
## Appendix I:A. Serogroups and Subtypes

Closely related microorganisms that share common, measurable surface components are said to belong to a serogroup. Each serogroup of *L. pneumophila* contains further subtypes that have different surface structures on the cell membrane and can be distinguished by special tests.

- Evidence indicates that some *L. pneumophila* serogroups are more virulent than others.
- *L. pneumophila* serogroup 1 is the most frequently identified form of the bacterium isolated from patients with Legionnaires' disease, although other serogroups and subtypes of the bacterium are frequently isolated from water sources.
- Serogroups 4 and 6 are the second and third types most frequently linked with Legionnaires' disease.

Close this Window


## Appendix I:B. Diagnostic Methods

The following diagnostic methods confirm the presence of Legionnaires' disease:

- Culture of the organism
- Detection by means other than culture
  - Serology (antibody titers)
  - Direct fluorescent antibody (DFA) staining
  - Urine Antigen Test
- Additional Considerations

**Culture of the organism:**

- The definitive laboratory method of confirming the presence of the bacterium is by culturing, on special media, viable cells of Legionnaires' disease bacteria (LDB) from sputum, a bronchial washing, or autopsy tissue.
- Further identification of the cultured bacteria will identify the species and serogroup. Special tests may determine the subtype of certain isolates.
- The sensitivity of this test to detect the disease is reported to be about 70 percent.

**Detection by means other than culture:**

- **Serology (antibody titers):**
  - An increase in the antibody level in the blood of infected persons occurs several weeks after the onset of the disease.
  - The treating physician compares the antibody level four to eight weeks after onset (convalescent titer) to an initial (acute) titer at the beginning of the disease.
  - A four-fold increase in the antibody titer coupled with a physician's diagnosis of pneumonia is considered a reliable indicator of disease.
  - Pontiac fever also produces an elevated antibody titer, but the flu-like symptoms of this disease do not match those of Legionnaires' disease.
- **Direct fluorescent antibody (DFA) staining:**
  - Direct fluorescent antibody staining of lung aspirates or sputum can detect *L. pneumophila.*
  - This test is frequently negative during the initial stages of the disease because few organisms are present in the aspirate or sputum.
  - This test also requires an antigen-specific reagent. There are a multitude of serogroups and subtypes of *L. pneumophila* as well as other species of *Legionella*, and a test will be negative if the exact antigen-specific reagent is not included.
- **Urine Antigen Test:**
  - The detection of antigens from *L. pneumophila* in an infected person's urine is considered a reliable measure of the disease.

- The presence of antigen in the urine is a strong indicator of the disease, and a patient may have a positive response for several months following the disease.
- The sensitivity of this test is limited because the only commercially available urinary antigen test detects only serogroup 1 forms of *L. pneumophila*. Fortunately, 80-90 percent of the clinically diagnosed cases are caused by serogroup 1.
- The Centers for Disease Control and Prevention (CDC) recommends the radioimmunoassay (RIA) or enzyme-linked immunosorbent assay (EIA) because the latex antigen (LA) test may incorrectly identify the presence of antigen when in a person without Legionnaires' disease.
- The absence of a positive urinary antigen test is not proof that a patient does not have Legionnaires' disease but merely indicates the absence of antigen in the urine at the time of the test.

**Additional considerations:**

- Frequently, only a convalescent titer has been measured from individuals who have symptoms of the disease. For situations in which these cases are associated with an outbreak of Legionnaires' disease, a single titer of 256 to 1 or higher is generally used as a presumptive indication of disease. Antibody strength is determined by the number of dilutions of serum that elicit a positive antibody response. The reciprocal value of the number of dilutions is the antibody titer. For example, an antibody titer of 256 means a positive antibody test of the patient's serum following serial dilutions of 1:2, then 1:4, then 1:16, etc., until the 1:256 dilution point is reached.
- The indirect fluorescent antibody (IFA) test is the accepted serological diagnostic tool for demonstrating *L. pneumophila* exposure. Another widely used test of antibody response is the enzyme-linked immunosorbent assay (ELISA) method. CDC believes that direct comparison of results between IFA and ELISA is not reliable because there is insufficient data supporting the comparison of the two. However, the ELISA method has gained wide medical acceptance as a useful means of demonstrating exposure to *Legionella* and positive results should be confirmed with an IFA test.

Close this Window


## Appendix II:A-1. Biocides

Traditional oxidizing agents such as chlorine and bromine have been proven effective in controlling Legionnaires' disease bacteria (LDB) in cooling towers.

**Continuous chlorination** at low free residual levels can be effective in controlling LDB growth.

- It is important that the proper oxidant level be established and maintained because free residual chlorine above 1 mg/L may be corrosive to metals in the system and may damage wood used in cooling towers.
- However, free residual levels below 1 mg/L may not adequately control LDB growth.
- Chlorine also combines with organic substances in water to form toxic by-products that are of environmental concern.
- Frequent monitoring and control of pH is essential for maintaining adequate levels of free residual chlorine.
    - Above a pH of 8.0, chlorine effectiveness is greatly reduced.
    - Proper control of pH will maintain the effectiveness of chlorination and minimize corrosion.

**Chloramine** is a weaker disinfectant than chlorine, but is more stable, thereby extending disinfectant benefits throughout a water distribution facility.

- Chloramine is not as reactive as chlorine with organic material in water, thereby producing substantially lower concentrations of disinfection byproducts in the distribution system.
- Because the chloramine residual is more stable and longer lasting than free chlorine, it provides better protection against bacterial regrowth in systems with large storage tanks and dead-end water mains.
- Chloramine, like chlorine, is effective in controlling biofilm, which is a slime coating in the pipe caused by bacteria. Controlling biofilms also tends to reduce coliform concentrations and biofilm-induced corrosion of pipes.

**Bromine** is an effective oxidizing biocide.

- Bromine is frequently added as a bromide salt and generated by reaction with chlorine.
- Bromine's effectiveness is less dependent on the pH of the water than chlorine.
- Bromine is less corrosive and produces less toxic environmental by-products.

**Little information exists on the demonstrated effectiveness of many commercial biocides for preventing LDB growth in actual operations.**

- Australian studies indicate that fentichlor [2,2'-thiobis (4-chlorophenol)] used weekly for four hours at 200 ppm, or bromo-chloro-dimethyl-hydantoin (BCD) in a slow-release cartridge at an initial concentration of 300 ppm are effective in controlling the growth of LDB. The Australian study also indicates that quaternary ammonium compounds, widely used for control of bio-fouling in cooling towers, are not effective in controlling LDB.
- There are no U.S. suppliers of Fentichlor, although the chemical is licensed by the EPA for water treatment in cooling towers.
- Towerbrom 60M™, a chlorotriazine and sodium bromide salt mixture, has been reported to be effective when alternated with BCD for control of LDB in U.S. studies of contaminated cooling towers.


## Appendix III:B-1. Sample Letter from Employer to Employees

**DATE:**

**MEMO TO: ALL EMPLOYEES**

**FROM: MANAGEMENT OFFICIAL**

**SUBJECT: Legionnaires' Disease**

On _____, we were notified that one of the employees of our company had contracted legionellosis, commonly referred to as Legionnaires' disease. The employee is assigned to _____ on _____ shift.

We want to share with you some general information concerning the disease. In addition, we want to tell you what we are currently doing here at _____ to ensure all necessary steps are taken to address health concerns.

Legionellosis, or Legionnaire's disease, is a type of pneumonia caused by Legionnaires' disease bacteria (LDB). Legionnaires' disease is not contagious, and you cannot catch it from another person. The bacteria are common and grow in water. People often receive low-level exposure in the environment without getting sick. Legionellosis usually occurs only when someone who is already susceptible receives concentrated exposure to the bacteria. Persons who are heavy smokers, elderly, or whose ability to resist infection is reduced are more likely to contract Legionnaires' disease than healthy nonsmokers. According to the Centers for Disease Control in Atlanta, there are between 10,000 and 50,000 cases of Legionnaires' disease every year in the U.S. We are cooperating fully with local health officials who are investigating this matter. Most cases of legionellosis are isolated and are not associated with an outbreak. To date, _____ case(s) of the disease has/have occurred among employees in this facility.

To identify any other cases, we will review sick-leave records for the period _____ to _____. Employees who took more than three consecutive days of sick leave will be identified, and we will attempt to determine if any in that group experienced pneumonia-like symptoms (fever, shortness of breath, cough). Those who used three or more consecutive days of sick leave during this period can expect to be contacted by a representative of our company for an interview. If you experienced a pneumonia-like illness in the past two months but used fewer then three consecutive days of sick leave, contact _____ to arrange an interview.

To assure that you are being protected during the interim, we are also instituting a medical surveillance program to identify any new or old cases. Part of this surveillance will be to ask you a few questions about your illness when you call in sick to your supervisor. In addition, we are offering counseling and employee information services. If you would like to take advantage of these services or want more information, contact your manager. For the present, please pay attention to the following important points:

WHAT YOU SHOULD DO NOW:

1. If you are not sick, there is no need for you to see a doctor.
2. If you are now sick with a cough and fever:
   A. See your private doctor or contact _____ to arrange to see a _____ physician.
   B. Tell the physician that you work in a building that may be involved in a Legionnaires' disease outbreak.
   C. If you see a physician, notify _____ so that your illness can be tracked.

If you have any concerns or questions about this investigation, please ask your manager. Your health and safety are of great concern to us, and we will be grateful for your cooperation in this matter. As further information develops we will keep you informed.

Close this Window


## Appendix III:B-2. Sample Information to be Obtained by Interview with Employees Calling in on Sick Leave

Interviewer: _____ Date: _____/_____/_____

**SUPERVISOR SURVEY FORM**

We are screening employee illnesses as a result of our Legionnaire's disease incident. You are not obligated to participate in the survey, but your participation will help you and your fellow workers.

We recommend that you see a physician if you currently have pneumonia-like symptoms such as severe chills, high fever, a cough, and difficult breathing.

Are you currently experiencing these symptoms?

Yes_____ No_____ Prefer not to answer_____

- If the answer to the question is "No," do not complete the rest of this form. Thank you for your cooperation.
- If the answer is "Yes," please read the statement below and complete the bottom half of this form (Employee name, etc).
- If you answer is "Prefer not to answer," please complete ONLY the bottom half of this form (Employee name, etc).

**STATEMENT**

You will be contacted by _____ to obtain additional information necessary to complete our survey. Thank you!

Employee's Name (please print): _____

Work Telephone Number: (____)_____

Home Telephone Number: (____)_____

Shift: Day ___ Swing ___ Graveyard ___ Rotating ___

Branch: _____ Organization Code: _____

Employee's Supervisor (please print): _____

Telephone Number: (____)_____

Date: _____/_____/_____

**PLEASE FORWARD TO _____ BY 10:00 am EACH DAY**

Close this Window


## Appendix III:B-3. Health Surveillance Questionnaire - *Legionellosis*

We at, _____(identify agency) are investigating a cluster of respiratory infections at _____(location), Records show that you took sick leave for three consecutive days or more. We would like to ask a few questions about your work absence.

1. Name: (last)_____, (first)_____

   Age:_____

   Gender: _____

   Work Location: _____

   Home Phone:_____

   Work Phone:_____

2. Dates of absence(s):_____
3. Stated reason for absence:_____

Ask about the following symptoms:

4. Fever: Yes____ No____ Unsure____

   If yes, highest temperature _____.

5. Cough: Yes____ No ____. If yes, was the cough productive? Yes____ No____
6. Headache: Yes_____ No_____
7. Diarrhea: Yes_____ No_____
8. Shortness of breath: Yes ____ No ____
9. Chest pain: Yes ____ No ____
10. Did you see a physician about these symptoms? Yes ___ No ___

    Was a chest x-ray taken? Yes_____ No_____

    Were you tested for legionellosis? Yes_____ No_____ Don't Know_____

    Were you diagnosed as having pneumonia? Yes ___ No ___

    What was the diagnosis?_____

    Physician's name:_____ Phone:_____

    Physician's Address:_____
11. Were you admitted to a hospital? Yes ____ No ____

    If yes, which hospital? _____(name) _____(location)

    Admission Date: _____/_____/_____

    Date released: _____/_____/_____
12. Interviewer:_____

    Date:_____/_____/_____


## Appendix III:B-4. Epidemiological Questionnaire

### Background

Employee's Name: (last)_____, (first) _____

Age: _____

Gender: _____

Home address: (city)_____, (zip)_____

Race/Ethnicity (circle all that apply):

African American, Asian, Caucasian, Latino/Hispanic, Native American, Pacific Islander, Other

Are you currently taking any oral steroid medications?: Yes / No

On what date did you first become ill?: ____ /____ /____

How many days were you ill?: _____

Was anyone else in your family ill?: Yes / No

If Yes, who? _____

What symptoms did they have? _____

Since _____, have any of your family, friends, or coworkers been diagnosed with pneumonia?:

Yes / No. If Yes, who? _____, (relationship)_____

### Work Exposure

*(During the 10 days prior to your illness)*

Job Description: _____

Primary work area: _____

List all areas in _____ building where you spent any time:

| Area | Hours per week |
|---|---|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Did you shower at work?: Yes / No

If Yes, where and how may times per week?: _____

List all places you eat lunch: _____

List all places where you take a break: _____

List all restrooms you use: _____

Do you smoke in the restrooms (or spend "extra" time, i.e., if a lounge is present): Yes / No

If Yes, which restroom(s)?: _____

Did you attend any training courses outside of the building?: Yes / No

If Yes, where were they held? _____

Do you have a second job?: Yes / No

If Yes, what job and where:

_____

Any other places that you have not mentioned where you spent time while on the job?:

_____

**Community Exposure**
*(During the two weeks prior to your illness)*

Did you use any health clubs?: Yes / No

If Yes, which ones?: _____

How many times?: _____

Did you use any hot tubs (whirlpool spas)?: Yes / No

If Yes, list which hot tubs and when used:

_____

Did you attend any churches?: Yes / No

If Yes, where _____

How many times? _____

Have you had any dental work performed?: Yes / No

If Yes, where _____

How many times? _____

Which grocery stores did you go to?: _____

How often? _____

Did you go to the movies?: Yes / No

If Yes, which one? _____

How often? _____

Did you go to any shopping malls?: Yes / No

If Yes, which one(s)? _____

Did you go to any other public places which you feel might be significant (i.e. public meetings, schools etc.)?: Yes / No

If Yes, where? _____

Did you engage in any activities that exposed you to water sprays or mists?: Yes / No

If yes, which one(s)?_____

How often? _____

Did you travel or stay overnight somewhere other than usual residence?: Yes / No

If yes, give cities, dates, and lodging.

_____

_____

_____

Close this Window


## Appendix II:B-5. Physician Survey Questionnaire - *Legionellosis*

We are calling to inform you that _____ is a patient of yours and an employee at _____. He/she has signed a medical release giving us permission to contact you to obtain information about her/his recent illness. This questionnaire will be used to determine if your patient's recent illness could be classified as a pneumonia that may have been caused by exposure to Legionnaires' disease bacteria (LDB) at the workplace.

1. Name of Physician: _____

   Address:_____

   Phone:_____

2. Date of visit(s): (1st)_____ (2nd)_____ (3rd)_____

3. What was the patient's complaint?:_____

| | | | |
|---|---|---|---|
| Cough? | Yes | No | Unknown |
| Short of breath? | Yes | No | Unknown |
| History of fever? | Yes | No | Unknown |

4. Physical Findings: _____

   _____

   Abnormal chest or lung findings: _____

   _____

| | | | |
|---|---|---|---|
| Rales? | Yes | No | Not examined |
| Dyspnea? | Yes | No | Not examined |
| Cyanosis? | Yes | No | Not examined |

   Temperature _____

   Other: _____

5. Chest x-ray done? Yes No

   Findings: _____

6. Sputum culture? Yes No

   Results:_____

   Sputum cultured for *Legionella?* Yes No

   Laboratory:_____

7. Diagnostic testing? Yes No

   Type of test (circle all that apply): Urine Antigen Test, Direct Fluorescent Antibody Serology Tests:

   Indirect Fluorescent Antibody (IFA) _____

   ELISA _____

   Laboratory:_____

8. Diagnosis or impression: _____