

Outbreak of Legionnaires' disease and Pontiac fever at Selfridge Air National Guard Base

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National Center for Immunization & Respiratory Diseases
Division of Bacterial Diseases

Selfridge Air National Guard Base (SANG)



Key Questions

- What is the source of the outbreak?
- How large is the outbreak?
- Should anything else be done to stop this outbreak?
- What should be done to prevent another similar outbreak?

- Team from U.S. Army, Michigan Air National Guard, Michigan Department of Community Health, and CDC answered these questions

Outline

- **Background on Legionnaires' disease (LD) and Pontiac fever (PF)**
- **Epidemiologic Component of Investigation**
 - *Case Finding*
 - *Cohort Studies*
- **Background on *Legionella* Bacteria in the Environment**
- **Environmental Component of Investigation**
 - *Environmental Assessment*
 - *Environmental Sampling*
- **Conclusions**

BACKGROUND ON LEGIONNAIRES' DISEASE AND PONTIAC FEVER

Diseases Discovered and Named Through Outbreaks

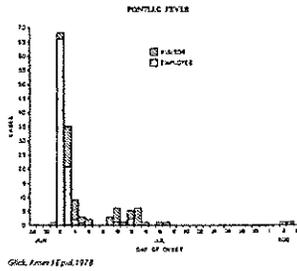
- Legionnaires' disease first described following 1976 outbreak at American Legion meeting in Philadelphia
- 221 cases of Legionnaires' disease with 34 deaths
- Previously unknown bacteria identified as cause
- Same organism retrospectively tied to 1968 mystery fever outbreak in Pontiac, Michigan



CDC 1976 <http://jshh.cdc.gov/jshh/home.asp>

Original Pontiac Fever Outbreak

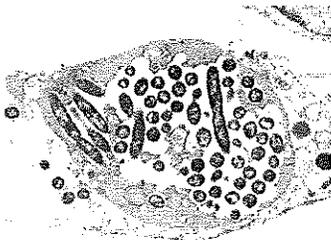
- Pontiac, Michigan health department
- 144 people developed fever during July and early August, 1968
 - 95 out of 100 health department employees
 - 7 out of 20 CDC investigators
- Investigation showed disease was infectious
- Causative organism identified 9 years later



Legionellosis (Pontiac fever and Legionnaires' disease)

	Pontiac fever	Legionnaires' disease
Clinical Features	Flu-like illness	Pneumonia
Hospitalization	Uncommon	Common
Treatment	None	Antibiotics
Case Fatality Rate	0%	5-40%
Attack Rate	>85%	<5%
High Risk Groups	None	Age 50+, smokers, immunosuppressed, diabetes, COPD
Incubation Period	1-3 days	2-10 days
Isolation of Organism	Virtually never	Possible
Pathogenesis	Inflammatory response to bacterial components	Replication of organism

Legionella pneumophila Replicating inside a Human Lung Fibroblast Cell



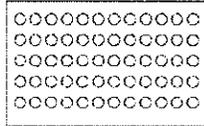
Legionella Bacteria

- Atypical gram-negative bacillus
- Intracellular parasite of free-living protozoa primarily found in freshwater environments
- There are 52 species and 70 serogroups of *Legionella*
- 22 species associated with human disease
- *Legionella pneumophila* accounts for 80-90% of all cases



Legionella Urine Antigen Test

- Detects chemical from LP1 in urine
 - Cannot detect non-LP1
 - Misses the 20-30% of legionellosis caused by non-LP1
- 60-80% sensitive, >99% specific (for LP1)
- Sensitivity decreases with time since symptoms began
- Rapid test (same day)
- Relatively simple
- Used to confirm 97% of cases reported to CDC



<http://www.atsjournals.org/doi/pdf/10.1164/ajrccm.161.12.2009.2512>

Legionella Culture

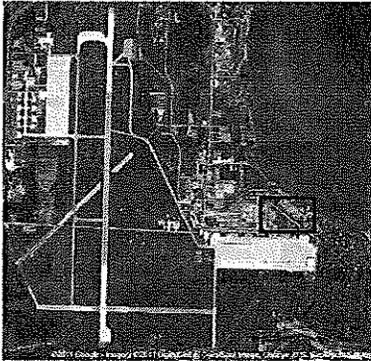
- Growth of *Legionella* on culture media, usually special Buffered Charcoal Yeast Extract (BCYE)
- Detects all species and serogroups of *Legionella*
- 100% specific
- Slow (>5 days to grow)
- Technically difficult, requires specialist materials
- Sensitivity highly dependent on skill of lab
- Used to confirm 5% of cases reported to CDC



<http://espebook.sagepub.com/legionella>

**EPIDEMIOLOGIC INVESTIGATION
- CASE FINDING**

Selfridge Air National Guard Base



**Methods
Case Definitions—Legionnaires' Disease**

Characteristic	Confirmed Legionnaires' Disease	Suspect Legionnaires' Disease
Radiographically-confirmed pneumonia	✓	✓
Exposure to area of interest no more than 10 days prior to symptom onset	✓	✓
Onset of illness on or after July 4	✓	✓
Laboratory evidence of <i>Legionella</i> by sputum culture, urine antigen or fourfold antibody titer rise	✓	

Case Definitions—Pontiac fever

Characteristic	Pontiac fever
Fever	√
At least one of following: Headache, cough, shortness of breath, muscle aches, vomiting, or diarrhea	√
Exposure to area of interest no more than 3 days prior to onset	√
Onset of illness between July 4 and July 25	√
Not Legionnaires' disease	√

Case Finding

- **Air National Guard**
 - Alert sent to staff and all tenants on base
 - Ill people instructed to call public health noncommissioned officer
 - Interviewed with simple respiratory disease screening form
 - Individuals with possible Legionnaires' disease or Pontiac fever interviewed by epidemiology team
- **Army**
 - Daily reporting by supervisors of ill Army employees to Army command
 - Individuals with possible Legionnaires' disease or Pontiac fever interviewed by epidemiology team

Case Interviews and Record Reviews

- All potential cases contacted and interviewed by phone or in person
- All ill persons not currently hospitalized meeting case definition invited to be tested by urine antigen on base
- Hospitalized cases also had medical records reviewed by clinicians on epidemiology team
- Any *Legionella* isolates identified through record review were sent to CDC *Legionella* lab for further testing

BACKGROUND ON *LEGIONELLA* IN THE ENVIRONMENT

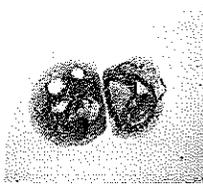
***Legionella* Found Naturally in Fresh Water**



BUT natural environments (e.g., lakes, rivers) do NOT spread sufficient quantities of *Legionella* to cause disease

Conditions for Amplification

- Temperature 25°C - 42°C (77°F-108°F)
- Stagnation
- Scale and sediments
- Absence of chlorine and bromine
- Presence of natural rubbers, wood and some plastics
- Absence of copper
- Biofilms
- Presence of amoebae



<http://asprebook.sppublications.org/visual>

CONCLUSIONS

Preventing Future Outbreaks

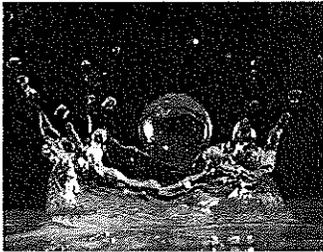
- Legionella is very difficult to eradicate from a water system
- Recurrent outbreaks are a real problem
- Legionella remediation specialists can be very helpful although their competence varies
- Remediation contractor hired for the cooling towers
 - Towers were hyperchlorinated to reduce Legionella to undetectable levels
 - Long term maintenance includes having a biocide and a halide automatically injected into sump water at regular intervals
 - Sump water continuously monitored to ensure chemical levels are appropriate
 - Towers regularly checked for Legionella

Legionellosis Surveillance

- Good respiratory disease surveillance at SANG allowed a quick response which probably reduced the size of the outbreak
- Legionnaires' disease surveillance by the local health departments and the Michigan Department of Community Health was crucial to investigation
 - One of the main ways that the investigative team learned of cases
 - Carla Marten from MDCH was essential in identifying Legionnaires' disease cases and facilitating the collection of data on them
- Post-remediation surveillance for Legionnaires' disease and clusters of Pontiac fever associated with SANG necessary for detection of recurrences of the outbreak

Take Home Points

- ❑ Legionnaires' disease and Pontiac fever (legionellosis) are caused by *Legionella* bacteria
 - Legionnaires' disease is a form of pneumonia
 - Pontiac fever is a flu-like illness
- ❑ *Legionella* bacteria are common in the environment
- ❑ Legionellosis outbreak investigations need both epidemiologic and environmental information
 - Epidemiologic data drive environmental sampling
 - Environmental sampling needed to confirm source of the outbreak
- ❑ Good surveillance crucial to identifying and investigating legionellosis outbreaks

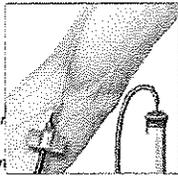


The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Legionella Serology

- ❑ Detection of antibodies in blood against *Legionella*
 - Test positive with a 4-fold rise in *Legionella* antibodies
 - Must have BOTH acute and convalescent titer (usually 3-6 weeks apart)
 - Single titers useless since 5-10% of population already has *Legionella* antibodies
- ❑ 70-80% sensitive, >90% specific
- ❑ Unaffected by antibiotics
- ❑ Can be technically and logistically difficult
- ❑ Used to confirm only 9 cases reported to CDC between 2005 and 2009



<http://www.nlm.nih.gov/medlineplus/ency/foodpage/10023.htm>

Legionella PCR Testing

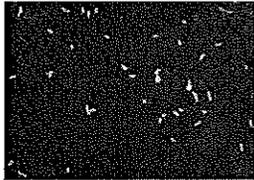


http://oregonstate.edu/handbook/equipment/2006/06/legionella_pcr_machine.htm

- ❑ Detects *Legionella* DNA using Polymerase Chain Reaction (PCR)
- ❑ Potentially able to detect all species and serogroups of *Legionella* in a variety of types of specimens
- ❑ Relatively quick
- ❑ Not yet validated for use with clinical specimens
- ❑ Unknown how often PCR is used with clinical specimens, but maybe very frequently

Legionella DFA and IHC Tests

- ❑ Detect chemical from *Legionella* with antibodies connected to a marker
 - Direct Fluorescent Antibody (DFA) test = fluorescent marker
 - Immunohistochemistry (IHC) test = staining marker



<http://expresbio.com/applications/legionella/>

- ❑ DFA: 25-75% sensitive, 95% specific
- ❑ Usable with most specimens, including pathologic ones
- ❑ Relatively rapid
- ❑ <1% of legionellosis cases reported to CDC between 2005 and 2009 had positive DFA tests

Disease Burden

- ❑ Number one cause of atypical community-acquired pneumonia among patients who are admitted to ICU
- ❑ 8,000-18,000 hospitalizations in the U.S. each year
- ❑ Inpatient cost estimates total \$92-582 million per year
- ❑ During 2005-2006, 50% of all drinking water outbreaks nationwide were caused by *Legionella*
- ❑ 10-20% are outbreak-associated
- ❑ 20% are travel-associated
- ❑ Incidence is increasing
