs 2 (20%) pediatric cases. Refer to [Tables 3 and 4](#) for further data on pacemaker and antibiotic usage, on hospital length of stay, and for a summary of cases.

By discharge, 25 (83%) cases had resolved heart block or improving first-degree heart block, 1 (3%) pediatric case had second-degree heart block, and 3 (10%) had a permanent pacemaker in place. One (3%) had reported resolved heart block without electrocardiogram tracing available for verification. There was 1 death in this series. This was a 25-year-old male who initially presented with syncope and second-degree Mobitz type 2 heart block, as well as disseminated erythema migrans rash. He required temporary pacing, and after 4 days of IV ceftriaxone, he had improvement of heart block to first-degree. He was discharged with oral doxycycline and reported feeling well. The patient returned home to a different state and reportedly died at home about 1 week after discharge. Further information surrounding the circumstances of his death was not available.

DISCUSSION

This is the first case series to compare pediatric and adult Lyme carditis presentations and outcomes. We included 8 patients with first-degree AV conduction delay, 6 of whom were symptomatic with presyncope or syncope. Overall, there were no major differences seen between the presentations or outcomes of pediatric and adult Lyme carditis cases. The demographics and presentations of cases were similar to those seen in previous case series. The male predominance was more pronounced than in other studies [5, 15]. This includes a 2008 series of 33 pediatric Lyme carditis cases being 64% male and a 1980 series of 20 adult cases having had a 3:1 male predominance [1, 2]. As in previous studies, complete heart block occurred only in males. The cause of this gender discrepancy is unclear, though there could have been differences in risks of exposure to ticks or differences in obtaining health care, but these could not be discerned with this study design.

What was more evident in this study, though, was the need for earlier recognition and treatment of early Lyme disease. The majority of cases in this series were evaluated by an outpatient provider before developing carditis, but the minority of cases (41%) were diagnosed with or suspected to have Lyme disease at that visit, and even fewer (12%) received appropriate antibiotics. Earlier diagnosis and treatment would likely have prevented carditis and the need for hospital admission. In a study of >600 patients treated at the onset of erythema migrans rash of Lyme disease, only 2 patients developed complications (seventh nerve palsy in 1, Lyme meningitis in a second), and no relapses followed successful treatment [16]. Lyme carditis, with typical onset at 3–6 weeks post-initial infection, should be largely preventable. Further provider education on Lyme disease and its diagnosis should be emphasized to reduce misdiagnoses and increase early treatment.

The timing of illness onset to admission was not consistently documented, but in cases with a recorded time frame, most

Table 1. Patient Demographics and Characteristics

Characteristic	All (n = 30)	Pediatric (<18) (n = 10)	Adults (≥18) (n = 20)	PValue
Demographic				
Age (range), y	29 (7–81)	13.5 (7–17)	36 (22–81)	
Male sex, No. (%)	27 (90)	8 (80)	19 (95)	
Race or ethnic group, No. (%)				
White, non-Hispanic	30 (100)	10 (100)	20 (100)	
Clinical history				
Prior Lyme disease history, No. (%)	1 (3)	1 (10)	0 (0)	.33
Prior cardiac history, No. (%)				
None	26 (87)	10 (100)	16 (80)	.27
Prior syncope	1 (3)	0 (0)	1 (5)	1
Coronary artery disease	2 (7)	0 (0)	2 (10)	.54
Rheumatic heart disease	1 (3)	0 (0)	1 (5)	1
Reported drug use history, No. (%)				
None	22 (73)	10 (100)	12 (60)	.029
Cocaine/stimulants	1 (3)	0 (0)	1 (5)	1
Opioids, PO or IV	4 (13)	0 (0)	4 (20)	.27
Marijuana	6 (20)	0 (0)	6 (30)	.074
Laboratory testing				
Positive Lyme ELISA, No. (%)	30 (100)	10 (100)	20 (100)	1
Positive Lyme Western blot, No. (%)				
IgG and IgM	9 (30)	1 (10)	8 (40)	.20
IgM only	16 (53)	6 (60)	10 (50)	.71
IgG only	1 (3)	0 (0)	1 (5)	1
Reported positive only	4 (13)	3 (30)	1 (5)	.095
Co-infections, No./No. tested	0/18	0/1	0/17	1
Cardiac findings				
Symptoms, No. (%)				
Syncope	10 (33)	3 (30)	7 (35)	1
Presyncope	19 (63)	6 (60)	13 (65)	1
Shortness of breath	1 (3)	0 (0)	1 (5)	1
AV block, No. (%)				
1°	8 (27)	4 (40)	4 (20)	.38
2°, Mobitz type 1	3 (10)	1 (10)	2 (10)	1
2°, Mobitz type 2	14 (47)	3 (30)	11 (55)	.26
3°/complete	5 (17)	2 (20)	3 (15)	1
Myocarditis	1 (3)	0 (0)	1 (5)	1
Pericardial effusion	1 (3)	1 (10)	0 (0)	.33
Noncardiac findings				
Documented rash, No. (%)				
None	14 (47)	5 (50)	9 (45)	1
Localized	8 (27)	1 (10)	7 (35)	.21
Disseminated	8 (27)	4 (40)	4 (20)	.38
Duration of illness to admission, No. (%)				
≤1 wk	5 (17)	2 (20)	3 (15)	
1–3 wk	5 (17)	1 (10)	4 (20)	
≥3 wk	3 (10)	1 (10)	2 (10)	
Not specified	17 (57)	6 (60)	11 (55)	
Fever, No. (%)	13 (43)	6 (60)	7 (35)	.26
Other findings, No. (%)				
Arthralgia	7 (23)	3 (30)	4 (20)	.66
Arthritis	1 (3)	0 (0)	1 (5)	1
Cranial neuritis	3 (10)	1 (10)	2 (10)	1
Meningitis	1 (3)	0 (0)	1 (5)	1

Abbreviations: AV, atrioventricular; ELISA, enzyme-linked immunosorbent assay; IgG, immunoglobulin G; IgM, immunoglobulin M; IV, intravenous; PO, oral.

Table 2. Outpatient Evaluations and Treatments

Characteristic	All (n = 30)	Pediatric (<18) (n = 10)	Adults (≥18) (n = 20)	PValue
Evaluated as outpatient before admission, No. (%)	17 (53)	7 (70)	10 (50)	.44
Days from first outpatient eval to admission, mean (range)	13 (0–28)	14 (0–28)	12.3 (0–21)	.75
Lyme disease diagnosed, No. (% of those evaluated as outpatient)	7 (42)	4 (57)	3 (30)	.35
Outpatient antibiotic therapy, No. (% of those evaluated as outpatient)				
Doxycycline	2 (12)	1 (14)	1 (10)	N/A
Trimethoprim/sulfamethoxazole	1 (6)	0 (0)	1 (10)	N/A
Cephalexin	1 (6)	1 (10)	0 (0)	N/A
Referral for admission for antibiotics	4 (24)	3 (30)	1 (10)	N/A
Alternate diagnoses, if not Lyme, if documented, No.				
Spider or insect bite	1	1	0	N/A
Skin abscess	1	0	1	N/A
Viral illness, unspecified	5	3	2	N/A
Erythema multiforme	2	0	2	N/A

cases presented before 3 weeks of illness. Serologic study results were also indicative of acute or subacute presentations. Eighty-three percent of cases had IgM band positivity on Western blot, with 53% having IgM positivity only. There was a potential for overinclusion of cases, specifically in cases positive for IgM only. However, these cases had clinical presentations consistent with Lyme disease and carditis and occurred during expected months. Additionally, improvement of heart block with antibiotics was further evidence of true Lyme disease and carditis. Such improvement in was documented in 27 patients (90%).

Overall, the most common heart block type was second-degree Mobitz type 2, with 14 (47%) cases. When segregated by

age group, though, first-degree heart block was most prevalent in pediatric cases (40%), and the majority of adults had second-degree Mobitz type 2 (55%). This difference between the age groups was not statistically significant, however. The significance of Mobitz type 2 heart block being most common is unclear. This may relate to capturing symptomatic patients, where more advanced heart blocks, like Mobitz type 2, may be more likely to have symptoms.

Presyncope and syncope were the predominant cardiac symptoms, with similar rates in pediatric and adult cases. The rate of reported rashes (53%) and joint symptoms/arthritis (23%) was similar to that in other case series [2]. Outside of

Table 3. Patient Treatment and Outcomes

Characteristic	All (n = 30)	Pediatric (<18) (n = 10)	Adults (≥18) (n = 20)	PValue
Cardiac therapy and diagnostics				
Pacing, No. (%)				
None	16 (53)	8 (80)	8 (40)	.058
Temporary	11 (37)	2 (20)	9 (45)	.25
Permanent	3 (10)	0 (0)	3 (15)	.53
Days of temporary pacing, mean (range)	4.9 (3–8)	4.5 (4–5)	5 (3–8)	.41
Echocardiogram performed, No. (%)	27 (90)	9 (90)	18 (90)	1
Antibiotic therapy				
IV antibiotic, mean (range), d	7 (2–28)	6.5 (2–21)	7.3 (3–28)	.74
PO antibiotic, mean (range), d	15.1 (2–24)	13.3 (6–19)	15.9 (2–24)	.27
Total antibiotic, mean (range), d	22.3 (7–42)	19.8 (14–21)	23.6 (7–42)	.046
Days of antibiotics for PR improvement <300, mean (range)	4.2 (0–10)	3.4 (0–8)	4.6 (0–10)	.33
Resource use				
Days of hospitalization, mean (range)	6 (1–12)	4.8 (1–8)	6.7 (3–12)	.07
Days in ICU stay, mean (range)	1.8 (0–8)	3.7 (0–5)	0.8 (0–4)	.012
Outcomes				
Discharge AV block, No. (%)				
Normal	2 (7)	0 (0)	2 (10)	.54
1°	23 (77)	9 (90)	14 (70)	.37
Permanent pacing	3 (10)	0 (0)	3 (15)	.53
Unknown, not documented	2 (6)	1 (10)	1 (5)	1
Death, No. (%)	1 (3)	0 (0)	1 (5)	1

Abbreviations: AV, atrioventricular; ICU, intensive care unit; IV, intravenous; PO, oral; PR, PR interval.

Table 4. Summary of Patient Presentation, Treatment, and Outcomes

Age, Sex	Noncardiac Symptoms	Cardiac Symptoms	Initial AV Block	Pace-maker	Antibiotics	Outcome
7, M	None	Syncope	1°	None	CTX 21 d	Improving 1° AV block after 1 d antibiotics
8, M	None	Syncope	2° Mobitz 2	None	CTX 5 d, Doxy 16 d	1° AV block after 4 d antibiotics
9, M	Localized rash, fever, arthralgia	None	1°	None	CTX 2 d, Doxy 19 d	Continued 1° AV block on discharge
11, M	Fever	None	2° Mobitz 1	None	CTX 4 d, Doxy 17 d	1° AV block after 3 d antibiotics
13, F	Fever, arthralgia	Presyncope	1°	None	CTX 5 d, Doxy 16 d	1° AV block after 4 d antibiotics
14, F	Disseminated rash	Syncope	2° Mobitz 2	Temporary	CTX 7 d, Doxy 14 d	1° AV block after 6 d antibiotics
14, M	Disseminated rash, fever, arthralgia	Presyncope	3°	None	CTX 8 d, Doxy 6 d	1° AV block after 8 d antibiotics
15, M	Localized rash, fever	Presyncope	3°	None	CTX 6 d, Doxy 15 d	AV block improvement not documented
16, M	Disseminated rash, cranial neuritis	Presyncope	2° Mobitz 2	Temporary	CTX 5 d, Doxy 16 d	1° AV block after 5 d antibiotics
17, M*	Fever	Presyncope	1°	None	CTX 2 d, Doxy 14 d	Continued 1° AV block on discharge
22, M	Localized rash	Syncope	3°	Temporary	CTX 7 d, Doxy 21 d	Resolution of AV block after 5 d antibiotics
25, M	Disseminated rash	Syncope, SOB	2° Mobitz 2	Temporary	CTX 5 d, Doxy 2 d	1° AV block after 4 d antibiotics; patient died 1 wk after discharge
26, M	Fever, arthralgia	Syncope	2° Mobitz 2	Temporary	CTX 4 d, Doxy 24 d	1° AV block after 2 d antibiotics
28, M	Localized rash, arthralgia	None	1°	None	CTX 3 d, Doxy 21 d	Improving 1° AV block after 3 d antibiotics
28, M	Localized rash, arthralgia, arthritis	Syncope	1°	None	CTX 3 d, Doxy 18 d	Continued 1° AV block on discharge
30, F	Disseminated rash	Presyncope	2° Mobitz 1	None	CTX 7 d, Doxy 14 d	1° AV block after 5 d antibiotics
31, M	Fever, cranial neuritis	Presyncope	1°	None	CTX 28 d	Continued 1° AV block on discharge
34, M	None	Syncope	2° Mobitz 2	Temporary	CTX 10 d, Doxy 11 d	1° AV block after 9 d antibiotics
34, M	Disseminated rash	Presyncope	3°	None	CTX 6 d, Doxy 22 d	AV block improvement not documented
35, M	Fever	None	2° Mobitz 2	Temporary	CTX 4 d, Doxy 17 d	Reported improvement after 4 d antibiotics but no discharge EKG available
37, M	Localized rash, cranial neuritis	Presyncope	2° Mobitz 1	None	CTX 11 d, Doxy 17 d	1° AV block after 10 d antibiotics
37, M	Localized rash, fever	None	2° Mobitz 2	None	CTX 5 d, Doxy 23 d	Resolution of AV block after 7 d antibiotics
38, M	Localized rash, fever	None	3°	None	CTX 2 d, Doxy 19 d	1° AV block after 2 d antibiotics
46, M	None	Presyncope	2° Mobitz 2	None	Doxy 14 d	1° AV block after 6 d antibiotics
48, M	None	Presyncope	2° Mobitz 2	Permanent	CTX 28 d, Doxy 14 d	Permanent pacer remains
54, M	Fever, arthralgia	Syncope	2° Mobitz 2	Temporary	CTX 8 d, Doxy 13 d	1° AV block after 8 d antibiotics
58, M	None	Presyncope	2° Mobitz 2	Temporary	CTX 7 d, Doxy 21 d	1° AV block after 7 d antibiotics
63, M	Disseminated rash	None	1°	None	Doxy 14 d	Improving 1° AV block after 2 d antibiotics
73, M	Localized rash, fever	Syncope	2° Mobitz 2	Permanent	CTX 4 d, Doxy 24 d	Permanent pacer remains
81, M	None	Presyncope	2° Mobitz 2	Permanent	CTX 4 d, Doxy 10 d	Permanent pacer later removed

Abbreviations: AV, atrioventricular; CTX, ceftriaxone; Doxy, doxycycline; EKG, electrocardiography.

*This patient reported prior Lyme disease.

cardiopulmonary symptoms, there were no obvious signs or symptoms found to be useful or practical predictors of carditis. Similarly, there were no significant findings that certain drug use or preexisting medical conditions, like ischemic heart disease or arrhythmias, predisposed to Lyme carditis or poorer outcomes.

Antibiotic treatment and duration were similar among cases. Pediatric patients were statistically more likely to be admitted to an intensive care unit, but this was likely due to pediatric telemetry only being available there. Pacemaker use was more common in adults, but this was not statistically significant. Outcomes were generally good, with patients having improvement in heart block after antibiotics and, when needed, temporary pacing. Most patients still had first-degree heart block on discharge. Notably, 3 adult patients received permanent pacemakers during their admissions. The indications for permanent pacing were not entirely clear, but 1 of these pacemakers was removed within several years without replacement. Two of the 3 patients were elderly, 1 with known atherosclerotic heart disease and the other with history of rheumatic heart disease. It is possible that the need for permanent pacing in these cases may not have been related to Lyme disease. Heart block from Lyme carditis is typically self-limited and not a usual indication for permanent pacing, though it has been required in at least 1 case report [11]. Underlying cardiac factors may contribute to the need for continued pacing, including congenital heart blocks, sick sinus syndrome, or symptomatic blocks felt to be irreversible. There was 1 death of a young male 1 week after discharge while on oral doxycycline. It is possible that there were other causes of sudden death related to factors other than Lyme carditis. Unfortunately, neither autopsy nor further information surrounding the death was available.

As this study examined only hospitalized patients, it may not have represented the full spectrum of Lyme carditis. Limitations or inaccuracies in the medical record were also evident, including occasionally incomplete documentation of laboratory studies and electrocardiograms, particularly among cases before 2013, before an electronic medical record was implemented. Outpatient records were not always available, limiting collection of pre-admission data, like indications for outpatient medications. Lastly, the ability to make strong conclusions and comparisons was limited by the overall small sample size of cases.

In brief, though there were no statistically significant differences in the clinical course and outcomes of pediatric and adult

cases in this series, there were still important observations. Namely, there is room for improving outpatient diagnosis and treatment of early Lyme disease, even in a high-incidence state like Maine.

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