SPECIAL PATHOGENS LABORATORY®
THE LEGIONELLA EXPERTS®

MONOCHLORAMINE

Hot Water Treatment For Legionella Control

Janet E. Stout, PhD
President, Director, Special Pathogens Laboratory
Research Associate Professor, University of Pittsburgh

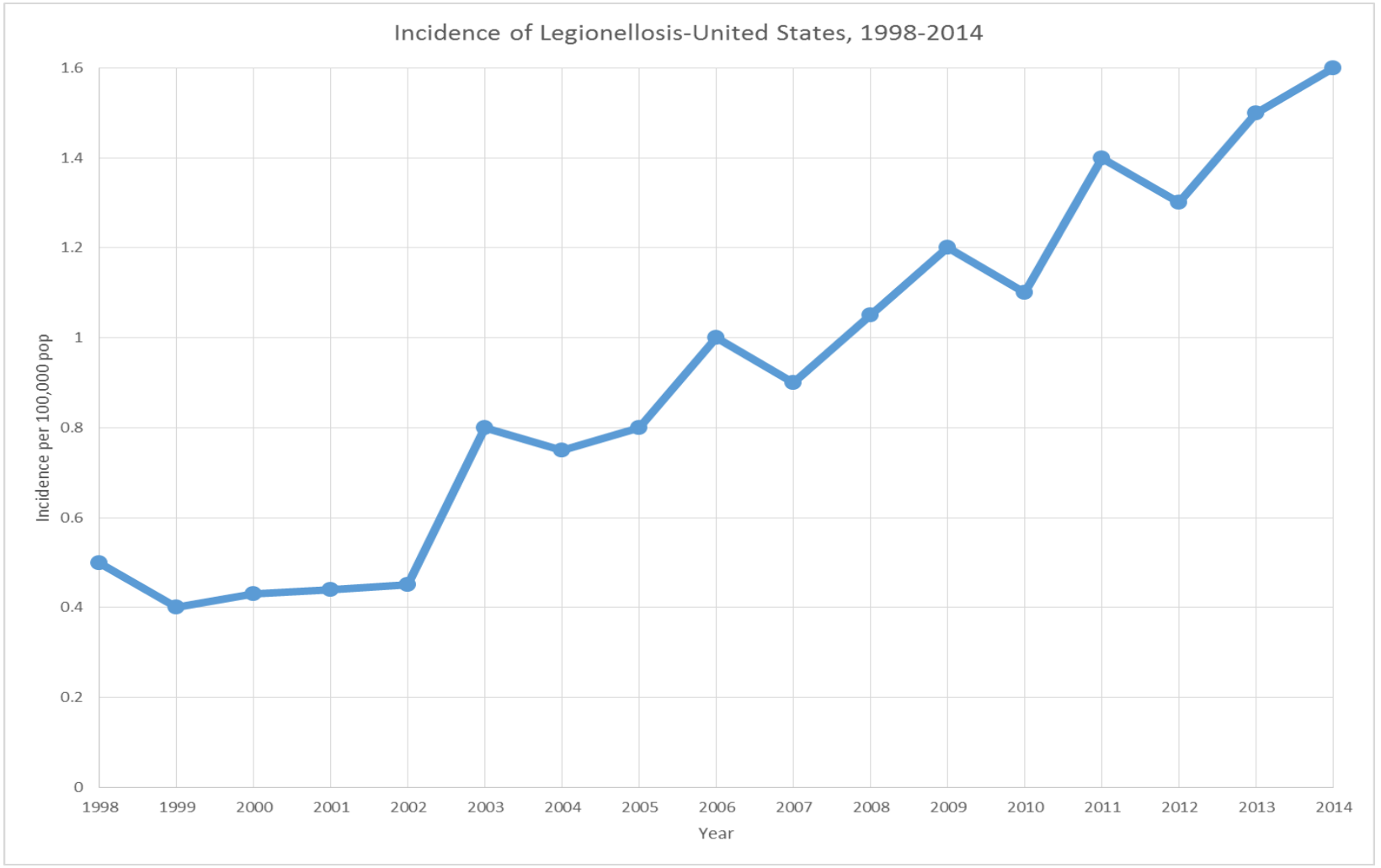
Today's Topics

- Our evolving understanding of *Legionella pneumophila as a* waterborne pathogen
- Approaches to prevention
  - Secondary water treatment of hot water
    - Monochloramine
  - Risk management (ASHRAE 188)

Legionella

A HIGHLY SUCCESSFUL MICROBE

Successful Microbe: Increasing Recognition?



Consider This…

- Legionellosis cases have increased substantially – over 200% in last 10 years

Many Cases Linked to Drinking Water

Morbidity and Mortality Weekly Report

Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water — United States, 2011–2012

Karlyn D. Beer, PhD[1,2]; Julia W. Gargano, PhD[2]; Virginia A. Roberts, MSPH[2]; Vincent R. Hill, PhD[2]; Laurel E. Garrison, MPH[3]; Preeta K. Kutty, MD[3]; Elizabeth D. Hilborn, DVM[4]; Timothy J. Wade, PhD[4]; Kathleen E. Fullerton, MPH[2]; Jonathan S. Yoder, MPH, MSW[2]

Morbidity Mortality Weekly Report (MMWR). August 14, 2015/64 (31); 842-848.
Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water — United States, 2011–2012

Legionella in Water

Centers for Disease Control and Prevention (CDC) reported:

- Legionella accounted for 66% of reported drinking water–associated outbreaks
- Legionella in building plumbing systems lead to drinking water–associated outbreaks.

Early Release / Vol. 65 June 7, 2016

Vital Signs: Deficiencies in Environmental Control Identified in Outbreaks of Legionnaires' Disease — North America, 2000–2014

Laurel E. Garrison, MPH[1]; Jasen M. Kunz, MPH[2]; Laura A. Cooley, MD[1]; Matthew R. Moore, MD[1]; Claressa Lucas, PhD[1]; Stephanie Schrag, DPhil[1]; John Sarisky, MPH[2]; Cynthia G. Whitney, MD[1]

Hospitals at Significant Risk According to Recent CDC Report

Legionella in hospitals – accounted for 57% of all cases and 85% of deaths

Most Significant Source

Potable water especially in hospitals
(and other buildings)
with complex hot water systems,
is the most important source of
Legionella transmission.

Origins of *Legionella*

- Incoming potable water (undetectable or very low conc.)
- Systems with warm water, such as water distributions systems and air cooling systems (provide growth factors)
- Biofilms within these systems (amplification)

Successful Legionella

MAKING HEADLINES - IN THE NEWS

Legionellosis Outbreaks

Sadly, outbreaks continue to occur (building warm water systems, cooling towers, fountains)

Outbreaks in Nursing Homes & Assisted Living Facilities

OUTBREAKS

Legionnaires' death toll rises to 10 in western Illinois

Published September 09, 2015 · 20 98

QUINCY, Ill. – At least 10 people in western Illinois have now died from Legionnaires' disease, after a state veterans home reported two new fatalities among its residents.

An outbreak first identified in late August after an initial case was detected several weeks earlier has sickened 53 residents at the Quincy home, nine of whom died. Four others in Quincy have been diagnosed with the illness, one of whom died. Officials say those cases aren't connected to the larger outbreak.

Legionnaires' outbreak linked to water

The hot water system sickened 11 patients at Miami Valley Hospital.

By Ben Sutherly

Staff Writer

DAYTON — Insufficient heating of the hot-water system in Miami Valley Hospital's new 12-story addition was the primary reason for the largest outbreak of Legionnaires' disease in Ohio since 2004, according to the hospital.

The outbreak of Legionnaires' disease at the hospital in February and March highlights an unintended result of plumbing codes that could put vulnerable populations like hospital patients at risk.

HOSPITAL OUTBREAK LINKED TO NEW CONSTRUCTION

Community Water System Outbreak

Epidemiol. Infect. (2015), **143**, 1322–1331.
doi:10.1017/S0950268814001964

Community outbreak of legionellosis and an environmental investigation into a community water system

P. D. COHN[1], J. A. GLEASON[1]*, E. RUDOWSKI[2], S. M. TSAI[2], C. A. GENESE[2] AND J. A. FAGLIANO[1]

Epidemiology & Infection 2015

Study Suggests Community Water Systems Could Be a Significant Source for *Legionella*

The Problem

New Jersey Health Department reports cases of Legionnaires' disease in senior high rise, geriatric center and single family housing

The Investigation

- The population in the area was ~9000 consistent with the area of influence of a 1 million gallon water tower.
- Investigation implicates poorly maintained water storage tank and surrounding distribution system

Probable Causes

1. Low flow conditions
2. Low or no chlorine
3. Little mixing of water storage tank
4. No regular flushing of water mains

Recommendations

1. Include community water systems as possible sources for *Legionella* transmission.
2. Community water systems supplied by surface water, especially where summer temperatures and available nutrients can amplify Legionella.

Flint: Not Just Lead In The Water

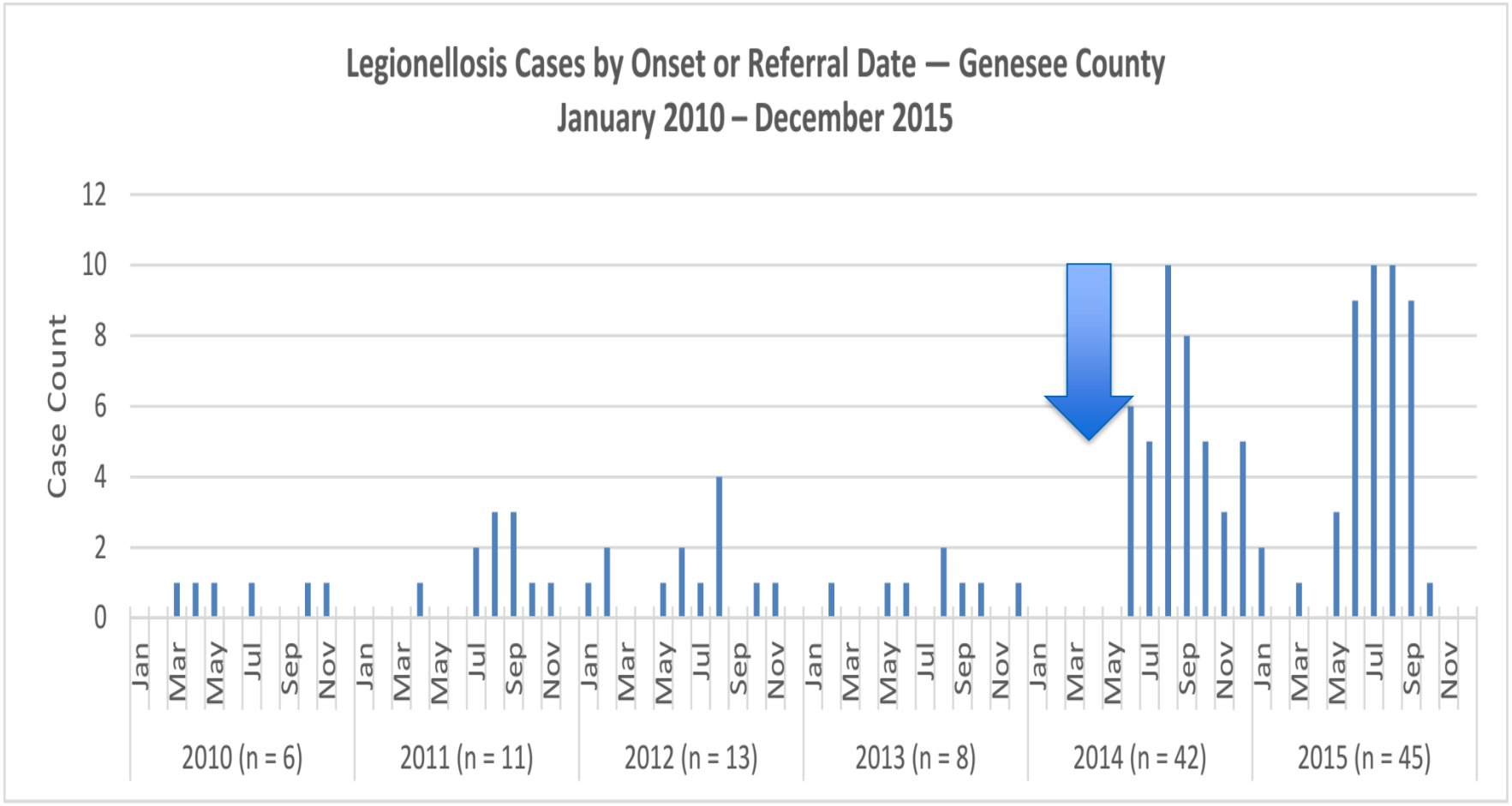
The Washington Post

Morning Mix

Can we blame the Michigan Legionnaires' disease outbreak on the Flint water crisis?

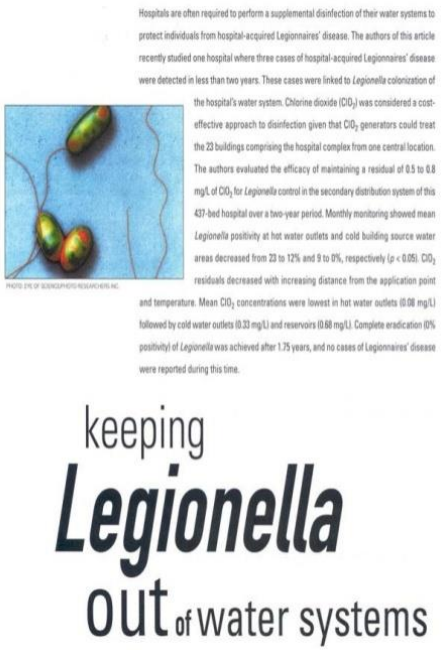
Flint Legionnaires' Disease Outbreak

Five-year History



I Have Legionella in My Building…
Now What?

SECONDARY DISINFECTION



Hospitals are often required to perform a supplemental disinfection of their water systems to protect individuals from hospital-acquired Legionnaires' disease. The authors of this article recently studied one hospital where three cases of hospital-acquired Legionnaires' disease were detected in less than two years. These cases were linked to *Legionella* colonization of the hospital's water system. Chlorine dioxide (ClO_2) was considered a cost-effective approach to disinfection given that ClO_2 generators could treat the 23 buildings comprising the hospital complex from one central location. The authors evaluated the efficacy of maintaining a residual of 0.5 to 0.8 mg/L of ClO_2 for *Legionella* control in the secondary distribution system of this 437-bed hospital over a two-year period. Monthly monitoring showed mean *Legionella* positivity at hot water outlets and cold building source water areas decreased from 23 to 12% and 9 to 0%, respectively ($p < 0.05$). ClO_2 residuals decreased with increasing distance from the application point and temperature. Mean ClO_2 concentrations were lowest in hot water outlets (0.08 mg/L) followed by cold water outlets (0.33 mg/L) and reservoirs (0.68 mg/L). Complete eradication (0% positivity) of *Legionella* was achieved after 1.75 years, and no cases of Legionnaires' disease were reported during this time.

keeping
Legionella
out of water systems

DISINFECTION OPTIONS

Why Treat Hot Water Only?

- Legionella grows best in warm water - near body temperature (98.6º F/37º C)
- Treatment of hot water systems only has controlled disease transmission
- Limits chemical addition to drinking water

Secondary Disinfection Methods

- Thermal shock treatment (heat & flush)
- Shock chlorination (>10 mg/L residual), may require water tanks to be 20-50 mg/L
- Continuous supplemental chlorination (2-4 mg/L)
- Copper-silver ionization (continuous)
- Chlorine Dioxide (ClO2)
- Monochloramine
- Point-of-use filtration

Newest Approach for *Legionella* Control in Hospital Water Systems

MONOCHLORAMINE

Why Monochloramine?

- Efficacy against *Legionella* in-vitro and in model plumbing systems
- Municipalities supplied with water treated with monochloramine were less likely to report hospital-acquired Legionnaires' disease

Monochloramine

- Used to treat potable water – Safe Drinking Water Act
- More stable than chlorine and chlorine dioxide at warm temperatures
- Italian company develops the first system for on-site generation
- Italian study shows efficacy

Report from Italy

Control of *Legionella* contamination in a hospital water distribution system by monochloramine

Isabella Marchesi, PhD,[a] Stefano Cencetti, MD,[b] Patrizia Marchegiano, MD,[b] Giuseppina Frezza, PhD,[a] Paola Borella, MD,[a] and Annalisa Bargellini, PhD[a]
Modena, Italy

American Journal Infection Control (AJIC) 2012;40:279-281

First Study in U.S.

OBJECTIVE

Determine the efficacy of this new system for on-site generation of monochloramine for controlling Legionella in a hospital water systems

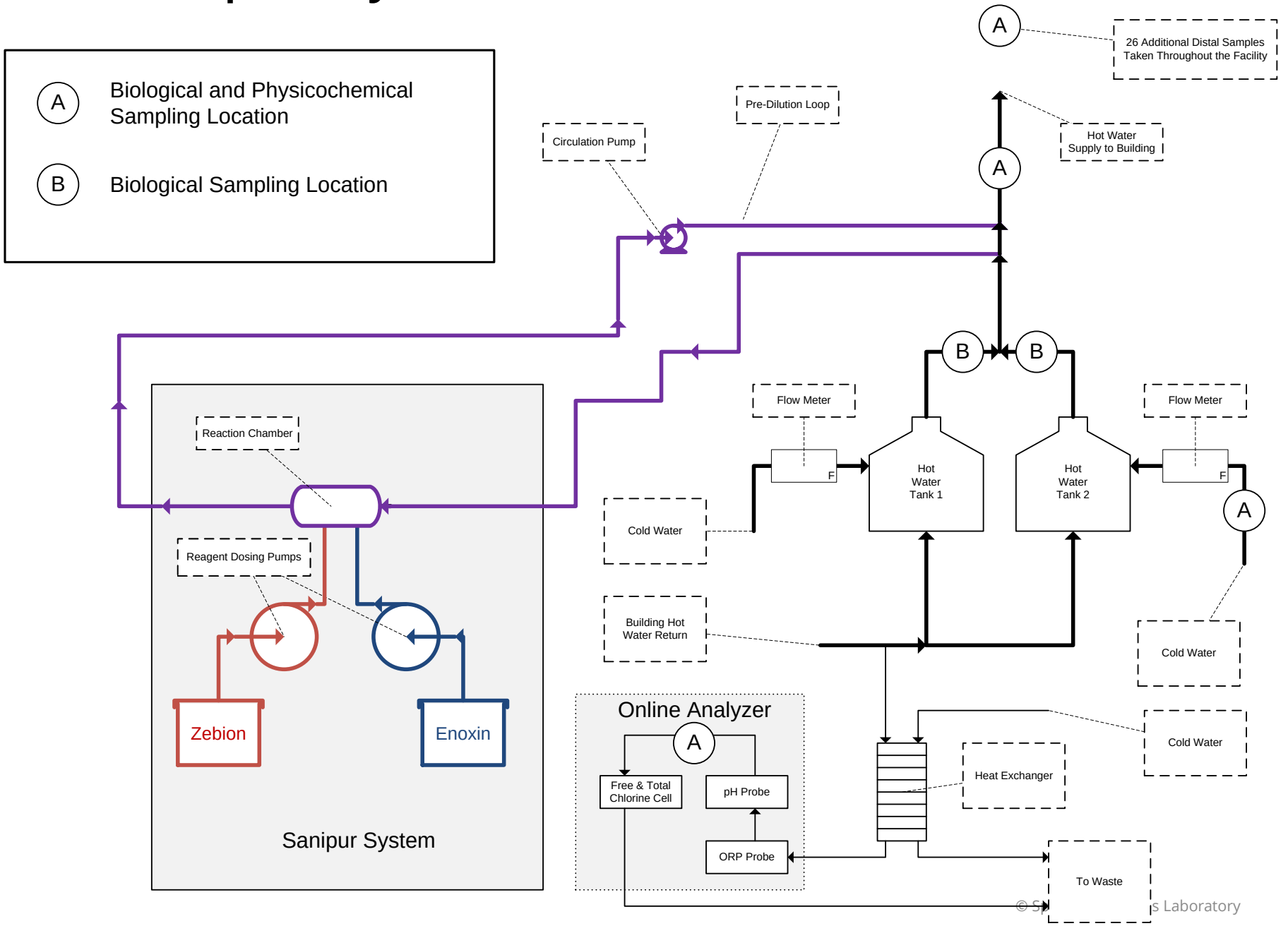
Our Study First U.S. Study: UPMC Mercy

- UPMC Mercy
  - 495 bed tertiary care hospital, Pittsburgh, Pa.
- 12 floors and 840,000 ft^2
- Serves 225,000 persons annually

Scope of Our Study

- 11 months – Started September 2011
- 27 distal outlets and hot water tanks tested monthly
- Approximately 100 baseline samples evaluated – April to September
- More than 200 post-disinfection samples

Sanipur System Installation Schematic

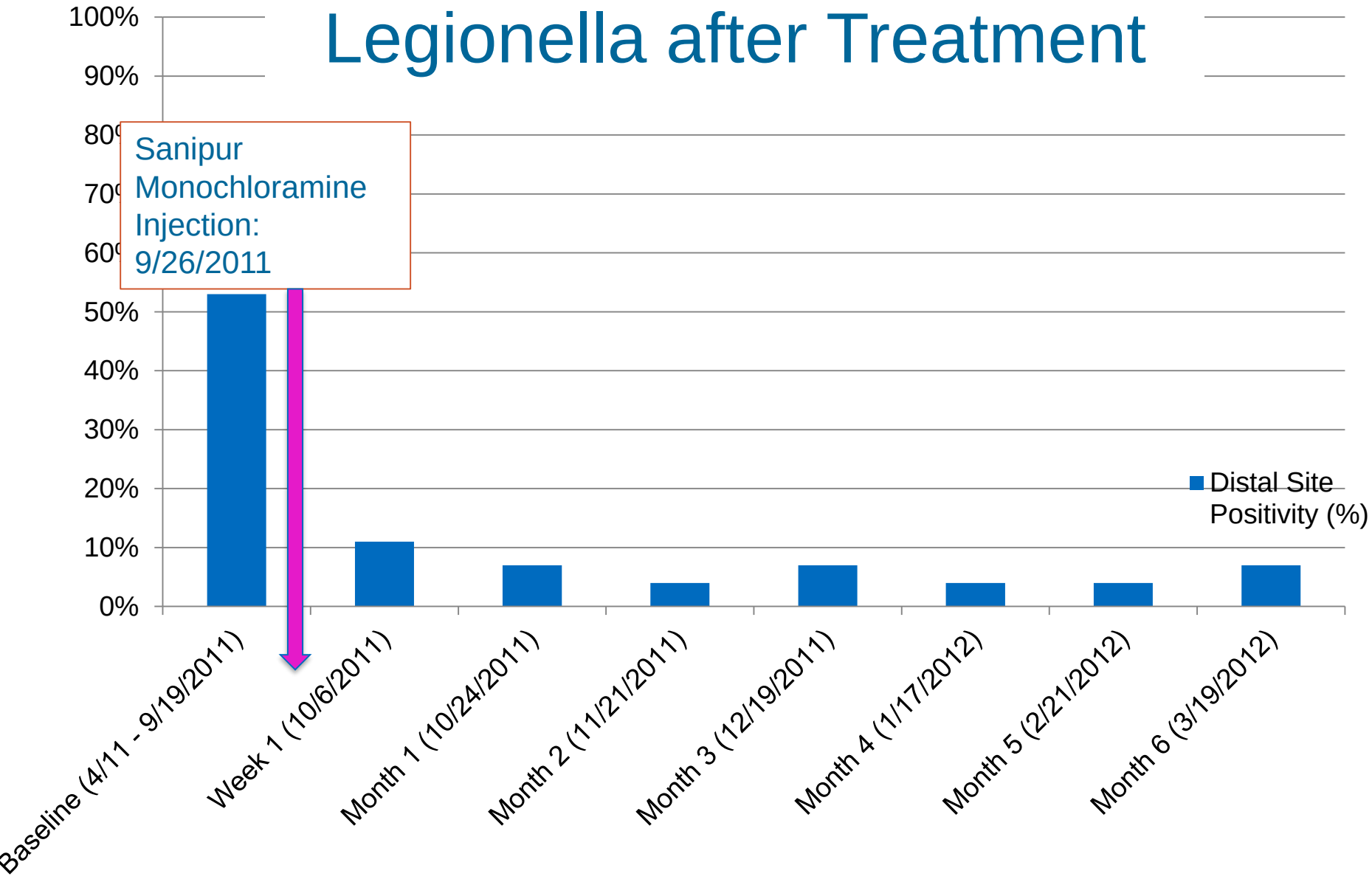


Legionella - Baseline

- Baseline Month 1 = 50% (15/30)
- Baseline Month 2 = 42% (11/26)
- Baseline Month 3 = 44% (12/27)
- Baseline Month 4 = 74% (20/27)

Baseline Average = 53%

Dramatic Reduction in Legionella after Treatment



Legionella

- Distal site positivity dropped to 11% after 1 week, and remained below 10% throughout the study ($p < 0.05$).

- After two months, *Legionella pneumophila* no longer isolated from water samples

- Legionella species isolated in a few locations (<10%)

Water Quality Parameters

- Average monochloramine concentration was 1.90 ppm (range 1.0 – 4.0).

- pH, ammonia, nitrate, nitrite, copper, silver, and lead concentrations remained below EPA MCLs for the duration of the study.

Results

On-site generation of monochloramine significantly reduced *Legionella* positivity (53% vs. <10% post-disinfection ($p<0.05$)

On-going Sampling

- Periodic testing shows distal site positivity for *Legionella* and non-tuberculous Mycobacteria remain low (<10%)
- No further cases
- No evidence for significant corrosion
- Operation and maintenance issues minor (ORP probe replacement)

Published Report

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY NOVEMBER 2014, VOL. 35, NO. 11

ORIGINAL ARTICLE

Evaluation of A New Monochloramine Generation System for Controlling *Legionella* In Building Hot Water Systems

Scott Duda, MS;[1] Sheena Kandiah, MD, PhD;[2] Janet E. Stout, PhD;[1,3] Julianne L. Baron, BS;[4] Mohamed Yassin, MD, PhD;[2] Marie Fabrizio, BSN, CIC;[2] Juliet Ferrelli, MS, MT (ASCP) CIC;[2] Rahman Hariri, PhD;[2] Marilyn M. Wagener, MS;[5] John Goepfert;[2] James Bond;[2] Joseph Hannigan, CWT;[6] Denzil Rogers[2]

2014: Cases Follow Renovation of Hematology-Oncology Unit

Healthcare-Associated Outbreak of Legionnaires' Disease on an Inpatient Hematology-Oncology Unit – Alabama, 2014

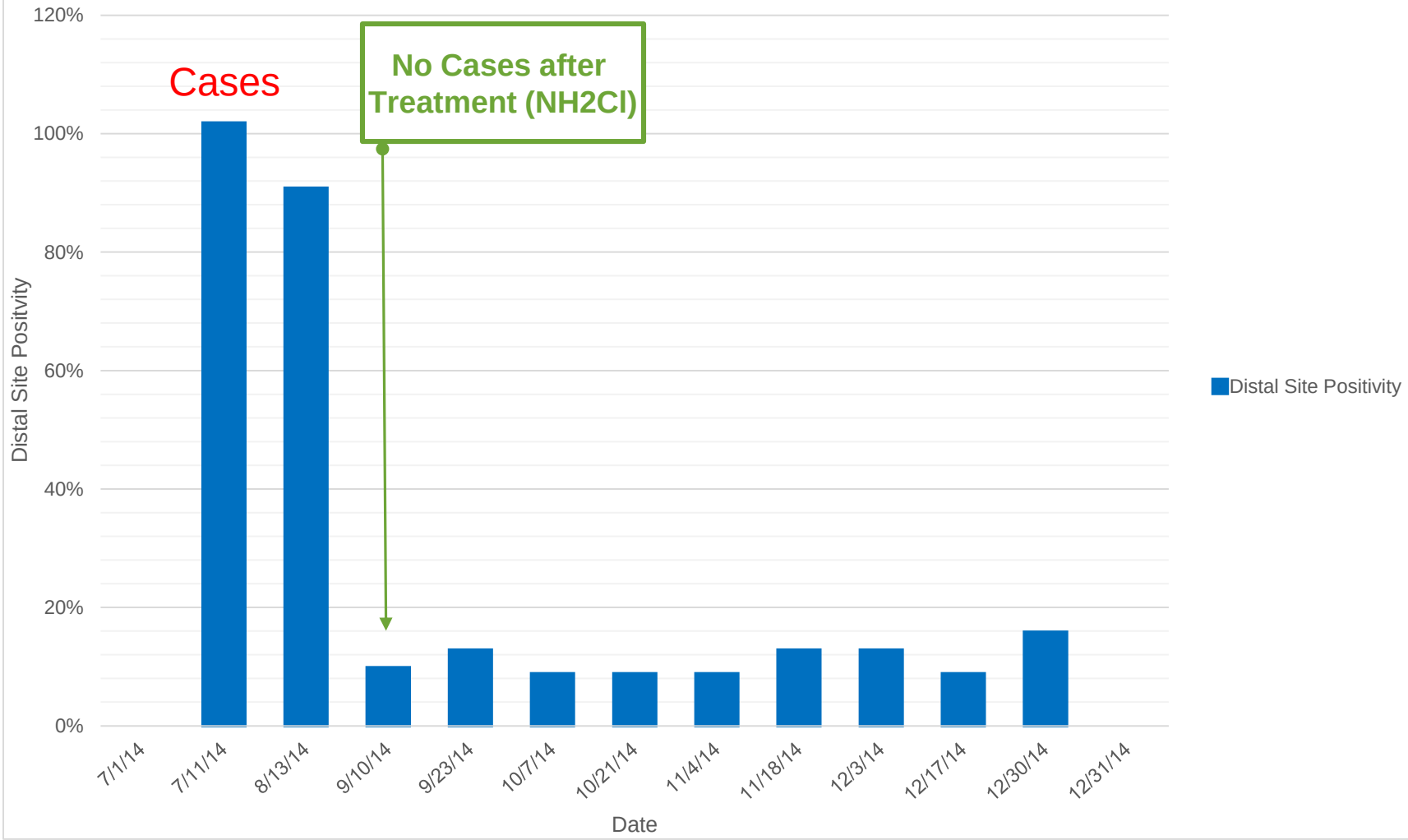
Author: Louise Francois Watkins
Date: Monday, April 20, 2015
Time: 9:35 am/et
Location: Ravinia Ballroom

Summary: A hospital unit for immune-compromised cancer patients experienced an outbreak of legionellosis, most likely associated with the hospital's water system. This outbreak highlights how vulnerable populations are at risk for healthcare-associated infections, including those from environmental exposures.

New Unit

- May 2014, 10 cases following completion of new hematology-oncology unit
- *L. pneumophila*, serogroup 1 isolated from 50% (17/34) heme-onc sites
- Cases stopped following:
  - shock disinfection, installation of point-of-use (POU) filters, monochloramine treatment

High (>30%) *Legionella* Distal Site Positivity And Cases Prior to Treatment



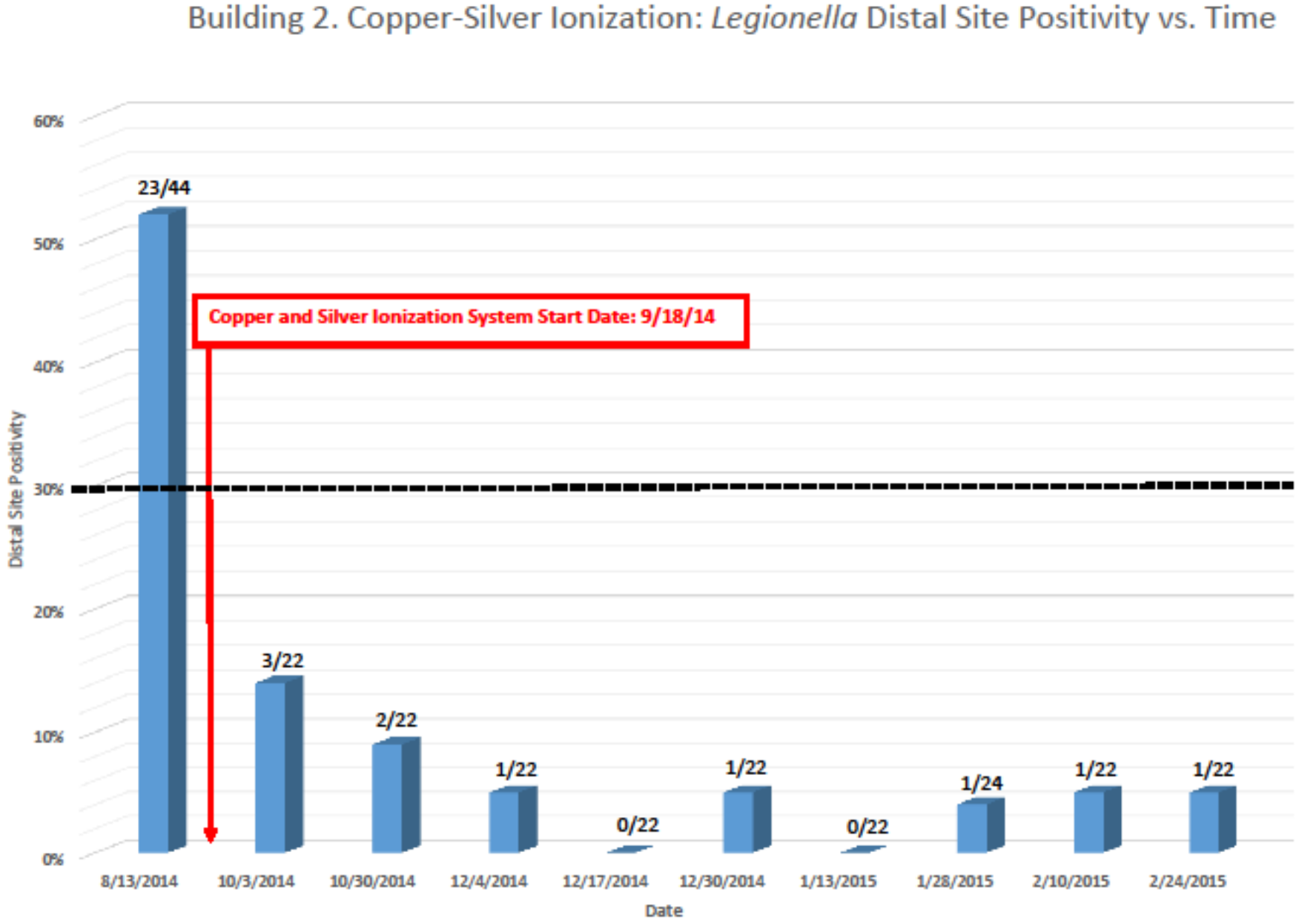
Multiple Approaches Effective

High Risk Bldg

- High percentage of outlets positive with cases;
- monochloramine system installed on hot water

Lower Risk Bldg

- High percentage of outlets positive no cases;
- copper-silver ionization system installed on hot water


Building 2. Copper-Silver Ionization: *Legionella* Distal Site Positivity vs. Time
60%
50%
40%
30%
20%
10%
0%
Distal Site Positivity
23/44
Copper and Silver Ionization System Start Date: 9/18/14
3/22
2/22
1/22
0/22
1/22
0/22
1/24
1/22
1/22
8/13/2014
10/3/2014
10/30/2014
12/4/2014
12/17/2014
12/30/2014
1/13/2015
1/28/2015
2/10/2015
2/24/2015
Date

Conclusions

- Both disinfection approaches were effective in reducing Legionella positivity
- Monochloramine was used in the building housing the highest risk group and to achieve the fastest reduction
- *Legionella* remediation - not “one size fits all”

Disinfection Methods Review:
Infection Control and Hospital Epidemiology

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY FEBRUARY 2011, VOL. 32, NO. 2

REVIEW ARTICLE

Controlling *Legionella* in Hospital Drinking Water: An Evidence-Based Review of Disinfection Methods

Yusen E. Lin, PhD, MBA;[1] Janet E. Stout, PhD;[2,3] Victor L. Yu, MD[3]

How are we doing?

PREVENTING LEGIONNAIRES' DISEASE

Progress Has Been Slow… Really Slow!

Legionella Has Their Attention

- ASHRAE
- CDC
- EPA
- NSF
- WRF
- Industry Organizations AWT and CTI

ASHRAE Standard to Prevent Legionnaires' Disease

Engineers' codes target Legionella

Group proposes new rules for building operators to prevent waterborne bacteria

BY ADAM SMELTZ

An engineering group that influences building codes nationwide is drafting tough new standards to prevent Legionella, the waterborne bacteria blamed in a deadly Legionnaires' disease outbreak in Pittsburgh.

Federal estimates show Legionnaires', a form of pneumonia, kills more than 4,000 people and sickens about 21,000 others each year, three decades after researchers figured out how to control the bacteria in tap water.

The proposed standards would require building operators to verify they are monitoring the Legionella threat in commercial, residential and medical facilities with established risk factors, such as multiple whirlpools and spas. It also outlines methods to prevent the growth of the bacteria.

The cost of implementing these standards is unknown. Single-family homes would not be included in the proposed changes.

"It's not the science or the engineering lacking here. It's the lack of a management system that can be applied in a practical and defensible way," said William McCoy, Standards Committee chairman at the American Society of Heating, Refrigerating and Air-Conditioning Engineers in Atlanta.

McCoy's international committee, part of the 55,000-member engineering society, worked for the past six years to craft the first unified and enforceable domestic rules for Legionella control in the plumbing of large buildings, where the bacteria can fester and grow. The proposed plan could be voted on by the society's board this year.

The International Code Council in Washington generally adopts ASHRAE recommendations in building code guidelines that are used by state and local code enforcement agencies across the country.

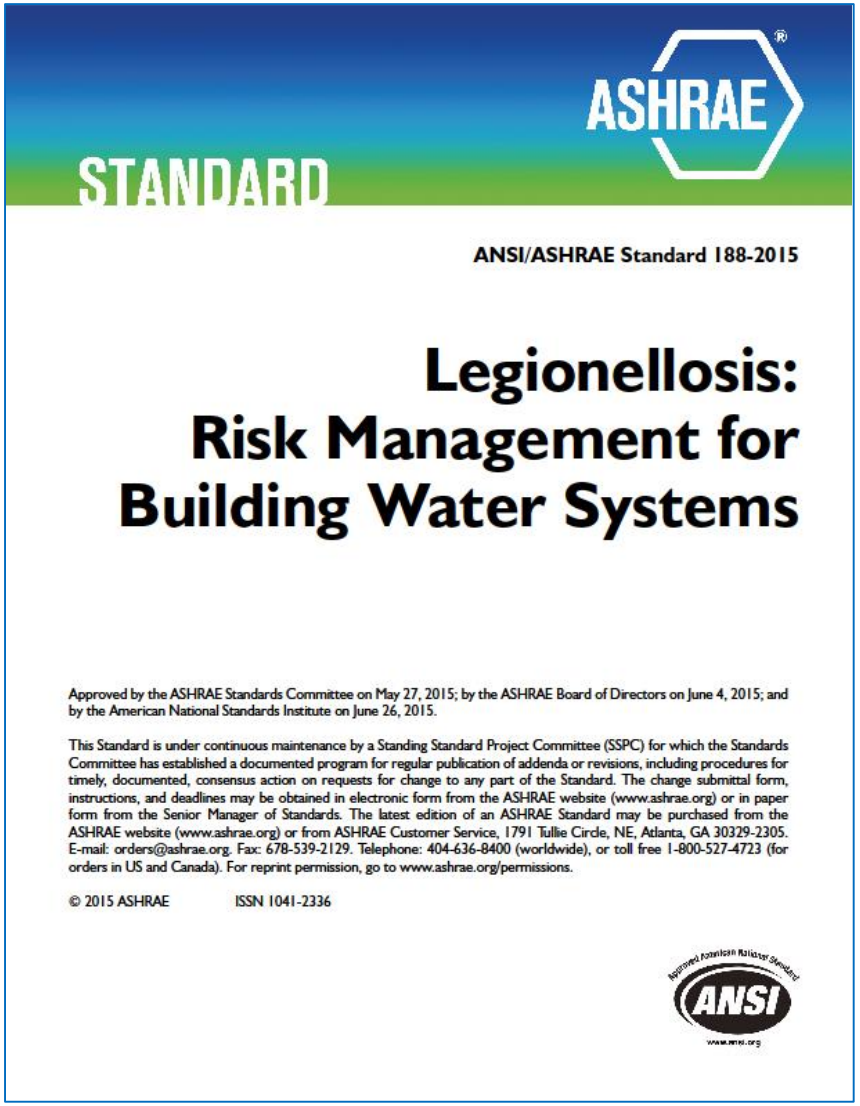
Current ICC recommendations do not mention Legionnaires' disease, spokesman Steve Daggers said. The little-known council drew national attention in 2008 for advocating stringent fire sprinkler standards for single-family homes that met with heavy resistance from builders and consumers.

ASHRAE will not perform a cost-

VA • B7

American Society of Heating, Refrigerating and Air-conditioning Engineers

- First Legionella standard in the United States.
- Approved June 26, 2015



STANDARD

ASHRAE

ANSI/ASHRAE Standard 188-2015

Legionellosis: Risk Management for Building Water Systems

Approved by the ASHRAE Standards Committee on May 27, 2015; by the ASHRAE Board of Directors on June 4, 2015; and by the American National Standards Institute on June 26, 2015.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

Approved American National Standard

ANSI

www.ansi.org

Purpose of ASHRAE Standard 188

Establish minimum Legionellosis risk management requirements for building water systems.

Elements of Water Management Program

Program Team – Persons responsible for Program development and implementation.

Water Systems/Flow Diagrams – Describe potable and non-potable water systems and develop water system-schematics.

Water System Analysis/Control Measures – Evaluate where hazardous conditions may occur and decide where control measures should be applied.

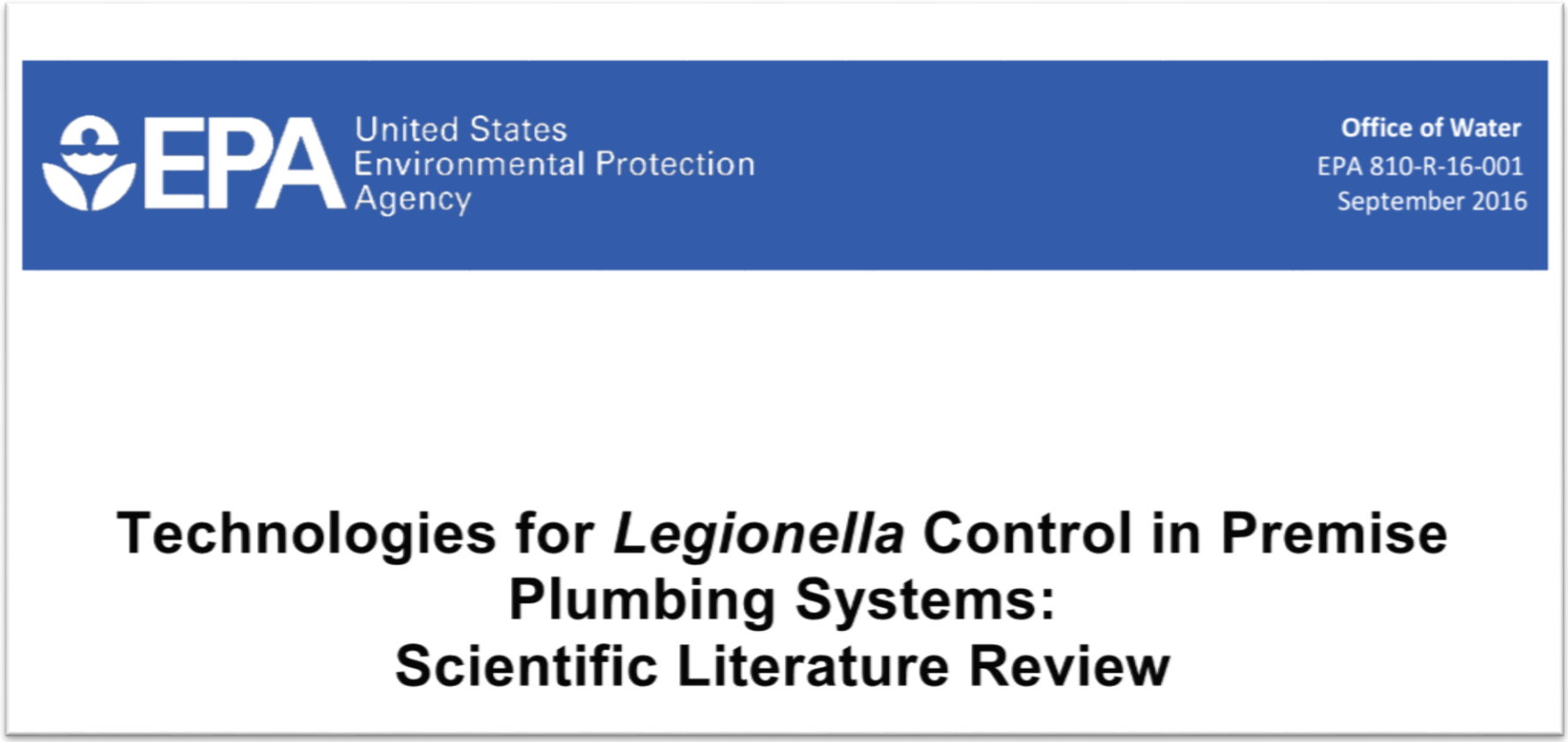
Monitoring/Corrective Actions – Establish procedure for monitoring whether control measures are within operating limits and, if not, take corrective actions.

Confirmation – Establish procedure to confirm Program is being implemented as designed (verification) and the Program effectively controls the hazardous conditions (validation).

Documentation – Establish documentation and communication procedures for all activities of the Program.

New Government Focus On Legionella Prevention

EPA Issues Review of Legionella Control & Disinfection Methods



CDC Focuses on Effective Water Management For Legionnaires' Disease Prevention

June 6, 2016 Version 1.

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

A PRACTICAL GUIDE TO IMPLEMENTING INDUSTRY STANDARDS

Did You Know CDC Has a New Position On Testing?

"We are not against testing" water for the presence of Legionella…We think it has its place, particularly in healthcare facilities."

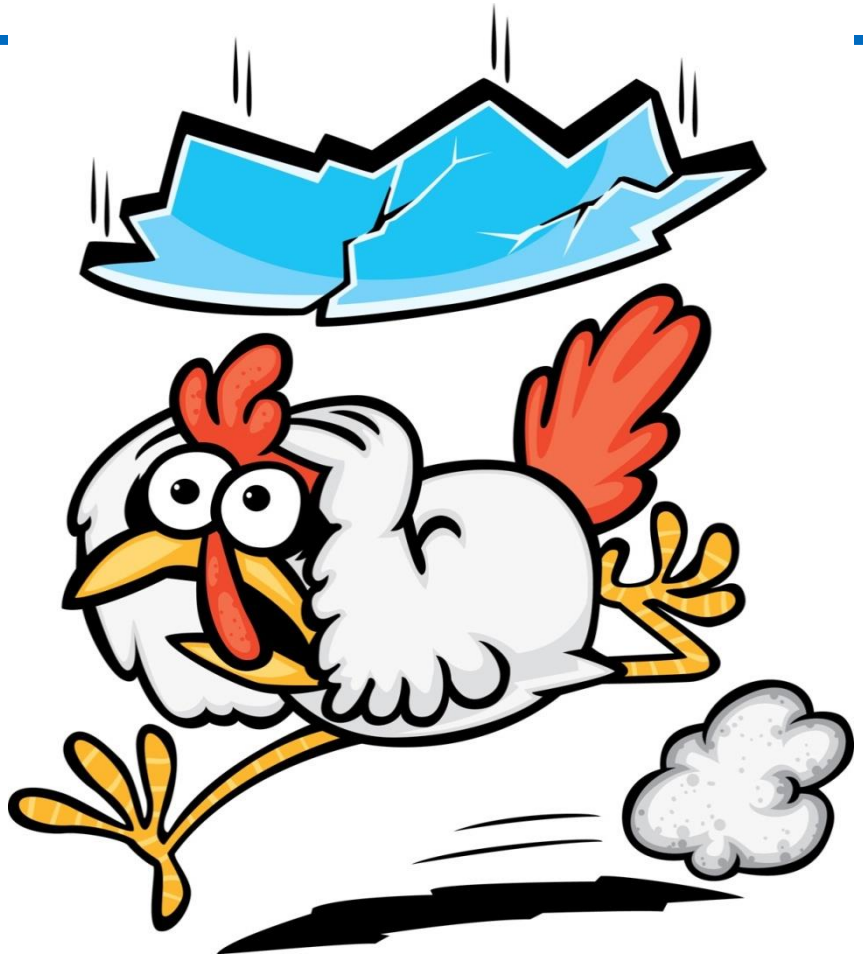
Cynthia Whitney, MD Division of Bacterial Diseases, National Center for Immunization and Respiratory Diseases, CDC. June 8, 2016 Pittsburgh Post Gazette

Risk – Potable Water

Risk of Legionnaires' disease was better predicted by the **proportion** of water system sites testing positive for *Legionella* than by the concentration of *Legionella* bacteria.

Kool J L, et al. Infect. Control Hosp. Epid. 1999 20:797-805

Is the Sky Falling?



If I Find Some *Legionella*?

Our Mission:
End Legionnaires' Disease

- No one should die from a preventable disease caused by a bacteria in water.
- Legionnaires' disease can and should be prevented.

Total Legionella Control

- Legionella & Pathogen Testing
- Consulting & Education
- ZEROutbreak™ Protection

An evidence-based, integrated platform of solutions:

- Legionella & Pathogen Testing
- Consulting & Education
- ZEROutbreak Protection

Let’s End LD Together

SPECIAL PATHOGENS LABORATORY®
THE LEGIONELLA EXPERTS®

THANK YOU

Dr. Janet E. Stout

President, Microbiologist

info@specialpathogenslab.com