Environmental Sources for Microorganisms

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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)
Infection Formula

Dose x Virulence of Organism

Susceptibility of Host

Examples

Small Dose of MRSA x Highly Virulent

_________________________ = Infection likely

Surgical Incision

Large Dose Staph Epidermidis x Low Virulence

_________________________ = Infection likely

Surgical Incision

Example: Air Handling System Outbreak
Surface Contamination (in hospitals) with MRSA, VRE, and C. Difficile

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

- **Patient Gowns:**
  - MRSA: 51%

- **Bedsheets:**
  - MRSA: 53%
  - VRE: 40%

- **Windowsill:**
  - C. Difficile: 33%

- **Overbed Table:**
  - MRSA: 40%
  - VRE: 20%

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

- **Blood Pressure Cuff:**
  - VRE: 14%

- **Commode:**
  - C. Difficile: 41%

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**Pathogens survival on surfaces**

- **Clostridium difficile**
  - Survival period: 35-200 days
- **Methicillin resistant Staphylococcus aureus (MRSA)**
  - Survival period: 14-300 days
- **Vancomycin-resistant enterococcus (VRE)**
  - Survival period: 58-200 days
- **Escherichia coli**
  - Survival period: >150-480 days
- **Acinetobacter**
  - Survival period: 150-300 days
- **Klebsiella**
  - Survival period: >10-900 days
- **Salmonella typhimurium**
  - Survival period: 10 days-4.2 years
- **Mycobacterium tuberculosis**
  - Survival period: 120 days
- **Candida albicans**
  - Survival period: 120 days
- **Most viruses from the respiratory tract (eg: corona, coxsackie, influenza, SARS, rhino virus)**
  - Survival period: Few days
- **Viruses from the gastrointestinal tract (eg: astrovirus, HAV, polio- or rota virus)**
  - Survival period: 60-90 days
- **Blood-borne viruses (eg: HBV or HIV)**
  - Survival period: >7 days

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**Patients as Source of Room Contamination**

Prior room occupancy increases risk

- **VRE**
  - Patients as Source of Room Contamination
  - Prior room occupancy increases risk of acquiring VRE
- **MRSA**
  - Similarly, prior room occupancy increases risk of acquiring MRSA
- **C. difficile**
  - Also, prior room occupancy increases risk of acquiring C. difficile

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


“Moist” 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

“Dry” and Skin Contaminated 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
- Dinamap
- 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 Klebsiella contamination of ultrasound gel
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

CDC Hand Hygiene Guideline - 2002

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. Lottas, MD,* Matthew K. Lidy, MD,* Jenniaths A. Brown, PhD, MD,‡ Michael A. Dracup, MD, PhD,* Matthew D. Holt, MD,* Howard L. Green, MD,* Stephen D. Sarginson, MD,* Kristyn E. Hedlund, MD,* and Mark P. Teague, MD*

Table 2. Baseline Provider Hand Contamination

<table>
<thead>
<tr>
<th>Organism</th>
<th>Providers %/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>Staphylococcus</td>
<td>16/164 (10%)</td>
</tr>
<tr>
<td>Coagulase-negative</td>
<td>11/164 (6.7%)</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>12/164 (7.3%)</td>
</tr>
<tr>
<td>Gram-negative</td>
<td>81/164 (49%)</td>
</tr>
</tbody>
</table>

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

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

Table 3. Incidence of Intraoperative Transmission of Bacterial Pathogens New Baseline Provider Hands to the Anesthesia Environment and Patient IV Catheter

<table>
<thead>
<tr>
<th>Site</th>
<th>Incidence of Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>Site 2</td>
</tr>
<tr>
<td>Premonostomy site</td>
<td>Premonostomy site</td>
</tr>
<tr>
<td>MRSA</td>
<td>1/164 (0.6%)</td>
</tr>
<tr>
<td>MSSA</td>
<td>32/164 (19.5%)</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>Staphylococcus</td>
<td>15/164 (9%)</td>
</tr>
<tr>
<td>Coagulase-negative</td>
<td>12/164 (7.3%)</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>81/164 (49%)</td>
</tr>
<tr>
<td>Gram-negative</td>
<td>81/164 (49%)</td>
</tr>
</tbody>
</table>

IV = intravenous; * = statistically significant.
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); 175:992-5

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

Identifying Opportunities to Enhance Environmental Cleaning in 23 Acute Care Hospitals. Phil Carling et al. InfecControl Hosp Epidemiol 2008;29:1-7

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
  - 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
Traffic control and visitors in OR
Keeping OR doors closed during surgery
Tape residue on equipment can attract organisms – must be removed

Carts, Tables, Wheels
www.equipsystems.com

Carts, tables, stands can be caked with dirt, dust, blood – often looks like rust
Source for organisms entering patient care areas and operating rooms, transmitting through air, on hands, on equipment to patient
Outsource deep scrub and cleaning – on a routine basis based on condition of equipment

M Spencer: The E=MC2 Project: Environment – Maintaining Cleanliness, A Multidisciplinary Approach to Establish a Routine Cleaning Schedule for Medical Equipment
Medequip, APIC Baltimore Conference 2005
Computer screen and keyboards


Reprocessing and Sterilization of Instruments

Cleaning tissue and blood from the instruments in the OR
Sorting used instruments for decontamination processing
Cleaning procedures for 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

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
“OneSource” is a software for instrument IFUs
Check how they handle instrument rep trays – must be cleaned in SPD
Check for double peel pack wrapping and IFUs from manufacturers of the peel packs
Check for immediate use steam sterilization (I USS) practices (“flashing”)
Laryngoscope blades and handles

Laryngoscope handles - contaminated with blood, fluid
Blade - high level disinfected
Handles – low level disinfection or manufacturers IFUs which may require HLD

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.


Contamination of laryngoscope handles: challenging current guidelines

**Abstract**

- 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.
  - 5 (12.5%) alpha-hemolytic Staphylococcus spp.
  - 1 (2.5%) of Enterococcus spp. ; 1 (2.5%) Staphylococcus 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.

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

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 / Serratia outbreak
  - Outbreak of Hepatitis B from a multi-dose vial
- Jet injector for IM injections outbreak of Hepatitis B
- Contaminated Ophthalmic solution led to keratitis.
- Insulin pens caused outbreaks of Hepatitis C – being used between patients

Multi-dose 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, cystoscope, bronchoscopes, ERCPs, 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.


https://disinfectionandsterilization.org/  

Multi-Society Guideline for Reprocessing Flexible Gastrointestinal Endoscopes

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)

Society of Gastroenterology Nurses and Associates, Inc. (SGNA)
Auxiliary Water Bottle and Tubing

Must be changed between each patient use

Diagnostic Equipment

CT Scans – contrast medium – a diagnostic tracer contaminated with Achromobacter


Contaminated Intrauterine pressure transducers– Pseudomonas


X-ray cassettes 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%

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.
Water Sources in Healthcare

- Potable water can be contaminated to Pseudomonas, 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 Sources

Faucet aerators have cultured Legionella and Pseudomonas – reason they are not used in hospitals although recently find them installed by facilities

Water in Medical Devices

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
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 Heater Cooler Infections

- 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)

Water Source: Cut Flowers

- Cut Flowers – stagnant water can grow Pseudomonas, Serratia, E.Coli, etc
- May pose a risk in ICU setting
- Dispose the water in soiled utility room – not in patient’s room
- Wear gloves and sanitize hands
- Instruct patient or 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.

Construction team must design safe traffic patterns for people and supplies.
Plans for immuno-compromised hosts in construction areas.
Dust, dirt, lint, stagnant water are the major problems for environmental control.

Aspergillus Infection from Contaminated Ceiling Tile Removal

- 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
- Personal items do not belong in the OR

Understanding the Role of Contaminated Air in Healthcare Acquired Infections
Aerobiology and Its Role in the Transmission of Infectious Diseases

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.
Air and 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

Air Current Transmission

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

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 39 – 126 colony-forming units). 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

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,14-14,14 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.15

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.

AORN Journal, January 2014

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?

**Result:** Coagulase-negative staphylococci were recovered from 80% of air samples, 71% from swabs 0.5 m of the surgical wound, whereas Staphylococcus aureus was recovered from 60% of air samples, 69% within 0.5 m from the wound. Anterior nares swabs were obtained from 12 members of the molecular team, colony was observed between 8 strains of S. epidermidis, and 2 strains of S. aureus were recovered from selected team members and swabs collected throughout the operating room environment. Hemolyticus Coagulase-negative isolates were recovered less frequently (13%), however, 7 isolates showed multiple patterns of antimicrobial resistance. The traditional surgical mask demonstrated limited effectiveness at containing microbial shedding, especially during sympathetic periods of sterility.

**Conclusion:** Coagulase-negative staphylococci were frequently isolated from air samples obtained throughout the operating room, including areas adjacent to the operative field. Staphylococcus aureus and S. epidermidis are major contaminants of the operating room environment, and their role in surgical site infections needs further investigation. Airborne contamination. Failure of the traditional surgical mask to prevent microbial shedding is likely associated with an increased risk of postoperative contamination of intramedullary implants, especially in procedures lasting longer than 90 minutes. (Surgery 2005;138:57-62.)

Air Contamination and Infection Studies


New Technology for Environmental Disinfection

- Copper surfaces
- 24/7 Air Purifying UV Ceiling Light Units
- Movable air treatment system with HEPA filter and UV
- Dry hydrogen peroxide
- Permanent fixture white light disinfection

Table 2: Example of system specification comparison checklist

<table>
<thead>
<tr>
<th>Attribute</th>
<th>System A</th>
<th>System B</th>
<th>System C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central core service and support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVC Lamp mounted in ceiling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UV-C dose</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Data capturing capability</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dose determination</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Monitor</td>
<td>No</td>
<td>No</td>
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</tr>
<tr>
<td>Treatment time</td>
<td>No</td>
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<td>No</td>
</tr>
<tr>
<td>Physical components of system</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>ECO, etc</td>
<td>X + 2 weeks</td>
<td>X + 2 weeks</td>
<td>X + 2 weeks</td>
</tr>
</tbody>
</table>

Consider Environmental Monitoring
- Glo-germ fluorescent powder
- www.glogerm.com
- ATP
- Dazo Environmental Monitor
- Glo-pens (Amazon)

Options for Evaluating Environmental Cleaning

See website for additional resources and case studies.

http://www.ecolab.com/encompassenvironmentalmonitoringprogram/
Use Evidence Based Guidelines for Environmental Control

Follow 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

Follow Evidence Based Guidelines for Prevention Practices

CDC - 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
CDC Guideline for Isolation Precautions 2007
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 MRSA Transmission in Hospital Settings, 2nd Edition 2010
Follow Evidence Based Guidelines for Prevention Practices

CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011
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

Follow 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

Follow AORN Evidence Based Practices

Join - www.aorn.org

- Preoperative Patient Site Antisepsis
- Environmental Cleaning in the Perioperative Setting
- 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 Teams

- 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.hponline.com (daily update)
www.apic.org
www.ajicjournal.org/
www.cdc.gov/hai/
www.jointcommission.org
www.shea-online.org
https://www.beckershospitalreview.com/