

# Effectiveness of onsite monochloramine disinfection for waterborne pathogen control in a Canadian acute care academic hospital

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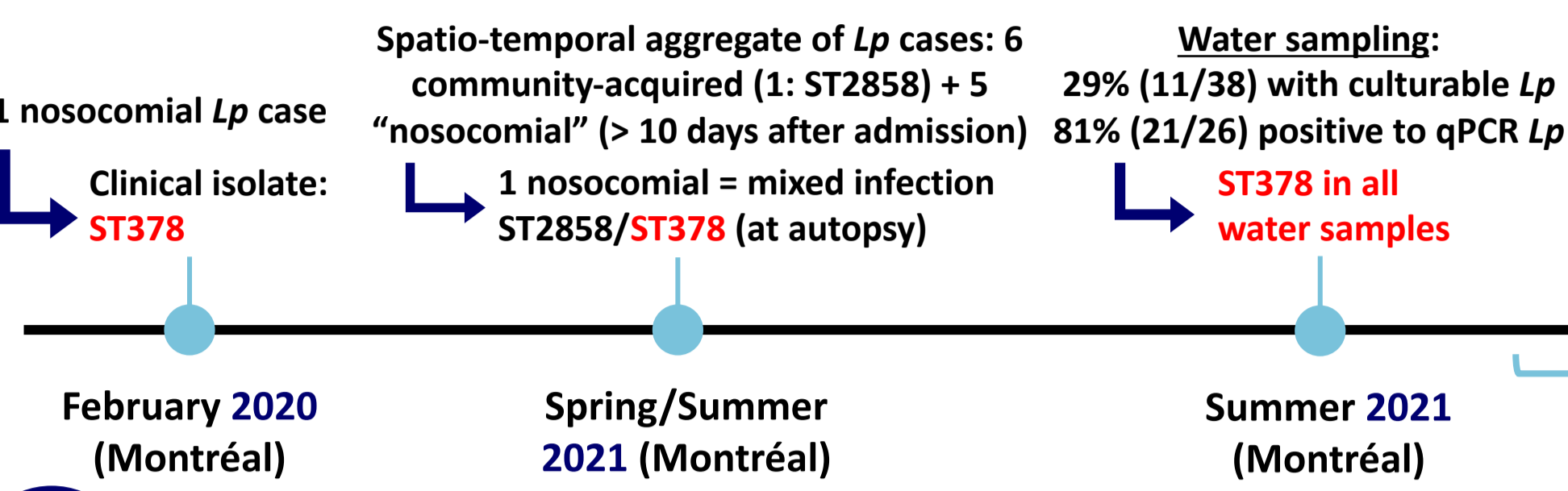
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## 1. Timeline background and objectives

At least 2 cases of *Lp* ST378 in 2 years confirmed to be acquired at an acute care hospital:



## Summer 2022 to summer 2023

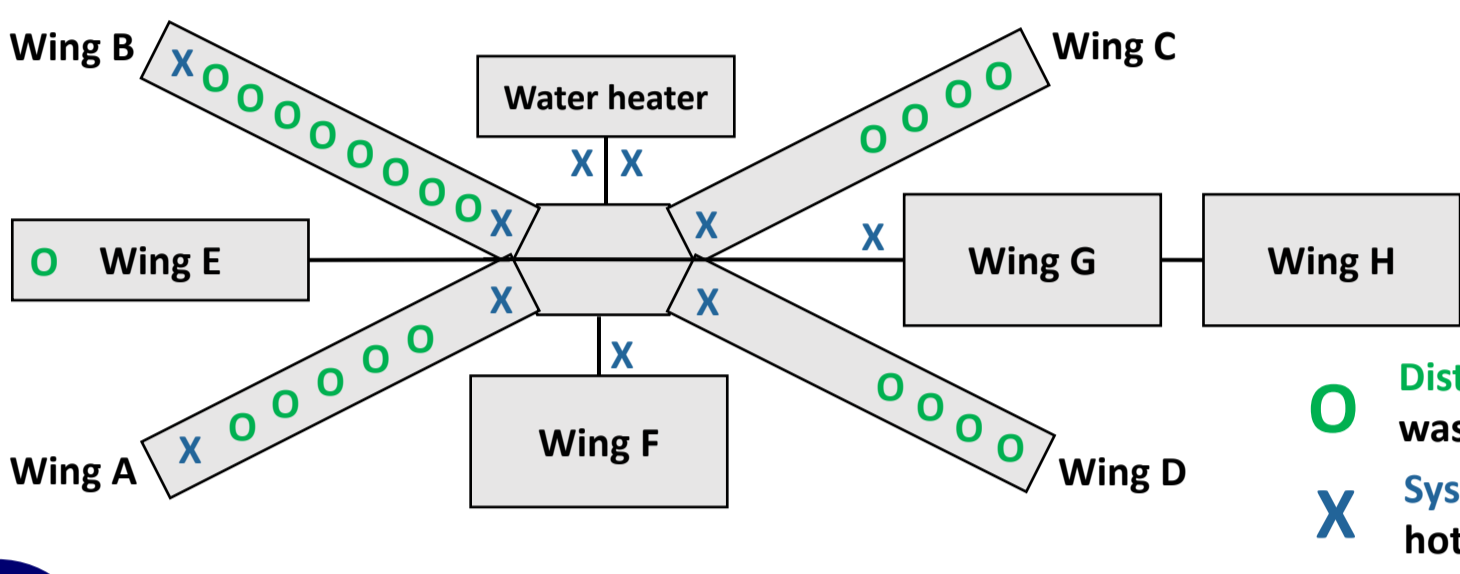
Measure the impact of *in situ* disinfection with  $\text{NH}_2\text{Cl}$  in a hospital hot water system on the:

1. Abundance of *Lp*, *Lp* sg 1, *Lsp*, NTM and *Pa*
2. Concentrations of general microbial indicators
3. Relative abundance of all bacterial (16S) and eukaryotic (18S) genera
4. Concentrations of other physico-chemical parameters and common plumbing metals

## 2. Materials and methods

540-bed Canadian academic hospital water system (1954)

- > 55 °C in all hot water return loops
- > 60 °C at the water heater outlet



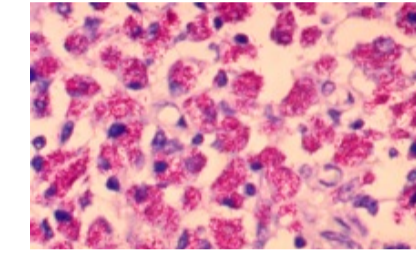
Biofilm-associated bacteria

*Legionella pneumophila* (*Lp*)



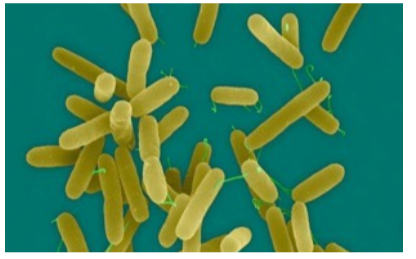
- Liquid enzymatic-based culture (*Lp*)
- qPCR triplex assay (*Lsp*, *Lp*, *Lp* sg1)

Nontuberculous mycobacteria (NTM)



- qPCR assay targeting the *atpE* gene in *Mycobacterium* spp (NTM in water)

*Pseudomonas aeruginosa* (*Pa*)

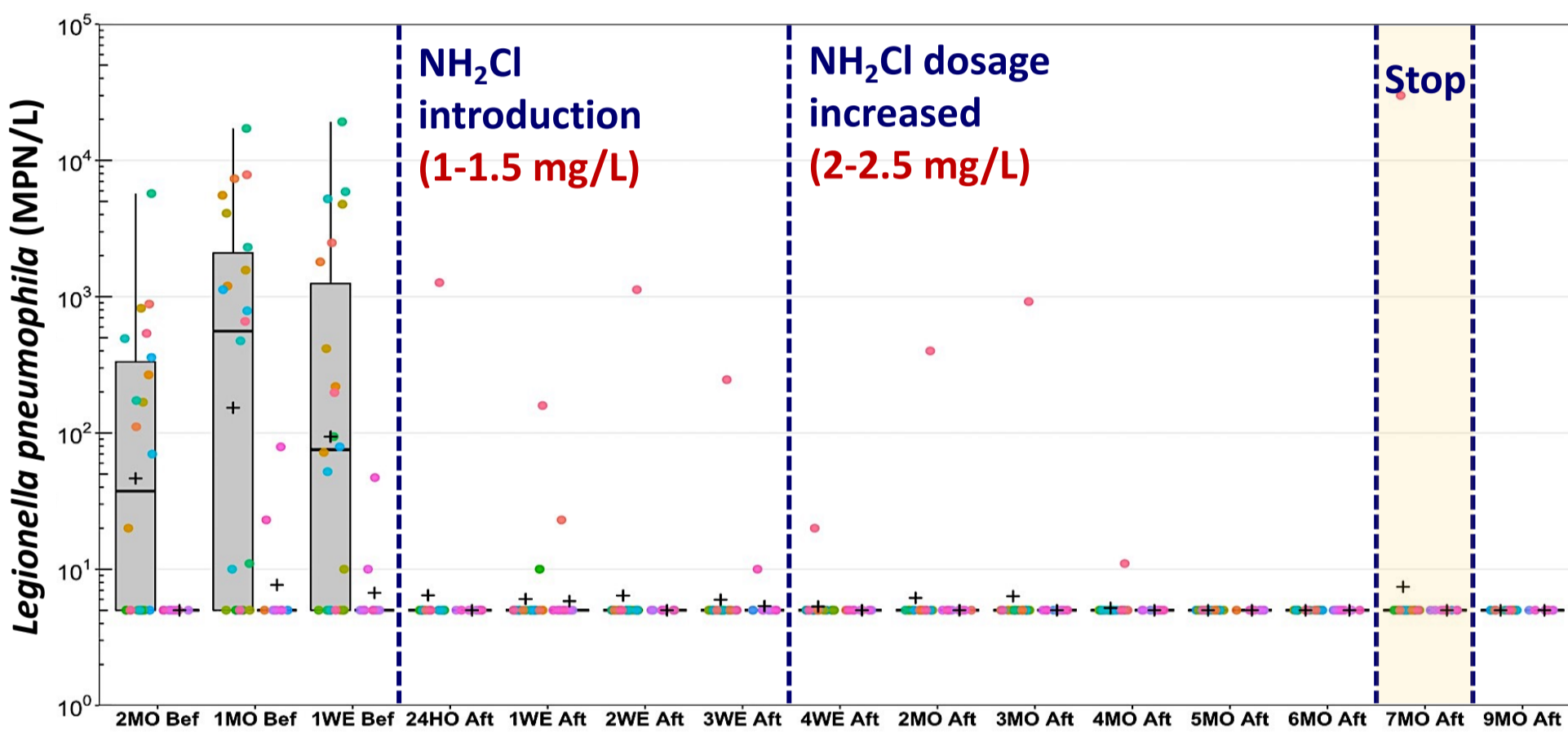


- qPCR assay targeting the *gyrB* gene (upcoming)

## 3. Results and discussion

Box plot legend: + Mean □ Distal points □ System points

### 3.1. *Legionella pneumophila* → Immediate (24h) cultivability suppression and rapid reductions (3 weeks) in gc/L



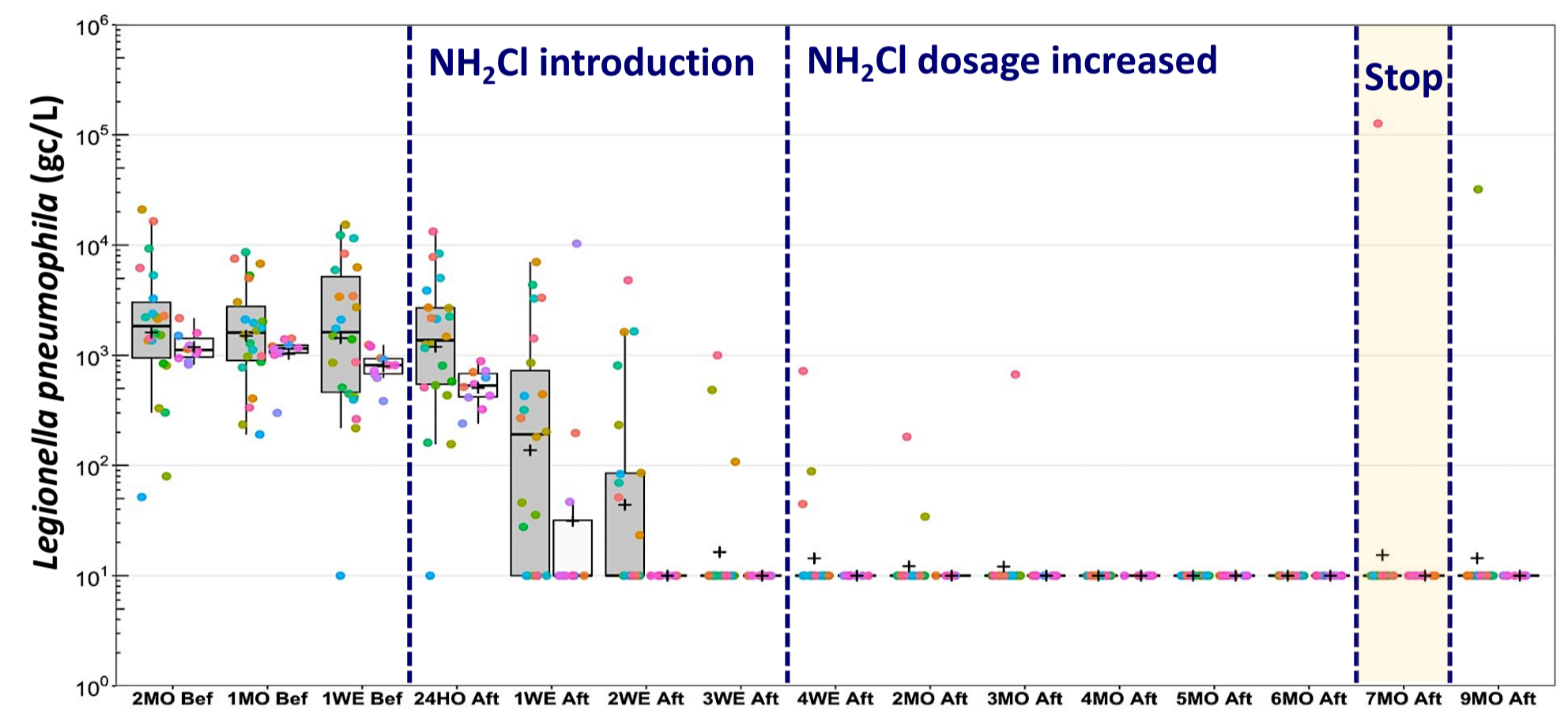
**BEFORE monochloramine:**

- 61% (40/66) of distal points positive ( $10^1$ - $10^4$  MPN/L) to culturable *Lp*
- 13% (4/30) of system points positive (<  $10^2$  MPN/L) to culturable *Lp*

**AFTER monochloramine:**

- One distal point remaining positive ( $10^1$ - $10^3$  MPN/L) despite receiving 0.1-1.7 mg/L of  $\text{NH}_2\text{Cl}$  throughout the study

- Discontinuation of  $\text{NH}_2\text{Cl}$  dosage resulted in important increases in cultivability (> 3-log) and gene copies (> 4-log) at one distal point



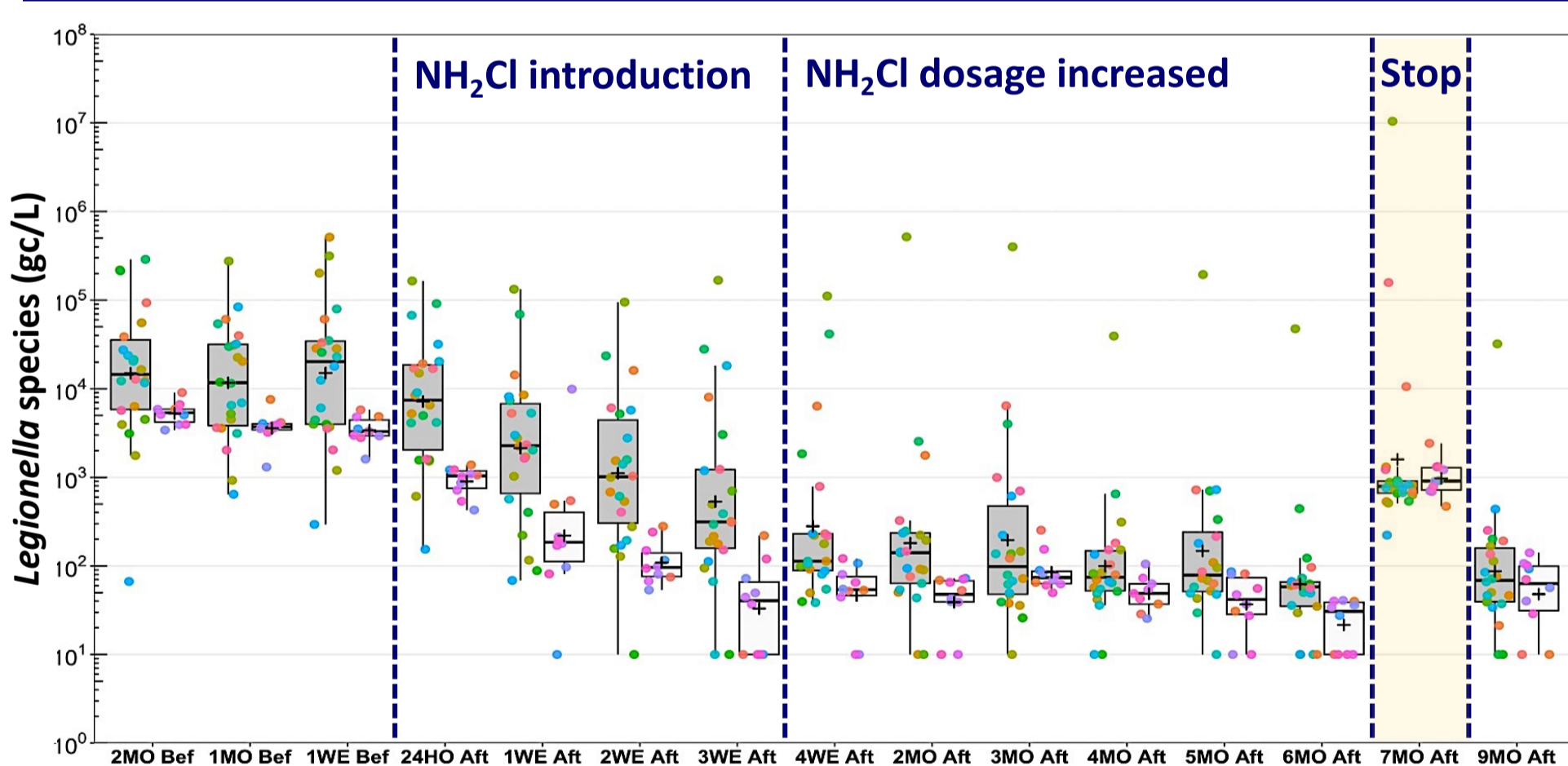
**BEFORE monochloramine:**

- 98% (65/66) of distal points positive (20-20 000 gc/L) to *Lp*
- 100% (30/30) of system points positive (300-3000 gc/L) to *Lp*

**AFTER monochloramine:**

- Gradual (3 weeks) reductions in *Lp* gene copies (faster in system points)
- Temporary shift from *Lp* sg 2-15 to *Lp* sg 1 observed at a few sites

### 3.2. *Legionella* spp → Rapid reductions (4 weeks) in gc/L



**BEFORE monochloramine:**

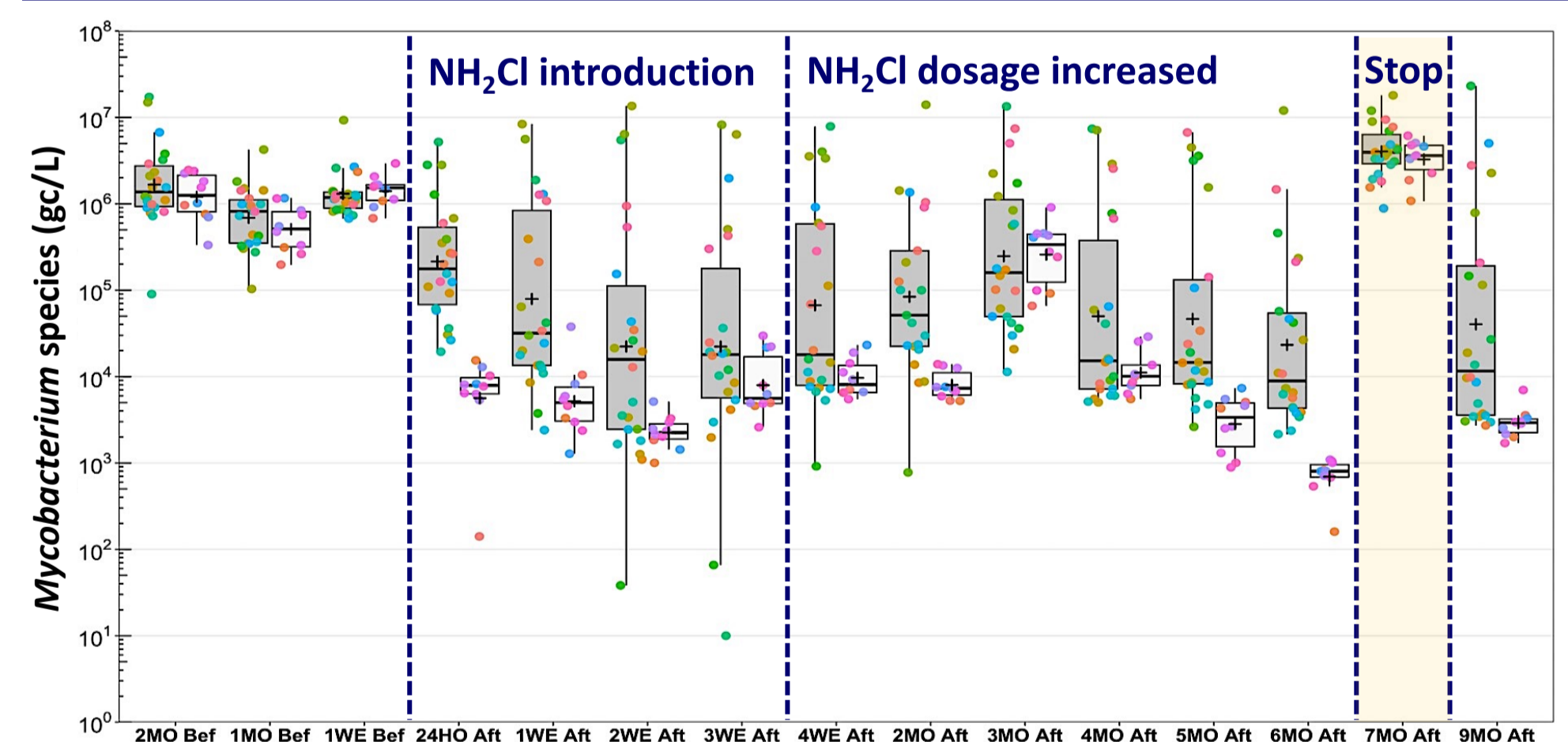
- 100% (66/66) of distal points positive ( $10^1$ - $10^6$  gc/L) to *Lsp*
- 100% (30/30) of system points positive ( $10^2$ - $10^4$  gc/L) to *Lsp*

**AFTER monochloramine:**

- Gradual (4 weeks) reductions in *Lsp* gene copies, then mean concentrations stabilized between LoD and LoQ

- Discontinuation of  $\text{NH}_2\text{Cl}$  dosage resulted in important increases in *Lsp* (> 2-log) and *Msp* (> 3-log) at all distal points and system points
- Stagnant distal points ( ● ● ● ● ) [showerheads, faucets] generally result in increased (> 1-log) *Lsp* and *Msp* gene copies

### 3.3. *Mycobacterium* spp → Rapid reductions (2 weeks) in gc/L



**BEFORE monochloramine:**

- 100% (66/66) of distal points positive ( $10^5$ - $10^8$  gc/L) to *Msp*
- 100% (30/30) of system points positive ( $10^5$ - $10^7$  gc/L) to *Msp*

**AFTER monochloramine:**

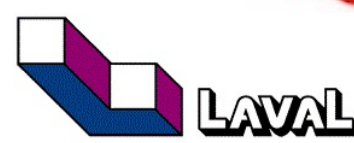
- Gradual (2 weeks) reductions in *Msp* gene copies, but important (up to 4-log) differences gene copies concentrations in distal points

## 3.4. Take-home messages

1. Recurring costs and inconveniences related to points of use filters highlight the need to seek effective long-term mitigation solution
2.  $\text{NH}_2\text{Cl}$  is a highly efficient treatment to mitigate *Lp* despite the optimization of other control parameters (e.g., hot water temperatures)
3. Persistence of lower levels of *Lsp* and NTM after  $\text{NH}_2\text{Cl}$  demonstrates the need for proper risk assessment
4. Interruption of  $\text{NH}_2\text{Cl}$  confirms persistence of *Lsp*/NTM in the biofilm (rebounds observed) → *in situ* disinfection must be maintained
5. Preventative flushing of low use distal sites should be implemented to ensure efficient treatment across all hospital water system

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