

Evaluation of the Efficacy of New Point-of-use Water Filters to Prevent Exposure to *Legionella* and Waterborne Bacteria



P.J. Sheffer, J.E. Stout, M.M. Wagener, and R.R. Muder*

VA Pittsburgh Healthcare System, Pittsburgh, PA and the University of Pittsburgh, Pittsburgh, PA



Abstract

Background/Objectives: *Legionella* and other waterborne pathogens are the cause of serious hospital-acquired infections, particularly in the immunocompromised patient. The disinfection of water systems to prevent Legionnaires' disease has been shown to be an effective approach to prevention. Current guidelines from the Centers for Disease Control and Prevention (CDC) suggest that no *Legionella* should be detected from water outlets in hospital units housing transplant patients. The ability of point-of-use filters to eliminate *Legionella* and other pathogens from water was evaluated.

Method: 100 ml hot water samples were collected from 7 faucets (4 with filters and 3 without) immediately and after a 1 minute flush. Samples were collected every 2-3 days for one week. This cycle was repeated for 12 weeks. Samples were cultured for *Legionella*, total heterotrophic bacteria (HPC) and *Mycobacterium gordonae*.

Results: 594 samples were collected over 12 cycles. No *Legionella* or *M. gordonae* were isolated from the faucets with filters between T=0 and T=8, whereas the mean concentration of *L. pneumophila* and *M. gordonae* from the control faucets was 104.5 CFU/ml and 0.44 CFU/ml respectively. The filters achieved a greater than 99% reduction in HPC bacteria in the immediate and post flush samples.

Conclusions: Point-of-use filters completely eliminated *L. pneumophila* and *M. gordonae* from hot water samples. These filter units could prevent exposure of high risk patients to waterborne pathogens.

Introduction

Sensitive sub-populations of patients are vulnerable to bacteria found in hospital and home water systems (Anaissie -2002). These patients include those with underlying conditions that impair their immune responses such as advanced age, cancer, diabetes, and transplantation. These individuals may require a higher standard of care that may include purification of the water used in their care (MMWR- 2003). Point-of-use water filters can be used for this purpose. The efficacy of such devices requires further evaluation before a recommendation for their use can be made.

Objective

To determine the efficacy of Aqua-Safe point-of-use water filters (Pall Corp. Pall Medical, Ann Arbor, MI) in the removal of waterborne bacteria (*Legionella*, mycobacteria, and gram negative non-fermenting bacteria) from water obtained from faucets.

Methods

Point-of-Use Water Filter: The Pall-Aquasafe™ Water Filter is a sterile disposable point-of-use water filter that contains Pall Nylon 6.6 Posidyne filter membrane rated and validated at 0.2 um. This provides a barrier for particles greater than 0.2 microns in size. The filter can be used for a maximum of seven days following initial installation and must be replaced after this time.

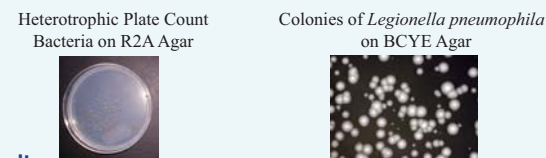
Location: A three-story hospital administrative building was the site of this evaluation. We previously established that this building was colonized with *Legionella*. The bacterial population in the hot water of this building was studied over a one-year period prior to the start of the filter evaluation. Hot water from the control faucets yielded mean concentrations of 108.2 CFU/ml *Legionella pneumophila*, serogroup 1; 13,144 CFU/ml total heterotrophic plate count (HPC) bacteria; and 0.4 CFU/ml *M. gordonae* for the same time period a year earlier than the point-of-use evaluation. This data established a baseline for comparison with the findings of this study. During the filter evaluation, seven (7) sinks were available for study. Water samples were collected and cultured for bacteria every 2 days for one week x 12 weeks (12 cycles). The filters were also challenged to a two week cycle twice during the evaluation period.

Sample Collection: Two 100 ml hot water samples were collected from each faucet, one immediately after opening the valve, and one after a 1 minute flush. After the initial sampling, the Pall-Aquasafe™ Water Filter was attached to four of the sink faucets, following the manufacturer's installation directions. Filters were changed weekly (one cycle), with two cycles having a duration of two weeks. The cycle of sampling was repeated until 12 cycles had been completed. Four (4) faucets were equipped with filters, and three (3) faucets had no filters attached to them and represented the "Control" faucets (Figure 1). A total of 594 water samples were collected over the 12 cycles.

Figure 1



Bacterial Monitoring: All cultures were performed in duplicate. Water samples were plated directly (0.1 ml per plate) and after concentration by filtering 100 ml of the sample and resuspending the filter in 10 ml of the original sample (0.1 ml per plate). Total HPC bacteria were monitored using R2A media. *Legionella pneumophila* was monitored using buffered charcoal yeast extract agar (BCYE) and DGVP selective agar media as previously described (Ta-1995). 7H10 agar was used to enumerate *Mycobacterium* species. *Mycobacterium* cultures were performed only at the beginning and end of a cycle due to the requirement for 6 week incubation. Plates were incubated at 35-37°C in humidified chambers, with CO₂ added for the *Mycobacterium* cultures.



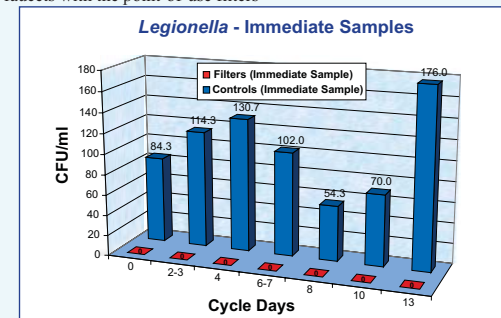
Results

Legionella Eradication: 12 cycles

Immediate Water Samples: Figure 2

- ◆ Controls - The mean concentration of *Legionella* was 104.5 CFU/ml.
- ◆ Point-of-use filters - No *Legionella* was detected in the water through 1 week of use (p<0.05). Samples collected after 10 and 13 days of use were also negative.

Figure 2. *Legionella* was not recovered from the immediate water samples obtained from faucets with the point-of-use filters

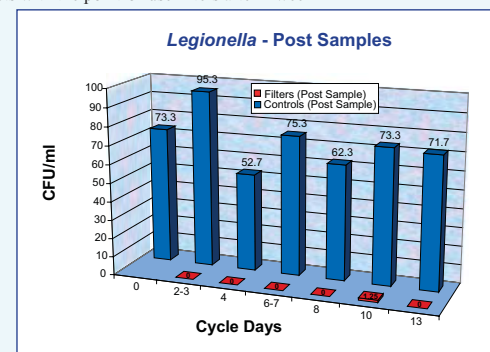


Post-flush Water Samples: Figure 3

- ◆ Controls - The mean concentration of *Legionella* was 72.0 CFU/ml.
- ◆ Point-of-use filters
 - ◆ No *Legionella* was detected in the water through 1 week of use (p<0.05).
 - ◆ One post-flush sample yielded *L. pneumophila* (5 CFU/ml) on day 10 of sampling.

At the end of a cycle, immediate and post-flush samples for the last sample day were obtained and then the filter was changed. Since the water had already been running, we did not collect a post-flush sample for the newly installed filters at T=0.

Figure 3. *Legionella* was not recovered from the post-flush water samples obtained from faucets with the point-of-use filters after 1 week

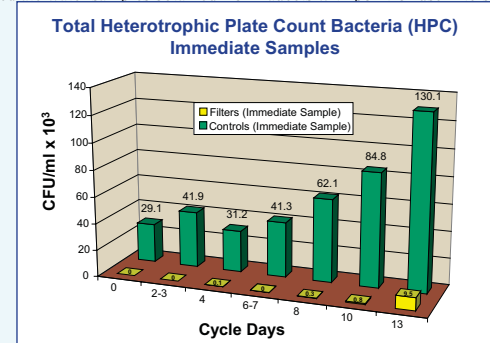


Heterotrophic Plate Count (HPC) Bacteria Eradication: 12 cycles

Immediate Water Samples: Figure 4

- ◆ Controls - The mean concentration of HPC bacteria was 60,100 CFU/ml.
- ◆ Point-of-use filters
 - ◆ The mean concentration of HPC bacteria was 18.8 CFU/ml through day 7 (p<0.05).
 - ◆ One faucet was positive once
 - ◆ One faucet was positive three times
 - ◆ The mean concentration of HPC bacteria increased on day 8 to 300 CFU/ml, and increased further to >9000 CFU/ml by day 13.

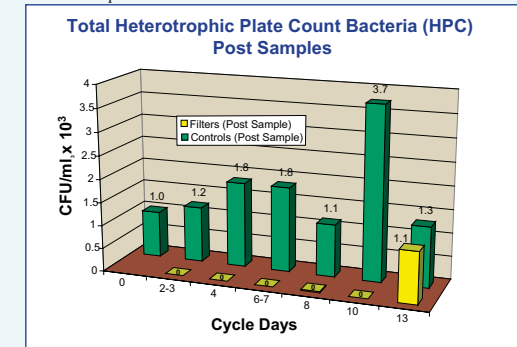
Figure 4. There was a significant reduction (>99%) in total bacteria recovered from the immediate water samples obtained from faucets with point-of-use filters



Post-flush Water Samples: Figure 5

- ◆ Controls - The mean concentration of HPC bacteria was 1,700 CFU/ml.
- ◆ Point-of-use filters
 - ◆ No HPC bacteria were detected through 1 week of use (p<0.05).
 - ◆ One sample was positive (100 CFU/ml) on day 8, and by day 13 the mean concentration of HPC bacteria was 1000 CFU/ml.

Figure 5. There was a significant reduction (>99%) in total bacteria recovered from the post-flush water samples obtained from faucets with point-of-use filters



Mycobacterium Eradication: 12 cycles

Immediate Water Samples:

- ◆ Controls
 - ◆ *Mycobacterium gordonae* was isolated during 4 of 12 cycles (from 1 faucet each time only).
 - ◆ 10.3% (4/39) of the immediate samples were positive for *M. gordonae* (mean concentration of 2.5 CFU/ml).
- ◆ Point-of-use filters - No *Mycobacterium* was isolated, even for 2 cycles that ended on day 14.

Post-flush Water Samples:

- ◆ Controls - No *Mycobacterium* were isolated.
- ◆ Point-of-use filters - No *Mycobacterium* were isolated.

Conclusions

- ◆ Point-of-use filters completely eliminated *L. pneumophila* from hot water samples through 8 days of use.
- ◆ Point-of-use filters completely eliminated *Mycobacterium sp.* from hot water samples through 8 days of use.
- ◆ There was a >99% reduction in HPC bacteria through 7 days of use with the point-of-use filters. There was an increase in recovery beyond day 8. The concentration was still significantly lower compared to the control faucets.
- ◆ The point-of-use filter units can prevent exposure of high-risk patients to waterborne pathogens.

Implications

Immunocompromised patients are at risk of infection from *Legionella* and other waterborne pathogens (Anaissie-2002). Current guidelines from the Centers for Disease Control and Prevention (CDC) state that no *Legionella* should be detected from water outlets in hospital units housing transplant patients (MMWR-2003). This strict limit may be achieved through the use of point-of-use filters.

References

- A.C. Yu, J.E. Stout, V.L. Yu, and M.M. Wagener. Comparison of culture methods for monitoring *Legionella* species in hospital potable water systems and recommendations for standardization of such methods. *J Clin Microbiol* 33:2118-2123, 1995.
- Package insert, Pall-Aquasafe™ Water Filters, Pall Medical, Ann Arbor, MI.
- Anaissie, E.J., Penzak S.R. and Dignani M.C. The hospital water supply as a source of nosocomial infections: a plea for action. *Arch. Intern. Med.* 162: 1483-1492, 2002.
- Centers for Disease Control and Prevention. Guidelines for environmental infectioncontrol in health-care facilities. *Morbidity and Mortality Weekly Report.* 52/No. RR-10: 14-21, 2003.