Environmental Cleaning / Disinfection and Microbial Resistance

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Cleaning

Cleaning in healthcare facilities:
• What must be cleaned?
  Whatever is dirty or dusty!

Franz Daschner
Freiburg, Germany:
“A hospital must be an absolutely clean place”

Disinfection

• Elimination of pathogenic micro-organisms (excluding spores)
• Reduction level >= 5 log CFU (3 log CFU for surfaces)
• High-level disinfection: Killing of all microbial pathogens except large numbers of bacterial spores
• Low-level disinfection: Killing of most vegetative bacteria and lipid-enveloped viruses

Commonly used Disinfectants (surfaces)

• Alcohols (ethanol, propanol) fast antimicrobial action (60% to 90% concn.), excellent environmental properties
• Peracetic acid, hydrogen peroxide oxidizing high-level disinfect., good environm. properties, corrosive
• Quaternary ammonium compounds (quats, i.e. benzalkoniumchloride) low-level disinfect., allergens, environm. concerns
• Chlorine and chlorine-releasing compounds (i.e. sodium hypochlorite) high-level disinfect. (>1,000 ppm); environmental concerns
• Glucoprotamine broad spectrum, good material compatibility, non-irritating

How long do nosocomial pathogens persist on inanimate surfaces?
A systematic review

“CONCLUSION:
The most common nosocomial pathogens may well survive or persist on surfaces for months … and can thereby be a continuous source of transmission if no regular preventive surface disinfection is performed.”

Kramer A et al.: BMC Infect Dis 2006: 6:130

Patient environment

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Pathogens in the hospital environment

- Some pathogens, notably *Pseudomonas* spp., mostly in damp places (sinks, showers and baths)
- *C. difficile* and enterococci/VRE, prefer toilet areas or commodes
- Staphylococci (including MRSA) and *Acinetobacter* settle on surfaces such as shelves, equipment
- *Klebsiella* spp. and *Serratia* spp.: buckets, bowls, mops and liquids
- *Norovirus*: widely spread during outbreaks

Role of hospital surfaces in the transmission of emerging health care-associated pathogens: *Norovirus*, *C. difficile*, and *Acinetobacter* spp.

- Evidence suggests that environmental contamination plays a role in the nosocomial transmission of *norovirus*, *C. difficile*, and *Acinetobacter* spp.
- Infections have been associated with frequent surface contamination (hospital rooms and health care worker hands)
- In some cases, the extent of patient-to-patient transmission has been found to be directly proportional to the level of environmental contamination

Multi-resistant Gram-negative versus Gram-positive bacteria in the hospital environment (I)

- 20 different locations around 190 patients surveyed (harbouring multi-resistant Gram-pos. or Gram-neg. bacteria)
- Detection rate for MRSA or VRE: 24.7% (174/705); multi-resistant Gram-neg. bacteria: 4.9% (89/1827) (P<0.001)
- Gram-pos. bacteria isolated more frequently than Gram-neg. from hands of patients (P<0.001) and personnel (P=0.115)

Multi-resistant Gram-negative versus Gram-positive bacteria in the hospital environment (II)

- Environmental contamination did not differ between ICUs and the general wards (GW)
- “… noteworthy because our ICUs are routinely disinfected twice a day, whereas GWs are cleaned just once a day with detergent.”

Management of an outbreak of vancomycin-resistant enterococci (VRE) in a German university hospital (III)

- Literature review of strategies to control VRE in hospitals
- Outbreak investigation of VRE in a German hospital
- Control measures implemented to prevent further transmission

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Contamination after contact with VRE-colonized patients

- Observational study (routine clinical care)
- Medical ICU (700-bed, tertiary-care teaching hospital, Chicago)
- Proportions of body sites and environmental sites positive for VRE highly correlated (r = 0.7; P < .001)
- HCWs nearly as likely to have contaminated their gloved or ungloved hands after touching an environmental surface in the room of a VRE+ patient as after touching both the patient and the patient’s environment
- Rates of contamination: 52% and 70%, respectively

Hayden MK et al.: ICH 2008; 29: 149

Reduction in acquisition of VRE after enforcement of routine environmental cleaning measures (I)

- Effects of improved environmental cleaning (with and without promotion of hand hygiene) on spread of VRE in a medical ICU (748 admissions, 9-month)
- Baseline (period 1)
- Improved environmental cleaning (period 2)
- "washout" (period 3)
- Multimodal hand hygiene intervention (period 4)

Hayden MK et al.: CID 2006; 42: 1552

Reduction in acquisition of VRE after enforcement of routine environmental cleaning measures (II)

- VRE acquisition rates:
  - 33.5 cases per 1000 patient-days at risk (period 1)
  - 16.8, 12.1, and 10.4 cases per 1000 pt.-days (periods 2, 3, 4)

Hayden MK et al.: CID 2006; 42: 1552

Reduction in acquisition of VRE after enforcement of routine environmental cleaning measures (III)

- Hazard ratio for acquiring VRE during periods 2-4: 0.36 (95% CI: 0.19-0.68)
- Only determinant explaining the difference in VRE acquisition was admission to the intensive care unit during period 1
- CONCLUSIONS: Decreasing environmental contamination may help to control the spread of some antibiotic-resistant bacteria in hospitals

Hayden MK et al.: CID 2006; 42: 1552

Environmental cleaning intervention and risk of acquiring MDROs from prior room occupants

[Datta R et al., Arch Intern Med 2011; 171: 491]

METHODS:
- Feedback: black-light marker, cleaning cloths saturated with disinfectant, increased education

RESULTS:
- Acquisition of MRSA and VRE lowered: 3.0% =< 1.5% for MRSA and 3.0% =< 2.2% for VRE (P < .001, both)
- Patients in rooms previously occupied by VRE carriers: increased risk of acquisition during baseline (4.5% vs 2.8%) and intervention periods (3.5% vs 2.0%, P < .001, both)

CONCLUSIONS:
- Enhanced ICU cleaning (intervention methods may reduce MRSA and VRE transmission
- It may also eliminate the risk of MRSA acquisition due to an MRSA-positive prior room occupant

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**Clostridium difficile** skin contamination in patients with **C. difficile**--associated disease

- Prospective study of 27 patients with CDAD
- **C. difficile** frequently contaminated multiple skin sites: groin, chest, abdomen, forearms, and hands
- **C. difficile** was easily acquired on investigators’ hands
- Skin contamination often persisted on patients’ chest and abdomen after resolution of diarrhea

Bobulsky GS et al., CID 2008; 46: 447

Effect of detergent vs. hypochlorite cleaning on environmental contamination and incidence of **C. difficile** infection

- Cross-over study on two elderly medicine wards to determine whether cleaning with a hypochlorite disinfectant was better than using neutral detergent
- Significant decrease of CDI incidence on ward X, from 8.9 to 5.3 cases per 100 admissions (P < 0.05) using hypochlorite; incidence of CDI significantly associated with the proportion of culture-positive environmental sites (P < 0.05)
- Use of hypochlorite for environmental cleaning may significantly reduce incidence of CDI (but: potential for confounding factors)

Wilcox MH et al., Journal of Hospital Infection 2003; 54: 109–14

Multiple reservoirs contribute to intraoperative bacterial transmission

- Multicenter study: stopcock transmission events observed in 274 operating rooms; 1st and 2nd cases of the day in each OR studied in series to identify within- and between-case transmission
- Stopcock contamination detected in 23% (126 out of 548 cases)
- The environment was a more likely source of stopcock contamination than provider hands (RR 1.91, CI 1.09 - 3.35, P = 0.029) or patients (RR 2.56, CI 1.34 - 4.89, P = 0.002)
- Stopcock contamination associated with increased mortality (OR 58.5, CI 2.32 - 1477, P = 0.014)

Loftus RW et al., Anesth Analg 2012; 114: 1236-48

**Surface disinfection**

German Guideline (2004)
CONTRA surface disinfection?

- Contra immediate removal of spillage (blood, urine, etc.) with a disinfectant/detergent? No
- Contra routine surface disinfection? (Yes)

Why?

- "There is no difference in hospital-acquired infection rates when floors are cleaned with detergent vs. disinfectant"
- 1 – 2 hours after floor disinfection identical number of bacteria as prior to disinfection
  [Ayliffe GAJ et al. BMJ 1966; 2: 442]

Surface disinfection: Yes and No

How may disinfectants harm the environment?

- By causing resistant bacteria (QAV) and affecting sewage treatment performance
- By forming organic halogen compounds (AOX - especially sodium hypochlorite)
- By contaminating surface water

Bacterial adaption and resistance to antiseptics, disinfectants and preservatives

"There are current concerns about the usage of quaternary ammonium compounds, chlorhexidine and triclosan and possible bacterial resistance to them and to antibiotics."

"It is thus essential that disinfectants should be employed only when necessary and then only with the full appreciation of the factors influencing their activity and of the mechanisms involved in bacterial insusceptibility."

[Russell AD: Bacterial adaption and resistance to antiseptics, disinfectants and preservatives is not a new phenomenon. J Hosp Infect 2004, 57: 97-104]

Use of antibacterial consumer products containing quaternary ammonium compounds and drug resistance

- Exposure of bacteria to antibacterial-containing products (QACs) may exert a selective pressure resulting in the co-selection of genes encoding reduced susceptibility for both biocides and antibiotics

Aiello AE, Larson EL, Levy SB. Consumer antibacterial soaps: effective or just risky? CID 2007; 45 Suppl 2: S137

Carson RT et al., JAC 2008; Aug. 11
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Surface disinfection: efficacy and safety issues

- Peroxygen compounds show good sporidical properties and will probably replace more problematical substances such as chlorine-releasing agents
- Scientific data support the need for proper use of disinfectants, i.e. avoidance of widespread application, especially in low concentrations and in consumer products
- There is a need for well-designed studies addressing the role of disinfection in infection control

Dettenkofer M, Spencer RC. JHI 2007;65(S2):55–7

Hospital cleaning in the 21st century (I)

- Cleaning practices should be tailored to clinical risk, given the wide-ranging surfaces, equipment and building design
- There is confusion between nursing and domestic personnel over the allocation of cleaning responsibilities (neither may receive sufficient training and/or time to complete their duties)
- Fear of infection encourages the use of powerful disinfectants for the elimination of real or imagined pathogens in hospitals


Hospital cleaning in the 21st century (II)

- Not only do these agents offer false assurance against contamination, their disinfection potential cannot be achieved without the prior removal of organic soil (=cleaning)
- Hospital cleaning deserves further investigation for routine and outbreak practices


Proper cleaning procedures
Targeted surface disinfection

Cleaning and disinfection are established components of hospital infection control, and special situations require special actions (infected or severely immuno-compromised patients; multi-resistant pathogens)

Do not use surface disinfectants for convenience!
Routine disinfection of frequently touched surfaces is indicated in special settings
But: Compliance with hand hygiene is of greater importance


Coming Soon

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