Healthcare Textiles and Laundry 101:
Management in Acute Care and Residential Care

Lynne Sehulster, PhD, M(ASCP)
Division of Healthcare Quality Promotion
Centers for Disease Control and Prevention
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Today’s Topics

• Healthcare textiles:
  – Epidemiology and microbiology
  – Infectious disease transmission principles
• Healthcare textile Laundry
  – Review of the process
  – Soil/pathogen removal vs. pathogen inactivation
• Your questions:
  – Textile management in Isolation care areas
  – Blood and OPIM contaminated textiles
  – Scrubs and uniforms, PPE
  – Textile/fabric item management in residential care
    • Resident clothing
    • Upholstered furniture
Healthcare-Associated Infections (HAIs) in the U.S.

- HAIs are an important public health problem.
- Approximately 1 out of every 20 hospitalized patients will contract an HAI.
- In 2002, ~1.7 million HAIs were identified
  - 33,269 in NICU infants, 19,059 in nursery infants
  - 417,946 in adults and children in ICUs
  - 1,226,857 in adults and children in general patient care areas
- From a 2009 report: HAIs cost $35.7 - $45 billion in 2007
- Major disease agents:
  - Acinetobacter, Burkholderia, antibiotic-resistant strains of Staphylococcus (e.g., MRSA), Enterococcus (e.g., VRE), Clostridium, Enterobacteriaceae (e.g., CRE, carbepenem-resistant K. pneumoniae)

What is the Purpose of Environmental Infection Control?

- Environmental management is only one of many infection prevention tasks
- Infection prevention:
  - Interrupt potential transmission of infectious agents
    - Patient to patient
    - Patient to healthcare worker
    - Healthcare worker to healthcare worker
    - Medical/dental instruments, devices, fomites, surfaces
    - Aerosols in air; water; food
- Modes of transmission of main concern
  - Direct, person-to-person
  - Indirect – involving an intermediate entity (e.g., surface, reservoir)
- Hand transfer of contamination is important

From Point A to Point B

- Medical/Dental Instruments and Accessories
- Physicians, Nurses, and Assistants
- Medical Equipment, Environmental Surfaces, Frequently Touched Surfaces
- Patient A
- Patient B
Basic Strategy Elements for Preventing and Eliminating Contamination of Environmental Surfaces

- **Prevent environmental surface contamination**
  - Handwashing / hand hygiene
  - Use of barrier coverings on clinical touch surfaces
  - Responsible use of gloves, personal protective equipment (PPE)
  - Clean-to-dirty work flow whenever practical
  - Avoid dirty-to-clean work flow as much as practical

- **Remove environmental surface contamination**
  - Cleaning

- **Inactivate environmental surface contamination**
  - Disinfection for inanimate surfaces
  - Antisepsis for living tissue

Laundry and Infectious Diseases

- Textiles contaminated with body substances can contain large numbers of microorganisms ($10^6 - 10^8$ cfu/100 cm² fabric)
- Few reports in the literature link laundry to disease transmission when proper procedures are followed
- Annual estimates for volume of laundry processed in U.S. health care: >10 billion lbs. (5 billion lbs. in the late 1980s)
- Continue current infection prevention practices

Epidemiologic Observations: Healthcare Textiles and Infection

- Of all the surfaces in a hospital, a patient will have the greatest degree of contact with his gown and the bed linens
- Despite studies documenting presence of microbes on textiles, little documentation of actual transmission
  - *Rhizopus* outbreak in U.S., 2009
- Difficult to measure a rare event
Pathogens on Healthcare Attire

- Physicians’ white coats
- Neck ties
- Medical students’ coats
- Nurses’ uniforms

Observations from a Recent Study

- 135 personnel (45% physicians, 55% nurses) in surgical depts. (60%) and medical depts. (40%)
- Nonpathogenic skin organisms isolated from all attire tested
- Rate of contamination with pathogens higher in attire changed every 2 days compared to that for daily changes (p<.05)
- Isolated pathogenic bacteria:
  - *Acinetobacter* spp. 37% (89/238 cultures)
  - *Staphylococcus aureus* 13% (32/238 cultures)
  - *Enterobacteriaceae* 8% (18/238 cultures)
  - *Pseudomonas aeruginosa* 3% (8/238 cultures)
- Only skin bacteria isolated from 4 uniforms cultured immediately after receipt from the hospital laundry
  - Bacterial loads significantly lower than on uniforms being worn

Survival of Microorganisms on Textiles

  - Gram positive bacteria can survive on various fibers / healthcare apparel from days to months
  - Smaller bioburden shorter survival time
  - Increased survival to shorter survival times:
    - Cotton: *Enterococcus faecium* > *E. faecalis* > *S. aureus*
      - > 90 days > 33 days > 21 days > 21 days
    - Polyester: *E. faecium* > *E. faecalis* > *S. aureus* > CNS
      - > 90 days > 80-90 days > 40-56 days > 20-22 days
  - Medically-important fungi survive on fibers and apparel
  - Cotton, polyester:
    - *Aspergillus* (> 30 days) > *Fusarium* (10 days) > *Candida* (1-8 days)
Some Observations About Textiles and Microorganisms in Health Care

  - Microbial sampling of HCW uniforms during normal wear
    - S. aureus was the only bacterium to have high counts (e.g., 10-100 CFU and > 100 CFU)
    - Surgery uniforms – S. aureus; Medicine and renal uniforms – S. aureus, VRE, and C. difficile
    - Increasing numbers of S. aureus on uniforms when worn for more than one day
  - Binding ability: microorganisms to fibers (100 mg), high conc.
  - Cotton: S. aureus 2%, MRSA 1%, Pseudomonas aeruginosa 8.1%
  - Polyester: S. aureus 96.2%, MRSA 87.9%, P. aeruginosa 99.9%

Current Healthcare Textiles Standard in the U.S.

- Standard for reusable textiles: Hygienically clean
  - Not quantified for microorganisms, but assume textiles are generally rendered free of vegetative pathogens
  - Through a combination of soil removal, pathogen removal, pathogen inactivation, contaminated laundry is rendered hygienically clean
  - Carries negligible risk to healthcare workers and patients, provided that the clean textiles are not inadvertently contaminated before use
- Reusable surgical textiles: Sterilized

Key Concepts in Quality for Healthcare Textiles

- Functional separation
  - Separation of soiled sort/soiled textile areas from clean textile areas
  - Primarily accomplished via structural design and ventilation specifications
  - Conceptually also can include work practices to keep clean textiles separate from soiled textiles
- Hygienically clean textiles
  - Contact with clean surfaces at minimum
  - Disinfected surfaces may be indicated
Main Steps of Healthcare Laundry Processing

- Collection of soiled textiles at point of use
- Transport to laundry
- Wash cycle:
  - Flush, main wash, bleaching, rinsing, souring
- Dried and pressed
- Packaged, loaded into carts
- Delivery back to the hospital

Laundry Operations

- If using hot water washing, water temperature ≥71° C (≥160° F) is needed
  - Some healthcare facilities may not have access to water at this temperature
- Chlorine bleach (50 – 150 ppm) is effective laundry additive at various water temperatures
  - Follow manufacturer instructions for bleach use
- One of the rinses includes a mild acid (sour) to neutralize residual alkalinity from the wash
  - Helps to inactivate microorganisms
  - Reduces risk of skin reaction to alkali

Alternatives to Hot-water Laundry

- In-house laundries consume an average of 50% - 70% of the facility's hot water (10% - 15% of the total energy used)
- Water temperature may be regulated locally
- Lower temperature (e.g., 22° – 50° C) wash cycles can be used with appropriate detergents and laundry additives
- New detergents and processes (e.g., oxidative products) are being evaluated in Europe
- Current problems associated with bleach use:
  - Not all fibers and fabrics are compatible with bleach
  - Chlorine + residual chlorhexidine gluconate (CHG) = brown stains
Conventional Laundering: Log Reductions in Bioburden

• In the wash, rinse cycles:
  – Agitation: ~3 log unit reductions
  – Addition of bleach: ~ 3 log unit reductions
• In the dry cycle:
  – ~ 1 – 2 log unit reductions


• Post wash microbial burden ~10 – 100 CFU/cm²
• Predominantly Gram-positive organisms

The Laundry Process: Log Reductions

<table>
<thead>
<tr>
<th>Process</th>
<th>Gram Positive LR</th>
<th>Gram Negative LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-wash at 35°C</td>
<td>0.73 – 2.47</td>
<td>0.70 – 1.16</td>
</tr>
<tr>
<td>Main wash at 45°C w/o pre-wash</td>
<td>0.97 – 2.58</td>
<td>1.11 – 2.66</td>
</tr>
<tr>
<td>Main wash at 60°C w/o pre-wash</td>
<td>1.34 – 5.55</td>
<td>3.71 – 5.5</td>
</tr>
<tr>
<td>E60 = 30 pre-wash at 35°C, main wash at 60°C</td>
<td>1.01 – 7.88</td>
<td>5.6 – 7.76</td>
</tr>
<tr>
<td>Completed main wash at 75°C</td>
<td>&gt;5.56 – &gt;7.88</td>
<td>&gt;5.56 – &gt;7.76</td>
</tr>
<tr>
<td>Disinfecting only at 75°C</td>
<td>&gt;5.56 – &gt;7.88</td>
<td>&gt;5.56 – &gt;7.76</td>
</tr>
<tr>
<td>Complete 3-step cycle (with disinfection at 80°C)</td>
<td>&gt;5.56 – &gt;7.88</td>
<td>&gt;5.56 – &gt;7.76</td>
</tr>
</tbody>
</table>

* Detergent was mix of anionic and nonionic surfactants, phosphates
* Bleach: H₂O₂ agent; Disinfecting agent was peracetic acid, H₂O₂, acetic acid
* Starting inocula: 10⁶ – 10⁷ CFU in 1 square cm
* The disinfecting step by itself could not remove stains
* E. faecium had the greatest survival; Gram positive > Gram negative

Laundry Transport / Storage

• Separate clean textiles from contaminated textiles when transporting in a vehicle
• Physical barriers and/or space separation
• Clean, unwrapped textiles can be stored in a clean location for short periods of time
• Unwrapped textiles should be stored so to prevent inadvertent contamination by soil or body substances
• This is the part of the overall process that is most vulnerable to outside contamination
Chain of Infection (COI)

- Virulent pathogen:
  - Bacteria, fungi, viruses, parasites, prions
- Sufficient number of pathogen:
- Infectious dose
- Mode of transmission:
  - Contact, droplet, airborne
- Portal of entry:
  - Broken skin, mucous membrane, respiratory tract, ingestion
- Susceptible host:
  - Age, immunity, medical conditions

Other possible links include reservoir, portal of exit

Mucormycosis

Outbreak and Hospital Textiles

Mucormycetes

- Mucormycetes are ubiquitous molds
- 23 pathogenic species; Genus Rhizopus causes half of all infections
- Rhizopus oryzae most common; genetic variety observed within species
- Mucormycosis:
  - Skin is common site of infection
  - Invasive mold: fatality rate highly variable (ranges from 10% - 94%)
Additional Results

• Patient specimens:
  – Type: culture (1), tissue block (3)
  – All four (+) for *Rhizopus oryzae*

• Environmental cultures:
  – Hospital A: 13/13 cultures (+) for *Rhizopus oryzae*
  – Laundry facility: No *Rhizopus oryzae*
  – *R. oryzae* from one patient and from clean linen/cart had the same genetic subtype
**Conclusions From the Outbreak Investigation**

- Hospital linens were the most likely vehicle to have brought *Rhizopus* in contact with the patients
- Genetic subtyping of fungal isolates supported this epidemiologic hypothesis
- Contamination of clean linens with *Rhizopus* happened repeatedly, but might have been intermittent
- Hospital linens should be laundered, shipped, and stored in a manner that minimizes exposure to environmental contaminants

**Let’s Talk About…**

- A variety of textile / fabric item management questions
  - Textiles in isolation care areas
  - Management of textiles and *Clostridium difficile*
  - Keeping upholstered furniture and carpeting clean
  - Privacy curtains
  - General patient care areas: textiles with body substance contamination
  - Laundering of HCW uniforms
  - Residential outerwear laundering issues
  - Home or facility laundering?

**Management of Textiles from Isolation Care Areas**

- Soiled textiles from isolation care areas can be laundered with textiles from general patient care areas
- Key principles for handling soiled textiles in isolation care areas
  - Use minimal agitation, avoid aerosol production
  - Minimize skin and clothing contact with soiled textiles
    - Isolation gown can protect HCW outerwear
  - Contain soiled textiles in designated laundry bags or bin for collection

Where Has C. difficile Contamination Been Found?

- Patient-Care Areas (HIV unit, ID unit):
  - Floors, bed rails, common toilets, portable toilets, communal blood pressure cuff
  - Positive environmental cultures:
    - Cook County Hospital: 14.7% (24/164)
    - Rush Presbyterian St. Luke’s Med Center: 2.9% (3/104)
- Outbreak strain (CD1A) at Cook County Hospital was detected in the environment 1 month after index outbreak patient was identified.

Supplemental Prevention Strategies:

Rationale for Considering Extending Isolation Beyond Duration of Diarrhea


Textile Management and C. difficile Contamination

- Consider cohorting symptomatic patients/ residents’ clothing to wash separately from clothing of healthy residents
- During a wash cycle, do not mingle used cleaning cloths in with clothing from healthy residents
  - High numbers of spores may remain on the cloths if used with a non-sporicidal disinfectant
  - Use of sporicidal disinfectant will reduce the viable spore number

From: Carbone HL, et al. 2010 Decennial Infection Prevention and Epidemiology Conference, poster #160
Furniture, Carpeting, and Privacy Curtains

- Upholstered furniture and carpeting:
  - Chain of Infection point: although pathogens have been found on these surfaces, little evidence of transmission
  - Professionally clean with appropriate EPA-registered sanitizer at least once a year and after significant body substance contamination
  - Consider use of protective cover for upholstered chair seat

- Privacy curtains:
  - Edges become contaminated: select a curtain whose edges can be easily cleaned and disinfected
  - Preference: replace with a clean curtain during terminal cleaning

Definition of Contaminated Laundry

OSHA definition:
Contaminated laundry: laundry which has been soiled with blood or other potentially infectious materials or may contain sharps.

Use PPE when handling these textiles and place in appropriate containment for collection.

Source: 29 CFR 1910.1030 OSHA Bloodborne Pathogen Standard

Scrubs/Uniforms vs. PPE

- Employer responsible for laundering:
  - PPE made of reusable fabric
  - Reusable fabric scrubs/uniforms that have been contaminated with blood and/or OPIM

- Reusable fabric scrubs/uniforms not contaminated with blood and/or OPIM
  - Chain of Infection point: although microbes have been identified on this outerwear, little direct evidence of transmission
  - Ongoing debate as to whether or not these can be laundered at home safely
  - AORN recommends that scrubs be laundered by the employer
Resident Clothing

- Chain of Infection point: although pathogens have been found on clothing, little evidence of direct transmission
- Challenge: making resident care facilities more of a residence
- Establish policy/procedures for resident clothing:
  - Determine what items will be laundered by the facility
  - Note laundering instructions for garments
  - Develop a laundering strategy
    - Water temperature, laundry additives, dryer temperature

CDC / HICPAC Guidelines: Laundry and Bedding

From the “Guidelines for Environmental Infection Control in Health-Care Facilities” (2003):

- Epidemiology and General Aspects of Infection Control
- Collecting, Transporting, and Sorting Contaminated Textiles and Fabrics
- Parameters of the Laundry Process
- Special Laundry Situations
- Surgical Gowns, Drapes, and Disposable Fabrics
- Antimicrobial-Impregnated Articles and Consumer Items Bearing Antimicrobial Labeling
- Standard Mattresses, Pillows, and Air-Fluidized Beds

The HLAC Standard for 2011

- Supersedes the HLAC Standard of 2006
- More detailed, less ambiguity
- Comprehensive in scope
- Thoroughly referenced
- Its message: Patient-focused infection prevention
- Advances the industry
Resources for More Information

CDC:
- Options for Evaluating Environmental Cleaning
- Appendices to the Conceptual Program Model for Environmental Evaluation
- CDC Environmental Checklist for Monitoring Terminal Cleaning
- CDC Environmental Checklist
- Environmental Cleaning Evaluation Worksheet (Excel format)
- CDI Prevention Tool Kit

EPA:
- Selected EPA-Registered Disinfectants: http://www.epa.gov/oppad001/chemregindex.htm

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Thank You!

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