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

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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
Transmission of microorganisms

- Direct Contact with blood & body fluids (urine, feces, saliva, pus)
- Indirect contact with contaminated inanimate objects (needles, equipment, furniture)
- Via the airborne route (TB, Influenza, Chickenpox)
- By vectors (Mosquitoes – Equine Encephalitis, Malaria)
Surface Contamination (in hospitals) with MSRA, 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.


<table>
<thead>
<tr>
<th>Organism</th>
<th>Survival period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clostridium difficile</td>
<td>35- &gt;200 days.²,⁷,⁸</td>
</tr>
<tr>
<td>Methicillin resistant Staphylococcus aureus (MRSA)</td>
<td>14- &gt;300 days.¹,⁵,¹⁰</td>
</tr>
<tr>
<td>Vancomycin-resistant enterococcus (VRE)</td>
<td>58- &gt;200 days.²,³,⁴</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>&gt;150- 480 days.⁷,⁹</td>
</tr>
<tr>
<td>Acinetobacter</td>
<td>150- &gt;300 days.⁷,¹¹</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>&gt;10- 900 days.⁶,⁷</td>
</tr>
<tr>
<td>Salmonella typhimurium</td>
<td>10 days- 4.2 years.⁷</td>
</tr>
<tr>
<td>Mycobacterium tuberculosis</td>
<td>120 days.⁷</td>
</tr>
<tr>
<td>Candida albicans</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>

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 BIOQUELL trials, unpublished data.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</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 – great source for water loving 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
- IV sites – staphylococcus and candida most common pathogens
- Rectal Electronic thermometers – C. Difficile, VRE, gram negative bacilli, such as E.Coli
- Stethoscopes, blood pressure apparatus - MRSA
- Beds, poles, stretchers, chairs, curtains – MRSA, VRE, staphylococcus
Overview of 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*
Hemodynamic monitoring equipment

- Hemodynamic monitoring equipment has been associated with over 24 outbreaks of HA bacteremia
- The use of disposable monitoring equipment and improved disinfection procedures have reduced this risk
- IV Stopcocks can become contaminated

Hand Contamination of Anesthesia Providers Is an Important Risk Factor for Intraoperative Bacterial Transmission
Anesth Analg 2011;112:98–105

Outbreak Investigation – at a large teaching institution 1989

- 36 cases of Pseudomonas Fluorescens
  - All in cardiac surgical patients
  - All were bacteremias – several patients died
  - Cultures from ICU arterial port stopcocks were positive with the organisms
  - Cultures from OR stopcocks were positive
  - Source – manometer used to calibrate the transducer in the OR
    - Why? To save money – anesthesia stopped using a 4 foot piece of sterile tubing between the stopcock and the unsterile manometer – direct contact with the manometer pushed fluid into the coil of the manometer and the organisms grew in the dark wet environment

Spencer, M et al. APIC Oral Presentation 1989
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 Epidemiol2008;29:1-7
MRSA contamination in precaution rooms

- 70% of rooms had environmental contamination when the patient was colonized or infected
- 42% of nurses’ gloves cultured were contaminated after touching environmental surfaces WITHOUT touching the patient!

Boyce, J et al. Infec Cont Hosp Epid 1977
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.
Environmental 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
Carpets in Hospitals

- Carpets
  - Can have increased microorganisms than floor coverings
  - Can be sources for Aspergillus, molds and fungus
  - Difficult to clean if wet or moist

Mattresses

- 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
- Many surfaces can become contaminated
- Wheels on carts moving dust
- Equipment interfering with air flow to exhaust vents
- Too many staff and visitors entering ORs
- Tape on equipment can attract organisms – must remove it
Carts, Tables, Wheels

- Many of the carts and stands in the hospital are caked with dirt, dust, blood, rust, etc.
- Cultures from wheels grew numerous organisms.
- Source for infection? Unlikely – however, serve as a source for organisms entering patient care areas and operating rooms and tracking organisms throughout.

Computer screen and keyboards

Computer Screens And Keyboards

Many pathogens including those that cause diarrhea, skin infections, colds and other respiratory infections can survive on surfaces for varying lengths of time. Researchers noted that keyboards would be just as likely to spread germs as other surfaces.

- Conjunctivitis is an inflammation of the eyelids that is relatively harmless. It is caused by a virus or bacterium and can be easily spread through person-to-person contact such as eye secretions, sneezing and coughing.
- During one outbreak on a college campus, about 10 percent of the student body, or nearly 500 students, contracted conjunctivitis. Computer keyboards were considered a source for the outbreak.

Computer Keyboards and Contaminated Faucets

- Computer keyboards and faucet handles in medical intensive care units are potential reservoirs of pathogens.

- 144 environmental samples from 10 computer keyboards in 8 patient rooms, 1 nurses' station and 1 doctors' station, as well as from 8 pairs of faucet handles in the hospital's medical ICU.

- Samples were collected over eight collection periods in a 2-month period.
Keyboards and Faucets

• Results:
  • In occupied rooms, 26% of keyboards and 15% of faucets were contaminated
  • In unoccupied rooms, the rates were 17% and 0%, respectively.
  • In the 33 environmental isolates obtained from these samples, methicillin-resistant Staphylococcus aureus (MRSA) was the most frequently occurring pathogen, followed by Enterococcus, Enterobacter and other gram-negative rods
  • In the 14 patient isolates, MRSA was again the most frequently occurring pathogen, followed by Enterobacter and other gram-negative rods.

• *AJIC* 2000, vol. 28, No 6, pp. 465-470
Reprocessing and Sterilization of Orthopedic Instruments

- Cleaning tissue and blood from 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 and blades.
Blade and handle should be high level disinfected
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.

Method: Sixty laryngoscope handles from the adult operating rooms were sampled with premoistened sterile swabs. Collection was performed between cases, in operating rooms hosting a broad variety of subspecialty procedures, after the room and equipment had been thoroughly cleaned for the subsequent case. Samples from 40 handles were sent for aerobic bacterial culture, and antimicrobial susceptibility testing was performed for significant isolates. Samples from 20 handles were examined for viral contamination using a polymerase chain reaction assay that detects 17 respiratory viruses.

Results: Of the 40 samples sent for culture, 30 (75%) were positive for bacterial contamination. Of these positive cultures, 25 (62.5%) yielded coagulase-negative staphylococci, seven (17.5%) Bacillus spp. not anthracis, three (7.5%) alpha-hemolytic Streptococcus spp., and one each (2.5%) of Enterococcus spp., Staphylococcus aureus (S. aureus), and Corynebacterium spp. No vancomycin-resistant enterococci, methicillin-resistant S. aureus, or Gram-negative rods were detected. All viral tests were negative. Call TR, et al. Anesth Analg 2009 Aug;109(2):479-83
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
- Check for immediate use steam sterilization practices ("flashing")
Contaminated Instruments with Creutzfeldt Jakob Disease (CJD)

- In May 2001, the Hotel-Dieu Hospital in Windsor, Ontario temporarily closed its operating rooms fearing a possible CJD outbreak. Neurosurgeons operated in March on a patient who later in May was tested and determined likely to have CJD. The same set of neurosurgical instruments used on this patient was likely used on several other patients.

- In March 2001, St. Joseph Hospital in Denver, Colo. announced that six patients might have been infected with CJD. Brain surgery was performed in November on a patient showing no symptoms, not known to have the disease. The patient died in December and following a postmortem brain biopsy was definitively diagnosed with CJD. The same set of neurosurgical instruments used on this CJD patient was used on six other patients. According to the hospital, this instrument set was washed and steam sterilized after each use.

- In October 2000, Tulane University Hospital in New Orleans, La. reported that eight patients may have been infected with CJD. A patient who underwent brain surgery in March died in May and was determined during autopsy to be infected with CJD. Some of the same potentially contaminated neurosurgical instruments used on this CJD patient were reused on eight other patients. After each use, the instruments were washed and sterilized in accordance with the hospital's decontamination procedures.
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 was contaminated with Serratia
  - sterile saline used for spinal anesthesia was contaminated with Pseudomonas and caused meningitis and an outbreak of Hepatitis B from a multi-dose vial.
- Jet injector for IM injections caused and 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
Hepatitis B and C Transmission Related to Multi-dose Vials of Heparin

- Hepatitis B outbreak related to multiple dose heparin vials should serve as a wake up call.
- July 17, 1996 Medication Safety Alert

- PROBLEM: Several patients in a California hemodialysis center, previously HBsAg-negative, developed hepatitis B after they received heparin administered from multiple dose vials shared with a patient with chronic infection

- Hepatitis C outbreak related to multiple dose heparin vials – Hepatology, Oct. 2002

http://www.contaminateddrugs.com/news.htm
Multidose vials and Syringes

- The American Society of Anesthesiologist's "Recommendations for infection control for the practice of anesthesiology" support the practice of using aseptic technique, using multiuse vials appropriately, and not reusing syringes and needles.
- Preventing contamination of medications requires safe handling of vials and syringes to prevent HAI infections in patients undergoing anesthesia or sedation.
- Recent outbreaks of MRSA and other pathogens from steroid injections.

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 addition to these recent outbreaks, there have been several previous outbreaks reported in the medical literature.
  - 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.

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)

Diagnostic Equipment

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

- Intrauterine pressure transducers were contaminated – Pseudomonas

- Xray cassettes caused a cross-contamination outbreak of MRSA in an Intensive Care Unit
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 – Two Common Findings are Uncovered Food and Dusty Fans in Refrigerators
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
Outbreak Investigation

- Problem – increased infection rate in cardiac surgery – mediastinitis with Staph aureus and Coag Neg Staph
- New Operating Room – heavy lead shielded doors were installed and the room was radiofrequency free
- Laminar flow – disrupted from front door being kept open by nurses who claimed it hurt their back and back door propped opened by Anesthesia to pick up radiowaves for their music – created a cross wind movement over the surgical field
- Smoke studies showed the air moved towards the heat of the overhead lights – incoming cool air pushed the smoke down over the operating room table onto the surgical field.
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 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 and Sewerage

- Faucet aerators have cultured Legionella and Pseudomonas – reason they are not used in hospitals.

- Contaminated distilled water containers have led to outbreaks of Pseudomonas and Enterobacter.
Water and Sewerage

- Contaminated ice baths and ice in open heart surgery have caused outbreaks of Pseudomonas and Staphylococcus
- Intra-aortic balloon pump contaminated water reservoir with Pseudomonas cepacia

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
Addenbrooke's Hospital in Cambridge, UK has banned flowers from a number of wards, including the orthopedic ward. A spokesman said: "These wards have had no fresh cut flowers for some time for health and safety reasons because they stand up in water and can be knocked over. All relatives are told as soon as a patient is admitted and they can either take the flowers home or give them to other wards."

**Probably not** – better infection control technique when handling contaminated water – use gloves and empty water in soiled utility room
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

Dirty stethoscope cover
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
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
Contaminated Hands Most Common Source
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
To Prevent Cross Contamination and Transmission: Wear Gloves, Wash Hands Often, Use Alcohol Based Hand Rub/Foam
Hand Cultures – before and after the use of Alcohol Based Hand Sanitizer
Bundled Approaches to Prevention of Healthcare Acquired Infections
### Relative Economic Burden Associated with HAIs

<table>
<thead>
<tr>
<th>Infection Type</th>
<th>Estimated Annual # of Infections</th>
<th>Direct Cost per Patient (2007$)</th>
<th>Average Increased Length of Stay</th>
<th>Attributable Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSI (Surgical Site Infections)</td>
<td>290,485 (17% of HAIs)</td>
<td>$34,670</td>
<td>~12 days</td>
<td>4%</td>
</tr>
<tr>
<td>CLA-BSI (Central-Line Associated Blood Stream Infections)</td>
<td>248,678 (14% of HAIs)</td>
<td>$29,156</td>
<td>~10-24 days</td>
<td>26%</td>
</tr>
<tr>
<td>VAP (Ventilator Associated Pneumonia)</td>
<td>250,205 (15% of HAIs)</td>
<td>$28,508</td>
<td>~9-13 days</td>
<td>24%</td>
</tr>
<tr>
<td>CA-UTI (Catheter-Associated Urinary Tract Infections)</td>
<td>561,667 (32% of HAIs)</td>
<td>$1,007</td>
<td>1 day</td>
<td>1%</td>
</tr>
<tr>
<td>Other / MDROs* (Multi-Drug Resistant Organisms)</td>
<td>386,090 (~22% of HAIs)</td>
<td>~$30,000</td>
<td>~9.1 days</td>
<td>~4%</td>
</tr>
</tbody>
</table>

Innovative Products and Practices to Prevent Exogenous Contamination - CLABSI

- Central line insertion kits – with antimicrobial catheters, impregnated CHG disc and checklist
- Alcohol cap protectors for injection hubs
- Daily line necessity
- Daily body cleanse with CHG impregnated washcloths reduces CLABSI

Centers for Disease Control and Prevention. Guidelines for the prevention of intravascular catheter-related infections. 2011

Innovative Products and Practices to Prevent Exogenous Contamination - CAUTI

Infection control foley catheter and drainage bag systems

- Preconnected system
- Injection hub for urine sampling
- Silver coated catheters
- Anti-reflux valve in bag

- Daily foley catheter necessity assessment
- Daily body cleanse with CHG impregnated washcloths reduces CAUTI

Innovative Products and Practices to Prevent Exogenous Contamination - VAP

- Oral care q2-4 hrs, CHG oral rinse q 12 hrs
- VAP Rounds and checklist (head of bed elevated 30 degrees, PPI, DVT prophylaxis, daily sedation vacation, ventilator necessity)
- CHG washcloths for daily bathing in the ICU reduces VAPs

Innovative Products to Prevent Exogenous Contamination – Preoperative Showers/Cleansing

• Preoperative CHG Showers or Washcloths

• Night before and morning of surgery has been shown to reduce SSIs

*IHI Project JOINTS 2013
“Instruct patients to bathe or shower with chlorhexidine gluconate (CHG) soap for at least 3 days before surgery”*
Innovative Products and Practices to Prevent Exogenous Contamination – Screening for MRSA/MSSA

Pre-screening for MRSA and MSSA prior to inpatient surgery

Molecular rapid technology provides one hour test results


IHI Project JOINTS 2013 “Screen patients for Staph aureus (SA) carriage and decolonize SA carriers with five days of intranasal mupirocin and at least three days of CHG soap prior to surgery”
Innovative Products to Prevent Exogenous Contamination – Surgical Skin Prep with Alcohol

Use an alcohol based skin antiseptic scrub prior to incision

Chlorhexidine/alcohol

Iodophor/alcohol
Innovative Products to Prevent Exogenous Contamination – Wound Protector/Retractor

Wound protector/retractor provides 360° of circumferential, atraumatic retraction, while significantly reducing surgical site infection and maintaining moisture at the incision.

The self-retaining design of the wound protector/retractor effectively holds the incision site open, allowing the surgeon to easily access the operative field and maximize surgical assistance.


Innovative Products to Prevent Exogenous Contamination – Incise Drapes and Incisional Sealants

Limited data to support the use of antimicrobial impregnated incise drapes to reduce SSI

Limited data to support the use of incisional skin sealant – claims:

- Protect against skin flora migration into surgical incision
- Seals and immobilizes pathogens
- Locks out bacteria residing deep in the skin
Innovative Products to Prevent Exogenous Contamination – Chlorhexidine Irrigation System

• “Solution to pollution is dilution”

• New tissue irrigant – 0.05% CHG

• Approved by the FDA for irrigation of mucous membranes and tissues

• In vitro testing has shown >99% kill of MDROs challenged in mesh

• Edmiston, ACS abstract
Effectiveness of 0.05% Chlorhexidine Gluconate (CHG) Against Selective Multidrug Resistant (MDR) Surgical Pathogens: An \textit{In-vitro} and \textit{In-vivo} Analysis

\textbf{Methods:}

CHG (0.05\%) efficacy was evaluated against Gram-positive/negative MDR isolates; \textit{in-vitro} log-reduction was determined at 1, 5, 30 and 60 min post-CHG exposure.

In separate analysis, polypropylene mesh was implanted in Sprague-Dawley rats; inoculated with MRSA (3.0 log$_{10}$ cfu/mL), simulating device contamination.

Control segments (N=8) were irrigated with saline (100 mL), while treatment segments (N=8) irrigated (100 mL) with 0.05\% CHG.

At 7 days, mesh was explanted, sonicated and cultured. All cultures were conducted in triplicate, incubated for 24-h at 37\°C.

\textit{Edmiston, Abstract Presentation – American College of Surgeons}
Effectiveness of 0.05% Chlorhexidine Gluconate (CHG) Against Selective Multidrug Resistant (MDR) Surgical Pathogens: An In-vitro and In-vivo Analysis

• RESULTS: In-vitro analysis revealed > 99.999993% log-reduction in MDR isolates (MRSA, E. faecium, K. pneumoniae, E. aerogenes, E. coli and A. baumannii) following 1-min exposure to 0.05% CHG.

• There was a significant ($p=0.001$) reduction in the number of in-vivo infected mesh segments in the 0.05% CHG irrigated group (1/8, mean 1.91 log$_{10}$ cfu/mesh segment) compared to the saline group (8/8, mean 5.51 log$_{10}$ cfu/mesh segment).

• CONCLUSIONS: At a concentration of 0.05% CHG - potent biocide resulting in a significant log-kill of selective MDR surgical pathogens. Furthermore, irrigation of contaminated (MRSA) mesh with 0.05% CHG was effective ($p=0.001$) in reducing the risk of device-related infection in an in-vivo animal model.

• Further clinical studies are warranted documenting the efficacy of this practice as an effective risk reduction strategy prior to wound closure.

• Edmiston, Abstract Presentation - ACS
Edmiston et al 2012, (independent research)
Surgical Microbiology Research Laboratory, Department of Surgery, Medical College of Wisconsin, Milwaukee, Wisconsin

- IrriSept® (0.05% CHG formulation), an FDA-cleared irrigation solution was evaluated using time-kill kinetics.
- Following standard methodology 18 separate Gram-positive and Gram-negative bacteria were exposed to IrriSept® at 1, 5 and 30 minutes.
- Each assay was repeated three times and results averaged.
- 14 of the 18 isolates were recovered from previous surgical site infections.
- In-vitro log-reduction studies using documented Gram-positive and Gram-negative surgical pathogens found that IrriSept® (0.05% CHG) was effective in reducing microbial counts by a factor equal to or greater than 99.99%.
Polyglactin 910 coated with Triclosan

Triclosan is a broad-spectrum antiseptic that has been widely used in humans for over 30 years.

In vitro antibacterial efficacy against Staphylococcus aureus, Staphylococcus epidermidis, MRSA, MRSE, vancomycin resistant Enterococcus faecalis, Pseudomonas aeruginosa and Escherichia coli
Meta-Analysis Showing Statistically Significant Reduction in SSI with Use of Antimicrobial Suture

Introduction

Surgical site infections comprise 20% of all healthcare-associated infections, having a significant impact on patient morbidity, mortality, and healthcare costs. Current standard interventions (SCIs) have had limited impact on improving patient outcomes, stimulating a search for adjunctive risk reduction interventions to complement the 4 core SCIP measures. The present meta-analysis evaluates the current evidence-based literature in an attempt to validate the efficacy of antimicrobial (brided-coated) sutures as an effective adjunctive strategy for reducing SSI in selective surgical patient populations.

Methods

Systematic Literature Search:
The Cochrane Collaborative handbook formed the basis for this analysis, Center for Evidence-Based Medicine (CEBM) at the University of Oxford.

Systematic search to identify randomized control trials (RCT) was performed on PubMed, Embase/Medline, the Cochrane database group (Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Health Economic Evaluation Database and Database of Health Technology Assessments) and www.clinicaltrials.gov using their own search engines.

References obtained with abstracts, keywords and notes were exported to EndNote (EndNote X5 Thompson-Reuters, Carlsbad, CA, USA).

Duplicate reference were identified using the software’s default settings, and shortlist publications were screened separately by two practicing physicians, a surgeon and a healthcare epidemiologist.

Data extraction applied to all eligible RCTs and consisted of study design, the number of patients in the tied-coated and non-antibiotic suture arms, or data calculating it from overall sample size and percentage per arm, reporting of the number of patients in the surgery arms who presented with post-surgical infection or death, calculating it from the study arms sample size and the percentage of infections per arm, regarding clinical characteristics to be included in the labels of the meta-analysis.

Results

20 relevant clinical trials were identified from peer-reviewed literature.

Meta-analysis of 33 RCTs in the tirilfa-coated suture and non-antibiotic suture arms were performed in 7 eligible RCTs which produced evidence level I or II met criteria to be pooled with I.

Random-effects model (Figure 1) showed a RR of 0.482 with a 95% confidence interval of 0.19 - 0.78, which indicates a statistically significant reduction in the risk of SSI when tirilfa-coated sutures were compared with non-antibiotic sutures (p = 0.012).

The fixed-effects model (Figure 2) showed a zero RR of 0.442 and a 95% confidence interval of 0.32 - 0.73 (p = 0.000).

The Cochrane Q statistic was not significant given the 0% threshold for type I error defined in the protocol and the F was less than 4.41 (<50% pre-defined threshold). Therefore the RR estimates of the seven remaining and eligible studies were homogenous in spite of the diversity of their settings.

The possibility of a publication bias was graphically assessed by the funnel plot (Figure 3). The Egger regression intercept test demonstrated an leptokurtosis that was not statistically different from zero, which was consistent with the funnel plot.

Conclusion

• The results of this meta-analysis demonstrate that the null hypothesis (4D: uses of tirilfa-coated sutures have a similar risk of SSI as compared with non-antibiotic sutures) can be rejected.

• The risk of SSI was significantly lower in patients treated with tirilfa-coated polyglycolic sutures compared to patients who received non-antibiotic suture technology (risk ratio: 0.482, 95% confidence interval: 0.19 - 0.78).

• The overall level of evidence was enough to support the recommendation of the CEMB cohort method.

• The significance of these findings of this meta-analysis have shown that antimicrobial-coated suture technology is an effective, adjunctive interventional strategy for reducing the risk of SSI within a wide variety of surgical procedures.

Edmiston, APIC June 2012
Innovative Products to Prevent Exogenous Contamination – Incisional Adhesive
Topical Incisional Adhesive (TSA) and Total Shoulder Replacements Evidence Based Performance

Total Shoulder Rates

- Propionibacterium acnes related total shoulder infections (TSR)
- Eliminated the use of staples for TSR
- Instituted the use of incisional adhesive
- Covered dressing until day of discharge for protection

Spencer, M  New England Baptist Hospital, Boston, MA
Use Principles of Social Learning Theory as the Theoretical Foundation to the Infection Prevention Program

- Role Modeling
- Self-Efficacy
- Reinforcement
- Contracting
- Reciprocity
Infection Control and Prevention Practices – How To Manage a Multi-disciplinary Program
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 healthcare 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: All evidence-based recommendations for prevention of healthcare-associated infections from CDC/HICPAC can be found at the following site: http://www.cdc.gov/hicpac/pubs.html
- 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
AORN Recommended Practices

*Preoperative Patient Skin Antisepsis. AORN, 2008:537-553.
*High Level Disinfection. AORN, 2008:303-309.
*Cleaning and Processing Anesthesia Equipment. AORN, 2008:275-284
*Sterilization in the Perioperative Setting. AORN, 2008:575-284
*Hand Hygiene in the Perioperative Setting. AORN, 2011;p. 73–8
*Surgical attire AORN, 2011;p. 57–72
Establish a Multi-disciplinary Working Toward Zero HAI Team
Establish a Multidisciplinary 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

**References**


Examples of WTZ Team Members

- **The teams:**

  - **Surgical Site Infections:** Director Surgical Services, OR Manager, SPD Director, Infection Control Manager, Two Surgeons, VP Patient Care Services, Director of Nursing, Nursing Manager, Clinical Educator, Microbiology Lab Director

  - **Ventilator Associated Pneumonia:** ICU Hospitalist, ICU Nurse Manager, ICU Nurse, Director of Anesthesia, ICU Clinical Educator, Respiratory Therapy, Infection Control Manager, Micro Lab

  - **Central Line Assoc Bloodstream Infections:** Surgeon who inserted most central lines, ICU Manager, Director of Anesthesia, ICU Clinical Educator, ICU Nurse, Infection Control Manager

  - **Catheter Assoc UTI:** Clinical Educator, Infection Control Manager, Chief Urology, Lab Director

  - **MRSA Elimination:** Infection Control Manager, Pre-admission testing, OR Director, Microbiology Lab Director, Two Surgeons, Director of Nursing, Patient Access Director, Information Technology, ID physician

  - **C. difficile:** Chiefs of Surgery and Gastroenterology, ICU Nurse Manager, Micro Lab Director, Infection Control Manager
Additional Resources

- www.creativehandhygiene.com
- www.workingtowardzero.com
- www.7SBundle.com
The End
Thank You!