

FROM WATERSHEDS TO SHOWERHEADS: A WORKSHOP ON *LEGIONELLA* RESEARCH AND POLICY**Workshop Summary****Paving Paths from Experience: New York City**

Ruth Berkelman (Moderator), Marci Layton, Chris Boyd, Sharon Balter

In this session, key staff from the New York City Department of Health and Mental Hygiene spoke on their experiences responding to outbreaks of Legionnaires' disease, including the large outbreak that took place in the South Bronx in 2015. The use of automated cluster detection methods was discussed. The creation of a national bank of *Legionella pneumophila* strains from around the country was proposed; a bank would allow public health departments to compare outbreak strains and further characterize high risk strains.

Water Security and Conservation

Gary Roselle (Moderator), Joan Rose (Moderator), Marc Edwards, Nicholas Ashbolt

This panel focused on the challenges of reducing *Legionella* proliferation given increased water age in a variety of situations. Current water treatment plans generally rely on the maintenance of a disinfectant residual high enough to inhibit bacterial proliferation. However, increasing water age in the distribution system and within buildings caused by conservation efforts and water storage requirements has sometimes resulted in insufficient disinfectant residuals that increases the risk of amplification of *Legionella* and other opportunistic premise plumbing (OPP) pathogens. OPP pathogen risk may also be increased by water reclamation efforts, including installation of low flow fixtures and/or water temperatures below 50 C. Quantitative biofilm and *Legionella* growth thresholds based on quantifiable microbial risk assessments (QMRA) that would be most likely to cause disease were discussed. Improved understanding bacterial risk thresholds and how different aspects of plumbing design affect microbial ecology of a plumbing system could provide novel risk-reduction methods while allowing conservation efforts to continue. Gaps in knowledge include the impact that free-living amoebae have on the microbial ecology of the built environment. Proposals to reduce risk of OPP pathogens include: reduction in pipe diameter to increase flow rate and improve mechanical disruption of biofilm and improved management of water on premises once it leaves the general distribution storage system. The session concluded with a discussion around the need to balance the risk of scalding with *Legionella* amplification. Research needs that were identified included:

- Understanding the impact of free-living amoebae and amoebae-resisting bacterial pathogens on biofilm ecology;
- Determining if a protective biofilm microbiome could provide robust protection in the absence of residual disinfectant;
- Understanding and quantifying the contribution of water storage to *Legionella* risk in buildings such as hospitals or long-term care facilities; and
- Identifying other possible methods to assuring continuity of operations that do not require water storage.

Diagnostic Testing, Public Health Surveillance, and Epidemiology

Michael Osterholm (Moderator), Sharon Greene, Leonard Mermel, Brian Raphael

This session focused on the current state of diagnostic testing and surveillance protocols for legionellosis in the United States. An overview of current laboratory testing for Legionnaires' disease was presented, and areas that could use improvement were discussed. A major focus of the panel was discussing the role that molecular methods could play in the future. The panel drew comparisons between the current diagnostic paradigms in the United States and Europe. Speakers discussed research and development needs in laboratory testing, such as the further refinement of culture-independent diagnostic tools and the need for a molecular test that can detect other *Legionella* strains in addition to *Legionella pneumophila*. Furthermore, there is a need to ensure that technicians in the clinical laboratory have the expertise and resources to conduct these molecular assays on-site.

The panel and the audience also discussed who should be tested for legionellosis and the need to revise current national guidelines for diagnosing the disease. Many in attendance felt that improving diagnostic accuracy (via improved laboratory tests and increased testing of patients with pneumonia) would be beneficial to targeting therapy in a world where antimicrobial resistance is a major concern in addition to improving data on *Legionella* burden. The lack of analysis of the cost-benefit of testing was noted. The session included a discussion of automated surveillance methods utilized by New York City DOHMH, including the pros and cons behind such statistical methods. Shifts in the epidemiology of LD in the United States were also discussed.

Legal Challenges of *Legionella*

Ruth Berkelman (Moderator) Susan Smith, Tom Bernier, Dan Moretti

This session provided an overview of significant claims and settlements that have been awarded in Legionnaires' disease related lawsuits in the past decade. This session offered attendees insights into how non-health related spheres of influence may be impacting the future of *Legionella* control. Common concerns expressed by building owners and cooling tower managers were relayed by the lawyers on the panel. The pros and cons of regular, proactive testing of environmental systems from a legal defense perspective were discussed. The session concluded with a discussion surrounding the ASHRAE industry standard or the American Industrial Hygiene Association guidelines, the impact that their widespread adoption could have, and the ins and outs of standard of proof.

Environmental Monitoring and Testing

Shantini Gamage (Moderator), Kim Musser (Moderator), Dana Flanders, Maria Luisa Ricci, Chuck Haas, Janet Stout

The public health benefits of proactive quantitative culture of *Legionella* in the environment were illustrated. Data were provided to demonstrate that a small measurement error was necessary to assure the validity of quantitative testing. Comparisons were drawn between environmental testing regimes in Europe and the United States. Advantages and disadvantages of various testing methodologies that are in use in Europe were explored. Quantitative microbial risk assessment (QMRA) methodologies and how they can be used in environmental testing were discussed. Consensus is needed for thresholds for remediation based on environmental sampling for *Legionella*.

Approaches for Control and Primary Prevention

Gary Roselle (Moderator), Christopher Boyd (Moderator), Sebastian Crespi, Noel Cleaves, Martin Exner, David Krauss, Tim Keane, Brian Shelton

Primary prevention and control strategies currently utilized in Spain, Australia, and Germany were shared by workshop attendees. The use of various strategies, such as bacterial thresholds to determine the necessity of remediation or the enactment of cooling tower registration legislation, were discussed through examples from jurisdictions that mandate environmental testing. Perspectives on control and prevention from representatives of the private sector were also presented.

Engineering and Infrastructure Controls

Amy Pruden (Moderator), Lut Raskin, Paul van der Wielen, Joe Falkinham III, Mark Rodgers

This session focused on strategies for and challenges regarding the prevention of *Legionella* amplification at the building level. Properties of premise plumbing that are conducive to the growth of opportunistic pathogens such as *Legionella* were discussed. Properties included the low organic carbon content, long stagnation time, variable flow velocity, warm temperature, and low disinfectant residual of water entering premises from the water distribution system. Strategies to reduce potential exposure to opportunistic pathogens in premise plumbing were also discussed. Potential infrastructure controls were described, including the use of ozone as a primary disinfection method in mass scale water treatment, and the pros and cons of such controls. Examples were given in presentations describing water treatment practices in Germany and The Netherlands. The current regulatory environment in the United States and how it relates to individual buildings was explored. A multiple barrier approach to control of *Legionella* was presented. The approach outlined legislative and non-legislative requirements. Legislative requirements included the development of a *Legionella* control plan for priority buildings, water utility monitoring of *Legionella*, and the required investigation of all cases reported to public health authorities, including investigation of the potential environmental source for each case. Non-legislative requirements included adjusting drinking water temperatures to remain outside the optimal growth range for *Legionella*, minimizing AOC levels within drinking water, and designing premise plumbing systems with the control of *Legionella* in mind. The problem of other pathogens in the water such as *Pseudomonas* and atypical mycobacteria were also discussed, and how taking measures against *Legionella* might alter the risk for these pathogens.

Identifying Gaps in Knowledge: Flint, MI

Jim Curran (Moderator), Suzanne Cupal

In this session, a representative of the Genesee County Health Department discussed the County's experience during the 2014 water crisis in Flint, MI. A brief description of the crisis was given, followed by the steps taken by the health department. The lessons learned by the health department were discussed, and the impact that this knowledge will have on future public health operations was explored.

Public Water Supply Community/Utility Level Controls

Amy Pruden (Moderator), Norm Pace, Jorge Santo-Domingo, Jen Clancy, Marc Edwards

The session opened with a discussion of the microbial ecology of the built environment. Opportunistic waterborne pathogens apart from *Legionella* were described. Pathogens included non-tuberculosis mycobacteria, *P. aeruginosa*, *Acanthamoeba*, and *N. fowleri*. The current state of molecular tools used to study the microbiology of the built environment was reported. The benefits of further refinement to molecular sequencing methods were also described. Necessary steps for improvement include development of cheaper, real-time sequencing methods with lower access barriers for technicians or plant managers. Research must be conducted to further verify molecular sequencing targets in *Legionella* and other pathogens. The benefits of RNA-based methods over methods utilizing another molecular target were described.

In addition, the current role of water utilities in preventing outbreaks was discussed. The Partnership for Safe Water, a conglomeration of federal agencies and water utilities around the country that agree to go farther than federal regulations and ensure high quality water in the distribution system was described. Partners go beyond federal regulations to ensure high quality water in the distribution system. Some experts called for modifications of regulations to ensure that water is safe to breathe, in addition to being safe to drink. A discussion arose surrounding the impact of corrosion control and the potential implications when corrosion control fails (as happened in Flint, MI). The future role of water utilities in preventing outbreaks was discussed, and a call was put out for a shared responsibility model of water quality maintenance.

Planning for the Future: Paths Forward for Research Policy

Ruth Berkelman, Shantini Gamage, Gary Roselle, Amy Pruden

Workshop sessions were briefly summarized by the planning committee and the audience was provided time for final remarks. The proposal for a full study on legionellosis by the National Academies of Science, Engineering and Medicine will likely lead to follow-up by the Academies with relevant governmental and non-governmental agencies potentially providing support.