CEP | Providers

Early Lyme Disease Management in Primary Care

This resource has been developed to support Canadian family physicians and primary care nurse practitioners to identify, diagnose and manage early Lyme disease. While the primary focus is early localized Lyme disease, certain signs and symptoms typically associated with early disseminated disease have been included as they may overlap into localized disease. Late disseminated Lyme disease and post-Lyme disease syndrome (PLDS) are not addressed in this resource. For more information on the phases of Lyme disease, please visit the PHAC website for healthcare professionals.[1]

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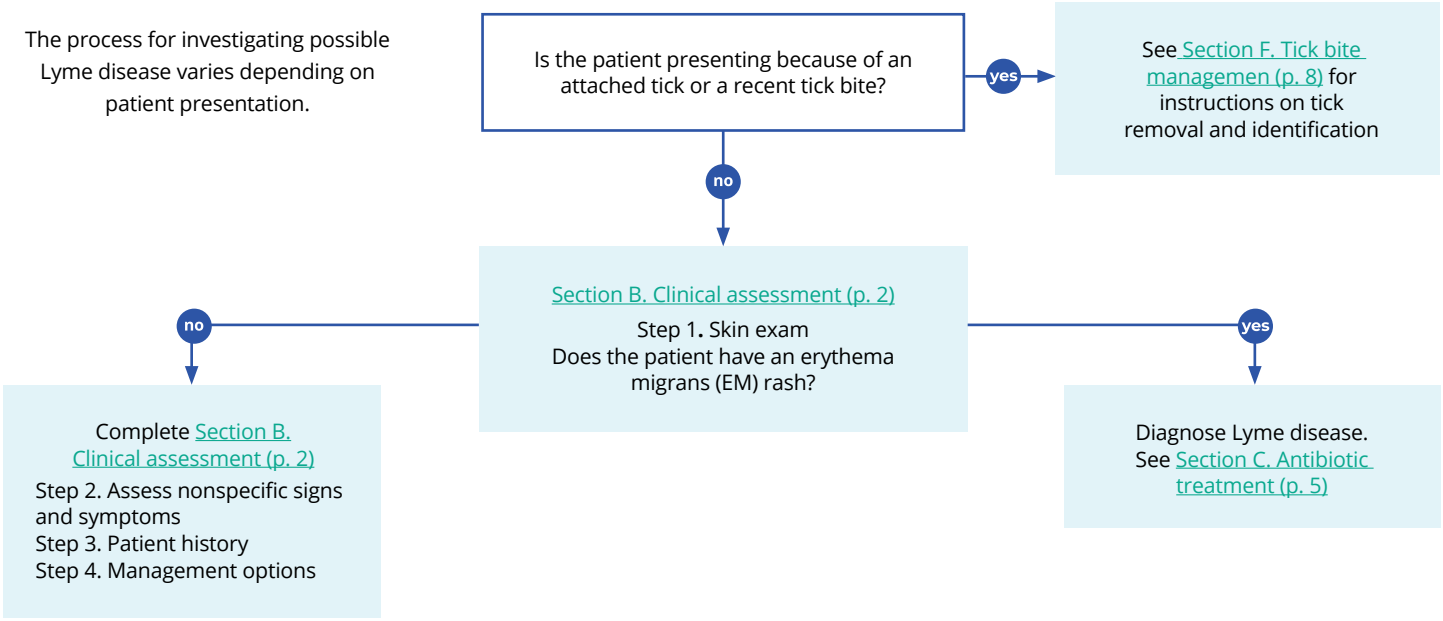
General management strategy

The process for investigating possible Lyme disease varies depending on patient presentation.



SECTION A: About Lyme disease

- Lyme disease is the most common tick-borne infection in Canada.[2] The number of reported cases of Lyme disease increased nationally by over 1,000% between 2009 and 2017, from 144 cases to 2,025.[2]
- Lyme disease is caused by the bacteria *B. burgdorferi*, which is spread to humans through bites from infected blacklegged ticks (*Ixodes scapularis* nationally, and *Ixodes pacificus* in British Columbia).[1]
- Lyme disease presents with varying symptoms, in phases that can overlap.[1] Early Lyme disease may be missed or misdiagnosed, which may allow the bacteria to disseminate through the bloodstream and cause serious illness that can last for months or years.[1] For the best outcome, it is vital to identify, diagnose and treat Lyme disease in the early phase.
- Serologic testing has poor sensitivity for early Lyme disease.[3,4]

Phase	Onset	Clinical course and symptoms[1]
Early localized	**3 - 30 days** after an infected tick bite	A patient will present with acute signs and symptoms that mimic a viral illness, often including an EM rash.
Early disseminated	**1 - 3 months** after an infected tick bite	If untreated, the bacteria can disseminate through the bloodstream and affect other parts of the body. Patients with disseminated disease can present with arthritis, cutaneous signs (multiple EM rashes), neurologic manifestations (facial palsy and meningitis) and cardiac symptoms (heart block), which can be fatal in rare cases.
Late disseminated	**> 3 months** after an infected tick bite	If it remains untreated, symptoms will worsen and can last months or years. Patients with a late infection may present with arthritis (common) and neuropathy (less common).

For more information about the phases of Lyme disease, please visit the PHAC website for healthcare professionals.[1]

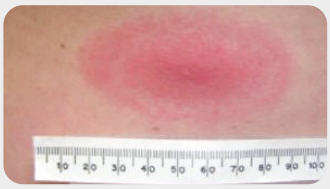
SECTION B: Clinical assessment

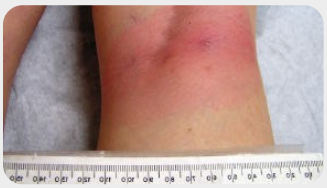
Step 1 : Perform a full-body skin exam to determine if the patient has erythema migrans (EM) rash.

EM is classically defined as a mainly flat, localized, expanding, uniformly red rash (with or without central clearing) appearing at the site of a tick bite.[1,3,5,6] **In the majority of cases, EM rash will not present with a bullseye appearance.**[1,6]

- While the majority of infected patients will develop an EM rash, a significant number of patients (at least 20%) will not.[6]
- The darker the patient's skin, the more difficult it may be to recognize EM rash.[1,7]
- See the PHAC website for healthcare professionals[1] website for more photos of varied presentations of EM rash.

If the patient has a localized rash that has appeared within the last 48 hours but is still relatively small (<5cm in diameter), consider tracing the outline of the rash with a waterproof marker. Instruct the patient to return to the clinic if the rash expands past the outline. Continued expansion is suggestive of EM.





Photos of erythema migrans rash.[1]

Features consistent with EM[1,3,5,6]

- Appears 3-30 days after a tick bite
- Expands within 48 hours of appearance, usually to >5 cm in diameter
- May last for weeks if untreated
- Often found near skin folds (underarm, groin, back of knee)[8,9]
- Development of additional EM rashes (indicates disseminated stage)

Features generally not consistent with EM[3,6,8]

These symptoms may indicate an irritant reaction to a tick bite.[2]

- Appears within hours after a bite
- Is itchy, painful, hot, vesicular, raised, generalized (i.e. not localized)
- Recedes within 48 hours of its appearance

Exam reveals EM rash.

↓

Diagnose Lyme disease and treat immediately using Section C, Antibiotic treatment (p. 5). Do not complete Steps 2 and 3.

or

Exam reveals no rash, or a rash inconsistent with EM.

↓

Continue through Steps 2 and 3 to assess nonspecific symptoms and exposure risk.

Step 2 : Identify nonspecific signs and symptoms consistent with early localized Lyme disease.

Infected patients will develop a collection of nonspecific signs and symptoms within 3-30 days, ranging from mild to severe.[1,3,6] Nonspecific signs and symptoms may be caused by many other illnesses, such as seasonal influenza. Before moving on to Step 3, rule out other potential causes of illness as per usual clinical practice. Unlike most self-limiting viral illnesses, early Lyme disease symptoms usually last for over 72 hours.[8]

Signs and symptoms consistent with early localized Lyme disease[1,3,6,8]

- Subjective or objective fever
- Generalized arthralgias and myalgias
- Fatigue
- Headache
- Swollen lymph nodes

Symptoms generally not associated with early localized Lyme disease[8]

- Nausea
- Sore throat
- Cough
- Runny nose
- GI symptoms

Continue to Step 3. Use the patient's symptoms, in combination with the patient's history taken in Step 3, to discern the level of suspicion of Lyme disease.

Step 3 : Take a detailed patient history to determine if the patient could have been exposed to an infected tick.

To contract Lyme disease, a patient must have been fed on by an infected blacklegged tick. The patient must come into physical contact with the tick for it to attach and feed. Ticks do not fly or jump.[9]

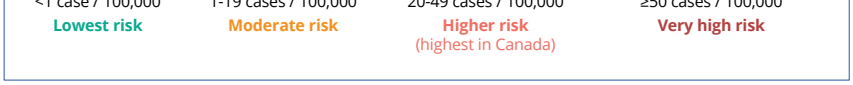
Patients can come into contact with ticks:

- **Outdoors** in areas such as parks, meadows, wooded yards, campgrounds, golf courses and soccer fields.
- **Indoors** if a tick travelled inside on pets, clothing or outdoor gear (e.g. tents or boots).

The recollection of a tick bite is not a requirement to diagnose Lyme disease. Many people will not recall or be aware of tick bites because ticks are small and their bites are painless.[1,3,9] If your patient remembers a tick bite, incorporate information from Section F. Tick bite management (p.8) into the assessment.

In the last 30 days, has the patient or the patient's pet been in woody or grassy areas such as parks, meadows, wooded yards, campgrounds, golf courses, soccer fields, etc.?

- no → Unlikely to have been exposed to blacklegged ticks. Ticks must come into physical contact in order to attach and feed. Consider an alternative diagnosis.
- yes → During outdoor activity, did the patient or the patient's pet come into contact with grass, underbrush, trees or leaf litter?
  - no → Unlikely to have been exposed to blacklegged ticks. Ticks must come into physical contact in order to attach and feed. Consider an alternative diagnosis.
  - yes → Where did this outdoor activity take place?
    - Canada → **Use this table to assess whether the patient visited an area with elevated risk. Click on a province abbreviation to see detailed risk information for that province.** While cases of Lyme disease have been reported in every province, the overall risk of Lyme disease varies considerably from province to province and within individual provinces.[2] It is possible for patients to contract Lyme disease in low and moderate risk areas as ticks are spreading due to climate change.[2]
    - outside Canada → Risk (based on incidence rate) / Jurisdiction



Province / territory	Overall provincial risk (based on incidence rate)[2]	Moderate or higher risk areas within province?
BC[10]	Lowest risk	yes
AB[11]	Lowest risk	no
SK[12]	Lowest risk	no
MB[13]	Moderate risk	yes
ON[14]	Moderate risk	yes - including very high risk areas
QC[15]	Moderate risk	yes
NB[16]	Moderate risk	yes
NL[17]	Lowest risk	no
NS[18]	Higher risk	yes - including very high risk areas
PEI[19]	Moderate risk	yes
NT/YT/NU[2]	There have been no reported cases of Lyme disease in the territories since the Public Health Agency of Canada began tracking cases in 2009.	

	Risk (based on incidence rate)	Jurisdiction
United States[20]	Moderate risk	Illinois, Indiana, Iowa, Maryland, Michigan, Massachusetts, New York, North Dakota, Ohio, Virginia, Washington D.C.
	Higher risk	Connecticut, Delaware, Minnesota, New Jersey, West Virginia, Wisconsin
	Very high risk	Maine, New Hampshire, Pennsylvania, Rhode Island, Vermont
Europe[21] *Please note that this is not an exhaustive list. For more information on risk areas in Europe, see the Resources page.*	Moderate risk	Belarus, Belgium, Bulgaria, Croatia, Finland, Hungary, Norway, Poland, the Russian Federation, Serbia, Slovakia
	Higher risk	the Czech Republic, Estonia, Lithuania
	Very high risk	Slovenia

Steps 2 and 3 reveal symptoms suggestive of early Lyme disease **and** high probability of exposure to infected ticks.
↓
Continue to Step 4 to consider options based on clinical suspicion.

or

Steps 2 and 3 reveal symptoms inconsistent with early Lyme disease **and/or** low probability of exposure to infected ticks.
↓
Unlikely to be Lyme disease. Consider an alternative diagnosis.

Step 4 : Choose a management option based on clinical suspicion and patient preference.

Clinical diagnosis of early Lyme disease in patients without EM rash can be difficult.[8]

If symptoms and exposure history raise clinical suspicion of early Lyme disease, there are two options for management. While neither option has been validated, both are reasonable.[8] Use the table below to make an informed decision in collaboration with your patient.[22]

Extra care should be taken to promptly diagnose and treat early Lyme disease in pregnant women.[8,9,23]
However, evidence for adverse effects on the fetus is weak and has been limited to retrospective case reports.[9,23,24]
Reassure pregnant patients that:

- No negative effects on the fetus have been found when mothers receive appropriate antibiotic treatment.[9,24]
- Current evidence does not support the transmission of *B. burgdorferi* through breastfeeding.[9,24]

Management options for patients without EM rash[8]

Option A: Treat empirically. Based on a high degree of clinical suspicion, treat empirically during acute infection.

Pros

- Enables early treatment, potentially relieving a patient's suffering sooner and halting disease progression before it reaches the disseminated stage

Cons

- May expose a patient to unnecessary antibiotics if initial diagnosis of Lyme proves incorrect. The harms of this can include:
  - An increased risk of antibiotic-associated adverse events/complications
  - Risk of developing resistance to antibiotics
  - Delayed identification of true cause of symptoms

Option B: Wait and watch. Monitor patient for symptom persistence or worsening, or development of new symptoms. Consider ordering serologic testing, and treat if serology is positive.

Pros

- Resistance is a global health problem and preserving the efficacy of our current antibiotics is essential

Cons

- May prolong patient's suffering due to potentially significant delays in reporting test results
- Increased risk of Lyme-associated morbidity (neurologic, cardiac and rheumatologic)

If selecting option A,
see Section C. Antibiotic treatment (p. 5).

or

If selecting option B:

- Treat symptoms as per usual clinical practice
- Consider ordering serologic testing. See Section D. Serologic testing (p. 6)
- Instruct the patient to return to the clinic if:
  - Symptoms persist or worsen after ~1 week
  - Suspected EM rash continues to expand
- Provide a copy of the patient tool to help inform the patient about symptoms and prevention of Lyme disease

SECTION C: Antibiotic treatment

Prescribe antibiotics according to Table 1. Doxycycline is the recommended first-line antibiotic for Lyme disease.[1,3,5,25] It is the most effective at preventing severe complications if started in the early phase.[3]

The recommended treatment duration for early Lyme disease is 21 days.[3] While some providers may be tempted to prescribe shorter courses, due to the acute nature of the infection as well as recommendations from other sources,[1,5,25] this practice should be avoided. There is some evidence suggesting that shorter courses may result in lower cure rates while not significantly reducing the number of adverse events.[3]

Both laboratory and clinically-diagnosed cases of Lyme disease are nationally notifiable.[26] See PHAC's National Case Definition for Lyme disease to determine if a patient's case is reportable.

Table 1. Antibiotic treatment of early localized Lyme disease[1,3,25-28]

Age	Line	Drug	Dosage	Frequency	Maximum	Duration
Adults	**1st**	**Doxycycline**	**100 mg orally**	**Twice/day**	**N/A**	**21 days**
	2nd	Cefuroxime axetil	500 mg orally	Twice/day	N/A	21 days
		Amoxicillin	500 mg orally	Three times/day	N/A	21 days
Children (< 18 years)	**1st**	**Doxycycline**	**4 mg/kg orally**	**Daily, 2 divided doses**	**100 mg per dose**	**21 days**
	2nd	Amoxicillin	50 mg/kg orally	Daily, 3 divided doses	500 mg per dose	21 days
		Cefuroxime axetil	30 mg/kg orally	Daily, 2 divided doses	500 mg per dose	21 days

Special populations:

- **Pregnant women**: Doxycycline is contraindicated during pregnancy, and should not be used for the treatment of early Lyme disease in pregnant women. Pregnant women should be treated using appropriate antibiotics for their stage of pregnancy.[1,3,25]
- **Children:** A growing consensus accepts the safety of doxycycline use with children <8 years old, for 21 days or less.[27] Historically doxycycline has been contraindicated in children <8 years old due to its potential to cause teeth staining.

For all patients, refer to post-treatment follow-up recommendations in Section E (p. 7).

SECTION D: Serologic testing

Providers should only consider serologic testing to assist with diagnosis if: 1) they understand the appropriate use of the testing algorithm; and, 2) they are uncertain about clinically diagnosing a patient who is only exhibiting nonspecific symptoms.[1,3] Antibiotic treatment for early Lyme disease may inhibit seroconversion and impact the validity of serologic tests.[3,8]

Cautions[1,3,8]

Choosing to Test:
- DO NOT test asymptomatic patients
- DO NOT test patients who have EM rash. They can be diagnosed and treated without serologic testing.

Testing and Diagnosis:
- DO NOT rely on test results alone to make a diagnosis
- DO NOT rule out early Lyme disease in patients with negative results
- DO NOT use either tier as a stand-alone test

Interpreting Test Results:
- DO NOT use as a test of cure
- DO NOT use 2-tiered test to measure treatment response

Standard two-tiered testing (STTT) algorithm[1,3,29,30]

This information is for general guidance. Laboratory testing procedures may vary by province/territory.

In Canada, laboratory testing for Lyme disease traditionally involves a sequential, two-tiered testing algorithm. The first tier is an enzyme immunoassay, followed by the second tier (western blot) in the event that the first tier is positive or equivocal.

The first tier is ordered from your provincial lab. For all provinces, except Ontario and British Columbia, positive/equivocal samples are automatically sent to the National Microbiology Laboratory (NML) for confirmatory testing using the second tier. For Ontario and British Columbia, second-tier testing is only sent to the NML if European exposure is suspected. Otherwise, second-tier tests are conducted in-province.[29,30]

Required information for lab requisitions may vary by province/region. **Providers should indicate if the potential exposure to a tick occurred in Europe, as different tests are required to detect European species of Borrelia.** The duration of symptoms should also be indicated, as testing for IgM antibodies should be avoided in patients who have been ill for ≥ 1 month (in these patients, IgG antibodies must be positive in order to diagnose Lyme disease).

1st Tier: Enzyme immunoassay (EIA/ELISA)
Turnaround time: ~1 week

Purpose: Screens for Lyme disease antibodies (IgG and IgM). Has poor sensitivity during early Lyme disease, which may lead to a high number of false negatives.[3,4]

If Positive or Equivocal:
- Serum referred for 2nd tier.

If Negative:
- Consider alternative diagnoses, but do not rule out Lyme disease.[3]
- If the test has been done within the first 30 days of onset, repeat the 1st tier 4-6 weeks after the initial test.[3] If negative again, do not order a third 1st tier test.[3,8]

2nd Tier: Western blot
Turnaround time: ~3 weeks from receipt at NML

Purpose: Confirmatory test used after positive/equivocal 1st tier test. European genospecies require different western blots. If symptoms have lasted ≥ 1 month, only IgG antibodies should be tested.

If Positive or Equivocal:
- Diagnose Lyme disease and prescribe antibiotic treatment.[1,3] See Section C, Antibiotic treatment (p. 5)
- If symptoms have lasted ≥ 1 month, IgG must be positive in order to diagnose. Do not diagnose based on positive IgM after 1 month.[1]

If Negative:
- Consider an alternative diagnosis, including non-infectious diseases[3,5,8]
- Consider consulting with or referring to an appropriate specialist[3,8]

Modified two-tiered testing (MTTT) algorithm[31]

In 2019, the U.S. FDA approved a modified two-tiered test (MTTT) as an alternative to the standard two-tiered test (STTT) based on evidence that showed MTTT performance to be equivalent or better than the STTT.[31] In the MTTT, the second tier is an additional EIA/ELISA (instead of a western blot) which can be performed concurrently with the first-tier EIA/ELISA.

- **Access:** All Canadian labs will use the STTT but may not use the new MTTT (at time of this resource's publication).[1,8]
- **Turnaround time:** EIA test results are returned more quickly than western blots. Faster results (~1 week) may support more timely treatment decisions.[8,31]

SECTION E: Monitoring and follow-up

The majority of patients who receive an appropriate antibiotic for an appropriate duration are cured once therapy is finished, and show a resolution of all signs and symptoms.[1,3,5] However, some patients may have symptoms that persist after therapy.[1,3,5] Immediately following the completion of antibiotic treatment, assess the patient for evidence of disease persistence or progression.[8] Include the patient in your decision-making as you consider the next steps.[22]

It is possible for patients to become infected with more than one tick-borne pathogen.[5] In Canada, the most common tick-borne infections other than Lyme disease are anaplasmosis (caused by *Anaplasma phagocytophilum*), babesiosis (caused by species of Babesia) and Powassan virus disease.[32] **Potential co-infection should be suspected in patients who present with symptoms that are more severe than commonly observed in cases of early Lyme disease alone, especially those with:**[5]

- High-grade fever for >48 hours, despite receiving appropriate antibiotic treatment for Lyme disease
- Unexplained leukopenia, thrombocytopenia or anemia
- No improvement (or worsening) of nonspecific symptoms despite resolution of EM rash

Satisfied with symptom resolution

↓

- Have the patient monitor any remaining symptoms for continuing resolution.
- Encourage the patient to return to the clinic if remaining symptoms persist. Schedule subsequent assessments as requested by the patient.[22]
- Share the patient tool and highlight methods of prevention to avoid future infection.

or

Not satisfied with symptom resolution

↓

Adults: Treat symptoms as per regular clinical practice, and consider the following as appropriate:[3,8]

- Second round of treatment with an alternative antibiotic.[3,5] See Section C. Antibiotic Treatment (p. 5).
- Alternative diagnosis.
- Referral to infectious disease specialist.
- Possibility of co-infection. See below for further information.

Children: If symptoms persist after a complete course of antibiotics, treat symptoms as per regular clinical practice, and refer the patient to an infectious disease specialist.[3,8]

If you are suspicious of co-infection:

- Consider a referral to an infectious disease specialist.[8]
- Doxycycline is effective at treating anaplasmosis. The treatment regime for Lyme disease should also resolve anaplasmosis.[5,33]
- Doxycycline alone is not effective for treating babesiosis or Powassan virus disease.[5]

Visit the U.S. Centers for Disease Control and Prevention websites for more information on babesiosis[34] and anaplasmosis[33], or the Public Health Agency of Canada website for more information on Powassan virus disease.[35]

SECTION F: Tick bite management

To transmit Lyme disease, a blacklegged tick infected with *B. burgdorferi* **must attach to a person and feed for an extended period of time (most evidence suggests a minimum of 24 hours).**[1,5,9] The likelihood of disease transmission increases with attachment time.[9] If a tick has been feeding, it will become engorged, but this level of engorgement is often difficult to determine in practice.

The images to the right may help to identify blacklegged ticks and determine if a recently-discovered tick was attached long enough to transmit disease. It may be very difficult for patients and healthcare professionals to identify tick species and estimate attachment time, especially if a tick has been damaged during removal.[8]

← Unfed blacklegged ticks (deer ticks)[36]

← Unfed American dog ticks (wood ticks)[36]

Levels of engorgement in adult blacklegged ticks as a result of feeding on blood[36]

Is the tick still attached?

- no
- yes

If the patient recalls removing a tick from their skin within the last 30 days:

- Use Section B. Clinical assessment (p. 2) to check for signs and symptoms of early Lyme disease. Note that signs and symptoms of early Lyme disease may take up to 30 days to appear after infection.
- Provide a copy of the patient tool, which will provide more information on course, treatment and prevention of Lyme disease.
- Advise the patient to monitor for symptom development over the next few weeks.
- If the tick was removed within the last 72 hours, and all other criteria are met, consider offering post-exposure prophylaxis.[5] See below for more information.

Remove tick:[37,38]

- Do not use sharp forceps. Use blunt, medium tipped, angled forceps to grasp the head of the tick as close to the skin as possible.
- Do not use a twisting or jerking motion to remove the tick. Use perpendicular traction, taking care not to twist or crush the tick. If the mouthparts break off and remain in the skin, remove them with forceps.
- Clean the area with an antiseptic solution.
- Record the date in the patient's record.
- Instruct the patient to monitor for signs and symptoms for the next 30 days.
- Provide a copy of the patient tool, which will provide more information on course, treatment and prevention of Lyme disease.
- Dispose of the tick. Do not submit ticks for testing to seek confirmation of Lyme disease. See the PHAC website[38] for information on submitting ticks for **surveillance purposes only.**
- If the patient meets all of the criteria, consider post-exposure prophylaxis (below).[5]

Post-exposure prophylaxis[5]

Post-exposure prophylaxis is not generally recommended. Providers may consider prophylactic treatment in **asymptomatic patients** if all the following criteria are met:

- Attached tick can be positively identified as a blacklegged tick (see images above)
- Tick was engorged and estimated to have been attached for >24 hours
- Prophylaxis can be started within 72 hours of tick removal
- Tick was acquired in an area where the infectivity rate of the tick population with *B. burgdorferi* is ≥20% . [Note: Infectivity rate is not uniformly collected in Canada. However, recent reports have shown that areas of Ontario, Manitoba and Nova Scotia have infection rates ≥20%.[39,40,41] Many provinces and U.S. states instead estimate incidence rate by confirmed and probable cases.]
- Doxycycline is not contraindicated

If all of the above criteria are met:

- A single prophylactic dose of doxycycline may be given to adults (200mg) and children (for children under 45kg, 4 mg/kg to a maximum dose of 200 mg). Recent research suggests a single dose of doxycycline is safe for pregnant women.[42,43]
- If doxycycline is contraindicated, do not offer an alternative antibiotic. Antibiotics other than doxycycline have not been proven effective.[1,5]
- As post-exposure prophylaxis is not 100% effective, patients should be monitored for the development of signs and symptoms for 30 days.[5,44]

Risk area resources: Canada, U.S. and Europe

Canada

National	• Government of Canada surveillance website: https://www.canada.ca/en/public-health/services/diseases/lyme-disease/surveillance-lyme-disease.html • Most recent data/report (2017): https://www.canada.ca/en/public-health/services/reports-publications/canada-communicable-disease-report-ccdr/monthly-issue/2017-43/ccdr-volume-43-10-october-5-2017/surveillance-surveillance-lyme-disease-canada-2009-2015.html
BC	• Surveillance website: http://www.bccdc.ca/health-info/diseases-conditions/lyme-disease-borrelia-burgdorferi-infection#Epidemiology • Interactive map: http://www.bccdc.ca/health-professionals/data-reports/reportable-diseases-data-dashboard
AB	• Surveillance website: https://www.alberta.ca/lyme-disease-tick-surveillance.aspx • Most recent data/report: (2018): https://open.alberta.ca/dataset/f0b7698f-03d4-4d32-858f-141ec7c3c108/resource/1cb2646b-bcdb-4299-84d6-7c1737518daa/download/tick-surveillance-2018-summary-report.pdf • Interactive map: https://public.tableau.com/profile/ellehojpublic#!/vizhome/Ticks_AB/AlbertaTicks
SK	• Surveillance website: https://www.saskatchewan.ca/residents/health/diseases-and-conditions/lyme-disease#risk-in-saskatchewan • Most recent data/report: (2019) https://publications.saskatchewan.ca/api/v1/products/100547/formats/111004/download
MB	• Surveillance website: https://www.gov.mb.ca/health/publichealth/cdc/tickborne/surveillance.html • Most recent data/report: (2017) https://www.gov.mb.ca/health/publichealth/cdc/tickborne/docs/tbd_report2017.pdf
ON	• Surveillance website: https://www.publichealthontario.ca/en/diseases-and-conditions/infectious-diseases/vector-borne-zoonotic-diseases/lyme-disease • Most recent data/report: (2018) https://www.publichealthontario.ca/data-and-analysis/infectious-disease/reportable-disease-trends-annually#/34
QC	• Surveillance website: https://www.msss.gouv.qc.ca/professionnels/zoonoses/maladie-lyme/surveillance-de-la-maladie/ • Most recent data/report: (French – 2017): https://www.inspq.qc.ca/en/node/14523 • (English – 2016): https://www.inspq.qc.ca/en/publications/2417
NB	• Surveillance: https://www2.gnb.ca/content/gnb/en/departments/ocmoh/cdc/content/vectorborne_andzoonotic/Tick-Borne_Diseases/ticks.html • Most recent data/report: (2017) https://www2.gnb.ca/content/gnb/en/departments/ocmoh/cdc/content/vectorborne_andzoonotic/Tick-Borne_Diseases/brief.html#1
NL	• Surveillance: https://www.faa.gov.nl.ca/agrifoods/animals/health/ticks/location_ixodes.html • Most recent data/report: (2015): https://www.faa.gov.nl.ca/agrifoods/animals/health/pdf/ds_08_006.pdf
NS	• Surveillance: https://novascotia.ca/dhw/populationhealth/ • Most recent data/report (2017): https://novascotia.ca/dhw/populationhealth/documents/Annual-Notifiable-Disease-Surveillance-Report-2017.pdf
PEI	• PEI Public Health: https://www.princeedwardisland.ca/en/information/health-and-wellness/lyme-disease-in-pei
NT	• NT Public Health: https://www.hss.gov.nt.ca/en/services/tick-borne-diseases
NU	• NU Public Health: https://www.gov.nu.ca/sites/default/files/nu_communicable_diseases_manual_-_complete_2018_0.pdf
YT	• YT Department of Health and Social Services: http://www.hss.gov.yk.ca/pdf/comm_diseases.pdf

International

U.S.	• Center for Disease Control (CDC) Lyme disease maps: https://www.cdc.gov/lyme/datasurveillance/maps-recent.html • Lyme disease incidence rates by state: https://www.cdc.gov/lyme/stats/tables.html
Europe	• European Centre for Disease Prevention and Control - Borreliosis: https://www.ecdc.europa.eu/en/borreliosis • WHO Lyme fact sheet: http://www.euro.who.int/en/media-centre/sections/fact-sheets/2014/03/fact-sheets-world-health-day-2014-vector-borne-diseases/fact-sheet-lyme-borreliosis-in-europe

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This Tool was developed by the Centre for Effective Practice with support from the College of Family Physicians of Canada. Clinical leadership for the development of the Tool was provided by Dr. Cecilia Newton, CCFP, and was subject to external review by healthcare providers and other relevant stakeholders. Funding for this project has been made possible through a contribution from the Public Health Agency of Canada.

Developed by:

CEP Centre for Effective Practice

With support from:

The College of Family Physicians of Canada / Le Collège des médecins de famille du Canada

Public Health Agency of Canada / Agence de la santé publique du Canada