



# TICK & LOUSE-BORNE RELAPSING FEVER

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## Disease Plan

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Last updated: December 15, 2016, by Dallin Peterson

Questions about this disease plan?

Contact the Utah Department of Health Bureau of Epidemiology: 801-538-6191.

## ✓ WHY IS TICK- & LOUSE-BORNE RELAPSING FEVER IMPORTANT TO PUBLIC HEALTH?

Relapsing fever is bacterial infection characterized by recurring episodes of fever, headache, muscle and joint aches, and nausea. It is caused by certain species of *Borrelia* spirochetes. There are two types of relapsing fever:

- Tick-borne relapsing fever (TBRF)
- Louse-borne relapsing fever (LBRF)

Ongoing surveillance is needed to establish the burden of disease and better define the epidemiology of the various infections caused by *Borrelia* spirochetes. This information will be used to better inform medical professionals about the disease and tailor prevention messages for the public.

## ✓ DISEASE AND EPIDEMIOLOGY

### Clinical Description

Often referred to as Tick-borne Relapsing Fever (TBRF) or Louse-borne Relapsing Fever (LBRF), Relapsing Fever is a disease characterized by relapsing (i.e., recurring) episodes of fever, often accompanied by other symptoms. Initial symptoms include fever, generalized body aches, myalgias, arthralgias, headache, chills, and sweats. Other symptoms which may develop later in the course of illness include nausea, vomiting, anorexia, dry cough, photophobia, rash, neck pain, eye pain, confusion, and dizziness. Given appropriate antibiotics, most patients recover within a few days. Patients with TBRF, however, often report prolonged symptoms and longer time to recovery. Often this is due to delayed diagnosis and treatment. Long-term sequelae of TBRF include cardiac and renal disturbances, peripheral nerve involvement, ophthalmia, and spontaneous abortion. With treatment, the case fatality rate is very low. With prompt treatment using appropriate antibiotics, the death rate for LBRF is 2-5% and for TBRF is less than 2%.

### Causative Agent

The relapsing fever *Borrelia spp* are gram negative, helical bacteria, normally 0.2-0.5 microns in width and 5-20 microns in length. They are visible with light microscopy and have the cork-screw shape typical of all spirochetes. They have a unique process of DNA rearrangement in their linear DNA. Each time the DNA is read, a different antigenic marker, also known as a variable major protein, is created, which allows the organism to evade the immune system and therefore cause recurrent patterns of fever and other symptoms.

**Tick-borne relapsing fever:** This is caused by *B. hermsii*, *B. parkerii*, and *B. turicatae*.

**Louse-borne relapsing fever:** This is caused by *Borrelia recurrentis*.

### Differential Diagnosis

The diseases should be considered in someone with recurrent episodes of a febrile illness: generalized infections (i.e., influenza, chronic meningococcemia, Salmonellosis, Shigellosis,

infectious mononucleosis, ascending [intermittent] cholangitis, lymphocytic choriomeningitis, echovirus 9); other vectorborne diseases (i.e., Colorado Tick Fever, Lyme disease); travel-associated diseases (yellow fever, dengue, malaria, African hemorrhagic fevers); and occupation-related diseases (brucellosis, leptospirosis, rat bite fever, *Bartonella* species).

## **Laboratory Identification**

The definitive diagnosis of relapsing fever is based on the observation of *Borrelia* spirochetes in smears of peripheral blood, bone marrow, or cerebrospinal fluid in a symptomatic person. The organisms are best detected in blood obtained while a person is febrile. With subsequent febrile episodes, the number of circulating spirochetes decreases, making it harder to detect spirochetes on a peripheral blood smear. Even during the initial episode, spirochetes will only be seen 70% of the time.

Serology testing is not widely available and results can be difficult to interpret due to cross reactivity with *Borrelia bergdorferii*. Incidental laboratory findings include normal to increased white blood cell count with a left shift towards immature cells, a mildly increased serum bilirubin level, mild to moderate thrombocytopenia (low platelet count), elevated ESR and slightly prolonged coagulation tests, PT and APTT.

**Direct visualization procedures** — Thin and thick smears of blood are usually the first tests performed for suspected relapsing fever. Giemsa or Wright stains typically reveal the spirochetes in a methanol-fixed thin smear if the concentration of microorganisms is greater than  $10^5$ /mL. The optimum time to obtain blood is between the fever's onset and its peak. Once the temperature is declining, or is back to the normal range in the absence of antipyretics, spirochetes usually cannot be visualized in blood. With current automated procedures for blood

**Polymerase chain reaction** — The polymerase chain reaction (PCR) is useful for the diagnosis of relapsing fever. PCR can be performed on blood samples or culture medium that is growing *Borrelia* species, and can identify the infecting species.

**Serologies** — For most infections, serology provides indirect evidence of disease when an etiologic agent cannot be detected directly. Such is not the case for relapsing fever because specific diagnostic *Borrelia* antibodies have not been defined. Currently, available serologic assays based upon whole cells of a relapsing fever *Borrelia* species may not include the antigens to which the patient is responding. Enzyme linked immunosorbent assay (ELISA) or IFA on whole cells offers the greatest diagnostic value. However, paired acute and convalescent sera must be analyzed in the same assay and must demonstrate a fourfold or greater change in titer. These assays are only available at a few reference laboratories.

## **Treatment**

Penicillins and tetracyclines have been the antibiotics of choice for relapsing fever for several decades. There is no evidence that *Borrelia* spp have acquired resistance to antibiotics.

**TBRF Treatment** — TBRF is more sporadic than LBRF; consequently, evidence about the efficacies of different treatment schedules is more anecdotal. Although the CDC has not developed specific treatment guidelines for TBRF, the preferred treatment in adults is

tetracycline (500 mg or 12.5 mg/kg orally every six hours) or doxycycline (100 mg twice daily), both for 10 days. When tetracyclines are contraindicated, erythromycin (500 mg or 12.5 mg/kg orally every six hours) for 10 days is the recommended alternative.

**LBRF Treatment** - LBRF can be treated with a single dose of oral tetracycline (500 mg for adults, 12.5 mg/kg for children), oral doxycycline (200 mg for adults, 5 mg/kg for children), or intramuscular penicillin G procaine (400,000 to 800,000 units for adults; 200,000 to 400,000 units for children). If the patient cannot take tetracycline orally, the recommended intravenous dose of doxycycline is 250 mg or 500 mg for adults. Tetracycline is the preferred oral agent in those without a contraindication as it has better efficacy than erythromycin. It is contraindicated in pregnant and nursing women, children <9 years of age, and those who are allergic to penicillin.

**Jarisch-Herxheimer reactions** — Jarisch-Herxheimer reactions (JHR) occur following antibiotic treatment for a number of spirochetal and bacterial infections. Signs and symptoms include rigors, fever, and hypotension. Treatment of LBRF is the classic situation in which this reaction arises, occurring in approximately 80 percent of treated patients. Both penicillin and tetracycline can induce JHR. JHR can also occur following treatment of TBRF, with an incidence of 54% in one series. These reactions tend to occur within two hours of antibiotic administration; therefore, observation for several hours after treatment is recommended. If treatment of an otherwise undifferentiated febrile illness with antibiotics results in an unexpected worsening of the patient's condition, relapsing fever should be considered as a possible diagnosis if epidemiologic risk factors are present.

## **Case Fatality**

The mortality rates for untreated louse-borne relapsing fever (LBRF) and tick-borne relapsing fever (TBRF) are in the ranges of 10-70% and 4-10%, respectively. With prompt treatment using appropriate antibiotics, the death rate for LBRF is 2-5% and for TBRF is <2%.

## **Reservoir**

The tick *Ornithodoros* usually feeds on small animals such as squirrels, mice, chipmunks, or rabbits. The ticks live in rodent nests, which can be found under flooring and between walls. If these rodents are scarce, the ticks feed on other warm-blooded animals, including humans.

## **Transmission**

*Borrelia* is transmitted to humans through the bite of infected soft ticks of the genus *Ornithodoros*. Soft ticks (family Argasidae) differ in many ways from the so-called hard ticks (family Ixodidae), including the more familiar dog tick and deer tick.

In contrast to hard ticks, soft ticks take brief blood meals lasting less than a half hour, usually at night. They live within rodent burrows, feeding as needed on the rodent as it sleeps. Between meals, the ticks may return to the nesting materials in their host burrows. Individual ticks will take many such blood meals during each stage of their life cycles, including the development of eggs by adult females. The bites of soft ticks are usually painless, and the persons who are bitten while asleep are usually unaware that they were bitten.



The individual *Borrelia* species that cause TBRF are usually associated with specific tick vectors. For instance, *B. hermsii* is transmitted to humans by *O. hermsi* ticks, while *B. parkerii* is transmitted by *O. parkeri* and *B. turicatae* is transmitted by *O. turicata*. Each tick has a preferred environment and preferred set of hosts. *O. hermsi* tends to be found at higher altitudes (1,500 – 8,000 feet) where it is associated primarily with ground or tree squirrels and chipmunks. *O. parkeri* live at lower altitudes, where they inhabit caves and the burrows of ground squirrels and prairie dogs, as well as those of burrowing owls. *O. turicata* live in caves and ground squirrel or prairie dog burrows in the plains regions of the southwest, feeding off these animals, and occasionally burrowing owls or other burrow- or cave-dwelling animals.

**IN PREGNANCY:** TBRF contracted during pregnancy can cause spontaneous abortion, premature birth, and neonatal death. The maternal-fetal transmission of *Borrelia* is believed to occur either transplacentally or while traversing the birth canal. In one study, perinatal infection with TBRF was shown to lead to lower birth weights, younger gestational age, and higher perinatal mortality. In general, pregnant women have higher spirochete loads and more severe symptoms than non-pregnant women. Higher spirochete loads have not, however, been found to correlate with fetal outcome.

## **Susceptibility**

Susceptibility is general. Duration and degree of immunity after clinical attack is unknown. Repeated infections may occur.

## **Incubation Period**

Louse-borne relapsing fever incubation period is typically 8 days with a range of 5-15 days. Tick-borne relapsing fever incubation period is usually 7 days with a range of 2-18 days. It is usually another 7 days after the resolution of the initial illness that a relapse will be experienced. Relapses can occur up to 10 times in untreated persons.

## **Period of Communicability**

Not directly transmitted from person to person, except in rare cases such as the maternal-fetal transmission of *Borrelia* that is believed to occur either transplacentally or while traversing the birth canal.

## Epidemiology

TBRF is endemic in the western U.S., southern British Columbia, plateau regions of Mexico, Central and South America, the Mediterranean, Central Asia, and much of Africa. The first endemic focus of TBRF in the US was identified in 1915 in Colorado though the first case was actually in 1905 in New York in a traveler to Texas. Since then, TBRF has been reported in 14 states: Arizona, California, Colorado, Idaho, Kansas, Montana, Nevada, New Mexico, Ohio, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming. Most recent cases and outbreaks have occurred in rustic cabin or vacation home settings at higher elevations (> 8,000 feet) in coniferous forests in the western US. TBRF normally occurs in summer months when people are traveling to mountainous areas on vacation. TBRF can, however, occur in winter, particularly when people go into rodent infested cabins and start fires, warming the cabin and producing carbon dioxide and warmth that attract the ticks that transmit TBRF.

LBRF is currently endemic in Ethiopia and Sudan. The highlands region of Ethiopia may have hundreds to thousands of cases of LBRF annually. The highest incidence in this region is during the rainy season when the poor gather together in shelters. Lice move from one person to another, thus spreading the infection to new hosts. When LBRF spreads outside the Horn of Africa, true epidemics can occur. Homeless people are also highly exposed to body lice in crowded shelters. Famine, war, and the movements and congregations of refugees are common predisposing factors for epidemics of LBRF and epidemic typhus. Under these conditions there is crowding, poor hygiene, few changes of clothing, and lack of access to washing. The large epidemics of LBRF during this century occurred around the two world wars. Millions of people were infected in these epidemics, and at least one million deaths occurred. The louse has a life span measured in weeks, instead of years for the tick, and must feed on blood frequently. *B. recurrentis* grows in the body cavity of the louse but does not appear in the saliva or feces. When people crush a louse with their fingers, the organism is introduced at the bite site, into the skin of the crushing fingers, or into the conjunctivae when they rub their eyes. There hasn't been a reported case of Relapsing Fever in Utah since 1992. Before that, Utah had a 5-year average of 1 case per 5 years.

## ✓ PUBLIC HEALTH CONTROL MEASURES

### Public Health Responsibility

- Investigate all suspect cases of disease and fill out and submit appropriate disease investigation forms.
- Provide education to the general public, clinicians, and first responders regarding disease transmission and prevention.
- Identify clusters or outbreaks of this disease.
- Identify sources of exposure and stop further transmission.

### Prevention

#### *Managing Special Situations: Response to a Tick Bite*

The longer a tick remains attached to someone, the higher the likelihood of disease transmission. Individuals should promptly remove any attached tick using fine-point tweezers.

The tick should not be squeezed or twisted, but grasped close to the skin and pulled straight out using steady pressure. Whenever an attached tick is removed from the body, one should monitor one's health for the appearance of rash, fever, or flu-like symptoms, and should immediately seek the advice of a health care provider should any symptoms occur, especially if the tick was attached for more than 24 hours. It may be helpful to save the tick after removal for two reasons: 1) if the person who was bitten goes on to develop signs or symptoms such as fever, flu-like symptoms, or a rash, it may be helpful for the physician to know the type of tick; and 2) depending on the circumstances of the bite (i.e., when a person was bitten, the type of tick, how long it was attached), a physician may choose to treat the person who was bitten. The tick may be kept either securely sealed in a small plastic bag or attached, with clear tape, to a piece of paper. For individuals who do not wish to keep the tick, it can be either drowned in alcohol or flushed down the toilet.

## **Preventive Measures**

### *Environmental Measures*

Prevention of diseases spread by ticks, involves making the yard less attractive to ticks.

- Keep grass cut short.
- Remove leaf litter and brush from around the yard.
- Prune low lying bushes to let in more sunlight.
- Keep woodpiles and bird feeders off the ground and away from the home.
- Keep the plants around stone walls cut short.
- Use a three-foot wide woodchip, mulch, or gravel barrier where the lawn meets the woods, and remind children not to cross that barrier.
- Ask a landscaper or local nursery about plants to use in the yard that do not attract deer.
- Use deer fencing (for yards 15 acres or more).

If an individual chooses to use a pesticide to reduce the number of ticks on his/her property, he/she should be advised to hire a licensed applicator who is experienced with tick control. A local landscaper or arborist may be a licensed applicator. In general, good tick control can be achieved with no more than two pesticide applications in any year. Advise individuals to ask, when selecting an applicator, if they will provide:

- A written pest control plan that includes information on the pesticide to be used.
- Information about non-chemical pest control alternatives.
- Signs to be posted around the property after the application.

### *Personal Preventive Measures/Education*

There is no human vaccine for Relapsing Fever. If someone lives, works, or spends leisure time in an area likely to have ticks, they should be advised of the following:

- The single most important thing one can do to prevent a tickborne disease is to check oneself for ticks once a day. Favorite places ticks like to go on the body include areas between the toes, back of the knees, groin, armpits, neck, along the hairline, and behind the ears. Remember to check children and pets too. Promptly remove any attached tick using fine-point tweezers. The tick should not be squeezed or twisted but grasped close to the skin and pulled straight out using steady pressure.
- Stick to main pathways and the centers of trails when hiking.

- Avoid wooded and bushy areas with high grass.
- Wear long-sleeved, light-colored shirts, and long pants tucked into socks.
- Talk to a veterinarian about the best ways to protect pets and livestock from ticks.

Use repellents containing DEET (N,N-diethyl-m-toluamide), and choose a product that will provide sufficient protection for the amount of time spent outdoors. Product labels often indicate the length of time that someone can expect protection from a product. DEET is considered safe when used according to the manufacturer's directions. The efficacy of DEET levels off at a concentration of 30%, which is the highest concentration recommended for children and adults. DEET products should not be used on children <2 months of age. The following precautions should be observed when using DEET products:

- Avoid using DEET products that combine the repellent with a sunscreen. Sunscreens may need to be reapplied too often, resulting in an over application of DEET.
- Apply DEET on exposed skin, using only as much as needed.
- Do not use DEET on the hands of young children, and avoid applying repellent to areas around the eyes and mouth.
- Do not use DEET over cuts, wounds, or irritated skin.
- Wash treated skin with soap and water after returning indoors, and wash treated clothing.
- Avoid spraying DEET products in enclosed areas.

Permethrin-containing products will kill mosquitoes and ticks on contact. Permethrin products are not designed to be applied to the skin. Clothing should be treated and allowed to dry in a well-ventilated area prior to wearing. Because permethrin binds very tightly to fabrics, once the fabric is dry, very little of the permethrin gets onto the skin.

## **Chemoprophylaxis**

None.

## **Vaccine**

None.

## **Isolation and Quarantine Requirements**

**Isolation:** None.

**Hospital:** None.

**Quarantine:** None.

## ✓ CASE INVESTIGATION

### Reporting

Report all suspect and confirmed cases of Relapsing Fever.

### Case Definition

#### Relapsing Fever (Utah 2015)

#### Clinical description

An acute febrile illness with four major symptoms: headache, fever (greater than or equal to 99°F), shaking chills and myalgia. Symptoms may relapse after afebrile periods of 2-4 days. Total duration of the illness averages from 13-16 days for louse-borne illness, and longer for tick-borne illness.

#### Laboratory criteria for diagnosis

- Demonstration of visible spirochetes in a peripheral blood smear, OR
- Demonstration of spirochetemia in inoculated swiss mice, OR
- Serological evidence of non-treponemal spirochetes in individuals not visiting endemic Lyme disease areas.

**Note:** Blood samples obtained before antibiotic treatment can be cultured using BSK medium or by inoculating immature mice. The spirochete will usually be evident within 24 hours if the blood was drawn during a febrile episode. Acute serum should be taken within seven days of symptom onset, and convalescent serum should be taken at least 21 days after symptoms start. Early antibiotic treatment may blunt the antibody response and antibody levels may wane quickly during the months after exposure.

#### Epidemiological Criteria

Exposure is defined as having been in wooded, brushy, grassy areas, or possibly having exposure to soft ticks in rustic cabins, caves, or around firewood (i.e., potential tick habitats) within 30 days of onset of symptoms.

#### Case classification

##### *Confirmed*

A case that is laboratory confirmed, with either a consistent history of exposure.

##### *Probable*

A compatible history of exposure and at least three of the major symptoms present.

<b>Classification Tables</b>	<b>Confirmed</b>	<b>Probable</b>
<i>Clinical Evidence</i>		
Fever ≥99°F		O <sub>1</sub>
Headache		O <sub>1</sub>
Chills		O <sub>1</sub>
Myalgia		O <sub>1</sub>
<i>Laboratory Findings</i>		
Demonstration of visible spirochetes in a peripheral blood smear	O	
Demonstration of spirochetemia in inoculated swiss mice	O	
Serological evidence of non-treponemal spirochetes in persons not visiting endemic Lyme disease area	O	
<i>Epidemiological Criteria</i>		
Exposure is defined as having been (≤30 days before onset of symptoms) in wooded, brushy, grassy areas, exposure to soft ticks in rustic cabins, caves or firewood (e.g., potential tick habitats)	O	N
Epidemiologically linked to a confirmed case	O	

Notes:

O = At least one of these “O” criteria in each category (i.e., clinical presentation and laboratory findings)—in conjunction with all other “N” criteria in the same column—is required to classify a case.

O<sub>1</sub> = At least three of these criteria are required.

### **Case Investigation Process**

- Fill out morbidity form.
- Verify case status.
- Fill out disease investigation form.
- Determine whether patient had travel/exposure history consistent with acquisition of disease in Utah or elsewhere.
- If patient acquired disease in Utah, identify the source of transmission and implement measures to eliminate it.

### **Outbreaks**

More than one case of Relapsing Fever in a one month period of time would constitute an outbreak.

### **Identifying Case Contacts**

None.

### **Case Contact Management**

None.

## ✓ REFERENCES

Barbour, A. (2016). Clinical Features, Diagnosis, and Management of Relapsing Fever. Up to Date. Retrieved on April 22, 2016 from [http://www.uptodate.com/contents/clinical-features-diagnosis-and-management-of-relapsing-fever?source=search\\_result&search=relapsing+fever&selectedTitle=1~32](http://www.uptodate.com/contents/clinical-features-diagnosis-and-management-of-relapsing-fever?source=search_result&search=relapsing+fever&selectedTitle=1~32).

Barbour, A. (2016). Microbiology, Pathogenesis, and Epidemiology of Relapsing Fever. Up to Date. Retrieved on April 22, 2016 from [http://www.uptodate.com/contents/microbiology-pathogenesis-and-epidemiology-of-relapsing-fever?source=search\\_result&search=relapsing+fever&selectedTitle=2~32](http://www.uptodate.com/contents/microbiology-pathogenesis-and-epidemiology-of-relapsing-fever?source=search_result&search=relapsing+fever&selectedTitle=2~32).

Centers for Disease Control and Prevention, Tick-borne Relapsing Fever(TBRF). Available from URL: <http://www.cdc.gov/relapsing-fever/index.html>.

Clinical Features, Diagnosis, and Management of Relapsing Fever (2014, June 24). Retrieved February 18, 2016, from [http://www.uptodate.com/contents/clinical-features-diagnosis-and-management-of-relapsing-fever?source=search\\_result&search=relapsing+fever&selectedTitle=1~27](http://www.uptodate.com/contents/clinical-features-diagnosis-and-management-of-relapsing-fever?source=search_result&search=relapsing+fever&selectedTitle=1~27).

Red Book: 2012 Report of the Committee on Infectious Diseases (29<sup>th</sup> Edition), Larry K. Pickering MD, Ed; 2012.

Relapsing Fever, Ehrlichiosis, Colorado Tick Fever (2015). In D. Heymann (Ed.), *Control of communicable diseases manual* (20th ed.). Washington, DC: American Public Health Association.

## ✓ VERSION CONTROL

Updated. Dec 15, 2016: Updated minimum data set.

Updated. Apr 22, 2016: Added the importance to public health section.

Updated. Apr 22, 2016: Updated laboratory diagnosis, case fatality, epidemiology, and treatment.

Updated. Apr 19, 2016: General update to formatting (separated tick-borne disease into individual disease plans).

## UT-NEDSS Minimum/Required Fields by Tab

### Demographic

- County
- State
- Street
- City
- Zip Code
- Date of Birth
- Birth Gender
- Race
- Ethnicity
- First Name
- Last Name
- Phone Number

### Clinical

- Date of Death
- Hospitalized
- Died
- Disease
- Onset Date
- Pregnant
- Clinician
- Diagnostic Facility
- Specific Disease Being Reported
- Did the patient have an underlying immunosuppressive condition?
- Did the patient experience any of the following life-threatening complications in clinical course of illness?
- Was the patient treated with antibiotics?

### Laboratory

- Organism
- Specimen Source

- Test Result
- Test Type

### Epidemiological

- Imported From

### Investigation

- List date 14 days prior to disease onset
- Was patient bitten by a tick during the above time period?
- Was patient in a wooded, brushy or grassy area (potential tick habitat) <30 days prior to onset of symptoms?
- Was the patient camping during exposure period?
- Was the patient hunting during exposure period?
- Did the patient visit any parks during exposure period?
- Did the patient traveled outside of Utah during exposure period?

### Contacts

- Last Name
- First Name
- Date of birth

### Reporting

- Date first reported to public health

### Administrative

- Outbreak Name
- Outbreak Associated
- State Case Status