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IAQ RADIO+

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Remediation of Microbial Contamination & Legionella

Good day and welcome to IAQ Radio+ episode 733 blog. This week we welcomed Dr. David Krause for an engaging and informative discussion on microbial contamination, Legionella and remediation.

Dr. David Krause is the founder of Healthcare Consulting and Contracting (HC3). He is a Certified Industrial Hygienist and Toxicologist, with 30 years of experience in public health, occupational hazard assessments, and indoor air quality. David received his Doctorate in Environmental and Occupational Health and Master of Science in Public Health Toxicology from the University of South Florida, College of Public Health in Tampa, FL. He is a nationally recognized expert in risk assessment, workplace exposures to pathogens and hazardous chemicals, health care facilities, Legionnaires' disease, combustion products, flame retardants, indoor air quality, and mold. From 2008 to 2011 Dr. Krause served as the State Toxicologist for the Florida Department of Health.

Nuggets mined from today's episode:

You have been involved with occupational health and IAQ for many years now. Please tell us a little about your path through the industry? David Krause was an Artillery Officer assigned to an Ordinance Brigade; where his job included the security, maintenance and eventual transport of atomic and chemical weapons from Europe back to the USA. After leaving the Army, he worked for Florida's Dept. of Health as a toxicologist. The State of Florida has a statute requiring the state health department respond to IAQ complaints. In 1994, his department received 5,000 requests for assistance and had a budget of $750K. From the application for funding until spending the money, his department needed to fill out 3 different applications. Mold, hemosiderosis, candle emissions, and IAQ were the most common concerns.

He worked with, and learned a lot from Richard Shaughnessy, Bill Turner, and Terry Brennan. This was early in his career and he wanted to convey his thanks to these

professionals who took him under their collective wings and helped inform his view of the IAQ field.
At the Florida DOH he was charged with establishing IAQ Programs within established health departments. The county health departments were around long before IAQ became a formal program. Now his old department is down to 1 person and $0 budget.

David conducted a deep research dive on Stachybotrys detoxification and found that in Russia in the 1920s-30s ammonia was successfully used to fumigate hay. David conducted chamber studies fungal growth on materials (e.g. fiberglass duct lining, duct board).

You and Jack Springston are cited as the authors of the Remediation of Microbial Contamination chapter. Tell our audience what is new?

Jack Springston led the effort on development of the initial draft. David led the effort to incorporate Legionella and other waterborne bacteria.

David had the opportunity to work with Phil Morey during his later career. David also worked on the bacteria chapter which was previously written by Harriett Burge.

There are 3 bullet points in the intro that help define microbial contamination:

- Biologicals likely to cause or predispose health effects (dependent upon the organism and the dose)
- Inappropriate airborne concentrations (concentrations are transient like an automatic lawn sprinkling system, sometimes its off sometimes its on, some areas receive more water than others)
- Indoor microbial growth, amplification or remnants which may become aerosolized (colonization and increase in growth)

"Surface samples capable of detecting the presence of fungal growth structures, viable and pathogenic bacteria or endotoxin levels are most useful in defining the extent of microbially contaminated building surfaces and materials."

Both Jack Springston and David concur and encourage surface sampling over air sampling. Many errors can occur during air sampling.

Give our audience examples of when they would want to check for pathogenic bacteria and especially endotoxin levels?

Following sewage spills, catastrophic flooding, bioterrorism and waterborne pathogens.

How do you remediate endotoxins?

Endotoxins are a great indicator. During life, Gram negative bacteria slowly release small quantities of endotoxin and release 20 times more upon death. Endotoxin are a chemical hazard causing adverse health effects. Endotoxin are measured in Endotoxin Units per m3 (in air), per gram (in dust) or per mL (in water). There is a TLV for endotoxin [TLV-TWA 90 Endotoxin Units CEU/m^3. inhalable particulate matter. A4- not classifiable as a human carcinogen]. Endotoxins are heat stable and known to survive autoclaving.

Dr. Krause has found endotoxin in office buildings with long duration water intrusion, in HVAC systems, in carpeting. A case in point was Friday afternoon use of a "Zamboni-looking" commercial carpet cleaning machine in an office building which left the carpet sloshing and turned off the HVAC. The carpet was dirtier than dirt, testing confirmed more endotoxin in the carpet than was in ground soil outside.

Actinomycetes poses a big health concern.

Stachybotrys requires moisture, nutrient food source and temperature cycling. Mycotoxin is commonly found in food (peanuts, corn, etc.) and our bodies have developed some tolerance to it. The term mycotoxin is often used to scare people into spending money.

Legionella

Legionella is known to cause health problems. In the prior book, 1,000 cases of Legionella disease were reported per year. Between 2001-2003 there was a 70% increase in cases; the majority of which occurred in PA and the MidAtlantic region. The CDC attributed the increased cases to greater rainfall. Factchecking found that rainfall was lower during the period and droughts also occurred. The Safe Drinking Water Act of 2002, mandated reduction of the levels of chlorine used in water systems to reduce the amount of chlorine related carcinogen. 2002 was the year that the Disinfectants and Disinfection By-Product (DDBP) Rule was implemented. The safe drinking water act was implemented years earlier (1974). The Stage 1 DDBP Rule mandated reduction of carcinogenic disinfecting byproducts (Total Trihalomethanes), which resulted in lower levels of chlorine used in drinking water systems. More of an unintentional consequence of removing a protective agent

(chlorine) to reduce the risk of carcinogens in water, but allowing pathogens to proliferate.

Water main breaks and vibration from heavy equipment are known to dislodge scale and biofilm from the interior of water pipes. This often results in no detectable level of chlorine in drinking water delivered to building water systems measured at the water meters.

Exposure to Legionella is through inhalation of small aerosols created from everyday activities, including showering, handwashing, washing a car, or using a (cool mist) humidifier. 96% of diagnosed-confirmed cases of Legionnaires' Disease are never investigated to identify the source of exposure, where samples are collected to confirm the source of exposure. Sampling is not required unless an outbreak occurs; an outbreak is defined as 2 or more people with like nexus (exposure) confirmed.

Legionella is 1 of the Big 3 which require national reporting: Legionella, pseudomonas, and NTM (nontuberculous mycobacteria). The combined annual healthcare costs for the Big 3 are $3B.

Legionella (an aerobic bacteria) requires oxygen to survive. Chemical free reduction of dissolved oxygen levels in water systems with special membranes suffocates legionella bacteria. 3M is a manufacturer of these membranes which can be used to either remove or inject gases into air or liquids.

"Few data are available on personal exposures that have occurred during fungal remediation." Phil Morey studied exposure levels in containments during mold remediation and found exposures of 10^6/per CM. Fungal organisms decompose materials. Fungal decomposition can create chemical exposures by mobilizing chemicals into the environment. During fungal remediation, workers are exposed to fungal fragments along with VOCs, odors and chemicals. Respirators and other PPE are not tested for performance against bio-organisms, resulting in a lack of evidence. Z-Man comment: Some basic mold remediation guidance is flawed, such as don't add moisture during remediation. Misting during drywall removal, dampening moldy surfaces prior to detachment.

"Contaminated porous materials in HVAC systems must be removed to underlying bare metal and contaminated materials appropriately discarded." This is a statement from the prior book. Dave and Jack opine this action is appropriate when possible and practical.

Cleaning fibrous insulation is akin to cutting the grass, only the top layer is removed leaving everything below. Fungi attach to fiberglass glass fibers and are not detached by vacuuming or gentle agitation.

HVAC System Remediation is defined as removing sources. Porous HVAC liner or duct board that is being cleaned and coated should not be referred to as remediated; rather accurately described for what it is: “managed in place” or “cleaned and coated”. Cleaning and coating porous duct liner or duct board may result in a loss of thermal capacity.

The Bioaerosols chapter is favorable about using surface samples to assess post remediation efficacy. Air sampling is more prone to errors.

Why don’t we hear more often about Legionella cases in residential properties? 96% of Legionella cares are never investigated, sample, or tested to confirm source.

Here are some key points we picked up from reading the section on Legionella. A lot of information was added. We hope our audience will check it out.
There are more variables involved than many realize:

- Ineffective cleaning, disinfection and flushing can increase concentrations by disturbing biofilms and releasing bacteria into the system.
- The diagram cross section of the pipe makes you think!!
- Interim mitigation such as POU filters are a part of the management of Legionella
- Thermal Shock Treatments of potable water systems is no longer recommended for control because of frequent failure and rapid recolonization
- Verification and validation. Verification involves confirming the water management program is being implemented as designed, while validation involves confirming that hazards are being controlled. How is validation best done?

At what pH level does chlorine only "tickle bacteria" and under what conditions is chlorine "lethal to bacteria? Hypochlorous acid is the primary antimicrobial agent contained within chlorine. Hypochlorous acid is released from chlorine at lower (acidic) pH levels.
[Z-Man example: 1 part chlorine bleach and 49 parts at a pH of ≤5 is a more powerful disinfectant (sterilant) than straight chlorine bleach.]

Legionella, in addition to cooling towers, what other areas should IEQ investigators consider as potential sources of contamination? Hot water heaters, hot tubs, water features.

Z-Man signing off

Resources:

Dr Krause has provided links here for folks (after the show, or to post as resources) on Legionella and AIHA guidance I have had a hand in developing.

Of relevance is the FREE Framework on Legionella (LINK). That lays out the knowledge, skills, and abilities that people should possess in pursuit of competency as it relates to assessing building water systems for *Legionella* (and other waterborne pathogens) and collecting samples to identify amplification sites that may cause outbreaks of disease.

AIHA Legionella Guideline (2nd Edition) (Not Free) https://www.aiha.org/education/marketplace/legionella-guide

Also, a couple of recent articles I have published on a new approach to controlling *Legionella* in hot water systems.

Legionella and the Role of Dissolved Oxygen in Its Growth and Inhibition: A Review (https://doi.org/10.3390/w14172644)

Controlling *Legionella pneumophila* growth in hot water systems by reducing dissolved oxygen levels (https://doi.org/10.1080/15459624.2024.2313580)

Trivia:

Question: Name both the international fraternity and the US Military Veterans Association who both experienced outbreaks of Legionnaire's Disease while meeting in the same place?

Answer: Oddfellows Society and American Legion

Sorry there were no correct answers to the question.

Dr. Krause has previously suggested that IF the CDC has investigated the outbreak of pneumonia at the Order of Odd Fellows convention 2 years before the Legionnaires convention in 1976 then we might have named the disease "Odd Fellows' Disease " rather than Legionnaires' Disease. Which one has a better 'ring' to it? It's association with veterans likely led to its status as a nationally notifiable disease.