Legionella: New Standards and Paradigm for Prevention

Janet E. Stout, PhD
Microbiologist, Director
Special Pathogens Laboratory

Research Associate Professor
University of Pittsburgh

Special Pathogens Laboratory®
The Legionella Experts®

Advocates for Prevention

- Ubiquitousness of *Legionella pneumophila* in the Water Supply of a Hospital with Endemic Legionnaires' Disease
- *New England Journal of Medicine* (1982)

Victor L. Yu, M.D. and Janet E. Stout, Ph.D.

Topics For Today

1. Disease-causing bacteria in hospital water systems: *Legionella* and others

2. New Proposed Legionella Standards
   a) ASHRAE proposed Standard 188P for buildings
   b) Cooling Technology Institute Standard 159 for cooling towers

Topics For Today

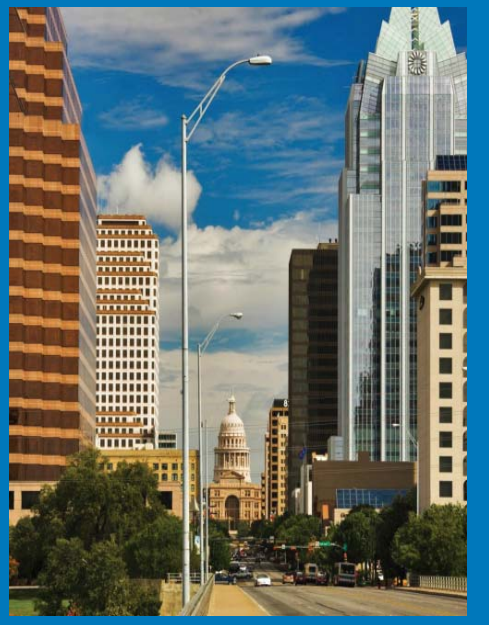
3. Disinfection methods – New Study on Monochloramine System

4. Legal perspective on new standards

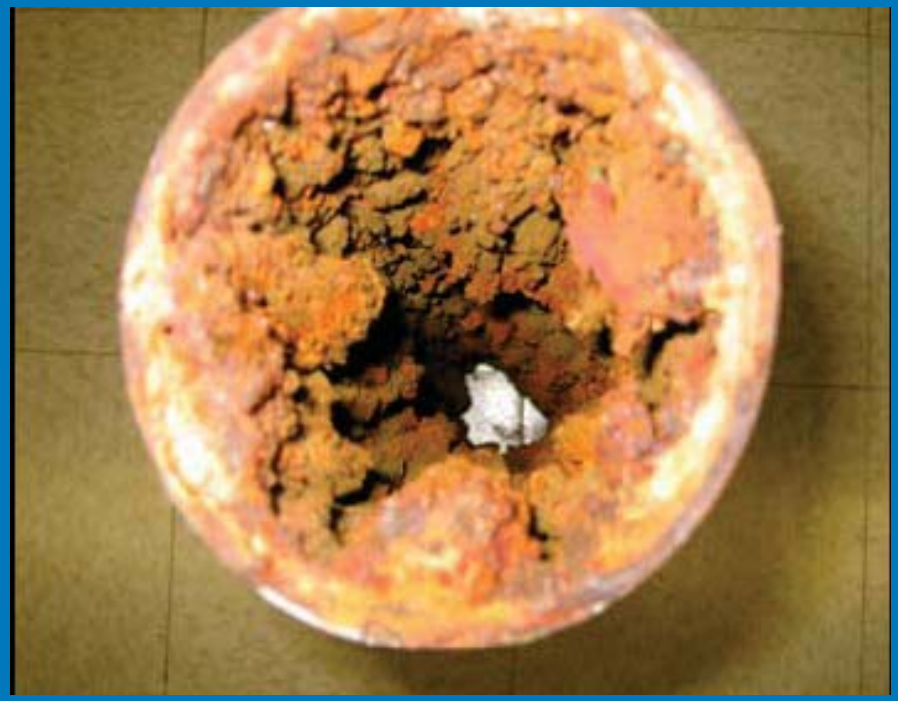
Bacteria Breeding Grounds

- Faucets
- Drains
- Humidifiers
- Fountains, spas

- Hospitals
- Hotels
- Commercial buildings
- Homes



What's in Your Water? ®

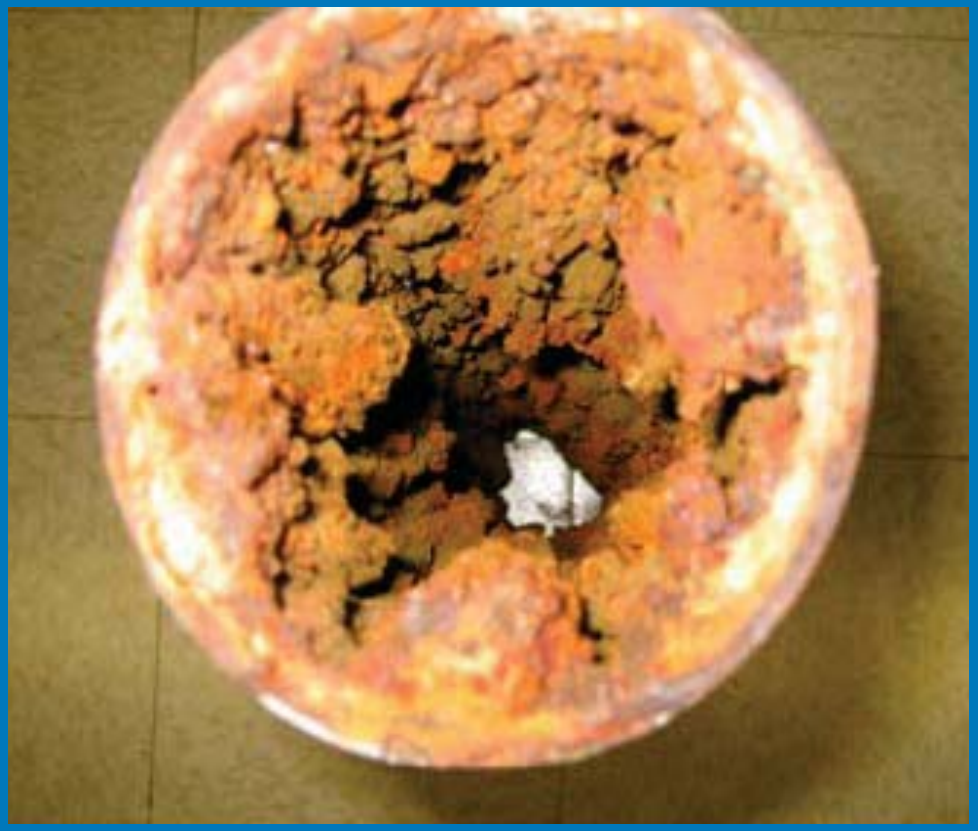


Cross section of 4 inch pipe from hospital hot water system

What's in Your Water? ®

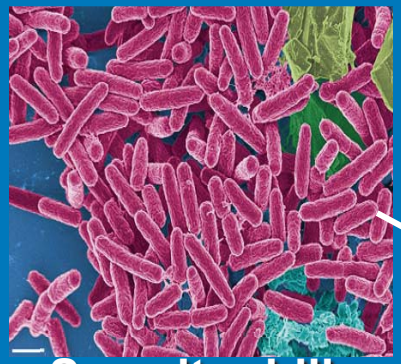
- Minerals:
  iron, calcium,
  magnesium

- Complex matrix of organic materials and microbial communities
  = **BIOFILM**

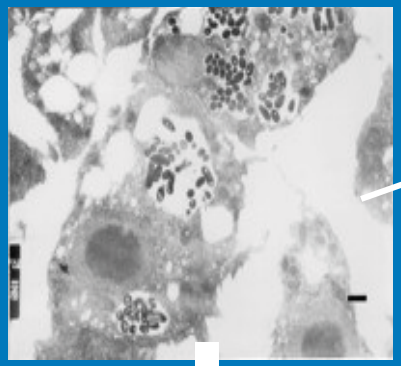


Want a drink of water?

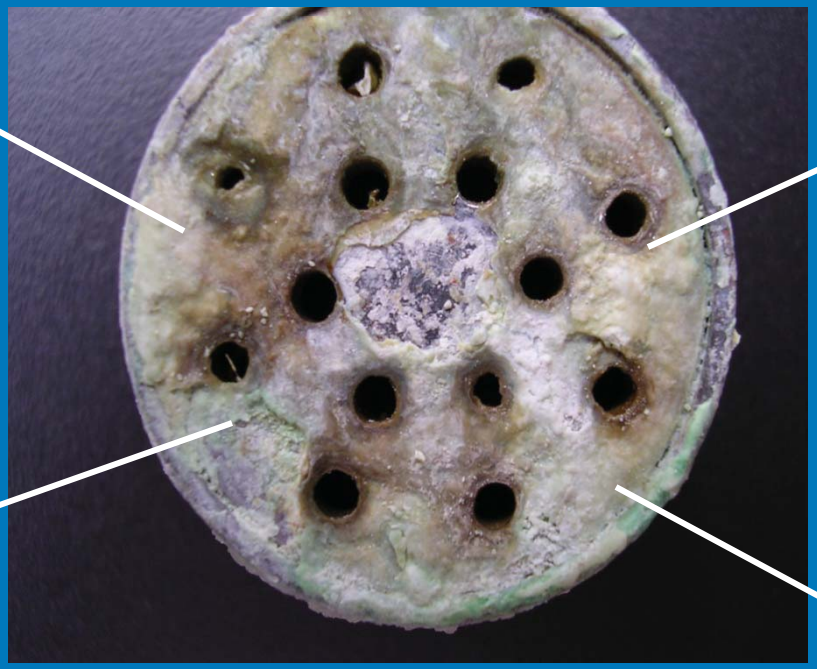
What Bacteria Are in Our Faucets?



S. maltophilia



Amoeba Resistant Microorganisms (*Legionella*)



Acinetobacter

P. aeruginosa

Bacteria in Hospital Water

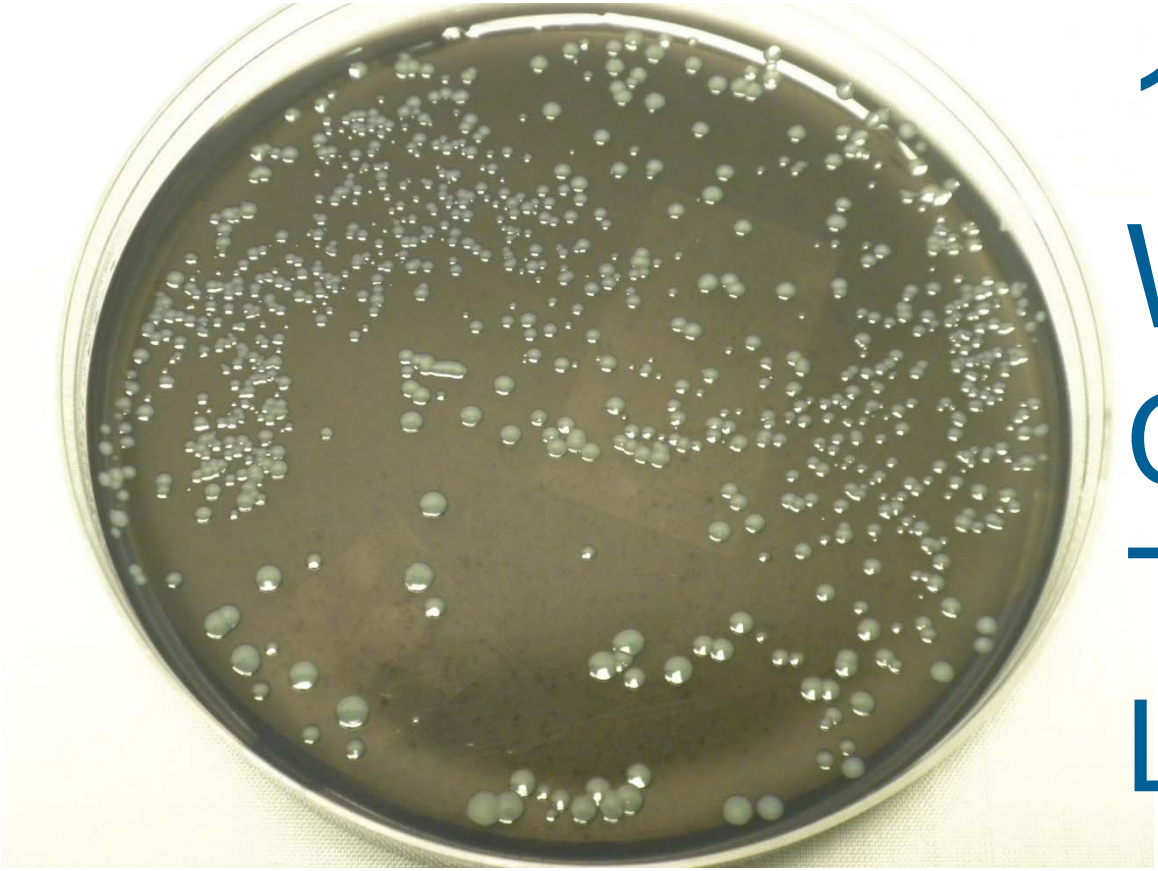
Water is the Reservoir

Organism	Site of Infection	Sources of Infection
Pseudomonas aeruginosa	Blood, catheter site, lungs, urinary – high mortality	**Potable water**, contaminated liquid solutions and disinfectants, endoscopes
Stenotrophomonas maltophilia	Blood (septicemia), pneumonia, urinary tract, wound infections, skin, stools, throat,	**Potable water**, distilled water, contaminated liquid solutions and disinfectants
Acinetobacter baumannii	Skin, wound	Room humidifiers, distilled water, moisture in mechanical ventilators
Chryseobacterium spp.	Blood	**Potable water** (burn unit), ice machine
Non-tuberculous Mycobacteria (NTM) *species (avium and fortuitum)*	Abscesses and wound infections, disseminated	**Hospital hot water system, shower**
Legionella pneumophila (other species rarely)	Lung (pneumonia), wound infection- high mortality	**Hospital hot water system**
Aspergillus species and *Fusarium* species	Wound infection, disseminated disease	**Hospital hot water system**

You' ll Never Drink… Another Glass of Water

"Take a look, Mom. You'll never drink another glass of water."

Legionella from a Hospital Drinking Fountain



1 Drop of Water Contains Thousands of Legionella

Legionella Is Winning

"***Legionella*** …
is the single most common
etiologic agent associated with
outbreaks involving drinking water."

Report by the U.S. Environmental Protection Agency (EPA) and the Committee on Public Water Supply Distribution Systems
2006. National Academy of Sciences Report

Legionnaires' Disease Increasing?

Increasing Incidence of Legionellosis in the United States, 1990–2005: Changing Epidemiologic Trends

Karen Neil and Ruth Berkelman

Department of Epidemiology, Emory University, Atlanta, Georgia

(See the editorial commentary by Ng et al. on pages 600–2)

Background. An abrupt increase in the incidence of legionellosis in the United States has been noted since 2003. Whether the recent increase is associated with shifting epidemiologic trends has not been well characterized.

Methods. We analyzed all cases of legionellosis reported to the Centers for Disease Control and Prevention through the National Notifiable Disease Surveillance System from 1990 through 2005.

Results. A total of 23,076 cases of legionellosis were reported to the Centers for Disease Control and Prevention from 1990 through 2005. The number of reported cases increased by 70% from 1310 cases in 2002 to 2223 cases in 2003, with a sustained increase to >2000 cases per year from 2003 through 2005. The eastern United States showed most of the increases in age-adjusted incidence rates after 2002, with the mean rate in the Middle Atlantic states during 2003–2005 exceeding that during 1990–2002 by 96%. During 2000–2005, legionellosis cases were most commonly reported in persons aged 45–64 years. Persons aged <65 years comprised 63% of total cases in 2000–2005. Age-adjusted incidence rates in males exceeded those in females for all age groups and years. Legionellosis incidence showed marked seasonality in eastern states, with most cases reported in the summer or fall.

Conclusions. Reported legionellosis cases have increased substantially in recent years, particularly in the eastern United States and among middle-aged adults. *Legionella* infection should be considered in the differential diagnosis of any patient with pneumonia. Public health professionals should focus increased attention on detection and prevention of this important and increasing public health problem.

Clinical Infectious Diseases 2008 vol. 47

Report available: www.specialpathogenslab.com

2008 Conclusion

- Legionellosis cases have increased substantially, particularly in the eastern U.S. and among middle-aged adults
- Public health professionals should focus on **prevention** of this important and increasing public health problem

217% Increase in Cases (2011)

Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 60 / No. 32
August 19, 2011

Legionellosis — United States, 2000–2009

Legionnaires disease (LD), a serious, sometimes lethal pneumonia, and Pontiac fever (PF), an influenza-like, self-limited illness, are the two most common forms of legionellosis, which is caused by *Legionella* bacteria. Legionellosis cases are reported to CDC through the National Notifiable Disease Surveillance System (NNDSS) and a Supplemental Legionnaires Disease Surveillance System (SLDSS) designed to manage surveillance data on travel-related cases and enhance outbreak detection. For this report, cases reported to NNDSS during 2000–2009 from the 50 states and the District of Columbia (DC) were assessed, and crude and age-adjusted incidence rates per 100,000 persons were calculated. U.S. legionellosis cases reported annually increased 217%, from 1,110 in 2000 to 3,522 in 2009, and the crude national incidence rate increased

Census divisions.* Only cases considered confirmed under the 2005 Council of State and Territorial Epidemiologists' (CSTE) legionellosis case definitions are described in this report.† To be classified as confirmed, cases must be clinically compatible with legionellosis (i.e., fever, myalgia, cough, and/or clinical or radiographic evidence of pneumonia) and meet at least one of the confirmatory laboratory criteria (i.e., recovery of *Legionella* sp. in culture, detection of *Legionella pneumophila* serogroup 1 antigen in urine, or fourfold or greater rise in *L. pneumophila* serogroup 1-specific serum antibodies).

States also are encouraged to report cases to SLDSS to enhance detection of travel-related outbreaks and to provide information on additional legionellosis case variables not captured by NNDSS.§ Legionellosis cases ideally should be reported

Estimated Number of Cases

- In the U.S. approximately 600,000 adults are diagnosed with community-acquired pneumonia requiring hospitalization

- Approximately 2-5% are caused by *Legionella*

Cost Associated with LD CDC Estimates

- Cost per patient $34,000
- Average hospital stay 10 days
- Total hospitalization costs per year between **$101 and $321 million dollars**

Collier, SA. 07. Presented at: 2010 International Conference on Emerging Infectious Diseases; July 11-14, 2010; Atlanta.

Why Should You Care about *Legionella?*

- *Legionella* in the water systems of buildings is a serious health risk
- Even a single case can dramatically affect the bottom line of an organization

Floors likely to reopen at Grady today

Hospital makes changes in wake of Legionnaires'

By CRAIG SCHNEIDER
cschneider@ajc.com

Grady Memorial Hospital expects to reopen some areas today that were contaminated with Legionnaires' dis[illegible] ing $[illegible] to prevent another outbreak, hospital officials said.

Hospital officials said for a person to contract the potentially deadly disease. Legionnaires' is a form of pneumonia.

Today, if tests determine the areas are safe, the hospital will begin moving patients back into the 42 beds on the 11th floor. The 12th-floor area, while safe, will remain closed because the space isn't needed.

Public Relations Nightmare

http://www.timesonline.co.uk/printFriendly/0,,1-210-1323726-210,00.html - Microsoft Internet ...

TIMES ONLINE

PRINT THIS ARTICLE

CLICK HERE TO PRINT

CLOSE WINDOW

October 22, 2004

Hospital shower kills cured patient

BY SAM LISTER

NHS admits liability after recovering cancer patient contracts legionnaires' disease on ward

A PATIENT who was due to leave hospital following successful cancer treatment died after contracting legionnaires' disease from a dirty shower on his ward.

Daryl Eyles, 37, had just completed a course of chemotherapy at the oncology unit at the Royal United Hospital, Bath, when his health suddenly deteriorated.

He died a week later — the day before he had been due to be discharged — from what doctors took to be pneumonia.

A post-mortem examination on Mr Eyles, who worked as a security officer at the University of Bath, identified the cause of death as legionella bacteria, which was traced to a shower head at the hospital. A spokesman for Royal United Hospital Bath NHS Trust said that the hospital had admitted liability, and would be offering his widow, Andrea, and the couple's children, compensation.

Mrs Eyles, who also works at the University of Bath, said yesterday that it beggared belief that her husband had been killed not by the

WANTED

ME has 2 positions, positi ng, data-entry. Macintosh rred.Full benefits.# benef lary req. to: 770-555-1234

Pocahontas seeks Geronimo for an Indian summer

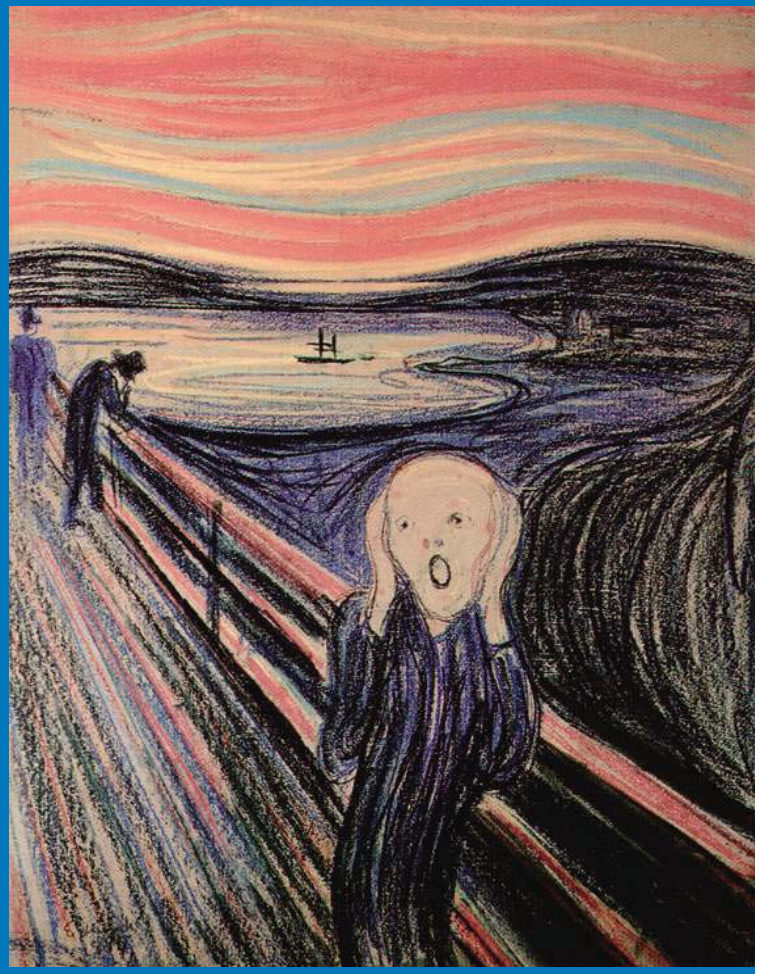
TDHM WLTM F30-35 2B SOULM8

Co. in ME has 2 positions, counting, data-entry. Maci preferred.Full benefits.# w/ salary req. to: 770-555

Print/Mail Co. in ME has Generali Accounting, dat or MOS exp. preferred. F

Start

http://www.timesonli...

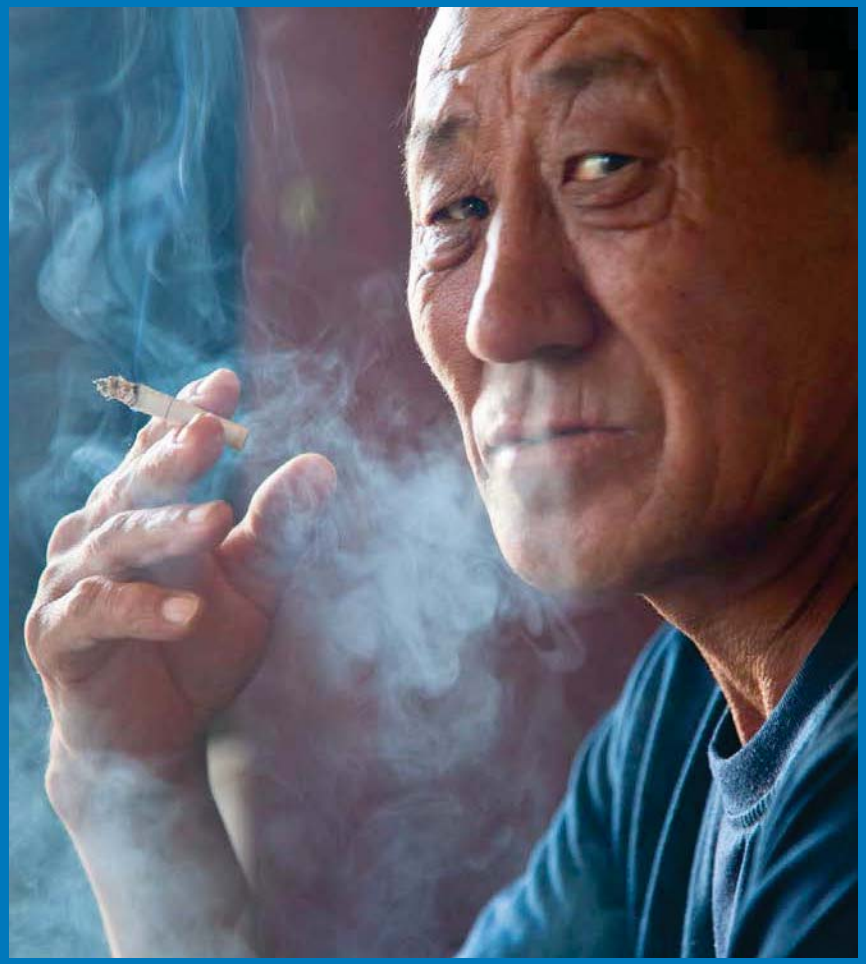


Legionella Didn't Kill the Patient … the Hospital Did!

Legionella makes the headlines and the stigma sticks!

Who Gets Legionnaires' Disease?

- Elderly
- Smokers
- Immunocompromised
  - Transplant patients
  - High-dose steroids for lung disease
  - Diabetes
  - Cancer



Q & A

- What percentage of LD cases have none of these typical host risk factors?

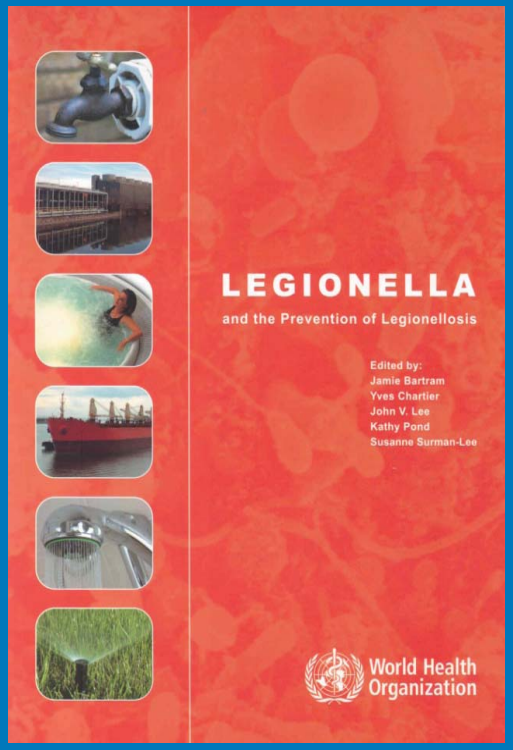
A. 5%
B. 1%
C. 22%

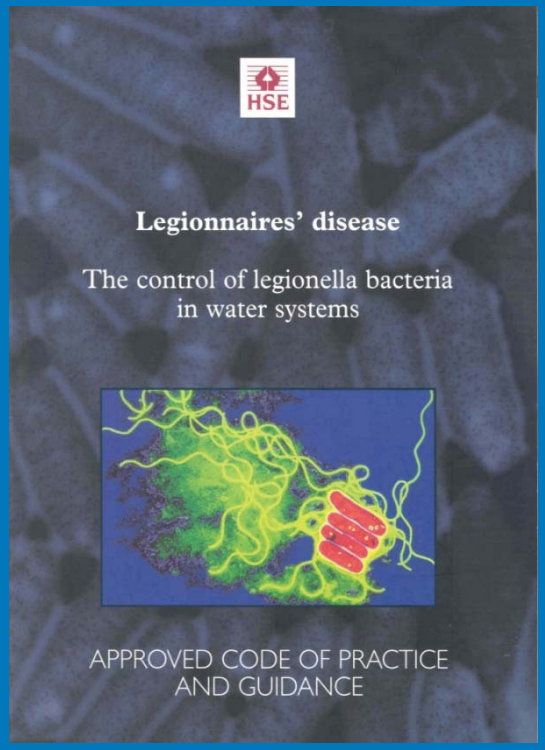
Squire et al.,
American Journal of Infection Control, 2005; 33:360-7

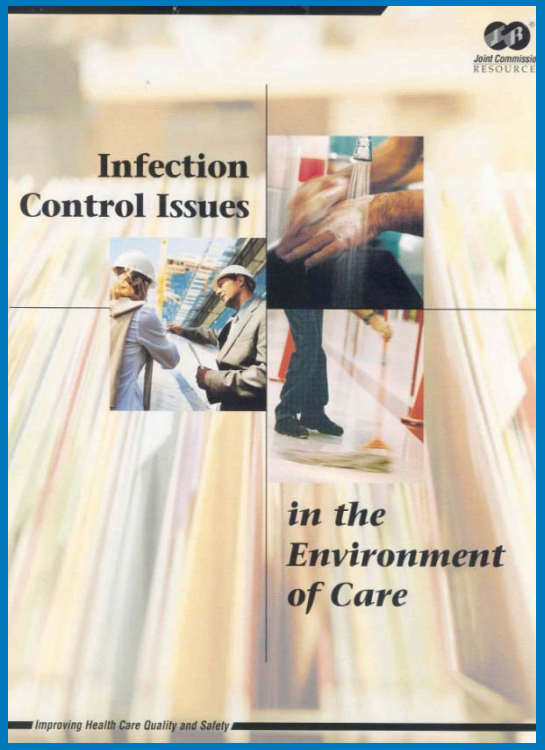
Policy of Avoidance

Most wait to address the problem until after a case of Legionnaires' disease is diagnosed

Legionella Guidance







U.S. *Legionella* Guidelines

- Centers for Disease Control and Prevention (CDC)
- Environmental Protection Agency (EPA)
- NY & MD State Dept.'s of Health
- Joint Commission for Accreditation of Hospitals
- Occupational Safety and Health Administration (OSHA)
- American Society for Heating, Refrigerating, and Air Conditioning Engineers(ASHRAE)
- Cooling Technology Institute (CTI)
- Veterans Healthcare System
- Allegheny Co. Health Department (Pittsburgh)

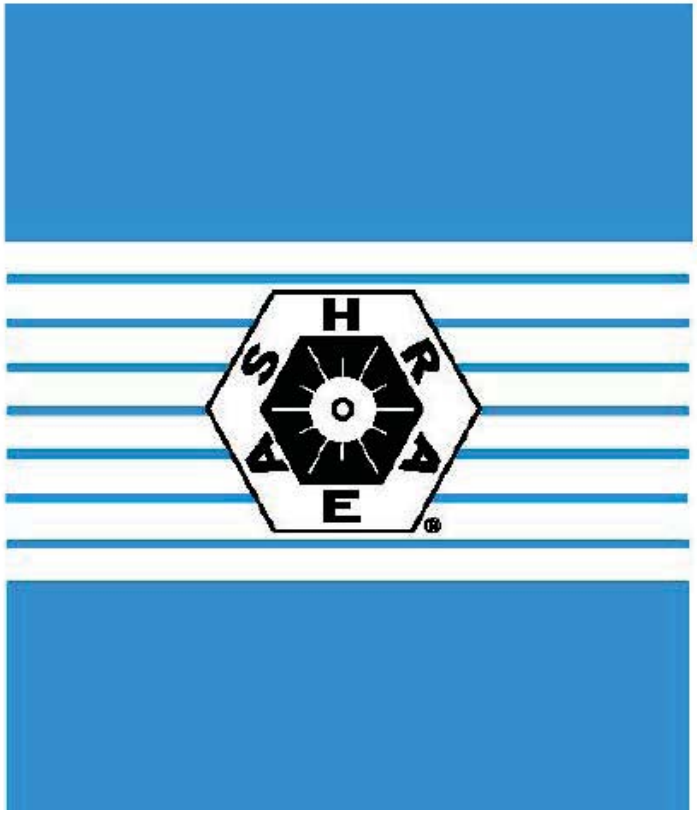
Guidance Hasn't Controlled Legionnaires' Disease

How Will Legionnaires' Disease Be Controlled in the U.S.?

- President Obama mandates new prevention plan … and makes it part of the new health care plan?
- Everyone voluntarily begins to test and treat water systems to control *Legionella*?
- New directives and standards are enacted requiring hospitals and building owners to address *Legionella* in building water systems

New *Legionella* Standards

Proposed ASHRAE *Legionella* Standard



BSR/ASHRAE Standard 188P

Public Review Draft

ASHRAE® Standard

Proposed New Standard 188, Prevention of Legionellosis Associated with Building Water Systems

Guidelines vs. Standards

Guideline

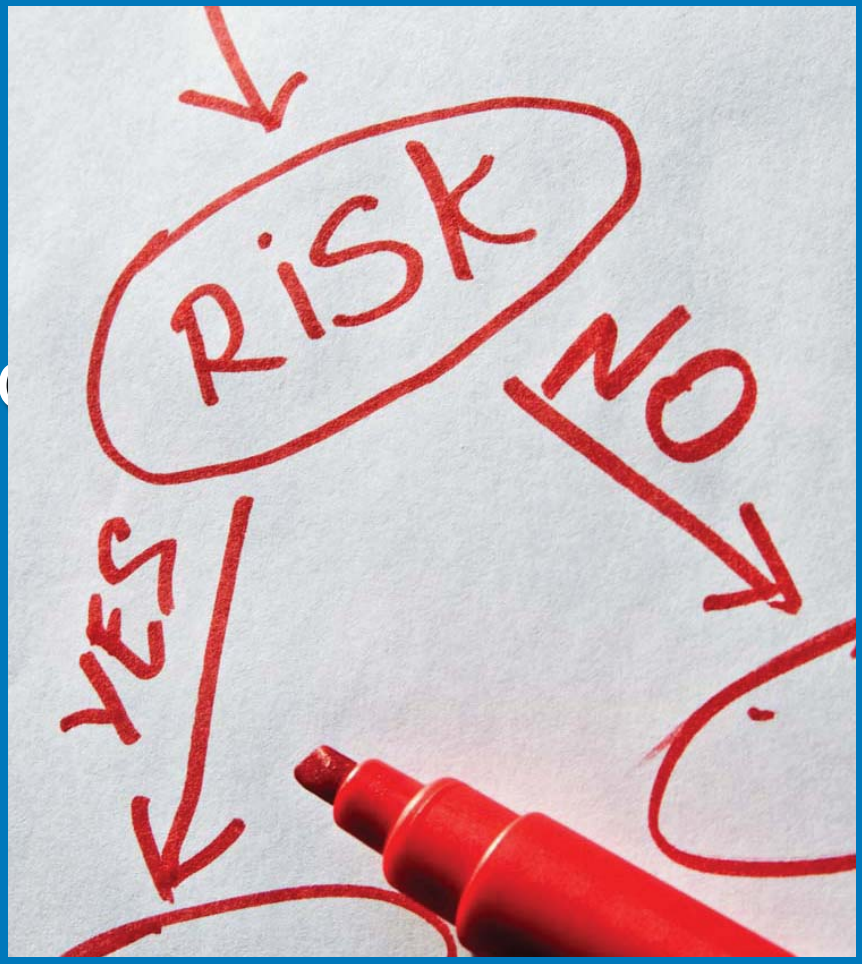
- Nonbinding
- Provides suggestions for management
- Should's and Could's

Standard

- Eventually ends up in codes
- Specific direction for management
- "You shall," "You must" language

ASHRAE Proposed Standard

Risk management approach for the prevention of *legionellosis* associated with centralized industrial and commercial building water systems.



Who Is Responsible?

Facility managers on front line for water safety

Responsibility

ASHRAE Proposed Standard will require facility managers to implement stronger safeguards to protect against *Legionellosis*.

Elements of Proposed Standard

Requirement for Hazard Analysis (HACCP)

- H = Hazard (*Legionella*)
- A = Analysis
- C = Critical
- C = Control
- P = Point

Annual Survey to Assess Risk

Facility owners and managers will be required to annually survey their buildings to determine risk characteristics using hazard analysis and critical control point (HACCP) methodology.

What is a HACCP Plan?

- HACCP team
- Flow diagrams
- Hazard summary
- Monitoring/maintenance schedule
- Validation summary
- Verification schedule
- Planned response to water service disruption

Identify Sources of Exposure

- Potable water system (faucets and showers)
- Ice machines
- Humidifiers
- Cooling towers
- Decorative Fountains

Requirements for Hazard Analysis

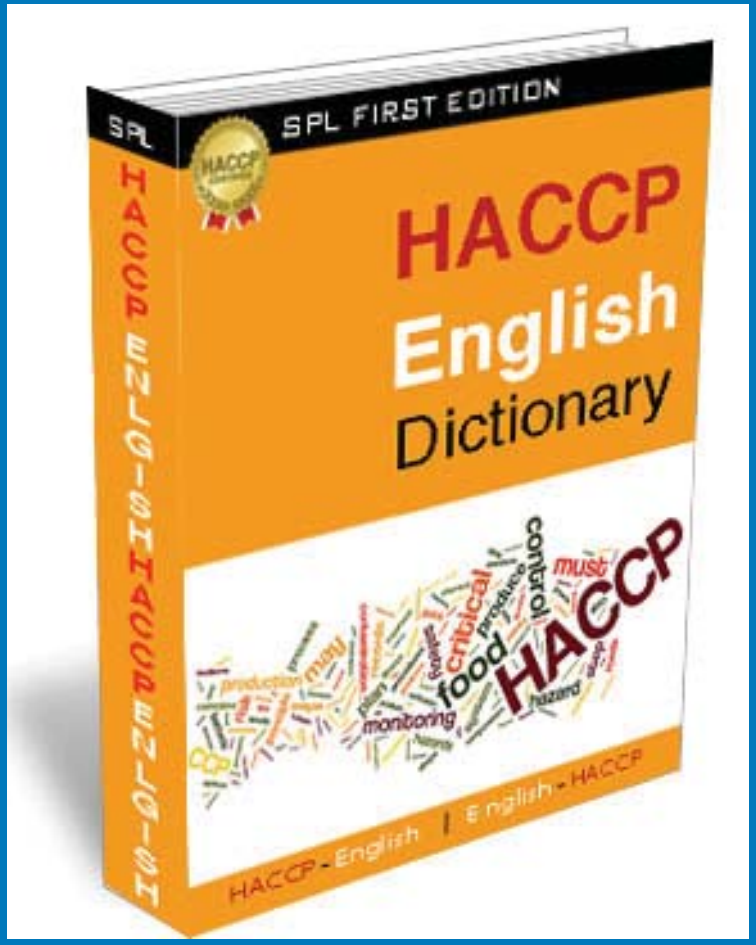
- Documentation of water systems and operation and maintenance as relates to reducing/controlling *Legionella* (Process Flow Diagrams)
- Establish critical control points
  – What eliminates or controls *Legionella*?

Some Building Risk Factors

1. Multistory buildings
2. Devices that release aerosols (e.g., cooling tower or evaporative condenser, fountains, misters, air washers or humidifiers)
3. Healthcare facilities
4. Occupants that are elderly or immunocompromised

Your New HACCP Vocabulary

- Control Point
- Critical Control Point
- Critical Limit
- Validation
- Verification
- Monitoring



Critical Control Point

A step in a process at which control can be applied and is essential to:

- Eliminate the hazard
- Prevent it from harming people

Validation

Obtain evidence that the elements of the HACCP plan are effective

- Validation that the hazard (*Legionella*) is under control
- Document results

Validation

- There are no “surrogate markers” for the presence/absence of Legionella
- Therefore, = culturing is the only way to accurately validate effectiveness of the program.

The Last Word

When approved, the new standard will impact legal liability. Where ASHRAE Standard 188 is adopted in building codes, it will have the force of law.

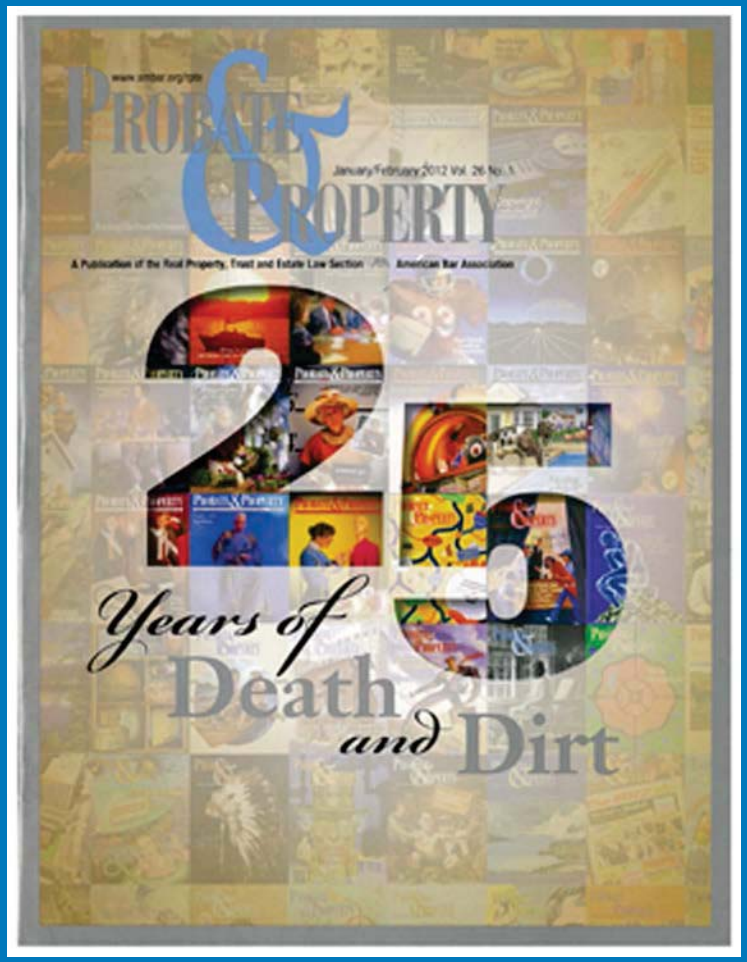
Legionella and the Law

Legionnaire's disease victim sues Md. retirement home

Charlotte man is suing Baltimore developers and others for $225 million.

By Tricia Bishop
Baltimore Sun
Posted: Friday, Aug. 13, 2010

Legal Liability and the New Proposed ASHRAE Standard



Impact of Proposed Standard on *Legionella* Litigation

New Mandates for Building Water Systems Affect Legal Liability in Legionnaires' Disease Cases

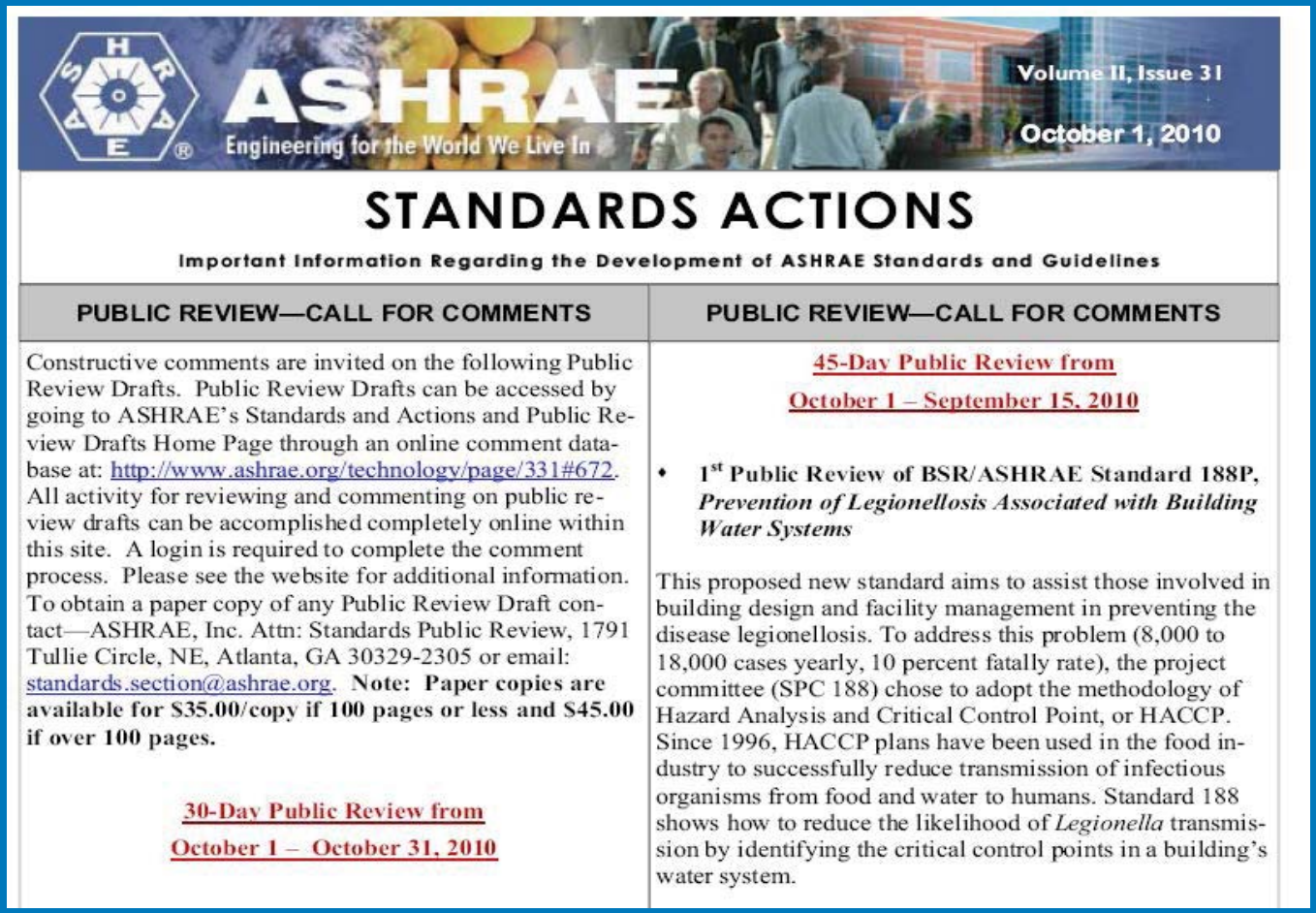
By Garry R. Boehlert and Janet E. Stout

Legionella bacteria are commonly present in man-made aquatic environments and contaminate up to 70% of all plumbing systems. The Centers for Disease Control and Prevention (CDC) estimate that *Legionella* bacteria annually cause as many as 18,000 cases of Legionnaires' disease in the United States. CDC, *Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water—United States*, 2007–2008, available at www.cdc.gov/mmwr/preview/mmwrhtml/ss6012a4.htm?s_cid=ss6012a4_w. More than 10% of those cases are fatal. *Legionella* bacteria also cause Pontiac Fever, a serious influenza-like illness. Together, these two water-borne illnesses are called Legionellosis. With increasing frequency the designers, owners, and managers of facilities believed to be the source of Legionellosis outbreaks find themselves defending claims and litigation demanding significant damages.

Change to the Status Quo Will Affect Legal Liability

Property & Probate, Jan/Feb 2012

Status of ASHRAE 188P Another Public Review?



ASHRAE
Engineering for the World We Live In

Volume II, Issue 31
October 1, 2010

STANDARDS ACTIONS

Important Information Regarding the Development of ASHRAE Standards and Guidelines

PUBLIC REVIEW—CALL FOR COMMENTS	PUBLIC REVIEW—CALL FOR COMMENTS
Constructive comments are invited on the following Public Review Drafts. Public Review Drafts can be accessed by going to ASHRAE's Standards and Actions and Public Review Drafts Home Page through an online comment database at: http://www.ashrae.org/technology/page/331#672. All activity for reviewing and commenting on public review drafts can be accomplished completely online within this site. A login is required to complete the comment process. Please see the website for additional information. To obtain a paper copy of any Public Review Draft contact—ASHRAE, Inc. Attn: Standards Public Review, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305 or email: standards.section@ashrae.org. **Note: Paper copies are available for $35.00/copy if 100 pages or less and $45.00 if over 100 pages.** **30-Day Public Review from** **October 1 – October 31, 2010**	**45-Day Public Review from** **October 1 – September 15, 2010** • **1st Public Review of BSR/ASHRAE Standard 188P, *Prevention of Legionellosis Associated with Building Water Systems*** This proposed new standard aims to assist those involved in building design and facility management in preventing the disease legionellosis. To address this problem (8,000 to 18,000 cases yearly, 10 percent fatally rate), the project committee (SPC 188) chose to adopt the methodology of Hazard Analysis and Critical Control Point, or HACCP. Since 1996, HACCP plans have been used in the food industry to successfully reduce transmission of infectious organisms from food and water to humans. Standard 188 shows how to reduce the likelihood of *Legionella* transmission by identifying the critical control points in a building's water system.

Fountains in Hospitals?

A cluster of nosocomial Legionnaire's disease linked to a contaminated hospital decorative water fountain

Tara N. Palmore, M.D.[1,2], Frida Stock, B.S.[1], Margaret White, M.S.[1], MaryAnn Bordner, M.S.[1], Angela Michelin, M.P.H.[1], John E. Bennett, M.D.[2], Patrick R. Murray, Ph.D.[1], and David K. Henderson, M.D[1]

[1]Warren Grant Magnusen Clinical Center, National Institutes of Health, Bethesda, Md.

[2]National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Md.

Infection Control and Hospital Epidemiology
2009 August ; 30(8): 764–768.

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY FEBRUARY 2012, VOL. 33, NO. 2

ORIGINAL ARTICLE

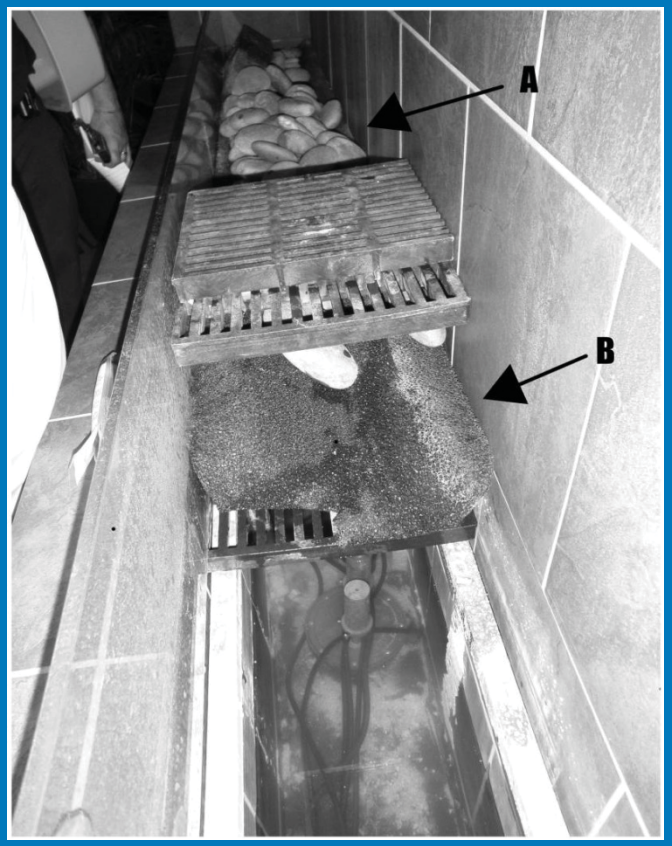
An Outbreak of Legionnaires Disease Associated with a Decorative Water Wall Fountain in a Hospital

Thomas E. Haupt, MS;[1] Richard T. Heffernan, MPH;[1] James J. Kazmierczak, DVM;[1] Henry Nehls-Lowe, MPH;[1] Bruce Rheineck, MS;[1] Christine Powell, BS;[2] Kathryn K. Leonhardt, MD;[3] Amit S. Chitnis, MD;[1] Jeffrey P. Davis, MD[1]

Infection Control and Hospital Epidemiology
2012 February; 33(2)

4,000 Exposed

Water Wall



Sponge-like foam material
1.2 million CFU *Legionella*

Outbreak of Legionnaires' Disease

- Total of 8 cases
- None were inpatients
- 3 were visitors as outpatients
- 3 visited the pharmacy
- 1 waited in lobby
- 1 made a delivery

They Should Have Had This!

WATER SAFETY PLAN

System Assessment

Monitoring

Management / Communication

Surveillance (Validation)

Example

- What eliminates or controls Legionella in a fountain?
  - Clean and Disinfect (measure residual)
- Validation that the hazard (*Legionella*) is under control
  - Quarterly Cultures
  - Document results

Good Example of a Simple Plan

Department of Veterans Affairs
Veterans Health Administration
Washington, DC 20420

VHA DIRECTIVE 2008-010

February 11, 2008

PREVENTION OF *LEGIONELLA* DISEASE

1. PURPOSE: This Veterans Health Administration (VHA) Directive establishes guidelines for the annual evaluation of *Legionella* risk at VHA inpatient facilities.

2. BACKGROUND

a. The Gram-negative bacterium, *Legionella*, causes respiratory diseases including *Legionella* pneumonia (traditionally known as Legionnaires' disease), hereafter abbreviated as "LD" for "*Legionella* disease." Disease is primarily caused by *Legionella pneumophila*; however other species of *Legionella* can be pathogenic, particularly in transplant and other immunocompromised patients. The bacteria, found naturally in water, have been associated with man-made reservoirs, such as building water distribution systems and cooling towers. Disease occurs after inhalation or aspiration of contaminated water, followed by an average incubation period of 2 to 10 days. The disease is not transmitted from person-to-person.

b. Health care facilities have been connected with the transmission of *Legionella* to patients

Risk Assessment: Environment

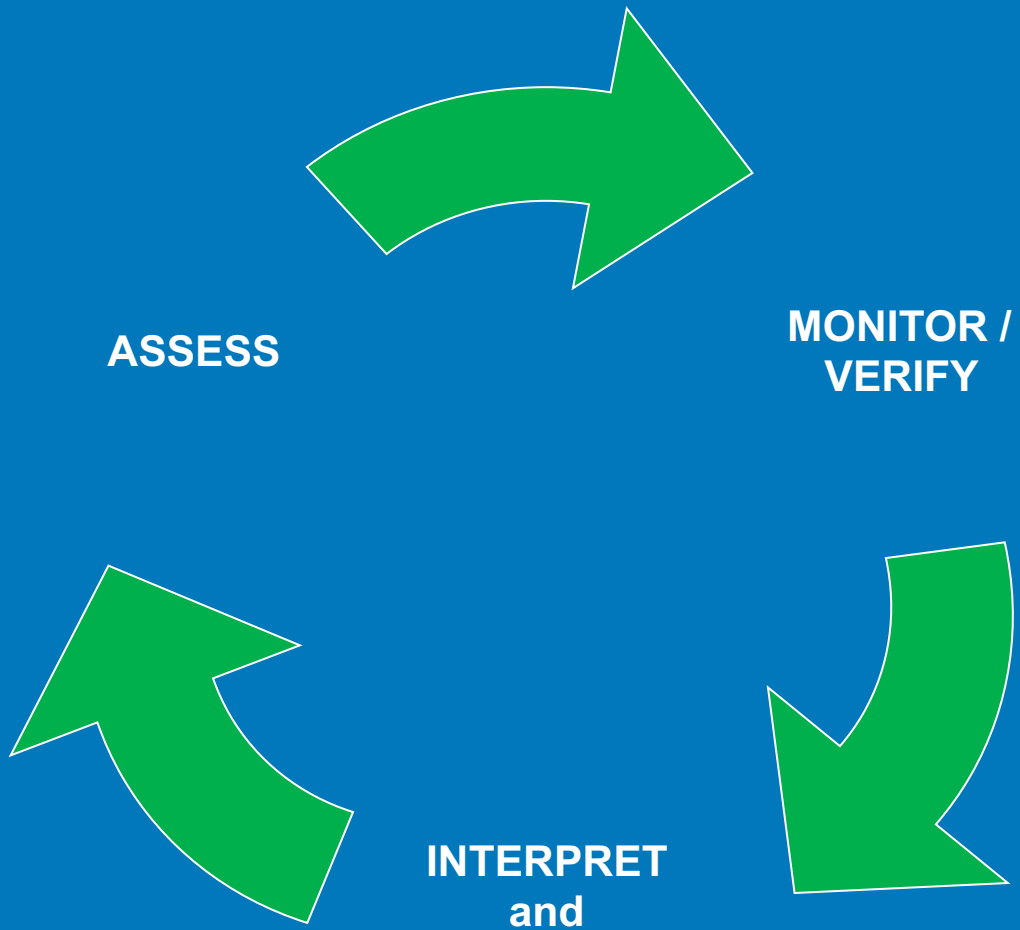
Annual environment testing for *L. pneumophila* SG 1

- Sample at least 10 distal water sites
  - > 500 beds, increase sample size by 2 distal sites per 100 beds over 500
  - Select sites that include all water distribution systems and high risk areas

VHA Directive Key Elements: Environmental Testing

- Determine if exceed “threshold level” (>30%) positive for *L. pneumophila* serogroup 1
  - If yes, proceed to “Action Plan”
  - If no, assessment complete

Water Safety: Systems Thinking



Is there a Standard for Controlling *Legionella* in Cooling Towers?

Cooling Technology Institute *Legionella* Standard CTI STD-159

- Standard being revised
- Require *Legionella* testing by culture as a part of qualification of water treatment protocols
- Detection of *Legionella* used to trigger remediation

Legionella Testing

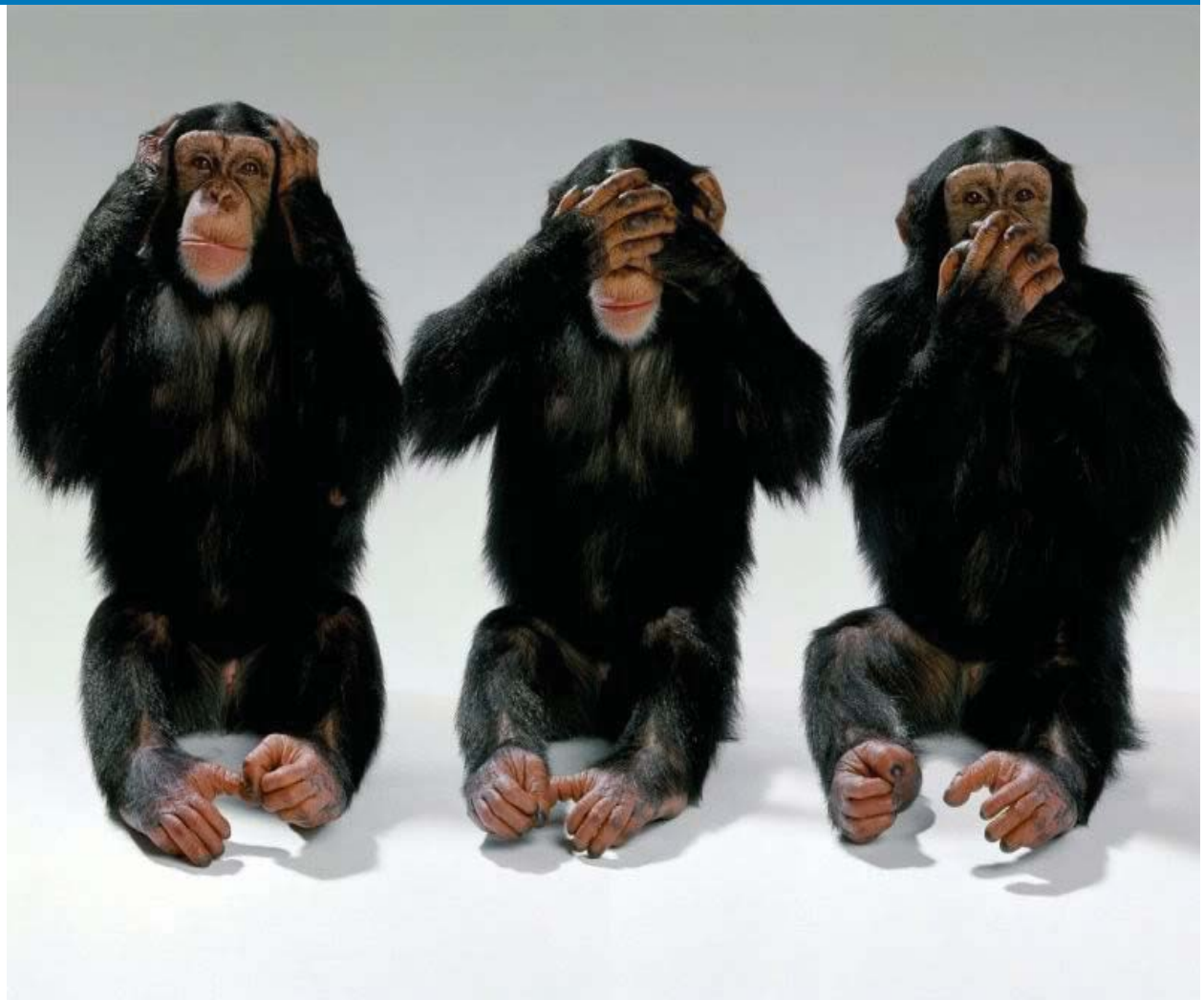
Legionella Testing

If you don't look for it,
you won't find it.

If you don't find it,
you don't think you
have a problem.

If you don't think you
have a problem,
you don't do anything
about it.

–Bruce Dixon, M.D.
Director, Pittsburgh ACHD



Methods for *Legionella* Detection

- Culture is the "gold standard" and described in the Informative section of 188
- Laboratories should be accredited and participate in the CDC ELITE test program
- Molecular and other "rapid" tests are not recommended

Testing for *Legionella*

- DFA, PCR, and ICT* are fast, however, they cannot differentiate between live and dead bacteria.

- This could lead to unnecessary and expensive decontamination procedures.

*Direct Fluorescent Antibody Stain | Polymerase Chain Reaction | Immunochromatographic Test

Culture Is Gold Standard

- Laboratory-based and validated culture method is the industry standard
- More Reliable than "rapid tests"
  - DFA
  - ICT
  - PCR
  - Dip slide

CDC Recommends Culturing

- The CDC position on culturing in the absence of disease: "No Recommendation for routinely culturing water systems for Legionella sp. . . **UNRESOLVED ISSUE**"
  (ref: MMWR. 1997. Vol. 46/ No. RR-1, page 54).

- According to CDC “This is not a recommendation **for or against** culturing.”

High Risk Units: HICPAC/CDC Recommends Culturing

Facilities with solid organ transplant programs or hematopoietic stem cell transplant recipients should perform periodic culturing for *Legionella* in the transplant unit's potable water supply.

Guidelines for the Prevention of Opportunistic Infections in Hematopoietic Stem Cell Transplant (HSCT) Recipients. Morb Mort Wkly Rep. 2000;49(RR10):

Test Results – Cooling Towers

- Concentration-based thresholds establish target values in CFU per liter or milliliter
- CFU's not a good measure of risk in hospital water systems
- OK for cooling towers

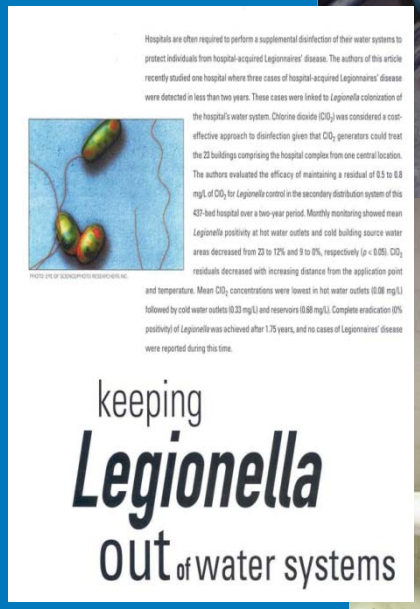
Preventing Legionellosis

By Janet Stout, Ph.D., Associate Member ASHRAE

Hospital engineers often go to guidance documents for help in preventing Legionnaires' disease. While advisory documents from health authorities and professional societies provide guidelines for approaches to prevention (*Table 1*),[1] a consensus opinion for

- Recommendations be prospectively validated through controlled studies;
- Studies should include a prolonged observational period (greater than one year) to evaluate the efficacy of recommended actions; and
- Recommended approaches/actions achieve the expected result, prevention of the disease through environmental

Disinfection Options



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 Methods

- Copper-silver ionization (continuous)
- Thermal shock treatment (heat & flush)
- Shock chlorination ($\geq$10 mg/L residual), may require water tanks to be 20-50 mg/L
- Continuous supplemental chlorination (2-4 mg/L)
- Chlorine Dioxide (ClO_2)
- Point-of-use filtration

What's New Disinfection Methods

Hospital Water Systems

Legionella in Biofilm Survives 50 ppm Chlorine

Journal of Hospital Infection (2010) 74, 152–159

Available online at www.sciencedirect.com

ScienceDirect

www.elsevierhealth.com/journals/jhin

Resistance of *Legionella pneumophila* serotype 1 biofilms to chlorine-based disinfection

I.R. Cooper*, G.W. Hanlon

Journal of Hospital Infection, 2010

Genetic Basis for Chlorine Resistance

WATER RESEARCH 46 (2012) 808–816

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/watres

Legionella pneumophila transcriptional response to chlorine treatment

Charles Bodet [a,*], Tobias Sahr [b], Mathieu Dupuy [a], Carmen Buchrieser [b], Yann Héchard [a]

[a] Laboratoire de Chimie et Microbiologie de l'Eau, UMR 6008, Université de Poitiers, 40 avenue du Recteur Pineau, 86022 Poitiers Cedex, France

[b] Institut Pasteur, Unité de Biologie des Bactéries Intracellulaires and CNRS URA 2171, 28 Rue du Dr Roux, 75724 Paris, France

Water Research, 2012

Copper-Silver Ionization

- Copper and silver ions are released from a flow through cell into the hot water system.
- Ions are maintained at
  - **Copper: ~ 0.4 mg/L; Silver ~ 0.04 mg/L**

Continuous vs. Intermittent Previous Research

Intermittent Use of Copper-Silver Ionization for *Legionella* Control in Water Distribution Systems: A Potential Option in Buildings Housing Individuals at Low Risk of Infection

Zeming Liu, Janet E. Stout, Marcie Boldin, John Rugh, Warren F. Diven, and Victor L. Yu

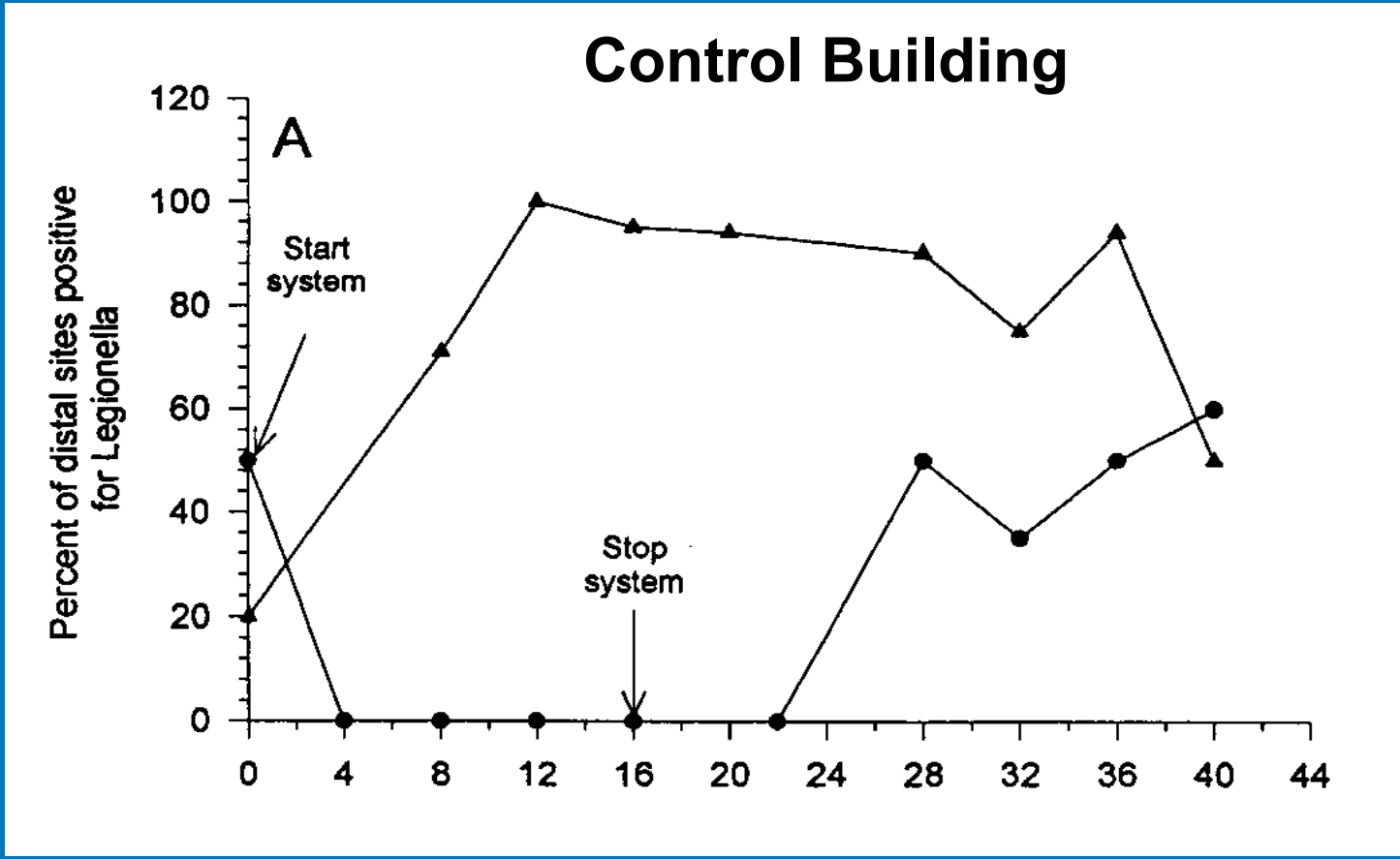
From the University of Pittsburgh and Veteran Affairs Medical Center, Pittsburgh, Pennsylvania

One copper-silver ionization system was sequentially installed onto the hot-water recirculation lines of two hospital buildings colonized with *Legionella pneumophila*, serogroup 1. A third building with the same water supply and also colonized with *Legionella* served as a control. Four weeks after

Clinical Infectious Diseases 1998; 26:138–40

Short Course Copper-Silver Ionization 1998:

Effective (0% positivity) within 4 weeks; recolonization in 12 weeks



Why Short Course Intermittent Treatment?

- Non-outbreak setting, long-term treatment not required

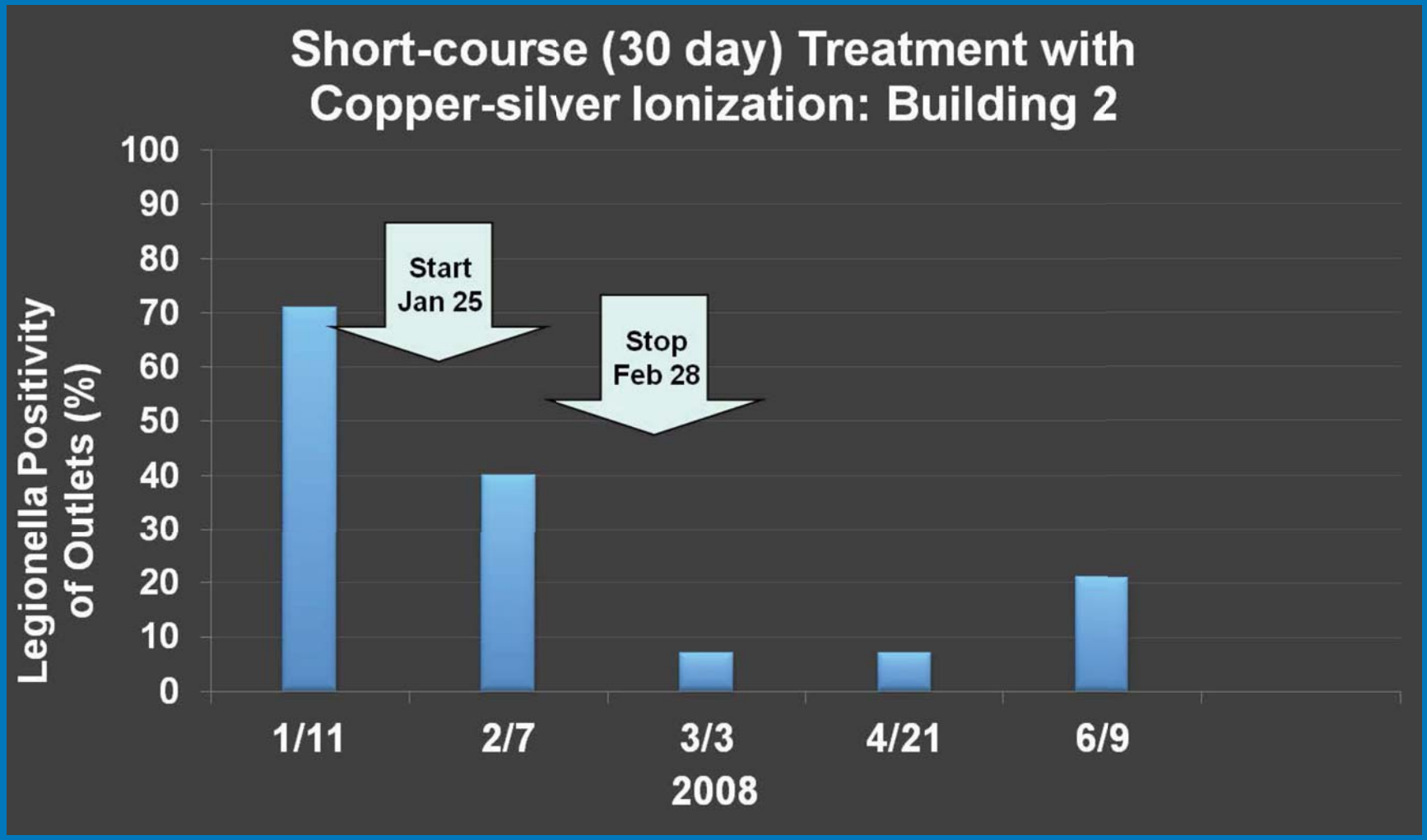
- Long-term care/assisted living
  - Need low impact treatment
  - No taste/odor
  - Not a capital expense

Short-course (30 day) Ionization

- Installed ionization system on hot water return (Tarn-Pure, Enrich Products, Pittsburgh, PA)
- Legionella testing performed before treatment (Pre-test) and after 15 and 30 days (Post-test)
- Pre-test was 70% outlets positive for Legionella pneumophila serogroup 1

RESULTS

Short Course Copper-Silver Ionization Effective within 2 weeks

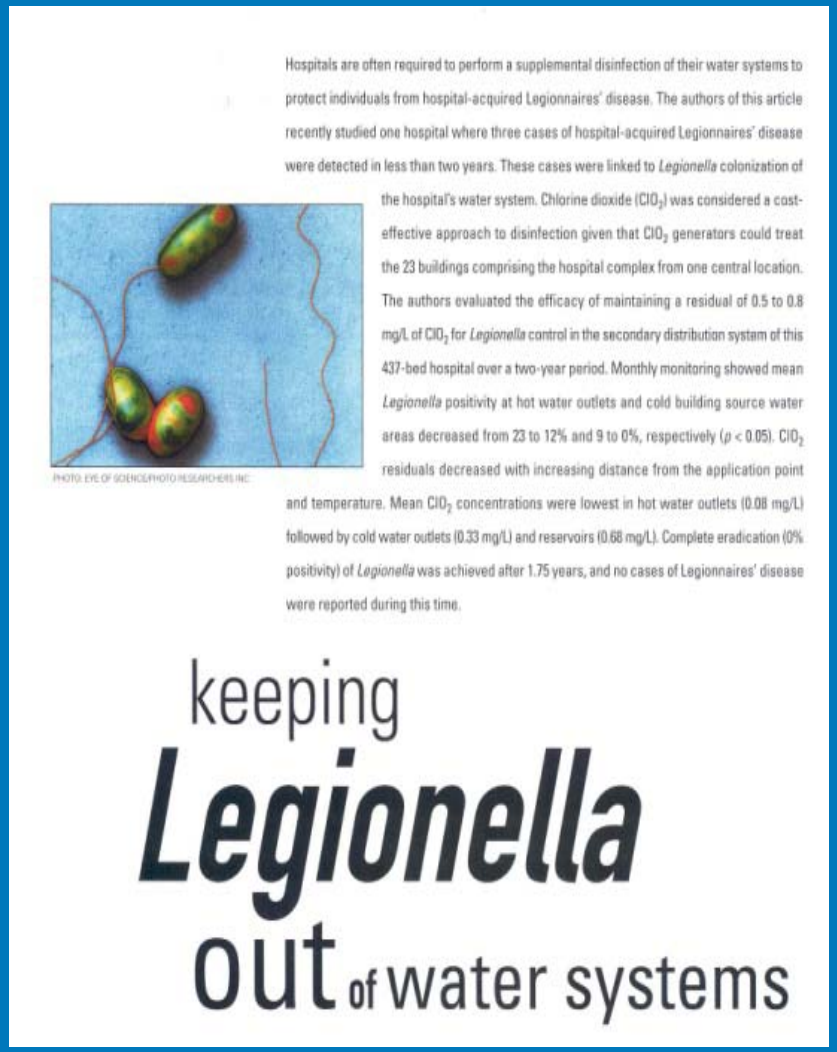


Chlorine Dioxide

- Keeping *Legionella* out of Water Systems

- Authors: F.P. Sidari, J.E. Stout, J.M. VanBriesen, V.L. Yu, A.M. Bowman, D. Grub, A. Neuner, M.M. Wagener

- *Journal of American Water Works Association*. 96:111-119, 2004.



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.

PHOTO: EYE OF SCIENCE/PHOTO RESEARCHERS INC

keeping
Legionella
out of water systems

Our Second Study

Safety and Efficacy of Chlorine Dioxide in *Legionella* Control in a Hospital Water System

Safety and Efficacy of Chlorine Dioxide for *Legionella* Control in a Hospital Water System

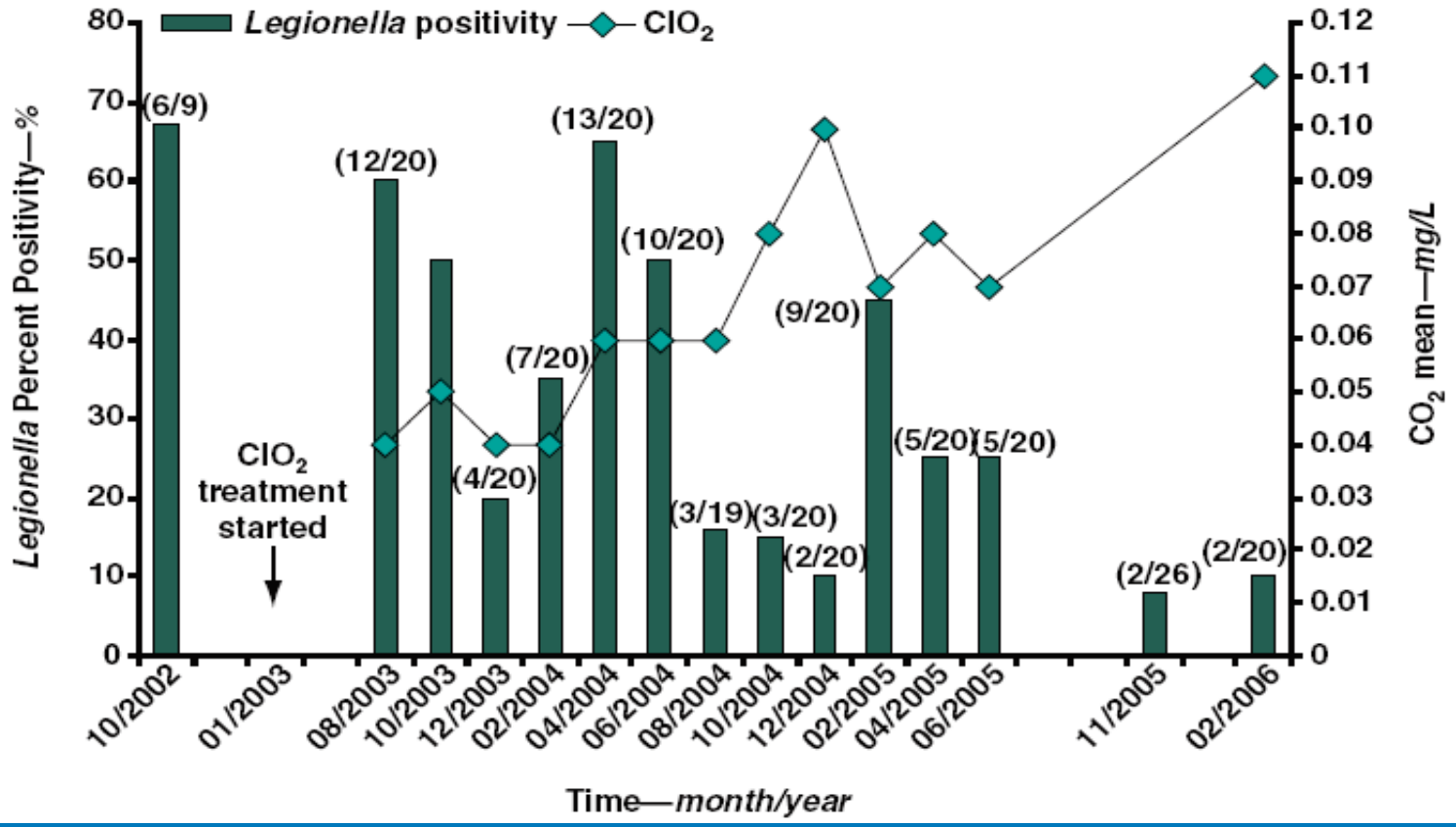
Zhe Zhang, PhD; Carole McCann, RN;
Janet E. Stout, PhD; Steve Piesczynski, BA;
Robert Hawks, ACT; Radisav Vidic, PhD;
Victor L. Yu, MD

In a 30-month prospective study, we evaluated the efficacy of chlorine dioxide to control *Legionella* organisms in a water distribution system of a hospital with 364 patient beds and 74 skilled nursing beds. The number of hot water specimens positive for *Legionella* organisms decreased from 12 (60%) of 20 to 2 (10%) of 20. An extended time (18 months) was needed to achieve a significant reduction in the rate of *Legionella* positivity among hot water specimens. At the time of writing, no cases of hospital-acquired Legionnaires disease have been detected at the hospital since the chlorine dioxide system was installed in January 2003. Use of chlorine dioxide was safe, based on Environmental Protection Agency limits regarding maximum concentrations of chlorine dioxide and chlorite.

Infect Control Hosp Epidemiol 2007; 28:1009-1012

Extended Time Needed

FIGURE 1 Percent distal site *Legionella* positivity and mean ClO2 concentrations over 40 months in hot water of hospital A



Chlorine Dioxide

Advantages

- Effective disinfectant against *Legionella* and other waterborne pathogens
- Applied to the incoming cold water supply

Disadvantages

- Extended time to achieve reduction in *Legionella* colonization
- Monitoring for disinfectant and by-products

Absolute Barrier Against Exposure to Waterborne Pathogens

Efficacy of new point-of-use water filter for preventing exposure to *Legionella* and waterborne bacteria

Patricia J. Sheffer, MPM,[a] Janet E. Stout, PhD,[a,b] Marilyn M. Wagener, MPH,[b] and Robert R. Muder, MD[a,b]
Pittsburgh, Pennsylvania

American Journal of Infection Control 2005; 33:S20-25.

Point-of-Use Filters

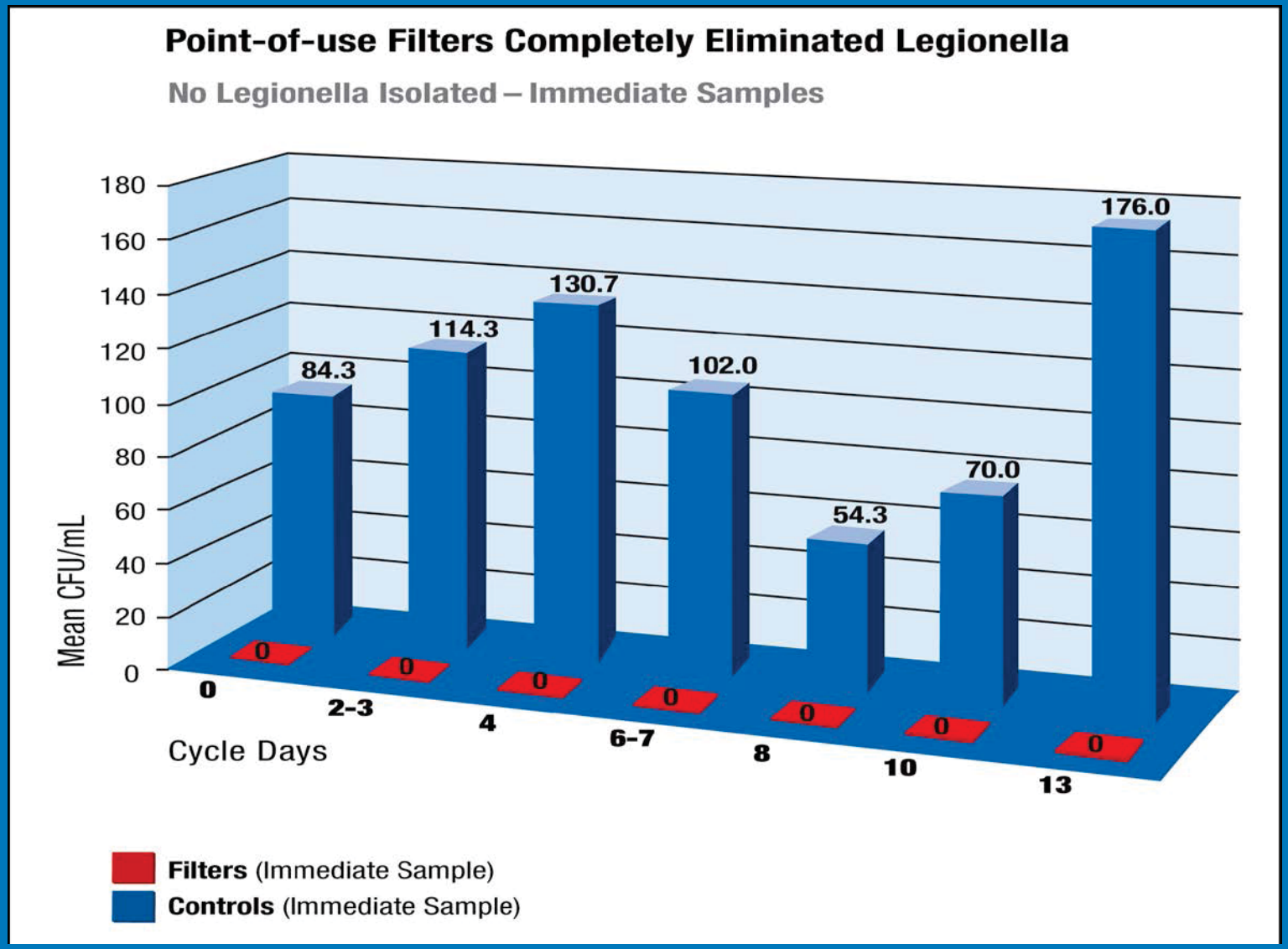
- System-wide disinfection may not always be the best answer. A targeted approach to disinfection may be more appropriate
- Filtration can be quickly implemented in an outbreak situation and used for a limited time
- High risk areas may require long-term use for maximum risk reduction

Point-of-Use Filtration
Recommended Applications

High Risk Patients

- Bone marrow and solid organ transplant units
- Hematology/oncology units
- NICU

Filters Eliminated *Legionella*



Another High Risk Group

INVITED COMMENTARY

Neonatal Legionellosis

The Tip of the Iceberg for Pediatric Hospital-Acquired Pneumonia?

Victor L. Yu, MD, and Tzielan C. Lee, MD

The Pediatric Infectious Disease Journal • Volume 29, Number 3, March 2010

Epidemiology of Pediatric LD

- CDC study showed 72% pediatric cases had healthcare exposure

- Mortality rate 22%

  Alexander NT, et al 2008 ICAAC

Outbreak Linked to Water in NICU

Rapid communications

Legionnaires' disease in a neonatal unit of a private hospital, Cyprus, December 2008: preliminary outbreak report

Unit for Surveillance and Control of Communicable Diseases (cycomnet@cytanet.com.cy)[1]
1. Medical and Public Health Services, Ministry of Health, Nicosia, Cyprus

We report an outbreak of Legionnaires' disease in neonates, affecting 11 newborn babies. The case fatality rate is currently 27%. The outbreak has been confirmed by detection of *Legionella pneumophila* antigen in eight of the 11 cases. Tests are in progress to determine the source of infection.

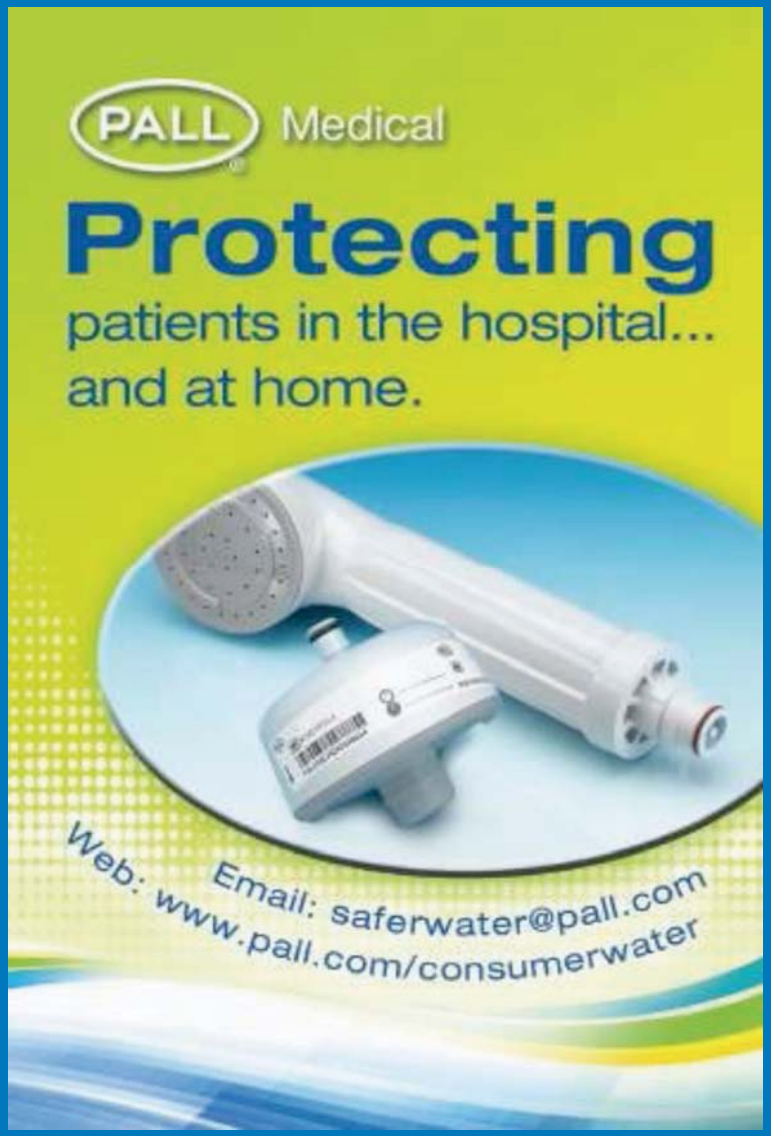
hospital. The dates of admission of the 11 cases are shown in the Figure.

Clinical characteristics

The newborns were admitted with the following clinical signs and

Something New: Home Use

- High risk patients go home (transplant, chemotherapy, immunocompromised)
- Legionella and other waterborne pathogens are in home water systems too!
- New product from Pall Medical just released for home use



Kleenpak filter

RESEARCH

New Approach for Legionella Control in Hospital Water Systems

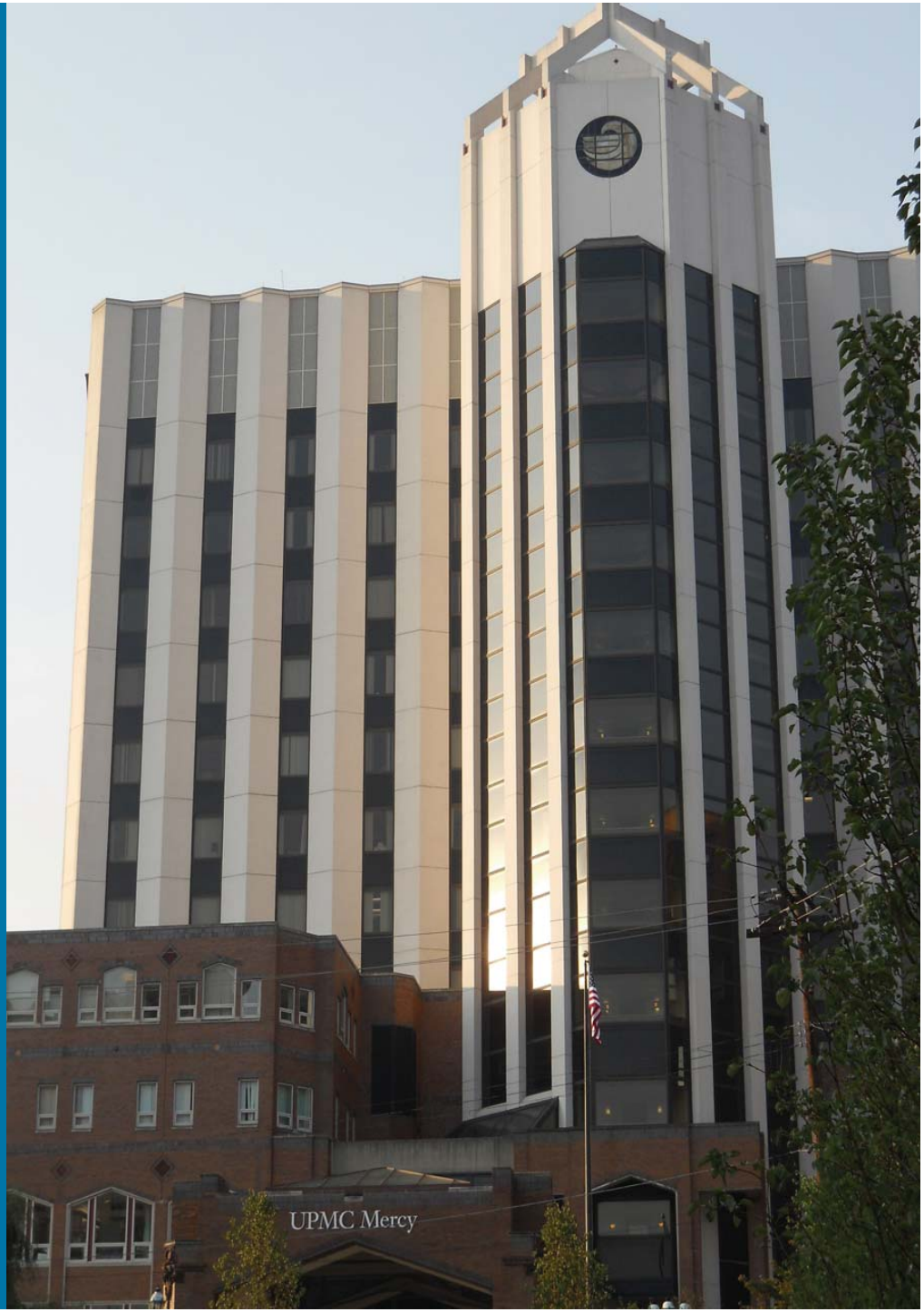
AWT 2012 Annual Convention and Exposition
September 19–22, 2012 | Renaissance Palm Springs Hotel and the Palm Springs Convention Center
Palm Springs, California

EVALUATION OF A NEW MONOCHLORAMINE GENERATION SYSTEM FOR CONTROLLING *LEGIONELLA* IN BUILDING HOT WATER SYSTEMS

Dr. Janet E. Stout
Director, Special Pathogens Laboratory

Site of Study: UPMC Mercy

- 495 bed tertiary care hospital, Pittsburgh, Pa.
- 12 floors, 840,000 ft
- Serves 225,000 persons annually



Legionella at UPMC Mercy

- Early 1990s, cases of Legionnaires' disease and *Legionella pneumophila* serogroup 1 detected in the water system
- Copper-silver ionization used to treat *Legionella* positivity from 1990s to 2011

Legionella in 2010

- *Legionella* positivity increased after building construction/renovation project
- Increase in sensor faucets/blending valves
- *Legionella* persisted and a case occurred

New approach needed

Monochloramine

Vol. 24 No. 8 INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY 569

RISK OF HOSPITAL-ACQUIRED LEGIONNAIRES' DISEASE IN CITIES USING MONOCHLORAMINE VERSUS OTHER WATER DISINFECTANTS

James D. Heffelfinger, MD, MPH; Jacob L. Kool, MD, PhD; Scott Fridkin, MD; Victoria J. Fraser, MD; Jeffrey Hageman, MHS; Joseph Carpenter, PE; Cynthia G. Whitney, MD, MPH; Society for Healthcare Epidemiology of America

-Infect Control Hosp Epidemiol 2003;24:569-574

Monochloramine

- Used to treat potable water at the municipal water treatment plant, but
- No system available for safe and effective use for smaller applications …
- Italian company Sanipur develops the first system

Sanipur

- Founded in 1985
- Based in Lombardo, Flero
- http://www.sanipur.it/

First Study in U.S.

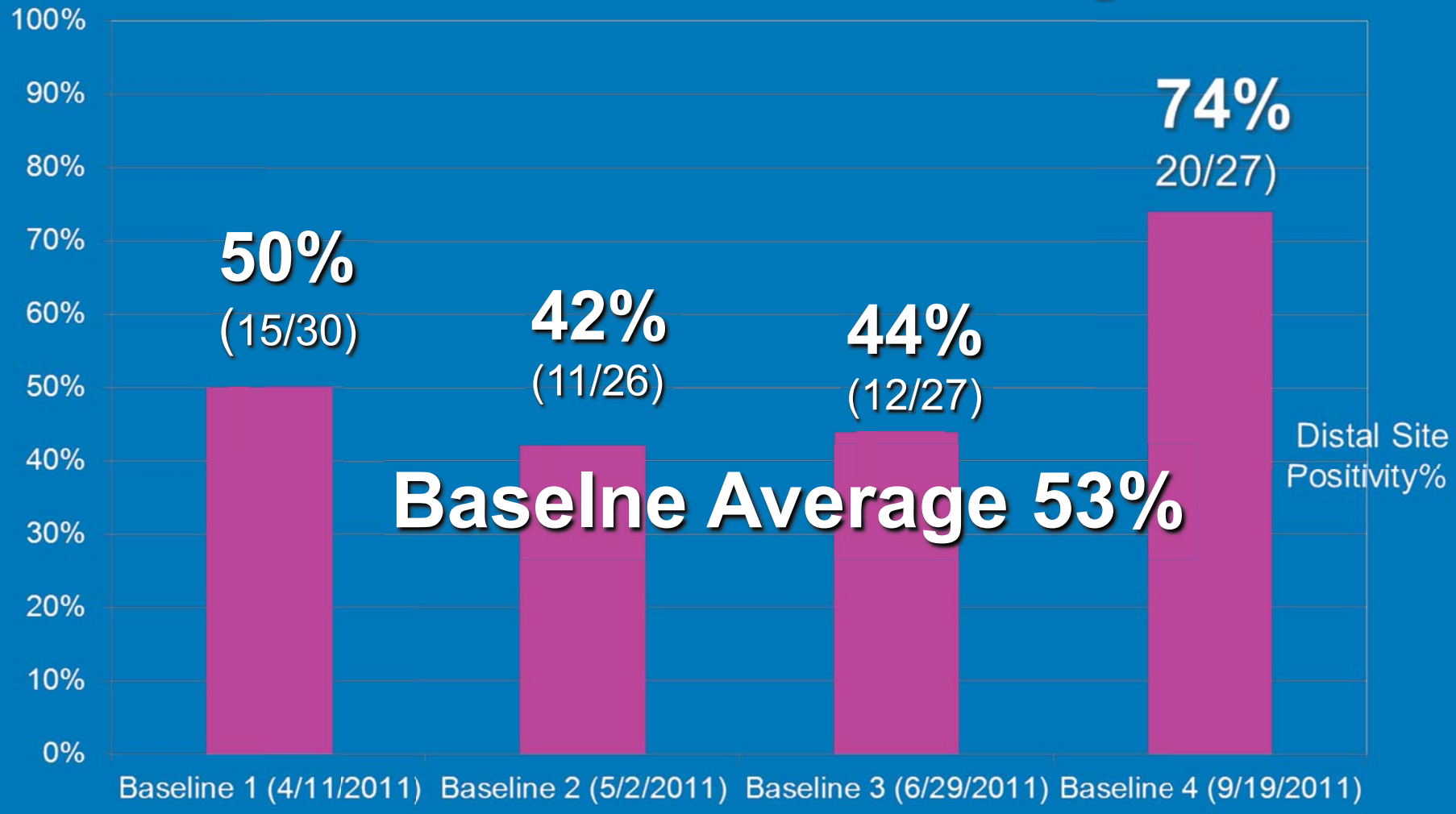
OBJECTIVE

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

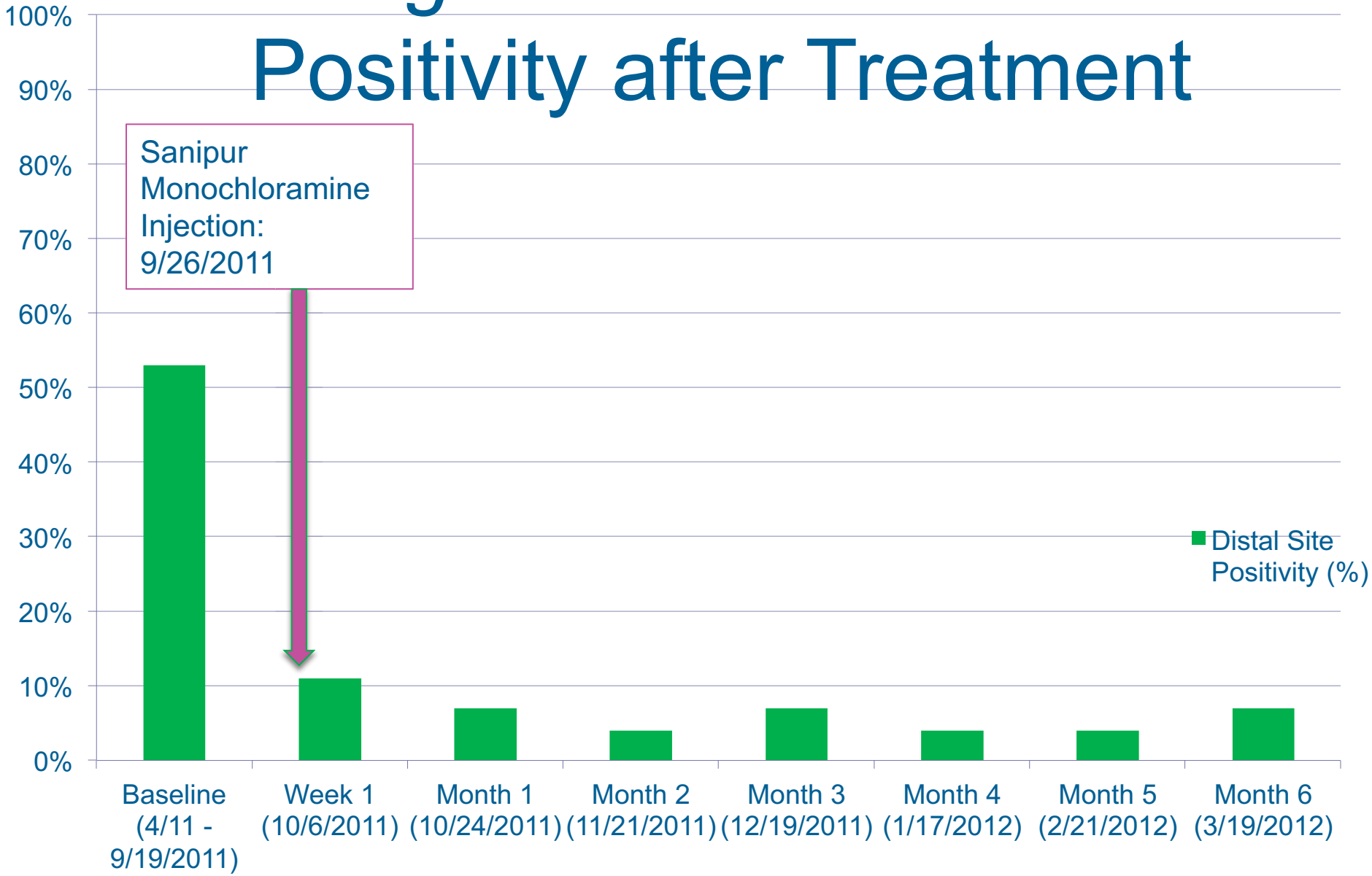
Scope of Our Study

- 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

Legionella Baseline Distal Site Positivity



Legionella Distal Site Positivity 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 bozemanii*, a blue-white fluorescing species isolated

Conclusions

Monochloramine may be more effective than current disinfection methods

- Chlorine dioxide
- Chlorination
- Copper-Silver Ionization
- Thermal (heat-and-flush)
- Ultraviolet (UV) light

Thanks to Collaborators

Special Pathogens Laboratory

UPMC Mercy
Pittsburgh, Pa

Sanipur
Italy

Klenzoid
Philadelphia, Pa.

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

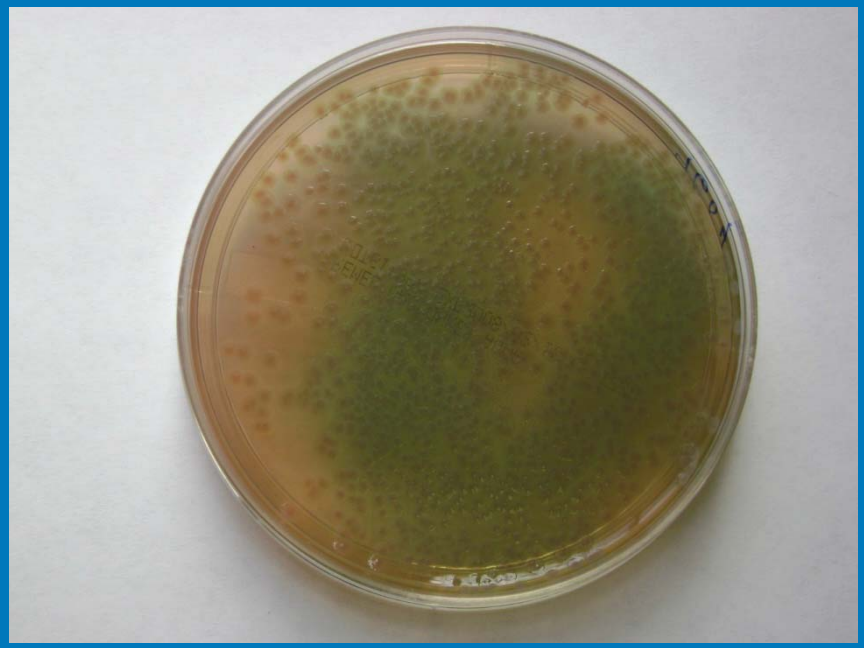
Yusen E. Lin, PhD, MBA;[1] Janet E. Stout, PhD;[2,3] Victor L. Yu, MD[3]

➡ Choice of method must include infection control in addition to engineering

Water Shows Pathogens

Klebsiella oxytoca* and *Enterobacter cloacae

Pseudomonas aeruginosa



Hospital MICU Faucet!

“That’s disgusting!
Think of the bacteria in that water!”

THE AUTOMATIC FAUCET
A POSSIBLE VECTOR OF INFECTION

IVAN C. HALL AND HELEN UPTON WING

Cornell University, Ithaca, N. Y.

THE PUBLIC drinking cup in public places has disappeared forever in America, for the bubbling fountain has

thing. It is evident that fresh saliva from the lips of a used glass may be conveyed directly to the next one placed in position

Am J Public Health (N Y). 1925 September; 15(9): 770–771.

BACTERIAL CONTAMINATION ASSOCIATED WITH ELECTRONIC FAUCETS: A NEW RISK FOR HEALTHCARE FACILITIES

James Hargreaves, DO; Larry Shireley, MS, MPH; Shannon Hansen, MT(ASCP), CIC; Virginia Bren, MPH, RN; Gordon Fillipi, PhD; Craig Lacher, BS; Virginia Esslinger, MS, RN; Terry Watne, MS, RN

Greater Risk with Proximity Taps/Sensor Faucets?

Manual Faucet

Sensor Faucet

Disturbing Findings

Journal of Hospital Infection (2001) **49**: 117–121
doi:10.1053/jhin.2001.1060, available online at http://www.idealibrary.com on IDEAL®

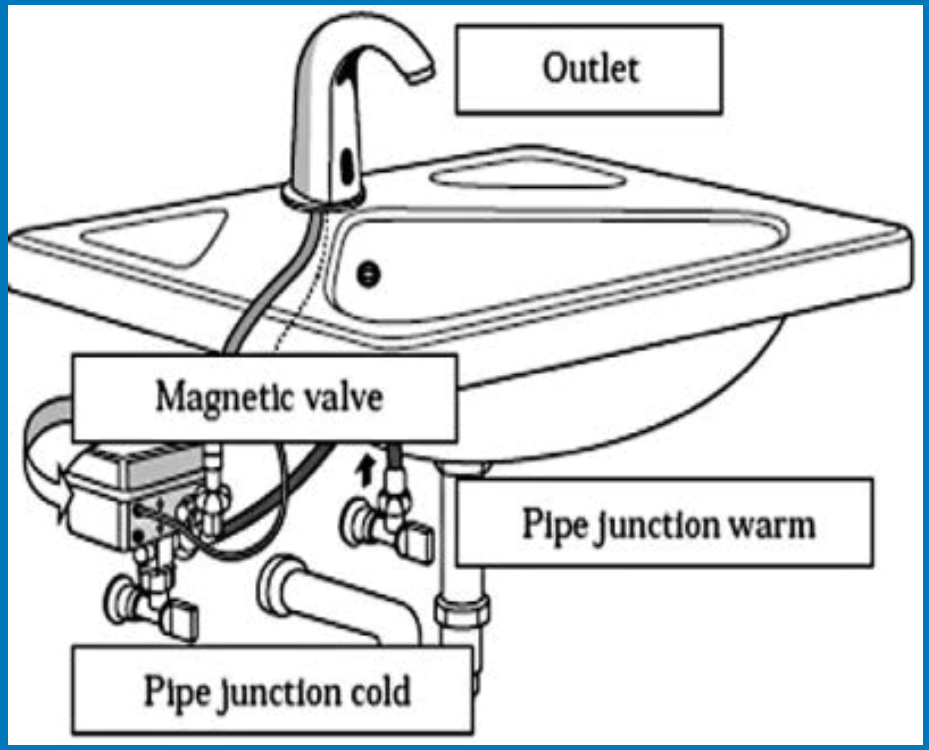
Non-touch fittings in hospitals: a possible source of *Pseudomonas aeruginosa* and *Legionella* spp.

M. Halabi*†, M. Wiesholzer-Pittl†, J. Schöberl† and H. Mittermayer‡

Study Findings

- Water samples from 38 non-touch taps tested. (with and without temperature selection) vs. 10 conventional taps
- 74% of non-touch taps without temp. selection were contaminated with P. aeruginosa vs. 7% with temp. selection, vs. 0% conventional taps
- Legionella found in all 38 non-touch taps, but only 3/10 conventional taps

Sensor Faucets:
2 steps forward, 3 steps back?



Study Findings

- The magnetic valve, the mixing device and outlet most contaminated
- Low water flow
- Lower hot water temperature
- Outcome = removed all non-touch taps and replaced with conventional taps!

Johns Hopkins University

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY MARCH 2012, VOL. 33, NO. 3

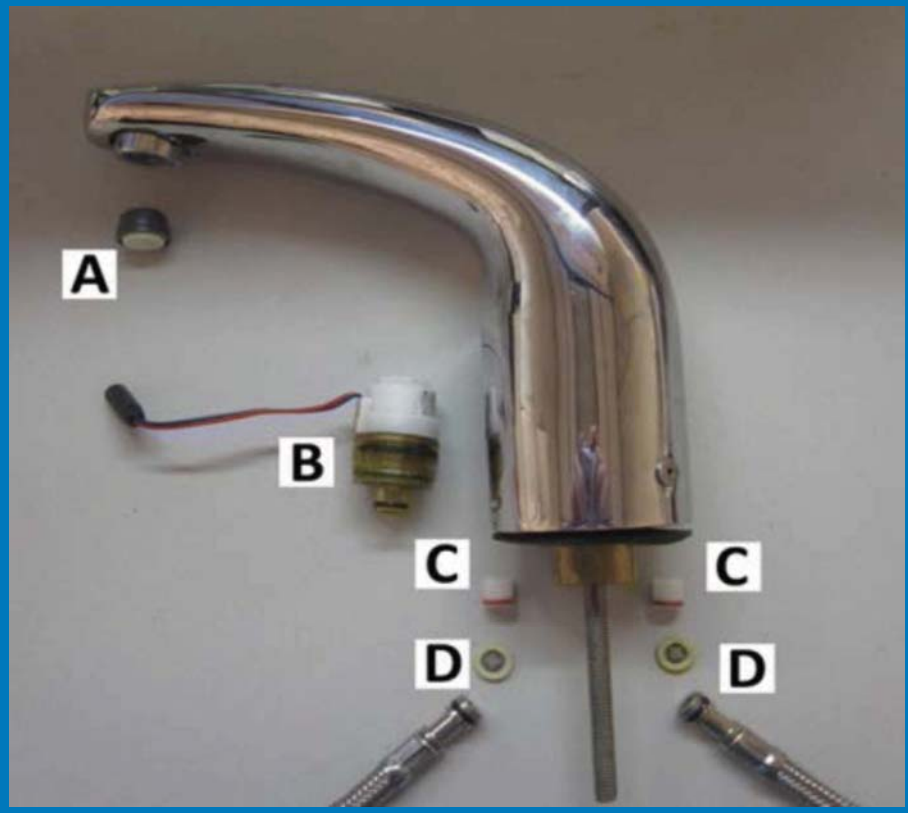
ORIGINAL ARTICLE

Electronic-Eye Faucets: *Legionella* Species Contamination in Healthcare Settings

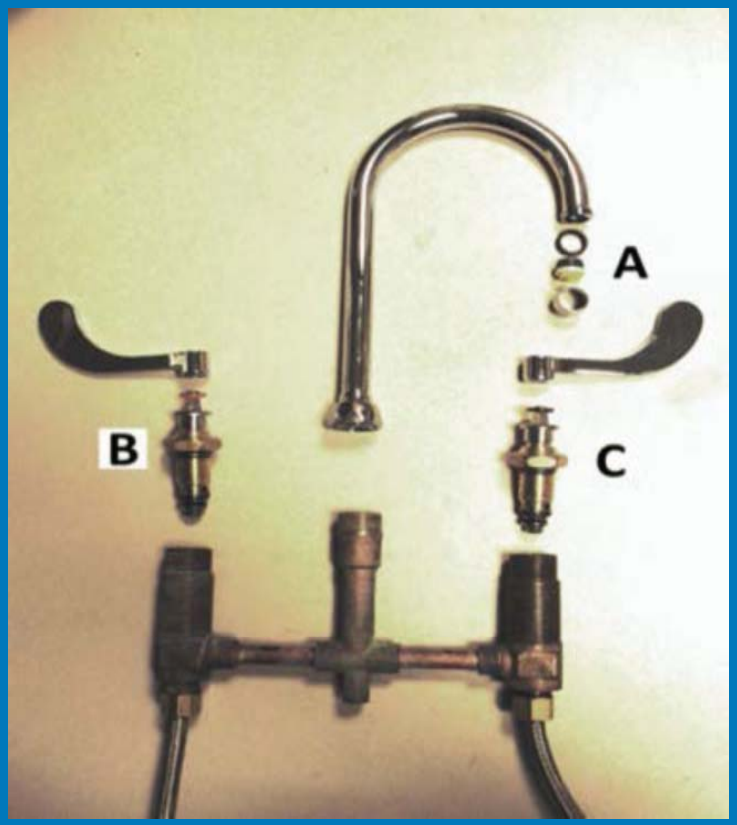
Emily R. M. Sydnor, MD, MHS;[1,2] Gregory Bova;[3] Anatoly Gimburg, BEE;[3] Sara E. Cosgrove, MD, MS;[1] Trish M. Perl, MD, MSc;[1,3] Lisa L. Maragakis, MD, MPH[1]

Anatomy of an Electronic Faucet

A = aerator
B = solenoid valve
C = check valve
D = inline filter



Standard Manual Faucet



A = Aerator

B = hot water
compression cartridge

C = cold water
compression cartridge

Hopkins Study Conclusion

- Electronic faucets were more commonly contaminated with Legionella species and other bacteria
- 19/20 (95%) of electronic faucets were positive for Legionella vs. 9/20 (45%) manual faucets

Conclusions

- Electronic faucets were less likely to be disinfected after chlorine dioxide remediation
- All 12 internal components of electronic faucet were positive for Legionella

Conclusions

- Electronic components may provide points of concentrated bacterial growth
- Periodic monitoring for Legionella recommended
- Consider removal from high risk areas – transplant units

Model Plumbing System Compares Sensor vs. Manual

Dr. Radisav Vidic
Scott Duda
Dr. Janet E. Stout

University of Pittsburgh
Swanson School of Engineering, Dept. of Civil and Environmental Engineering

Flow Programmed

Solenoid Valves Controlled Flow

- Weekday daytime flushing periods all faucets flushed for a duration of 30 seconds once every 20 minutes.
- Weekday evening flushing periods all faucets flushed for a duration of 30 seconds once every hour.
- Weekday nights and weekends flushed for a duration of 10 seconds once every 2 hours

Conclusion

- Sensor faucets did not demonstrate any significant difference in *Legionella* control when compared to manual faucets

- All tested positive for *Legionella*

The Answer

There may be a risk associated with sensor faucets in healthcare facilities

Be old fashioned in high risk areas – avoid electronic faucets?

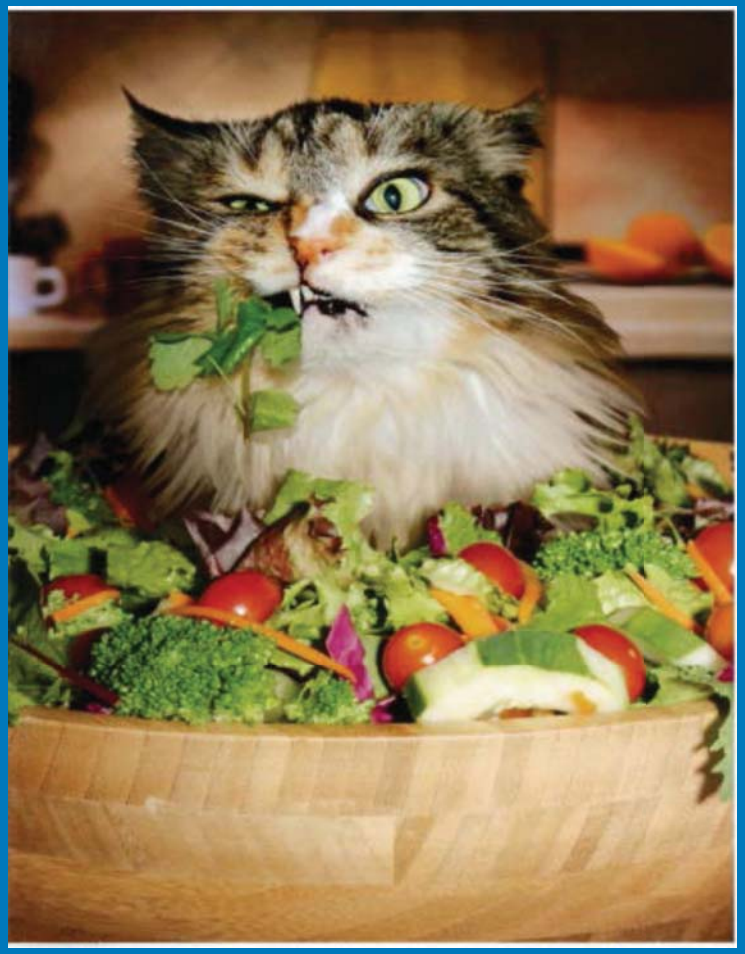
Should Electronic Faucets Be Recommended in Hospitals?

Iris F. Chaberny, MD; Petra Gastmeier, MD

ABSTRACT

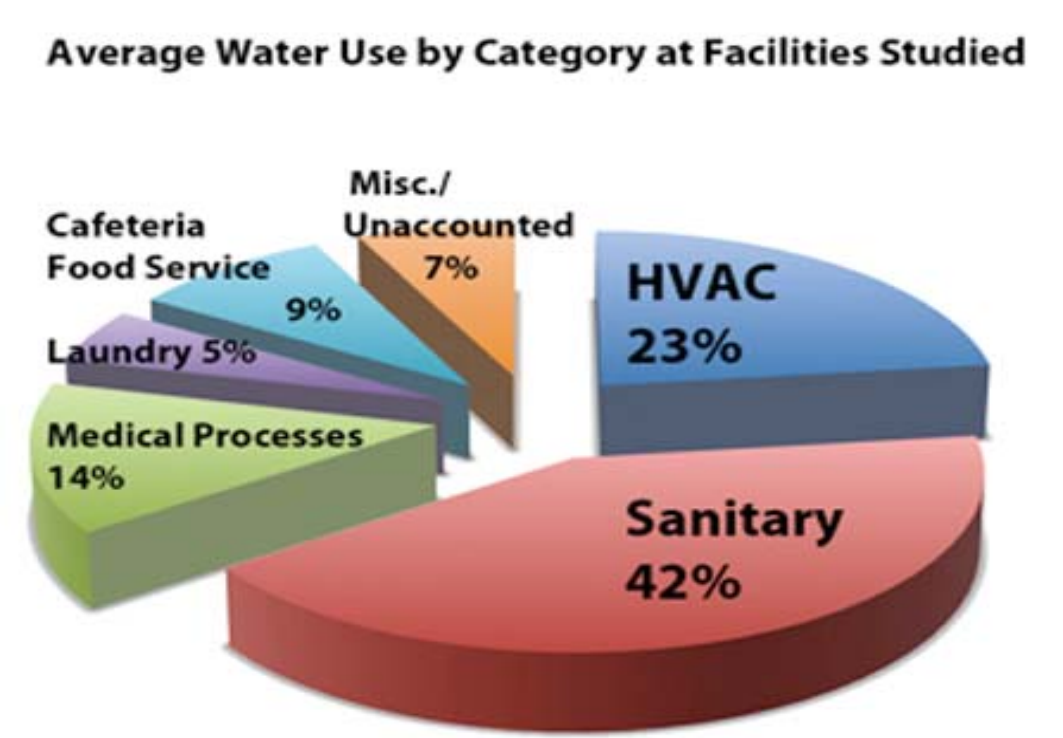
Microbiological examinations of electronic faucets newly installed in a hospital kitchen revealed high bacteria counts and *Pseudomonas aeruginosa* during a 6-month period of observation. Our data suggest that the use of electronic faucets poses a potential risk for nosocomial infection in high-risk areas of hospitals (*Infect Control Hosp Epidemiol* 2004;25:997-1000).

When Going Green… Be Careful What You Wish for



Special Pathogens Laboratory
The Legionella Experts

Annual Water Usage from 15 to 67 Million Gallons



*Facilities studied in chart include hospitpals with 138 to 550 bed capacities, in-patient admissions of 5,100 to 11,600 per year and annual water usage ranging from 15 to 67.2 million gallons.The 7 hospitals studied include: 1 large (Boston), 1 large long-term care, 4 small community and 1 region urban.

RESEARCH

“Green” Technology for Cooling Water Systems

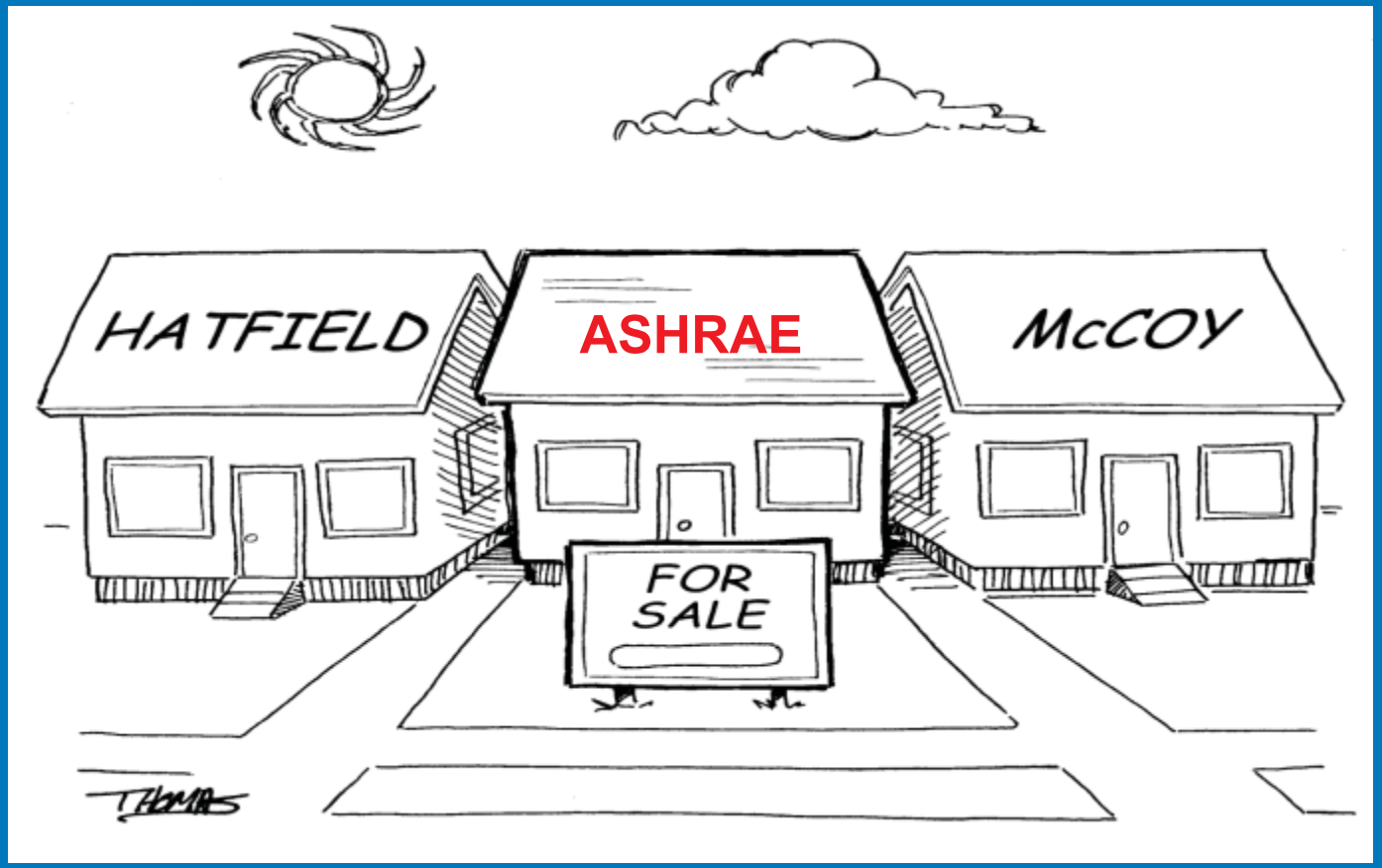
Non-chemical Methods

Introduction: Non-chemical Treatment Devices

- Operate by **physical** alteration of water
  - Magnetic fields
  - Electric fields (pulsed and static)
  - Ultrasonic radiation
  - Cavitation (acoustic and hydrodynamic)

Water Treatment

Non-chemical (Hatfield's) vs. Chemical Treatment (McCoy's)



Why Did ASHRAE Fund the Study - Project 1361-RP?

- Most evidence of effective operation of non-chemical devices has been anecdotal and/or from the manufacturers or their representatives
- Thus, their reported efficacy was not based on objective scientific data (not evidence-based)

Cooling Towers: Biological Control Using Non-Chemical Water Treatment

Dr. Radisav Vidic
Principal Investigator

Dr. Janet E. Stout
Co-Investigator

Scott Duda
Graduate Student Researcher

University of Pittsburgh
Swanson School of Engineering
Civil & Environmental Engineering

ASHRAE Project 1361-RP

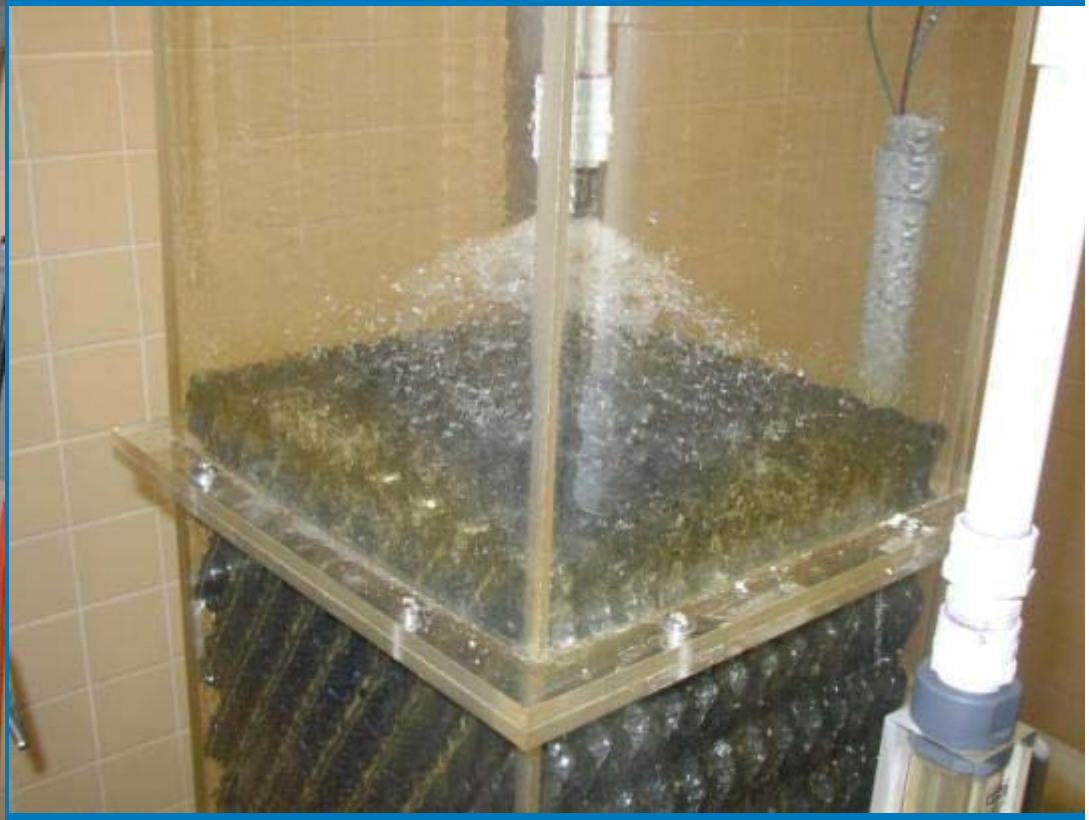
- Controlled study compared the operation of two identical model cooling towers
  - T1: Untreated control tower
  - T2: Experimental NCD device tower

Device Testing

Treatment Technology	Total Days of Testing
Magnetic	56
Pulsed Electric Field	58
Electrostatic	29
Ultrasound	29
Hydrodynamic Cavitation	29

Model Cooling Tower (T 2)

CF1200 packing in Tower 1

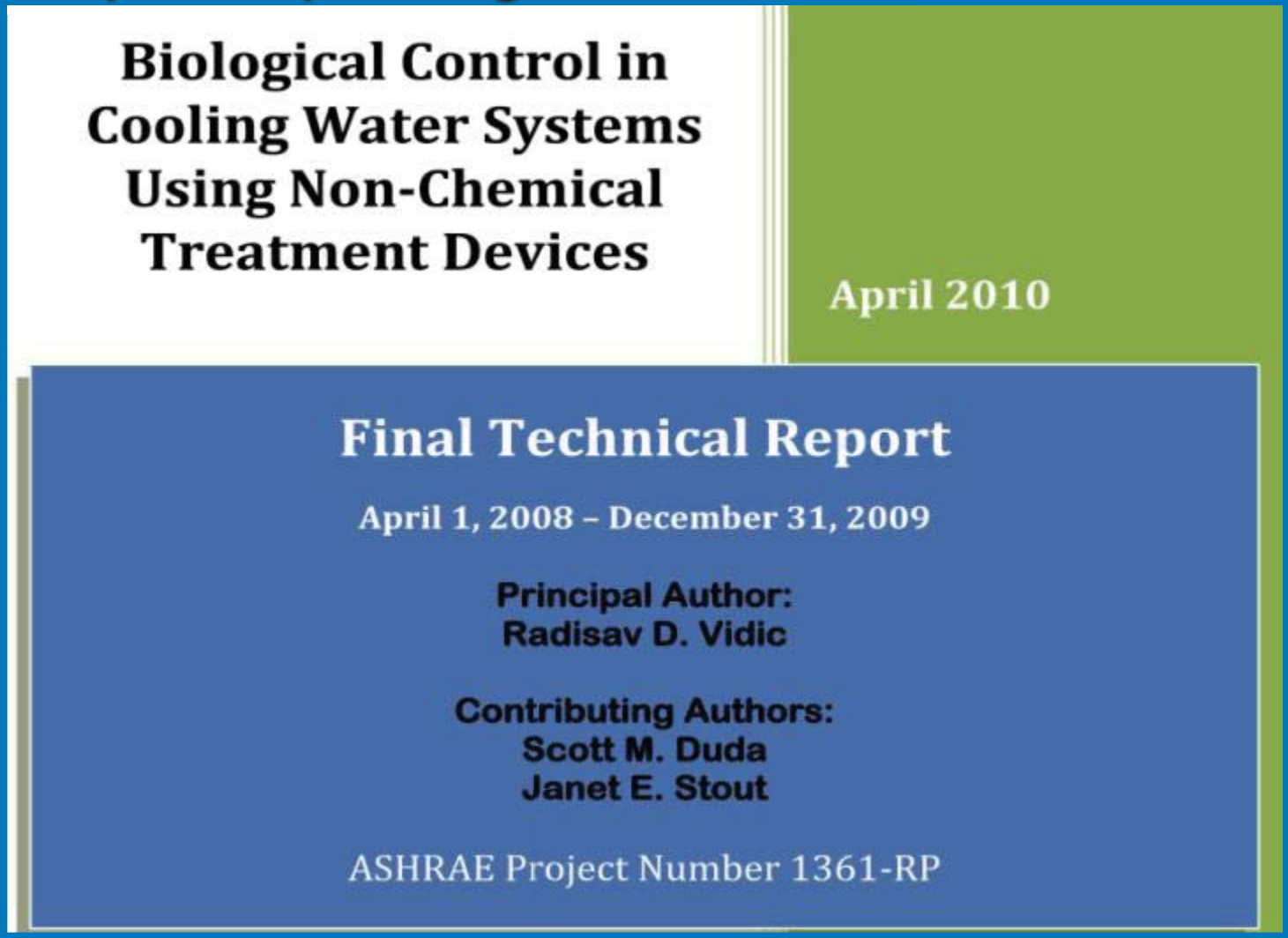


Water Distribution in Tower 2

Non-Chemical Devices Tested in Model Cooling Tower

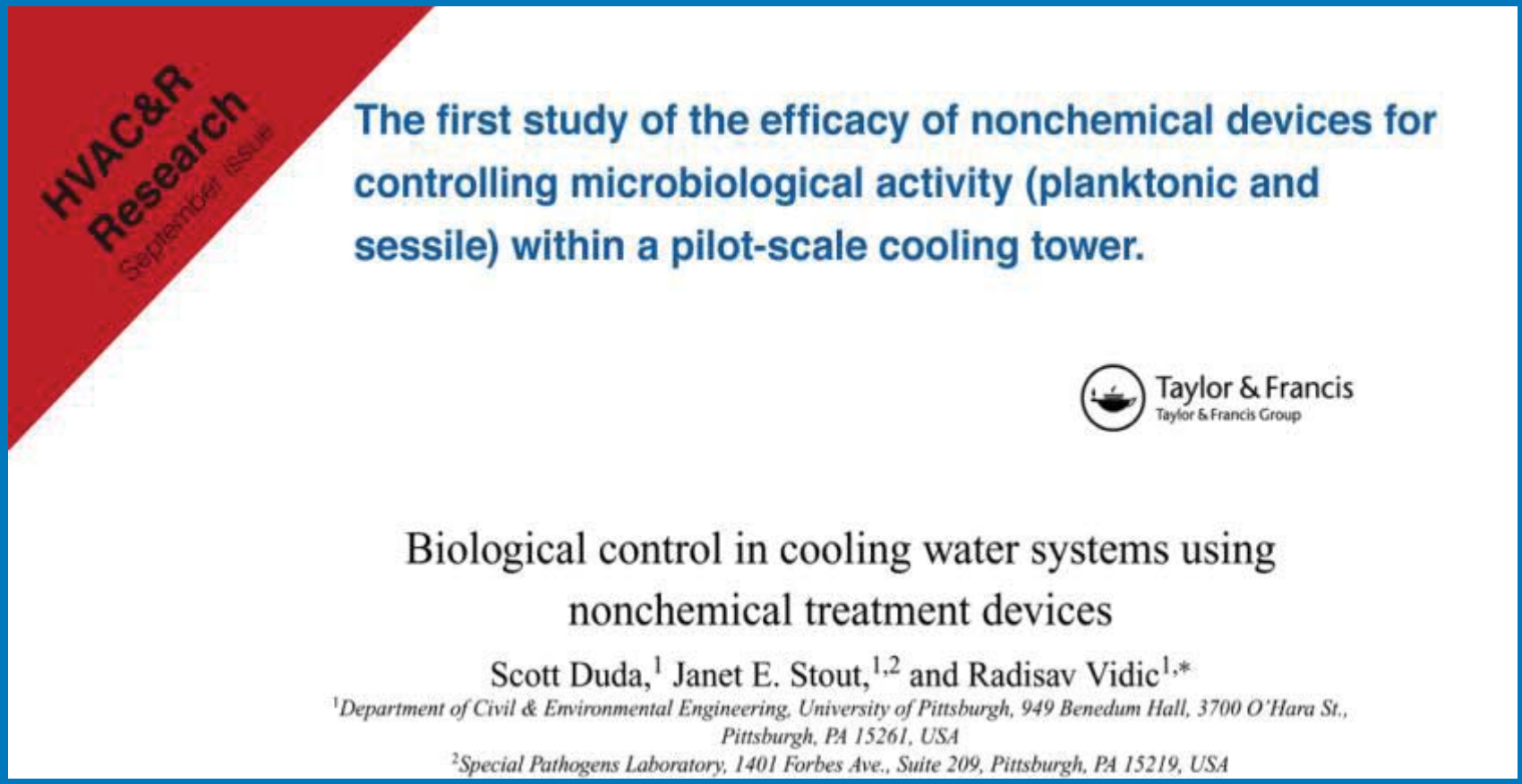
- Tests showed that **none** of the non-chemical devices controlled or reduced bacteria (including *Legionella*)
- Report RP-1361 available to ASHRAE members at www.ashrae.com

Hear podcast about NCD study at
www.specialpathogenslab.com



Available upon request

info@specialpathogenslab.com



"With wine comes wisdom,
with beer comes freedom,
with water comes *Legionella*"

Janet E. Stout, PhD

info@specialpathogenslab.com

- Presentation materials
- Guidelines and Standards
- *Legionella* Testing
- Risk Assessments
- Outbreak Response
- Research and Education

Special Pathogens Laboratory®

SPL®

The Legionella Experts®

www.specialpathogenslab.com