

Disinfection and Sterilization: Challenges in the XXI Century

William A. Rutala, Ph.D., M.P.H.
University of North Carolina (UNC) Health Care and UNC
at Chapel Hill, NC
Disclosure: Advanced Sterilization Products

Disinfection and Sterilization: Challenges in the XXI Century

- Disinfection and sterilization principles
- Challenges
 - Emerging pathogens
 - ◆ Norovirus and *C. difficile* spores
 - ◆ CJD
 - Reprocessing complex medical instruments
 - ◆ Compliance and new AERs/HLDs
 - Compliance and practice
 - ◆ Surface disinfection
 - New Technologies/Products
 - ◆ Critical-Class 6 chemical indicator
 - ◆ Semicritical items-new AERs/HLDs
 - ◆ Noncritical-surface disinfection
 - Microfiber
 - Computer disinfection

disinfectionandsterilization.org

Disinfection and Sterilization

EH Spaulding believed that how an object will be disinfected/sterilized depended on the object's intended use.

CRITICAL - objects which enter normally sterile tissue or the vascular system or through which blood flows should be **sterile**.

SEMICRITICAL - objects that touch mucous membranes or skin that is not intact require a disinfection process (**high-level disinfection [HLD]**) that kills all microorganisms but high numbers of bacterial spores.

NONCRITICAL - objects that touch only intact skin require **low-level disinfection**.

Critical Objects

- Surgical instruments
- Cardiac catheters
- Implants

Sterilization of “Critical Objects”

Steam sterilization
Hydrogen peroxide gas plasma
Ethylene oxide
Peracetic acid (0.2%)-chemical sterilization
Ozone
Vaporized hydrogen peroxide

Semicritical Items

- Endoscopes
- Respiratory therapy equipment
- Anesthesia equipment
- Endocavitary probes
- Tonometers
- Diaphragm fitting rings

High Level Disinfection of “Semicritical Objects”

Exposure Time \geq 12 m-30m (US), 20°C

Germicide	Concentration
Glutaraldehyde	\geq 2.0%
Ortho-phthalaldehyde (12 m US)	0.55%
Hydrogen peroxide*	7.5%
Hydrogen peroxide and peracetic acid*	1.0%/0.08%
Hydrogen peroxide and peracetic acid*	\geq 7.35%/ \geq 0.23%
Hypochlorite (free chlorine)*	650-675 ppm
Glut and phenol/phenate	1.21%/1.93%
Glut and alcohol	3.4%/26% IPA

*May cause cosmetic and functional damage

Low-Level Disinfection for “Noncritical” Objects

Germicide	Exposure time \geq 1 min Use Concentration
Ethyl or isopropyl alcohol	70-90%
Chlorine	100ppm (1:500 dilution)
Phenolic	UD
Iodophor	UD
Quaternary ammonium	UD
Accelerated hydrogen peroxide	0.5%

UD=Manufacturer’s recommended use dilution

Disinfection and Sterilization: Challenges in the XXI Century

- Disinfection and sterilization principles
- Challenges
 - Emerging pathogens
 - ◆ Norovirus and *C. difficile* spores
 - ◆ CJD
 - Reprocessing complex medical instruments
 - ◆ Compliance and new AERs/HLDs
 - Compliance and practice
 - ◆ Surface disinfection
 - New Technologies/Products
 - ◆ Critical-Class 6 chemical indicator
 - ◆ Semicritical items-new AERs/HLDs
 - ◆ Noncritical-surface disinfection
 - Microfiber
 - Computer disinfection

***C. difficile* spores**

Environmental Contamination ***C. difficile***

- 25% (117/466) of cultures positive (<10 CFU) for *C. difficile*. >90% of sites positive with incontinent patients. Samore et al. Am J Med 1996;100:32.
- 31.4% of environmental cultures positive for *C. difficile*. Kaatz et al. Am J Epid 1988;127:1289.
- 9.3% (85/910) of environmental cultures positive (floors, toilets, toilet seats) for *C. difficile*. Kim et al. J Inf Dis 1981;143:42.
- 29% (62/216) environmental samples were positive for *C. difficile*. 8% (7/88) culture-negative patient, 29% (11/38) positive cultures in rooms occupied by asymptomatic patients and 49% (44/90) in rooms with patients who had CDAD. NEJM 1989;320:204
- 10% (110/1086) environmental samples were positive for *C. difficile* in case-associated areas and 2.5% (14/489) in areas with no known cases. Fekety et al. Am J Med 1981;70:907.

Role of the Environment

C. difficile

- The presence of *C. difficile* on the hands correlated with the density of environmental contamination. Samore et al. Am J Med 1996;100:32.
 - 0-25% environmental sites positive-0% hand cultures positive
 - 26-50% environmental sites positive-8% hand cultures positive
 - >50% environmental sites positive-36% hand cultures positive
- 59% of 35 HCWs were *C. difficile* positive after direct contact with culture-positive patients.
- *C. difficile* incidence data correlated significantly with the prevalence of environmental *C. difficile*. Fawley et al. Epid Infect 2001;126:343.
- Environmental contamination may play a role in nosocomial CDAD in endemic situations. Cohen et al. Clin Infect Dis 200;30:952.

Disinfectants and Antiseptics

C. difficile spores at 20 min, Rutala et al, 2006

- No measurable activity (1 *C. difficile* strain, J9)
 - CHG
 - Vesphene (phenolic)
 - 70% isopropyl alcohol
 - 95% ethanol
 - 3% hydrogen peroxide
 - Clorox disinfecting spray (65% ethanol, 0.6% QUAT)
 - Lysol II disinfecting spray (79% ethanol, 0.1% QUAT)
 - TBQ (0.06% QUAT); QUAT may increase sporulation capacity- Lancet 2000;356:1324
 - Novaplus (10% povidone iodine)
 - Accel (0.5% hydrogen peroxide)

Disinfectants and Antiseptics

C. difficile spores at 10 and 20 min, Rutala et al, 2006

- ~4 log₁₀ reduction (5 *C. difficile* strains including BI-9)
 - Clorox, 1:10, ~6,000 ppm chlorine (but not 1:50, ~1,200 ppm)
 - Clorox Clean-up, ~1,910 ppm chlorine
 - Tilex, ~25,000 ppm chlorine
 - Steris 20 sterilant, 0.2% peracetic acid
 - Cidex, 2.4% glutaraldehyde
 - Cidex-OPA, 0.55% OPA
 - Wavicide, 2.65% glutaraldehyde
 - Aldahol, 3.4% glutaraldehyde and 26% alcohol

Control Measures

C. difficile

- Handwashing (soap and water) , contact precautions, and meticulous environmental cleaning (disinfect all surfaces) with an EPA-registered disinfectant should be effective in preventing the spread of the organism. McFarland et al. NEJM 1989;320:204.
- In units with high endemic *C. difficile* infection rates or in an outbreak setting, use dilute solutions of 5.25-6.15% sodium hypochlorite (e.g., 1:10 dilution of bleach) for routine disinfection. (Category II)
- For semicritical equipment, glutaraldehyde (20m), OPA (12m) and peracetic acid (12m) reliably kills *C. difficile* spores using normal exposure times

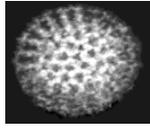
Decontamination with Hydrogen Peroxide Vapor

Boyce et al: ICHE 2008;29:723

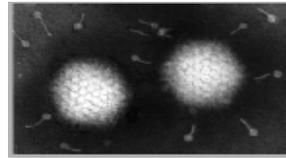
- 5 wards with a high incidence of *C. difficile*
- HPV was injected into sealed wards and individual patient rooms using generators until approx 1 micron film of HP was achieved on the surface
- 11/43 (25.6%) surface samples yielded *C. difficile* compared to 0/27 (0%) after HPV decontamination
- The incidence of nosocomial CDAD was significantly lower during the intervention period
- Conclusion: HPV was efficacious in eradicating *C. difficile* from contaminated surfaces

Norovirus

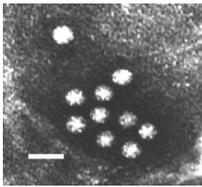
Virus Morphology



Rotavirus (60-80 nm)



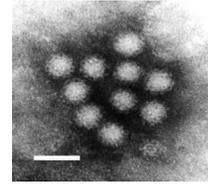
Adenovirus (70-90 nm)



Astrovirus (27-30 nm)



Sapovirus (27-35 nm)



Norovirus (27-35 nm)

www.virology.net/Big_Virology/BV/FamilyIndex.html

Noroviruses

- Norovirus (formerly Norwalk-like viruses-NLV) is a genus within the family *Caliciviridae*. SS-RNA with a capsid structure provides increased resistance to chemical disinfection.
- Causes acute gastroenteritis in humans; fecal-oral transmission primarily, although droplet and fomite transmission may facilitate spread.
- Infective dose as low as 10-100 particles.
- Outbreaks have been reported in hospitals, homes, camps, schools, restaurants, hotels, rehabilitation centers and cruise ships
- Outbreaks in hospitals have increased in recent years and this may lead to the closure of wards
- This group of viruses cannot be grown in cell culture so feline calicivirus used as a surrogate

Environmental Contamination

Norovirus

- Hospital-11/36 (31%) environmental swabs were positive for RT-PCR. Positive swabs were from lockers, curtains and commodes and confined to the immediate environment of symptomatic patients. *J Hosp Infect* 1998;39:39.
- Hotel-61/144 (42%) were positive for NLV RNA. Cheesbrough et al. *Epid. Infect* 2000;125:93.
- Rehabilitation Center-Norovirus detected from patients and three environmental specimens (physiotherapy instrument handle, toilet seat (2-room of symptomatic guest, public toilet) RT-PCR. *Epid Infect* 2002;129:133-138.
- LTCF-5/10 (50%) of the environmental samples were positive for norovirus by RT-PCR. Wu et al. *ICHE* 2005;26:802.

Some positive PCR results may represent non-infectious virus.

Environmental Survival

Norovirus

- Distilled water or saline: Survival 0-2 days West AP, et al. *J Clin Path* 1992;48:228
- Sterile river water: Survival 2 to 20-30 days Shahamat M, et al. *Appl Environ Micro* 1993;59:1231
- Tap water at 4°C: 4 days Fan EG, et al. *J Gastroenterol Hepatol* 1998;13:1096
- At 20°C a 9-log₁₀ reduction of FCV between 21-28 days in a dried state Doultree et al. *J Hosp Infect* 1999;41:51
- At 20°C a 9-log₁₀ reduction of FCV between 14-21 days in suspension Doultree et al. *J Hosp Infect* 1999;41:51
- At 20°C a 3-log₁₀ reduction in infectivity (two animal caliciviruses) occurred in 1 week. Duizer et al. *Appl Env Micro* 2004;70:4538.

Role of the Environment Norovirus

1. Prolonged outbreaks on ships suggest NLV survives well
2. Outbreak of GE affected more than 300 people who attended a concert hall over a 5-day period. Norwalk-like virus (NLV) confirmed in fecal samples by RT-PCR. The index case was a concert attendee who vomited in the auditorium. GI illness occurred among members of 8/15 school parties who attended the following day. Disinfection procedure was poor. Evans et al. *Epid Infect* 2002;129:355
3. Extensive environmental contamination of a hospital ward.
Suggest transmission most likely occurred through direct contact with contaminated fomites.

Inactivation of Feline Caliciviruses

Doutree et al. *J Hosp Infect* 1999;41:51

Disinfectant	Log Reduction	Contact Time
Glutaraldehyde, 0.5%	5	1
Hypochlorite, 1000 and 5000 ppm	5	1
QUAT	0	1
Iodine, 0.8%	5	1
Ethanol, 75%	1.25	1

INACTIVATION OF MURINE AND HUMAN NOROVIRUES

Rutala WA, Folan MP, Tallon LA, Lyman WH, Park GW, Sobsey MD, Weber DJ. 2007

Disinfectant, 1 min	MNV Log ₁₀ Reduction	HNV Log ₁₀ Reduction
70% Isopropyl alcohol	4.2	2.2
0.5% Accel H ₂ O ₂	3.9	2.8
79% Ethanol + QUAT	3.4	3.6
Chlorine (24,000ppm)	2.4	4.3
Phenolic, QUAT, Ag, 3% H ₂ O ₂	≤1	≤1 (2.1 QUAT)

Surface Disinfection

Norovirus

- School outbreak of NLV-cleaning with QUAT preparations made no impact on the course of the outbreak. The outbreak stopped after the school closed for 4 days and was cleaned using chlorine-based agents. Marks et al. *Epid Inf* 2003;131:727
- Detergent-based cleaning to produce a visibly clean surface consistently failed to eliminate norovirus contamination. A hypochlorite/detergent formulation of 5000 ppm chlorine was sufficient to decontaminate surfaces. Barker et al. *J Hosp Infect* 2004;58:42.

***C. difficile* and Norovirus**

Due to the relative resistance of *C. difficile* spores and norovirus, during clusters, surfaces should be disinfected with a product shown to be effective (e.g., chlorine 5000ppm [1:10 bleach])

Creutzfeldt Jakob Disease (CJD): Disinfection and Sterilization

(not in CDC Guideline now but in AORN)

Prion Diseases

- Etiology
 - Prions
 - ◆ Proteinaceous infectious agent
 - ◆ No agent-specific nucleic acid
 - ◆ Host protein converts to pathologic isoform
 - ◆ Accumulates in neural cells, disrupts function
 - ◆ Resistant to conventional D/S procedures

Decreasing Order of Resistance of Microorganisms to Disinfectants/Sterilants

Prions
Spores
Mycobacteria
Non-Enveloped Viruses
Fungi
Bacteria
Enveloped Viruses



CJD : potential for secondary spread through contaminated surgical instruments

Iatrogenic Transmission of CJD

- Contaminated medical instruments
 - Electrodes in brain (2)
 - Neurosurgical instruments in brain (4)
- Dura mater grafts (>110)
- Corneal grafts (3)
- Human growth hormone and gonadotropin (>130)

Risk Assessment for Special Prion Reprocessing: Patient, Tissue, Device

- High-Risk Patient
 - Known or suspected CJD or other TSEs
 - Rapidly progressive dementia
 - Familial history of CJD, GSS, FFI
 - History of dura mater transplant, cadaver-derived pituitary hormone injection
- High-Risk Tissue
 - Brain, spinal cord, eyes
- High-Risk Device
 - Critical or semicritical

CJD: Disinfection and Sterilization Conclusions

- Critical/Semicritical-devices contaminated with high-risk tissue from high-risk patients requires special prion reprocessing
 - NaOH and steam sterilization (e.g., 1N NaOH 1h, 121°C 30 m)
 - 134°C for 18m (prevacuum)
 - 132°C for 60m (gravity)
- No low temperature sterilization technology effective*
- Noncritical-four disinfectants (e.g., chlorine, Environ LpH) effective (4 log decrease in LD₅₀ within 1h)

*VHP reduced infectivity by 4.5 logs (Lancet 2004;364:521)

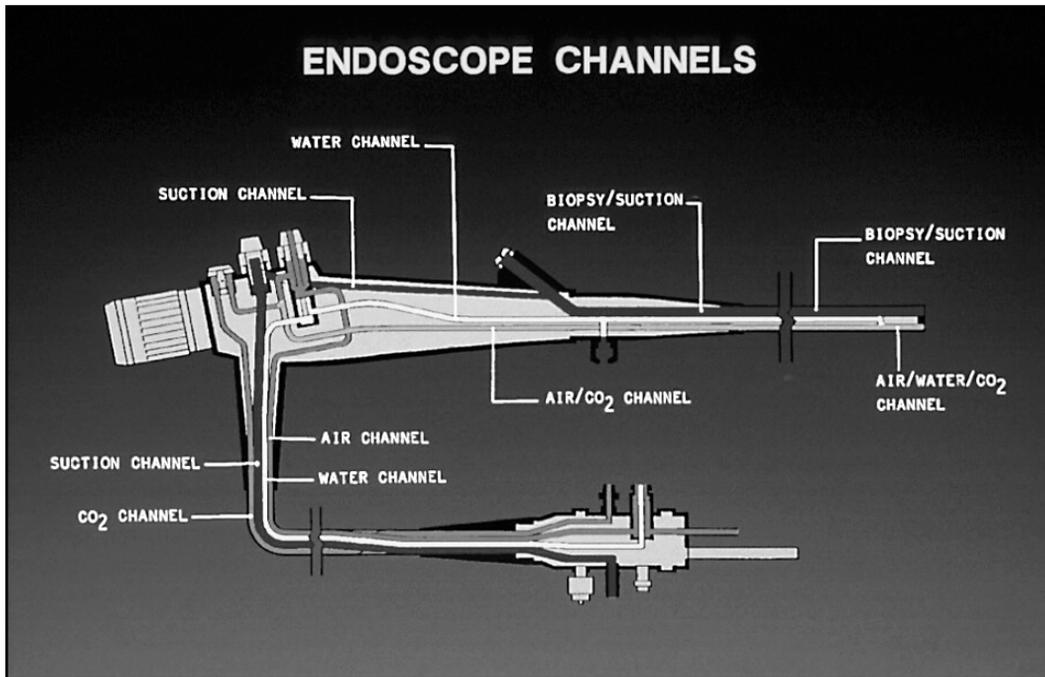
Inactivation of Prions

Recent Studies

- Yan et al. Infect Control Hosp Epidemiol 2004;25:280.
 - Enzymatic cleaner (EC)-no effect
- Fichet et al. Lancet 2004;364:521.
 - Phenolic (Environ LpH), alkaline cleaner (AC), EC+VHP-effective
- Baier et al. J Hosp Infect 2004;57:80. AC-effective
- Lemmer et al. J Gen Virol 2004;85:3805.
 - SDS/NaOH, AC, 0.2% PA, 5% SDS-effective (in vitro)
- Jackson et al. J Gen Virol 2005;86:869. E (Pronase, PK)-effective
- Race R and Raymond G. J Virol 2004;78:2164.
 - Environ LpH-effective
- Peretz et al. J Virol 2006;80:1. Acidic SDS and SDS+SS-effective
- Fichet et al. JHI 2007;67:278. Gaseous HP-effective

Disinfection and Sterilization: Challenges in the XXI Century

- Disinfection and sterilization principles
- Challenges
 - Emerging pathogens
 - ◆ Norovirus and *C. difficile* spores
 - ◆ CJD
 - Reprocessing complex medical instruments
 - ◆ Compliance and new AERs/HLDs
 - Compliance and practice
 - ◆ Surface disinfection
 - New Technologies/Products
 - ◆ Critical-Class 6 chemical indicator
 - ◆ Semicritical items-new AERs/HLDs, endocavitary
 - ◆ Noncritical-surface disinfection
 - Microfiber
 - Computer disinfection



TRANSMISSION OF INFECTION

- Gastrointestinal endoscopy
 - >300 infections transmitted
 - 70% agents *Salmonella sp.* and *P. aeruginosa*
 - Clinical spectrum ranged from colonization to death (~4%)
- Bronchoscopy
 - 90 infections transmitted
 - *M. tuberculosis*, atypical *Mycobacteria*, *P. aeruginosa*

Spach DH et al Ann Intern Med 1993; 118:117-128 and Weber DJ, Rutala WA Gastroint Dis 2002;87

Errors in designing and reprocessing semicritical items continue and place patients at risk of infection

Endoscope Reprocessing, Worldwide

- Worldwide, endoscopy reprocessing varies greatly
 - India, of 133 endoscopy centers, only 1/3 performed even a minimum disinfection (1% glut for 2 min)
 - Brazil, “a high standard ...occur only exceptionally”
 - Western Europe, $\geq 30\%$ did not adequately disinfect
 - Japan, found “exceedingly poor” disinfection protocols
 - US, 25% of endoscopes revealed $>100,000$ bacteria

Schembre DB. Gastroint Endoscopy 2000;10:215

ENDOSCOPE DISINFECTION

- CLEAN-mechanically cleaned with water and enzymatic cleaner
- HLD/STERILIZE-immerse scope and perfuse HLD/sterilant through all channels for at least 12 min
- RINSE-scope and channels rinsed with sterile water, filtered water, or tap water followed by alcohol
- DRY-use forced air to dry insertion tube and channels
- STORE-prevent recontamination

High Level Disinfection of “Semicritical Objects”

Exposure Time \geq 12 m-30m (US), 20°C

Germicide	Concentration
Glutaraldehyde	\geq 2.0%
Ortho-phthalaldehyde (12 m)	0.55%
Hydrogen peroxide*	7.5%
Hydrogen peroxide and peracetic acid*	1.0%/0.08%
Hydrogen peroxide and peracetic acid*	7.5%/0.23%
Hypochlorite (free chlorine)*	650-675 ppm
Glut and phenol/phenate**	1.21%/1.93%

*May cause cosmetic and functional damage; **efficacy not verified

Nosocomial Infections via GI Endoscopes

- Infections traced to deficient practices
 - Inadequate cleaning (clean all channels)
 - Inappropriate/ineffective disinfection (time exposure, perfuse channels, test concentration, ineffective disinfectant, inappropriate disinfectant)
 - Failure to follow recommended disinfection practices (tapwater rinse)
 - Flaws in design of endoscopes or AERs

ENDOSCOPE REPROCESSING

- Inappropriate disinfectants
 - Benzalkonium chloride (Greene WH. Gastroenterol 1974;67:912)
 - 70% alcohol (Elson CO. Gastroenterol 1975;69:507)
 - QUAT (Tuffnell PG. Canad J Publ Health 1976;67:141)
 - Hexachlorophene (Dean AG. Lancet 1977;2:134)
 - Hexachlorophene (Beecham HJ. JAMA 1979;1013)
 - 70% alcohol (Parker HW. Gastro Endos 1979;25:102)
 - Povidone-iodine (Low DE. Arch Intern Med 1980;1076)
 - Cetrimonium bromide. (Schliessler KH. Lancet 1980;2:1246)

ENDOSCOPE SAFETY

- Ensure protocols equivalent to guidelines from professional organizations (APIC, SGNA, ASGE)
- Are the staff who reprocess the endoscope specifically trained in that job?
- Are the staff competency tested at least annually?
- Conduct IC rounds to ensure compliance with policy
- Perform microbiologic testing of the endoscope or rinse water-no recommendation (unresolved issue)

Automatic Endoscope Reprocessors (AERs)

- Manual cleaning of endoscopes is prone to error.
- AER Advantages: automate and standardize reprocessing steps, reduce personnel exposure to chemicals, filtered tap water
- AER Disadvantages: failure of AERs linked to outbreaks, does not eliminate precleaning, does not monitor HLD concentration
- Problems: incompatible AER (side-viewing duodenoscope); biofilm buildup; contaminated AER; inadequate channel connectors; used wrong set-up or connector MMWR 1999;48:557
- Must ensure exposure of internal surfaces with HLD/sterilant

EVOTECH w/Cleaning Claim



- Product Definition:
 - Integrated double-bay AER
 - Eliminates manual cleaning
 - Uses New High-Level Disinfectant (HLD) with IP protection
 - Single-shot HLD
 - Automated testing of endoscope channels and minimum effective concentration of HLD
 - Incorporates additional features (LAN, LCD display)

Reliance™ EPS Endoscope Processing System



Reliance™ DG



Klenszyme®, CIP® 200



Endoscope Processing Support



Reliance™ PI

Automatic Endoscope Reprocessors

- EvoTech-integrates cleaning (FDA-cleared claim) and disinfection. Automated cleaning comparable to manual cleaning. All residual data for cleaning of the internal channels as well as external insertion tube surfaces were below the limit of $<8.5\mu\text{g}/\text{cm}^2$
- Reliance-requires a minimal number of connections to the endoscope channels and uses a control boot (housing apparatus that creates pressure differentials to ensure connectorless fluid flow through all channels that are accessible through the endoscope's control handle channel ports). Data demonstrate that the soil and microbial removal effected by Reliance washing phase was equivalent to that achieved by optimal manual cleaning. Alfa, Olson, DeGagne. AJIC 2006;34:561.

Disinfection and Sterilization: Challenges in the XXI Century

- Disinfection and sterilization principles
- Challenges
 - Emerging pathogens
 - ◆ Norovirus and *C. difficile* spores
 - ◆ CJD
 - Reprocessing complex medical instruments
 - ◆ Compliance and new AERs/HLDs
 - Compliance and practice
 - ◆ Surface disinfection
 - New Technologies/Products
 - ◆ Critical-Class 6 chemical indicator
 - ◆ Semicritical items-new AERs/HLDs
 - ◆ Noncritical-surface disinfection
 - Microfiber
 - Computer disinfection

Patient Area Cleaning/Disinfecting

PC Carling et al, SHEA 2007 and ICHE 2008;29:1

- Monitor cleaning performance using an invisible fluorescent targeting method. Rooms (14 high-touch objects) were marked and evaluated after terminal cleaning.
- Results: 1,119 rooms and 13,369 objects were evaluated in 23 hospitals. Mean proportion of objects cleaned was 49%. Following education and process improvement feedback, cleaning improved to 77%
- Conclusion: Substantial opportunity for improving terminal cleaning/disinfecting activities.

Practice* NOT Product

*surfaces not wiped

Risk of Acquiring MRSA and VRE from Prior Room Occupants

- Admission to a room previously occupied by an MRSA-positive patient or VRE-positive patient significantly increased the odds of acquisition for MRSA and VRE (although this route is a minor contributor to overall transmission). Arch Intern Med 2006;166:1945.
- Prior environmental contamination, whether measured via environmental cultures or prior room occupancy by VRE-colonized patients, increases the risk of acquisition of VRE. Clin Infect Dis 2008;46:678.

Patient Area Cleaning/Disinfecting

- Health care facilities may need to introduce other controls to ensure all surfaces are completely cleaned daily and terminally
 - Checklists (side rail, call box, bedside table, phone, chair, etc)
 - Assignments of responsibility to ensure complete cleaning of all potentially contaminated surfaces. Ensure all surfaces are disinfected and all equipment is assigned (e.g., assign all equipment and environmental surfaces in a patient room to either ES, Nursing, etc)
 - Invisible fluorescent marker (mark high-touch objects and if not cleaned-educate, monitor process improvement, and feedback); ATP; dyes
 - New Technology-HPV, ozone, UV

Disinfection and Sterilization: Challenges in the XXI Century

- Disinfection and sterilization principles
- Challenges
 - Emerging pathogens
 - ◆ Norovirus and *C. difficile* spores
 - ◆ CJD
 - Reprocessing complex medical instruments
 - ◆ Compliance and new AERs/HLDs
 - Compliance and practice
 - ◆ Surface disinfection
 - New Technologies/Products
 - ◆ Critical-Class 6 chemical indicator
 - ◆ Semicritical items-new AERs/HLDs
 - ◆ Noncritical-surface disinfection
 - Microfiber
 - Computer disinfection

Recommendations Monitoring of Sterilizers

- Monitor each load with physical and chemical (internal and external) indicators. If the internal indicator is visible, an external indicator is not needed.
- Use biological indicators to monitor effectiveness of sterilizers at least weekly with spores intended for the type of sterilizer (Class 6 emulating indicators not a substitute).
- Use biological indicators for every load containing implantable items and quarantine items, whenever possible, until the biological indicator is negative.

Types of Sterilization Monitoring Devices

- Chemical Indicators
 - External chemical indicators
 - ◆ Class 1 (process indicator, indicator tape)-outside of every package
 - Internal chemical indicators
 - ◆ Class 2 (Bowie Dick)-routine testing of vacuum; within a test pack daily in an empty sterilizer
 - ◆ Class 3 (single variable indicator; temperature, ETO conc)-may be used as internal monitor
 - ◆ Class 4 (multi-variable indicator)-may be use as internal monitor

Types of Sterilization Monitoring Devices

- Chemical Indicators
 - Internal chemical indicator
 - ◆ Class 5 (integrating indicator)-may be used as internal monitor, suppose to mimic the behavior of a biological indicator (BI)
 - ◆ Class 6 (emulating indicator)-suppose to emulate or mimic the behavior of a biological indicator; are cycle-specific (need a emulating indicator designed to validate a 10 min/270F cycle and a different indicator to validate a 3 min/270F). No professional organization (e.g., AORN) has recommended the use of Class 6 emulating indicator as a substitute for biological indicators and there are no data that demonstrate that it mimics a BI at suboptimal sterilization times.

Disinfection and Sterilization: Challenges in the XXI Century

- Disinfection and sterilization principles
- Challenges
 - Emerging pathogens
 - ◆ Norovirus and *C. difficile* spores
 - ◆ CJD
 - Reprocessing complex medical instruments
 - ◆ Compliance and new AERs/HLDs
 - Compliance and practice
 - ◆ Surface disinfection
 - New Technologies/Products
 - ◆ Critical-Class 6 chemical indicator
 - ◆ Semicritical items-new AERs/HLDs
 - ◆ Noncritical-surface disinfection
 - Microfiber
 - Computer disinfection

Microfiber Cleaning

- Pad contains fibers (polyester and polyamide) that provide a cleaning surface 40 times greater than conventional string mops
- Proposed advantages: reduce chemical use and disposal (disinfectant solution not changed after every third room, clean microfiber per room [washing lifetime 500-1000x]); light (~5 lb less than string mop) and ergonomic; reduce cleaning times.
- Does the microfiber provide the same or better removal of microorganisms on surfaces?

Effectiveness of Microfiber Mop

- Test conditions with a EPA-registered disinfectant: compared routine mop and bucket; microfiber mop and bucket; microfiber mop and system bucket. Twenty-four replicates per condition.
- Conducted RODAC sampling before and after floor disinfection (5 samples per room)
- New disinfectant solution for each test condition
- Dry time varied from 2 (routine mop and bucket)-8 (microfiber mop and bucket) minutes

Effectiveness of Microfiber Mop

(Rutala, Gergen and Weber, Am J Infect Control, 2007;35:569)

Disinfectant-regular mop	95%
Disinfectant-microfiber system	95%
Disinfectant-microfiber mop and regular mop bucket	88%
Detergent-regular mop	68%
Detergent-microfiber system	95%
Detergent-microfiber mop and regular mop bucket	78%

Microfiber Summary

- The microfiber system demonstrated superior microbial removal compared to cotton string mops when used with a detergent cleaner
- The use of a disinfectant did not improve the microbial elimination demonstrated by the microfiber system
- Use of a disinfectant did significantly improve microbial removal when a cotton string mop was used

Disinfection of Computer Keyboards Computer Keyboards, ICHE 2006;27:372

- Increased use of computers in patient areas has led to contamination of keyboards as reservoirs of pathogens
- Study performed to
 - Examine the efficacy of different disinfectants on the computer keyboard
 - Determine if there were cosmetic (key lettering removed) or functional changes after 300 wipes

Disinfection of Computer Keyboards

- All tested products were effective (>95%) in removing and/or inactivating the test pathogens (MRSA, *P. aeruginosa*). No functional/cosmetic damage after 300 wipes.
- Disinfectants included: 3 quaternary ammonium compounds, 70% isopropyl alcohol, phenolic, chlorine (80ppm)
- At present, recommend that keyboards be disinfected daily (for 5 sec) and when visibly soiled

Disinfectants are effective in removing/inactivating nosocomial pathogens from computers

Disinfection and Sterilization: Challenges in the XXI Century

- Disinfection and sterilization principles
- Challenges
 - Emerging pathogens
 - ◆ Norovirus and *C. difficile* spores
 - ◆ CJD
 - Reprocessing complex medical instruments
 - ◆ Compliance and new AERs/HLDs
 - Compliance and practice
 - ◆ Surface disinfection
 - New Technologies/Products
 - ◆ Critical-Class 6 chemical indicator
 - ◆ Semicritical items-new AERs/HLDs
 - ◆ Noncritical-surface disinfection
 - Microfiber
 - Computer disinfection

Thank you

References

- Rutala WA, Weber DJ. CJD: Recommendations for disinfection and sterilization. *Clin Infect Dis* 2001;32:1348
- Rutala WA, Gergen MF, Weber DJ. Microbiologic evaluation of microfiber mops for surface disinfection. *Am J Infect Control* 2007;35:569
- Rutala WA, Weber DJ, HICPAC. CDC guideline for disinfection and sterilization in healthcare facilities. *MMWR*. In press.
- Rutala WA. APIC guideline for selection and use of disinfectants. *Am J Infect Control* 1996;24:313

References

- Rutala WA, Peacock JE, Gergen MF, Sobsey MD, Weber DJ. Efficacy of hospital germicides against adenovirus 8, a common cause of epidemic keratoconjunctivitis in health care facilities. *Antimicrob Agents Chemother* 2006;50:1419
- Rutala WA, White MS, Gergen MF, Weber DJ. Bacterial contamination of keyboards: Efficacy and functional impact of disinfectants. *Infect Control Hosp Epidemiol* 2006;27:372
- Rutala WA, Weber DJ. Surface disinfection: Should we do it? *J Hosp Infect.* 2000; 48:S64.
- Schneider PM. New technologies for disinfection and sterilization. In: Rutala WA (ed). *Disinfection, Sterilization and Antisepsis*. 2004:127-139