Point-of-use Water Filtration Reduces Healthcare-associated Infections in Bone Marrow Transplant Recipients

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Disclosures

- Filter materials for this study were provided by Pall Medical.
- Drs. Cervia, McAlister, Canonica, Ortolano, and Ms. Stanchfield are employed by Pall Medical.

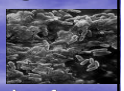
Healthcare-Associated Infections (HAIs)

According to CDC…

- 1 out of 22 patients hospitalized in the U.S. this year will suffer an infection
- 1.7 million persons will be infected
- 99,000 will die
- Cost to treat these infections: tens of billions of dollars

http://www.cdc.gov/ncidod/dhqp/pdf/hicpac/infections_deaths.pdf

Tap Water: A Reservoir of Risk



- Tap water harbors potentially pathogenic microorganisms from biofilm on internal surfaces of pipes and fixtures.
- In the healthcare setting, waterborne microorganisms can pose a substantial health threat to patients and staff.
- Waterborne microbes enter into the healthcare environment via:
  - direct contact with water streams,
  - aerosols from showers and faucets,
  - ice from ice machines,
  - rinsing of improperly reprocessed medical devices.

Cervia, J. Canonica, F. Ortolano, G. "Water as a Source of Health Care-Associated Infections." *Archives of Internal Medicine*. 2007;167:92.

Waterborne Microorganisms of Primary Clinical Significance

Bacteria:

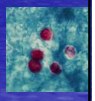
- *Pseudomonas aeruginosa*
- *Stenotrophomonas maltophilia*
- *Legionella pneumophila*
- *Acinetobacter spp.*
- *Mycobacterium spp.*

Fungi:

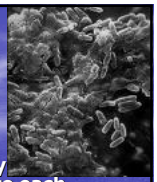
- *Aspergillus fumigatus*
- *Fusarium solani*

Parasites:

- *Cryptosporidium parvum*
- *Giardia lamblia*
- *Acanthamoeba spp.*



Biofilm



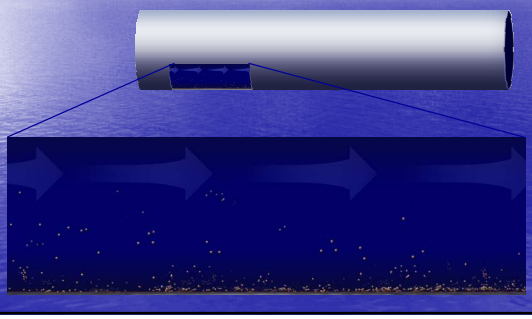
Definition:

- A microbially-derived sessile community
- characterized by cells that are irreversibly attached to a substratum or interface or to each other,
- are embedded in a matrix of extracellular polymeric substances that they have produced, and
- exhibit an altered phenotype with respect to growth rate and gene transcription.

Donlan, R.M. and J.W. Costerton. Biofilms: survival mechanisms of clinically relevant microorganisms. *Clin. Microbiol. Reviews.* 2002; 15(2):167-193.

NYC Hospital Water Pipe

The Process of Biofilm Formation



The Process of Biofilm Formation

Surface Preconditioning

Biofilm Formation

Reversible Adhesion

Biofilm Formation

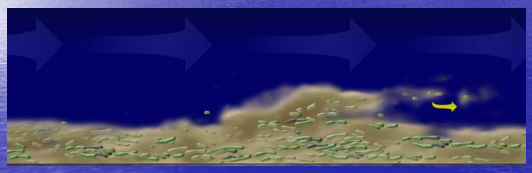
Irreversible Adhesion

Biofilm Formation

Critical Mass Expansion & Maturation

Biofilm Formation

Shedding & Dispersal



Biofilm shedding is intermittent…

…thus, so too are positive cultures.

Pseudomonas aeruginosa in Tap Water: A Relevant Risk Factor

36-42% of healthcare-associated *Pseudomonas aeruginosa* infections are possibly due to contaminated tap water

Reuter, S., A. Sigge, W. Heidemarie, and M. Trautmann. 2002. Analysis of transmission pathways of *Pseudomonas aeruginosa* between patients and tap water outlets. *Crit.Care Med.* 30(10):2222-2228.

Recent Evidence Suggests Interruption of a *P. aeruginosa* Outreak in a Hematology Unit with Point-of-Use Water Filtration

- November 2002: POU filters installed throughout the unit.
- Results:
  - Number of positive *P. aeruginosa* blood cultures:
    - 2002: 61
    - 2003: 7 (p:2002 vs. 2003 = 0.0001)
    - 2004: 11

Vianelli, N. et al. Resolution of a *Pseudomonas aeruginosa* outbreak in a hematology unit with the use of disposable sterile water filters. *Haematologica.* 2006;91(7):983-985.

Purpose

- Infections with Gram-negative bacteria (GNB), such as *Pseudomonas aeruginosa* and *Stenotrophomonas maltophilia* are major contributors to serious morbidity and mortality in hospitalized patients.
- Immunocompromised individuals, such as recipients of bone marrow transplants (BMT) are known to be at particularly high risk.
- Recent literature indicates that infections with GNB are increasing in incidence, and that GNB clinical isolates are becoming increasingly resistant to antimicrobial therapy, and thus more difficult to treat.
- In addition, it has been recognized that outbreaks of infection with GNB have been linked to hospital water, and interrupted by point-of-use (POU) water filtration.
- We sought to determine whether POU filtration might result in a diminished risk of infection in hospitalized bone marrow transplant recipients in the absence of any recognized outbreak of GNB infection.

Methods

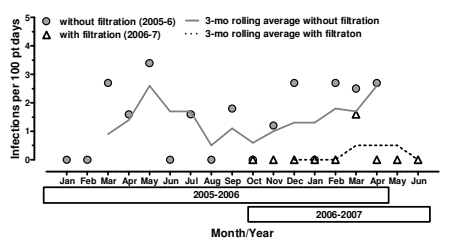
- Unfiltered water was sampled from taps in the BMT unit of a major U.S. teaching hospital, and cultured at a reference laboratory (Special Pathogens Laboratory, Pittsburgh, PA).
- Specially adapted 0.2 micron filters (Aquasafe, Pall Medical, East Hills, NY) were installed at the POU (sinks, showers, ice machines) throughout that unit.
- POU filters were replaced every 14 days as per instructions for use.
- Infection rates in the unit were tracked over a 9-month period, and compared with rates for a 16-month period prior to the implementation of POU filtration.

Point-of-Use Water Filters

Results

- Unfiltered water samples from 50% (2 of 4) outlets sampled in the BMT unit grew *P. aeruginosa* (2 of 4) and *S. maltophilia* (1 of 4).
- Clinical infection rates in the unit were significantly reduced from 1.4 total and 0.4 GNB infections per 100 patient days in the period prior to POU filtration to 0.18 total and 0.09 GNB infections per 100 patient days ($p=0.0068$ and $p=0.0431$, respectively) in the 9-month period for which filters were in place.
- No infections were noted in 8 of those 9 months.
- All infections during the POU filtration period were due to non-waterborne pathogens (coagulase-negative Staphylococcus and *E. Coli*)

Monthly infections per 100 patient days for control (unfiltered) and experimental (filtered) periods.



Cervia, J, Farber, B, Armellino, D, Klocke, J, Bayer, RL, McAlister, M, Stanchfield,I, Canonica, F, Ortolano, GA. "Point-of-Use Water Filtration Reduces Healthcare-Associated Infections in Bone Marrow Transplant Recipients." *Transplant Infectious Disease. 2009.* In Press.

POU Water Filtration vs. HAI Treatment Costs

- Added cost of infectious complications incurred for HAIs:

  $15,275 - $38,656 per infection[1,2]

- Cost of a one-year supply of POU Filters for one water outlet (e.g. one faucet; one shower):

  Approximately $1,500 per year

1. Roberts, R.R., R.D. Scott II, R. Cordell et al. 2003. The use of economic modeling to determine the hospital costs associated with nosocomial infections. *Clin. Infect. Dis.* 36(11):1424-1432.
2. Zahn, C. and M.R. Miller. 2003. Excess length of stay, charges, and mortality attributable to medical injuries during hospitalization. *JAMA.* 290(14):1868-1874.

Conclusions

- Recognized waterborne pathogens that are frequently resistant to multiple antimicrobial agents, such as *P. aeruginosa* and *S. maltophilia* may be recovered from cultures of hospital tap water, and pose a particularly high risk to immunocompromised BMT recipients.
- POU filtration may significantly and cost-effectively reduce infection rates in such high-risk patient populations.

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Thank You! - Questions?