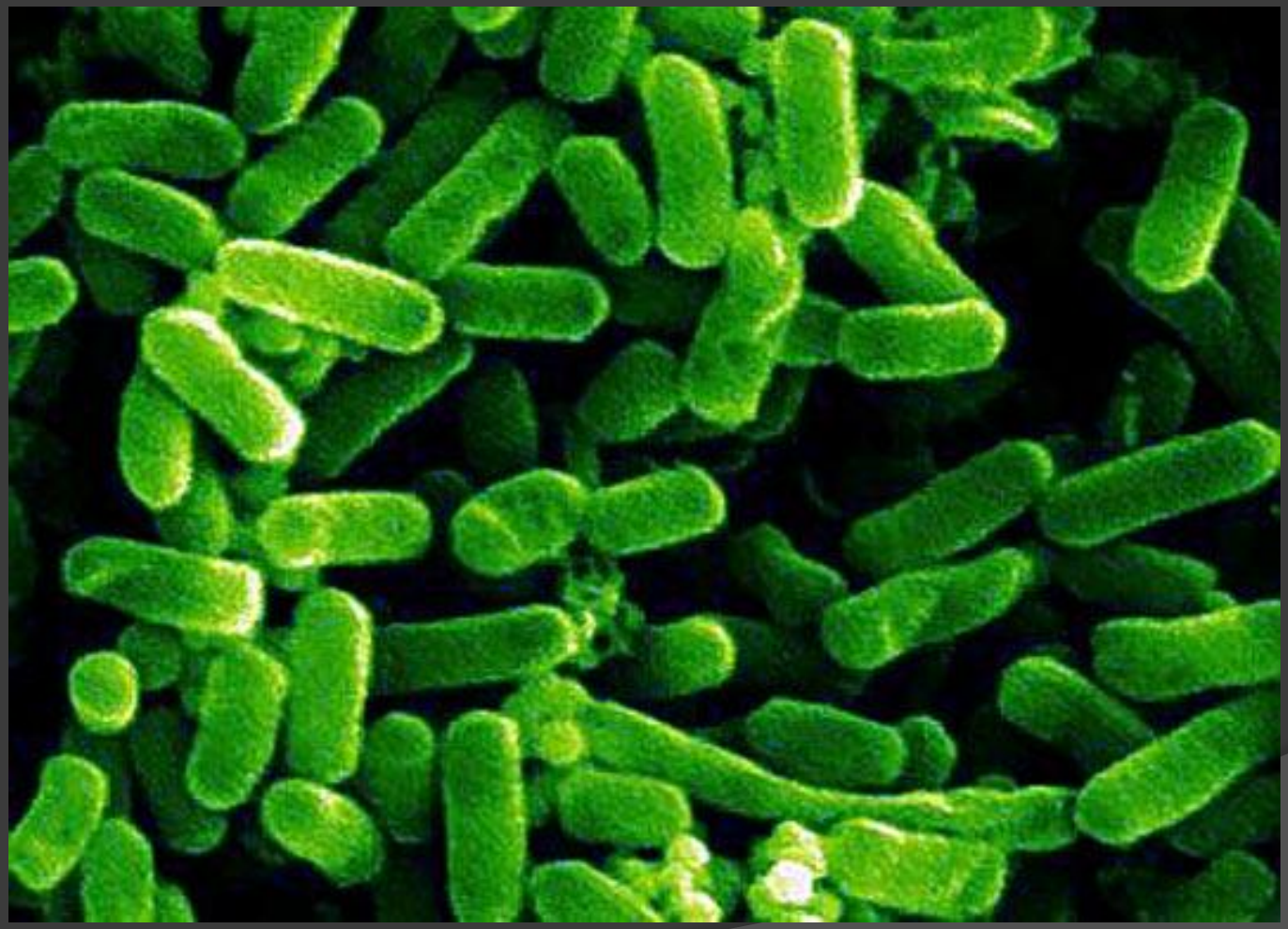
The Emergence of *Legionella* and the Real-world Problems of Prevention

ROSS COOPER, M. S.
ES III
BUREAU OF SAFE DRINKING WATER

Total Coliform Rule

Escherichia coli



E. coli

- *E. coli* are a large and diverse group of bacteria. Although most strains of *E. coli* are harmless, O157:H7 is an enterohemorrhagic serotype that can cause bloody diarrhea, anemia, kidney failure, and even death.

E. coli infections result through contact with the feces, or stool, of humans or animals.

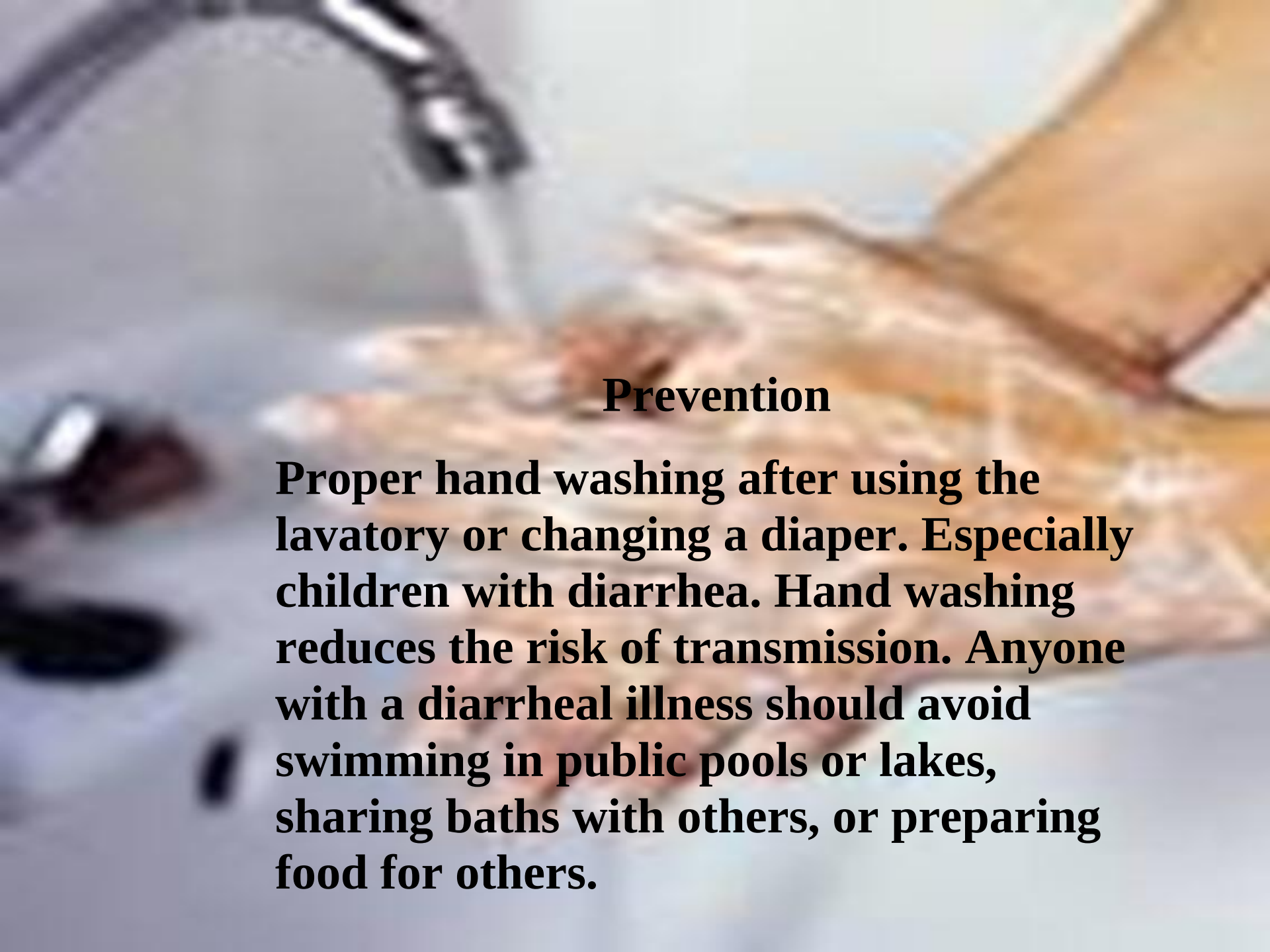
Transmission

Infection with *E. coli* follows ingestion of contaminated food or water, or oral contact with contaminated surfaces. It is highly virulent, with a low infectious dose: an inoculation of fewer than 100 CFU of *E. coli* is sufficient to cause infection, compared to over one-million CFU for other pathogenic strains.

Signs and symptoms

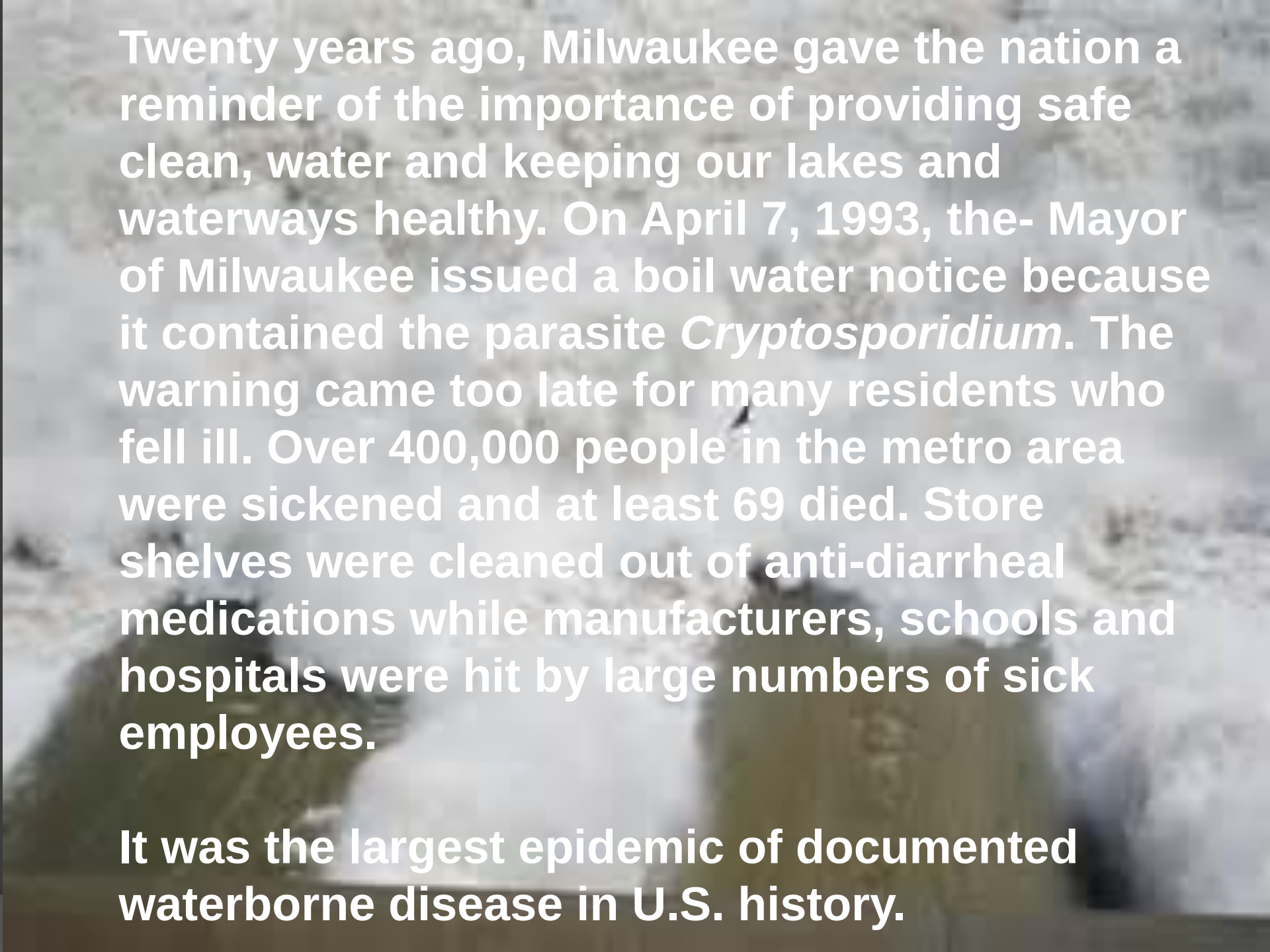
E. coli infection often causes severe, acute hemorrhagic diarrhea and abdominal pain. Sometimes little or no fever is present, and the illness resolves in five to 10 days. It can also be asymptomatic.

In some people, especially children under five, the elderly, and those with compromised immune systems, the infection can destroy red blood cells resulting in kidney failure. About 7% of infections lead to this complication.



Prevention

Proper hand washing after using the lavatory or changing a diaper. Especially children with diarrhea. Hand washing reduces the risk of transmission. Anyone with a diarrheal illness should avoid swimming in public pools or lakes, sharing baths with others, or preparing food for others.



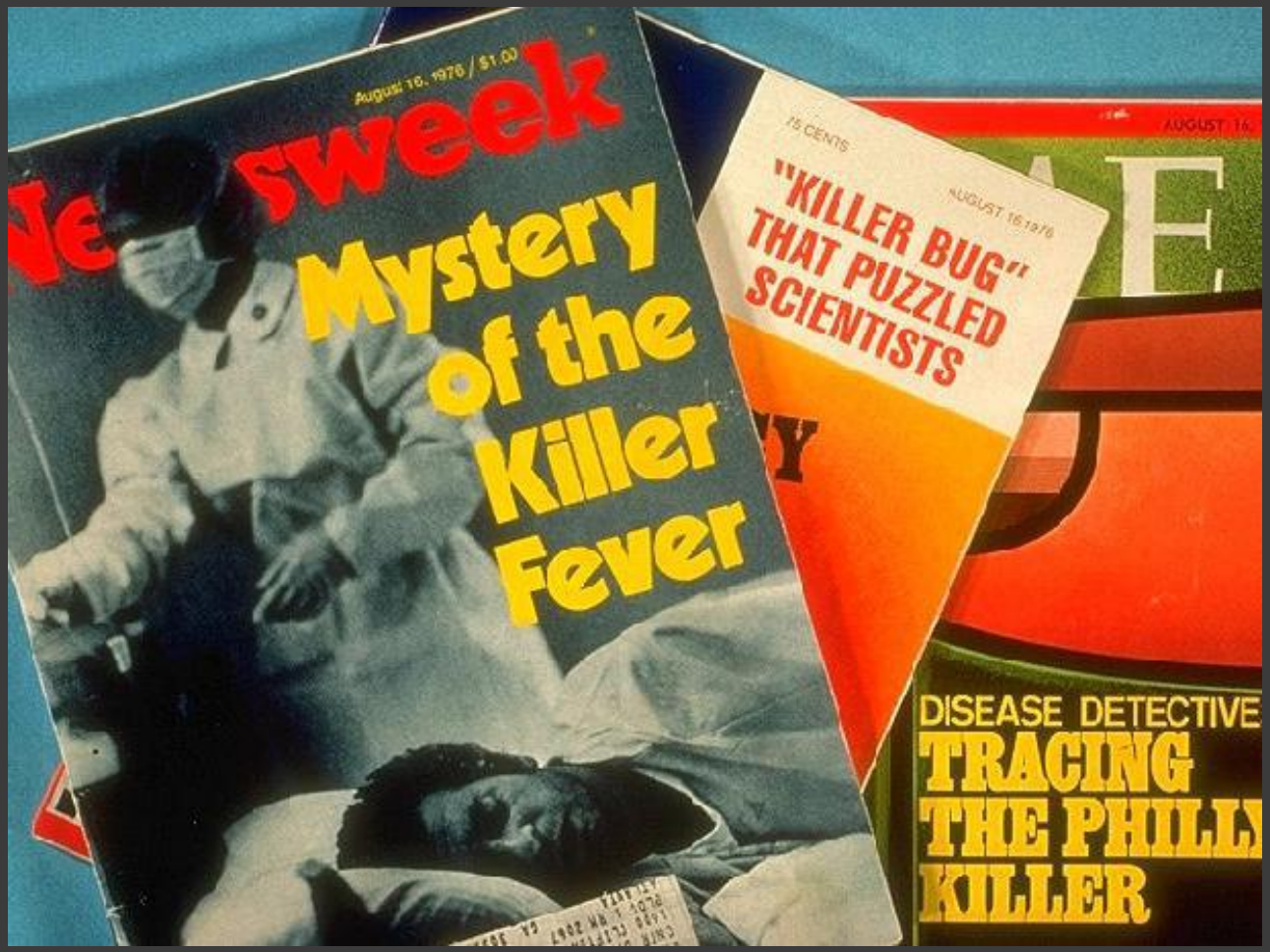
Twenty years ago, Milwaukee gave the nation a reminder of the importance of providing safe clean, water and keeping our lakes and waterways healthy. On April 7, 1993, the- Mayor of Milwaukee issued a boil water notice because it contained the parasite *Cryptosporidium*. The warning came too late for many residents who fell ill. Over 400,000 people in the metro area were sickened and at least 69 died. Store shelves were cleaned out of anti-diarrheal medications while manufacturers, schools and hospitals were hit by large numbers of sick employees.

It was the largest epidemic of documented waterborne disease in U.S. history.

Legionella 101

History of Legionellosis

- **First described following 1976 outbreak at American Legion convention in Philadelphia**



CDC 1976 http://phil.cdc.gov/phil/home.asp

History of Legionellosis

- 221 cases of Legionnaires' disease with 34 deaths
- Cooling system eventually suspected to be the source

Pathogenicity

- A CDC study of reported cases indicated a death rate of 40% for cases acquired during a hospital stay (nosocomial cases), but a death rate of 20% for community-acquired cases.

- Some outbreaks have claimed more than 50 percent.

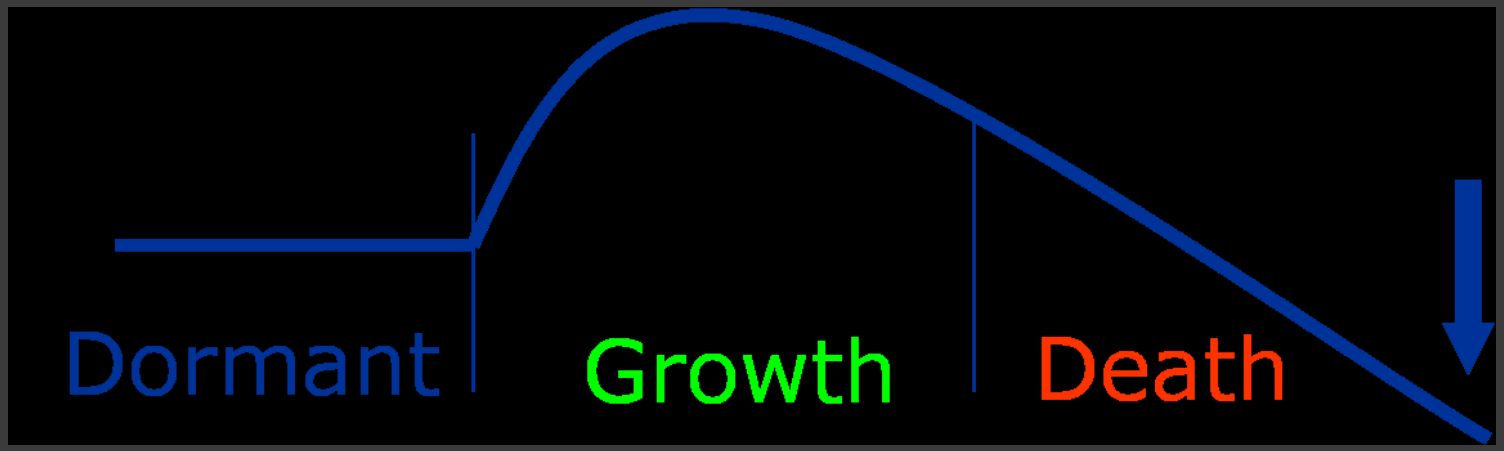
Legionella

- **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 is found naturally in fresh water

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

Temperature Range for Legionella



Amplification (growth)

Temperature 25ºC - 42ºC (77ºF-108ºF)

Amplification

- **Stagnant water**
- **Scale and sediments within plumbing**
- **Biofilms**
- **Presence of amoebae**
- **Natural rubbers, wood and some plastics support growth, while copper inhibits growth**

Pathogenesis

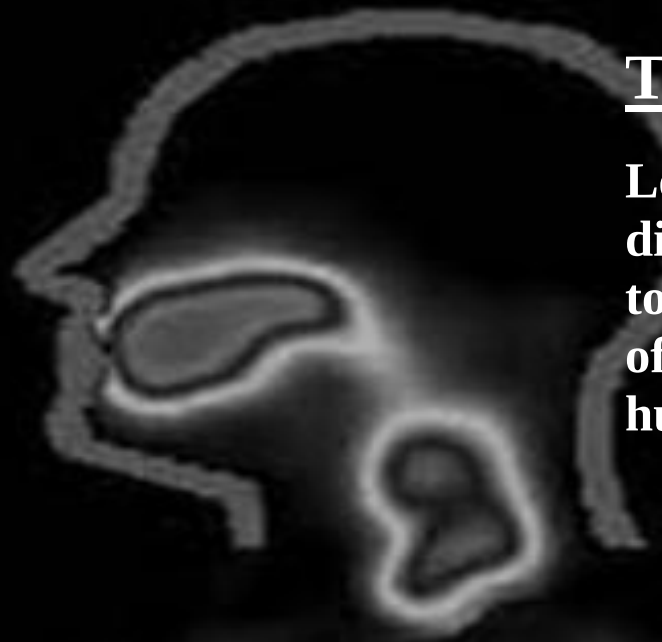
- Bio-films containing *Legionella* sp. develop in infrastructure in systems in the temperature range between 77-108^{o}F
- The protozoan infected with *Legionella sp.* burst and release the bacteria into the water

Pathogenesis

- The bacteria travel downstream to locations where they are aerosolized.

- A person inhales the aerosolized bacteria, where it establishes in the macrophage of the lungs.

Transmission via Aerosolized Water



Transmission

Legionella are transmitted directly from the environment to humans. There is no evidence of human-to- human or animal-to-human transmission of the bacteria.

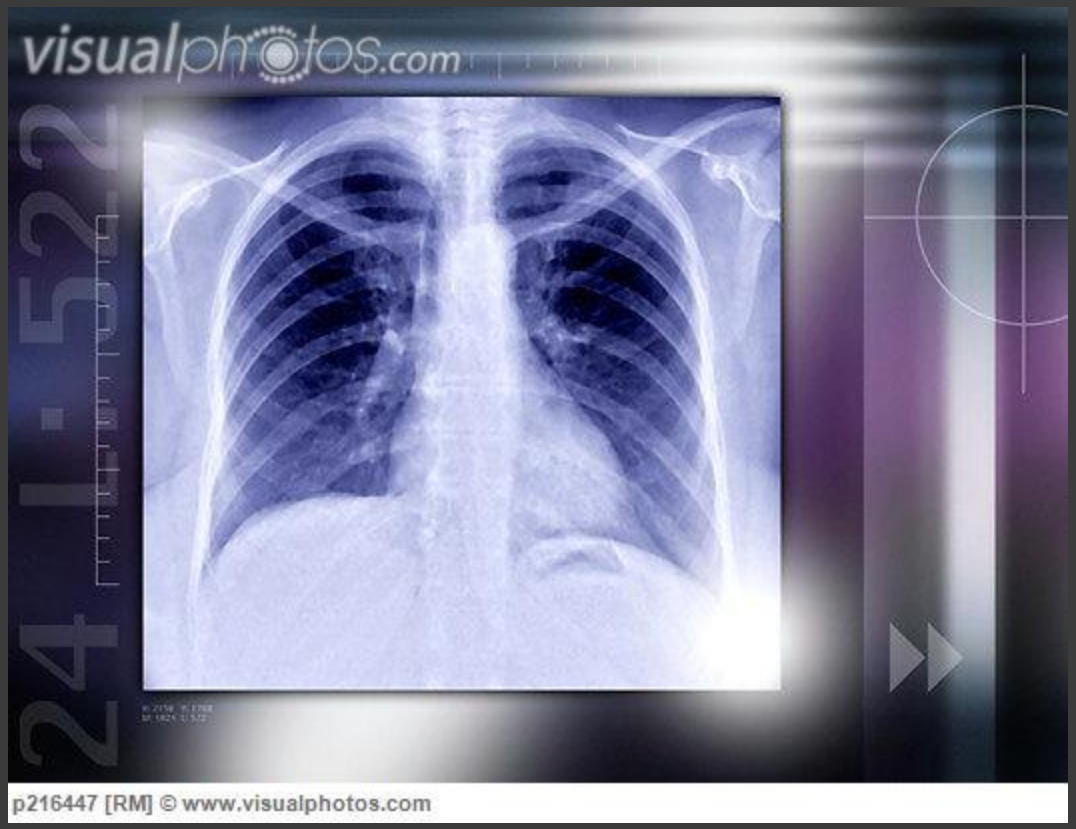
Humans may inhale contaminated aerosols or aspirate small amounts of contaminated drinking water

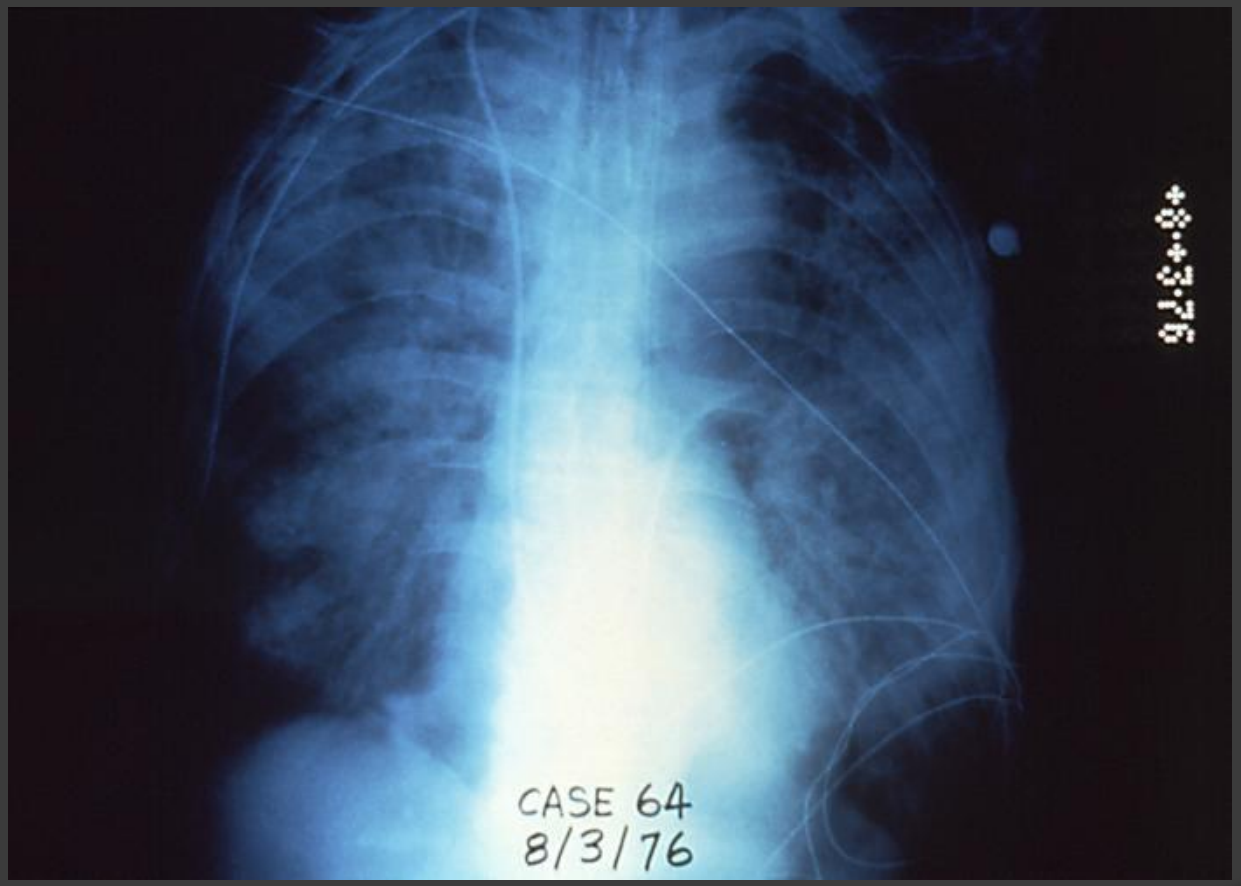
No vaccine is available to prevent infection.

Legionellosis (Legionnaires' disease and Pontiac fever)

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

Image of healthy lungs



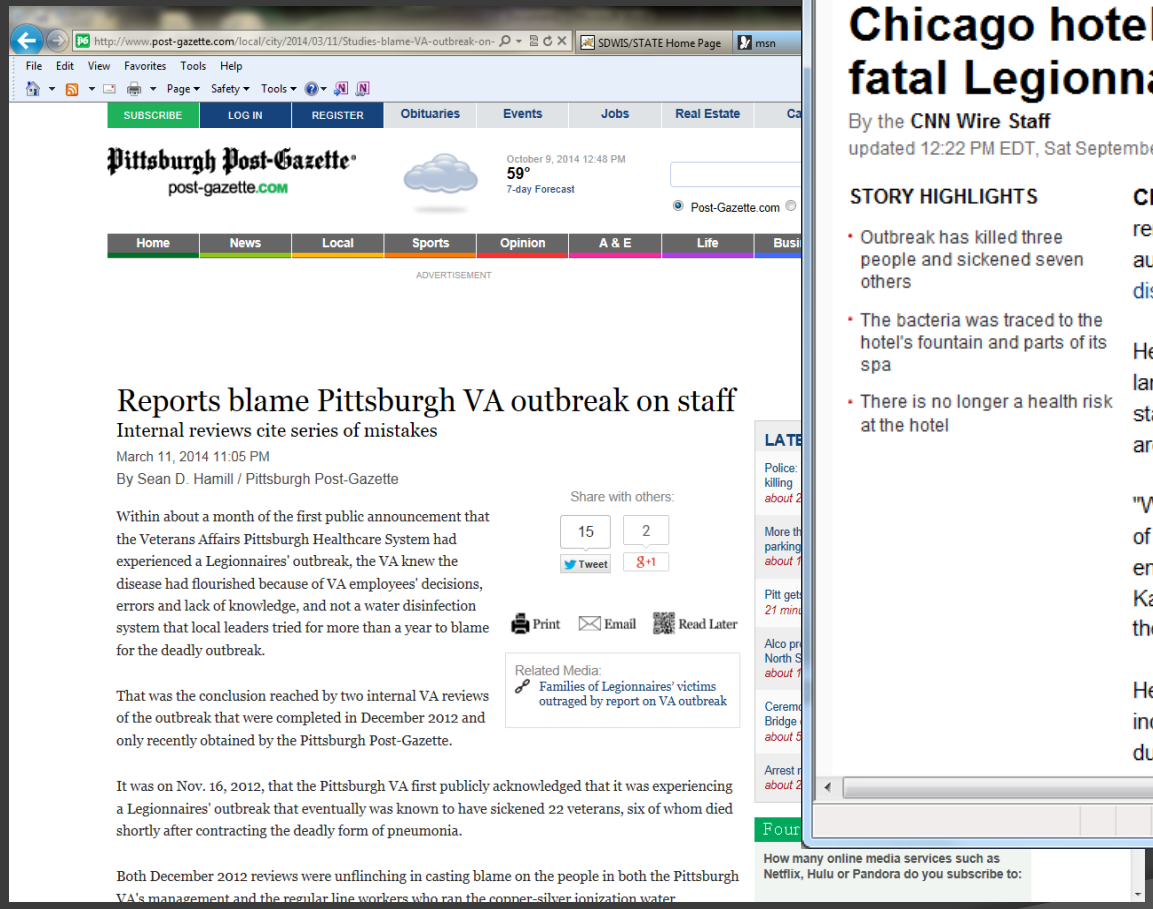


Anteroposterior CXR

Bilateral pulmonary infiltrates in a 1976 outbreak victim

Pathogenesis

- The person's immune system responds and causes Legionnaires' disease in a susceptible person who:
  - Is older than 50 years of age
  - Has a chronic lung disease (i.e. emphysema)
  - Has a weakened immune system
  - Is a current or former smoker



Pittsburgh Post-Gazette
post-gazette.com

Reports blame Pittsburgh VA outbreak on staff

Internal reviews cite series of mistakes

March 11, 2014 11:05 PM

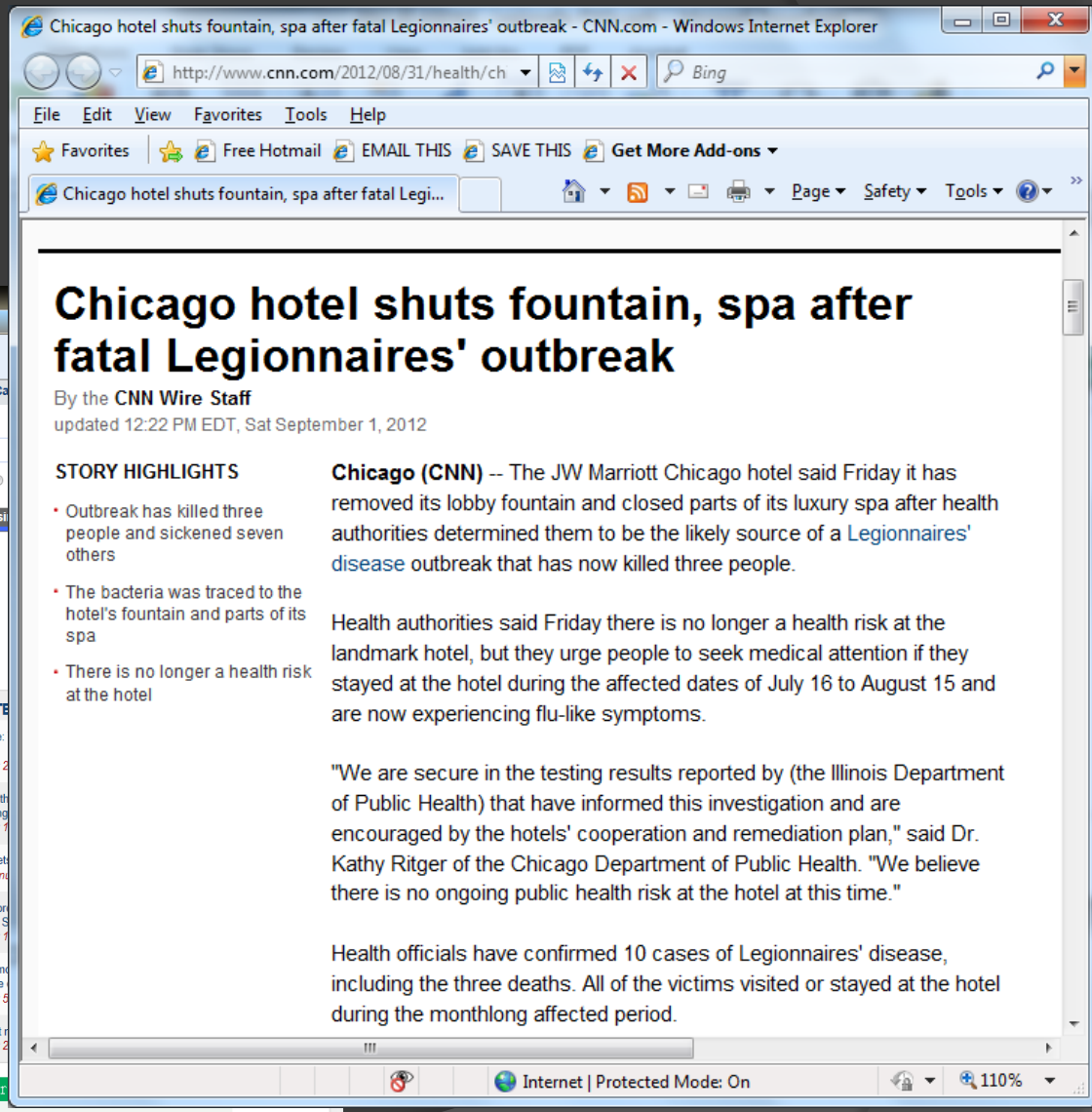
By Sean D. Hamill / Pittsburgh Post-Gazette

Within about a month of the first public announcement that the Veterans Affairs Pittsburgh Healthcare System had experienced a Legionnaires' outbreak, the VA knew the disease had flourished because of VA employees' decisions, errors and lack of knowledge, and not a water disinfection system that local leaders tried for more than a year to blame for the deadly outbreak.

That was the conclusion reached by two internal VA reviews of the outbreak that were completed in December 2012 and only recently obtained by the Pittsburgh Post-Gazette.

It was on Nov. 16, 2012, that the Pittsburgh VA first publicly acknowledged that it was experiencing a Legionnaires' outbreak that eventually was known to have sickened 22 veterans, six of whom died shortly after contracting the deadly form of pneumonia.

Both December 2012 reviews were unflinching in casting blame on the people in both the Pittsburgh VA's management and the regular line workers who ran the copper-silver ionization water



Chicago hotel shuts fountain, spa after fatal Legionnaires' outbreak - CNN.com - Windows Internet Explorer

Chicago hotel shuts fountain, spa after fatal Legionnaires' outbreak

By the **CNN Wire Staff**

updated 12:22 PM EDT, Sat September 1, 2012

STORY HIGHLIGHTS

- Outbreak has killed three people and sickened seven others
- The bacteria was traced to the hotel's fountain and parts of its spa
- There is no longer a health risk at the hotel

Chicago (CNN) -- The JW Marriott Chicago hotel said Friday it has removed its lobby fountain and closed parts of its luxury spa after health authorities determined them to be the likely source of a Legionnaires' disease outbreak that has now killed three people.

Health authorities said Friday there is no longer a health risk at the landmark hotel, but they urge people to seek medical attention if they stayed at the hotel during the affected dates of July 16 to August 15 and are now experiencing flu-like symptoms.

"We are secure in the testing results reported by (the Illinois Department of Public Health) that have informed this investigation and are encouraged by the hotels' cooperation and remediation plan," said Dr. Kathy Ritger of the Chicago Department of Public Health. "We believe there is no ongoing public health risk at the hotel at this time."

Health officials have confirmed 10 cases of Legionnaires' disease, including the three deaths. All of the victims visited or stayed at the hotel during the monthlong affected period.

Clinical Features of LD

- Incubation period is 2-10 days (most often 5-6 days)
- Difficult to distinguish from other causes of pneumonia
- Initial symptoms include anorexia, malaise, myalgia, headache
- Within 24 hrs, rapidly rising fever 102-105°F
- Nonproductive cough, abdominal pain, nausea, vomiting, and diarrhea are common
- Chest radiograph: patchy infiltrates or focal areas of consolidation which may progress to bilateral involvement and respiratory failure

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 (~1,600-7,200 fatalities a 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**

Key Future Activities

- **Surveillance**
- **Training and Education**
- **Outbreak Coordination and Response**
- **Development and Revision of Guidelines**
- **Clinical and Environmental Laboratory Diagnostics**
- **Research**

Public Health Surveillance

- Legionellosis is one of ~67 nationally notifiable infectious diseases reported to the National Notifiable Diseases Surveillance System (NNDSS)
- NNDSS collects basic count data, sex, and age
- RDB maintains a supplemental surveillance system, which collects travel history, hospitalizations/LTCF exposures, disease (LD vs. PF), method of lab confirmation, and case status
- Additionally, outbreaks are reported through the National Outbreak Reporting System (NORS) to the Waterborne Disease Prevention Branch (WBDPB)
- National case definition is defined by CDC & CSTE

SO HOW DOES NEVADA BECOME INVOLVED?

http://abcnews.go.com/Health/legionnaires-disease-strikes-aria-resort-casino-las-vegas

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Deadly Legionnaires' Disease Sickens 6 on Las Vegas Strip

July 18, 2011

By SUSAN DONALDSON JAMES and MIKAELA CONLEY via **WORLD NEWS**

AUTO START: ON | OFF

Nevada health authorities are investigating an outbreak of **Legionnaires' disease** that has been reported at the posh 4,000-room Aria Resort and Casino on the Las Vegas Strip. Four guests who stayed at the resort were treated for the bacteria-borne disease, but many more may have been exposed from June 21 to July 4.

Stephanie Bethel of the Southern Nevada Health District told the Associated Press that this

Guest who stayed at Luxor dies of Legionnaires' disease - Las Vegas Sun News - Windows Int...

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Guest who stayed at Luxor dies of Legionnaires' disease

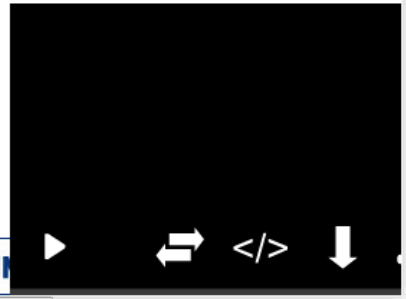
By Jackie Valley (contact)

Monday, Jan. 30, 2012 | 4 p.m.

Three guests at the Luxor have contracted Legionnaires' disease since last spring, including one who recently died as a result, the Southern Nevada Health District announced today.

The other two cases were not fatal, health district officials said. The Centers for Disease Control and Prevention contacted the health district about each case of the disease, which causes respiratory illness.

Disease kills one Luxor guest



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Where NDEP & SNHD Started

- Polo Towers – (Press in 2001, 2007,2008)
  - When Legionnaires' Disease is reported and SNHD investigation finds bacterial presence, remediation is required
  - Polo Towers installed chlorine dioxide system
- Polo Towers – Summer 2009
  - SNHD routine inspection - discussed chlorine dioxide equipment for Legionella treatment

Where NDEP & SNHD Started

- Other Las Vegas Strip Properties – Fall 2009
  - Also found to have chlorine dioxide disinfection equipment by SNHD
- Both Properties worked thorough decisions on what to do next...

Rules & Regulations

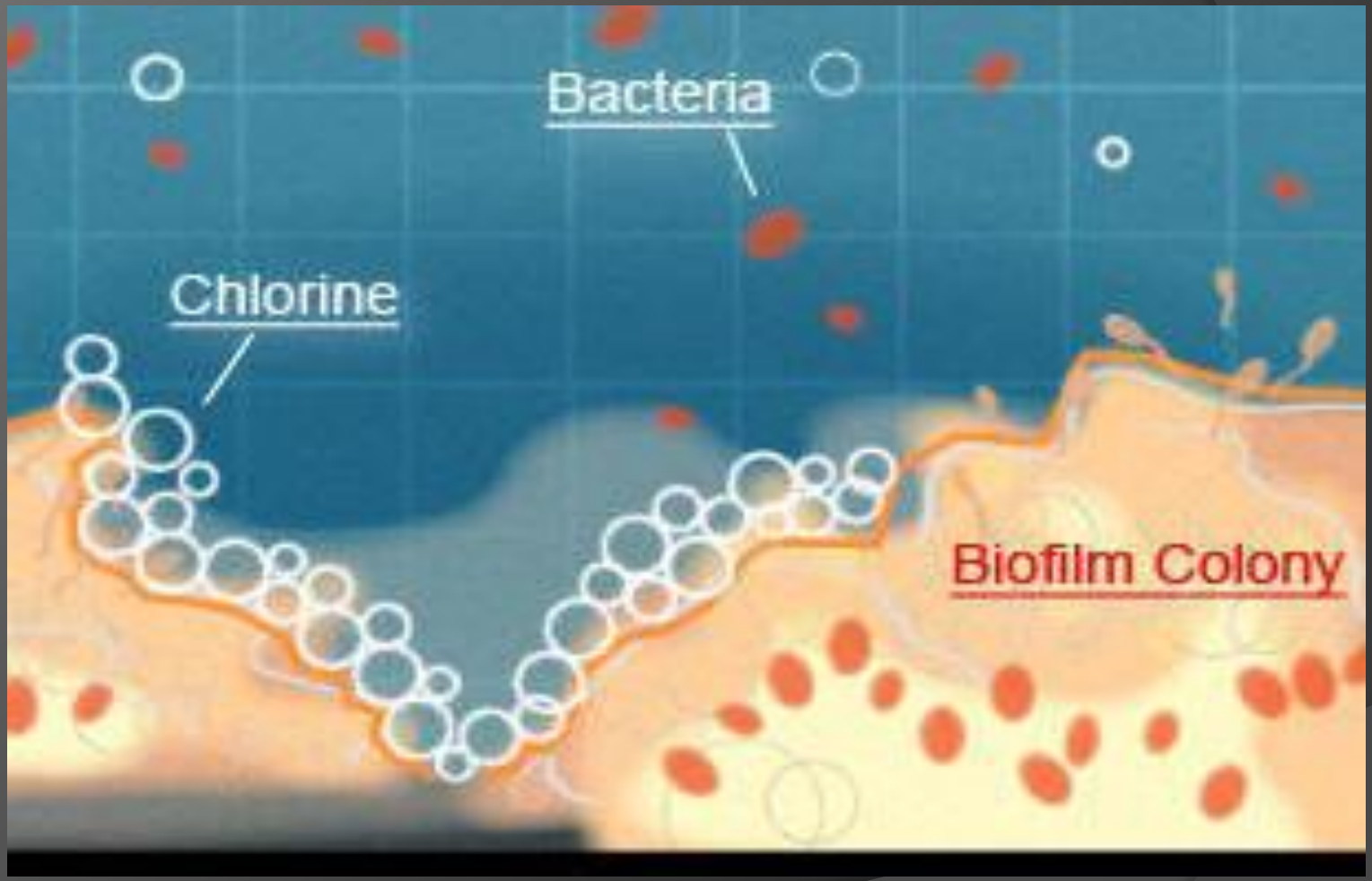
SDWA *A super quick primer *

- Community Public Water System (PWS)
  - Regularly serves at least 25 year-round residents
- Non-Transient Non-Community PWS
  - Regularly serves the same 25 people, but they don't live there
- If you treat water (even if from another supply), you become a separate PWS!

Rules & Regulations

- The SDWA regulates contaminants that can be harmful to public health
- The US EPA sets Maximum Contaminant Levels (MCLs)
- Nevada adopts the standards by reference & maintains compliance and enforcement authority independent of US EPA

Chlorine vs. Chlorine Dioxide



The Issue with Chlorine Dioxide

- It is documented to work; it penetrates the biofilm better than other methods ... ***but***
- Chlorine Dioxide is an Acute Contaminant
  - ClO_2 > MRDL = Public Notice within 24 hours
- Chlorite (a DBP) is a Chronic Contaminant
  - Chlorite > MCL = Public Notice within 30 days
- *Daily* monitoring is required
  - More frequent than chlorine or chloramines

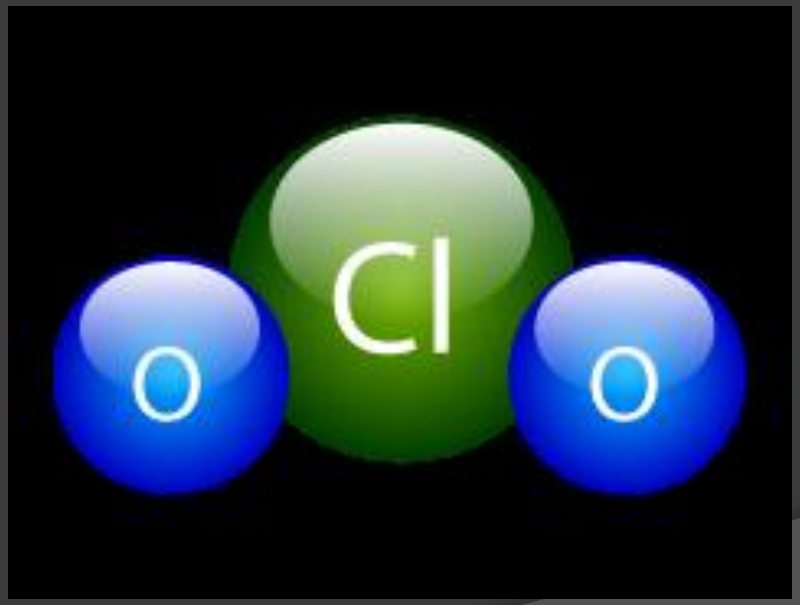
PN Mandatory Language:

"*Some infants and young children who drink water containing* ClO_2 [or chlorite] *in excess of the MRDL could experience nervous system effects.*

Similar effects may occur in fetuses of pregnant women who drink water containing ClO_2 [or chlorite] *in excess of the MRDL. Some people may experience anemia."*

The Concern with Chlorine ioxide?

- Despite these issues, in some cases, it might still be a good way to go, that's a managerial decision that needs to be made.



What Happened Next?

- Properties removed ClO_2 equipment and started looking for other options
  - Super-heated hot water – temperature at the unit
  - Intermittent disinfection – O&M hand addition
  - Permanent disinfection – physical equipment

- NDEP Decision #1 & #2 = Not a PWS
- Third Option = Regulated as a PWS

What Happened Next?

- Jump forward to Summer 2011
  - MGM/Aria makes the news
  - Strip Systems start to re-think intermittent, random hand chlorination practices
  - Decision to install permanent chlorination on their hot water system
  - Aria becomes first NTNC PWS of this type
- Other properties also moves forward with disinfection

What Happened Next?

- Jump again to January 30, 2012
  - System makes the news with a case of Legionellosis, which sadly results in a fatality.
  - Once decided on preferred approach, planning happened quickly using the Aria NTNC PWS model, and permit number issued on May 2nd.
- Other properties are also now permitted – preventative measure; others seem to be following suit.

Equipment

Zoned application on a large hotel tower with 35 floors

Larger chlorine pumps to overcome 325+ psi to upper zones

Equipment Controls

Replicated 5 times; one for each pumping zone

Where Are We Now?

- Continuing plan review for a number of properties
  - Residential properties and casino/hotel
  - Plans must be prepared & stamped by a NV Professional Engineer
- PWS Permitting follows Approval to Construct
- Applying the SDWA
  - Which Rules apply, and how?

Regulatory Oversight

- Regulatory Oversight - NTNC
  - Total Coliform Rule
  - Lead & Copper Rule

NV Regulations: “Provide the public with reasonable assurance that water is satisfactory for consumption, ablutionary and culinary purposes.”

Coupon Corrosion Study

Regulatory Oversight

- Regulatory Oversight - NTNC
  - Disinfection Byproducts Rules

Highly Recommend Baseline Data Collection – for all Rules

- Regulatory Oversight – Community
  - CCR's required
- Inspections: NDEP & SNHD
- Cross connection control

Operator Certification

- Community PWSs and NTNC PWSs require operation by a Certified Operator
  - Chlorination = Distribution Operator
  - ClO_2 treatment = Distribution *& Treatment* Operator(s)
- Systems are Graded based on population and complexity (1-4)
- Program is administered by BSDW

Forms of Treatment

- Continuous application of disinfectant:
  - Chlorine
  - Chlorine dioxide
  - Monochloramine
  - Ozone
  - Copper/Silver ionization

Note: Silver-Copper Ionization is not an approved treatment method in NV

BSDW Contact Information

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Mandy Corder – Administrative Assistant

775-687-9521

http://ndep.nv.gov/bsdw/staff_directory.htm


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Questions?