Lyme disease is caused by the bacteria *Borrelia burgdorferi* and is transmitted by blacklegged ticks (*Ixodes scapularis* and *Ixodes pacificus*). It was first recognized in the United States in 1977, after an unusual outbreak of arthritis among children near Lyme, Connecticut. Public health surveillance for Lyme disease began in 1980, and was nationally notifiable beginning in 1991. Today, it is the most commonly reported vector-borne disease in the United States. Cases of Lyme disease have been increasing in West Virginia in recent years. The state is now considered a “high endemic” Lyme disease state. **Suspected and confirmed Lyme disease cases should be reported to the local health department where the patient resides within one week.**

**Provider Responsibilities**
1. Report suspect and confirmed cases of Lyme disease (including copies of lab results) to the local health department within one week of diagnosis.
2. Follow national guidelines for Lyme disease testing. Appropriate Lyme disease testing should include a two-tier testing approach that includes EIA or IFA screening with Western blot confirmation.

**Laboratory Responsibilities**
1. Report positive laboratory results for Lyme disease to the local health department within 1 week.
2. Follow national guidelines for Lyme disease testing. Appropriate Lyme disease testing should include a two-tier testing approach that includes an EIA or IFA screening of serum with Western blot confirmation.

**Local Health Responsibilities**
1. Conduct an appropriate case investigation. For each case:
   a. Contact the physician that either reported the case or ordered Lyme disease testing
   b. Using “Form A” from the Lyme disease case investigation toolkit (see Appendix A of this document), collect the clinical information necessary to perform case ascertainment. Local forms may be used, if the same information is collected. A provider “quick sheet” on Lyme disease has been developed (also in Appendix A), and may accompany “Form A” if faxed or mailed.
   c. If the patient had physician-diagnosed erythema migrans measuring 5 cm or greater, contact the patient to determine relevant exposure information. Patients without EM do not need to be contacted. For patients with EM, use “Form B” from the Lyme disease case investigation toolkit (see Appendix A of...
this document) to collect the information about exposure. Local forms may be used, if the same information is collected.

d. Educate the patient and the patient’s family on Lyme disease prevention; reinfection is possible and has been documented\(^5\).

e. Report all case data using WVEDSS.

**State Health Responsibilities**

1. Educate the public about Lyme disease, especially regarding the mode of tick transmission and use of personal protection. Cases of Lyme disease usually occur between April and November in West Virginia. Increased public education should be targeted during this time period with the understanding that Lyme disease may be reported year-round. Additionally, the eastern panhandle of West Virginia borders sections of 3 states (Maryland, northern Virginia, and southeastern Pennsylvania) that have considerable Lyme disease activity\(^6\). Therefore, greater outreach and education may be needed in this area.

2. Educate providers and laboratories to report cases of Lyme disease to the local health department in the patient’s county of residence within one week of diagnosis.

3. Educate providers and laboratories about appropriate laboratory confirmation of Lyme disease using the recommended two-tiered testing approach (EIA/IFA screening using serum samples with Western blot confirmation).

4. Conduct tick surveillance when ticks are most active:
   a. Determine areas of West Virginia where *Ixodes scapularis* are located.
   b. As able, test ticks for the causative agent of Lyme disease, *Borrelia burgdorferi*.

**Disease Control Objectives**

1. Increase the number of patients treated with antibiotics in the early stages of Lyme disease to reduce the number of patients with disseminated and late disease.

**Disease Prevention Objectives**

1. Reduce disease risk through public education by encouraging use of personal protective measures that prevent tick bites.

**Disease Surveillance Objectives**

1. To identify and monitor the epidemiologic characteristics (including demographics and risk factors) of Lyme disease in West Virginia.

2. To identify areas endemic for Lyme disease in West Virginia.

3. To assess the use of appropriate testing by physicians diagnosing Lyme disease in WV
Public Health Significance
Lyme disease is transmitted to humans by the bite of infected deer ticks. In the United States, endemic foci of Lyme disease exist along the Atlantic coast and are concentrated between Massachusetts and Maryland; in the upper midwest, an expanding focus is currently concentrated in Wisconsin and Minnesota. Cases are also identified in some areas of California and Oregon. Lyme disease continues to increase nationally. In 2015, 95% of Lyme disease cases were reported from 14 states. State health departments reported over 28,000 confirmed cases of Lyme disease to CDC in 2015, compared with just over 15,000 confirmed cases in 1999.

Initial infection occurs primarily during summer, with a peak in June and July, but may occur throughout the year, depending on the seasonal abundance of the tick in different geographic areas. The distribution of most cases coincides with the distribution of Ixodes scapularis (formerly called I. dammini) ticks in the eastern and midwestern United States. The explosive repopulation of white-tailed deer in the eastern USA has been linked to the spread of Lyme disease in this region. Reported Lyme disease cases are most common among boys ages 5-9 years of age.

Clinical Description
This tickborne disease is characterized by a distinctive skin lesion, systemic symptoms and neurologic, rheumatologic and cardiac involvement that occur in varying combinations over a period of months to years. An initial skin lesion occurs in 60-80% of patients and appears as a red macule or papule that expands slowly in an annular manner, often with central clearing. This distinctive skin lesion is called erythema migrans (EM) or may sometimes be referred to as a “bull’s eye rash.” EM may be single or multiple. To be considered significant for case surveillance purposes, the EM lesion must be physician diagnosed and measure at least 5 cm in diameter. According to the Infectious Disease Society of America (IDSA), EM is the only objective sign of Lyme disease in the United States that is considered to be characteristic enough to allow clinical diagnosis of Lyme disease in the absence of laboratory confirmation.

Within weeks to months after onset of the EM lesion, neurologic abnormalities such as aseptic meningitis and cranial neuritis—including cranial nerve palsy, radiculopathy, cerebellar ataxia, motor or sensory radiculoneuritis, myelitis and, rarely, encephalitis may develop; symptoms fluctuate, may last for months and may become chronic. In the United States, cranial
neuropathy is the most common manifestation of early neurologic Lyme disease. Cardiac abnormalities (including atrioventricular block and rarely, acute myopericarditis or cardiomegaly) usually occur around 2 months after onset of EM. Weeks to years after initial disease onset, intermittent episodes of swelling and pain in large joints, especially the knees, may develop and recur for several years; chronic arthritis may occasionally result. Similarly, sometimes following long periods of latent infection, chronic neurologic manifestations may develop and include encephalopathy, polyneuropathy or leukoencephalitis; the CSF often shows lymphocytic pleocytosis and elevated protein levels, while the electromyogram is usually abnormal.

It should be noted that in recent years, the number of cases with documented late manifestations of Lyme disease (including neurologic, rheumatologic and cardiac complications) have appeared to decline compared with earlier reports of the prevalence of these manifestations. IDSA suggests these declines may be due to ascertainment bias in earlier studies, or more successful treatment of early Lyme disease due to better recognition of EM.

**Etiologic Agent**
The bacterium that causes Lyme disease is *Borrelia burgdorferi*, a spirochete.

**Reservoir**
Ixorid ticks are reservoirs for Lyme disease through transstadial transmission, meaning *B. burgdorferi* can be transmitted from one tick stage to the next. Wild rodents, especially *Peromyscus* spp. (deer mice) in the northeastern and midwestern USA and *Neotoma* spp. (pack rats) in the western USA maintain the enzootic transmission cycle. Deer serve as important maintenance mammalian hosts for vector tick species. Larval and nymphal ticks feed on small mammals, and adult ticks feed primarily on deer. Most Lyme disease cases result from bites by infected nymphs.

**Mode of Transmission**
The most important and by far the most common mode of transmission is through the bite of an infected tick. In experimental animals, transmission by *I. scapularis* and *I. pacificus* usually does not occur until the tick has been attached for more than 36 hours; this may also be true in humans. Additionally, *B. burgdorferi* can survive in blood products; therefore, patients with suspected Lyme disease should refrain from donating blood until after completing adequate antibiotic therapy. Information on the current criteria for blood donation is available on the Red Cross website [http://www.redcross.org/donate/give/](http://www.redcross.org/donate/give/). Transmission from infected blood
products is theoretically possible; however, to date there have been no reports of cases acquiring Lyme disease through blood products\textsuperscript{10}.

Lyme disease acquired during pregnancy may lead to infection of the placenta and possible stillbirth, however, no negative effects on the fetus have been found when the mother receives appropriate antibiotic treatment\textsuperscript{10}. There are no reports of Lyme disease transmission from breast milk. Although dogs and cats can get Lyme disease, there is no evidence that they spread the disease directly to their owners. However, pets can bring infected ticks into the home or yard. Consider protecting pets by using tick control products for animals\textsuperscript{10}.

There is no evidence of natural transmission from person to person. There are rare case reports of congenital transmission.

**Incubation Period**
For EM, the incubation period ranges from 3 to 32 days (mean 7 to 10 days) after tick exposure\textsuperscript{7}; however, the early stages of the illness may be unapparent, and the patient may present with later manifestations weeks to months after becoming infected.

**Period of Communicability**
Person-to-person transmission is not known to occur; however, transplacental transmission may occur.

**Outbreak Recognition**
The ecology of Lyme disease is based on the presence of the vector, causative agent and appropriate hosts. Because West Virginia is considered a Lyme disease endemic state, increased cases will be monitored for greater understanding of the geographic distribution of disease. During active tick season, bi-monthly reports will be disseminated to provide situational awareness of Lyme disease activity in West Virginia.

**Case Definition**
The 2017 case definition is the most current (CSTE Position Statement Number 16-ID-10)

**Clinical Description**
A systemic, tick-borne disease with protean manifestations, including dermatologic, rheumatologic, neurologic, and cardiac abnormalities. The most common clinical marker for the disease is erythema migrans (EM), the initial skin lesion that occurs in 60\%-80\% of patients.
Lyme disease

Surveillance Protocol

For purposes of surveillance, EM is defined as a skin lesion that typically begins as a red macule or papule and expands over a period of days to weeks to form a large round lesion, often with partial central clearing. A single primary lesion must reach greater than or equal to 5 cm in size across its largest diameter. Secondary lesions also may occur. Annular erythematous lesions occurring within several hours of a tick bite represent hypersensitivity reactions and do not qualify as EM. For most patients, the expanding EM lesion is accompanied by other acute symptoms, particularly fatigue, fever, headache, mildly stiff neck, arthralgia, or myalgia. These symptoms are typically intermittent. A physician must make the diagnosis of EM. Laboratory confirmation is recommended for persons with no known exposure.

For purposes of surveillance, late manifestations include any of the following when an alternate explanation is not found:

Musculoskeletal system. Recurrent, brief attacks (weeks or months) of objective joint swelling in one or a few joints, sometimes followed by chronic arthritis in one or a few joints. Manifestations not considered as criteria for diagnosis include chronic progressive arthritis not preceded by brief attacks and chronic symmetrical polyarthritis. Additionally, arthralgia, myalgia, or fibromyalgia syndromes alone are not criteria for musculoskeletal involvement.

Nervous system. Any of the following signs that cannot be explained by any other etiology, alone or in combination: lymphocytic meningitis; cranial neuritis, particularly facial palsy (may be bilateral); radiculoneuropathy; or, rarely, encephalomyelitis. Headache, fatigue, paresthesia, or mildly stiff neck alone, are not criteria for neurologic involvement.

Cardiovascular system. Acute onset of high-grade (2nd-degree or 3rd-degree) atrioventricular conduction defects that resolve in days to weeks and are sometimes associated with myocarditis. Palpitations, bradycardia, bundle branch block, or myocarditis alone are not criteria for cardiovascular involvement.

Laboratory Criteria for Diagnosis

For the purposes of surveillance, laboratory evidence includes:

- A positive culture for *B. burgdorferi*, OR
- A positive two-tier test. (This is defined as a positive or equivocal enzyme immunoassay (EIA) or immunofluorescent assay (IFA) followed by a positive Immunoglobulin M (IgM) or Immunoglobulin G (IgG) western immunoblot (WB) for Lyme disease) OR
- A positive single-tier IgG2 WB test for Lyme disease³.
IgM WB is considered positive when at least two of the following three bands are present: 24 kilodalton (kDa) outer surface protein C (OspC)*, 39 kDa basic membrane protein A (BmpA), and 41 kDa (Fla). Disregard IgM results for specimens collected >30 days after symptom onset.

IgG WB is considered positive when at least five of the following 10 bands are present: 18 kDa, 24 kDa (OspC)*, 28 kDa, 30 kDa, 39 kDa (BmpA), 41 kDa flagellin (Fla), 45 kDa, 58 kDa (not GroEL), 66 kDa, and 93 kDa.

While a single IgG WB is adequate for surveillance purposes, a two-tier test is still recommended for patient diagnosis.

*Depending upon the assay, OspC could be indicated by a band of 21, 22, 23, 24 or 25 kDa.

Criteria to Distinguish a New Case from an Existing Case

Case not previously reported to public health authorities.

Exposure

Exposure is defined as having been (less than or equal to 30 days before onset of EM) in wooded, brushy, or grassy areas (i.e., potential tick habitats) of Lyme disease vectors. Since infected ticks are not uniformly distributed, a detailed travel history to verify whether exposure occurred in a high or low incidence state is needed. An exposure in a high-incidence state is defined as exposure in a state with an average Lyme disease incidence of at least 10 confirmed cases/100,000 for the previous three reporting years. A low-incidence state is defined as a state with a disease incidence of <10 confirmed cases/100,000 (see https://www.cdc.gov/lyme/stats/tables.html). A history of tick bite is not required.

Case Classification

**Suspected**

- A case of EM where there is no known exposure (as defined above) and no laboratory evidence of infection (as defined above), OR
- A case with evidence of infection but no clinical information available (e.g., a laboratory report).

**Probable**

- Any other case of physician-diagnosed Lyme disease that has laboratory evidence of infection (as defined above).

**Confirmed**

- A case of EM with exposure in a high incidence state (as defined above), OR
February 2017
Lyme disease
Surveillance Protocol

- A case of EM with laboratory evidence of infection and a known exposure in a low incidence state, OR
- Any case with at least one late manifestation that has laboratory evidence of infection.

**Case Classification Comments**

Lyme disease reports will not be considered cases if the medical provider specifically states this is not a case of Lyme disease, or the only symptom listed is "tick bite" or "insect bite."

**Preventive Interventions**

- Avoid potential tick habitat (such as woody, brushy, or grassy areas) when possible.
- Minimize exposure by wearing light-colored clothing that covers legs and arms so that ticks are more easily seen; tuck pants into socks and apply tick repellent such as 20% DEET to the skin (according to label directions) or permethrin (a repellent and contact acaricide) to pant legs and sleeves (not skin).
- Many infections from tickborne diseases happen at home — create tick-free zones. Remove leaf litter and brush around the home and at the edges of lawns. Place wood chips or gravel between lawns and wooded areas. Mow the lawn and clear brush regularly. Keep playground equipment, decks and patios away from yard edges and trees.
- If working or playing in potential tick habitats, search the total body area daily, including haired areas.
  - Remove ticks promptly. Keep in mind ticks may be very small and difficult to see.
  - Remove any attached ticks by grasping the tick with tweezers as close to the skin as possible.
  - Pull upward using gentle, steady pressure to avoid leaving mouth parts in the skin; protect hands with gloves, cloth or tissue when removing ticks from humans or animals. Following tick removal, cleanse the attachment site with soap and water.
- Check pets for ticks regularly; consult with a veterinarian regarding medications effective for controlling ticks

**Treatment**

Studies have shown that most patients can be cured of Lyme disease with a few weeks of antibiotics taken by mouth. Antibiotics commonly used for oral treatment include doxycycline, amoxicillin, or cefuroxime axetil. Patients with certain neurological or cardiac forms of illness may require intravenous treatment with drugs such as ceftriaxone or penicillin.

Patients treated with antibiotics in the early stages of the infection usually recover rapidly and completely. A few patients, particularly those diagnosed with later stages of disease, may have persistent or recurrent symptoms. The authors of studies sponsored by the NIH have concluded
that these patients may benefit from a second 4-week course of therapy; however, longer courses of antibiotic treatment are not beneficial. Longer courses of antibiotics have been linked to serious complications, including death\textsuperscript{13}.

Studies of women infected during pregnancy have found that there are no negative effects on the fetus if the mother receives appropriate antibiotic treatment for Lyme disease. In general, treatment for pregnant women is similar to that for non-pregnant persons, although certain antibiotics are not used because they may affect the fetus.

**Surveillance Indicators**

1. Proportion of cases with complete demographic information.
2. Proportion of cases with complete clinical information (i.e., presence of physician-diagnosed EM or late manifestations).
3. Proportion of cases reported with physician-diagnosed EM that also contain information on county of exposure.
4. Proportion of cases with appropriate laboratory testing (as defined by the CDC case definition as “Laboratory Evidence”) including copies of lab results submitted to DIDE.
References

This toolkit can be used by local health department staff to facilitate Lyme disease case investigations. Items in the toolkit include:

- Case Investigation Flowchart
- Form A for Healthcare Providers
- Form B for Patients with Erythema Migrans (EM)
- Enzyme Immunoassay (EIA) Tips
- Interpretation IgM/IgG Western Blots
- 2016 Case Ascertainment Guide
- Provider Quicksheet
Lyme Disease Case Investigation Flowchart

1. Positive lab report received at health department
2. Call healthcare provider, advise that a faxed request for case details is being sent¹
3. Fax "Form A" to healthcare provider to collect relevant clinical data (include Provider Quicksheet)
4. Follow up if no response after 3-4 days (repeat faxes if needed)
5. Call patient and use "Form B" to collect exposure information from patient
6. If EM is documented, attempt to contact patient
7. Enter all data into WVEDSS and send case to regional review
8. Regional review is sent to state and state sends final notification to CDC

¹ Request copies of any supplemental lab results; also ask for demographic data (e.g. race and ethnicity).
² Attempt to get in contact with patients through different methods. Try calling at least three times at different times of the day. Try alternate contact numbers and addresses. Mail a certified letter to the patient’s address. Be sure to document all attempts.

Division of Infectious Disease Epidemiology
350 Capitol Street, Room 125, Charleston, WV 25301-3715
Phone: 304.558.5358 or (800) 423-1271 Fax: 304.558.8736 (www.dide.wv.gov)
Form A: Lyme Disease Assessment Tool (2017)
For Healthcare Providers

Dear Healthcare Provider:
The ____________ County Health Department has been notified of a positive Lyme disease laboratory report for patient ____________________ (DOB: ____/____/____). In order to comply with state and federal infectious disease reporting requirements, we are requesting the following information about this patient. Please return this completed sheet via fax to (304 ____-____) within 72 hours of receipt.

A. Have you contacted this patient about Lyme disease positive laboratory results? □YES □NO

B. Date of first symptom onset (month/day/year): ____ / ____ / _______ □YES □NO

C. Did this patient have an erythema migrans measuring at least 5 cm in diameter? □YES □NO
   a. Did the patient travel outside of WV within 30 days of the start of symptoms? □YES □NO
   b. If yes, where? (county): ____________________ (state): ____________________

D. Did patient exhibit any of the following symptoms of late-stage Lyme disease? □YES □NO

   Rheumatologic/musculoskeletal (mark one):
   □Recurrent, brief attacks objective joint swelling (one or few joints)
   □Chronic arthritis preceded by brief attacks (one or few joints)
   □Other: ____________________
   □No rheumatologic/musculoskeletal symptoms associated with LD were observed

   Neurologic (mark all that apply):
   □Lymphocytic meningitis □Facial palsy (may be bilateral) □Cranial neuritis
   □Radiculoneuropathy □Encephalomyelitis □Other: ____________________
   □No neurologic symptoms associated with LD were observed

   Cardiovascular (mark one):
   □Acute onset of high-grade (2nd or 3rd degree) atrioventricular conduction defects (that resolves in days to weeks)
   □Other: ____________________
   □No cardiac symptoms associated with LD were observed

E. Did you diagnose this patient as having Lyme disease? □YES □NO

F. Please indicate what testing was ordered for this patient and any known results.

<table>
<thead>
<tr>
<th>Test Ordered</th>
<th>Date</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serology screen (IFA/EIA)</td>
<td>/ /</td>
<td>Positive</td>
</tr>
<tr>
<td>Borrelia burgdorferi IgG WB</td>
<td>/ /</td>
<td>Positive</td>
</tr>
<tr>
<td>Borrelia burgdorferi IgM WB</td>
<td>/ /</td>
<td>Positive</td>
</tr>
<tr>
<td>Other:</td>
<td>/ /</td>
<td>Positive</td>
</tr>
</tbody>
</table>

G. Why was Lyme disease testing ordered for this patient? Mark all that apply.
   □Patient had clinical evidence of infection □Patient requested Lyme testing
   □Patient had exposure to tick habitats □Other: ____________________

H. Did you prescribe antibiotics for this patient? □YES □NO
   If yes, indicate type of antibiotic and # of days: ____________________
   Comments: ____________________

Thank you for filling out this form. This information is important to Lyme disease surveillance in West Virginia.
**Form B: Patient Lyme Disease Exposure Assessment Tool (2017)**

Note: Call patients with erythema migrans (EM)

**THIS STEP SHOULD BE LIMITED TO CASES WITH DOCUMENTED EM BY HEALTHCARE PROVIDER**

Optional Script

“Hello, this is (your name), a (nurse/sanitarian) from (county name) County Health Department. I am following up on a recent report our department received about (case name)’s Lyme disease illness. In order for us to better understand the risk for Lyme disease in our county, I would like to ask you a few questions about the time leading up to your illness.”

A. On what date were symptoms first noticed? (month/day/year): _____/_____/__________

B. Did you travel outside of your home county within 30 days of the start of your symptoms?

☐ YES ☐ NO

   a. If yes, report travel information:

<table>
<thead>
<tr>
<th>Destination (city, state)</th>
<th>Date of departure (month/day/year)</th>
<th>Date of return (month/day/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Is there anything else you would like to share about your illness?

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

Thank the patient, and end the call.
Enzyme Immunoassay (EIA) Interpretation Tips

- EIA tests detect the amount of antibodies produced by the patient. Immunoglobulin M (IgM), immunoglobulin G (IgG), and combined (or quantitative) IgM/IgG EIA tests are common for Lyme disease diagnostics.
  - IgM antibodies are produced by the body early in an infection. The presence of IgG antibodies indicates that the patient was infected with Lyme disease at some point in life.

- If the Lyme disease test result you receive has numbers like “0.91” or “5.65,” it is an EIA/IFA test.
  - The higher the number, the more antibodies are being produced.

- Some tests will have a reference ranges for “positive,” “equivocal,” and “negative” test results listed on the laboratory report (see example below).

- An “indeterminate” or “equivocal” result means that the level of antibodies detected in the patient’s specimen is low. It could also indicate a false positive result. Either way, more information is needed to determine if the patient’s immune system produced a response to an infection with Lyme disease; therefore, the EIA and IgM/IgG Western blot are recommended.

- “Positive” also means “reactive.” “Negative” also means “non-reactive.”

### Sample reference ranges

<table>
<thead>
<tr>
<th>Reference Value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤0.90</td>
<td>Negative</td>
</tr>
<tr>
<td>0.91-1.09</td>
<td>Equivocal</td>
</tr>
<tr>
<td>≥1.10</td>
<td>Positive</td>
</tr>
</tbody>
</table>

Division of Infectious Disease Epidemiology

350 Capitol Street, Room 125, Charleston, WV 25301-3715
Phone: 304.558.5358 or (800) 423-1271 Fax: 304.558.8736 (www.dide.wv.gov)
Interpreting IgG and IgM Western Blots

**IgM Western Blot**

An IgM immunoblot should be considered positive if **two of the following three bands** are present:
- 24 kDa (OspC) band
- 39 kDa (BmpA) band
- 41 kDa (Fla) band

**IgG Western Blot**

An IgG immunoblot should be considered positive if **five of the following ten bands** are present:
- 18 kDa band
- 21 kDa (OspC) band
- 28 kDa band
- 30 kDa band
- 39 kDa (BmpA) band
- 41 kDa (Fla) band
- 45 kDa band
- 58 kDa band
- 66 kDa band
- 93 kDa band

Visit the CDC’s Lyme disease testing page for more information:
http://www.cdc.gov/lyme/diagnosistesting/index.html

Sample Western blot

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No laboratory evidence of infection
OR
Insufficient/inappropriate laboratory testing conducted

Appropriate laboratory testing¹
A positive culture for *B. burgdorferi*
OR
A positive two-tier test. (This is defined as a positive or equivocal enzyme immunoassay (EIA) or immunofluorescent assay (IFA) followed by a positive Immunoglobulin M (IgM) or Immunoglobulin G (IgG) western immunoblot (WB) for Lyme disease)
OR
A positive single-tier IgG WB test for Lyme disease

Physician-diagnosed erythema migrans (EM) at least 5 cm with known exposure² in a high incidence state

Physician-diagnosed EM at least 5 cm with known exposure² in low incidence state

One or more late manifestations of disease³

Physician-diagnosed Lyme disease lacking clinical criteria (EM and/or late manifestations) of a confirmed case

No/unknown clinical information available

Physician-diagnosed EM at least 5 cm with no known exposure

Confirmed Case

Probable Case

Suspect Case

Not A Case

¹Laboratory tests in this guide are the only ones recommendation for case ascertainment. Other diagnostic tests (e.g. PCR) should not be used. CDC recommends a two-tier approach for Lyme disease testing using serum (EIA/IFA with reflex to Western blot). CSF and synovial fluid are not considered appropriate specimens for two-tier testing.

²Exposure is defined as having been (less than or equal to 30 days before onset of EM) in wooded, brushy, or grassy areas (i.e., potential tick habitats) of Lyme disease vectors. Since infected ticks are not uniformly distributed, a detailed travel history to verify whether exposure occurred in a high or low incidence state is needed. An exposure in a high-incidence state is defined as exposure in a state with an average Lyme disease incidence of at least 10 confirmed cases/100,000 for the previous three reporting years. A low-incidence state is defined as a state with a disease incidence of <10 confirmed cases/100,000 (see https://www.cdc.gov/lyme/stats/tables.html). A history of tick bite is not required.

³Late manifestations include musculoskeletal (recurrent, brief attacks of joint swelling followed by chronic arthritis), nervous system (lymphocytic meningitis, cranial neuritis, facial palsy (may be bilateral), and radiculoneuropathy, or rarely encephalomyelitis), and cardiovascular (acute onset 2nd -3rd atrioventricular conduction defects that resolve in days to weeks) signs of disease.
IMPORTANT INFORMATION ABOUT SELECTING LABORATORY TESTS

1. CDC recommends a two-tier approach for testing serological specimens: IFA/EIA antibody screen, followed by IgM\(^1\) and IgG western blot if IFA/EIA is positive or equivocal.

2. Other CDC recommended diagnostic assays for Lyme disease include:
   - A positive culture for \textit{B. burgdorferi}, \textbf{OR}
   - A positive single-tier IgG\(^2\) WB test for Lyme disease\(^3\).

\(^{1}\) IgM WB is considered positive when at least two of the following three bands are present: 24 kilodalton (kDa) outer surface protein C (OspC)*, 39 kDa basic membrane protein A (BmpA), and 41 kDa (Fla). Disregard IgM results for specimens collected >30 days after symptom onset.

\(^{2}\) IgG WB is considered positive when at least five of the following 10 bands are present: 18 kDa, 24 kDa (OspC)*, 28 kDa, 30 kDa, 39 kDa (BmpA), 41 kDa flagellin (Fla), 45 kDa, 58 kDa (not GroEL), 66 kDa, and 93 kDa.

\(^{3}\) While a single IgG WB is adequate for surveillance purposes, a two-tier test is still recommended for patient diagnosis. *Depending upon the assay, OspC could be indicated by a band of 21, 22, 23, 24 or 25 kDa.

*THE USE OF SINGLE-TIER IGM WESTERN BLOT TESTING IS NOT RECOMMENDED AND WILL NOT BE CONSIDERED CONFIRMATORY FOR PUBLIC HEALTH SURVEILLANCE PURPOSES*

RESOURCES FOR PATIENTS

- CDC website has several brochures and info sheets for patients: \texttt{http://www.cdc.gov/lyme/}.

RESOURCES FOR HEALTHCARE PROVIDERS

- CDC has a “Resources for Clinicians” page available at: \texttt{http://www.cdc.gov/lyme/healthcare/clinicians.html}

- Information about two-tier testing for Lyme disease is available at: \texttt{http://www.cdc.gov/lyme/diagnosistesting/LabTest/TwoStep/index.html}

- The Infectious Disease Society of America (IDSA) has developed a FREE online CME case study about the diagnosis and management of Lyme disease available at: \texttt{http://lymecourse.idsociety.org/}

- The West Virginia Department of Health and Resources provides information about the state’s Lyme disease surveillance system as well as links to useful resources available at: \texttt{http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Tick/Pages/Lyme.aspx}

- The CDC has a “Tickborne Diseases of the United States”, reference manual for healthcare providers located at: \texttt{https://www.cdc.gov/lyme/resources/tickborneDiseases.pdf}