Establishing a Culture of Safety: Eliminating Environmental Infection Risks with Effective Prevention Measures

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www.workingtowardzero.com
www.7SBundle.com
www.creativehandhygiene.com
List of Sources

- Patient Care Equipment
- Environmental surfaces
- Medications
- Food and Enteral Feedings
- Air Handling Systems
- Water and Sewerage
- Construction sites
- Unique environmental sources
- Air as source of contamination
- Innovative technology to self-disinfect environment
Transmission of microorganisms

- Direct Contact with blood & body fluids (urine, feces, saliva, pus)
- Indirect contact with contaminated inanimate objects (needles, equipment, furniture)
- Airborne route (TB, Influenza, Chickenpox)
- Vectors (Mosquitoes – Equine Encephalitis, Malaria)
Surface Contamination (in hospitals) with MRSA, VRE, and C. Difficile

Blood Pressure Cuff:
- VRE 14%

Overbed Table:
- MRSA 40%
- VRE 20%

Bedrail:
- MRSA 29%
- VRE 28%
- C. Difficile 19%

Bedsheets:
- MRSA 53%
- VRE 40%

Windowsill:
- C. Difficile 33%

Commode:
- C. Difficile 41%

Patient Gowns:
- MRSA 51%

Floors:
- MRSA 55%
- C. Difficile 48%

Did you know that every time you get a new roommate, there is an increase of 3-10% that you will acquire an HAI.


## Pathogens survival on surfaces

<table>
<thead>
<tr>
<th>Organism</th>
<th>Survival period</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Clostridium difficile</em></td>
<td>35- &gt;200 days.²,⁷,⁸</td>
</tr>
<tr>
<td><strong>Methicillin resistant <em>Staphylococcus aureus</em> (MRSA)</strong></td>
<td><strong>14- &gt;300 days.¹,⁵,¹⁰</strong></td>
</tr>
<tr>
<td>Vancomycin-resistant enterococcus (VRE)</td>
<td>58- &gt;200 days.²,³,⁴</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>&gt;150- 480 days.⁷,⁹</td>
</tr>
<tr>
<td><em>Acinetobacter</em></td>
<td>150- &gt;300 days.⁷,¹¹</td>
</tr>
<tr>
<td><em>Klebsiella</em></td>
<td>&gt;10- 900 days.⁶,⁷</td>
</tr>
<tr>
<td><em>Salmonella typhimurium</em></td>
<td>10 days- 4.2 years.⁷</td>
</tr>
<tr>
<td><em>Mycobacterium tuberculosis</em></td>
<td>120 days.⁷</td>
</tr>
<tr>
<td><em>Candida albicans</em></td>
<td>120 days.⁷</td>
</tr>
<tr>
<td>Most viruses from the respiratory tract (eg: corona, coxsackie, influenza, SARS, rhino virus)</td>
<td>Few days.⁷</td>
</tr>
<tr>
<td>Viruses from the gastrointestinal tract (eg: astrovirus, HAV, polio- or rota virus)</td>
<td>60- 90 days.⁷</td>
</tr>
<tr>
<td>Blood-borne viruses (eg: HBV or HIV)</td>
<td>&gt;7 days.⁵</td>
</tr>
</tbody>
</table>

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2. BIOQUELL trials, unpublished data.
Patients as Source of Room Contamination
Prior room occupancy increases risk

<table>
<thead>
<tr>
<th>Study</th>
<th>Healthcare associated pathogen</th>
<th>Likelihood of patient acquiring HAI based on prior room occupancy (comparing a previously ‘positive’ room with a previously ‘negative’ room)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martinez 2003¹</td>
<td>VRE – cultured within room</td>
<td>2.6x</td>
</tr>
<tr>
<td>Huang 2006²</td>
<td>VRE – prior room occupant</td>
<td>1.6x</td>
</tr>
<tr>
<td></td>
<td>MRSA – prior room occupant</td>
<td>1.3x</td>
</tr>
<tr>
<td>Drees 2008³</td>
<td>VRE – cultured within room</td>
<td>1.9x</td>
</tr>
<tr>
<td></td>
<td>VRE – prior room occupant</td>
<td>2.2x</td>
</tr>
<tr>
<td></td>
<td>VRE – prior room occupant in previous two weeks</td>
<td>2.0x</td>
</tr>
<tr>
<td>Shaughnessy 2008⁴</td>
<td>C. difficile – prior room occupant</td>
<td>2.4x</td>
</tr>
<tr>
<td>Nseir 2010⁵</td>
<td>A. baumannii – prior room occupant</td>
<td>3.8x</td>
</tr>
<tr>
<td></td>
<td>P. aeruginosa – prior room occupant</td>
<td>2.1x</td>
</tr>
</tbody>
</table>

Overview of Patient Care Equipment

- Urinary drainage systems – urine is a culture medium for microorganisms and provides a medium to transfer antibiotic resistance
- Urinals, bedpans, commodes – sources for multiple drug resistant organisms (VRE) and Clostridium difficile
- Respiratory therapy equipment, suction devices, spirometers – great source for water borne organisms, such as Pseudomonas, Serratia, Enterobacter, Klebsiella, Acinetobacter
Overview of Patient Care Equipment

- Intravenous therapy equipment – can become contaminated with gram negative bacilli and Candida (especially hyperalimentation)
- IV sites – staphylococcus and Candida most common pathogens
- Stethoscopes, blood pressure apparatus – MRSA, Staph aureus, Coagulase negative staph
- Beds, poles, stretchers, chairs, curtains – MRSA, VRE, Staphylococcus
Patient Care Equipment

- EKG machine and leads
- Telemetry units
- Dynamap
- Defibrillator
- Crutches and walkers
- Lifts and scales
- IV and other pumps
- Pulse oximeters
- Venoflow machine
- Storage Bins
- Ultrasound Gel
  - CDC Alert April 20, 2012 – Pseudomonas and Klebs contamination of ultrasound gel
Nondisposable Blood Pressure Cuffs as a Potential Source for Cross Contamination

Spencer M, RN, M.BBE, CIC, Susan Cohen, MT(ASCP)SM, Diana Gokcen, RN, MS, CNOR, Linda Cunningham, RN, BSN, CNOR, Kimberlee Kelly, RN - New England Baptist Hospital, Boston, MA, USA

Abstract

Background: Multiple studies have demonstrated the potential for cross-contamination from blood pressure cuffs. This study evaluated the effectiveness of disposable cuff covers in reducing cross-contamination.

Methods: Cuff covers were applied to the inflating bulb of a reusable blood pressure cuff and the cuff was used on a mannequin. Samples were collected before and after cuff use.

Results: Cuff covers significantly reduced cross-contamination, reducing colony counts of bacteria by 99.9%.

Conclusion: Cuff covers can significantly reduce cross-contamination from blood pressure cuffs and should be considered for use in healthcare settings.

Keywords: Blood pressure cuffs, cross-contamination, cuff covers, disinfection.
Hands as a Source of Microorganisms

The Role of Handwashing in Preventing Intensive Care Unit Infections, B. Simmons, et al, 1990, Infection Control Hospital Epidemiology

Bacterial Contamination of the Hands of Hospital Staff during Routine Patient Care. D. Pittet, 1999, Archives of Internal Medicine
Hands and Gloved Hands as Sources for Spread

- Imprint of a health care worker's gloved hand after examining a patient infected with Clostridium difficile.
- The larger yellow colonies outlining the fingers are clusters of Clostridium difficile.
- The patient had showered an hour before the specimen was collected.

Clinical Infectious Diseases, February 2008.
Most Important Control Measure

- Microorganisms multiply every 20 minutes
- They communicate with one another and transfer resistance factors
- Gloves can also be contaminated and transmit organisms
Hand Contamination of Anesthesia Providers Is an Important Risk Factor for Intraoperative Bacterial Transmission

Randy W. Loftus, MD,* Matthew K. Muffly, MD,* Jeremiah R. Brown, PhD, MS,* Michael L. Beach MD, PhD,* Matthew D. Koff, MD,* Howard L. Corwin, MD,* Stephen D. Surgenor, MD,* Kathryn B. Kirkland, MD,* and Mark P. Yeager, MD*

(Anesth Analg 2011;112:98–105)
<table>
<thead>
<tr>
<th>Organism</th>
<th>Providers $N$/total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>12/164 (7%)</td>
</tr>
<tr>
<td>MSSA</td>
<td>18/164 (11%)</td>
</tr>
<tr>
<td>VRE</td>
<td>4/164 (2%)</td>
</tr>
<tr>
<td>Enterococcus (non-VRE)</td>
<td>1/164 (0.6%)</td>
</tr>
<tr>
<td>Staph other</td>
<td>164/164 (100%)</td>
</tr>
<tr>
<td>Micrococcus</td>
<td>110/64 (67%)</td>
</tr>
<tr>
<td>Corynobilacterium</td>
<td>14/164 (9%)</td>
</tr>
<tr>
<td>Streptococcus</td>
<td>128/164 (78%)</td>
</tr>
<tr>
<td>Gram negative$^b$</td>
<td>81/164 (49%)</td>
</tr>
</tbody>
</table>

MRSA = methicillin-resistant Staphylococcus aureus; MSSA = methicillin-sensitive Staphylococcus aureus; VRE = vancomycin-resistant Enterococcus.

$^a$ Samples taken upon entry to the patient environment but before patient contact and after an opportunity to perform hand hygiene.

$^b$ E. coli, Klebsiella, Serratia, Pseudomonas, and Acinetobacter.
Table 3. Evidence for Intraoperative Transmission of Bacterial Pathogens from Anesthesia Provider Hands to the Anesthesia Environment and Patient IV Catheters

<table>
<thead>
<tr>
<th>Direction of transmission →</th>
<th>Provider hands (site B)</th>
<th>End case 1</th>
<th>Machine APL/D</th>
<th>Provider hands (site E)</th>
<th>End case 2</th>
<th>Machine APL/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro</td>
<td>Attending</td>
<td>X</td>
<td></td>
<td>Attending</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>S. epi</td>
<td>Attending</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>S. hae</td>
<td>Attending</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>S. epi</td>
<td>Attending</td>
<td>X</td>
<td></td>
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<td>X</td>
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<td>X</td>
<td></td>
<td>X</td>
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<td>Micro</td>
<td>Attending</td>
<td>X</td>
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<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Micro</td>
<td>Attending</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>MRSA</td>
<td>Resident</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>MSSA</td>
<td>Resident</td>
<td>X</td>
<td></td>
<td>Attending</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>S. auric</td>
<td>CRNA</td>
<td>X</td>
<td></td>
<td>CRNA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Micro</td>
<td>CRNA</td>
<td>X</td>
<td></td>
<td>CRNA</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>S. epi</td>
<td>CRNA</td>
<td>X</td>
<td></td>
<td>CRNA</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Sites were cultured as described, and pathogens were found at the times and locations noted.

APL = anesthesia machine adjustable pressure limiting valve; D = anesthesia machine inhaled agent concentration dial; X = transmission event confirmed by biotype analysis; S. epi = Staphylococcal epidemicis; S. hae = Staphylococcal haemolyticus; Strep = streptococcus; Pseud = pseudomonas; MRSA = methicillin-resistant Staphylococcal aureus; MSSA = methicillin-sensitive Staphylococcal aureus; S. auric = Staphylococcal auricularis; CRNA = certified registered nurse anesthetist.

* Provider was negative at the start of case 1; hands contaminated by bacterial organisms brought in by other providers.

(Anesth Analg 2011;112:98–105)
Artificial Nails and Outbreaks

- Artificial nails worn by healthcare providers have caused several outbreaks: Klebsiella, Candida, Pseudomonas and other gram negative bacilli.

A Prolonged Outbreak of Pseudomonas aeruginosa in NICU: Did Staff Fingernails Play a Role in Disease Transmission?" Ronald L. Moolennar, MD, et al. Infection Control and Hospital Epidemiology, 2000;21:80-85


Postop Serratia marcescens” Passaro, D, et al. Journal of Infectious Diseases (1997); 175.
Environmental Surfaces

- Source for numerous types of microorganisms hospitals should be clean – free of dirt, dust, lint
- Floor
- Bathrooms
- Bed, side rails, bedside table, chairs
- Shelving and Bins
- Privacy Curtains
- Trash Barrels
- Intake and exhaust grills
- Carts, wheels, stands

Blood contamination – and HBV

- Estimated to be four million infectious doses of HBV in a drop of blood.

- Can survive on environmental surfaces for long periods of time, even in dried blood.
EVS Sources

- Mops, buckets, sponges, cloths – anything with stagnant water can proliferate large numbers of microorganisms
- Organisms multiply every 20 minutes
- Periodic changing of the water and exchange of cleaning cloths is of utmost importance to prevent spreading infectious agents
- No brooms or sponges allowed in healthcare setting

CDC Guideline on Environmental Control 2004
Carpets in Healthcare Settings

- Carpets
  - Increased microorganisms than floor coverings
  - Sources for Aspergillus, molds and fungus
  - Difficult to clean if wet or moist

Mattresses and Positioners

- Cracked mattresses
  - outbreak in a burn unit with Pseudomonas and Acinetobacter
    - Terminal cleaning fails to eliminate bacteria from the surface of the hospital mattress”. A randomized trial to evaluate a launderable bed protection system for hospital beds. Antimicrobial Resistance and Infection Control 2012, 1:27

- Cracked gel pads can attract organisms in OR
Operating Room Equipment

- Buttons and equipment to touch and clean
- Wheels on carts moving dust
- Equipment interfering with air flow to exhaust vents
- Lack of traffic control and visitors in OR
- Tape residue on equipment can attract organisms – must be removed
Carts, tables, stands can be caked with dirt, dust, blood – often looks like rust

Cultures from wheels grew numerous organisms

Source for infection? Unlikely – however, serve as a source for organisms entering patient care areas and operating rooms

The E=MC2 Project: Environment = Maintaining Cleanliness, A Multidisciplinary Approach To Establish a Routine Cleaning Schedule for Medical Equipment

M Spencer, RN, M.Ed., CIC, P Anderson, T Johnson, T Cappuccio, A Creamer, MBA, CHE
New England Baptist Hospital, Boston, MA

Poster Presentation at the Association for Professionals in Infection Control and Epidemiology – 2005 Annual Education Conference and International Meeting – Baltimore, Maryland, June 20, 2005

**Issue:** During environmental rounds, the infection control coordinator noticed many pieces of medical equipment within the hospital, including wheelchairs, stretchers, conveyors, medical carts, and other equipment. The issue was presented to the environmental care committee, and a multidisciplinary team was assigned to address the problem. The team needed administrative and financial support to complete the project.

**Project:** The E=MC2 Project (Environment = Maintaining Cleanliness) was instituted as a multidisciplinary team approach involving nursing, clinical engineering, environmental services, radiology, operating room, lab services, laboratory, transport, endoscopy, exam lab, ambulatory care, and central sterile service. First, all departments within the hospital were requested to submit a list of the equipment and the method of cleaning each item. Over time, it was observed that some equipment that required cleaning was not cleaned, and a standard cleaning protocol was developed.

**DEPARTMENT RESPONSIBILITIES IN THE E=MC2 PROJECT**

<table>
<thead>
<tr>
<th>Department</th>
<th>Equipment Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection Control</td>
<td>Equipment Cleaning</td>
</tr>
<tr>
<td>Clinical Engineer</td>
<td>Score room clean-up</td>
</tr>
<tr>
<td>General Store</td>
<td>Radiology equipment</td>
</tr>
<tr>
<td>Nursing</td>
<td>Recycle/move project</td>
</tr>
<tr>
<td>EHS – “Trash or Treasure” Project</td>
<td>OR equipment cleaning</td>
</tr>
<tr>
<td>Operating Room</td>
<td>CSS cleaning of carts/tables</td>
</tr>
<tr>
<td>Central Supply</td>
<td>Construction clean up</td>
</tr>
<tr>
<td>Hospital Face UHC</td>
<td>Air Handling System</td>
</tr>
</tbody>
</table>

**Environmental Services**

**Food & Nutrition**

**EQUIPMENT TO BE CLEANED:**

<table>
<thead>
<tr>
<th>Food Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport Carts/Small rolling Tables</td>
</tr>
<tr>
<td>Infusion Baskets</td>
</tr>
<tr>
<td>Trash Cans</td>
</tr>
<tr>
<td>Walk in Refrigerator</td>
</tr>
<tr>
<td>Microscope</td>
</tr>
<tr>
<td>Misc. Carts</td>
</tr>
</tbody>
</table>

**Clinical Engineering**

| Wheelchairs                           |
| JVs/Ports                             |
| ESSUs                                  |
| Medical Equipment                      |

**RESULTS:**

During a 2-week period, over 1,000 pieces of medical equipment were brought to the loading dock for high-pressure cleaning or ultrasonic cleaning. Staff members were instructed to ensure that all equipment was cleaned and that any damaged or lost equipment was documented.

**Conclusion:** A process to clean medical equipment on a routine basis is an important part of the environment of care program. Infection control is an important member of the EOC team and should ensure that all medical equipment is cleaned. This multidisciplinary approach made the process more organized and involved staff participation. The most important factor was the support of administrative staff. The project resulted in staff appreciation for the cleaning team and increased awareness of the importance of cleaning.

**New England Baptist Hospital Cleaning Schedule for Patient Units**

<table>
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<tr>
<th>Equipment Type</th>
<th>Responsibility</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Beds</td>
<td>Cleaning</td>
<td>7:00 AM</td>
</tr>
<tr>
<td>Cribs</td>
<td>Sterile</td>
<td>7:00 AM</td>
</tr>
<tr>
<td>Patient Privacy</td>
<td>Disinfection</td>
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**NEW ENGLAND BAPTIST HOSPITAL CLEANING SCHEDULE FOR PATIENT UNITS**

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Computer screen and keyboards

Reprocessing and Sterilization of Orthopedic Instruments

- Cleaning tissue and blood from the instruments in the OR
- Sorting used instruments for decontamination processing
- Cleaning procedures for the inside lumens of instruments
- Sterilization process
- CMS and TJC focusing on SPD and instrument reprocessing due to outbreaks

CDC Investigation Uncovers Dirty Surgical Instruments at Houston Hospital Human tissue and bone found stuck in shavers and cannulas. Outpatient Surgery. April 4, 2012
Laryngoscopy blades and handles

Laryngoscopes handles - contaminated with blood, fluid

Blade - high level disinfected

Handles – low level disinfection or manufacturers IFUs which may require HLD

Three papers on contamination of handles
Contamination of Laryngoscope Handles

- Total of 192 specimens from 64 laryngoscope handles deemed 'ready for patient use' in the anaesthetic rooms of 32 operating theatres were semi-quantitatively assessed for bacterial contamination.
- One or more species of bacteria were isolated from 55 (86%) of the handles, and included organisms such as enterococci, methicillin-susceptible Staphylococcus aureus, Klebsiella and acinetobacter.

Nosocomial contamination of laryngoscope handles: challenging current guidelines

**Method:**
- 60 laryngoscope handles from the adult operating rooms were sampled.
- Collection was performed between cases, in operating rooms after the room and equipment had been thoroughly cleaned for the subsequent case.
- 40 handles were sent for aerobic bacterial culture, and antimicrobial susceptibility testing.
- 20 handles were examined for viral contamination using a polymerase chain reaction assay that detects 17 respiratory viruses.

**Results:**
- 30 of the 40 samples (75%) were positive for bacterial contamination.
- 25 (62.5%) yielded coagulase-negative staphylococci.
- 7 (17.5%) Bacillus spp.
- 3 (7.5%) alpha-hemolytic Streptococcus spp.
- 1 (2.5%) of Enterococcus spp., 1 (2.5%) Staphylococcus aureus (S. aureus), 1 (2.5%) Corynebacterium spp.
- No vancomycin-resistant enterococci, methicillin-resistant S. aureus, or Gram-negative rods were detected. All viral tests were negative.

Instrument Reprocessing

- Check biological indicator logs and assure they are being done correctly
- Check location of manufacturers recommendations for cleaning and sterilization – make sure they are following them
- Check how they handle instrument rep trays
- Check for double peel pack wrapping and IFUs from manufacturers of the peel packs
- Check for immediate use steam sterilization (IUSS) practices ("flashing")
Microorganisms which have contaminated antiseptics and disinfectants

- Benzalkonium chloride – Enterobacter, Pseudomonas and Serratia
- Chlorhexidine – Flavobacterium, Pseudomonas, and Serratia
- Hexachlorophene – Pseudomonas, E.Coli
- Povidine-iodine – Pseudomonas cepacia
- Phenolic – Alcaligens and Pseudomonas
- Quaternary Ammonium – Pseudomonas and Serratia

Antimicrob. Agents Chemother Outbreaks Associated with Contaminated Antiseptics and Disinfectants. December 2007 vol. 51 no. 12 4217-4224
Medication Vials and Equipment

- Package integrity and checking expiration dates to assure sterility
- Multi-dose vials have caused numerous outbreaks
  - heparinized solution with Serratia
  - sterile saline used for spinal anesthesia was contaminated with Pseudomonas and caused meningitis
  - an outbreak of Hepatitis B from a multi-dose vial.
- Jet injector for IM injections caused an outbreak of Hepatitis B
- Contaminated Ophthalmic solution led to keratitis.
- Insulin pens caused outbreaks of Hepatitis C – being used between patients

http://www.contaminateddrugs.com/news.htm
Multi-dose Bottles of Albuterol

- Apr. 19, 2002
  - hospital outbreaks of lower respiratory tract colonization and infection with Burkholderia cepacia attributed to contaminated multi-dose bottles of albuterol sulfate.
  - In most cases, colonization or infection occurred in the ICU setting, often in patients receiving mechanical ventilation.
Diagnostic Equipment

- Endoscopes, gastroscopes, colonoscopes, hysteroscopes, sigmoidoscopes, bronchoscopes*, esophagogastroduodenoscopy, etc.

- Contaminated brushes, endoscope tips, biopsy ports and forceps, biopsy and suction channels, automated reprocessing machines have all been implicated in numerous outbreaks.

- Most common pathogens have been Pseudomonas, Salmonella, Hepatitis B, Strongyloides, Mycobacterium species, including TB from bronchoscopes.

ENDOSCOPE CHANNELS

- WATER CHANNEL
- SUCTION CHANNEL
- BIOPSY/SUCTION CHANNEL
- AIR/CO₂ CHANNEL
- AIR/WATER/CO₂ CHANNEL
- CO₂ CHANNEL
- AIR CHANNEL
Multi-Society Guideline for Reprocessing Flexible Gastrointestinal Endoscopes, 2011

- Since 2003, changes in High-level disinfectants
- Automated endoscope reprocessors (AER)
- Endoscopes
- Endoscopic accessories
- Efficacy of decontamination and high-level disinfection is unchanged and the principles guiding both remain valid
- Additional outbreaks of infection related to suboptimal infection prevention practices during endoscopy or lapses in endoscope reprocessing (unfamiliarity with endoscope channels, accessories, attachments; gaps in infection prevention at ambulatory surgery centers)

Auxiliary Water Bottle and Tubing

- Must be changed between each patient use.
Old Process

New Process
Diagnostic Equipment

- **CT Scans** – contrast medium – a diagnostic tracer was contaminated with Achromobacter

- **Contaminated Intrauterine pressure transducers** – Pseudomonas

- **Xray cassettes** caused a cross-contamination outbreak of MRSA in an Intensive Care Unit
Food and Enteral Nutrition Solutions

- Food preparation areas can be reservoirs of pathogens, such as cutting boards, meat slicers, handling of raw foods (eggs, vegetables, salads) milk, cream products
- Food temperatures and utensil cleaning is extremely important to reduce microbial growth
- Contaminated blenders, mixers, homogenizers, dish cloths, work surfaces, metal sieves, juice, milk, coffee, ice cream/yogurt dispensers and a detergent dispenser have been shown to be reservoirs for pathogens.
Kitchen Issues – Common Findings are Uncovered
Food, Food Not Dated, Dusty Fans in Refrigerators, Lack of Sanitizer Strips
Outbreak Investigation in a large teaching institution

- Leuconostoc bacteremia in a Burn Unit
  - 12 cases of bacteremia
  - Cultures of powdered egg white with protein grew the organism
    - Blenders were contaminated
    - Enteral feed equipment left standing more than 4 hours supported the growth of the organism

- Spencer, M et al  APIC Oral Presentation 1989
Air Handling Systems and Fans

- Air handling system and 95% efficiency filters
- Humidity & temperature of air
- Source and mix of outdoor air
- Air intakes – keep away from cooling towers, waste storage areas, incinerators, exhaust vents for gases
- Negative vs positive pressure, air exchanges – documentation needed
- Fans – if allowed have cleaning policy or give out personal fans
Outbreak of *Serratia marcescens* infection in a special-care baby unit (SCBU)

- Outbreak involved 36 infants and lasted for 20 weeks.
- Seven of the colonized infants developed invasive illnesses in the form of bacteremia (four cases), bacteremic meningitis (two) and clinical sepsis (one).
- Three other term infants had purulent conjunctivitis.
- There were five deaths with an overall mortality of 14%.
Outbreak of Serratia marcescens infection in a special-care baby unit (SCBU)

- S. marcescens was cultured from airflow samples from the air conditioning (AC) which was the reservoir of infection in this outbreak.
- Elimination of the source and outbreak containment were eventually achieved by specialized robotic cleaning of the entire AC duct system of the SCBU.
- Strict adherence to the infection control policies was reinforced to prevent transmission of cross-infection.

"Outbreak of multidrug-resistant Serratia marcescens infection in a neonatal intensive care unit Infect Control Hosp Epidemiol. 2008 May;29(5):418-23"
Water and Sewerage

- Potable water can be contaminated to Pseudomona, Legionella, and Acinetobacter
- Contaminated potable water was used to dilute alcohol skin antiseptic and caused an outbreak of bacteremia Burkholderia cepacia
- Shower heads, drinking fountains, eyewash stations have grown Legionella and Pseudomonas
- Dialysis water and dialysate can become contaminated
- Waterfalls and Legionella
- Water baths to thaw or warm sterile bottles and defrost frozen breast milk caused outbreaks of Pseudomonas and Acinetobacter
Water and Sewerage

- Faucet aerators have cultured Legionella and Pseudomonas – reason they are not used in hospitals although recently find them installed by facilities
- Contaminated distilled water containers have led to outbreaks of Pseudomonas and Enterobacter
Water and Sewerage

- Contaminated ice in open heart surgery for cardioplegia - outbreaks of Pseudomonas and Staphylococcus
- Heater Coolers and nontuberculous TB infection
- Intra-aortic balloon pump contaminated water reservoir with Pseudomonas cepacia


Distilled water sitting on windowsill in hot sun incubating in NICU – used for a cooling machine.
POLICY NO: Water Management Plan Policy

Effective Date: TBD

Revision Date: TBD

WATERBORNE PATHOGEN PREVENTION

I. PURPOSE

To ensure the safety of Universal Health Services, Inc. patients, visitors and employees by defining the process by which Universal Health Services, Inc. will manage the environmental aspects of its water streams (e.g., domestic/potable water systems, cooling tower systems, outdoor decorative water features).

II. SCOPE

This policy applies to Universal Health Services, Inc. and any entity or facility owned or controlled by Universal Health Services, Inc.

III. DEFINITIONS

A. Water Management Program (WMP) is a comprehensive process to manage the environmental aspects of a facility’s water streams.

B. A Hazard Analysis Critical Control Point (HACCP) is a scientifically based system that is used to systematically analyze hazards in order to determine opportunities for improved control.
Sorin Heater-Cooler

- Heater-cooler machines used during open-heart surgery to regulate temperature
- Potential for water used in the machine to become contaminated
- Bacteria can become airborne through a vent on the device and then transmit to patients, surgical incisions (and possible staff)
US Cases

- Nov 2015 - Well Span York Hospital, PA report eight infected patients due to heater-cooler and 4 died
- Hospital notified 1,300 patients of possible bacterial exposure between January 2010 and August 2015
- FDA received 32 Medical Device Reports of patient infections or device contamination
- Patients presented with infections several months to years after their surgical procedures
- Half of the 32 reports submitted to the FDA describe bacterial contamination of the heater-cooler device without known patient involvement or infection
- FDA is not aware of infections acquired by hospital staff (such as Legionella that has been cultured
Cut Flowers

- Cut Flowers – dirty water can be steaming with Pseudomonas, Serratia and E.Coli
- Dispose the water in dirty utility room – not in patient’s room and wear gloves and sanitize hands
- Instruct staff to take flowers home
- Planters are okay
Construction Sites – Infection Control Risk Assessment (ICRA)

- Ceiling tiles and fireproof materials have caused aspergillus and rhizopus outbreaks
- Pigeon droppings from outside the building can transmit aspergillus
- To prevent infection, construction team must design safe traffic patterns for people and supplies
- Accomodations for immuno-compromised hosts in construction areas
- Dust, dirt, lint, stagnant water are the major problems for environmental control

Floors require removal of tiles if stained, show signs of mildew and mold
Sentinel Event – Case Review

- Pediatric patient in hospital with leukemia
- Mother is an artist – volunteers to paint the ceiling tiles in his room with cartoon characters to cheer the kids while in bed
- Child developed severe case of invasive mucocutaneous Aspergillosis of nose and face
- Source – ceiling tiles painted and brought into his room by his mother
Unique Environmental Sources

- Hepatitis B linked to use of contaminated capillary-blood-sampling devices
- Contaminated silicone oil used for oil bath to promote wound healing caused an MRSA outbreak
- Acinetobacter outbreak from contaminated cell phones
- Contaminated elasticized bandage with Rhizopus caused deep tissue invasion
Staff Personal Items Can Become Contaminated and Lead to Cross Contamination

Dirty stethoscope cover – also advise Pediatricians not to place stuffed toys on stethoscopes

Do not belong in the OR
Understanding the Role of Contaminated Air in Healthcare Acquired Infections
Airborne dispersion may play a role in air and surface contamination with MDROs, such as MRSA and *Clostridium difficile*, with subsequent contact and cross contamination¹

Study shows abundance of human bacteria in indoor air, floor dust, and ventilation systems.²

¹University of Leeds, Superbugs ride air currents around hospital wards, M. King, et al, ²Human Occupancy as a Source of Indoor Airborne Bacteria, April 18, 2012,
Aerobiology and Its Role in the Transmission of Infectious Diseases

Journal of Pathogens
Volume 2013 (2013), Article ID 493960, 13 pages
Aaron Fernstrom\textsuperscript{1} and Michael Goldblatt\textsuperscript{2}
Practitioners of all kinds agree that the airborne transmission of infectious disease is a problem. Just how big or urgent a problem, however, continues to be debated. For example, there is currently a wide range in the reported frequencies of airborne transmission in hospital-acquired infections (10–33%).

A better understanding of the true contribution of airborne transmission to infection rates would allow hospital administrators to determine the degree to which they should commit resources to minimize this vector of disease transmission.
Environmental Reservoirs

- MRSA infected/colonized pts. contaminate rooms, contribute to endemic MRSA
- Prospective study of 25 MRSA pts.
- Sampling of isolation rooms
  - 53.6% of surface samples positive
  - 28% of air samples
  - 40.6% of settle plates
- Isolates identical or closely related in 70% of patients

[Sexton et al, J Hosp Infect 2006]
Airborne Transmission

- MRSA counts remain elevated for up to 15 minutes after bed making
- Consider air ventilation & filtration
- Keep doors closed

[Shiomori et al, J Hosp Infect 2002]
Aerial Dissemination of *Clostridium difficile* spores

*BMC Infectious Diseases*
Katherine Roberts, Caroline F. Smith, Anna M Snelling, Kevin G. Kerr, Kathleen R. Banfield, Andrew sleigh and Clive B. Beggs

*BMC Infectious Diseases* 2008, 8:7 doi:10.1186/1471-2334-8-7
Aerial Dissemination of *Clostridium difficile* spores

**Results:** On both days in February 2006, *C. difficile* was cultured from the air with 23 samples yielding the bacterium (mean counts 53 – 426 cfu/m$^3$ of air). One representative isolate from each of these was characterized further. Of the 23 isolates, 22 were ribotype 001 and were indistinguishable on REP-PCR typing. *C. difficile* was not cultured from the air or surfaces of either hospital bay during the two days in March 2007.

**Conclusion:** This pilot study produced clear evidence of sporadic aerial dissemination of spores of a clone of *C. difficile*, a finding which may help to explain why CDAD is so persistent within hospitals and difficult to eradicate. Although preliminary, the findings reinforce concerns that current *C. difficile* control measures may be inadequate and suggest that improved ward ventilation may help to reduce the spread of CDAD in healthcare facilities.
An Outbreak of Surgical Wound Infections Due to *Group A Streptococcus* Carried on the Scalp

The New England Journal of Medicine
An Outbreak of Surgical Wound Infections Due to Group A Streptococcus Carried on the Scalp

Bacterial settling plates proved to be the most sensitive means of detecting the strain responsible for the outbreak, and their use led to the identification of the carrier. Although other investigators have used settling plates to demonstrate that group A streptococcus was present in the air and to confirm dissemination from a known carrier, we used settling plates to identify the carrier by demonstrating her association with dissemination of the outbreak strain. This outbreak further supports the hypothesis that airborne dissemination of group A streptococcus is responsible for infecting surgical wounds in operating rooms. The carrier was present in operating rooms only briefly, if at all, during operations and was unlikely to have come close to open incisions. However, she could have aerosolized the outbreak strain in the operating rooms before the operations when she performed her principal duties.
Evidence in Support of Covering the Hair of OR Personnel

John M. Boyce, M.D.
AORN Journal - January 2014 Vol 99 No 1
Evidence in Support of Covering the Hair of OR Personnel

THE EVIDENCE

Several types of evidence support recommendations that perioperative personnel cover their head and ears in the OR. This evidence includes the following: human skin is naturally colonized with many bacteria, personnel shed microorganisms into the air around them, airborne bacteria in the OR can fall into the operative field and be the cause of surgical site infections, and wearing appropriate headgear can reduce the number of bacteria introduced into OR air by personnel.
In one study, dispersal of S aureus in the air increased sharply when staphylococcal dispersers were present in the OR, and the presence of nine dispersers were considered to be the cause of 19 postoperative wound infections.
Molecular Epidemiology of Microbial Contamination in the Operating Room Environment: Is There a Risk for Infection?

Charles E. Edmiston, Jr, Ph.D., Gary R. Seabrook, M.D., Robert A. Cambria, M.D., Kellie R. Brown, M.D., Brian D. Lewis, M.D., Jay R. Sommers, Ph.D., Candace J. Krepel, M.S., Patti J. Wilson, BSN, Sharon Sinski, B.S.N., and Jonathan B. Towne, M.D., Milwaukee, WI and Roswell, GA.

Surgery 2005;138:573-82
Molecular Epidemiology of Microbial Contamination in the Operating Room Environment: Is There a Risk for Infection?

Results. Coagulase-negative staphylococci were recovered from 86% of air samples, 51% from within 0.5 m of the surgical wound, whereas Staphylococcus aureus was recovered from 64% of air samples, 39% within 0.5 m from the wound. Anterior nares swabs were obtained from 11 members of the vascular team, clonality was observed between 8 strains of S epidermidis, and 2 strains of S aureus were recovered from selected team members and air-samples collected throughout the operating room environment. Miscellaneous Gram-negative isolates were recovered less frequently (<33%); however, 7 isolates expressed multiple patterns of antimicrobial resistance. The traditional surgical mask demonstrated limited effectiveness at curtailing microbial shedding, especially during symptomatic periods of rhinorrhea.

Conclusions. Gram-positive staphylococcal isolates were frequently isolated from air samples obtained throughout the operating room, including areas adjacent to the operative field. Nasopharyngeal shedding from person participating in the operation was identified as the source of many of these airborne contaminants. Failure of the traditional surgical mask to prevent microbial shedding is likely associated with an increased risk of perioperative contamination of biomedical implants, especially in procedures lasting longer than 90 minutes. (Surgery 2005;138:573-82.)
Fig 4. Percent intraoperative recovery of airborne microbial populations during 70 reconstructive vascular procedures.
Fig 5. PFGE of clonally related strains of *S. epidermidis* and *S. aureus* recovered from members of the vascular surgical team and perioperative airborne sampling. Lanes 3a/3b and 4a/9a, *S. epidermidis* clonality; lanes 7a/7b and 1a/1b/1c/1d, *S. aureus* clonality.
Consider New Innovative Technology to Create Self Disinfecting Hospital Environments
Steriliz UV-C Room Decontaminator
www.rapiddisinfector.com

28 have been purchased in UHS hospitals
• Dashboard allows us to monitor usage
Vidashield UV Air “Scrubbing” device
Aerobiotix UV room disinfecter
http://aerobiotix.com

• Aerobiotix system uses a novel and proprietary air disinfection technology to disinfect large amounts of room air with virtually complete eradication of bacteria, viruses, and spores.

• The unit disinfects 450 cubic feet per minute of air, circulating and sterilizing the air of a typical 20 x 20 operating room every 8 minutes.

• Draws contaminated air from the base of unit and expels cleaned high volume, low velocity air from the top of the unit creating a continuous circulation without disruptive air currents.
Indigo Clean™ White Light

Best used in areas that are vacated at the end of the day: OR, CSS, Endo, Radiology, Cath Lab, Pharmacy Clean Room
Indigo Clean™

- Indigo-Clean™ inactivates a wide range of microorganisms that are known causes of HAIs, (MRSA, C. difficile and VRE)
- Light operates continuously and requires no operator, kills bacteria in the air and on all surfaces
- Indigo-Clean™ uses a narrow spectrum of visible indigo-colored light at an output of 405 nanometers (nm) on the light spectrum - absorbed by molecules within bacteria producing a chemical reaction that kills the bacteria from the inside
- Safe for use in the presence of patients and staff
Copper Hard Surfaces
http://eoscu.com/how-it-works/
Copper Surfaces in Nurses Station, Bedrails, Bedside Tables, IV Poles, Chairs
Copper surfaces – Cupron EOS
Hard Surfaces

<table>
<thead>
<tr>
<th>Organism</th>
<th>Exposure time</th>
<th>Percentage reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>2 hours</td>
<td>&gt;99.999</td>
</tr>
<tr>
<td><em>Enterobacter aerogenes</em></td>
<td>2 hours</td>
<td>&gt;99.99</td>
</tr>
<tr>
<td><em>Candida albicans</em></td>
<td>2 hours</td>
<td>&gt;99.999</td>
</tr>
<tr>
<td><em>MRSA</em></td>
<td>2 hours</td>
<td>&gt;99.9</td>
</tr>
<tr>
<td><em>VRE</em></td>
<td>2 hours</td>
<td>&gt;99.9</td>
</tr>
<tr>
<td><em>ESBL K. pneumoniae</em></td>
<td>2 hours</td>
<td>&gt;99.9</td>
</tr>
<tr>
<td><em>ESBL E.coli</em></td>
<td>2 hours</td>
<td>&gt;99.9</td>
</tr>
<tr>
<td><em>CR K.pneumoniae</em></td>
<td>2 hours</td>
<td>&gt;99.999</td>
</tr>
<tr>
<td><em>MDR Acinetobacter</em></td>
<td>2 hours</td>
<td>&gt;99.999</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>2 hours</td>
<td>&gt;99.9</td>
</tr>
</tbody>
</table>
SENTARA LEIGH HOSPITAL: THE STUDY
Q1 2014 to Q1 2015

129 beds
Side by side control tower
EOS \textsuperscript{Cu} Overbed tables, bed rails, nurses stations, room vanities, over 8,000 sf horizontal surfaces
Cupro Linens

ROUND 1: CDC NHSN
National Healthcare Safety Network
MRSA
VRE
CRE
Acinetobacter
ESBL
C. Diff
CAUTI
CLABSI

ROUND 2: ICD-9 CODES
Non-CDC-Defined Infections:
Bacterial
Skin
Eye
Mycoses (fungal)
Respiratory
Viral
27 in total

Multi Drug Resistant Organisms
Device Related HAI
SENTARA LEIGH HOSPITAL: THE STUDY

Preliminary Results

- Medical/Surgical patients – excluding ICU/PCU
- Multi-Drug Resistant Organisms (no C. Diff) reduction
- Clostridium difficile (C. diff) reduction

- Trial publication expected in Spring 2016.
Use Evidence Based Guidelines for Environmental Control
Use Evidence Based Guidelines for Environmental Control

- CDC Guideline for Isolation Precautions in Hospitals, 2007
- CDC Guideline for Environmental Infection Control in Health-Care Facilities, 2003
- CDC Guideline for Hand Hygiene in Health-Care Settings, 2002
- CDC Guidelines for Design and Construction Of Hospital and Health-Care Facilities, 2002
Use Evidence Based Guidelines for Prevention Practices

- APIC Guidelines for Topical Antimicrobials
- APIC Guidelines for Selection and Use of Disinfectants 1996
- OSHA Bloodborne Pathogens Standard, 1992
- APIC Guide to the Elimination of Clostridium difficile in Healthcare Settings
- APIC position paper: Safe injection, infusion, and medication vial practices in health care 2010
- APIC Guide to the Elimination of Orthopedic Surgical Site Infections 2010
- APIC Guide to the Elimination of Ventilator-Associated Pneumonia 2009
- APIC Guide to the Elimination of Infections in hemodialysis 2010
- CDC Guideline for Prevention of CAUTI, 2009 Guide to the Elimination of
- APIC Methicillin-Resistant Staphylococcus aureus (MRSA) Transmission in Hospital Settings, 2nd Edition 2010
Use Evidence Based Guidelines for Prevention Practices

- APIC Guidelines for Topical Antimicrobials
- CDC Recommendations for Preventing the Spread of Vancomycin Resistance 1995
- CDC Guideline for Prevention of Surgical Site Infection, 1999 (currently under revision)
- CDC Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings, 2005
- CDC Management of Multidrug-Resistant Organisms In Healthcare Settings, 2006
- CDC Guide of infection prevention recommendations for outpatient (ambulatory care) setting
- CDC Guidelines for Infection Control in Dental Health-Care Settings – 2003
Use Evidence Based Guidelines for Prevention Practices

- CDC Guideline for Infection Control in Healthcare Personnel 1998
- CDC Recommendations for Preventing Transmission of Infections Among Chronic Hemodialysis Patients
- CDC Guidelines for the Prevention of Healthcare Associated Infections
- CDC Website on Healthcare-associated infections: www.cdc.gov/hai
- CDC Website on Hand Hygiene in Healthcare facilities: www.cdc.gov/handhygiene
- CDC Website on Injection Safety: www.cdc.gov/injectionsafety
- CDC Website on Influenza: www.cdc.gov/flu
- CMS – Conditions of Participation – Infection Control and Infection Control Survey Tool
- All evidence-based recommendations for prevention of healthcare-associated infections from CDC/HICPAC can be found at the following site: http://www.cdc.gov/hicpaccpubs.html
Follow AORN Evidence Based Practices
www.aorn.org

- Preoperative Patient Skin Antisepsis
- Environmental Cleaning in the Perioperative Setting
- Surgical Tissue Banking
- Surgical Hand Antisepsis
- Cleaning and Care of Instruments and Powered Equipment
- Cleaning and Care of Surgical Instruments
- Cleaning and Processing of Flexible Endoscopes
- High Level Disinfection
- Cleaning and Processing Anesthesia Equipment
- Sterilization in the Perioperative Setting
- Hand Hygiene in the Perioperative Setting
- Prevention of Transmissible Infections in Perioperative Settings
- Surgical attire
- Sharps Safety
Establish a Multi-disciplinary Working Toward Zero HAI Team
Engage a Multidisciplinary Team

- OR nursing
- CSS
- Surgeons & Anesthesia

- Managers from infection control
- Healthcare quality
- Facilities and environmental services

Evaluate:
- Procedures and Practices
- Facility design and Environment of Care Issues
- Patient Risk Factors
- Infection Rates
- Innovative Infection Prevention Products and Practices


How To Keep Up With New Knowledge?

www.infectioncontroltoday.com
www.sciencedaily.com (health – daily update)
www.hpnonline.com (daily update)
www.apic.org
www.ajicjournal.org/
http://www.cdc.gov/Other/emailupdates/
www.cdc.gov/hai/
www.jointcommission.org
www.shea-online.org
Association of Perioperative Registered Nurses  
www.aorn.org  
Association for the Advancement of Medical Instrumentation  
www.aami.org  
American Institute of Architects  
www.aia.org  
Quality Net  
http://www.qualitynet.org  
Food and Drug Administration  
www.fda.gov/MedicalDevices  
PubMed  
Morbidity&Mortality Weekly Report (MMWR)  
http://www.cdc.gov/mmwr/  
IDSA  
http://www.idsociety.org/IDSA_Practice_Guidelines/
The End
Thank You!