# Hand Hygiene, Isolation and Disinfection

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Fellows course 2014

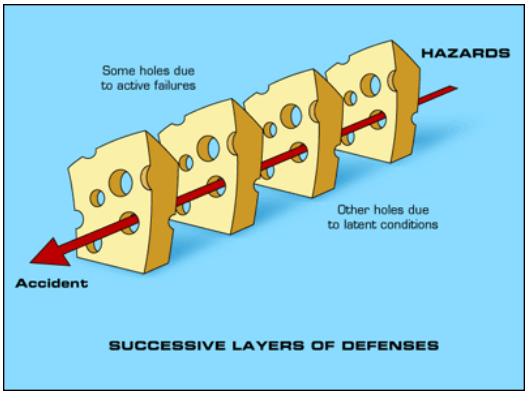
## Overview

- Hand Hygiene
- Standard and Isolation Precautions
- Discussion of Disinfection, Sterilization & Environmental cleaning

# Goal of Infection Prevention

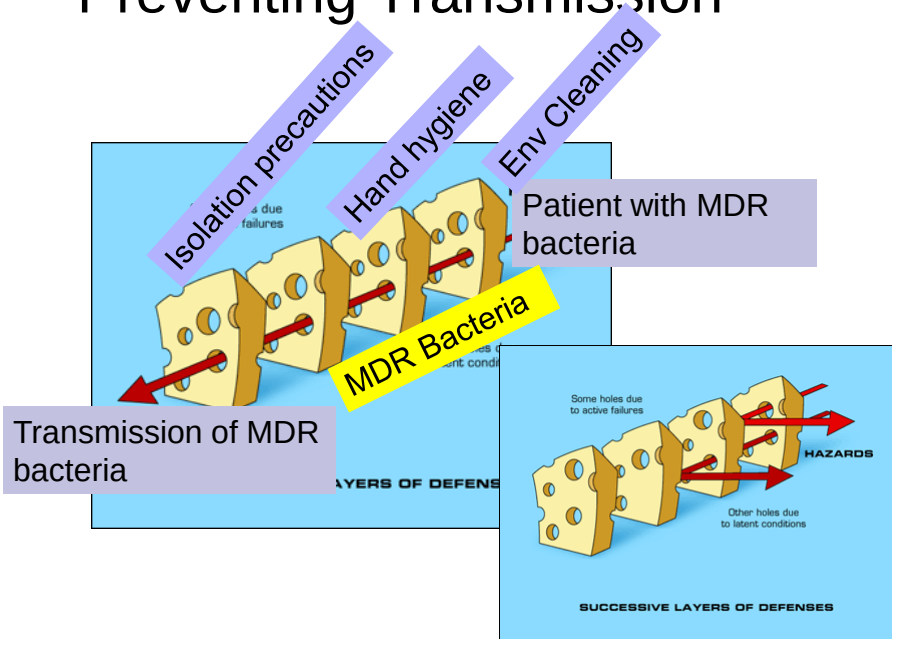
- Prevent Infections
- Prevent transmission

# Preventing Transmission




Reason 1990

# Preventing Transmission



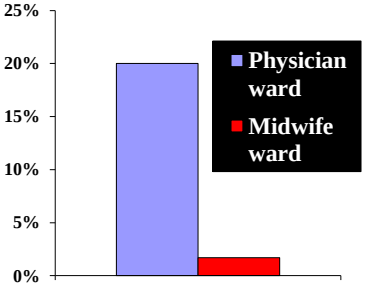

# Ignaz Philipp Semmelweis (1818-1865)

# Puerperal Fever “Childbed Fever”

- Postpartum Endometritis
  - Group A streptococci
  - Polymicrobial
- Currently Known Risk Factors
  - PROM and prolonged duration of labor
    - number of vaginal exams
    - internal monitoring
  - Maternal soft tissue damage
    - mid forceps delivery
    - C-section

# Post-Partum Mortality

- Two wards, each had 3500 deliveries/year
  - Physicians and medical student
    - 600-800 mothers died/year
  - Midwives
    - 60 mothers died/year

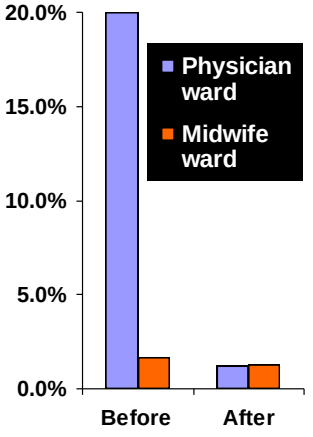


# Initial Interventions

- No change in mortality with:
  - Maternal delivery position
  - Decreasing the number of medical students
  - Eliminating foreign born medical students

# Intervention Trial

Rub hands in chlorinated lime solution until slippery and cadaver smell gone before every vaginal exam



# Why Did So Few Listen?

- “The Cause, Concept and Prophylaxis of Childbed Fever” published in 1861 - 14 years after his discovery
- 9 years before Pasteur discovered bacteria cause putrefaction
- 20 years before Lister and aseptic surgery

## How NOT to do hand hygiene

## Types of Hand Hygiene

- Handwashing - soap and water
- Alcoholic Hand Antiseptics (rubs)
  - 60-70% alcohol
    - Foams / rinse / gels
  - Emollients
    - glycerol, silicone oils, refattening agents

## Handwashing Versus Alcohol Rub

- To achieve 100% compliance, handwashing with soap estimated to consume 16 hours of nursing time/day shift
- Alcohol hand disinfection from a bedside dispenser required only 3 hours

Voss A & Widmer ICHE 1997

## Alcohol as a Hand Antiseptic

- excellent against bacteria and fungi
  - good against mycobacteria
  - excellent against enveloped viruses
    - HIV, respiratory viruses
- *Soap/water for C. difficile or Norovirus*

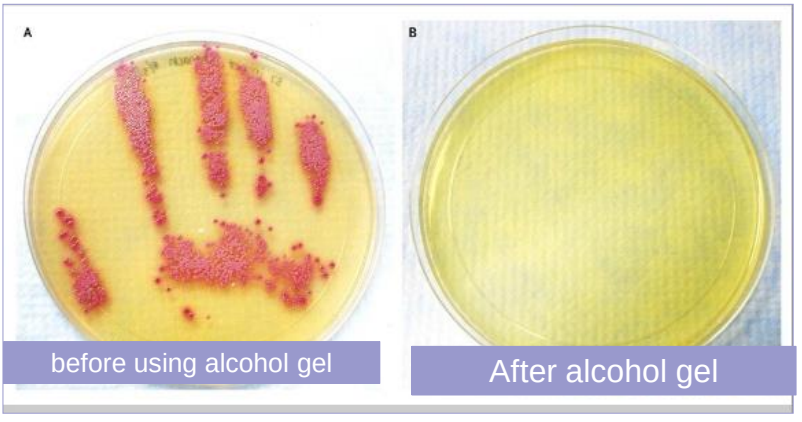
# Handwashing Works!

- Reduces organisms 10,000 fold
  - from $10^7$ CFU to $10^3$ CFU
- Reduces
  - overall healthcare associated infection rates
  - incidence of certain organisms and certain infections
  - mortality

Doebbeling 1988, AIM

Larson 1988, ICHE

# After touching patient with MRSA



# Hand Ecology

- Resident flora
  - live in the upper hair follicles and dead epithelium
  - coagulase-negative Staphylococci and micrococci
- Transient flora
  - cannot multiply on skin
  - easily removed by mechanical means
  - Pseudomonas and other Gram-negative rods
- Somewhere in between…
  - *S. aureus* and beta-hemolytic streptococci

# Purpose of Hand Hygiene

- Prevent cross transmission of microorganisms
  - from patient-to-patient
  - from body site to body site within the patient

## When to Wash Your Hands?

- Hands soiled - soap and water (>15 sec)
- Hands appear clean - use alcohol hand rub
- Decontaminate hands prior to:
  - Direct patient contact (and after contact)
  - Before inserting central IV or urinary catheter
  - Moving from a contaminated site to a clean site
  - Putting on gloves (and after)

HICPAC Guidelines: MMWR October 25, 2002

## Hand Hygiene Compliance by Profession

- Nurses and students

  Better than

**Compliance varies by individual More than by profession**

- Technicians/therapists

What can we do to improve hand hygiene in our hospitals?

## Be a Hand Hygiene Role Model

- Hypothesis: New hospital with better sink to patient ratios would improve hand hygiene compliance
- Poor compliance if senior member of medical team did not wash hands (OR=0.4, 95%CI 0.2 to 0.6)

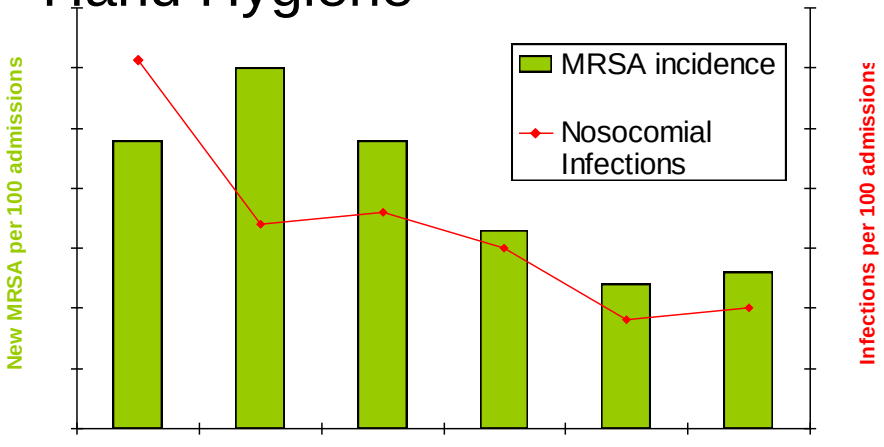
Lankford et al. EID, 2003

# Alcohol Rubs and Healthcare-Associated Infections

- Best study of hand hygiene Geneva hospital
- Alcohol hand rubs (in conjunction with hospital-wide campaign to increase compliance)
- Improved compliance (48% to 66%)
- Decreased
  - MRSA incidence (2.16 to 0.93 episodes per 10,000 patient days)
  - Overall nosocomial infections (17% to 10%)

Pittet, Lancet, 2000

# Infection Rates with Improved Hand Hygiene



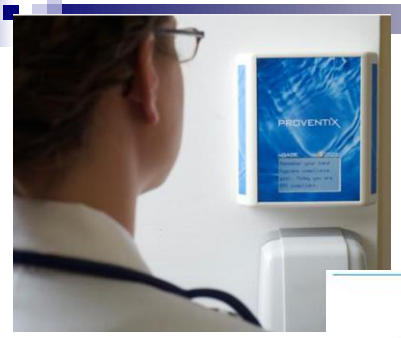

Pittet, Lancet 2000

## *C. difficile* and hand hygiene

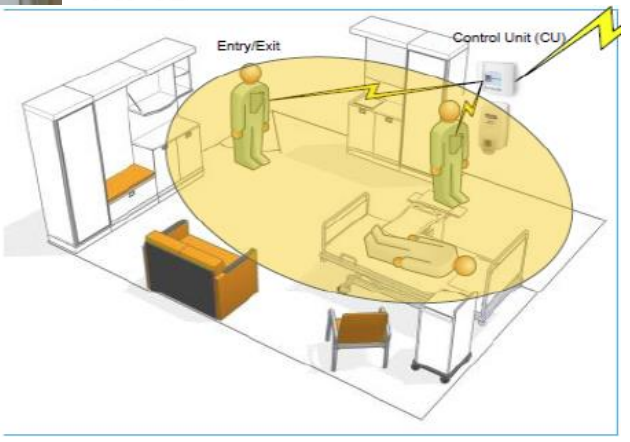
- Alcohol doesn't kill spores
- Recommend soap and water if hospital having a problem with *C. difficile*

Dubberke et al ICHE 2008

## New approaches to improving hand hygiene

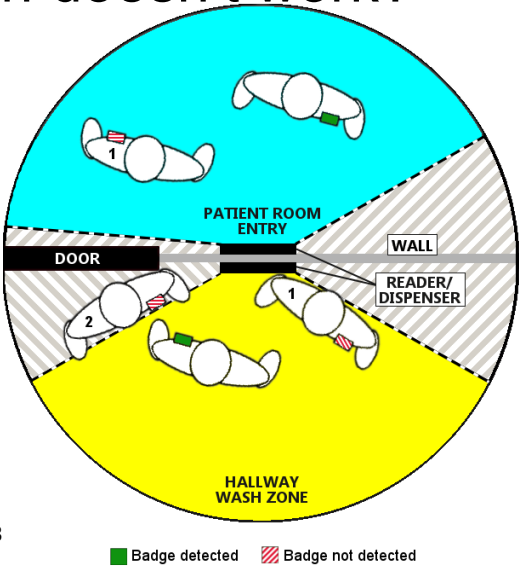



## Automated monitoring of Hand hygiene with RFID


## Why RFID often doesn't work?

- Bodies block RFID
- Fields difficult to orient




Pineles et al. AJIC 2013

# Automated monitoring of hand hygiene

- Many companies
- Many unsupported claims…e.g. “100% reduction in infections”
- Technology, so far, inadequate to monitor hand hygiene accurately (RFID, Alcohol detection, WiFi, infrared etc…)

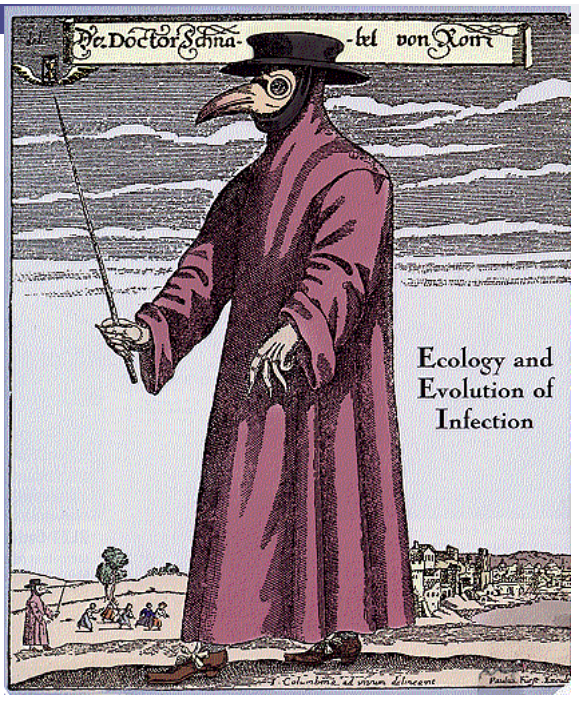
| Monitoring system | HCP tracking method |
|---|---|
| nGage™ | Badge |
| HyGreen | Badge |
| BIOVIGIL | Badge |
| Versus SafeHaven™ | Badge |
| UltraClenz Patient Safeguard System™ | Badge |
| Hyginex | Wristband |
| MedSense | Badge |
| HandGiene HHMS™ | Badge or wristband |
| IntelligentM | Wristband |

Pineles et al. AJIC in press

# How to do hand hygiene

**Handwashing is the single most important means of preventing the spread of infection.**

**Centers for Disease Control and Prevention**




May 11, 2001
Science

# Isolation Precautions: two tiers

**Standard Precautions**

**Transmission-Based Precautions**

# Standard Precautions – All Patients All The Time

- Gloves for contact with
  - blood or
  - any contaminated body fluid (wounds, diarrhea etc.)
- Gowns & goggles for splashes

## Control & Prevention based on Modes of Transmission of Infectious Agents

- **Contact**
  - Direct (body-to-body)
  - Indirect (e.g., fomites/environment, HCWs' hands)
- Large **Droplet** (>5 μm; travel 3-6 feet)
- Small Droplet (droplet nuclei ≤5 μm; remain **airborne**)

## Contact Precautions

- VRE, MRSA, multiple antibiotic resistant gram negative rods, *Clostridium difficile**
  - most common form of isolation
- private room
  - cohort same organisms
- gloves & gowns for any contact with patient or environment

*wash hands with soap and water for *C. difficile*

# How often do we use Contact Precautions?

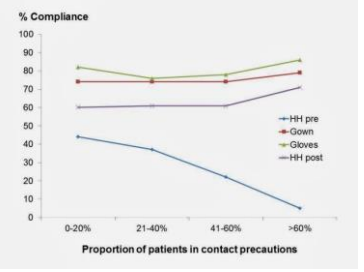
- 20 ICUs (BUGG)—Active surveillance for MRSA ~10%;  MRSA or VRE~18%
- All VAs—clinical cultures <2% + MRSA, active surveillance 14-16% + MRSA
- Prevalence one hospital: 11% ward, 22.4% ICU
- Over 11 US hospitals: 11% ward, 25% ICU

Jain et al NEJM 2011; Day et al JHI 2011; Harris et al JAMA 2013; Dhar et al ICHE 2014

# Effect of gloves and gowns on hand hygiene

- Recent studies argue <u>better HH on exit</u>
  1. BUGG Study:  Entry 56% vs. 50%
     Exit 78% vs. 63%
  2. Multicenter study: Entry 43% vs. 30%
     Exit 63% vs. 47%

3. 11 center US Study:
(thanks M. Edmond)

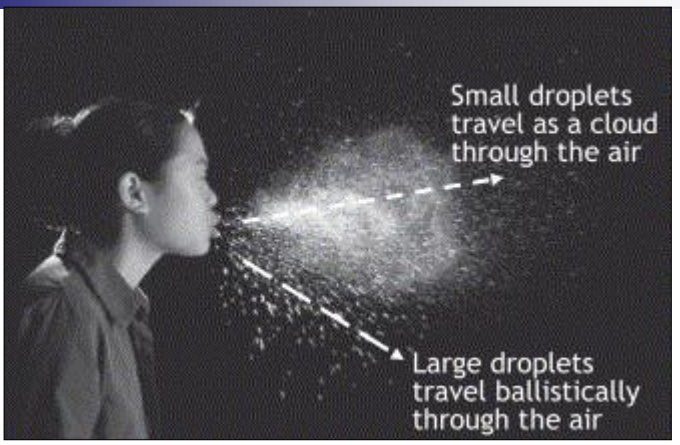



Harris et al JAMA 2013; Morgan et al ICHE 2013; Dhar et al ICHE 2014


# QUESTION

The most appropriate hospital room placement for a patient with seasonal influenza is:

1. No special precautions once anti-viral therapy initiated
2. Private room; surgical mask for patient contact (3-6 feet of patient)
3. Private room; surgical mask and gown to enter room
4. Private room with negative pressure
5. Private room, negative pressure and 100% exhaust



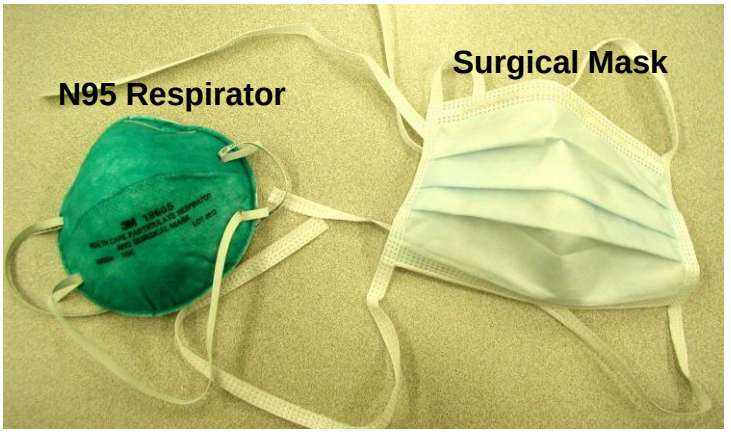

TB

Flu

Permission of Prof. Andrew Davidhazy, School of Photographic Arts and Sciences, Rochester Institute of Technology, Rochester NY, USA.

Tang JW et al, *J Hosp Infect* 2006

# Respiratory Protection



# Droplet precautions

- rationale
  - infectious particles are airborne, but large and fall out of the air within 3 feet of the patient
- examples
  - **influenza**, RSV, pertussis, meningococcus
- consist of
  - wear surgical masks for contact with in 6 feet
  - private room or cohort

# Airborne precautions

- rationale
  - infectious particles are airborne due to small
- examples
  - tuberculosis, varicella, measles, smallpox
- consists of
  - Negative pressure room
  - wearing approved respiratory protection to enter patient room


Figure 9: Principle of Operation

## Isolation Categories are Based on Modes of Transmission

| | Hand Hygiene | Private Room | Gloves | Gown | Mask | Eye Protection |
|---|---|---|---|---|---|---|
| Standard | **Yes** | PRN | PRN | PRN | PRN | PRN |
| Droplet | **Yes** | **Yes*** | PRN | PRN | **W/in 3 ft** | PRN |
| Contact | **Yes** | **Yes*** | **Yes** | **Yes** | PRN | PRN |
| Airborne | **Yes** | **AII** | PRN | PRN | **N95** | PRN |

* When possible; cohort if not possible. Avoid rooming with immunosuppressed or high risk patients. AII = Airborne Infection Isolation: negative pressure with no air recirculation (unless HEPA-filtered); 6-12 ACH.

## Do Contact Precautions work?

# Gowns and gloves are frequently contaminated

| Organism | Glove or Gown Contamination | Gown Contamination |
|---|---|---|
| VRE | 11% | 5% |
| MRSA | 16% | 5% |
| KPC | 14% | 3% |
| MDR *P. aeruginosa* | 14% | 3% |
| MDR *A. baumannii* | 33% | 13% |

Snyder et al ICHE 2008; Morgan et al ICHE 2010/CCM 2012; Rock et al ICHE 2014

# Reviews of Contact Precautions

- Cooper et al.
  - 4 studies with aggressive IC including CP were effective
  - 2 studies with endemic MRSA failed to show effect
- Marshall et al.
  - "unable to claim that our [MRSA isolation] practices are fully evidence-based and we question whether current guidelines can or should be followed"

Cooper et al BMJ 2004; Marshall et al. JHI 2004

## Are there harms from Contact Precautions?

## Patient Outcomes?

- ~30% fewer visits
- Possible delays in admit/discharge
- Adverse events
  - Mixed results
- Psychological effects
  - More depression in patients with MRSA/VRE
  - CP likely does not increase depression
- Patient satisfaction
  - Worse perception of care and satisfaction

# A few words on Disinfection Sterilization & Cleaning

## Bacteria live on surfaces

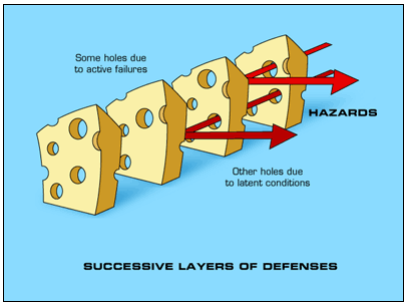
| Type of Bacteria | Duration of persistence (range) |
|---|---|
| *Acinetobacter* | 3 days -5 months |
| *C. difficile* | 5 months (spores) |
| *Enterococcus* | 5 days – 4 months |
| *Staphylococcus aureus* | 7 days – 7 months |

(yeast and viruses as well)

Kramer et al BMC ID 2006

## Therefore….

- There is a risk of inanimate surfaces remaining contaminated if not cleaned
- The higher the risk of the surface, the better it should be cleaned




## Definitions

- **Clean**: remove all visible soil (dust, blood, soil, organic material)
- **Disinfect**: eliminate most pathogenic microorganisms except spores
- **Sterilize**: completely eliminate or destroy all forms of microbial life by physical or chemical processes (pressurized steam, ethylene oxide, hydrogen peroxide gas)

# Selecting a Disinfectant

- Noncritical items:  come in contact with intact skin but not mucous membranes
  - bedpans, blood pressure cuffs--requires low level disinfection
- Semicritical items: contacts mucous membranes or non-intact skin
  - respiratory therapy and anesthesia equipment, endoscopes--requires high level disinfection
- Critical items: enters a normally sterile tissue, the vascular system or blood will flow through it
  - urinary or IV catheters--items must be sterile

# Common Disinfectants

- Chlorhexidine
  - skin preparation prior to surgery or procedures
- Alcohol
  - stethoscopes, rubber stoppers of vials
- Chlorine (bleach)/Hydrogen peroxide
  - counter tops, CPR mannequins, dialysis equipment, decontaminating blood spills
- Glutaraldehyde-like products
  - endoscopes
  - hemodialysers

# Chlorine bleach: sodium hypochlorate

- Rapidly
  - bacteriocidal,
  - tuberculocidal
  - fungicidal
  - virucidal
- Broad spectrum
- Inexpensive
- Low toxicity
- Corrosive
- Longer Contact time
- Employee complaints

**Uses: counter tops, dialysis equipment, decontaminating blood spills, rooms of *C. difficile***

# Activated hydrogen peroxide

- Similar to bleach
- Some have shorter contact time (as low as 1 minute)
- Active against C. diff spores (and other organisms)

# Fomites

- Stethoscopes
- BP cuffs
- Doctors ties

All become contaminated with use—MRSA, VRE, GNRs etc….

# Porous vs. non-porous

- Non-porous = smooth (e.g. countertop)
- Porous = textured (cloth, money etc.)

- Non-porous (smooth) appears better at transmission
- Porous hard to clean

Pope et al S. Med Journal 2012

# Fomites and transmission

- Capable of transmitting infections but no proven impact on transmission (few good studies)

Can be cleaned

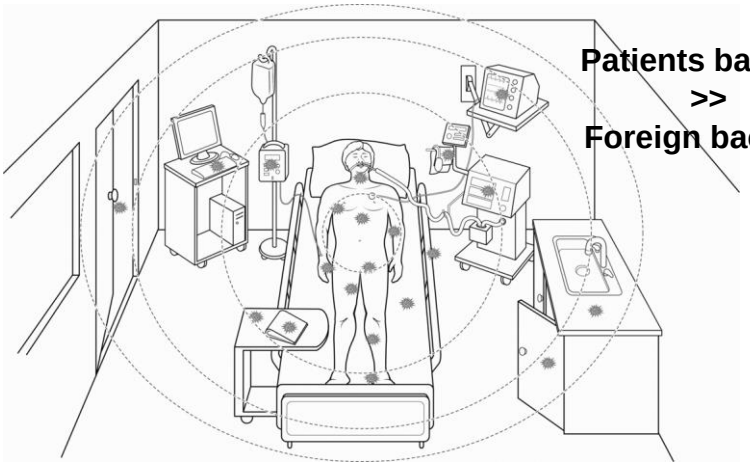
- Wiping stethoscopes with alcohol or similar
- Wash clothing with washing machine

# Protecting stethoscopes

- Silver impregnated diaphragm covers associated with *higher* colony counts!


Wood et al AJIC 2007

# Room Contamination



**Patients bacteria**
**>>**
**Foreign bacteria**

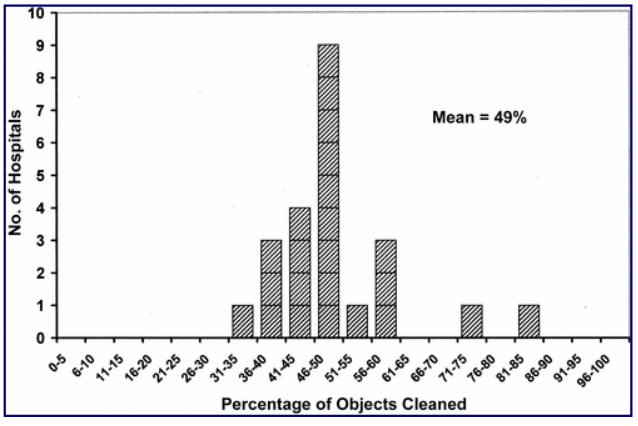
Lin & Hayden CCM 2010

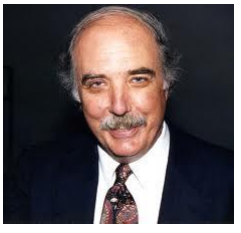
INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY JANUARY 2008, VOL. 29, NO. 1

ORIGINAL ARTICLE

## Identifying Opportunities to Enhance Environmental Cleaning in 23 Acute Care Hospitals

P. C. Carling, MD; M. F. Parry, MD; S. M. Von Beheren, RN, BSN, MS, CIC;
for the Healthcare Environmental Hygiene Study Group



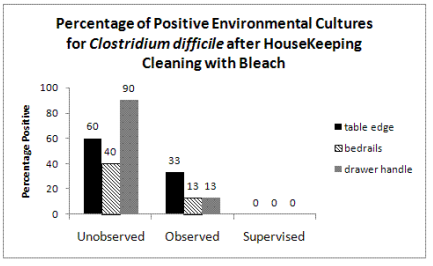



# Reducing contamination of the inanimate environment

- Cleaning
  - Standard
  - Touchless
    - HPV
    - UV
- Change the environment
  - Coat surfaces
  - Use different surfaces

# How to improve environmental cleaning

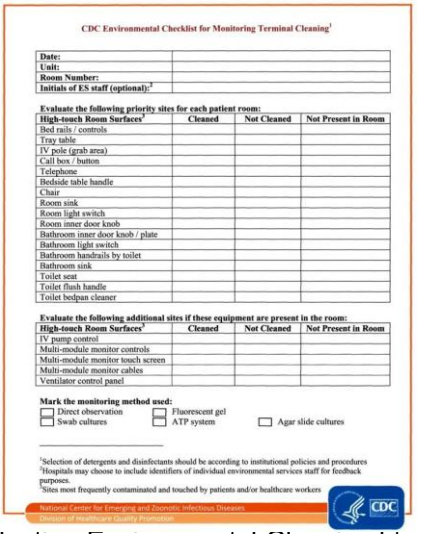
- Improve housekeeping
  - education, observation and supervision
- Implement new approaches to monitoring
- Invest in new technology




Guerrero 2010

# Environmental Cleaning Checklist

Checklist tool to make sure key areas are cleaned—available from the Centers for Disease Control and Prevention



CDC Environmental Checklist for Monitoring Terminal Cleaning[1]

| | |
|---|---|
| Date: | |
| Unit: | |
| Room Number: | |
| Initials of ES staff (optional):[2] | |

Evaluate the following priority sites for each patient room:

| High-touch Room Surfaces[3] | Cleaned | Not Cleaned | Not Present in Room |
|---|---|---|---|
| Bed rails / controls | | | |
| Tray table | | | |
| IV pole (grab area) | | | |
| Call box / button | | | |
| Telephone | | | |
| Bedside table handle | | | |
| Chair | | | |
| Room sink | | | |
| Room light switch | | | |
| Room inner door knob | | | |
| Bathroom inner door knob / plate | | | |
| Bathroom light switch | | | |
| Bathroom handrails by toilet | | | |
| Bathroom sink | | | |
| Toilet seat | | | |
| Toilet flush handle | | | |
| Toilet bedpan cleaner | | | |

Evaluate the following additional sites if these equipment are present in the room:

| High-touch Room Surfaces[3] | Cleaned | Not Cleaned | Not Present in Room |
|---|---|---|---|
| IV pump control | | | |
| Multi-module monitor controls | | | |
| Multi-module monitor touch screen | | | |
| Multi-module monitor cables | | | |
| Ventilator control panel | | | |

Mark the monitoring method used:

☐ Direct observation ☐ Fluorescent gel
☐ Swab cultures ☐ ATP system ☐ Agar slide cultures

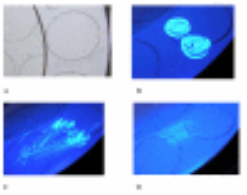
[1]Selection of detergents and disinfectants should be according to institutional policies and procedures
[2]Hospitals may choose to include identifiers of individual environmental services staff for feedback purposes.
[3]Sites most frequently contaminated and touched by patients and/or healthcare workers

National Center for Emerging and Zoonotic Infectious Diseases
Division of Healthcare Quality Promotion

http://www.cdc.gov/HAI/toolkits/Evaluating-Environmental-Cleaning.html

# Monitoring cleaning

- Direct observation
- Special Monitoring
  - Environmental cultures
  - Fluorescent Dye
  - ATP bioluminesence



# Hydrogen Peroxide vapor

- New technology
- Unclear benefit
- Only used for terminal cleaning (not daily)
- Significant time requirement for room to be unoccupied
- Expensive
- Must be used in addition to normal cleaning

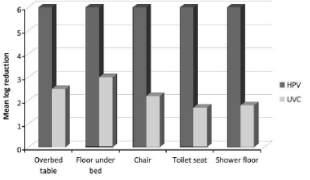
# UV decontamination

- New technology
- Unclear benefit
- Only used for terminal cleaning (not daily)
- Significant time requirement for room to be unoccupied
- Expensive
- Must be used in addition to normal cleaning

# Hydrogen peroxide vs. UV light

- Slower (~2 ½ hours)
- Kills more

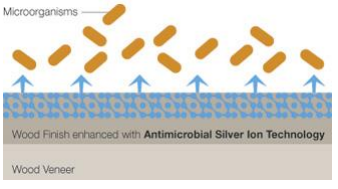
- Faster (~1 hour)
- Only kills organism in line of sight




Havill et al 2012

# Coating surfaces

- Lots of different materials

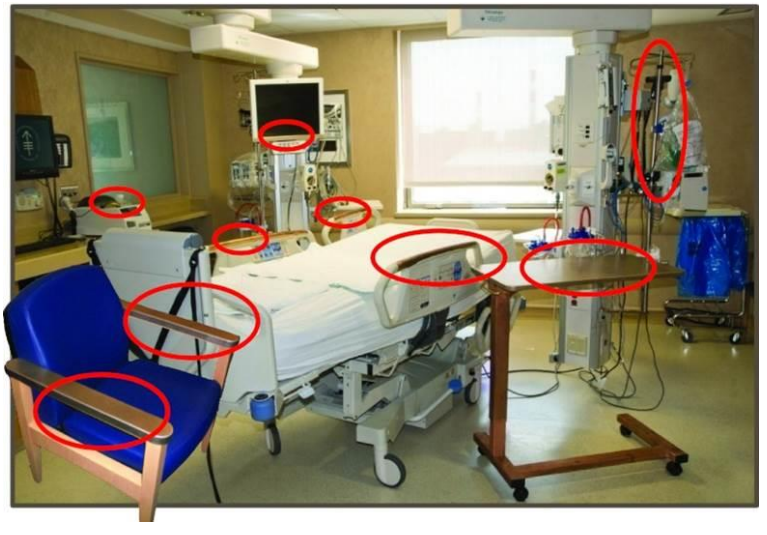




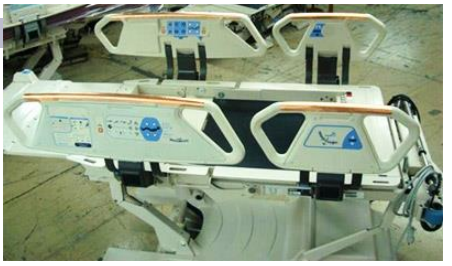
## Changing the environment

- Copper
  - Described by Hippocrates to treat leg ulcers
  - >60% copper
  - In vitro effect
  - Less contamination of copper pens vs. stainless steel


## Copper plating?



## copper



- Copper high touch surfaces vs. plastic, had lower colony counts prolonged after cleaning
- May reduce HAIs (biggest study involved 8 hospital beds and was not blinded)

Schmidt et al ICHE 2013;
Salgado et al ICHE 2013

## Treating surfaces summary

- Experimental in my opinion
  - Many surfaces
  - Buildup of bioburden likely makes function difficult
  - Lots of industry involvement

  Anyone looking for a research topic to develop?

# Summary

- Promote hand hygiene
  - Wash your hands
  - Be a leader and role model
- Promote compliance with isolation precautions
- Need for proper cleaning, disinfection, sterilization
- The environment could be cleaned better and likely transmits bacteria