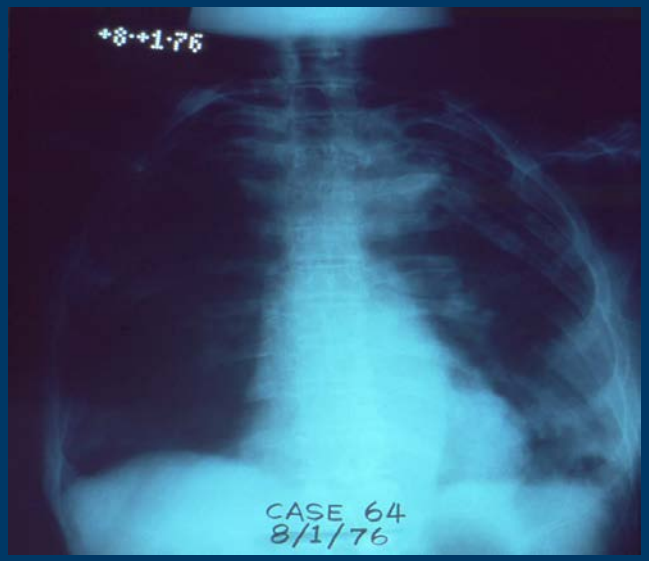
Legionnaires' Disease: Epidemiology and Outbreak Investigation

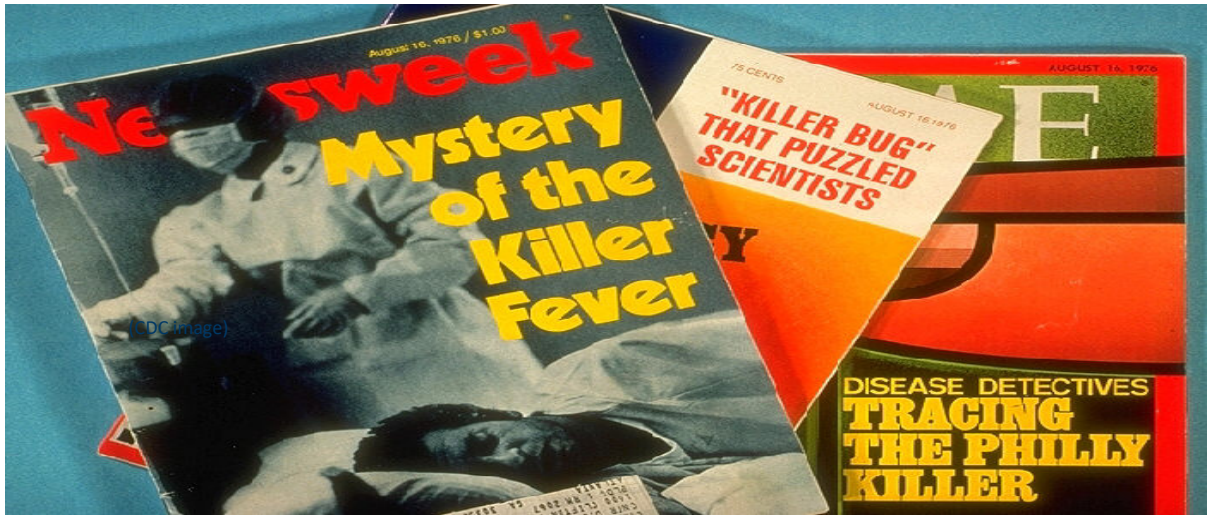


Ellen Laine, JD, MPH
Emerging Infections Unit
Infectious Disease Epidemiology, Prevention and Control Division

DEPARTMENT OF HEALTH

History of Legionnaires' Disease

- First described after July 1976 outbreak at American Legion convention at a Philadelphia hotel
- 221 cases, 34 deaths



(CDC image)

THE DOCTOR'S WORLD

In Philadelphia 30 Years Ago, an Eruption of Illness and Fear

Associated Press

A snapshot from an American Legion convention in Philadelphia in July 1976. Within a month, an infectious disease killed two of these men.

By LAWRENCE K. ALTMAN
Published: August 1, 2006

E-MAIL
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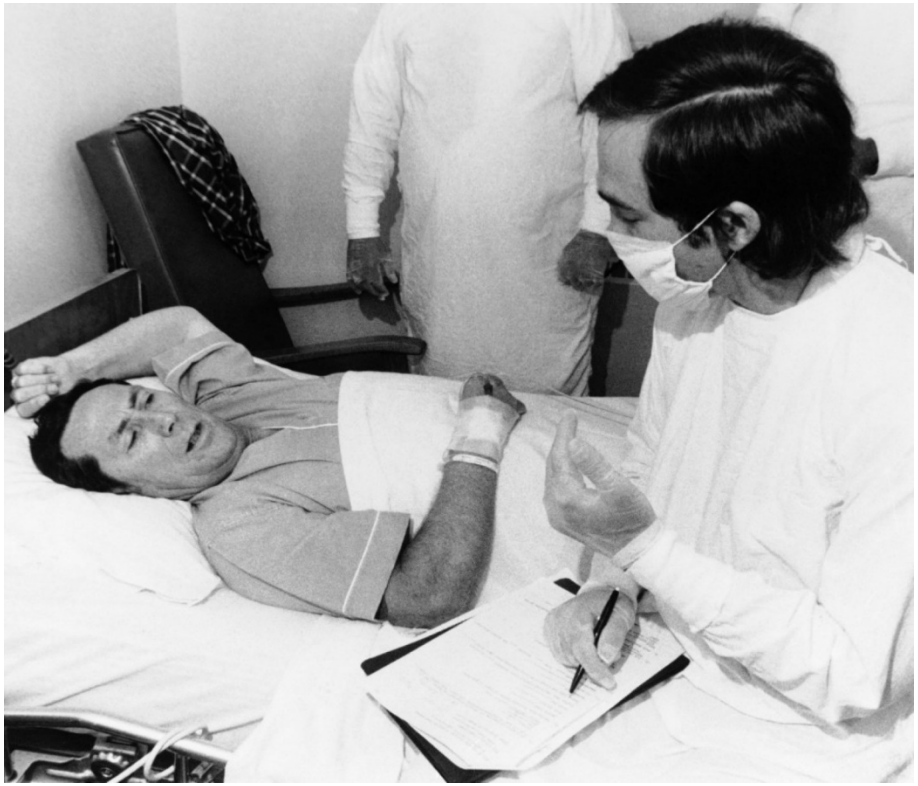
REPRINTS

In late July 1976, American Legionnaires returning from a state convention in Philadelphia began to fall ill with mysterious



Stephen Thacker, right, of the U.S. Center for Disease Control, interviews Thomas Payne in Chambersburg Hospital in Pennsylvania on Aug. 4, 1976. Payne was one of the Legionnaires who became ill after attending a state convention in Philadelphia.

(Associated Press Photo)

Identification of the *Legionella* Bacterium by CDC, 1977

17 Metals Dropped In Tests for Cause Of Legion Disease

By LAWRENCE K. ALTMAN

Special to The New York Times

HARRISBURG, Pa., Aug. 12—The Center for Disease Control in Atlanta said today that 17 metals had been excluded as possible causes of the mysterious legionnaires' disease that has killed 27 persons in Pennsylvania.

At the same time, tests made for one of the chemicals still under suspicion, nickel carbonyl, were declared invalid because of contamination and will have to be repeated before a firm conclusion can be drawn.

The metals ruled out by the Atlanta center, based on tests there and at Georgia Tech, were mercury, arsenic, antimony, cobalt, zinc, copper, iron, silver, tungsten, thallium, gold, osmium, chromium, selenium,

Scientists Link the Legion Disease To a Hitherto Unknown Bacterium

By HAROLD M. SCHMECK Jr.

Special to The New York Times

WASHINGTON, Jan. 18—Federal scientists believe that they have discovered the cause of the mysterious legionnaires' disease that killed 29 persons who were in Philadelphia during an American Legion convention there last July.

The apparent cause was a hitherto unknown bacterium discovered by scientists at the Center for Disease Control in Atlanta. The center is the Federal agency that has been searching for the cause of the mysterious deaths since midsummer.

Announcing the discovery today, Dr. David Sencer, director of the center, said that the bacteria have been "quite definitely associated with the disease." The newly discovered type of bacterium also appears to have been the cause of an earlier mysterious outbreak of fatal pneumonia among patients at St. Elizabeths Hospital here in 1965.

"The present findings provide very strong evidence that the two epidemics were caused by the bacterium," said a report on the discovery released today by the center.

The report said that there had not been time to identify the organism, thus leaving open the question of whether it was something entirely new to medical science or some obscure germ that had previously been seen but not identified with pneumonia in humans.

The source of the bacteria and the manner in which they were transmitted to humans in Philadelphia and in the earlier outbreak at St. Elizabeths Hospital are

Continued on Page D17, Col. 4

LEGION DISEASE LINKED TO MICHIGAN ILLNESSES

Special to The New York Times

WASHINGTON, Feb. 11 — Evidence linking a mysterious outbreak of illness about eight and a half years ago in Michigan to bacteria like those found in the "legionnaires' disease" last summer was reported today by Federal scientists.

The report, from the Center for Disease Control in Atlanta, also gave further evidence that members of the American Legion who became ill after a convention in Philadelphia last July were infected with the still unidentified bacteria. There were 29 deaths.

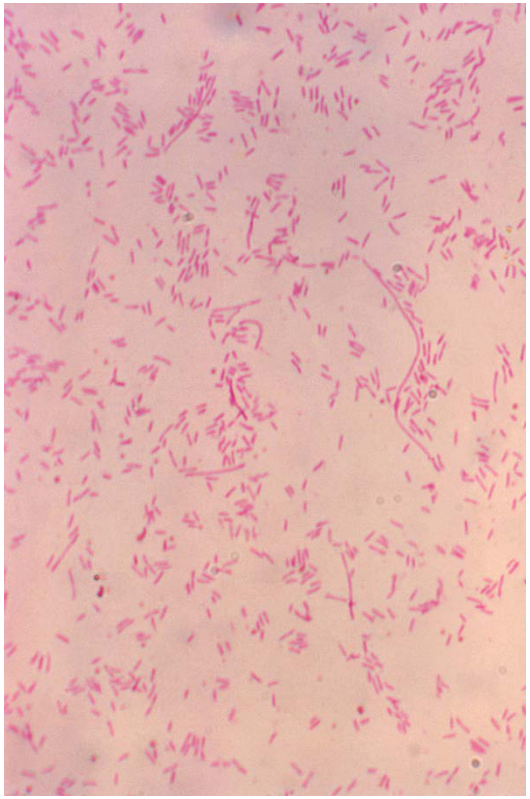
The bacteria were discovered soon after Christmas by scientists at the center who were reviewing evidence from the outbreak among the legionnaires.

Officials at the center said that the bacteria were clearly present in many of the legionnaires' disease victims and had probably caused the illness, though that latter point has not been proved conclusively. It is possible for a germ to be present in an ill person without causing the sickness.

The scientists recently tested blood samples preserved from an outbreak in Pontiac, Mich., and found antibodies to the presumed legionnaires' disease bacteria in those samples, too.

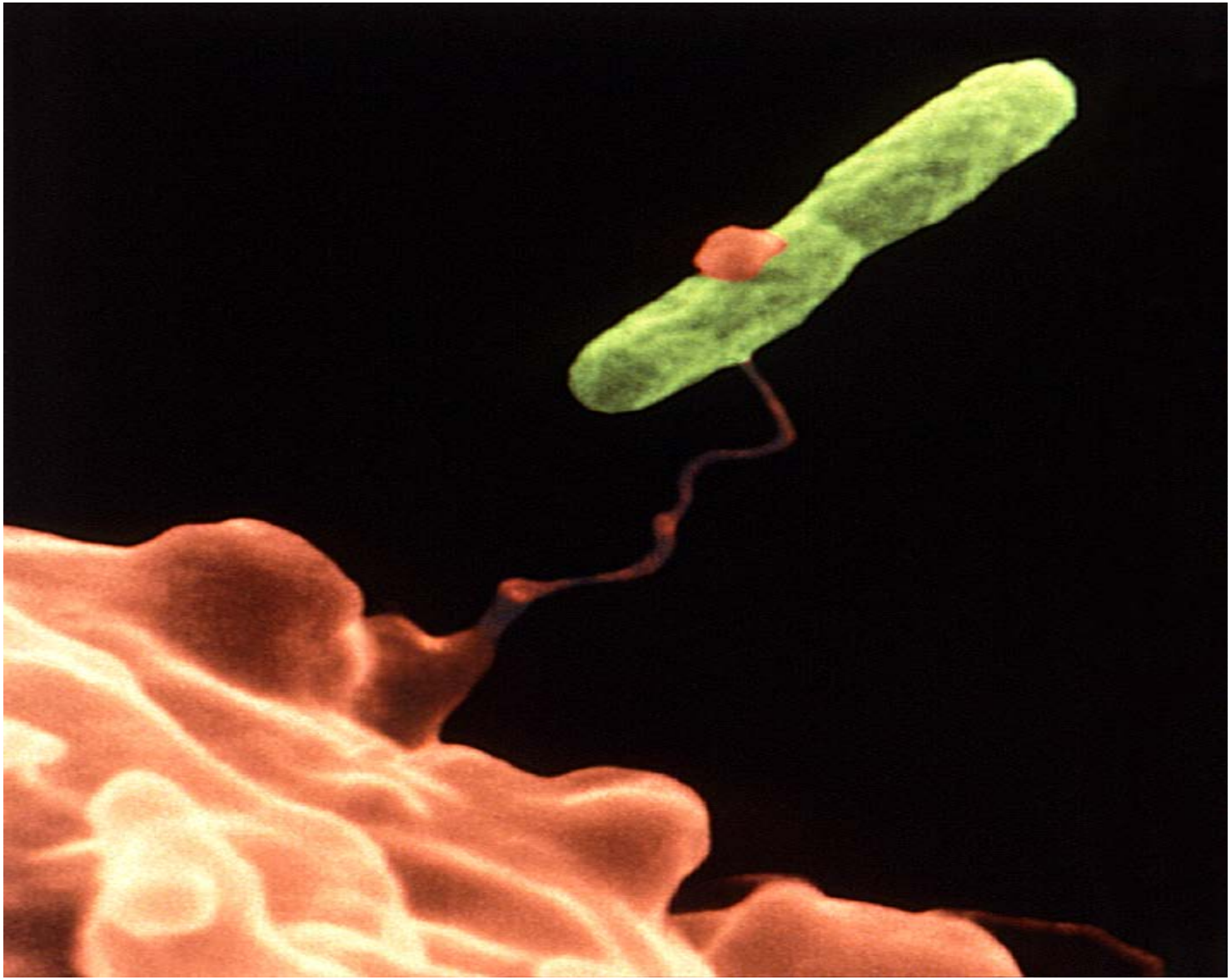
Legionella Bacteria

- **Gram-negative bacteria**
  - **58 species (22 associated with human illness) and many serogroups within species**
  - **Most important clinically: *L. pneumophila*, *L. micdadei*, *L. longbeachae*, *L. dumoffii***
  - ***L. pneumophila* serogroup 1 causes 90% of the diagnosed cases of Legionnaire's disease**



Legionella Bacteria (cont.)

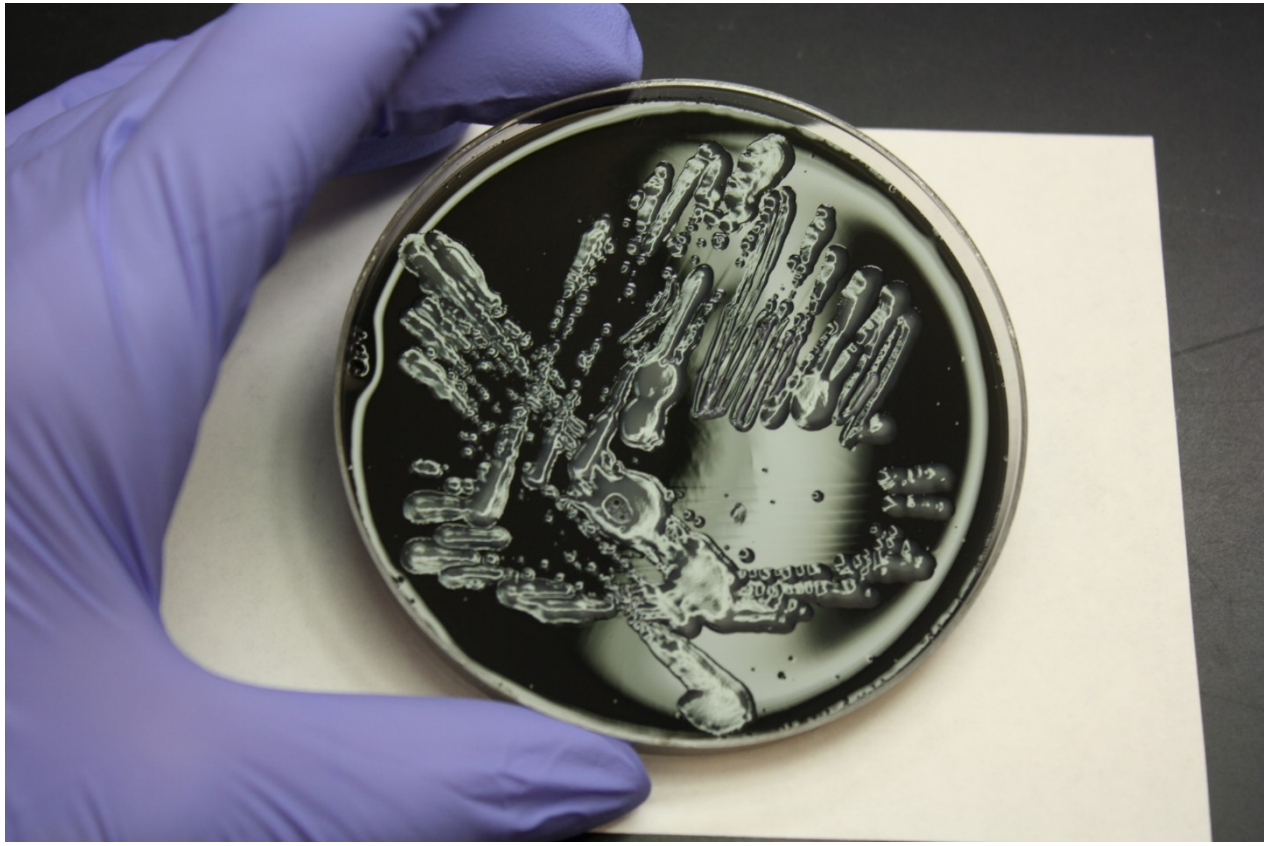
- Very common in water sources; found in freshwater but unlikely to have sufficient quantity and aerosolization for human infection in natural environs
- Can withstand high temperatures - loves temps in 20 – 45 C (68 – 113 F), stagnant environments, sediment, biofilm
- Can exist within free-living amoeba – can multiply and be protected from biocides (similar to how it can live within alveolar macrophages when inhaled)



***Legionella pneumophila* (green) and amoeba (orange)**

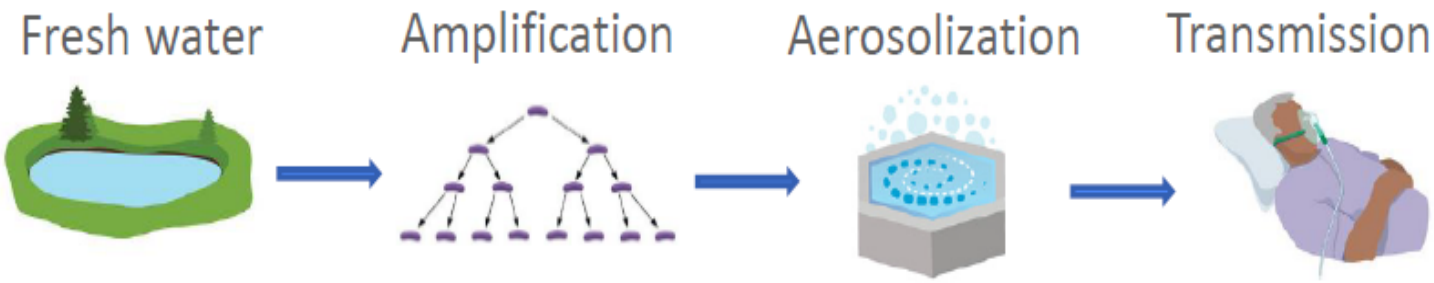
(CDC Public Health Image Library)

Legionella pneumophila



Culture on buffered charcoal yeast extract (BCYE) agar.

Legionella growth and transmission



- Natural reservoir for *Legionella*
- Insufficient quantities to cause disease

- Temperature (77–108ºF)
- Stagnation
- Scale and sediment
- Biofilm
- Protozoa
- Absence of disinfectant

- Showers and faucets
- Cooling towers
- Hot tubs
- Decorative fountains

- Susceptible host
- Adults 50+ years
- Current or former smokers
- People with chronic diseases or weakened immune system

[CDC graphic]

Legionnaires' Disease: Clinical Features

- Fever, chills, fatigue, headache, myalgia, cough, SOB, chest pain, GI symptoms such as nausea, vomiting, diarrhea, confusion
- Clinical and/or radiographic (CXR/CT)evidence of pneumonia
- Often requires hospitalization; can progress to respiratory failure, septic shock, acute kidney failure; IV antibiotics (commonly a respiratory quinolone); discharged on oral antibiotics
- Case fatality rate 5-10%

Legionnaires' Disease: Clinical Features (cont.)

- Attack rate <5%
- Risk factors: age ≥ 50 years, current or former smoker, COPD, diabetes, renal/hepatic failure, cancer, immunosuppression
- Incubation period typically 2-10 days

Legionnaires' Disease: Diagnostic Tests

- Most common diagnostic test is *Legionella* urinary antigen test (detects *L. pneumophila* serogroup 1 infection)
- Culture of lower respiratory specimens (sputum, bronchoalveolar lavage) valuable especially in outbreaks (special media)
- PCR
- Serology as a diagnostic test is disfavored—a single elevated titer at any level is NOT considered diagnostic of Legionnaires'

Legionnaires' Disease: Neonatal/Pediatric

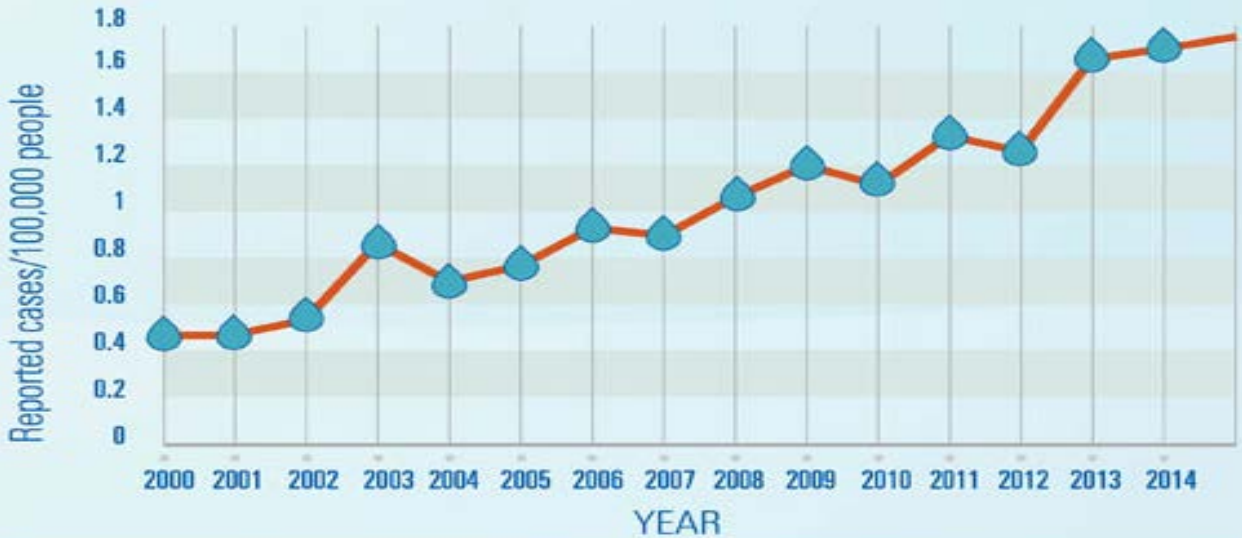
- LD in children is very rare; a few health care-associated outbreaks in the literature
  - Water birth tubs (Texas, UK, Italy, Japan)
  - Neonatal units; one with cold mist ultrasonic humidifier (Cyprus)

Non-Pulmonary *Legionella* Infections

- **2016: 9 year old MN child punctured knee with a garden implement; infection in knee; PCR of synovial fluid positive for *Legionella micdadei***

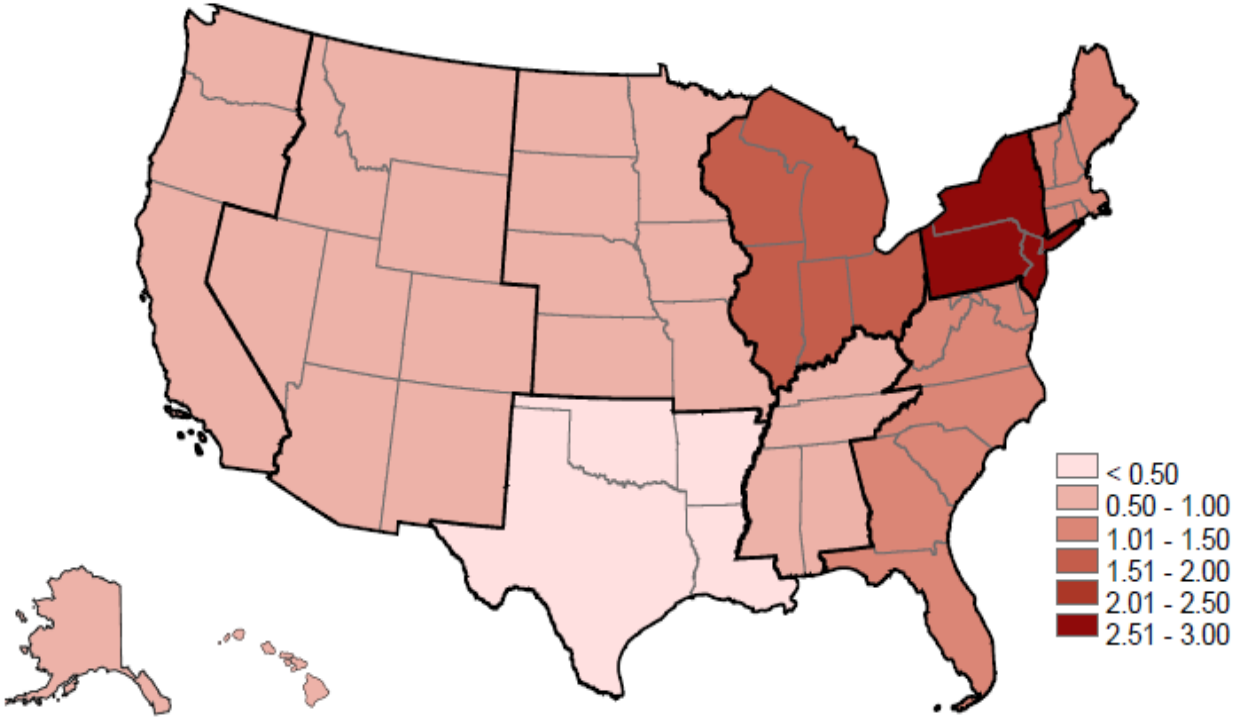
- ***L. micdadei* has also been documented to cause infection of prosthetic joints, soft tissue abscesses, cellulitis, and endocarditis**

Legionnaires' disease is on the rise



SOURCE: National Notifiable Diseases Surveillance System, CDC, 2000–2014.

Average annual rates of reported legionellosis cases per 100,000 population, 2000–2009



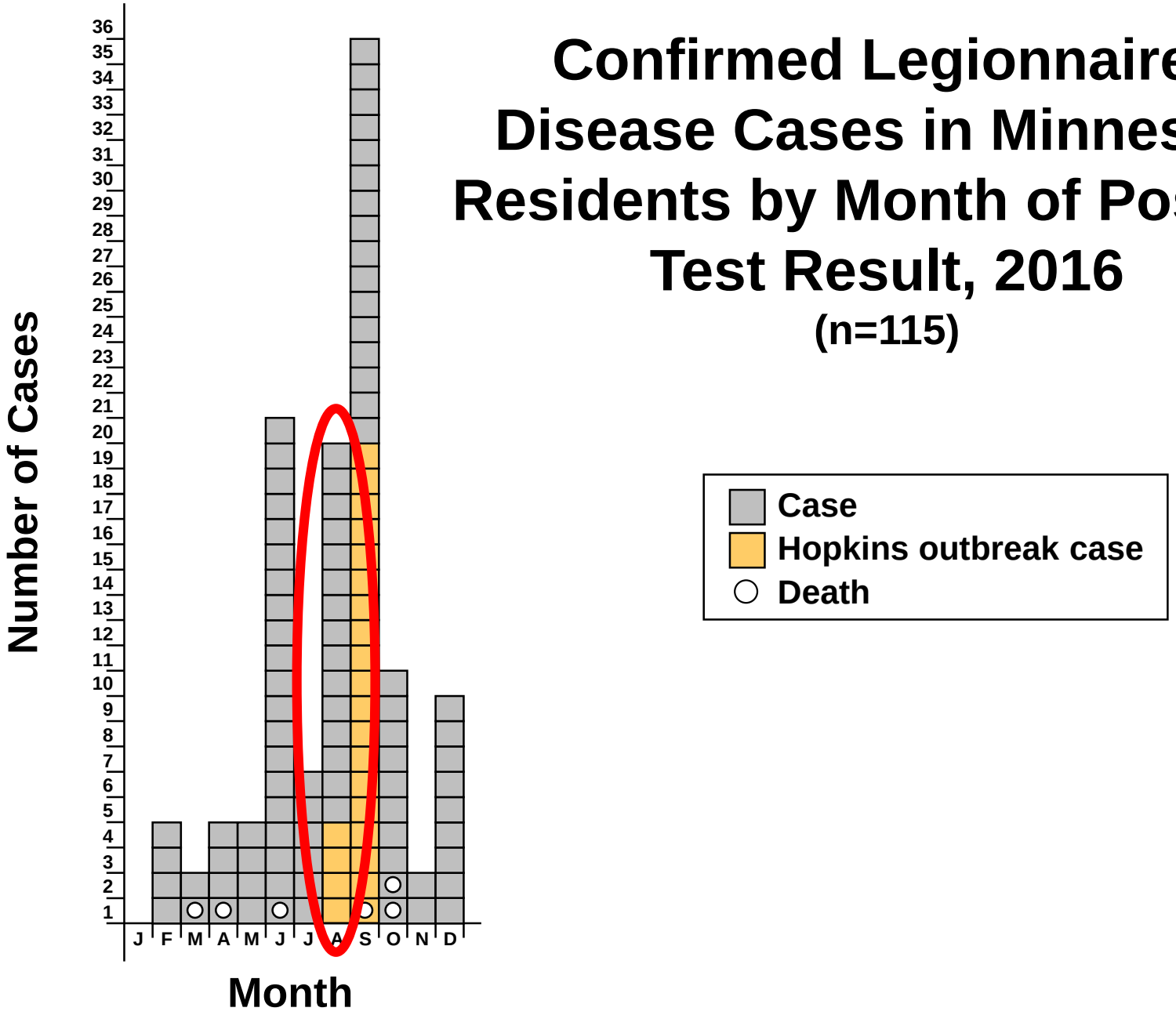
Note: Alaska and Hawaii are part of the Pacific Reporting Area

[CDC graphic]

Confirmed Legionnaires' Disease Cases Minnesota, 2004 – 2016

Confirmed Legionnaires' Disease Cases in Minnesota Residents by Month of Positive Test Result, 2016

(n=115)



www.weather.gov/mpx/Wettest_Year_on_Record

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Wettest Year on Record for the Twin Cities

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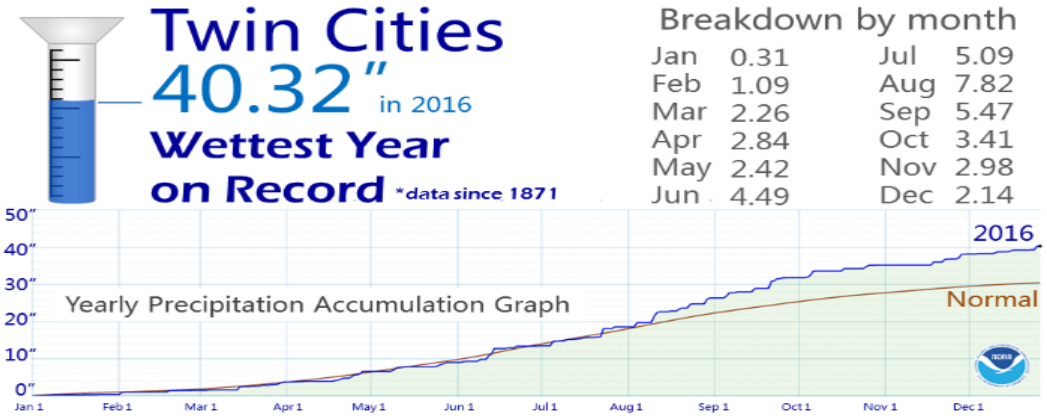
Twin Cities, MN
Weather Forecast Office

Current Hazards | Current Conditions | Radar | Forecasts | Rivers and Lakes | Climate and Past Weather | Local Programs

2016 was the wettest year on record for the Twin Cities area in Minnesota. 40.32 inches of precipitation fell, eclipsing the previous record of 40.15 inches back in 1911. Data goes back to 1871. The top 5 annual precipitation years are listed below, along with a graphic showing the breakdown by month for 2016 and comparison to normal.

2016 - 40.32"
1911 - 40.15"
1965 - 39.94"
1983 - 39.07"
1881 - 39.06"



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PLOS | ONE

Rainfall Is a Risk Factor for Sporadic Cases of *Legionella pneumophila* Pneumonia

Carolina Garcia-Vidal[1,2]*, Maria Labori[1], Diego Viasus[1], Antonella Simonetti[1], Dolors Garcia-Somoza[3], Jordi Dorca[4], Francesc Gudiol[1,2], Jordi Carratalà[1,2]

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Abstract

It is not known whether rainfall increases the risk of sporadic cases of *Legionella* pneumonia. We sought to test this hypothesis in a prospective observational cohort study of non-immunosuppressed adults hospitalized for community-acquired pneumonia (1995–2011). Cases with *Legionella* pneumonia were compared with those with non-*Legionella* pneumonia. Using daily rainfall data obtained from the regional meteorological service we examined patterns of rainfall over the days prior to admission in each study group. Of 4168 patients, 231 (5.5%) had *Legionella* pneumonia. The diagnosis was based on one or more of the following: sputum (41 cases), antigenuria (206) and serology (98). Daily rainfall average was 0.556 liters/m^2 in the *Legionella* pneumonia group vs. 0.328 liters/m^2 for non-*Legionella* pneumonia cases ($p = 0.04$). A ROC curve was plotted to compare the incidence of *Legionella* pneumonia and the weighted median rainfall. The cut-off point was 0.42 (AUC 0.54). Patients who were admitted to hospital with a prior weighted median rainfall higher than 0.42 were more likely to have *Legionella* pneumonia (OR 1.35; 95% CI 1.02–1.78; $p = .03$). Spearman Rho correlations revealed a relationship between *Legionella* pneumonia and rainfall average during each two-week reporting period (0.14; $p = 0.003$). No relationship was found between rainfall average and non-*Legionella* pneumonia cases (−0.06; $p = 0.24$). As a conclusion, rainfall is a significant risk factor for sporadic *Legionella* pneumonia. Physicians should carefully consider *Legionella* pneumonia when selecting diagnostic tests and antimicrobial therapy for patients presenting with CAP after periods of rainfall.

Citation: Garcia-Vidal C, Labori M, Viasus D, Simonetti A, Garcia-Somoza D, et al. (2013) Rainfall Is a Risk Factor for Sporadic Cases of *Legionella pneumophila* Pneumonia. PLoS ONE 8(4): e61036. doi:10.1371/journal.pone.0061036

Editor: Yousef Abu Kwaik, University of Louisville, United States of America

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Competing Interests: The authors have declared that no competing interests exist.

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Introduction

Legionella pneumophila has been increasingly recognized as a significant cause of sporadic and epidemic community-acquired pneumonia (CAP) in all age groups and in both healthy and immunosuppressed hosts [1–6]. *Legionella* pneumonia (LP) is particularly frequent among patients who require admission to an intensive care unit (ICU) [7,8]. Moreover, *Legionella pneumophila* is the pathogen most frequently associated with early failure caused by inappropriate empirical therapy for pneumonia [9]. In to sporadic infection have been much more difficult to identify. LP has been related with summertime, especially when humid weather is present [14]. Some researchers have hypothesized that rainfall could be associated with a higher incidence of LP [15], although data supporting this hypothesis are scarce. Moreover, the available information comes from passive surveillance systems and mixes sporadic and epidemic cases. Significantly, no studies have evaluated the impact of rainfall on the incidence of LP compared with the incidence of pneumonia caused by other microorganisms.

We aimed to determine whether sporadic cases of *Legionella*

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Increased rainfall is associated with increased risk for legionellosis

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(*Accepted 4 October 2006; first published online 23 November 2006*)

SUMMARY

Legionnaires' disease (LD) is caused by *Legionella* species, most of which live in water. The Mid-Atlantic region experienced a sharp rise in LD in 2003 coinciding with a period of record-breaking rainfall. To investigate a possible relationship, we analysed the association between monthly legionellosis incidence and monthly rainfall totals from January 1990 to December 2003 in five Mid-Atlantic states. Using negative binomial model a 1-cm increase in rainfall was associated with a 2·6% (RR 1·026, 95% CI 1·012–1·040) increase in legionellosis incidence. The average monthly rainfall from May to September 1990–2002 was 10·4 cm compared to 15·7 cm from May to September 2003. This change in rainfall corresponds to an increased risk for legionellosis of approximately 14·6% (RR 1·146, 95% CI 1·067–1·231). Legionellosis incidence increased during periods of increased rainfall; identification of mechanisms that increase exposure and transmission of *Legionella* during rainfall might lead to opportunities for prevention.

INTRODUCTION

Legionellosis, an infection caused by the intracellular bacterial pathogen, *Legionella* (most commonly as severe pneumonia, results in 8000–18 000 hospitalizations for US residents annually with a case-fatality rate of ~8% [1, 2]. Most of what we know about

Reportable Diseases, MN Rule 4605.7040

Diseases Reportable to the Minnesota Department of Health

651-201-5414 or 1-877-676-5414 24 hours a day, 7 days a week

REPORT IMMEDIATELY BY TELEPHONE

Anthrax (*Bacillus anthracis*) ( )
Botulism (*Clostridium botulinum*)
Brucellosis (*Brucella* spp.) ( )
Cholera (*Vibrio cholerae*) ( )
Diphtheria (*Corynebacterium diphtheriae*) ( )
Free-living amebic infection ( )
(Including at least: *Acanthomoeba* spp., *Naegleria fowleri*, *Balamuthia* spp., *Sappinia* spp.)
Hemolytic uremic syndrome ( )
Measles (rubeola) ( )
Meningococcal disease (*Neisseria meningitidis*) (invasive) ( )
Middle East Respiratory Syndrome (MERS) ( )
Orthopox virus ( )
Plague (*Yersinia pestis*) ( )
Poliomyelitis ( )
Q fever (*Coxiella burnetii*) ( )
Rabies (animal and human cases and suspected cases)
Rubella and congenital rubella syndrome ( )
Severe Acute Respiratory Syndrome (SARS) ( )
Smallpox (variola) ( )
Tularemia (*Francisella tularensis*) ( )
Unusual or increased case incidence of any suspect infectious illness ( )
Viral hemorrhagic fever ( )
(including but not limited to Ebola virus disease and Lassa fever)

REPORT WITHIN ONE WORKING DAY

Amebiasis (*Entamoeba histolytica/dispar*)
Anaplasmosis (*Anaplasma phagocytophilum*)
Arboviral disease
(including, but not limited to, La Crosse encephalitis, eastern equine encephalitis, western equine encephalitis, St. Louis encephalitis, West Nile virus disease, Powassan virus disease, and Jamestown Canyon virus disease)
Babesiosis (*Babesia* spp.)
Blastomycosis (*Blastomyces dermatitidis*)
Campylobacteriosis (*Campylobacter* spp.) ( )
Carbapenem-resistant Enterobacteriaceae (CRE) ( )
Cat scratch disease (infection caused by *Bartonella* species)
Chancroid (*Haemophilus ducreyi*)
Chikungunya virus disease
Chlamydia trachomatis infections
Coccidioidomycosis
Cronobacter sakazakii in infants under one year of age ( )
Cryptosporidiosis (*Cryptosporidium* spp.) ( )
Cyclosporiasis (*Cyclospora* spp.) ( )
Dengue virus infection
Diphyllobothrium latum infection
Ehrlichiosis (*Ehrlichia* spp.)
Encephalitis (caused by viral agents)
Enteric *Escherichia coli* infection ( )
(*E. coli* O157:H7, other Shiga toxin-producing *E. coli*, enterohemorrhagic *E. coli*, enteropathogenic *E. coli*, enteroinvasive *E. coli*, enteroaggregative *E. coli*, enterotoxigenic *E. coli*, or other pathogenic *E. coli*)
Giardiasis (*Giardia intestinalis*)
Gonorrhea (*Neisseria gonorrhoeae* infections)
Haemophilus influenzae disease (all invasive disease) ( )
Hantavirus infection
Hepatitis (all primary viral types including A, B, C, D, and E) ( )
Histoplasmosis (*Histoplasma capsulatum*)
Human immunodeficiency virus (HIV) infection, including Acquired Immunodeficiency Syndrome (AIDS) ( )
Influenza ( )
(unusual case incidence, critical illness, or laboratory-confirmed cases)
Kawasaki disease
Kingella spp. (invasive only) ( )
Legionellosis (*Legionella* spp.) ( )
Leprosy (Hansen's disease) (*Mycobacterium leprae*)
Leptospirosis (*Leptospira interrogans*)
Listeriosis (*Listeria monocytogenes*) ( )
Lyme disease (*Borrelia burgdorferi*, and other *Borrelia* spp.)
Malaria (*Plasmodium* spp.)
Meningitis (caused by viral agents)
Mumps ( )
Neonatal sepsis ( )
(bacteria isolated from a sterile site, excluding coagulase-negative *Staphylococcus*) less than seven days after birth
Pertussis (*Bordetella pertussis*) ( )
Psittacosis (*Chlamydophila psittaci*)
Retrovirus infections
Salmonellosis, including typhoid (*Salmonella* spp.) ( )
Shigellosis (*Shigella* spp.) ( )
Spotted fever rickettsiosis
(*Rickettsia* spp. infections, including Rocky Mountain spotted fever)
Staphylococcus aureus ( )
(only vancomycin-intermediate *Staphylococcus aureus* (VISA), vancomycin-resistant *Staphylococcus aureus* (VRSA), and death or critical illness due to community-associated *Staphylococcus aureus* in a previously healthy individual)
Streptococcal disease - invasive disease caused by Groups A and B streptococci and *S. pneumoniae* ( )
Streptococcal disease - non-invasive *S. pneumoniae*
(urine antigen laboratory-confirmed pneumonia)
Syphilis (*Treponema pallidum*) ( )
Tetanus (*Clostridium tetani*)
Toxic shock syndrome ( )
Toxoplasmosis (*Toxoplasma gondii*)
Transmissible spongiform encephalopathy
Trichinosis (*Trichinella spiralis*)
Tuberculosis (*Mycobacterium tuberculosis* complex) ( )
(pulmonary or extrapulmonary sites of disease, including clinically diagnosed disease). Latent tuberculosis infection is not reportable.
Typhus (*Rickettsia* spp.)
Unexplained deaths and unexplained critical illness
(possibly due to infectious cause) ( )
Varicella (chickenpox) ( )
Vibrio spp. ( )
Yellow fever
Yersiniosis, enteric (*Yersinia* spp.) ( )
Zika virus disease ( )
Zoster (shingles) ( )
(all cases <18 years old; unusual case incidence/complications regardless of age)

SENTINEL SURVEILLANCE*

*Diseases reportable through sentinel surveillance are reportable based on the residence of the patient or the specific health care facility. Sentinel surveillance is not statewide reporting.

Staphylococcus aureus ( )
Candidemia (*Candida* spp.) (blood isolates only) ( )
Carbapenem-resistant *Acinetobacter* spp. (CRA), and *Pseudomonas aeruginosa* (CR-PA) ( )
Clostridium difficile ( )
Severe Acute Respiratory Illness ( )
Respiratory syncytial virus (RSV)

FOOTNOTES

( ) Submission of clinical materials required. Submit isolates or, if an isolate is not available, submit material containing the infectious agent in the following order of preference: a patient specimen; nucleic acid; or other laboratory material. Call the MDH Public Health Laboratory at 651-201-4053 for instructions.

( ) Invasive disease only: isolated from a normally sterile site, e.g.: blood, CSF, joint fluid, etc.

( ) In the event of SARS or another severe respiratory outbreak, also report cases of health-care workers hospitalized for pneumonia or acute respiratory distress syndrome.

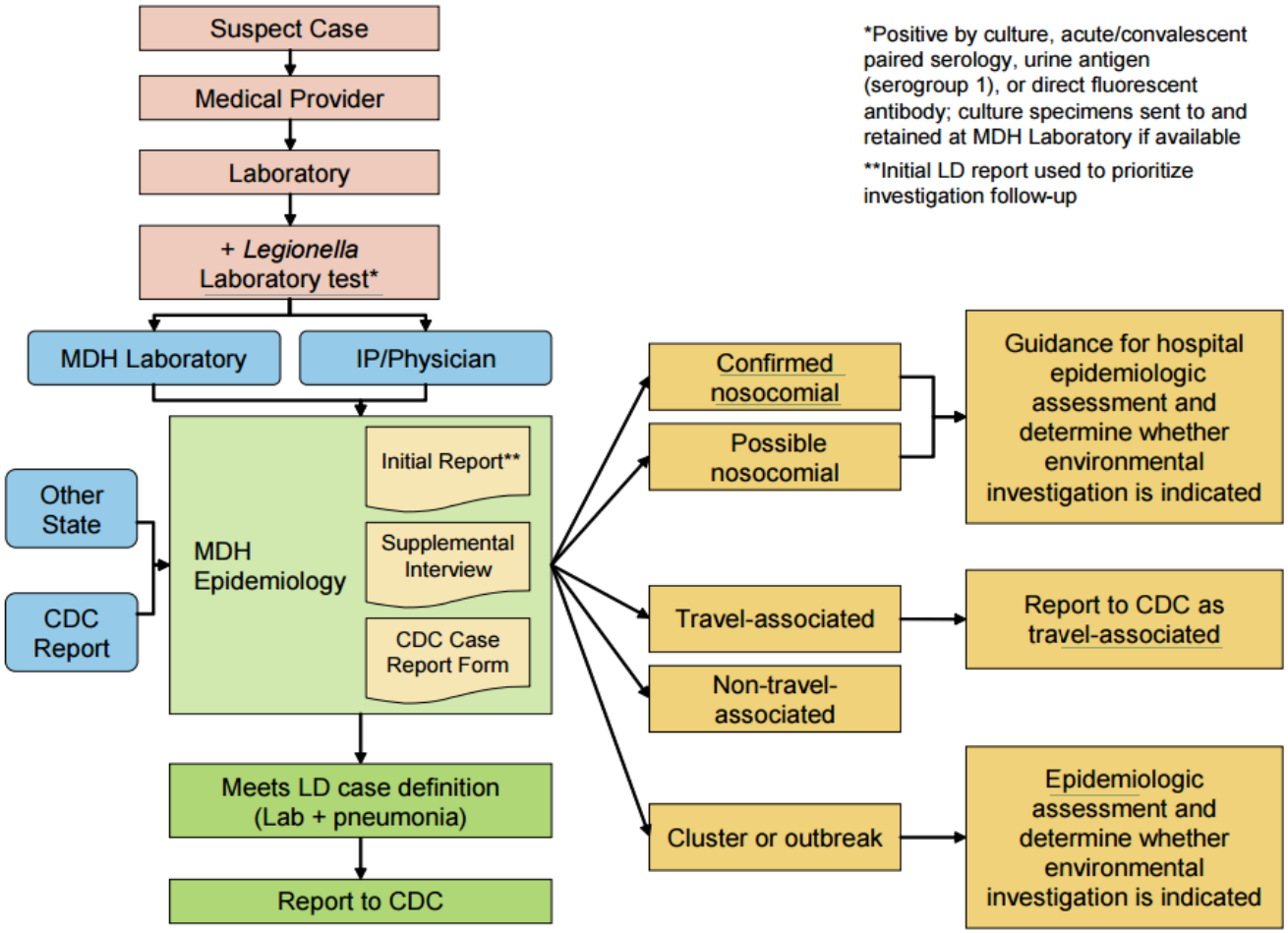
( ) Also report a pregnancy in a person with Zika; or a person chronically infected with hepatitis B, HIV, or syphilis.

TO REPORT

- For diseases that require immediate reporting call: 651-201-5414 or 1-877-676-5414.
- Report forms can be downloaded at: http://www.health.state.mn.us/diseasereport

MDH Minnesota Department of Health
Infectious Disease Epidemiology, Prevention and Control
Phone: 651-201-5414 or 1-877-676-5414 | Fax: 651-201-5743
www.health.state.mn.us/diseasereport

Figure 1. Legionnnaires' Disease (LD) Reporting and Follow-up, Minnesota



*Positive by culture, acute/convalescent paired serology, urine antigen (serogroup 1), or direct fluorescent antibody; culture specimens sent to and retained at MDH Laboratory if available

**Initial LD report used to prioritize investigation follow-up

Interviewer: ____ Date/Time: _____

MDH *LEGIONELLA* CASE INTERVIEW FORM

Patient Contact Information	
Name: ☐ M ☐ F	**DOB/Age:**
Phone Number:	

Surrogate Info, if applicable	
Name:	
Phone Number:	
Relationship to Patient:	**Why Used Surrogate:**

Hello, my name is _____ and I'm calling from the Minnesota Department of Health. I'm calling about your recent infection with *Legionella* (Legionellosis/Legionnaires' Disease). Legionellosis is a reportable disease under state law, which means that healthcare providers must report cases to MDH. We follow up with each case by phone to ask some routine questions, so that we can determine if there is a public health concern. 'd like to ask you a few questions about your exposures and travel during the 10 days before you got sick. All information we collect about your health is private; the only persons who will have access to this information will be public health staff at MDH. Under no conditions will your name be released to anyone else without your written permission. You do not have to answer any of the questions, but your cooperation is appreciated. It takes about 5 minutes. If not now, when would be a good time for me to call back? Tennessen done? ☐ Yes ☐No

I have that your first symptoms started on _____. Is this correct? ☐ Yes ☐No

If NO, when did your symptoms first start? _____

EXPOSURE INFORMATION

I'd like to ask you some questions about your travel and exposures during the 10 days BEFORE you got sick. The time period I'm asking about is between _____ and _____. During this 10 day period did you:

Reported Cases, MN, 2016

- 115 confirmed cases (additional 5 suspected cases by PCR only)
- Pneumonia: 100%
- Hospitalized: 91% (median 6d, range 1-39 d)
- ICU admit: 38%
- Mechanical ventilation: 22%
- Died: 6 (5%)
- Male: 72%
- Age ≥50 years: 82% (median 60y, range 23-97y)
- Onset June – September: 70%
- Metro area resident: 63%
- Sporadic (not part of an outbreak/cluster): 78%

Pontiac Fever

- Form of legionellosis
- Milder, flu-like illness rarely requiring treatment
- Attack rate 85%
- Not restricted to high risk groups
- Incubation period 1-3 days (may be an inflammatory response to *Legionella* endotoxin vs. true infection)
- Generally only identified in the context of an outbreak

Minnesota Outbreaks 1988-2000

Year	*Outbreak Type*	*Illness Type*	*Source*	*Setting*	*No. Cases*
1988	Recreational Water	PF	Spa Pool	Hotel	28
1995	Cooling Tower	LD	Hospital Cooling Tower	Community	27
1995	Cooling Tower	LD	Hospital Cooling Tower	Community	20
2000	Other	PF	Plant lagoon/power washer	Sugar beet plant	15
2000	Recreational Water	PF	Spa Pool	Hotel	51

***PF* = Pontiac Fever; *LD* = Legionnaires' Disease**

Minnesota Outbreaks 2001-2015

Year	*Outbreak Type*	*Illness Type*	*Source*	*Setting*	*No. Cases*
2001	Drinking Water	LD	-	Hospital	2
2005	Recreational Water	PF	Spa Pool	Private Home	3
2011	Recreational Water	PF	Spa Pool	Membership Club	48
2012	Recreational Water	PF	Spa Pool	Private Home	4
2013-14	Other	LD	Decorative water wall	Casino	2
2015	Premise Plumbing	LD	Dish sprayer	Restaurant	2

***PF* = Pontiac Fever; *LD* = Legionnaires' Disease**

HOT
NO REC
SE
1-800-431

Flint, Michigan 2014-2015

- Corrosive damage to water distribution infrastructure as a result of water supply change created conditions amenable to *Legionella* proliferation in plumbing
- Genesee County noted a large jump in Legionnaires' disease cases after the water supply changed—over 87 cases in 17 months vs. about 10 cases annually before
- Rare example of a community water systemwide source vs. a building water system source

Challenges with Legionnaires' Disease Outbreak Detection

- Most common diagnostic method is the Legionella urinary antigen test
  - Culture-independent diagnostic method
- Cultures are rarely performed, and isolates rarely available to subtype to see if cases may be related
- Epi interviews of cases may sometimes clearly reveal an outbreak location (such as common hotel or workplace) but cooling tower cases can be dispersed through a community

www.coolingtowerproducts.com/blog/how-cooling-towers-work-diagram-pictures-2015.htm

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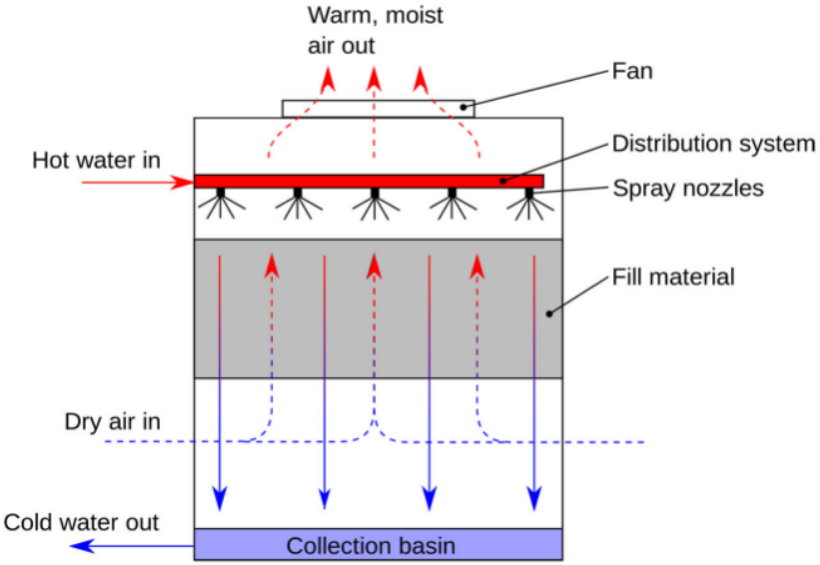
How Cooling Towers Work

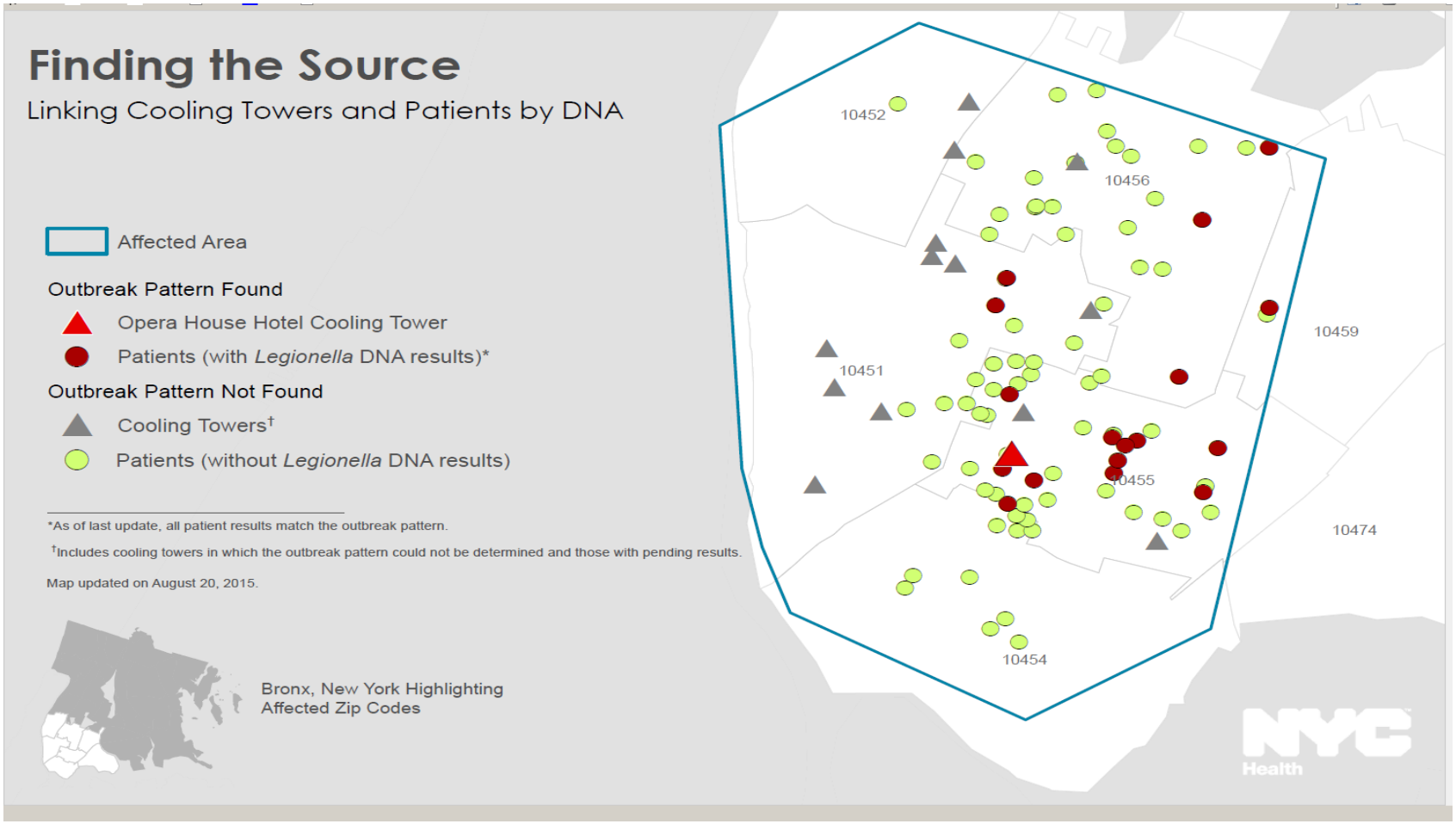


There are many different types of cooling towers but the **cooling tower working priciples** stay pretty much the same. Most cooling towers work based on the principle of "*evaporative cooling*".

What is Evaporative Cooling? Evaporative cooling is the process where warm water from an industrial process is pumped up to the top of the cooling tower where the water distribution system is. The water then gets distributed by cooling tower nozzles to the wet deck. At the same time, air is being drawn through the air-inlet louvers forcing water to evaporate. Evaporation causes the heat to be removed from


SPX
Marley

Bronx Outbreak, 2015



Implicated cooling tower atop Opera House Hotel, South Bronx, NYC.

Photo: James Keivom/New York Daily News

Hopkins Cluster Detected

- On 9/7/16, noted that 4 recently reported cases all either lived or worked in Hopkins, within a 1.7 mile area (the entire suburb covers a 4 square mile area; pop. 18,000)
- No single common location (residence, workplace or other location visited) within Hopkins was evident
- A review of surveillance data revealed no cases over the prior 4 years reported living or working in Hopkins
- On 9/9/16 MDH launched an outbreak investigation and alerted health care providers, clinical labs, and the public

MDH Minnesota Department of Health

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- News and Announcements Home
- 2016 news releases
- 2015 news releases
- 2014 news releases
- 2013 news releases
- Audio Clips
- Podcasts
- Public Service Announcements
- Resources for reporters
- Information Officers

News Release
September 9, 2016

Contact information

Legionnaires' disease investigation underway

The Minnesota Department of Health is working with Hennepin County Public Health officials to investigate a cluster of five confirmed cases of Legionnaires' disease in people who live or work in Hopkins, Minn.

The people became ill between Aug. 4 and Sept. 1. Three are currently hospitalized, and two others were hospitalized and have recovered. The patients are all over the age of 50.

MDH and Hennepin
Legionnaires' diseas
sources containing
you cannot get it by
been linked to cooli
misters, decorative

Minnesota typically
cases have been re
increase in cases in
this year.

Most people expose
over the age of 50,
weakened immune
conditions, are at in
Legionnaires' diseas

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MDH news releases are posted on Facebook, Twitter, and are subscribable via email and RSS feed. See the links above.

MLS Laboratory Update: Heightened Surveillance for Legionellosis in the Hopkins, MN Area

September 9, 2016

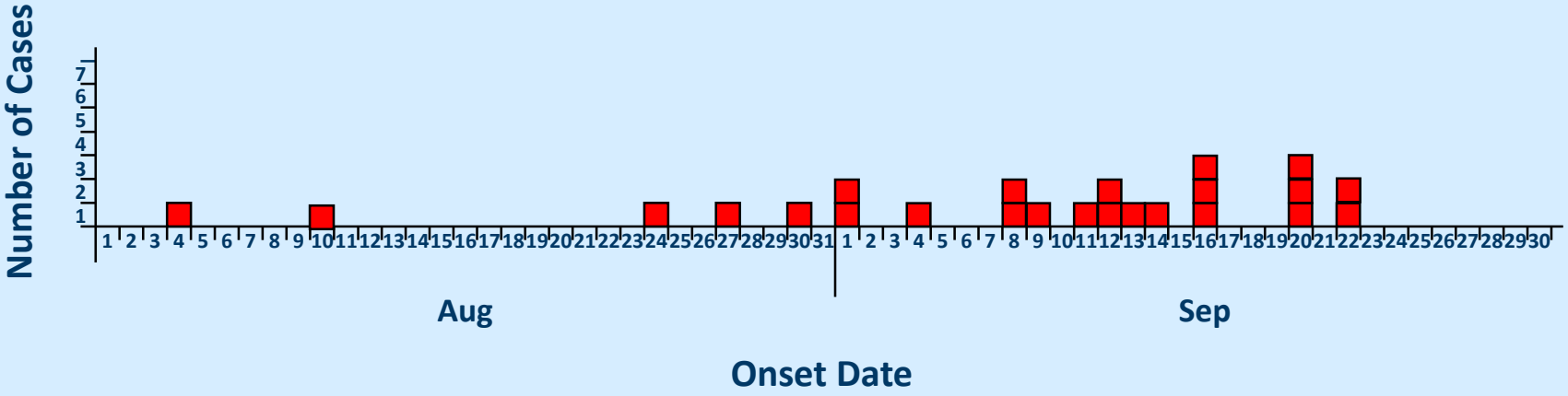
Purpose of this Message: To inform MLS Laboratories that the Minnesota Department of Health (MDH) is investigating a cluster of 5 confirmed cases of Legionnaires' disease.

Action Items: None.

Background: The Minnesota Department of Health (MDH) has been informed of five confirmed cases of legionellosis with onset between August 4th and September 1st, who either work or reside within a 2 mile radius in Hopkins, MN.

Symptoms of legionellosis include: muscle aches, chills, shortness of breath, headache, fatigue, loss of appetite, and coughing. These symptoms are often followed by high fever (102-105°F), pneumonia, and occasionally abdominal pain and/or diarrhea.

Onset of Illness of Confirmed Legionnaires' Disease Cases with Exposure to Hopkins, 2016 (n=24)



Summary of 24 Outbreak Cases

- **Epidemiologic Case Definition:**
  Illness onset since August 1, 2016; met CDC/CSTE case definition for Legionnaires' disease; and lived, worked, or spent time in Hopkins during 10 days prior to illness onset
- **59 years old median age (range, 29 to 97 years)**
- **71% male (17/24)**
- **75% hospitalized (18/24)**
- **25% required mechanical ventilation (6/24)**
- **4% died (1/24)**

Summary of 24 Outbreak Cases (cont.)

- All cases were positive by *Legionella* urinary antigen test; four also had cultures of respiratory samples grow *Legionella pneumophila* serogroup 1 (Lp1); these four isolates were indistinguishable genetically

- 58% lived in Hopkins (14/24)
- 29% worked in Hopkins (7/24)
- 13% visited Hopkins (3/24)

Hopkins Locations for Suspect Case Interviews

(to use in conjunction with regular Legionella Interview Form)

Please get dates asking about 10 days before onset date. If they are able to look at check register, date book, debit or credit card statement, to better pinpoint date, encourage that. Please write Yes/No and any details next to location name.

1. Grocery stores
    a. Driskill's Downtown Market, 25 - 11th Ave N, Hopkins
    b. Casablanca Market, 716 - 11th Ave S, Hopkins
    c. Other(s):

2. Restaurants
    a. Wendy's, 303 -11th Ave S, Hopkins
    b. Jersey Mike's Subs, 525 Blake Rd. N, Hopkins
    c. Arbys, 140 Blake Rd., Hopkins
    d. Five Guys, 525 Blake Rd., Hopkins
    e. Taco Bell, 919 Cambridge St, Hopkins
    f. Other(s):

3. Gas stations
    a. Holiday, 300- 11th Ave S, Hopkins
    b. McCoy gas station, 1102 -2nd St NE, Hopkins
    c. Other(s):

4. Other places
    a. Luther Hopkins Honda, 250 - 5th Ave S
    b. SuperValu warehouses, Hopkins
    c. Cargill corporate campus, 9320 Excelsior Blvd, Hopkins
    d. American Legion, 10 -12th Ave S, Hopkins
    e. Farmer's Market, 16-9th Ave S, Hopkins (open Saturdays only)
    f. Center Drug, 913 Hopkins Center, Hopkins
    g. Citizens Banks, 10843 Excelsior Blvd., Hopkins
    h. Other(s):

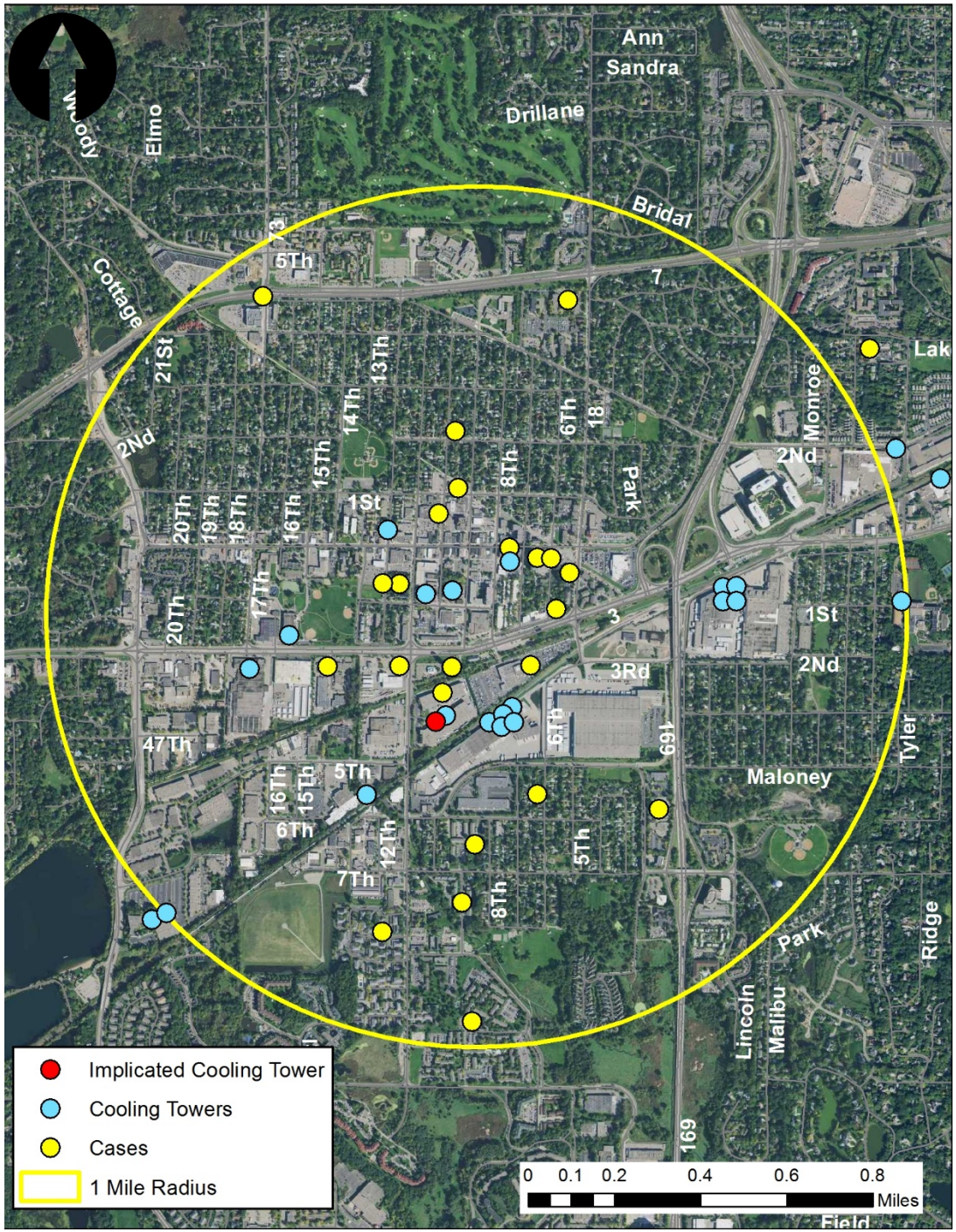
5. Apartment buildings, condos, townhomes, or other people's houses (other than patient's own):

Environmental Investigation

- Hennepin County and City of Hopkins worked with MDH to identify and evaluate potential sources of aerosolized water including cooling towers, fountains, grocery store misters
- The epidemiology of cases continued to indicate no single common location; some cases did not even enter any buildings while in Hopkins
- This suggested a source capable of aerosolizing water over at least one mile; the investigation turned to cooling towers

Environmental Investigation (cont.)

- Cooling tower identification was extremely challenging due to lack of systematic info on locations; not regulated in MN
- Identified using a variety of means including Google maps, info from city workers, and phone tips from the public
- Focused on the 1 mile radius around the geographic mean center of case locations


Ann
Sandra
Drillane
Bridal
Elmo
Woody
Cottage
21St
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5Th
13Th
14Th
15Th
16Th
18Th
19Th
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17Th
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8Th
6Th
18
Park
Monroe
2Nd
Lak
1St
2Nd
3Rd
3
7
47Th
16Th
15Th
6Th
5Th
12Th
7Th
8Th
5Th
169
Maloney
Tyler
Park
Ridge
Lincoln
Malibu
Field
Implicated Cooling Tower
Cooling Towers
Cases
1 Mile Radius
0 0.1 0.2 0.4 0.6 0.8
Miles

Environmental Investigation (cont.)

- Contractors from the Institute for Environmental Assessment collected bulk water and swab samples from 16 cooling towers in the 1 mile zone
- Cooling tower operators were given ASHRAE and Cooling Technology Institute guidelines for emergency remediation (cleaning/disinfection) to be done after samples taken
- Additional cooling towers were identified that had already undergone remediation, and therefore were not sampled

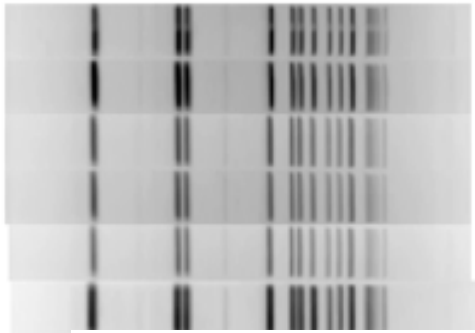
Environmental Investigation (cont.)

- Environmental samples were cultured by MDH and tested by PCR by Wadsworth Center lab at the New York State Department of Health
- PCR gave a quick indication of which towers had *Legionella* present, to then be confirmed by culture (which takes much longer – up to 14 days)
- All Lp1 isolates obtained underwent molecular subtyping at MDH by PFGE and WGS
- Of the 16 cooling towers samples, 2 (19%) yielded Lp1 isolates

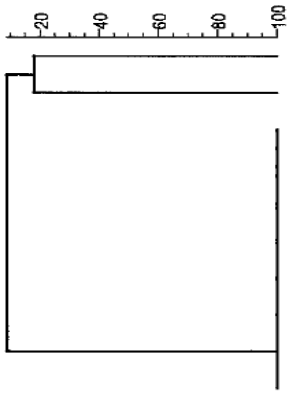
Results: Environmental Investigation

Only 1 of the cooling towers tested yielded Lp1 isolates indistinguishable from outbreak case isolates by molecular subtyping (PFGE and WGS)

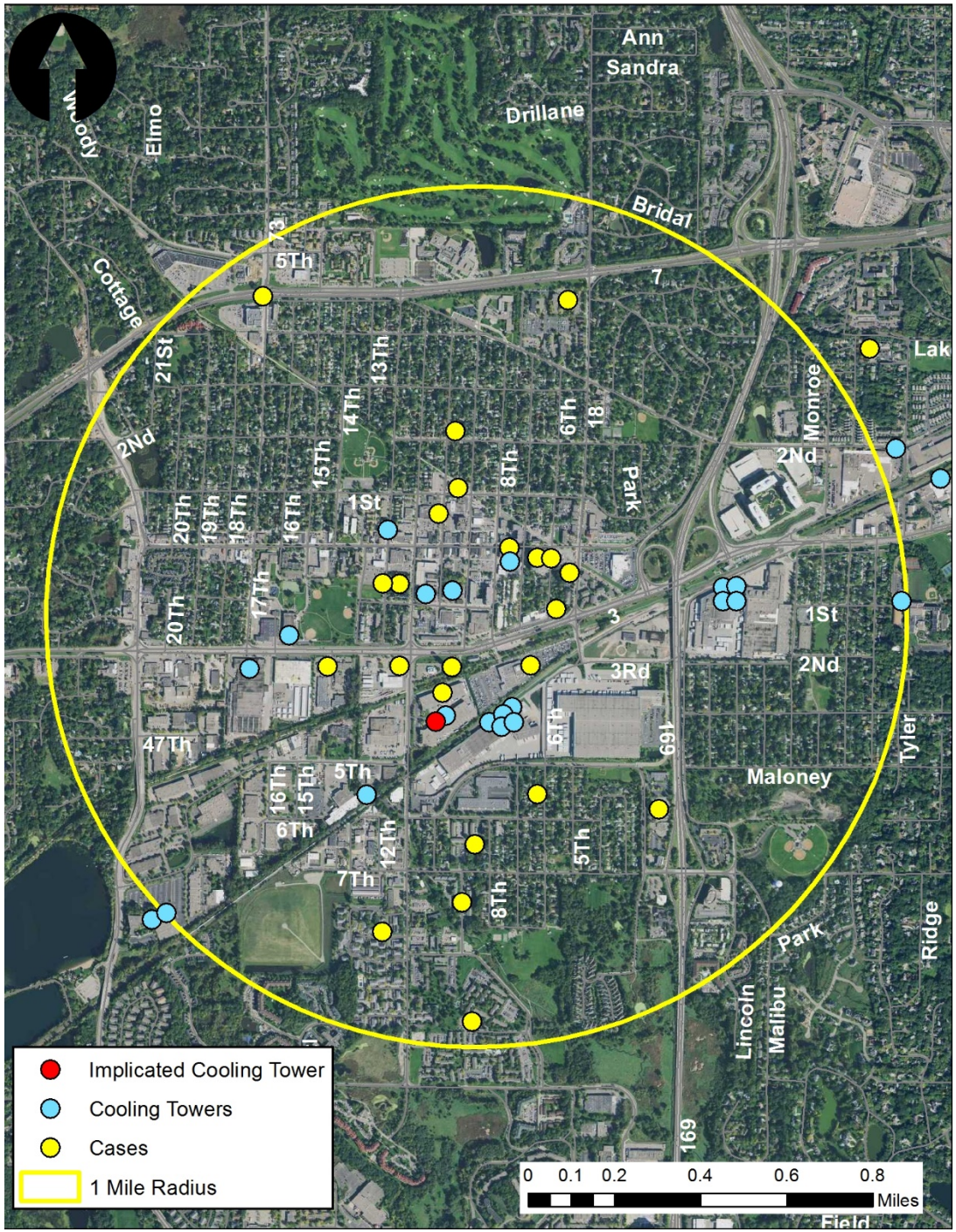
PFGE-SfiI



M2016014994-3	LPS1	Human	
M2016015185-6	LPS1	Enviro.	Water CS-01A-01G
M2016015186-5	LPS1	Enviro.	Water CS-02A-02G
M2016015187-3	LPS1	Enviro.	Swab CS-01
M2016015188-4	LPS1	Enviro.	Swab CS-02
M2016014548-1	LPS1*	Human	



Outbreak	Sample_ID	Serogroup	Source
MN-16	M2016014532-3		Environmental
Reference	Philadelphia		
MN-16	C2016014069	Lp1	Clinical
MN-16	C2016014870	Lp1	Clinical
MN-16	M2016014548-1	Lp1	Clinical
MN-16	M2016014994-3		Clinical
MN-16	M2016015185-6		Environmental
MN-16	M2016015186-5		Environmental
MN-16	M2016015187-3		Environmental
MN-16	M2016015188-4		Environmental


Ann
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Elmo
Woody
Cottage
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17Th
1St
8Th
6Th
18
Park
Monroe
2Nd
Lak
1St
2Nd
3Rd
3
7
47Th
16Th
15Th
6Th
5Th
12Th
7Th
8Th
5Th
169
Maloney
Tyler
Park
Ridge
Lincoln
Malibu
Field
Implicated Cooling Tower
Cooling Towers
Cases
1 Mile Radius
0 0.1 0.2 0.4 0.6 0.8
Miles


415 11th Avenue South
Citrus Systems Inc

News Release
October 12, 2016

Contact information

Health officials identify source of Hopkins Legionnaires' disease outbreak

The Minnesota Department of Health (MDH) today announced that it has identified the likely source of the Legionnaires' disease outbreak in Hopkins as a set of cooling towers at Citrus Systems, Inc., located at 415 11th Avenue South, Hopkins.

MDH investigators based their conclusion on the distribution of cases and their exposure histories (where they live, work, or otherwise were in Hopkins) and the test results of water samples taken from the Citrus Systems cooling towers. Laboratory testing showed the strain of *Legionella* bacteria found in one of the cooling towers matched the strain of bacteria in samples taken from patients linked to the outbreak. *Legionella* bacteria cause Legionnaires' disease. Other cooling towers in the outbreak area were sampled, but did not have the specific *Legionella* strain identified.

MDH, working with Hennepin County Public Health and the City of Hopkins, confirmed on Sept. 26 that Citrus Systems had cooling towers, following a tip from the public. Water samples were collected and the towers were chemically cleaned and disinfected on Sept. 27. The MDH Public Health Laboratory found positive bacterial growth for *Legionella* from one of Citrus Systems' two towers. Isolates were then analyzed further, using pulsed-field gel electrophoresis testing and whole genome sequencing to obtain a DNA fingerprint of the specific strain. The DNA fingerprint of the isolates exactly matched the DNA fingerprint of *Legionella* isolates from four patients. New York's Wadsworth Public Health Laboratory and the Centers for Disease Control and Prevention in

Legionnaires' Disease Outbreak at a Long-Term Care Facility Caused by a Cooling Tower Using an Automated Disinfection System—Ohio, 2013

Celia Quinn, MPH, MD
Epidemic Intelligence Service assigned to Ohio Department of Health
Centers for Disease Control and Prevention

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Louise Francois Watkins, MPH, MD
Sara Tomczyk, MSc, PHN
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National Center for Immunization and Respiratory Diseases
Centers for Disease Control and Prevention

Claressa Lucas, PhD
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Laurel E. Garrison, MPH
National Center for Immunization and Respiratory Diseases
Centers for Disease Control and Prevention

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National Center for Environmental Health
Centers for Disease Control and Prevention

Scott Brewer, MPH
Samantha Eitniear, MPH
Franklin County Public Health

Mary DiOrio, MPH, MD
Ohio Department of Health

Abstract

On July 9, 2013, an outbreak of Legionnaires' disease (LD) was identified at Long-Term Care Facility A in central Ohio. This article describes the investigation of the outbreak and identification of the outbreak source, a cooling tower using an automated biocide delivery system. In total, 39 outbreak LD cases were identified; among these, six patients died. Water samples from a cooling tower were positive for *Legionella pneumophila* serogroup 1, reactive to monoclonal antibody 2, with matching sequence type to a patient isolate. An electronic control system turned off cooling tower pumps during low-demand periods, preventing delivery of disinfectant by a timed-release system, and leading to amplification of *Legionella* in the cooling tower. Guidelines for tower maintenance should address optimal disinfection when using automated systems.

Introduction

Kool et al., 1998; Lau, Maqsood, Harte,

Methods

From: Journal of Environmental Health, December 2015
http://www.cdc.gov/nceh/ehs/docs/jeh/2015/legion-ohio-2013.pdf

Outbreak Conclusions

- A community outbreak of 24 cases of Legionnaires' disease was associated with an industrial cooling tower that used an automated biocide delivery system
- Low periodic demand for use of this cooling tower may have contributed to intermittent biocide injection and stagnation, with resulting *Legionella* amplification
- Tracing the cases to a source was challenging; molecular comparison of isolates from cases and potential sources was key

Epidemiol. Infect. (2015), **143**, 2416–2425.
doi:10.1017/S0950268814003094

An unusually long-lasting outbreak of community-acquired Legionnaires' disease, 2005–2008, Italy

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Received 22 July 2014; Final revision 2 October 2014; Accepted 29 October 2014; first published online 27 November 2014

SUMMARY

An unusually long-lasting community-acquired outbreak of Legionnaires' disease (LD) occurred in the inhabitants of a town in northern Italy from 2005 to 2008. Overall, 43 cases were diagnosed including five deaths. Hundreds of water samples were collected for *Legionella* isolation but only two clinical samples were obtained. Clinical strains were ST23 as were environmental isolates detected in most *Legionella*-positive patients' homes and those from a public fountain. Although no *Legionella* was found in the municipal water mains, a continuous chlorination was applied in 2008. This action resulted in a halving of cases, although incidence remained tenfold higher than the Italian average incidence until the end of 2013, when it dropped to the expected rate. Retrospective analyses of prevalent wind direction suggested that a hidden cooling tower could have been the main cause of this uncommon outbreak, highlighting the importance of implementation of cooling tower registers in supporting LD investigations.

Key words: Community-acquired pneumonia, disinfection, *Legionella*, public health emerging infections, water (safe).

INTRODUCTION

Since Legionnaires' disease (LD) was first described at the end of the 1970s, many community-acquired outbreaks have occurred and *Legionella pneumophila* serogroup 1 (Lp1) has been found to be the most common causative agent [1]. In Europe, the largest community-acquired outbreak of LD occurred in Spain in 2001 with 449 confirmed cases [2]. In Italy, since the 1990s three outbreaks have been identified: the first outbreak involving 34 cases occurred in 1995 in Sestri Ponente [3], the second occurred in Rome in 2003 with 15 cases [4, 5], and the latest in Lazise in 2011 with 17 cases [6]. In three of these events, epidemiological and molecular investigations identified a cooling tower as the source of infection, while in the Lazise outbreak the source of most cases was found to be the water distribution system of a campsite. However, globally the occurrence of both sporadic cases and community outbreaks of LD has also been associated with other environmental sources, such as spa pools, water distribution systems of accommodation sites, private homes and ships

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Health Department Investigating Community Cluster of Legionnaires' Disease in Section of Lenox Hill in Manhattan

Seven cases of Legionnaires' disease have been reported in the last 11 days

Legionnaires' disease cannot be spread from person to person; those at high risk include people aged 50 or older, especially cigarette smokers, people with chronic lung disease or with weakened immune systems

New Yorkers with respiratory symptoms, such as fever, cough, chills and muscle aches, are urged to promptly seek medical attention

June 16, 2017 — The Health Department is currently investigating a community cluster of Legionnaires' disease in a section of Lenox Hill in Manhattan. A total of seven individuals have been confirmed with Legionnaires' disease in the last 11 days. Four persons are hospitalized and recovering, two have been discharged from the hospital and one person with significant underlying health conditions in their 90s has died. The Health Department is actively investigating these cases and has sampled and is testing water from all cooling tower systems within a half kilometer radius of this section of Lenox Hill. New Yorkers with respiratory symptoms, such as fever, cough, chills and muscle aches, are urged to promptly seek medical attention. The Health Department has alerted health care providers in the area. Legionnaires' disease is treatable with standard antibiotics used to treat pneumonia. Every year, there are between 200 and 400 cases of Legionnaires' disease in the city.

"The Health Department has identified an increase and cluster of Legionnaires' disease cases in the Lenox Hill area," said **Health Commissioner Dr. Mary T. Bassett**. "We have begun an investigation to determine the source of the cluster, focusing on cooling towers in the neighborhood. I urge individuals in this area with respiratory symptoms to seek medical attention right away."

"Residents should be looking out for signs of Legionnaires: anybody with fever, cough, chills and muscle aches, should quickly see medical attention," said **Council Member Ben Kallos**. "We are working with the Department of Health and Mental Hygiene to identify the source immediately. My thoughts and prayers are with the family of the individual who passed away."

Legionnaires' disease is caused by the bacteria *Legionella*. Symptoms include fever, cough, chills, muscle aches, headache, fatigue, loss of appetite, confusion and diarrhea. Symptoms usually

Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings

A PRACTICAL GUIDE TO IMPLEMENTING INDUSTRY STANDARDS

Identifying Buildings at Increased Risk

Survey your building (or property) to determine if you need a water management program to reduce the risk of *Legionella* growth and spread.

If you answer YES to any of questions 1 through 4, you should have a water management program for *that building's* hot and cold water distribution system.

Healthcare Facilities

Yes ____ No ____ 1. Is your building a healthcare facility where patients stay overnight or does your building house or treat people who have chronic and acute medical problems† or weakened immune systems?

Yes ____ No ____ 2. Does your building primarily house people older than 65 years (like a retirement home or assisted-living facility)?

Yes ____ No ____ 3. Does your building have multiple housing units and a centralized hot water system (like a hotel or high-rise apartment complex)?

Yes ____ No ____ 4. Does your building have more than 10 stories (including basement levels)?

Devices in buildings that can spread contaminated water droplets should have a water management program even if the building itself does not. If you answer NO to all of questions 1 through 4 but YES to any of questions 5 through 8, you should have a water management program for *that device*.

Yes ____ No ____ 5. Does your building have a cooling tower*?

Yes ____ No ____ 6. Does your building have a hot tub (also known as a spa) that is not drained between each use?

Yes ____ No ____ 7. Does your building have a decorative fountain?

Yes ____ No ____ 8. Does your building have a centrally-installed mister, atomizer, air washer, or humidifier?

If you answer NO to questions 1 through 8, you should still maintain water systems according to manufacturer recommendations. On properties with multiple buildings, prioritize buildings that house or treat people who are at increased risk for Legionnaires' disease (see Appendix A to learn who is at increased risk).

The building standards discussed in this toolkit do not apply to single-family or small multiple-family residences (e.g., duplexes), even those with the devices in questions 6 through 8, but residents do need to take steps to protect themselves from waterborne diseases.

Homeowners should follow local and state guidelines for household water use, and owners of the devices in questions 6 through 8 should follow the manufacturer's instructions regarding cleaning, disinfecting, and maintenance.

Legionella can grow and spread in many areas of a building.

Effective water management programs can **REDUCE** the risk of Legionnaires' disease.

Legionella **can make people sick** when the germs grow in water and spread in droplets small enough for people to breathe in.

Legionella **grows best** in warm water that is not moving or that does not have enough disinfectant to kill germs.

SOURCE: Vital Signs, June 2016

DEPARTMENT OF HEALTH & HUMAN SERVICES
Centers for Medicare & Medicaid Services
7500 Security Boulevard, Mail Stop C2-21-16
Baltimore, Maryland 21244-1850

Center for Clinical Standards and Quality/Survey & Certification Group

Ref: S&C 17-30-*Hospitals/CAHs/NHs*
REVISED 06.09.2017

DATE: **June 02, 2017**

TO: State Survey Agency Directors

FROM: Director
Survey and Certification Group

SUBJECT: Requirement to Reduce *Legionella* Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires' Disease (LD)
****Revised to Clarify Provider Types Affected****

Memorandum Summary

- ***Legionella* Infections**: The bacterium *Legionella* can cause a serious type of pneumonia called LD in persons at risk. Those at risk include persons who are at least 50 years old, smokers, or those with underlying medical conditions such as chronic lung disease or immunosuppression. Outbreaks have been linked to poorly maintained water systems in buildings with large or complex water systems including hospitals and long-term care facilities. Transmission can occur via aerosols from devices such as showerheads, cooling towers, hot tubs, and decorative fountains.
- **Facility Requirements to Prevent Legionella Infections:** Facilities must develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce the risk of growth and spread of *legionella* and other opportunistic pathogens in water.
- *This policy memorandum applies to Hospitals, Critical Access Hospitals (CAHs) and Long-Term Care (LTC). However, this policy memorandum is also intended to provide general awareness for all healthcare organizations.*

Background

LD, a severe sometimes fatal pneumonia, can occur in persons who inhale aerosolized droplets of water contaminated with the bacterium *Legionella*. In a recent review of LD outbreaks in the United States occurring in 2000–2014, 19% of outbreaks were associated with long-term care facilities and 15% with hospitals. The rate of reported cases of legionellosis, which comprises both LD and Pontiac fever (a milder, self-limited, influenza-like illness) has increased 286% in the US during 2000–2014, with approximately 5,000 cases reported to the Centers for Disease Control and Prevention (CDC) in 2014. Approximately 9% of reported legionellosis cases are fatal.

Legionella (Legionnaires' Disease and Pontiac Fever)

Environmental Investigation Tools

Assessment and Sampling

The following tools are available to assist in the environmental component of legionellosis outbreak investigations.

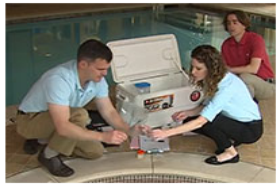
- *Legionella* Environmental Assessment Form [13 pages] (UPDATED June 2015)
  Use this form to document a facility's water systems, help determine whether to conduct *Legionella* environmental sampling, and, if so, develop a sampling plan.
- CDC Sampling Procedure and Potential Sampling Sites [6 pages]
  Use this protocol to collect environmental samples for *Legionella* culture during a cluster or outbreak investigation or when cases of disease may be associated with a facility (includes sampling supply checklist).
- Sample Data Sheet [1 page]
  Use this form to keep track of environmental samples taken for *Legionella* culture during an investigation.
- Environmental Investigation Videos
  Watch six instructional videos for information on various environmental aspects of legionellosis outbreak investigations.

Guidelines and Best Practices

These resources can be used to guide the environmental component of legionellosis outbreak investigations.

- Disinfection of Hot Tubs Contaminated with *Legionella* [2 pages]
  Learn about best practices for how to remediate hot tubs.
- ASHRAE Guideline 12-2000: Minimizing the Risk of Legionellosis Associated with Building Water Systems 2000 (Also available from SPX Cooling Technologies and Baltimore Air Coil Company.)

Environmental Investigation Videos



CDC developed six instructional videos on various environmental aspects of legionellosis outbreak investigations.

View the videos

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES BRANCH

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Preventing Legionnaires' Disease: Environmental Health Expertise Is Key

Editor's Note: **NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature a column from the Environmental Health Services Branch (EHSB) of the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.**

In these columns, EHSB and guest authors share insights and information about environmental health programs, trends, issues, and resources. The conclusions in this article are those of the author(s) and do not necessarily represent the views of CDC.

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allow *Legionella* bacteria to survive and reach a susceptible host. Due to the relationship of *Legionella* to the environment, environmental health practitioners are ideally situated to provide expertise essential to both responding to Legionnaires' disease outbreaks and preventing future ones. Working with epidemiologists and public health laboratorians, environmental health practitioners need to be proficient in applying environmental interventions (e.g., recommending potable water flushing procedures to address *Legionella*-contaminated water in an unoccupied building wing) in outbreak settings to stop

Guidelines and Helpful Info

- **CDC: http://www.cdc.gov/legionella/index.html includes investigation tools for environmental assessment and sampling, and toolkit for developing building water management programs**
- **ASHRAE Guideline 12-2000: *Minimizing the Risk of Legionellosis Associated with Building Water Systems***
- **ASHRAE Standard 188-2015: *Legionellosis: Risk Management for Building Water Systems***

Acknowledgments

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Institute for Environmental Assessment

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THANK YOU!

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