Objectives

- Describe the Impact of Non-Compliance with Horizontal Infection Prevention Measures
  - Environmental Hygiene
  - Hand Hygiene

- Discuss Behavior Models and Methods to Promote Compliance
  - Human Behavior Models and Compliance
  - Traditional Methods to Improve Compliance
  - Behavior Modification

- Review Methods to Measure Compliance
  - Environmental Hygiene
  - Hand Hygiene
HORIZONTAL INFECTION PREVENTION MEASURES: IMPACT OF NON-COMPLIANCE
## Strategic Approaches to Infection Prevention

<table>
<thead>
<tr>
<th></th>
<th>Vertical</th>
<th>Horizontal</th>
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</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
<td>Pathogen-based: Reduce infection or colonization due to <strong>specific</strong> pathogen(s)</td>
<td>Population-based: Reduce all infections</td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>Selective</td>
<td>Generally universal</td>
</tr>
<tr>
<td><strong>Resources/Cost</strong></td>
<td>Typically high</td>
<td>Lower</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>MDRO active surveillance</td>
<td>Hand hygiene Environmental hygiene Care bundles</td>
</tr>
<tr>
<td></td>
<td>Nasal decolonization</td>
<td></td>
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<tr>
<td></td>
<td>Isolation</td>
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</tr>
</tbody>
</table>

- Horizontal measures are consistent with patient need to avoid all infections, not just those due to a specific organisms
- Horizontal measures often require modification of behavior of healthcare workers

Wenzel RP, Edmond MB. Infection Control: The case for horizontal rather than vertical interventional programs. Int J Inf Dis. 2010; S3-S5
Increasing Patient and Staff Safety

Successful Hand Hygiene + Effective Environmental Hygiene = Horizontal Approach to Infection Prevention
Patients with pathogens (e.g., MRSA, VRE, C. difficile) contaminate environmental surfaces near them.

These pathogens become a source from which healthcare workers contaminate their hands or gloves.

Contaminated environmental surfaces can contribute to the spread of HAIs.
Pathogens Survive on Environmental Surfaces

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Presence on Surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. difficile</td>
<td>&gt; 5 months</td>
</tr>
<tr>
<td>Staphylococci</td>
<td>7 months</td>
</tr>
<tr>
<td>VRE</td>
<td>4 months</td>
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<tr>
<td>Acinetobacter</td>
<td>5 months</td>
</tr>
<tr>
<td>Norovirus</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Adenovirus</td>
<td>3 months</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>3 months</td>
</tr>
<tr>
<td>SARS, HIV</td>
<td>Days to week</td>
</tr>
</tbody>
</table>

VRE

Presence on Surfaces
> 5 months
7 months

Acinetobacter
5 months

Norovirus
3 weeks

Adenovirus
3 months

Rotavirus
3 months

SARS, HIV
Days to week

C. difficile colonies on a blood agar plate.
Survival of *Clostridium difficile* Spores in the Environment

- Incidence and severity of *C. difficile* disease has increased dramatically.
- Mulligan et al. found *C. difficile* on environmental surfaces 40 days after an affected patient left the room.

Contamination of Hands with MRSA after Contact with Environmental Surfaces and Skin Colonized Patients

Hand contamination was equally likely after contact with touched environmental surfaces and skin sites.

No significant difference in mean number of CFU’s per gloved hand after contact with skin and environmental sites.

Stiefel et al. Infect Cont Hospital Epidemiol. 2011;32:185
Link Between Environmental Contamination and Hand Contamination

HCWs who have no direct contact with an affected patient, but touch bedding or objects in room may contaminate hands

<table>
<thead>
<tr>
<th>Environmental Sites Positive</th>
<th>Percent of HCWs with Hand Cultures Positive for C. difficile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0/25 (0%)</td>
</tr>
<tr>
<td>1-25</td>
<td>0/11 (0%)</td>
</tr>
<tr>
<td>26-50</td>
<td>1/12 (8%)</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>9/25 (36%)</td>
</tr>
</tbody>
</table>

The more surfaces that are contaminated, the more likely HCW hands will be contaminated

In one study, 42% of nurses who had no direct patient contact, contaminated their gloves by touching objects in the rooms of patients with MRSA.

Volunteers touched bed rails and overbed tables in rooms of patients not in Contact Precautions:
- 31% of hand imprint cultures yielded S. aureus (35% = MRSA).

Volunteers touched bed rails and overbed tables in unoccupied rooms that had been terminally cleaned:
- 7% of hand imprint cultures were positive for S. aureus.

HCW Hands are contaminated even when no direct patient contact occurs.
Efficacy of Alcohol-Based Hand Sanitizer: Impact of Human Behavior

Health care worker's ungloved hand was cultured after the worker had performed an abdominal examination of a patient colonized with MRSA in his nares.

The MRSA colonies grown from this handprint show the outline of the worker's fingers and thumb.

After the worker's hand had been cleaned with alcohol foam, another hand imprint was obtained and the resulting culture was negative for MRSA.

These images illustrate the critical importance of hand hygiene in caring for patients, including those not known to carry antibiotic-resistant pathogens.

MRSA is susceptible to alcohol-based hand rubs.
Efficacy of Cleaning/Disinfection: Impact of Human Behavior

Failure to remove MRSA from environmental surfaces is most likely due to:

- Failure to clean the surface
- Failure to apply detergent/disinfectant for adequate contact time
- Failure to apply disinfectant at proper concentration
- Disinfection attempted without cleaning

MRSA is susceptible to in-use concentrations of EPA-approved hospital disinfectants

Dharan S et al. J Hosp Infect 1999; 42:113
Sehulster LM et al. ASM meeting 1998; abstr. Y-3
Evidence That Environmental Cleaning Can Reduce Transmission of *C. difficile*

During an **outbreak** of CDAD, disinfecting environmental surfaces with 1:100 dilution of hypochlorite decreased contamination to 21% of initial levels, and halted the outbreak


Environmental monitoring, housewide **daily** use of hydrogen peroxide/peroxyacetic acid and EVS staff training decreased hospital-onset *C. difficile* SIR from 1.629 to 0.667 in 6 months

- Allen, VG, Scott MG, Yoder BA et al. Abstract presented at APIC Annual Conference 2015

*C. difficile* is susceptible to in-use concentrations of EPA-approved hospital sporicides
Environmental Contamination

There is a continuous flow of pathogens between patients, healthcare worker and the environment.

Disinfectants and hand sanitizers/soap are effective if used correctly.

Q: So why do we still have a problem?
A: People!
PROMOTING COMPLIANCE:
SOCIAL COGNITIVE MODELS
Social Cognitive Models for Health Behavior

Health Belief Model¹

- **Threat**
- Developed to explain why some people do not use health services such as immunization and screening
- A person will be more likely to adopt the recommended action if perceived high susceptibility, high severity, high benefits and low barriers

Protection Motivation Theory¹

- **Threat**
- **Behavioral control**
- A person will be more motivated to protect himself or herself (i.e., adopt the recommended action) if he or she believes that the threat is likely, the consequences will be serious, the recommended action is effective and that he or she is able to carry out the recommended action

Self-Efficacy Model¹

Theory of Planned Behavior¹

Health Locus of Control²

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1. Sutton S. Psychosocial Theories. 2002
Health Belief Model: Influencing Behavior

- Perceived susceptibility
- Perceived seriousness
- Cues to action (internal, external)
- Perceived benefits
- Perceived barriers
- Self-efficacy
- Social pressure
- Intention to perform action
Perceived Susceptibility

Self-opinion of the likelihood of acquisition of a disease

Is this patient at risk of infection?
Perceived Seriousness

Self-opinion of how serious a condition and its sequelae are

Is this guy really that vulnerable?
Cues to Action

- Strategies to activate readiness to act
- Human Factors Engineering

The blue cloth is for the patient room

Alcohol gel is right in front of me – I’ll use it!
Perceived Benefits

Self opinion of the ability of the advised action to reduce the risk or seriousness of impact

I think using this hand sanitizer will help keep my patient from getting an infection
Perceived Barrier

Self-opinion of the tangible and psychological costs of the advised action

I don’t want to touch anything that has a button or alarm

We don’t have time for hand hygiene!
Self-Efficacy

Confidence in self ability to take action

I have the cleanest toilets in the hospital!
Social Pressure

The perceived social pressure to engage or not engage in a behavior

Someone will notice my exceptional compliance in using this hallway dispenser.
Intention to Perform Action

Individual’s readiness to perform a given behavior

I intend to foam in and out of the room every time; it’s a habit for me
PROMOTING COMPLIANCE: OTHER FACTORS
Factors Affecting Performance of Hand Hygiene

- Role
- Time
- Distractions
- Accessibility
- Skin condition
- Gloves
- Education
- Products
Role: Doctors vs Nurses

- Measured daily number of HH opportunities and compliance
- 21,450 HH opportunities from med/surg unit
- Nurses have 3 times more HH opportunities than physicians, yet have 1.5 times higher compliance than physicians

HH compliance in physicians cannot be explained by burden of HH opportunities

Factors Affecting Environmental Hygiene

- Education
- Time
- Recognition
- Tools
- Products
METHODS TO IMPROVE COMPLIANCE
Traditional Methods to Improve Compliance

- Motivational Programs
- Administrative Measures
- Training
Motivational Programs

- Use real-life examples
- Have patients and families participate
“Every year hospital-acquired infections cause or contribute to the death of more people than breast cancer, heart disease, and car accidents combined. Most of these infections are initiated by otherwise caring healthcare workers who forget or neglect to clean their hands. And for those who, like our friend David, succumb to one of these unnecessary infections there are many more who ache for their loss. These are not numbers on month-end reports. These are our fathers, our mothers, our children and our dear friends who are dying because of unclean hands. The little bit of extra time that it takes for healthcare workers to wash or to use an alcohol sanitizer is pittance compared to the waste of so many productive, loved and loving lives.”
Administrative Measures

- Institutional Priority
- Facility-wide program implementation
- Monitoring and Feedback
Training

- Training, re-training, and training again!

Educational Programs

- **WHO** expects them to follow hygiene practices
- **WHAT** are the benefits of hygiene
- **WHEN** hygiene is indicated
- **WHERE** tools and products are located
- **WHY** hygiene is important
- **HOW** to perform hygiene practices
Increasing Evidence to Support Behavior Modification Methods

- Rotating Signage
- Recognition Programs
- Positive Deviance
- Patient Empowerment
- Peer Mentors
- Endorsement by Authority Figures
Behavior Modification: Recent Studies

- Just 15% of staff and visitors washed hands at a hospital
- An image of man's eyes boosted handwashing by 33%
- A citrus smell around the sanitizer saw 50% increase in handwashing

Objective: To address the conspicuity of alcohol gel dispensers

Affixed flashing lights to hand sanitizer dispensers for 6 weeks and compared compliance at beginning and end of intervention.

Flashing lights improved HH compliance from 11.8% to 20.7%. This effect was unchanged over 6 weeks.

Brighter lights were more effective.

Human Factors Engineering

The inter-relationship between humans, the tools they use, and the environments in which they live and work.
Medical profession sometimes uses blame to encourage proper performance

Personal responsibility and training are often the only solution

Design of the system is often overlooked
- Environment, organization, technology, task
What Should We Do to Change?

- Don’t look at error in compliance as a human problem … it is a systems problem
- Don’t make it worse by punishing people … this creates incentive to conceal mistakes
- Use technology and tools to enhance the task and make it safer; build in stop checks and affordances
- Analyze the near misses and accidents; learn from mistakes
- Create a culture of support
COMPLIANCE MONITORING AND FEEDBACK
Feedback Creates Accountability

Creates

Accountable People Who

Ask For & Offer

Feedback

Connors, Smith, Hickman: The Oz Principle
MEASURING HAND HYGIENE COMPLIANCE
WHO Multi-Modal HH Improvement Strategy

Step 1: Ensure the preparedness of the institution
- Necessary resources in place
- Key leadership to head the program, including a coordinator and his/her deputy.
- Map out a clear strategy for the entire program.

Step 2: Conduct baseline evaluation
- Hand hygiene practice, perception, knowledge, and infrastructure

Step 3: Implement the improvement program
- Availability of an alcohol-based handrub at the point of care
- Staff education and training
- Well-publicized events involving endorsement and/or signatures of commitment of leaders and individual HCWs will draw great dividends.

Step 4: Follow-up evaluation
- Assess the effectiveness of the program

Step 5: Develop an ongoing action plan and review cycle
- The overall aim is to ensure hand hygiene is an integral part of the hospital culture.
Hospitals Have Several Factors to Consider

Choosing a Compliance Monitoring Program

- HAI status (vs peers)
- Hand Hygiene Initiatives
- C-Suite Agreement
- Cost per room or bed
- Compatible IT Structure
- Individual vs Group data
Hospitals Need to Plan a Strategy Around Compliance

For accreditation, all hospitals must:

- Implement a program that follows CDC or WHO HH guidelines
- Set goals for improving compliance
- Improve compliance based on established goals

Hospitals have different options:

**Direct observation**
- “Secret shopper” method where HH moments are recorded by an observer

**Product usage measurement**
- Manually or electronically track how much product is consumed

**Electronic monitoring**
- Technology-enhanced solution that delivers specific data around who, where, and when HH events are performed
**Direct Observation**

| Description | • Direct observation of hand hygiene practices.  
|             | • May be manual (pen and paper) or technology assisted |
| Advantages  | • The only method that can evaluate the "Five Moments for HH"  
|             | • Considered gold standard method because it is the only method that directly measures HCW HH compliance |
| Disadvantages | • Hawthorne effect, especially with manual method  
|             | • Interobserver agreement can vary, thus requiring a great effort in training data collectors  
|             | • Time intensive to observe and manually create reports  
|             | • Short observation periods  
|             | • Captures a fraction of HH opportunities |

Improvements in Direct Observation Tools

- New Hand Hygiene Observation Tools are more robust
- More covert, reducing Hawthorne Effect
- Monitor technique
- Monitor PPE compliance
- Secure reporting portal

# Measuring Product Use

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>• Indirect way to measure hand hygiene compliance by measuring soap/ABHR consumption</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Advantages</th>
<th></th>
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<tbody>
<tr>
<td>• Less resource intensive than direct observation</td>
<td></td>
</tr>
<tr>
<td>• Possible to do it manually or electronically</td>
<td></td>
</tr>
<tr>
<td>• Can be done in different hospital settings</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Disadvantages</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Not possible to distinguish HH practice among HCWs</td>
<td></td>
</tr>
<tr>
<td>• Does not measure specific moments from “Five Moments”</td>
<td></td>
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</tbody>
</table>

# Electronic Monitoring

| Description | • Several different types of electronic sensors using different technologies  
• Real time locating systems |
|-------------|---------------------------------------------------------------------|
| Advantages  | • Designed to ensure that HCWs perform HH prior to patient care and may issue an automated notice to do so  
• Promote real-time feedback to HCWs  
• When integrated with a database, allow for automated reports |
| Disadvantages | • Some technologies can be expensive with high maintenance costs  
• Some technologies make it necessary to work closely with engineering to assess possible interference with existing equipment  
• Some technologies connect to hospital network and may overload the network |

Evaluating Automated Systems

- Cost
- Accuracy
- Reporting Capability
- Ease of Install
- Individual HCW vs Group Monitoring
- HH Moments Monitored
- Monitoring Area
  - Room vs Patient Zone
- Hospital IT Requirement
- Battery Life
- Maintenance

Cost

Accuracy

Ease of Install

Reporting Capabilities
MEASURING ENVIRONMENTAL HYGIENE COMPLIANCE
Recommendations to optimize high touch surface cleaning:

- Clean high-touch objects (HTOs)
- Perform objective monitoring of the thoroughness of disinfection cleaning of HTOs
- Provide continuous feedback that drives focused education for ES staff
- Develop reports documenting progress to share with staff, leadership and surveyors
Total Aerobic Bacteria Count

- Measure of amount and type of pathogens on a surface
- Reliable, specific results
- Outbreak investigation
- Pre-cleaning culture taken of HTOs
- Post-cleaning cultures taken to measure appropriate reduction of organisms (CFUs)
- At least 2 days before results available
ATP (Adenosine Triphosphate) Measurement

- Measure of organic cellular material (ATP) on surfaces
  - Pre-cleaning swab to measure baseline organic material
  - Post-cleaning swab to evaluate organic material removal
  - Provides quick results
  - Can be used for teaching

Swab surface → luciferase tagging of ATP → Hand-held luminometer
ATP in Healthcare

**Designed for Industrial Use**
- Developed in the 1970s for commercial food preparation
- Very clean stainless steel surfaces
- High-grade disinfectants + water flushing
- Testing immediately after cleaning and just before use is the standard
- Looking for “0” Relative Light Units (RLU)

**Healthcare Use**
- Healthcare disinfection process does not completely remove dead organic material
- ATP measures all organic debris-microbial and non-microbial, live and dead
- Can’t expect “0” RLU. An RLU standard has not been set to define clean versus contaminated surfaces in healthcare
- Surface contaminants may artificially increase or decrease RLU Readings
  - Bleach quenches the ATP reaction
Qualitative Environmental Monitoring Methods

Visual Assessment

- Measure of visible appearance of cleanliness
- Traditional Environment of Care rounds
- Observations – overt or covert
- Limited to visible soil-can’t see pathogens
- Can be subjective

Shiny floors ≠ Clean!
Fluorescent Marker

- Measure of cleaning process/thoroughness of cleaning
- Objective, accepted methodology
- Clear marker applied to HTOs after cleaning is completed
- Marker reviewed by auditor with black light after cleaning
- Removal of the mark is a “pass.” Intact or disturbed mark is a “fail”
Environmental Monitoring is Effective

**Decreasing Operating Room Pathogen Contamination Through improved Cleaning Practice**

- Prospective environmental study using feedback with UV markers and environmental cultures
- Percentage of UV markers cleaned increased from 47% to 82%
- Recovery of gram negative bacilli from environment decreased from 10.7% to 2.3%
- As cleaning improved, environmental bioburden decreased

Munoz-Price LS et al. Infection Control and Hospital Epidemiology, Vol. 33, No. 9 (September 2012)
Environmental Monitoring is Effective

Environmental Cleaning Intervention and Risk of Acquiring Multi-Drug Resistant Organisms from Prior Room Occupants

10 ICUs

Targeted feedback

- Fluorescent marker
- Cleaning cloths saturated with disinfectant
- Increased education

Acquisition was lowered

- 3.0% to 1.5% for MRSA
- 3.0% to 2.2% for VRE

Summary

- Hand Hygiene and Environmental Hygiene are horizontal infection prevention strategies that are effective against a broad range of pathogens and infections.
- There is a constant transfer of pathogens between the patient, healthcare worker and environment that we strive to minimize.
- FDA-approved hand soaps/ABHRs and EPA-registered disinfectants are effective if used correctly.
- Human behavior impacts the effectiveness of horizontal infection prevention methods.
- Monitoring hand hygiene and environmental hygiene compliance provides information to help drive behavior changes and improve outcomes.
- Understanding the advantages and disadvantages of monitoring methods can help you choose the right method for your situation.
THANK YOU!

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