Monitoring for Environmental Management

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Environmental Sampling in Healthcare

- Validation
  - Sanitation
    - Food preparation surfaces
  - Mechanical specification
    - Ventilation parameters
  - Contamination level
    - Air and water quality
    - Fomites
  - Prevention of growth
    - Water damage control

Environmental Surveillance

What to monitor?
- Microbes
  - Air and surfaces
  - Water
- Ventilation parameters
  - Air exchanges
  - Pressure
  - Filtration
- Construction and maintenance practice
  - Water response plan
  - Mold recognition and clean-up
  - Construction management

Environmental Sampling

- Environmental microbiology is not clinical microbiology
- Sampling is supported by epidemiologic assessment
- Random, undirected sampling is not recommended
- Sampling requires a protocol for sampling and culturing, analysis of results, and action based on the interpretation of results

CDC Guideline for Environmental Infection Control, MMWR June 6, 2003

Air Sample Considerations

When to sample?

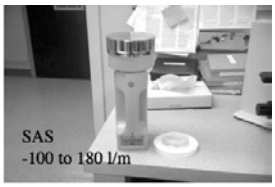
- **Commissioning-before occupancy=baseline data**
  - All parameters for ventilation assurance and cleanliness
  - Provide comparison data
- **Disease outbreak analysis**
  - All environmental parameters with emphasis on source detection.
  - Surface and air content for fungi
  - Surface samples help find aerosol sources
- **Validation of ventilation**
  - Pressure most meaningful?
  - Air exchanges needed for purging
  - Non viable particles can be used to assess filtration efficacy
  - Medical staff understand the viable counts the best

EIC CDC Guidelines 6/6/03 MMWR

Table 23. Air sampling methods and examples of equipment*

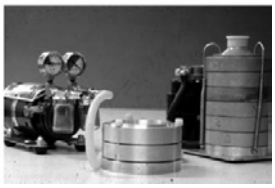
Method	Principle	Suitable for measuring:	Collection media or surface	Rate of collection (L/min.)	Auxiliary equipment needed+	Points to consider	Prototype sampler§
Impingement in liquids	Air drawn through a small jet and directed against a liquid surface	Viable organisms, and concentration over time. Example use: sampling water aerosols to *Legionella* spp.	Buffered gelatin, tryptone saline, peptone, nutrient broth	12.5	Yes	Antifoaming agent may be needed. Ambient temperature and humidity will influence length of collection time.	Chemical Corps. All Glass Impinger (AGI)
Impaction on solid surfaces	Air drawn into the sampler; particles deposited on a dry surface	Viable particles; viable organisms (on non-nutrient surfaces, limited to organisms that resist drying and spores); size measurement, and concentration over time. Example use: sampling air for *Aspergillus* spp., fungal spores	Dry surface, coated surfaces, and agar	28 (sieve) 30–400 (slit)	Yes	Available as sieve impactors or slit impactors. Sieve impactors can be set up to measure particle size. Slit impactors have a rotating support stage for agar plates to allow for measurement of concentration over time.	Andersen Air Sampler (sieve impactor); TSI, Casella MK 2 (slit impactor)
Sedimentation	Particles and micro-organisms settle onto surfaces via gravity	Viable particles. Example uses: sampling air for bacteria in the vicinity of and during a medical procedure; general measurements of microbial air quality.	Nutrient media (agars) on plates or slides	–	No	Simple and inexpensive; best suited for qualitative sampling, significant airborne fungal spores are too buoyant to settle efficiently for collection using this method.	Settle plates

Slit impactor



Sieve impactors

Optical particle counter



Sampler criteria
- high volume
- lab friendly
- culture methods

Average yearly cfu/m^3 University Minnesota Hospital locations

TOTAL AIRBORNE FUNGI

35 C	1997	1998	1999	2000	2001	2002	2003	2004
Bonemarrow	3	1.9	1	1.6	1.9	3.6	2.8	3.8
5-Med Surg	10.3	5.6	3	3.4	4.8	5.3	5.1	16
6-Transplant	4.2	1.6	5.3	2.8	5.9	6.9	6.4	4.4
7-Oncology	3.8	2.5	3.5	3.7	5.1	7.1	6.4	5.6
Reference	2.8	7.2	2.4	26.9	6.4	6.8	33	14
Outdoors	82.5	69.9	313.5	59.1	91.6	180	80	136

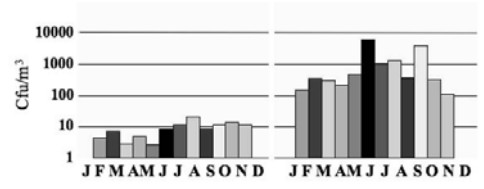
25C	1997	1998	1999	2000	2001	2002	2003	2004
Bonemarrow	24.5	14	9.2	9.8	6.1	6.9	16	11
5-Med Surg	4.8	46.3	17.9	22.6	16.5	12.3	20	22
6-Transplant	17	19.2	20.3	15.8	14.6	15.5	19	23
7-Oncology	18.7	11	13	59.5	16	20.5	37	13
Reference	22.4	30.2	15.7	25.2	16.3	21.6	32	48
Outdoors	408.3	1131.9	1216.8	728.8	315	673	914	1138
Aspergillosis tot cases		21	28	14	21	18	11	14

Interpretation of Data

- Rank order analysis
  - Lowest counts in the areas with best filtration
  - Comparison necessary with outdoor control
- Qualitative analysis
  - Pathogen recovery (Aspergillus)
  - Homogeneous population (versus heterogeneous isolates)
- Indoor outdoor ratio
  - I/O <1 normal (seasonal considerations)
  - I/O >1 potential problem
- Temperature selectivity
  - Pathogens grow best at >35C (<1 cfu/m^3 pathogens)
  - Filtration efficacy determined at 25C (lowest counts = best filtrtion)

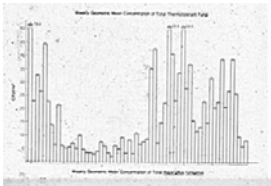
Viable airborne fungal samples

University of Minnesota Hospital Air Sampling 1999



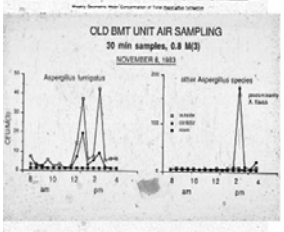
Bone Marrow Transplant

Outdoors

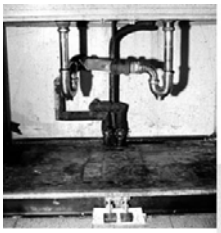


EXPOSURE VARIATION

Seasonal variation is dependant on the climate and local flora

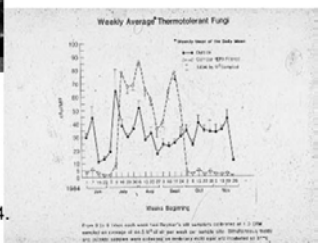


Local sources can create high dose-short term exposures



Indoor variation is dependant on local sources and filtration

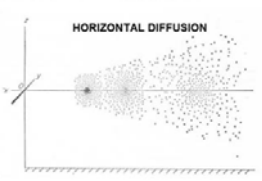
What did water do under this sink?



Mold growth caused the I/O ration to be >1

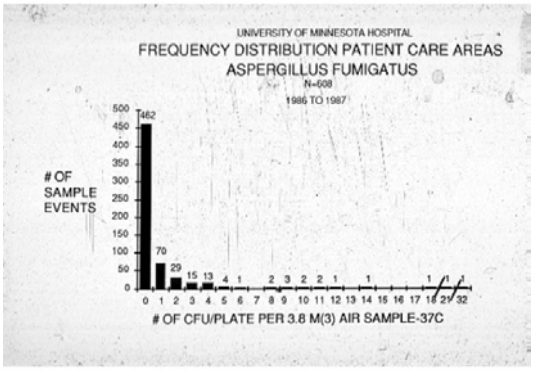
J.Clin Micro Jan 1987 p1-4.

Horizontal Diffusion of Spore Cloud from Mold Source



Diffusion of spore cloud during horizontal travel in wind. 0 = origin of coordinates at source point of liberation; x, y, z = down wind, cross wind, and vertical axes respectively. Growth of cloud is measured by increase in standard deviation after the center of the cloud has traveled to three positions down wind.

DESTROY OR LOCK DOWN MOLD SOURCE BEFORE DISTURBING



University of Illinois Medical Center 1998 to 1999
CFU per M^3 total fungi 25C Incubation

Location	N	average	range	Asp tot
Solid Organ Wards	62	44	2 - 248	12
Bone Marrow TX	62	40	0 - 220	8.4
Outside	122	257	10 - 1340	6.8

Curis, et al JIH 2005

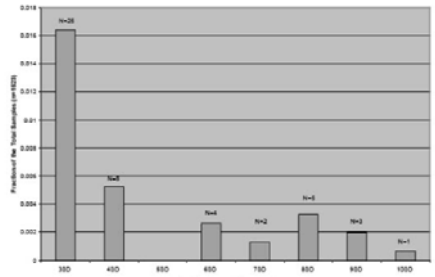
University of Minnesota Medical Center 1995 to 2005
CFU per M^3 total fungi 25C Incubation

Location	N	average	range	Asp tot
Solid Organ Wards	123	46	0 - 1120	Nd (10)
Bone Marrow TX	249	20	0 - 320	Nd (1.1)
Outside	129	848	16 - 5828	Nd (45)

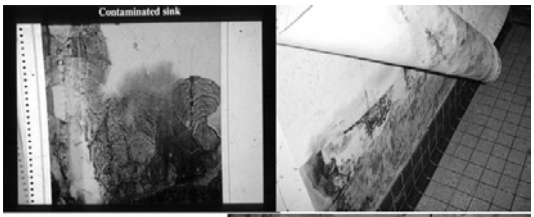
Streifel unpublished data 2006

( )=Asp @ 35C

What is a burst of fungal spores?



A burst is >3 standard deviations above the average?

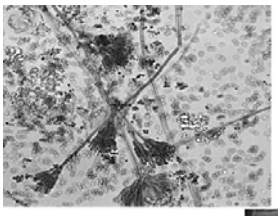


MOLD SOURCES ARE COMMON CONTROL PREVENTS INFECTION & OTHER ISSUES

Cassette air samples

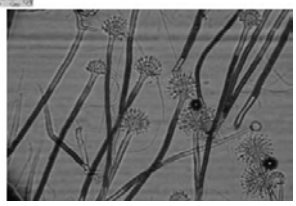
- Long term sampling up to 2 hrs
- Portable battery operated pump (2 liters/min)
- Not very size selective
- Fungal spore death due to desiccation (drying out)
- Nonviable spore counts
- Recovery of Stachybotrys conidia .
- Many other fungal spores not identified to genus
- Rank order determination

Mold spores can be ID'd with visual morphology.



When collecting spores for microscopic identification it becomes difficult to distiguish between Aspergillus and Penicillium species

Culture and microscopic evaluations should be use clinical areas clearance.



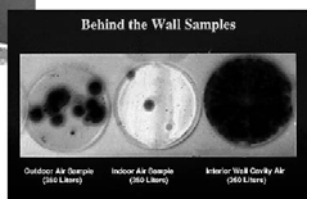
FIELD IDENTIFICATION

Tease tapes with adhesive allows for spore forming component to be removed for identification

Once on tape the tape is placed on slide with contrast dye for microscopic identification based on morphology Keys on filamentous fungi

Looking for sources in areas with known water leaks.

Sampling behind the wall shows gross differences from other sample locations.



Non-Viable Particle Counter Usage:

Biological Safety Cabinets
- -product & specimen protection
- -employee protection
- -microbiology lab
- -pharmacy sterile mfg

Healthcare application
- -bone marrow transplant
- -operating rooms
- -pharmacy sterile compounding USP 797
- -filter validation

Particle counting and microbiological management
- -Mil Spec 209E
- -ISO Classification of Room Particulates
- ->0.5μm diameter

Optical particle counter

Surveillance Condensation Particle and Pressure Analysis-Bone Marrow
August 2000

LOCATION	P/CC	PRESSURE DIFERENTIAL (Pa	FILTRATION
Outside	3500	na	---------
Lobby	1500	na	90%
BMT area corridor	450	(+) 4-10	99.97%
-21/32 rooms	<10	(+) 6.8-30	99.97%
-9/32 rooms	10-80	(+) 8.6-17	99.97%
-2/32 rooms	>500	(+) 11 & 12	99.97%
Diffusers	0-1	na	99.97%
Radiation therapy	1000	na	90%
Adjacent bldg.	5300	na	50%

Essential Surveillance Parameters

- **Room air exchanges per hour**
  - each air exchange reduces particles about 66%
  - All and PE rooms at >12 ac/hr
- **Pressure control for All & PE rooms**
  - air velocity to create 2.5 Pascals
  - air velocity 0.25Pascals=0.61 m/s, 2.5Pa=2.0 m/s, 25Pa= 6.6 m/s
  - air velocity 0.001"wc =120 fpm, 0.01"wc = 400 fpm, 0.1"wc =1300 fpm
  - design for >3.5 m^3/min offset for supply versus exhaust air volumes
  - minimal leakage < 0.0464 m²
  - current standards for leakage at 2.5 inches/100 square feet
- **Filtration supply to PE rooms & exhaust from All rooms**
  - particle reduction to include both viable and nonviable particles
  - rank order reduction of particles from dirty to cleanest areas
  - non viable particles can be analyzed real time

TESTING FOR FILTER INEFFICENCY?

"in situ" filter testing with condensation particle counter

Common causes of filter leaks are:

- Loose filters
- Missing gaskets
- Missing or damaged filters
- Incorrect filters installed
- High air velocity
- Overloaded filters

Examples of data interpretation for particle reduction in various filtered efficiencies:

Optical PC*	Outside air particles	After filter PC	Percent reduction
MERV** 12 filters	120000	24000	80
MERV 14 filters	120000	12000	90
MERV 16 filters	120000	36	99.97

Note Optical Particle Counts Are Report As Particles Per Cubic Foot.
* PC = particle counts
**MERV = minimum efficiency rating value (current ASHRAE rating system).

Before filter
12176 p/ft^3

After filter
40 p/ft^3

>99% reduction

Objective analysis of critical environments:pressure and particles

Validation of ventilation air from a BMT room
-Low particle counts
-High pressure

Validation of filters at the point of use
-Particle count scan
-Check filter installation

Do we need to culture or clean?
Should we verify cleaning?

Does real time sampling
Allow for quick response?
Is it safe? Could the test be microbe specific or a measure of microbial reduction?

CDC Environmental Infection Control-MMWR 6/6/2003

Box 15. Undertaking environmental-surface sampling*

The following factors should be considered before engaging in environmental-surface sampling:

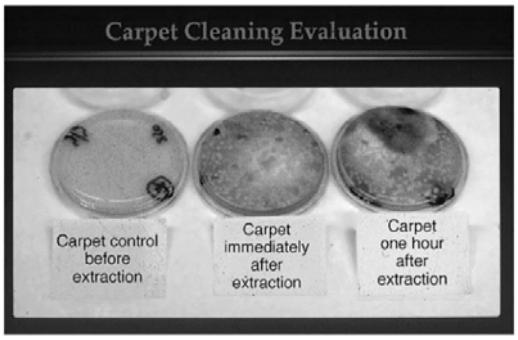
- Background information from the literature and present activities (i.e., preliminary results from an epidemiologic investigation)
- Location of surfaces to be sampled
- The method of sample collection and the appropriate equipment for this task
- The number of replicate samples needed and which control or comparison samples are required
- The parameters of the sample assay method and whether the sampling will be qualitative, quantitative, or both
- An estimate of the maximum allowable microbial numbers or types on the surface(s) sampled (refer to the Spaulding classification for devices and surfaces)
- Some anticipation of a corrective action plan

* The material in this box is compiled from reference 124.

Table 25. Methods of environmental-surface sampling

Method	Suitable for appropriate surface(s)	Assay technique	Procedural notes	Points of interpretation	Available standards	References
Sampler/rinse Moistened swab/rinse	Nonabsorbent surfaces, corners, crevices, devices, and instruments	Dilutions; qualitative or quantitative assays	Assay multiple moistened areas or devices with separate swabs	Report results per moistened areas or if assaying an object, per the entire sample site	YES – food industry; NO – health care	1214, 1239–1242
Moistened sponge/rinse	Large areas and housekeeping surfaces (e.g., floors or walls)	Dilutions; qualitative or quantitative assays	Vigorously rub a sterile sponge over the surface	Report results per measured area	YES – food industry; NO – health care	1214, 1239–1242
Moistened wipe/rinse	Large areas and housekeeping surfaces (e.g., countertops)	Dilutions; qualitative or quantitative assays	Use a sterile wipe	Report results per measured area	YES – food industry; NO – health care	1214, 1239–1242
Direct immersion	Small items capable of being immersed	Dilutions; qualitative or quantitative assays	Use membrane filtration if rinse volume is large and anticipated microbiological concentration is low	Report results per item	NO	1214
Containment	Interior surfaces of containers, tubes, or bottles	Dilutions; qualitative or quantitative assays	Use membrane filtration if rinse volume is large	Evaluate both the types and numbers of microorganisms	YES – food and industrial applications for containers prior to fill	1214
RODAC*	Previously cleaned and sanitized flat, nonabsorbent surfaces; not suitable for irregular surfaces	Direct assay	Overgrowth occurs if used on heavily contaminated surfaces; use neutralizers in the agar if surface disinfectant residuals are present	Provides direct, quantitative results; use a minimum of 15 plates per an average hospital room	NO	1214, 1237, 1239, 1243, 1244

* RODAC stands for "replicate organism direct agar contact."

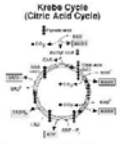


Rapid Environmental Analysis

Rapid turn around time for construction & mold remediation
-PCR

- **spore equivalents per unit volume or surface area**
- **surface and air sample**
- **prior micro sample determines species identification**
- **interpretation of data guidelines prior to sampling**
- **example-air sample (-) surface (+) clean & move or air sample (+) surface (+) sanitize & resample**

Rapid Environmental Analysis



Rapid turn around time for construction & mold remediation
Adenine tri-phosphate (ATP)

- **-energy source living cells+biolumenesence =light**
- **-surrogate determination of environmental cleaning**
- **-relative light units determines surface cleanliness?**
- **- <100 ok 100 to 1000 look and clean >1000 problems?**
- **-advantage real time--HACCP-USFDA approved**

Microbial indicators can be used to detect water damage mold if it is growing.

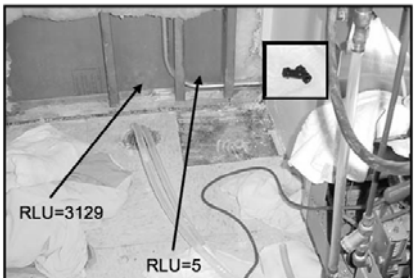
This test uses ATP + bio light emitting enzyme to produce relative light unit

SCRUB THE SURFACES WITH SOAP & WATER

Before @ 9999 RLU

Retest surface for ATP
After at 67 RLU

ATP TEST AFTER A WATER LEAK



RLU=relative light unit an indicator of biological ATP

Flood occur especially if something is caught in the cleanout and along come a lot of water to cause a "burp".

This grey water represents a potential infection control problem in an ICU.
How do we know we have sanitized this bioload?

Aquarium provide high humidity environment which can promote mold growth.

Accumulated dust in on the fan housing was full of Aspergillous fumigatus spores recovered with surface contact plates.

Fungal source management

- Recognize fungal potential
  - Outward signs such as colonies on wall
  - Odors
  - Water damage
- Control methods
  - Containment
  - Clean-up
  - Verification

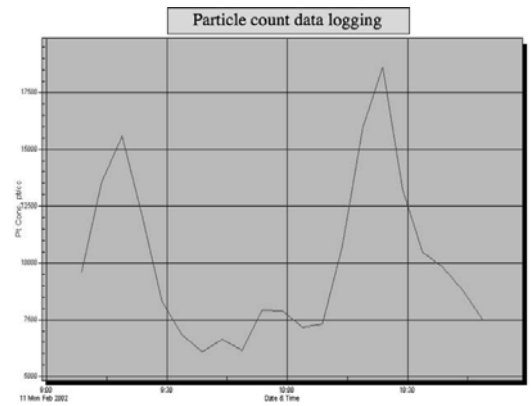
Moisture meter

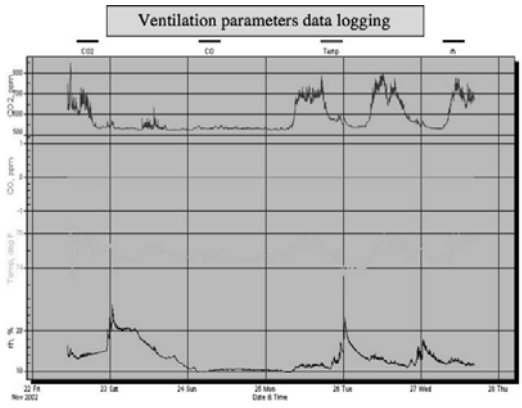
Air sampler

Pressure gauge & Particle counter

REAL TIME MONITORING HAS AN ADVANTAGE OVER REQUIRED LAB ANALYSIS DUE TO CULTURE OR MICROSCOPIC METHODS.

Condensation Particle Counter-0.01 to 1.0 μm





Tool kit

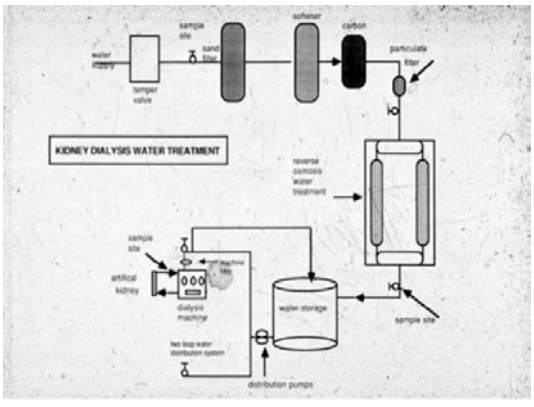
- Air samplers-particle counters
  - -optical versus condensation
- Pressure gauge
  - -sensitive to <.001'wg
- Moisture monitor
  - -contact versus probe
  - -thermal differences
- Air samplers-microbial
  - -high volume versus low volume
  - -viable versus non viable
- Surface sampling
  - -swab versus contact plate
  - -viable vs ATP

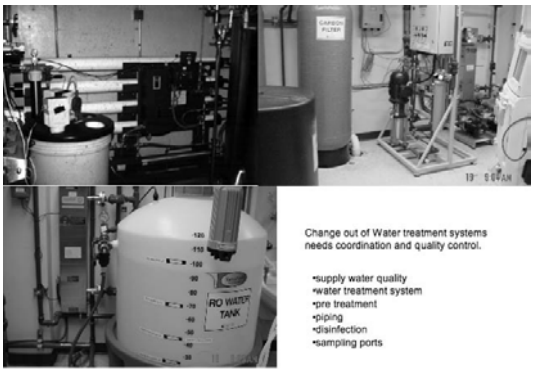
GUIDELINES FOR ENVIRONMENTAL INFECTION CONTROL
CDC MMWR JUNE 6, 2003
Water Section

- Waterborne microorganisms
- Facility water systems
- Strategies for controlling *Legionella* spp.
- Cooling towers
- Hemodialysis and water quality
- Ice machines
- Hydrotherapy
- AERs and dental unit water lines (DUWLs)

Reservoir	Associated pathogens	Transmission	Strength of evidence*	Prevention and control
Potable water	*Pseudomonas*, gram-negative bacteria, NTM	Contact	Moderate	Follow public health guidelines.

Reservoir	Associated pathogens	Transmission	Strength of evidence*	Prevention and control
Potable water	*Legionella*	Aerosol inhalation	Moderate	Provide supplemental treatment for water.
Holy water	Gram-negative bacteria	Contact	Low	Avoid contact with severe burn injuries. Minimize use among immunocompromised patients.
Dialysis water	Gram-negative bacteria	Contact	Moderate	Dialysate should be <2,000 cfu/mL; water should be <200 cfu/mL.
Automated endoscope reprocessors and rinse water	Gram-negative bacteria	Contact	Moderate	Use and maintain equipment according to instructions; eliminate residual moisture by drying the channels (e.g., through alcohol rinse and forced air drying).
Water baths	*Pseudomonas*, *Burkholderia*, *Achromobacter*	Contact	Moderate	Add germicide to the water; wrap transducers (probes) in protective plastic wrap if using the bath to modulate the temperature of these products.
Tub immersion	*Pseudomonas*, *Enterobacter*, *Acinetobacter*	Contact	Moderate	Drain and disinfect tub after each use; consider adding germicide to the water; water in large hydrotherapy pools should be maintained, disinfected, and filtered.
Ice and ice machines	NTM, *Enterobacter*, *Pseudomonas*, *Cryptosporidium*, *Legionella*	Ingestion, contact	Moderate	Clean periodically; use cosmetic dispenser (avoid open-chest storage compartments in patient areas).
Faucet aerators	*Legionella*	Aerosol inhalation	Moderate Low	Clean and disinfect monthly in high-risk patient areas; consider removing if additional reflection exists.
Faucet aerators	*Pseudomonas*, *Acinetobacter*, *Stenotrophomonas*, *Chryseobacterium*	Contact, droplet	Low	No precautions are necessary at present in immunocompetent patient-care areas.
Sinks	*Pseudomonas*	Contact, droplet	Moderate	Use splash sinks for handwashing and disposal of contaminated fluids.





Change out of Water treatment systems needs coordination and quality control.

- supply water quality
- water treatment system
- pre treatment
- piping
- disinfection
- sampling ports

CDC Environmental Infection Control-6/6/2003

Table 18. Microbiologic limits for hemodialysis fluids*

Hemodialysis fluid	Maximum total heterotrophs (CFU/mL)+	Maximum endotoxin level (EU/mL)§
Present standard		
Product water¶		
Used to prepare dialysate	200	No standard
Used to reprocess dialyzers	200	5
Dialysate	2,000	No standard
Proposed standard*		
Product water	200	2
Dialysate	200	2

* The material in this table was compiled from references 789 and 791 (ANSI/AAMI standards RD 5-1992 and ANSI/AAMI RD 47-1993).
+ Colony forming units per milliliter.
§ Endotoxin units per milliliter.
¶ Product water presently includes water used to prepare dialysate and water used to reprocess dialyzers.
** Dialysate for hemodialysis, RD 52, under development, American National Standards Institute, Association for the Advancement of Medical Instrumentation (AAMI).

Action level of 50 cfu/ml = do something?

Infections associated with use of hydrotherapy equipment

Microorganisms	Medical conditions
Acinetobacter baumanii	Sepsis
Citrobacter freundii	Cellulitis
Enterobacter cloacae	Sepsis
Legionella spp.	Legionellosis
Mycobacterium abscessus, Mycobacterium fortuitum, Mycobacterium marinum	Skin ulcers and soft tissue infections
Pseudomonas aeruginosa	Sepsis, soft tissue infections, folliculitis, and wound infections
Adenovirus, adeno-associated virus	Conjunctivitis

Microorganisms and their sources in ice and ice machines

Sources of microorganisms

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

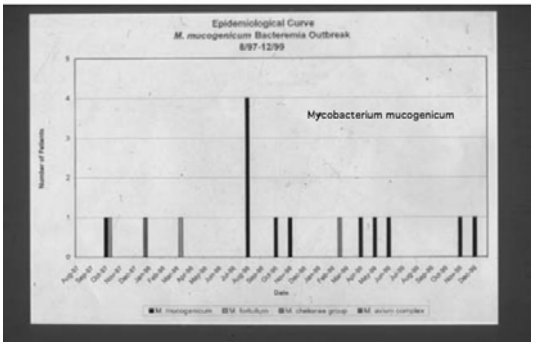
From fecally-contaminated water
- Norwalk virus
- *Giardia lamblia*
- *Cryptosporidium parvum*

From hand-transfer of organisms
- *Acinetobacter spp.* 859
- Coagulase-negative staphylococci 859
- *Salmonellaenteritidis* 865
- *Cryptosporidium parvum*

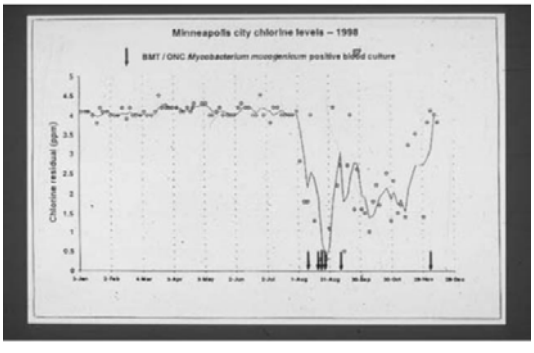
Non-Tuberculous Mycobacteria: Infections or Colonization

Implicated Environmental Vehicle	*Mycobacterium* spp.
Inadequately sterilized medical instruments	*M. abscessus, M. chelonae, M. fortunitum*
Potable water, ice	*M avium* complex (MAC), *M. fortuitum, M. ulcerans*
Hydrotherapy tanks and pools	*M. chelonae, M. fortuitum, M. marinum*
Reprocessed dialyzers	*M. chelonae*
Shower aerosols	*M. fortuitum*

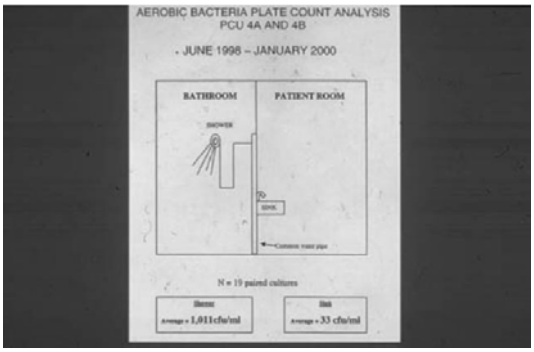
EPIDEMIOLOGICAL CURVE FOR BLOOD ISOLATES RECOVERED FROM BONEMARROW TRANSPLANTS



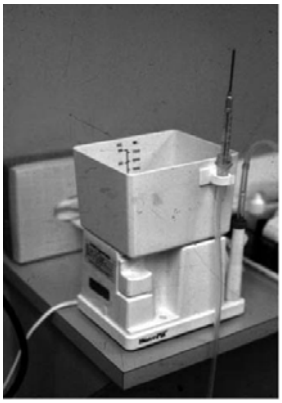
Chloramine levels in Minneapolis near the hospital



Paired water samples from patient rooms



Bio-film on the inside of plumbing fixtures



Some devices can are water reservoirs and must be considered contaminated.

Nutrients from food will feed bacteria to create significant sources of opportunistic microbes.

Special formulas need to be carefully prepared.

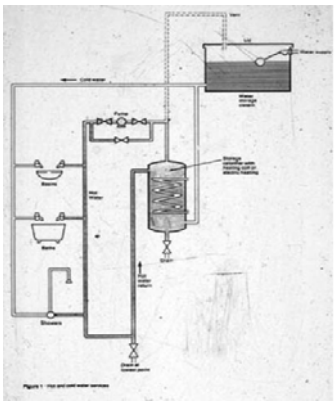
COMMON WATER MICROBES CAN MULTIPLY IN AREAS THAT CANNOT BE DISINFECTED

Healthcare-associated Outbreaks of Legionellosis

- Contaminated aerosols
- Exposure to aerosols produced from:
  - Cooling towers
  - Showers, aerators
  - Faucets
  - Respiratory therapy equipment
  - Room-air humidifiers
  - Decorative fountains

PREVENTION AND CONTROL

- **CULTURE WATER FOR LEGIONELLA**
  - IF FOUND CULTURE PATIENTS
  - RETROSPECTIVE EPIDEMIOLOGY
  - WATER SYSTEM DECONTAMINATION
- **FOLLOW HIGH RISK PATIENT**
  - IF FOUND IN PATIENT WITH NOSOCOMIAL PNEUMONIA
  - INITIATE SEARCH FOR WATER SOURCE
  - MAINTAIN COOLING TOWERS AND USE STERILE WATER FOR NEBULIZATION
- **MAINTAIN POTABLE WATER**
  - >50C OR <20C RECIRCULATION IDEAL
  - HEATED WATER AT 1-2MG/L FREE RESIDUAL CHLORINE



WATER DISTIBUTION SYSTEM BUILDING ISSUES RELATED TO DEAD END CONNECTIONS FROM DISCONTINUED LINES.

Legionella Control with Chlorination

- In 1990 - 23% of municipalities with >50,000 people used mono chloramine disinfection
- Advantages:
  - does not form trihalomethanes
  - heat stable
  - more effective at penetrating bio film

  Hospitals with outbreaks of Legionellosis predominately >200 beds
  - 73% of those hospitals have a transplant program
  - 31 outbreaks in hospitals with free available chlorine
  - only one outbreak with mono chloramine
- Chlorine dioxide

  local production for legionella management (PCU area or whole hospital?)

  long term disinfection Royal Infirmary Glasgow Scotland (10 years)

Monochloramine in Municipal Water Systems

Number of Municipal water buildings tested=53

-37 of 53 (70%) buildings colonized before chloramine
- 5 of 53 (9%) buildings colonized after chloramine

or

246 culture positive of 624 samples before chloramine

9 culture positive of 622 samples after chloramine

Wide spread use of chloramines may reduce Legionellosis transmission and disease in the United States

Reducing Legionella Colonization of Water Systems with Monochloramine,B.Flannery,et.al, Emerging Infectious Diseases, www.cdc.gov/eid • Vol. 12, No. 4, April 2006

Cooling Tower Concerns

- Cooling towers provide ideal environments for *Legionella* spp. growth
- Locate cooling towers to minimize intake of drift aerosols into the ventilation system
- Perform maintenance cleaning and treatment as per manufacturer's instructions and other available guidance
- Clean and treat before seasonal start-up

Cooling Tower considerations:
-location of air intake
-drift eliminators
-design to facilitate cleaning & disinfection
-continuous treatment for control of biomass
-tower and pipe resistant to disinfection
-start up best time for dispersal
-routine maintenance
-testing & record keeping

Verification of Ventilation
USP 797 Environmental Assessment

- Clean, Cleaner and Cleanest
  - ISO standards
- Cleanest
  - Biosafety cabinet
    - Chemo therapy or antibiotic preparation
  - Clean bench-LAF
    - IV preparation
- Cleaner inventory dispensing area
- Clean general public circulation area

UMMC PHARMACY MANUFACTURING

PRESSURE MEASUREMENT & PARTICLE ANALYSIS

Comparison analysis

- Particle counter
  - Outside vs other areas
  - Lowest levels in the cleanest locations
- Pressure management
  - Airflow from cleanest to cleaner to clean
  - Pressurized environment
- Filtration and Air exchanges
  - Dilution ventilation

Cleanliness Verification

- Hands
  - Demonstrate compliance of hand washing
- Air quality
  - Demonstrate comparison data
- Surfaces
  - Demonstrate cleaning
- Training
  - Demonstrate understanding and competency

The Next Few Teleclasses

May 8	***Panton-Valentine Leucocidin Producing Staphylococcus aureus*** … with Brenda Dale & Adam Brown, National Health Service, UK
May 10	***Infection Control in the Dialysis Clinic*** … with Dr. Charmaine Lok, University of Toronto
May 17	***Ethics of Care During a Pandemic*** … with Dr. Eric Wasylenko, Calgary Health Board
May 24	***Importance of Vaccination Among Dialysis Patients*** … with Dr. Matthew Arduino, CDC
May 31	***Evaluation and Management of Infectious Disease Outbreaks in Nursing Homes*** … with Dr. Chesley Richards, CDC

For the full teleclass schedule – www.webbertraining.com
For registration information www.webbertraining.com/howtoc8.php