Water as a Source of Hospital Acquired Infections

APIC SF Bay Area Chapter, May 13, 2015

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Purpose: Review potable water systems in the Healthcare Industry, focusing on Engineering & Plumbing Challenges (systemic vs. immunocompromised populations). Review both outbreak response and proactive risk minimization plans and best practices.

Process: An interactive presentation focusing on evidence based data, published best practices & common potable water system challenges.

Pay-off: Members of APIC SF Bay Area will have more resources & background to minimize the risk associated with waterborne pathogens (both proactively and reactively) in your healthcare facility.

Michael Castro

Disclosure: *Pall Medical* Employee
Western Region, Hospital Water Specialist

- B.S. in Mechanical Engineering, Bucknell University
- Enrolled in Masters in Public Health Program, GCU
- Pursuing Certification in Infection Prevention & Control (CIC®)
- Over 16 years of experience in advising and helping healthcare facilities, universities, commercial buildings & manufacturing facilities reduce their risk due to waterborne pathogens in all water systems including cooling water and domestic water.
- Specific areas of focus include microbiological filtration and secondary disinfection of domestic water systems.
  Previously worked with Hospital's Potable Water Systems in KY, NJ, NY & AZ.
- *Member in APIC, ASHE, AWT, and ASHRAE*

Kevin Olson

Disclosure: *Nalco, an Ecolab Company*
Environmental Hygiene Services Specialist

- BS Chemical Engineering, University of California at Davis
- 28 years with Nalco; Water treatment in Industrial, Food & Beverage, Semiconductor and Institutional markets
- Over 7 years of experience in advising and helping healthcare facilities, universities, commercial buildings & manufacturing facilities reduce their risk due to waterborne pathogens in all water systems (domestic water, industrial/HVAC water, other at-risk systems)
- Specific areas of focus include Water Safety Plans, secondary disinfection of domestic water systems, industrial water systems, and microbiological filtration
- Work with Healthcare and Institutional Facilities in Western US
- Member of APIC, ASHRAE, NSF Certified HACCP Manager

What do Facility Managers and Infection Preventionists have in common?

Not Enough Hours In The Day!

You Each Have Your Own Perspective

You Each Have Your Own Priorities

Both Teams Can Reduce the Risk Associated with Waterborne Pathogens & HAIs

But it takes a team effort!

Water is essential…
And yet, water can cause unintended human harm if not properly engineered, managed and monitored.

What happens to drinking water from its origin to the tap?

In most circumstances, well-controlled, hygienic water is delivered from water plants to cities. During transport, water is cold and flows continuously through large diameter pipes. However, this situation changes dramatically at the point-of-entrance to buildings1, 2. Within buildings water stagnates and its temperature increases. It passes through complex internal distribution systems consisting of narrow pipes with possibly corroded inner surfaces and dead ends. This environment provides optimal conditions for the formation of biofilm from which bacteria and other microorganisms are continuously released into the water [3-5].

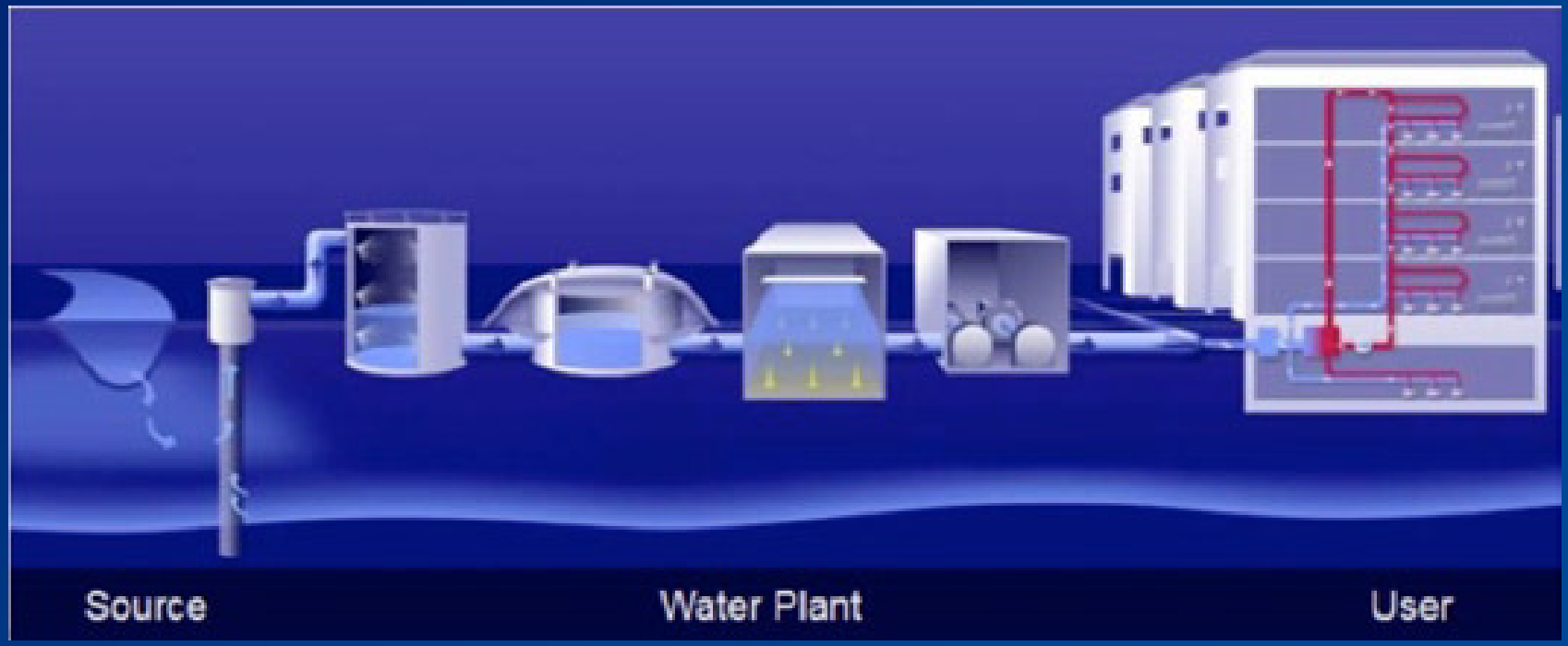
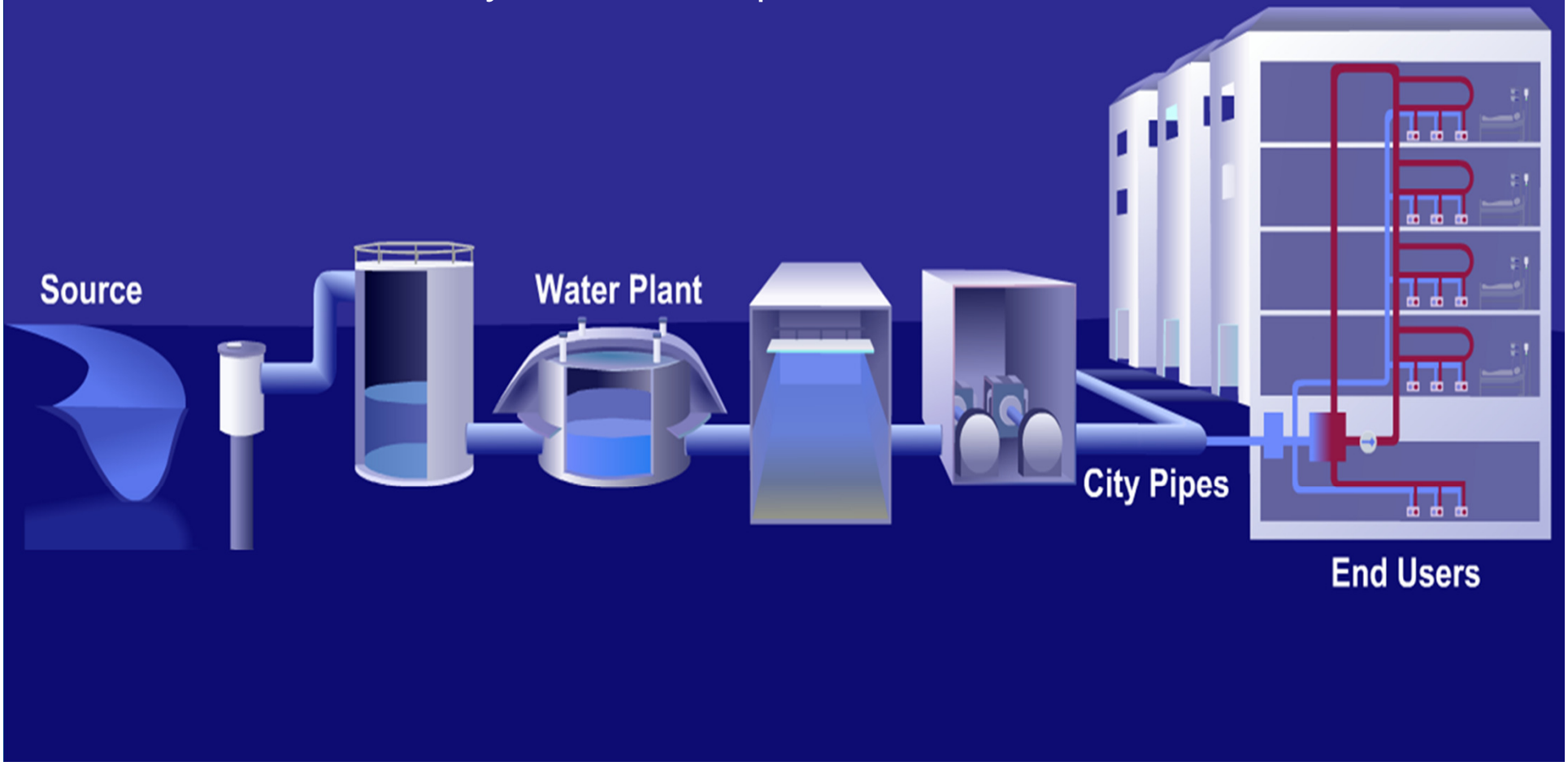


Image 1: Drinking water is derived from lakes, rivers or deep underground. It is purified in water plants and transported underground in large diameter pipes to cities and buildings, where it then runs through small diameter pipes, stagnates and warms up. These conditions are ideal for biofilm formation.

Complex Drinking Water Supply Chain

Why can we not rely on the Water Treatment Plant alone?

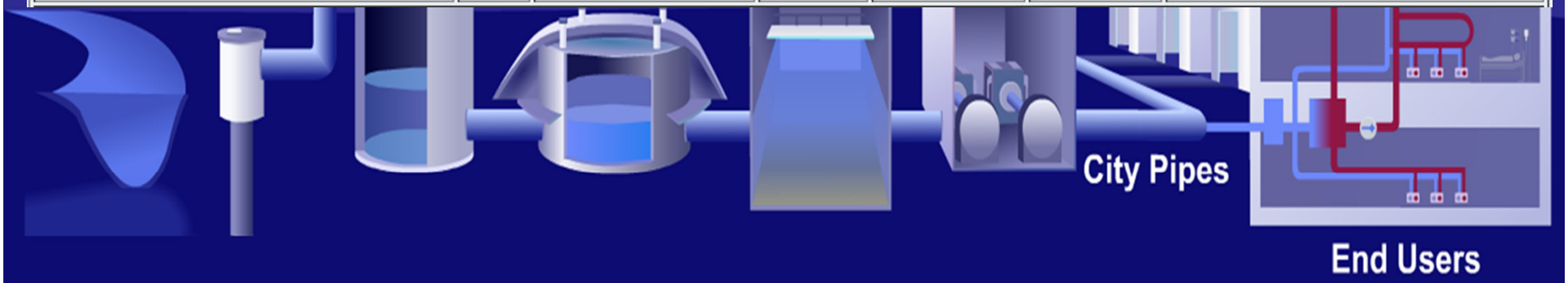
- Domestic Water is not Sterile Upon Entry into Facility
- Building Plumbing Systems Allow Further Biofilm Growth and Proliferation
- Often Times Severely Immunocompromised Patients Contact & Use H2O



Complex Drinking Water Supply Chain

Why can we not rely on the Water Treatment Plant alone?

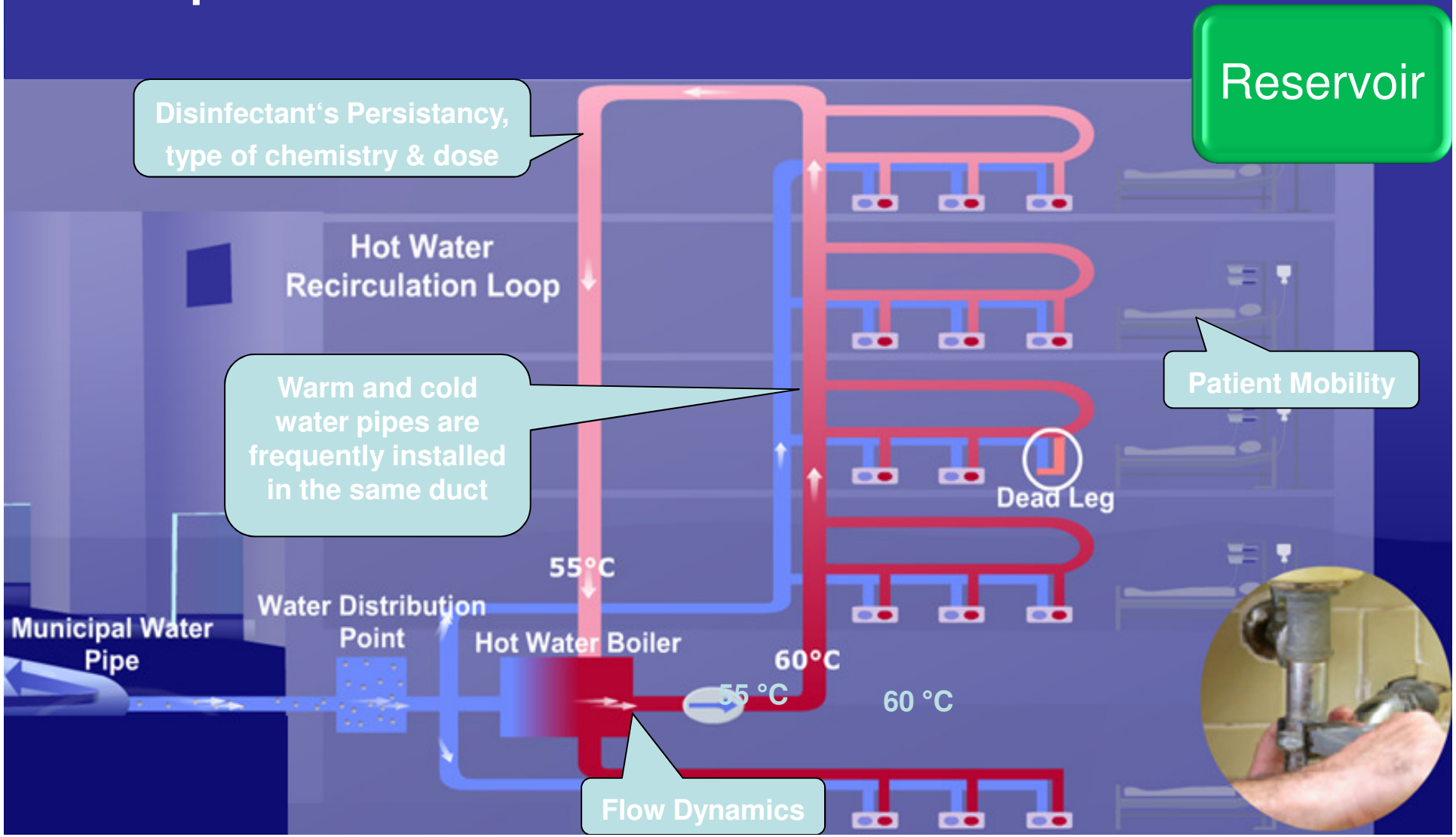
DETECTED CONTAMINANTS	UNIT	MCL	PHG OR (MCLG)	RANGE OR LEVEL FOUND	AVERAGE OR [MAX]	MAJOR SOURCES IN DRINKING WATER
TURBIDITY						
Unfiltered Hetch Hetchy Water	NTU	5	N/A	0.2 - 0.3 (1)	[3.6] (2)	Soil runoff
Filtered Water from Sunol Valley Water Treatment Plant (SVWTP)	NTU	1 (3)	N/A	--	[0.98]	Soil runoff
	--	min 95% of samples ≤0.3 NTU (3)	N/A	99.9 %	--	Soil runoff
Filtered Water from Harry Tracy Water Treatment Plant (HTWTP)	NTU	1 (3)	N/A	--	[0.13]	Soil runoff
	--	min 95% of samples ≤0.3 NTU (3)	N/A	100 %	--	Soil runoff



FOOTNOTES: (1) Turbidity is measured every four hours. These are monthly average turbidity values. (2) The highest turbidity of the unfiltered water in 2013 was 3.6 NTU. (3)There is no turbidity MCL for filtered water. The limits are based on the TT requirements for filtration systems.

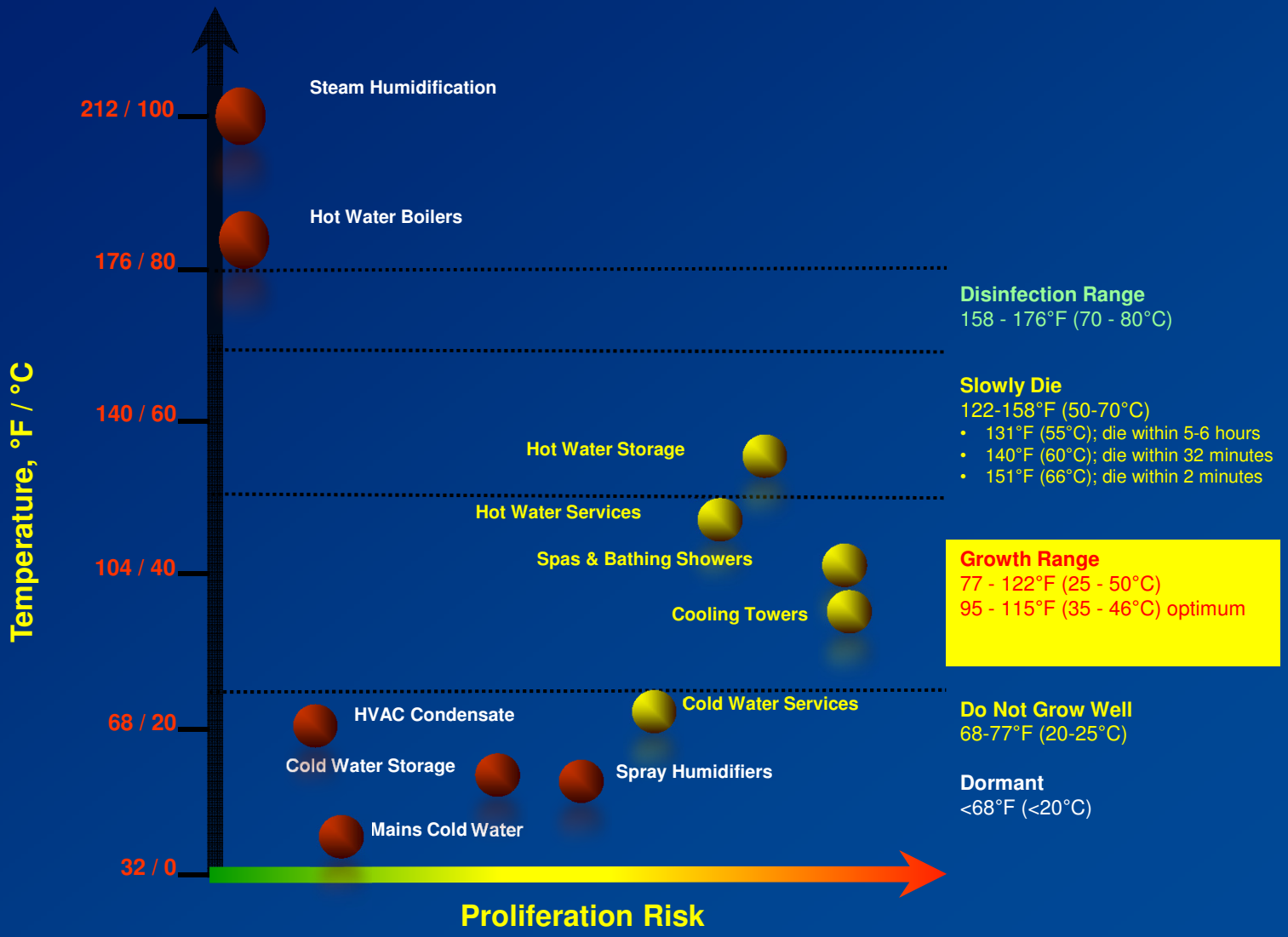
Annual Water Quality Report 2013. (2013). Retrieved from San Francisco Water Power Sewer: http://sfwater.org/index.aspx?page=634

SYSTEM CONDITIONS Complexity, age, poor temperature controls, lack of residual disinfectant, and water stagnation can provide conditions that allow formation of biofilms.



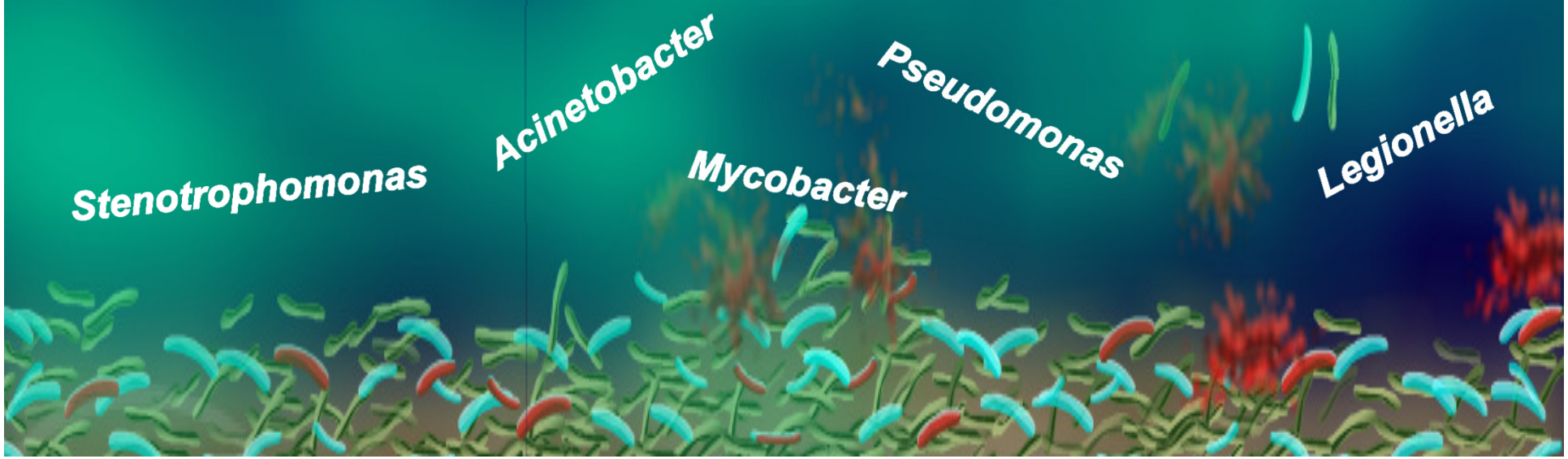
Utility & Domestic Services

Temperature vs. Proliferation Risk



Biofilm is our enemy

This is where most pathogens live, thrive and are often well protected from human interventions



Which sink option is best?

Portal of Exit

Knee/foot pedals

Sensor faucets

Wrist blades

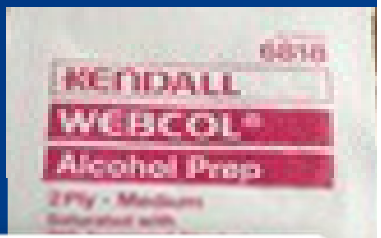
What do you consider when evaluating these options?

What does the wetted surface look like inside sink fixtures?

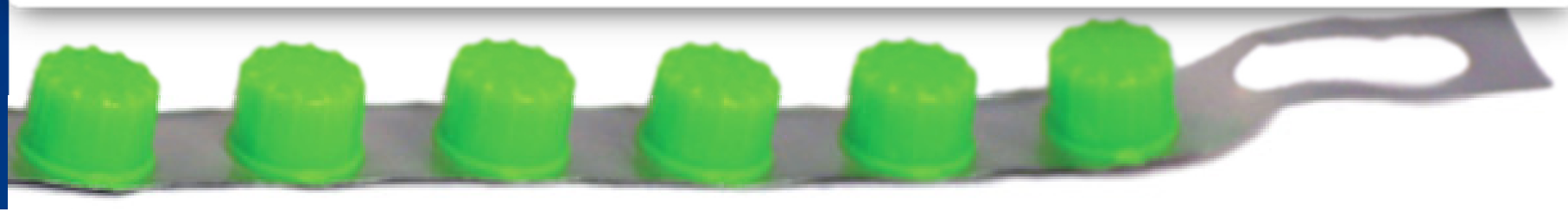
Why does your healthcare facility use these?

Bioburden / Biofilm

Why are these interventions appropriate for medical devices, but not effective with respect to hospital plumbing systems?



- Mechanical Action (scrubbing)
- Contact time
- High levels of disinfectant
- Disposal after a certain time



What is biofilm and how does it develop?

In water distribution systems biofilm can develop within a few days even if the water meets drinking water criteria [2]. Biofilm can host bacteria, amoeba, algae and other microorganisms. Under low flow conditions, such as in dead legs, particularly thick biofilms can form. Under the force of water flow biofilm shears off and biofilm particles can colonize other parts of the water distribution system3. External physical stress in the pipework, such as disinfection measures, can result in an increased expression of the biofilm phenotype cell which is responsible for the strong attachment of cells to a surface [5].

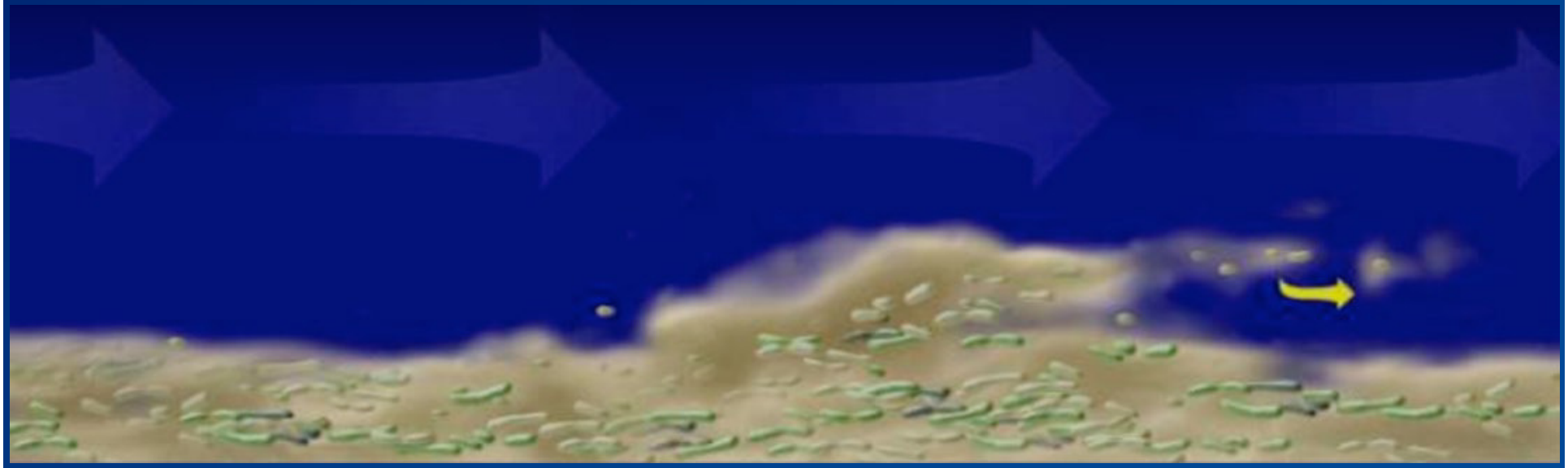


Image 2: Biofilm establishes in several phases over a few days.
It contains microorganisms within its slimy matrix. With increasing thickness, biofilm particles containing large amounts of bacteria are released into the water stream.

Why does biofilm influence the water quality?

With increasing thickness, biofilm better protects the microorganisms within, from chemical agents and thermal disinfection procedures [2, 5]. It is extremely difficult to completely eradicate the biofilm community once established. Irregular shedding from a biofilm can result in significant deviations of bacterial counts at sampling sites or points-of-use (POU) [2-4]. Bacteria within biofilm communities have been shown to exhibit greater resistance against antimicrobial treatments than corresponding planktonic cells [3].

Image 3: When biofilm loaded with bacteria is released into the water stream, high microbial counts may be measured at the outlets. Annual testing provides only a snapshot of information, while regular testing is useful to monitor the bacterial risk of a pipe network.

Which microorganisms can be found inside biofilms?

The majority of bacteria in a water pipework live within biofilm (about 95%) and only about 5% occur in the water phase [4, 6]. Biofilms contain a large variety of waterborne microorganisms. These include protozoa (e.g. Acanthamoeba), fungi (e.g. *Aspergillus* spp.), viruses and a number of human pathogenic bacteria [1, 3-6],. Among those bacterial species found in biofilm that are potentially harmful for immunocompromised people are *Pseudomonas aeruginosa*, non-tuberculous Mycobacteria, *Stenotrophomonas maltophilia*, *Acinetobacter baumanii, Chrysobacterium* spp., *Sphingomonas* spp., and *Klebsiella* spp. [3-6]. *Legionella pneumophil*a is perhaps the best-known bacterium colonizing biofilm, and it can be found in both central storage areas (e.g. water tanks) as well as peripheral water outlets [2,3,5]. Waterborne *Pseudomonas aeruginosa* is a major cause of severe infections [7-9] including pneumonia, sepsis, wound and skin infections.

Image 4: Biofilm in water networks may contain a large variety of microorganisms such as fungi (e.g. Aspergillus spp., left), rod-shaped bacteria (e.g. Legionella spp., middle) and protozoa (e.g. amoeba, right).

What are Viable But Non-Culturable cells?

The Viable But Non-Culturable (VBNC) cell fails to grow on routine bacteriological culture media, but is alive and capable of renewed metabolic activity - indeed it can be “resuscitated” to a culturable state with renewed virulence [6,10-12]. This discovery has thrown the accuracy of quantifying culturing techniques into question. It is understood that a high proportion of biofilm dwelling cells live in the VBNC state and that the VBNC state can be induced by antibacterial material such as copper pipes [11] as well as by thermal treatments [12]. As water pathogens such as *P. aeruginosa* in their VBNC state are not detectable by standard culture methods, alternative diagnostic technologies such as Polymerase Chain Reaction (PCR) or Fluorescence *In Situ* Hybridization (FISH) are required in order to confirm their presence [6].

Image 5: Chemical or heat disinfection can destroy layers of biofilm and organisms within those layers. However, biofilm is rarely completely removed and bacteria can survive in a VBNC state (displayed as blue cells). Those cells can establish new colonies after chemical or heat treatment cessation.

What role do amoeba play in the biofilm community?

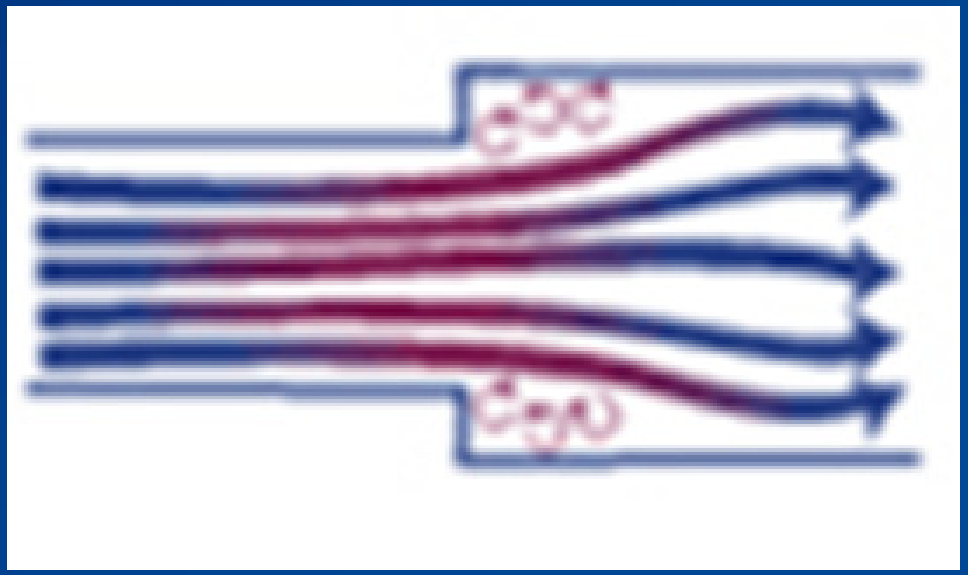
Amoeba are very important hosts for water bacteria. *L. pneumophila, Mycobacteria* spp. and other “amoeba resistant bacteria” can be carried by these protozoa [13,14]. *Legionellae* are taken up into amoeba without being digested and replicate there within vacuoles. When the *Legionellae* have reached a certain density, the vacuoles release them into the water system [14].

Image 6: Amoeba can incorporate Legionella which then proliferate inside vacuoles and are later released, either in the form of planktonic, free living bacteria, or packed within vacuoles.

Are there any Mechanical Engineers in the room?

Civil Engineers in the room?

Has anyone considered Fluid Dynamics as it pertains to Infection Control?



Which is the best option at point of use?

50% AIR

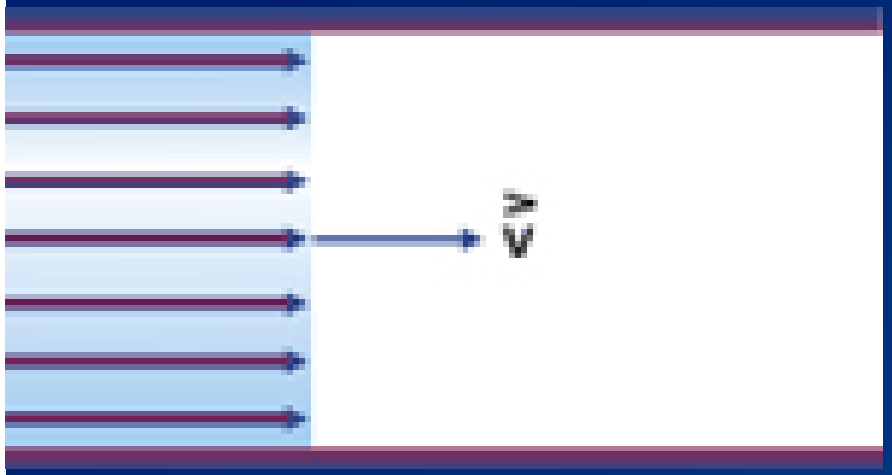
100% WATER

Point of Use Filter

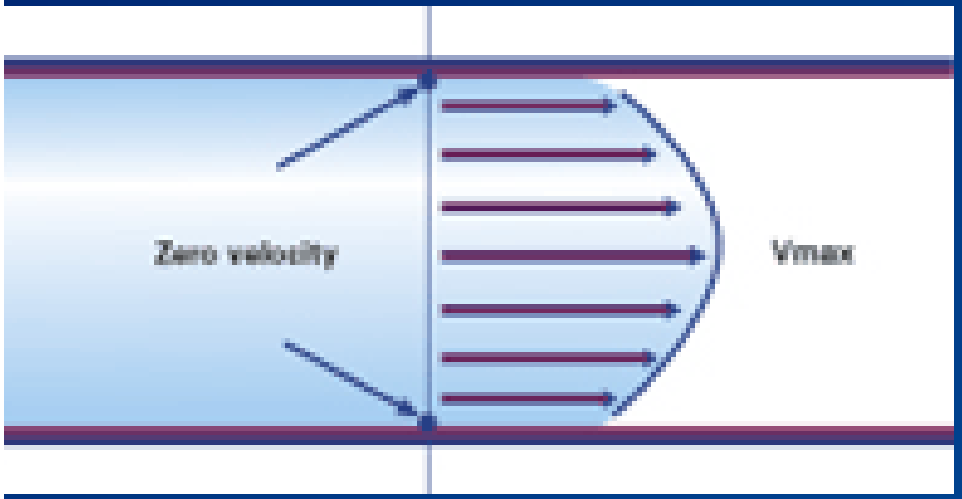
Sink	Before Filter (gpm)	With Filter (gpm)	After 31 Days with Filter
Hot/Cold	1.00	4.13	3.85

What do you consider when evaluating these options?

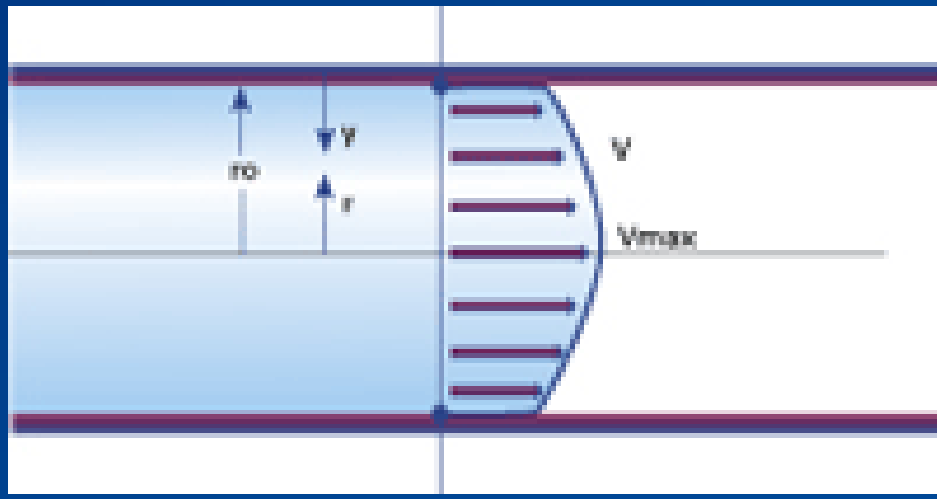
Low Flow (use, flushing or laminar flow devices)



Hypothetical: Zero Liquid Viscosity & Pipe Wall Friction results in a velocity profile that is a straight line. The vertical sheet of fluid moves forward at velocity V.



Laminar Flow Profile for Newtonian Fluid
The velocity is zero at the pipe wall and increases parabolically with flow, reaching its maximum at the pipe's center.



Turbulent Flow Profile for a Newtonian Fluid
The velocity is zero at the pipe wall, but the face velocity is straighter and squared up.

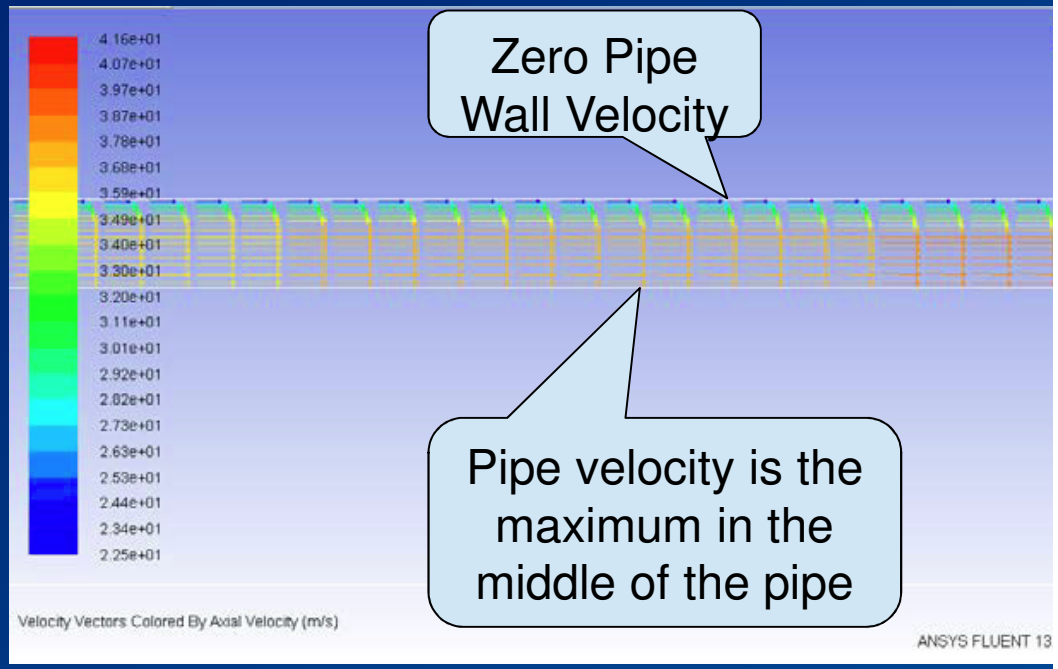
http://www.coleparmer.com/TechLibraryArticle/815

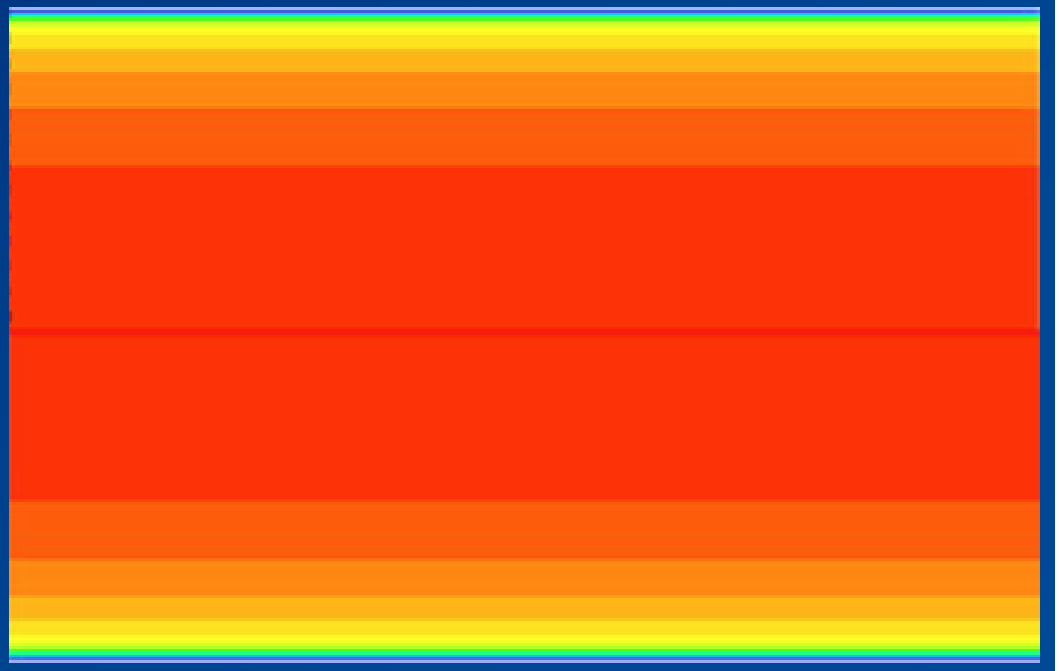
Improved Pipe Wall Velocity

- Larger Pipe Diameter
- Higher Flow Rates
- Smoother Surface (Coefficient of Friction)
- No Presence of Deposits
- Shorter Piping Runs

Poor Pipe Wall Velocity

- Smaller Pipe Diameter
- Lower Flow Rates
- Rougher Surface (Coefficient of Friction)
- Presence of Biofilm, Corrosion or Scaling Deposits
- Longer Piping Runs





frontiers in MICROBIOLOGY

REVIEW ARTICLE
published: 02 June 2014
doi: 10.3389/fmicb.2014.00258

The importance of the viable but non-culturable state in human bacterial pathogens

Laam Li[1], Nilmini Mendis[1], Hana Trigui[1], James D. Oliver[2] and Sebastien P. Faucher[1]*

[1] *Department of Natural Resource Sciences, Faculty of Agricultural and Environmental Sciences, McGill University, Ste-Anne-de-Bellevue, QC, Canada*
[2] *Department of Biology, University of North Carolina at Charlotte, Charlotte, NC, USA*

Table 1 | The species of human pathogens with a proven VBNC state.

Species	VBNC state inducing factor	Resuscitation condition	Resuscitation window	References
Acinetobacter calcoaceticus	Starvation			Lemke and Leff, 2006
Aeromonas hydrophila	Starvation	Temperature upshift		Rahman et al., 2001; Maalej et al., 2004
Agrobacterium tumefaciens	Starvation, chemicals (copper)			Byrd et al., 1991; Alexander et al., 1999
Arcobacter butzleri	Starvation	Rich medium, NOT temperature upshift	270 days	Fera et al., 2008

"Unlike normal cells that are culturable on suitable media and develop into colonies, VBNC cells are living cells that have lost the ability to grow on routine media, on which they normally grow" (Oliver, 2000).

Why is *Pseudomonas aeruginosa* of particular concern?

Pseudomonas aeruginosa is one of the most problematic bacteria in health care facilities and is responsible for about 10-20% of hospital-associated infections (HAIs) (pneumonia, wound infections, blood stream infections and urinary tract infections) in intensive care units (ICUs) [8]. Several studies have shown that up to 50% of the hospital acquired *P. aeruginosa* infections may be derived from the water distribution system [15-17]. Infection chains from water taps to people have been reported. *P. aeruginosa* easily colonizes all kinds of fluids (even distilled water) and rapidly forms biofilms8. *P. aeruginosa* strains have developed resistance against commonly used antibiotics, rendering effective treatment increasingly complicated and expensive [18]. *P. aeruginosa* is also increasingly recognized as a problematic water pathogen outside of hospital settings.

Image 7: Pseudomonas aeruginosa is an aerobic bacterial species and commonly found at the periphery of water systems such as taps, showers or sinks. A greenish color on the underside of a tap aerator may indicate colonization with Pseudomonas aeruginosa.

What are the pathways for infection transmission from water sources to people?

Inhalation and aspiration represent transmission pathways for *Legionella* spp. whereas *Pseudomonas* spp. is mainly transmitted by contact and aspiration. During daily routines, tap water is used for personal hygiene. For example, in the healthcare environment, due to the severity of their disease states, ICU patients often have multiple access devices such as catheters, drains and tracheal tubes. These portals of entry represent potential entrance sites for bacteria. Droplets of contaminated tap water or contaminated hands of nursing staff can inadvertently come into contact with those entrance sites. Rogues *et al*. reported that 14% of ICU health care workers hands were *Pseudomonas* positive when washed with contaminated tap water and 12% were positive when the last contact was with a *Pseudomonas* positive patient [19]. Contaminated bottled water or contaminated water from drinking water dispensers has also been described as a source of hospital-associated *Pseudomonas* infections in ICUs and Bone Marrow Transplantations (BMTs) [20, 21].

Image 8: Water for wound care, or the patient's personal hygiene, may contain bacteria resulting in patient colonization and infection. A patient may not necessarily have to use a water outlet to become colonized; immobilized patients, e.g. within ICUs, can come in contact with contaminated water brought by the nursing staff to the patient's bed.

Why is complete biofilm eradication by systemic treatments so difficult?

Water distribution systems in large buildings are frequently complex networks and can be up to 50 km in length. Dead ends, corroded pipes, low throughput, insufficient temperature below 55 °C in the hot water pipes and above 20 °C in the cold pipes contribute to biofilm formation and impede eradication of biofilm. Heat & flush procedures (10-20 minutes of simultaneous flushing of all outlets with water heated to > 70 °C) may have only short term effects [22],. *Legionella* strains may even become heat resistant after thermal treatment over a long time [12],. Thermal procedures can result in warming up cold water [23] when both hot and cold water pipes are located in the same duct increasing the risk of biofilm in cold water.

Chemical treatments are bactericidal to free floating bacteria but have limited effects on biofilm and may create hazardous byproducts during use [22, 24, 25].

Therefore, areas with vulnerable users require additional interventions (e.g. point-of-use water filtration) to minimize patient's exposure to waterborne pathogens.

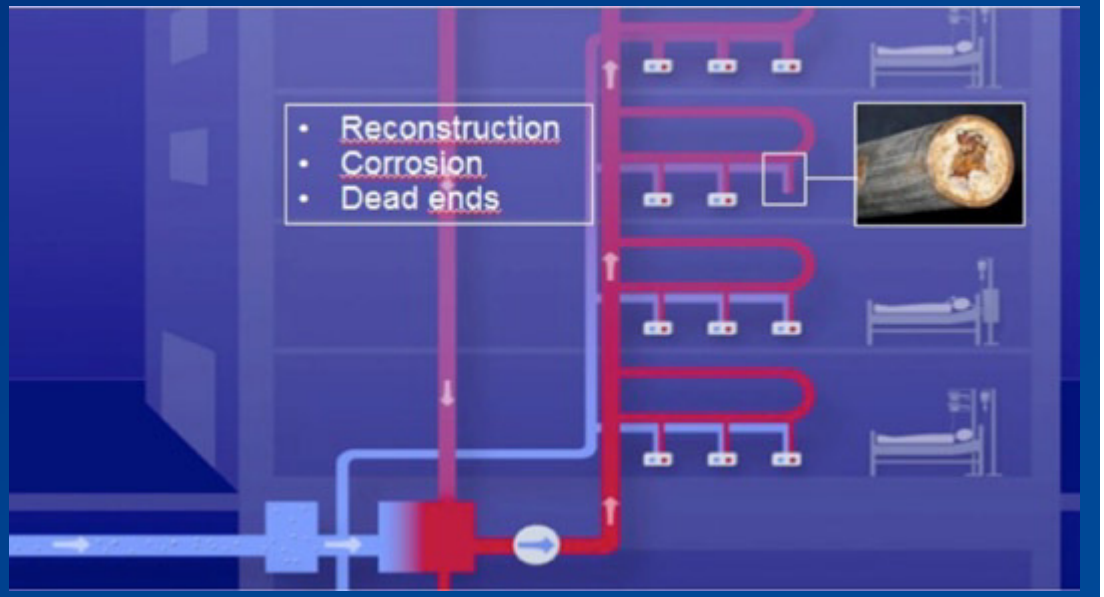


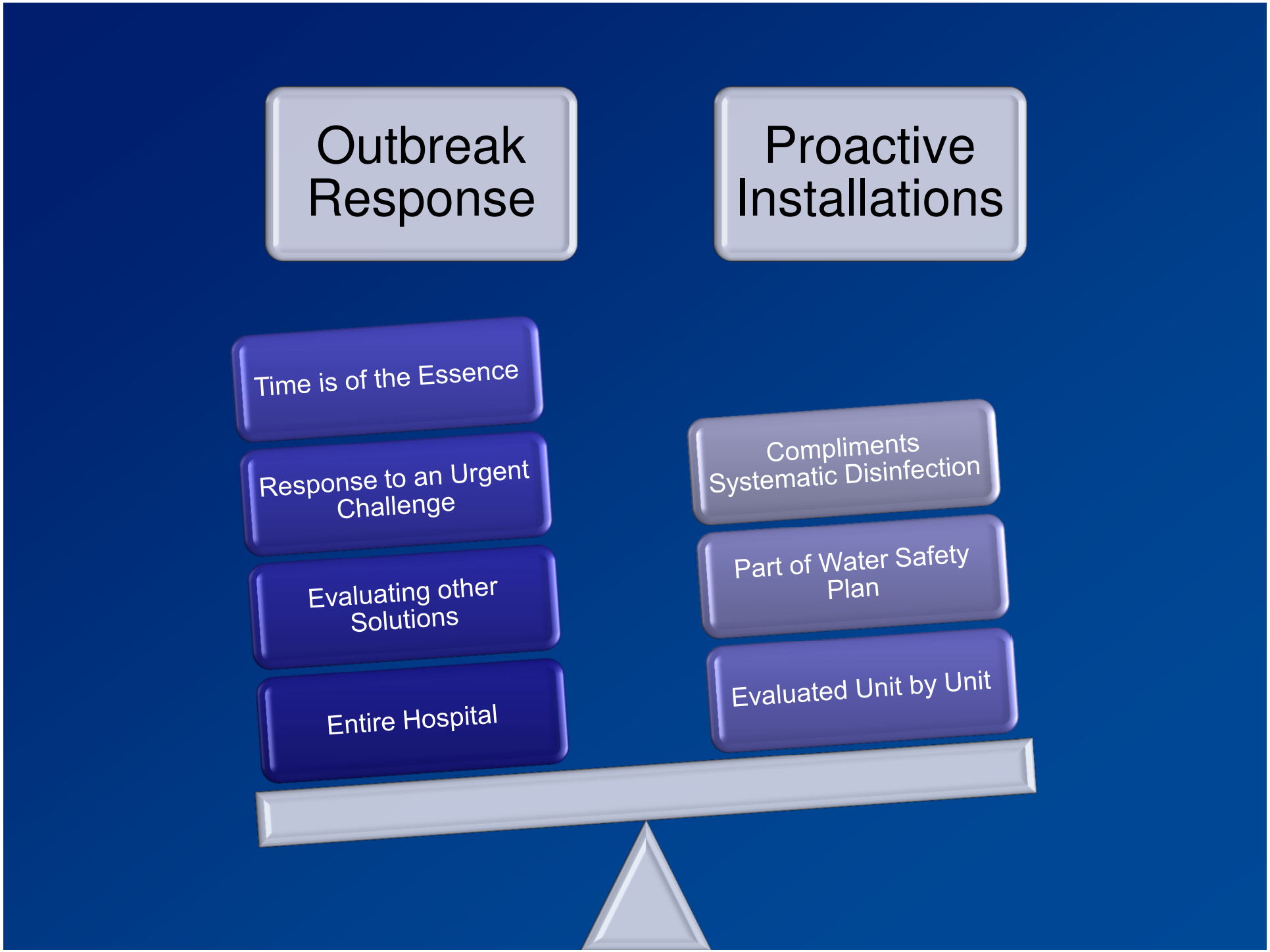
Image 9: Water systems in hospitals can contain corroded pipes and dead ends which cannot be reached by systemic disinfection. From there, bacteria can be released to recolonize the system after disinfection has been stopped. Construction work may also cause biofilm release into the network, colonizing other parts of the water system.

Where are point-of-use (POU) water filters (tap filter, shower filter) typically used?

Point-of-use water filters are used as an additional physical barrier in those areas where immunocompromised people come into contact with water [26-47] and in outbreak or critical contamination situations. They can be flexibly installed at faucets (tap filters) or connected to shower hoses (shower filters). In medical facilities the most common areas for POU water filter installation are bone marrow transplant units, hematology/oncology units, ICUs, transplantation units, burn units, neonatology, manual endoscopic reprocessing, birth tubs, kitchen (for food preparation and drinking water provision), and geriatric departments. Based on the clinical experiences POU water filtration is also increasingly used in other areas with immunocompromised patients such as nursing homes or home care settings.

POU filters are quickly installed which makes them an effective management tool in acute situations such as outbreaks e.g. in public buildings, apartment houses, swimming pools, sports centers and hotels.

Image 10: Point-of-use water filters can be installed at taps, showers or in-line applications in various health care settings, such as hospitals, day surgery units, dental practices, dialysis units, or rehabilitation centers. They may also be used for immunocompromised homecare patients.


Outbreak Response
Proactive Installations
Time is of the Essence
Response to an Urgent Challenge
Evaluating other Solutions
Entire Hospital
Compliments Systematic Disinfection
Part of Water Safety Plan
Evaluated Unit by Unit


Genotype Isolates
Litigation Price Tag
Medicare Reimb.
Sicker Patients
Filter Validation
Evidence Based Publications
MDROs
Operators License (secondary disinfection)
Why consider proactive water safety now?

721 Hospitals Penalized For Patient Safety

By Jordan Rau | December 19, 2014

Medicare Reimb.

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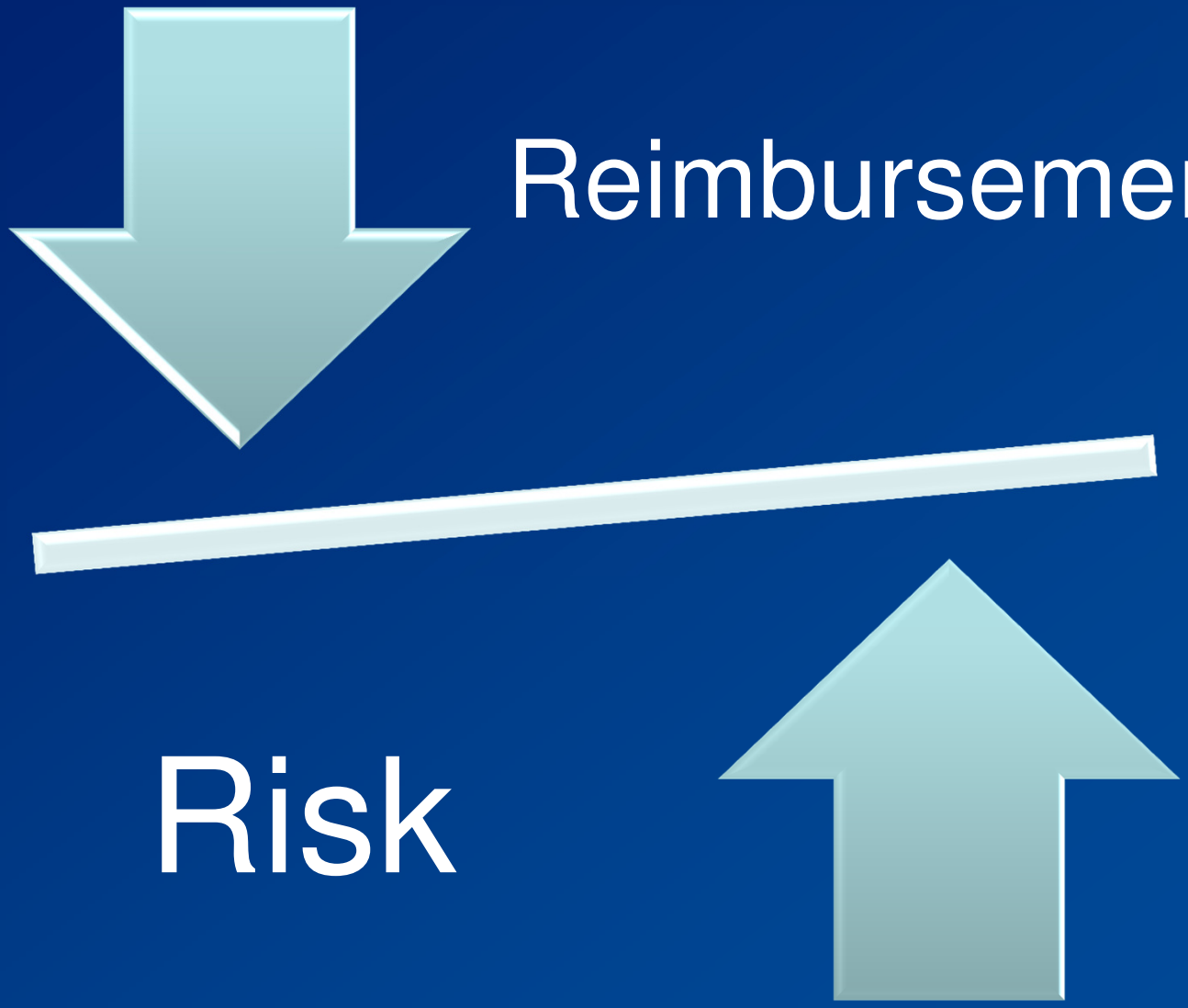
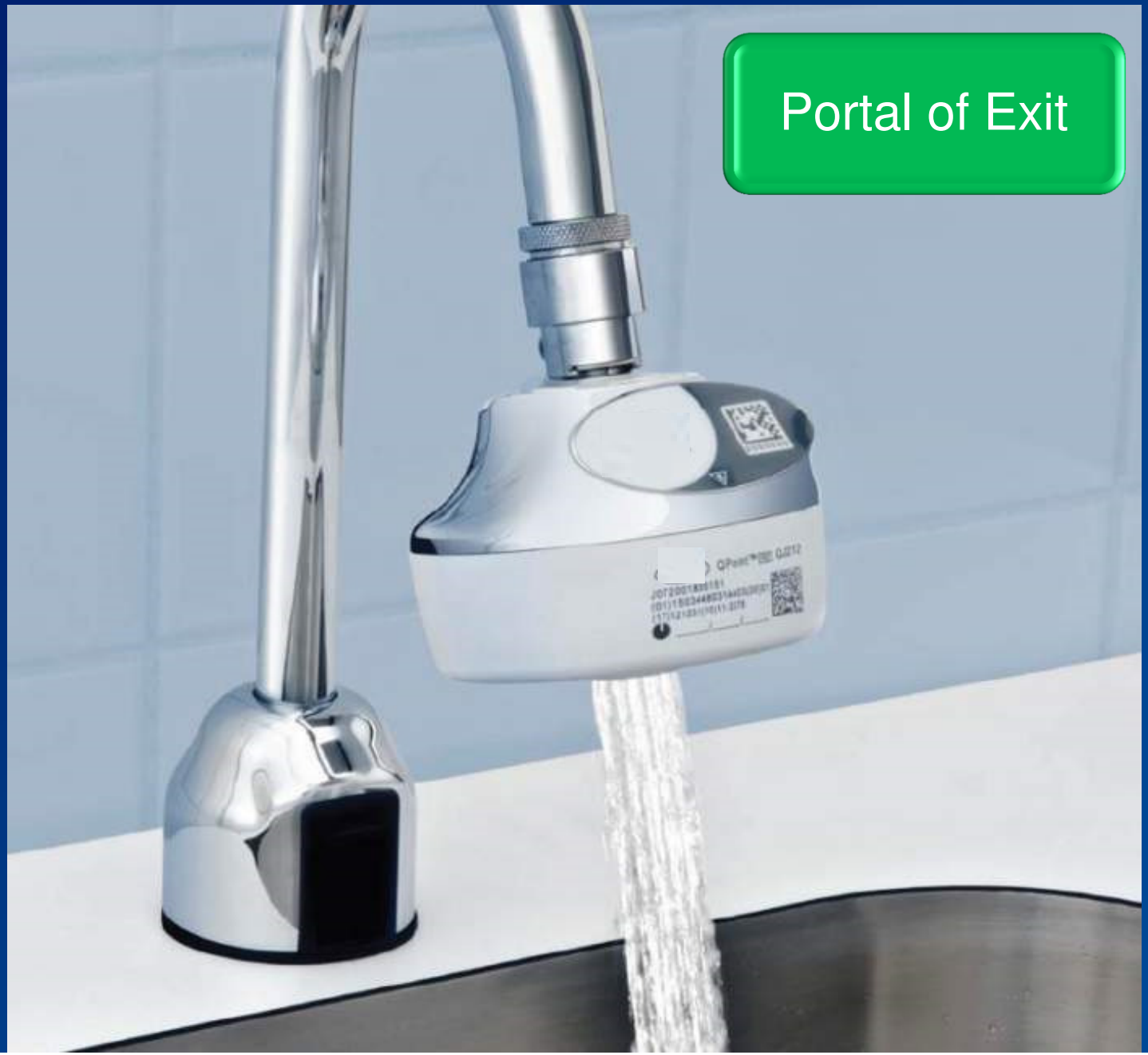
Medicare is penalizing 721 hospitals with high rates of potentially avoidable mistakes that can harm patients, known as "hospital-acquired conditions." Penalized hospitals will have their Medicare payments reduced by 1 percent over the fiscal year that runs from October 2014 through September 2015. To determine penalties, Medicare evaluated three types of HACs. One is central-line associated bloodstream infections, or CLABSIs. The second is catheter-associated urinary tract infections, or CAUTIs. The final one, Serious Complications, is based on eight types of injuries, including blood clots, bed sores and falls. Here are the hospitals that are being penalized:

Why Consider Point of Use (POU) Filtration Today?



What is Point of Use Filtration?



There are various types of POU filters & manufactures

The Definition of Point of Use Filtration may differ

Point-of-use filters may be

- Immediate and efficient barrier
- Documented validation
- Suited for cold and hot water
- Compatible with chemical & thermal disinfection
- Quick & easy to install
- Comfortable handling

Can infection/colonisation rates be reduced?

Ice Machines

TRIBLIVE | News

Legionella bacteria found in hospital ice machines at UPMC Presbyterian

Pittsburgh Tribune-Review

By Luis Fábregas and Adam Smeltz

Published: Friday, May 2, 2014, 12:01 a.m.

Legionella bacteria in ice machines at UPMC Presbyterian contributed to one patient's death and sickened two others, hospital officials disclosed on Thursday, calling it an unusual episode uncovered because a patient aspirated ice chips.

Ice Machines Maintenance

Ice Machine Statement from CDC

"Guidelines for Environmental Infection Control in Health-Care Facilities Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)"

Ice Machines are a possible source of infection due to microorganism contamination

"Microorganisms may be present in ice, ice storage chests, and ice-making machines. The two main sources of microorganisms in ice are the potable water from which it is made and a transferral of organisms from hands. Ice from contaminated ice machines has been associated with patient colonization, blood stream infections, pulmonary and gastrointestinal illnesses, and pseudoinfections. Microorganisms in ice can secondarily contaminate clinical specimens and medical solutions that require cold temperatures for either transport or holding."

Ice Machine Statement from CDC

"Guidelines for Environmental Infection Control in Health-Care Facilities Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)"

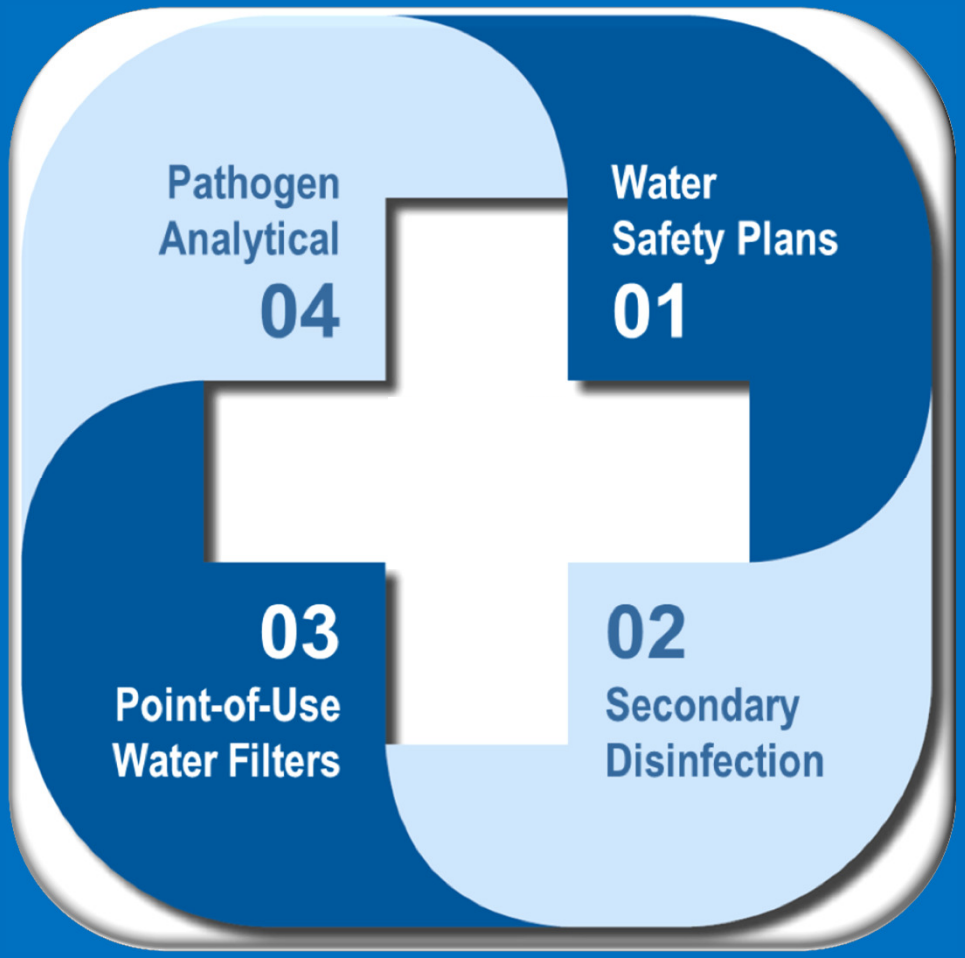
Microorganisms associated with ice machine contamination from potable water:

- *Legionella* spp.
- Nontuberculous mycobacteria (NTM)
- *Pseudomonas aeruginosa*
- *Burkholderia cepacia*
- *Stenotrophomonas maltophilia*
- *Flavobacterium* spp.

Ice Machine Best Practices

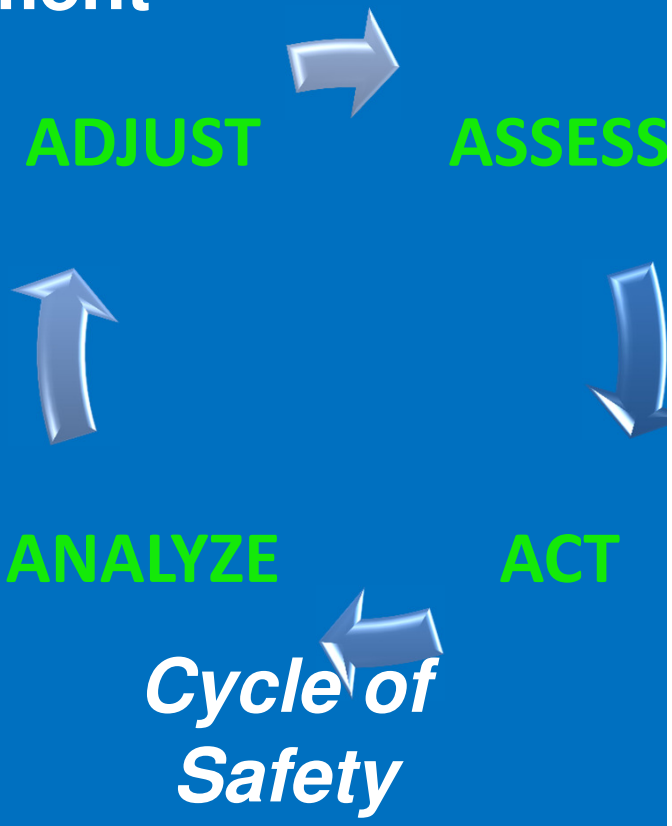
- Manufacturers guidelines need to be adhered to. Cleaning and disinfection procedures and frequency.
- Filter incoming water with sediment filters (1-10 micron) and change-outs as per manufacturer recommendation. Be aware of bacteria bleed by of sediment filters and change accordingly.
- Do not use carbon filters on ice machines unless only required if disinfectant (chlorine, chlorine dioxide) odor/taste is objectionable
- Consider 0.2 micron absolute point-of-use filtration on high risk ice machines placed downstream of sediment/carbon filters.
- Use sterile or sterile grade filtered water with 0.2 micron for all water used to clean and disinfect machine components.
- Use sterile or sterile disposable basin for soaking components. Do not use a sink due to drain contamination.
- Avoid contamination of ice machine drains trays. This increases risk retrograde contamination on ice chute and water dispenser.

Systematic Risk Management



Water Safety Plans

Expert Risk Management



» **Pathogen Water Safety Plans**

- *Hazard Analysis*
- *Process Flow Diagrams*
- *Plan Design & Implementation*
- *Awareness Training*
- *Verification & Validation*

» **Web-based Data Monitoring & Management**

» **Consulting & Support**

Best Practices: Domestic Water Services

Strategy	Purpose	Reference
New Construction/ Renovation	Goal is to be aware of design features (cross connections, need for piping insulation, dead-legs, low flow zones, water hammer arrestors, etc.) or stagnant conditions that can increase risk if not properly managed.	**ASHRAE 12, 188P OSHA**
New Systems, Startup/Shutdown	Goal is to define practice to manage the water system to limit stagnation, implement practices to flush systems after lengthy shutdown or interruption of water service, and requirements for clean and disinfection before commissioning new systems.	**ASHRAE 12, 188P**
System Maintenance	Goal is to define practice (Clean and disinfect, flushing, repair, etc.) for system maintenance of hot and cold water tanks, ice machines, water filters, shower heads and hoses, faucets, etc.	**ASHRAE 12, 188P**
Water Temperature	Water temperature recommendations for legionellae control are: • Maintain water heater outlet temperatures at or above 140°F (60°C); • Maintain the hot water temperature at coldest point in the water heater, the storage tank, or the distribution system at or above 124°F (51°C); • Maintain the cold water temperature in any part of system at or below 77°F (25°C).	**ASHRAE 12, 188P OSHA**
Water Disinfection	Where water disinfection or treatment is performed, a defined program must be followed to assure it meets EPA requirements for potable water applications.	**ASHRAE 12, 188P OSHA**
Emergency Disinfection	Goal is to define practice to be followed if there are suspected legionellosis health problems associated with the use of potable water in a building system.	**ASHRAE 12, 188P OSHA**
***Legionella* Monitoring**	Recommended to verify control of the hazard. ** Typically recommended for investigative or post remedial verification purposes.*	**ASHRAE 12 OSHA***

Best Practices: Cooling Tower

Strategy	Purpose	Reference
System Operation	Goal is to operate in a manner that keeps the system treated and limits stagnant conditions. Startup/Shutdown; Intermittent operation; New system startup	**ASHRAE 12, 188P** **CTI**
Inspection & Maintenance	Goal is to maintain mechanical design intent to limit aerosol release, to maintain balanced water flows and to eliminate dead zones.	**ASHRAE 12, 188P** **CTI** **OSHA**
Design & Siting	Be aware of design features (sumps, drift eliminators, location of tower) that can increase risk if not properly managed.	**ASHRAE 12, 188P** **CTI** **OSHA**
Scale & Corrosion Control	A comprehensive scale and corrosion program is necessary to limit scale and corrosion formation to within specified critical limits.	**ASHRAE 12, 188P** **CTI**
Biocide Control	A comprehensive biocide program applied to within critical limits is necessary to maintain microbial control. Biocides must be applied in a manner that demonstrates control.	**ASHRAE 12, 188P** **CTI** **OSHA**
Clean & Disinfect (C&D)	Goal is to prevent accumulation of slimes and sludge which can allow microbial proliferation and increase *Legionella* risk. Twice annual C&D; Off-line and On-line	**ASHRAE 12, 188P** **CTI** **OSHA**
***Legionella* Monitoring**	Recommended to verify control of the hazard. * *Typically recommended for investigative or post remedial verification purposes.*	**ASHRAE 12** **CTI** **OSHA***
Aerobic Bacteria Monitoring	Monitoring is essential to verify biocide program is sufficient to control microbial growth.	**CTI**

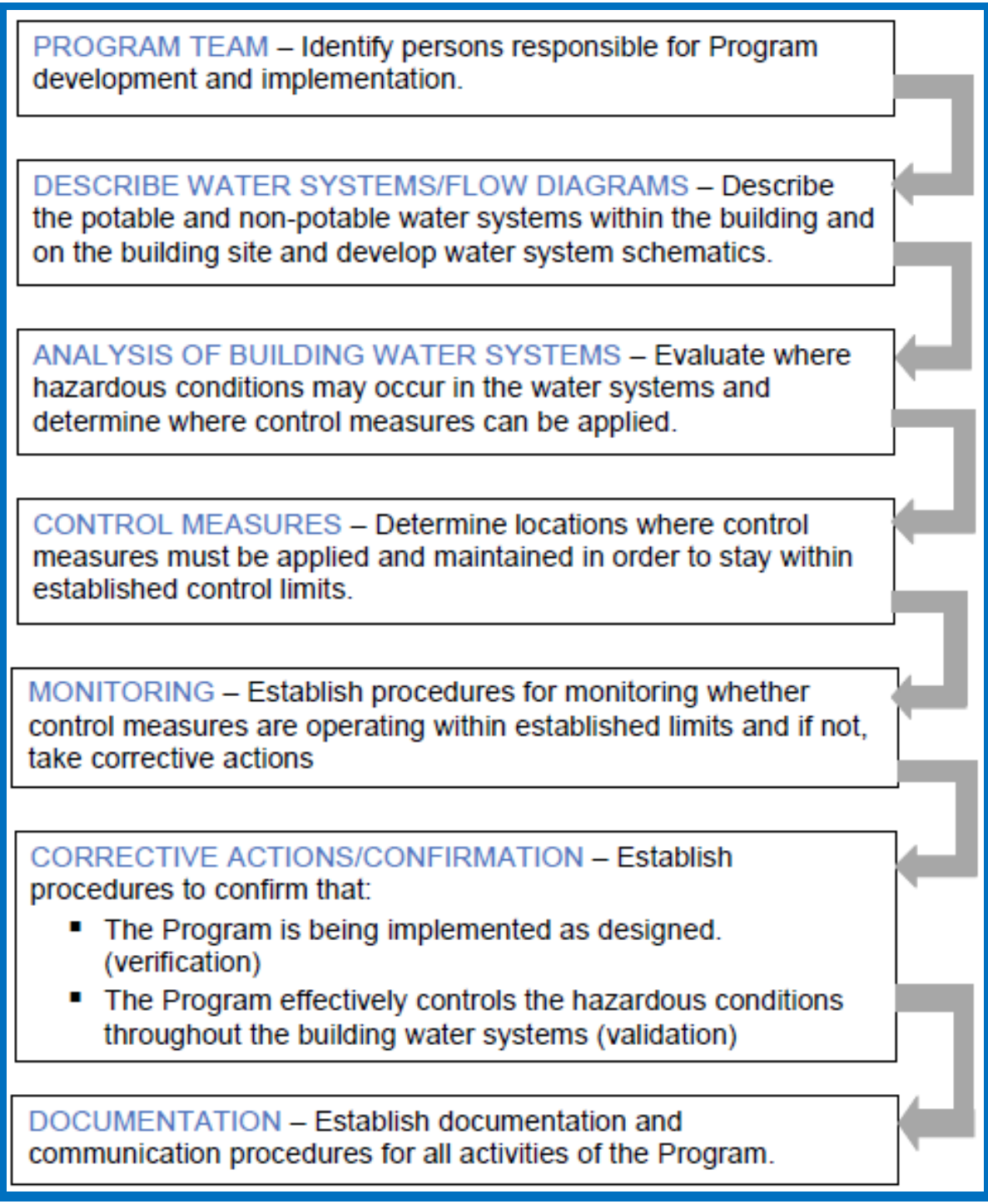
ASHRAE 188p

4.3. Health Care Facility Requirements

4.3.1 Health care facilities that do not meet all of the qualifications of 4.3.2 shall comply with the requirements in Section 4.2, Section 6, and Section 7.

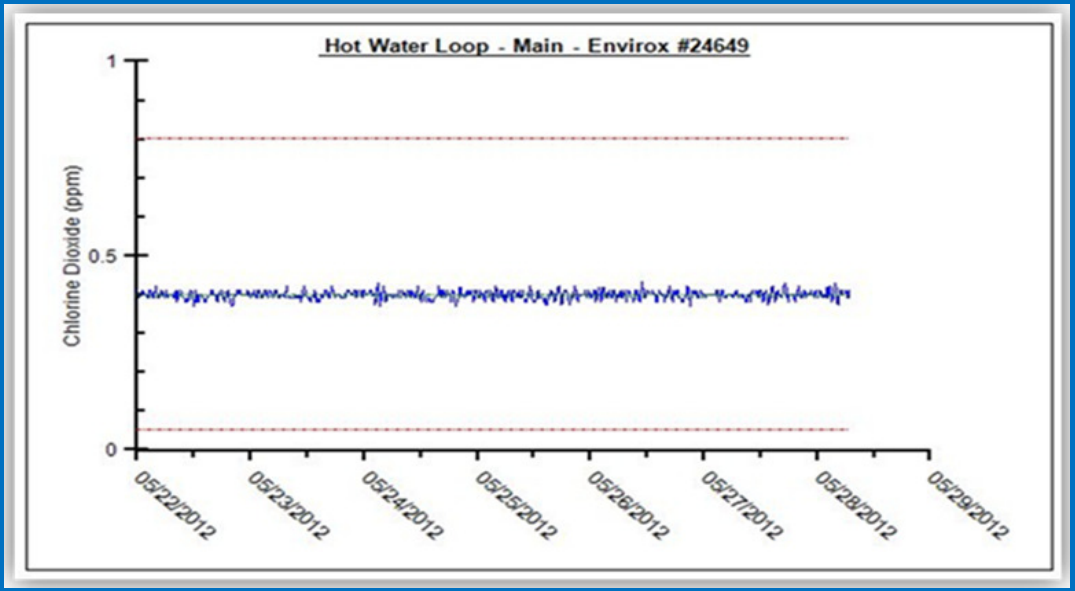
4.3.2 Health care facilities that meet all of the following qualifications shall comply with either the requirements in Sections 4.2, 6 and 7 or the requirements in normative Appendix A "Health Care Facilities":

a. The health care facility is accredited by a regional, national or international accrediting agency or by the Authority Having Jurisdiction (AHJ) over the health care facility Infection Prevention and Control (IC) activities; and
b. The health care facility Infection Control program has an Infection Preventionist that is Certified in Infection Control (CIC) by the Certification Board of Infection Control and Epidemiology (CBIC) or other regional, national or international certifying body or the health care facility has an Epidemiologist with a minimum of a Master's degree or equivalent.


PROGRAM TEAM – Identify persons responsible for Program development and implementation.
DESCRIBE WATER SYSTEMS/FLOW DIAGRAMS – Describe the potable and non-potable water systems within the building and on the building site and develop water system schematics.
ANALYSIS OF BUILDING WATER SYSTEMS – Evaluate where hazardous conditions may occur in the water systems and determine where control measures can be applied.
CONTROL MEASURES – Determine locations where control measures must be applied and maintained in order to stay within established control limits.
MONITORING – Establish procedures for monitoring whether control measures are operating within established limits and if not, take corrective actions
CORRECTIVE ACTIONS/CONFIRMATION – Establish procedures to confirm that:
The Program is being implemented as designed. (verification)
The Program effectively controls the hazardous conditions throughout the building water systems (validation)
DOCUMENTATION – Establish documentation and communication procedures for all activities of the Program.

Secondary Disinfection
A Continuous Treatment Strategy

- » Evaluation of alternatives: Pros & Cons
- » Hot and cold potable water treatment
- » NSF-61 certified equipment
- » NSF-60 certified chemistry
- » Water treated per EPA regulations
- » 360 24/7 monitoring of disinfectant residuals
- » 360 automation of system alarms



Chlorine Dioxide Generator (ClO_2)

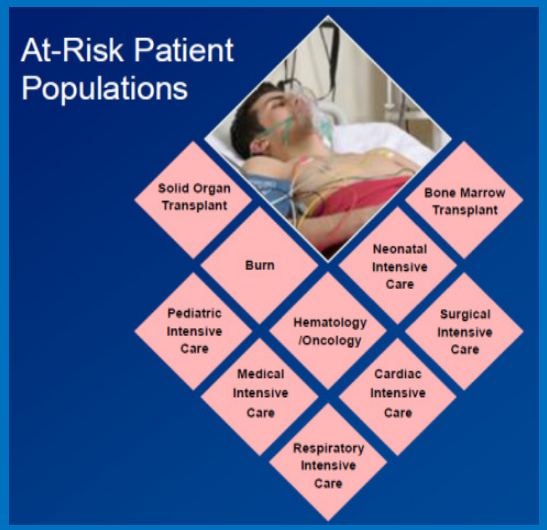
Summary of Secondary Disinfection Choices

	Chlorine Dioxide	Chloramine	Chlorine	Copper-Silver	Ozone	UV-Light	Thermal Disinfect
Effective against legionellae	YES	YES	YES	YES	YES	YES	YES
Effective against most bacteria	YES	YES	YES	YES	YES	YES	NO
Effective against biofilm	YES	YES	YES	NO	YES	NO	NO
No Legionella resistance	YES	NO	NO	NO	YES	YES	YES
Protects whole system	YES	YES	YES	YES	YES	NO	NO
Not affected by pH	YES	NO	NO	NO	YES	YES	YES
Not affected by water hardness	YES	YES	YES	NO	YES	YES	YES
Easy to monitor	YES	YES	YES	NO	NO	NO	YES
Low corrosion rates	YES	YES / NO	NO	NO	NO	YES	YES
No Trihalometanes (THM's)	YES	NO	NO	YES	NO	YES	YES
Low disinfection by-products (DBP)	YES	YES	NO	YES	NO	YES	YES

Point of Use (POU) Filters

A Point Control Strategy

- *An absolute barrier for waterborne pathogens*
- *"Sterilizing Grade Filtered Water"*
- *For high risk patient areas (BMT, ICU, NICU, BURN, ONCOLOGY, ETC.)*
- *For immediate response to an outbreak or incident*



Pathogen Analytical

Validation of the Control Strategy

- A Certified CDC-ELITE Proficient Lab
- *Legionella* Culture Test per ISO 11731
- Interpretation & Consulting
- Testing Plans

CDC's ELITE Program

PLAN REQUIREMENT: EMERGENCY REMEDIATION DOMESTIC WATER SYSTEMS

If a possible HCA infection case is identified and if *waterborne pathogens* are detected in building's water distribution system, an Action Plan must be in place.

Strategy	Purpose
Thermal Eradication	Increasing temperature in the hot water distribution system of 160°F – 170°F while continuously flushing each outlet in the system for at least 30 minutes
Shock Chlorination	Increasing chlorine level of the hot and cold water distribution systems to 2 mg/L and maintaining that level throughout the system at least 2 hours
High Level Disinfection	Increasing chlorine level of the hot and cold water distribution systems to 50 mg/L and maintaining at least 10 mg/L throughout the system and at outlets for 24 hours

Remediation Strategies

» Cleaning & Disinfection Services

- *Cooling Water Systems*
- *Potable Hot & Cold Water Systems*
- *Therapy Pools*
- *Decorative Fountains*
- *Ice Machines*

BEFORE

DURING

AFTER

Water as a Source of Hospital Acquired Infections: Summary

- Potable water is not sterile
- Healthcare facilities inherently amplify waterborne pathogens
- A Water Safety Plan should be implemented
- Systemic solutions can be added to provide overall/general risk reduction
- Critical care units need additional interventions to improve point of use water quality to the immunocompromised population
- Publications are available by critical care unit & by pathogen to show how sterilizing grade filtered water can help reduce risk of HAI.

Questions??

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