"BEST" PRACTICES FOR DISINFECTION OF NON-CRITICAL SURFACES AND EQUIPMENT AND MEDICAL WASTE MANAGEMENT

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1

LECTURE OBJECTIVES

- Review the CDC Guideline for Disinfection and Sterilization: Focus on role of environmental surfaces
- Review "best" practices for environmental cleaning and disinfection
- Review the use of low-level disinfectants and the activity of disinfectants on key hospital pathogens
- Review medical waste management

2

Environmental Contamination Leads to HAIs

Weber, Kanamori, Rutala. Curr Op Infect Dis .2016.29:424-431

Evidence environment contributes

- EPI-MRSA, VRE, *C. difficile*
- Surfaces are contaminated-~25%
- EIP survive days, weeks, months
- Contact with surfaces results in hand contamination
- Disinfection reduces contamination
- Disinfection (daily) reduces HAIs
- Rooms not adequately cleaned

3

Admission to Room Previously Occupied by Patient C/I with Epidemiologically Important Pathogen

- Results in the newly admitted patient having an increased risk of acquiring that pathogen by 39-353%
- For example, increased risk for *C. difficile* is 235% (11.0% vs 4.6%)
  Shaughnessy MK ICHE 2011
- Exposure to contaminated rooms confers a 5-6 fold increase in odds of infection, hospitals must adopt proven methods for reducing environmental contamination (Cohen et al. ICHE. 2018;39:541-546)

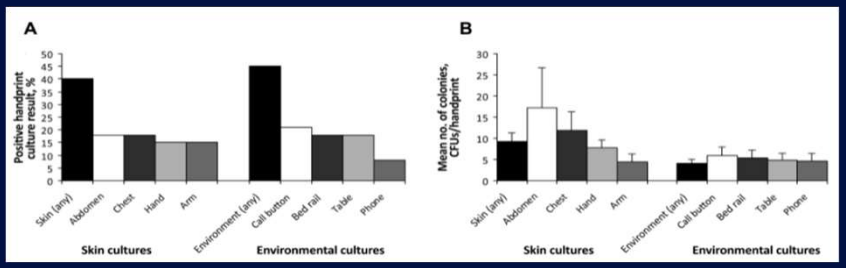
4

Acquisition of EIP on Hands of Healthcare Providers after Contact with Contaminated Environmental Sites and Transfer to Other Patients

5

FREQUENCY OF ACQUISITION OF MRSA ON GLOVED HANDS AFTER CONTACT WITH SKIN AND ENVIRONMENTAL SITES

No significant difference on contamination rates of gloved hands after contact with skin or environmental surfaces (40% vs 45%; p=0.59)



Stiefel U, et al. ICHE 2011;32:185-187

6

Acquisition of EIP on Hands of Patient after Contact with Contaminated Environmental Sites and Transfers EIP to Eyes/Nose/Mouth

7

DISINFECTION AND STERLIZATION

- EH Spaulding believed that how an object will be disinfected 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; however, small numbers of bacterial spores are permissible.**
  - **NONCRITICAL -objects that touch only intact skin require low-level disinfection**

8

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9

Best Practices in Disinfection of Noncritical Surfaces in the Healthcare Setting: A Bundle Approach

A set of evidence-based practices, generally 3-5, that when performed collectively and reliably have been proven to improve patient outcomes

10

Best Practices in Disinfection of Noncritical Surfaces in the Healthcare Setting: A Bundle Approach

NL Havill AJIC 2013;41:S26-30; Rutala, Weber. AJIC 2019

A Bundle Approach to Surface Disinfection

- Develop policies and procedures
- Select cleaning and disinfecting products
- Educate staff-environmental services and nursing
- Monitor compliance (thoroughness of cleaning, product use) and feedback
- Implement "no touch" room decontamination technology and monitor compliance (and new strategies)

11

GUIDELINE FOR DISINFECTION AND STERILIZATION IN HEALTHCARE FACILITIES, 2008

Rutala WA, Weber DJ., HICPAC

Available on CDC web page-www.cdc.gov

12

Blood Pressure Cuff
Non-Critical Patient Care Item

13

Surface Disinfection
Noncritical Patient Care
Rutala, Weber, HICPAC. CDC 2008. www.cdc.gov

- Disinfecting Noncritical Patient-Care Items
  - Process noncritical patient-care equipment with a EPA-registered disinfectant at the proper use dilution and a contact time of at least 1 min. *Category IB*
  - Ensure that the frequency for disinfecting noncritical patient-care surfaces be done minimally when visibly soiled and on a regular basis (such as after each patient use or once daily or once weekly). *Category IB*

14

15

Surface Disinfection

Environmental Surfaces

Rutala, Weber, HICPAC. CDC 2008. www.cdc.gov

- Disinfecting Environmental Surfaces in HCF
  - Disinfect (or clean) housekeeping surfaces (e.g., floors, tabletops) on a regular basis (e.g., daily, three times per week), when spills occur, and when these surfaces are visibly soiled. *Category IB*
  - Use disinfectant for housekeeping purposes where: uncertainty exists as to the nature of the soil on the surfaces (blood vs dirt); or where uncertainty exists regarding the presence of multi-drug resistant organisms on such surfaces. *Category II*

16

Use of a Daily Disinfectant Cleaner Instead of a Daily Cleaner Reduced HAI Rates

Alfa et al. AJIC 2015.43:141-146

- Method: Improved hydrogen peroxide disposable wipe was used once per day for all high-touch surfaces to replace cleaner
- Result: When cleaning compliance was ≥ 80%, there was a significant reduction in cases/10,000 patient days for MRSA, VRE and *C. difficile*
- Conclusion: Daily use of disinfectant applied to environmental surfaces with a 80% compliance was superior to a cleaner because it resulted in significantly reduced rates of HAIs caused by *C. difficile*, MRSA, VRE

17

It appears that not only is disinfectant use important but how often is important

Daily disinfection vs clean when soiled

18

Daily Disinfection of High-Touch Surfaces

Kundrapu et al. ICHE 2012;33:1039

Daily disinfection of high-touch surfaces (vs cleaned when soiled) with sporicidal disinfectant (PA) in rooms of patients with CDI and MRSA reduced acquisition of pathogens on hands after contact with surfaces and of hands caring for the patient. Daily disinfection less hand contamination.

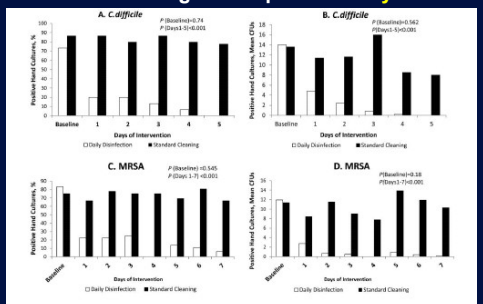

FIGURE 1. Effect of daily disinfection of high-touch environmental surfaces on acquisition of *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus* (MRSA) on gloved hands of investigators after contact with the surfaces. *A*, Percentage of positive *C. difficile* cultures; *B*, mean number of *C. difficile* colony-forming units acquired; *C*, percentage of positive MRSA cultures; *D*, mean number of MRSA colony-forming units acquired.

19

MICROBIAL BURDEN ON ROOM SURFACES AS A FUNCTION OF FREQUENCY OF TOUCHING

Huslage K, Rutala WA, Weber DJ. ICHE. 2013;34:211-212

Surface	Prior to Cleaning Mean CFU/RODAC (95% CI)	Post Cleaning (mean) Mean CFU/RODAC (95% CI)
High	71.9 (46.5-97.3)	9.6
Medium	44.2 (28.1-60.2)	9.3
Low	56.7 (34.2-79.2)	5.7

- **The level of microbial contamination of room surfaces is similar regardless of how often they are touched both before and after cleaning**
- **Therefore, all surfaces that are touched must be cleaned and disinfected**

20

ALL "TOUCHABLE" (HAND CONTACT) SURFACES SHOULD BE WIPED WITH DISINFECTANT

"High touch" objects only recently defined (no significant differences in microbial contamination of different surfaces) and "high risk" objects not epidemiologically defined. Cleaning and disinfecting is one-step with disinfectant-detergent. No pre-cleaning necessary unless spill or gross contamination.

21

Wipes

Cotton, Disposable, Microfiber, Cellulose-Based, Nonwoven Spunlace

22

WIPES

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

- Wipes-cotton, disposable, microfiber, nonwoven spunlace
- Wipe should have sufficient wetness to achieve the disinfectant contact time. Discontinue use of the wipe if no longer leaves the surface visible wet for ≥ 1 minute.
- When the wipe is visibly soiled, flip to a clean/unused side and continue until all sides of the wipe have been used (or get another wipe)
- Dispose of the wipe/cloth wipe appropriately
- Do not re-dip a wipe into the clean container of pre-saturated wipes

23

Effectiveness of Different Methods of Surface Disinfection for MRSA

Rutala, Gergen, Weber. Unpublished data.

Technique (with cotton)	MRSA Log_{10} Reduction (QUAT)
Saturated cloth	4.41
Spray (10s) and wipe	4.41
Spray, wipe, spray (1m), wipe	4.41
Spray	4.41
Spray, wipe, spray (until dry)	4.41
Disposable wipe with QUAT	4.55
Control: detergent	2.88

24

Evaluation of Hospital Floors as a Potential Source of Pathogen Dissemination

Koganti et al. ICHE 2016. 37:1374; Deshpande et al. AJIC 2017. 45:336.

- Effective disinfection of contaminated surfaces is essential to prevent transmission of epidemiologically-important pathogens
- Efforts to improve disinfection focuses on touched surfaces
- Although floors contaminated, limited attention because not frequently touched
- Floors are a potential source of transmission because often contacted by objects that are then touched by hands (e.g., shoes, socks)
- Non-slip socks contaminated with MRSA, VRE (Mahida, J Hosp Infect. 2016;94:273

25

26

Recovery of Nonpathogenic Viruses from Surfaces and Patients on Days 1, 2, and 3 After Inoculation of Floor Near Bed

Koganti et al. ICHE 2016. 37:1374

Variable	Day 1 (% Positive)	Day 2 (% Positive)	Day 3 (% Positive)
Patient Hands	40	63	43
Patient Footwear	100	100	86
High-touch surface <3ft	58	62	77
High-touch surface >3ft	40	68	34
Personal items	50	44	50
Adjacent room floor	NA	100	80
Adjacent room environment	NA	40	11
Nursing station	53	47	63
Portable equipment	33	23	100

Surfaces <3ft included bedrail, call button, telephone, tray table, etc; surfaces >3ft included side table, chair, IV pole, etc; personal-cell phones, books, clothing, wheelchairs; nurses station included computer keyboard, mouse, etc

27

Recovery of Nonpathogenic Viruses from Surfaces and Patients on Days 1, 2, and 3 After Inoculation of Floor Near Bed

Koganti et al. ICHE 2016. 37:1374

- Found that a nonpathogenic virus inoculated onto floors in hospital rooms disseminated rapidly to the footwear and hands of patients and to high-touch surfaces in the room
- The virus was also frequently found on high-touch surfaces in adjacent rooms and nursing stations
- Contamination in adjacent rooms in the nursing station suggest HCP contributed to dissemination after acquiring the virus during contact with surfaces or patients
- Studies needed to determine if floors are source of transmission

28

Evaluation of Hospital Floors as a Potential Source of Pathogen Dissemination

Deshpande et al. AJIC 2017. 45:336.

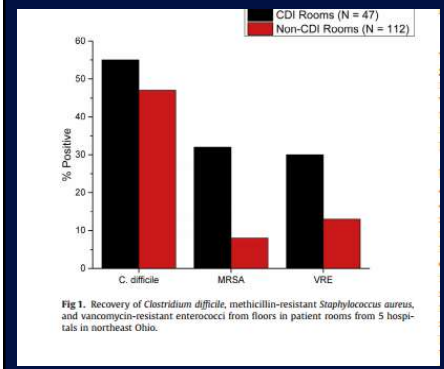

Fig 1. Recovery of *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus*, and vancomycin-resistant enterococci from floors in patient rooms from 5 hospitals in northeast Ohio.

- 318 floors sites sampled in 159 rooms
- *C. difficile* most frequently isolated
- MRSA and VRE isolated more frequently from CDI rooms
- 41% (100) had objects (personal-clothing, phone chargers; medical-BP cuff, call button) in contact with floor
- Of 31 objects on floor, 18% MRSA, 6% VRE, 3% Cd bare/glove cultures positive
- Demonstrates potential for indirect transfer of pathogens to hands from fomites on floor

29

Disinfection of Noncritical Surfaces Bundle

NL Havill AJIC 2013;41:S26-30; Rutala, Weber AJIC 2019;47:A96-A105

- Develop policies and procedures
- Select cleaning and disinfecting products
- Educate staff-environmental services and nursing
- Monitor compliance (thoroughness of cleaning, product use) and feedback
- Implement "no touch" room decontamination technology and monitor compliance

30

Disinfection of Noncritical Surfaces Bundle

- Develop policies and procedures
  - Standardize C/D patient rooms and pieces of equipment throughout the hospital
  - All touchable hand contact surfaces wiped with disinfection daily, when spills occur and when the surfaces are visibly soiled.
  - All noncritical medical devices should be disinfected daily and when soiled
  - Clean and disinfectant sink and toilet
  - Damp mop floor with disinfectant-detergent
  - If disinfectant prepared on-site, document correct concentration
  - Address treatment time/contact time for wipes and liquid disinfectants (e.g., treatment time for wipes is the kill time and includes a wet time via wiping as well as the undisturbed time).

31

Disinfection of Noncritical Surfaces Bundle

NL Havill AJIC 2013;41:S26-30

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32

REVIEW THE "BEST" PRACTICES FOR CLEANING AND DISINFECTING

Cleaning and disinfecting is one-step with disinfectant-detergent. No pre-cleaning necessary unless spill or gross contamination. In many cases "best" practices not scientifically determined.

33

Effective Surface Decontamination

Product and Practice = Perfection

34

LOW-LEVEL DISINFECTION FOR NONCRITICAL EQUIPMENT AND SURFACES

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865; Rutala, Weber. AJIC 2019;47:A3-A9

Exposure time ≥ 1 min

Germicide	Use Concentration
Ethyl or isopropyl alcohol	70-90%
Chlorine	100ppm (1:500 dilution)
Phenolic	UD
Iodophor	UD
Quaternary ammonium (QUAT)	UD
QUAT with alcohol	RTU
Improved hydrogen peroxide (HP)	0.5%, 1.4%
PA with HP, 4% HP, chlorine (*C. difficile*)	UD

UD=Manufacturer's recommended use dilution; others in development/testing-electrolyzed water; polymeric guanidine; cold-air atmospheric pressure plasma (Boyce Antimicrob Res IC 2016. 5:10)

35

PROPERTIES OF AN IDEAL DISINFECTANT

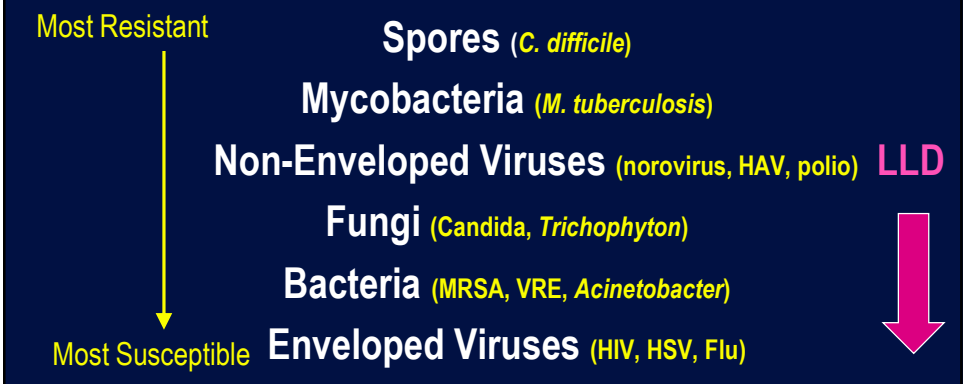
Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

- **Broad spectrum**-wide antimicrobial spectrum
- **Fast acting**-should produce a rapid kill
- **Remains Wet**-meet listed kill/contact times with a single application
- **Not affected by environmental factors**-active in the presence of organic matter
- **Nontoxic**-not irritating to user
- **Surface compatibility**-should not corrode instruments and metallic surfaces
- **Persistence**-should have sustained antimicrobial activity
- **Easy to use**
- Acceptable odor
- Economical-cost should not be prohibitively high
- Soluble (in water) and stable (in concentrate and use dilution)
- Cleaner (good cleaning properties) and nonflammable

36

Microbiological Disinfectant Hierarchy

Rutala WA, Weber DJ, HICPAC. www.cdc.gov



37

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38

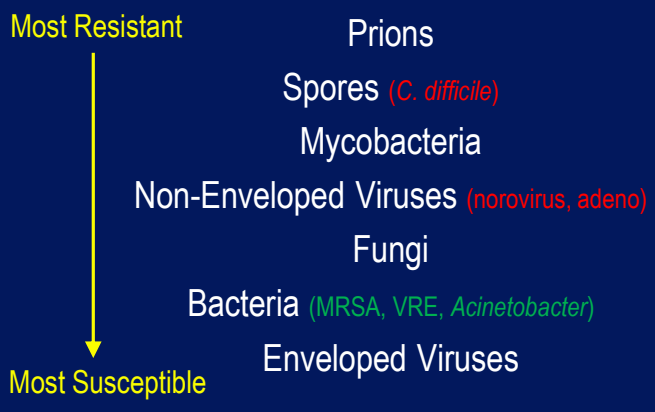
MOST PREVALENT PATHOGENS CAUSING HAI

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865; Weiner et al ICHE 2016;37:1288

- **Most prevent pathogens causing HAI (easy to kill)**
  - *E. coli* (15.4%)
  - *S. aureus* (11.8%)
  - *Klebsiella* (7.7%)
  - Coag neg Staph (7.7%)
  - *E. faecalis* (7.4%)
  - *P. aeruginosa* (7.3%)
  - *C. albicans* (6.7%)
  - *Enterobacter* sp. (4.2%)
  - *E. faecium* (3.7%)
  - C. difficile (now common)
- **Common causes of outbreaks and ward closures (relatively hard to kill)**
  - *C. difficile* spores
  - Norovirus
  - Rotavirus
  - Adenovirus

39

Decreasing Order of Resistance of Microorganisms to Disinfectants/Sterilants



40

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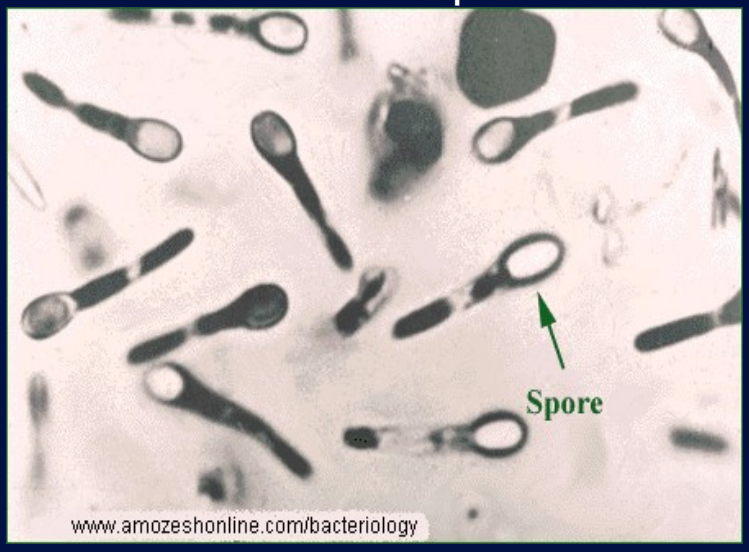
41

C. difficile spores



42

DISINFECTANTS AND ANTISEPSIS

C. difficile spores at 10 and 20 min, Rutala et al, 2020

- ~4 $\log_{10}$ reduction (3 *C. difficile* strains including BI-9)
  - Clorox, 1:10, ~6,000 ppm chlorine (but not 1:50)
  - Clorox Clean-up, ~19,100 ppm chlorine
  - Tilex, ~25,000 ppm chlorine
  - Steris 20 sterilant, 0.35% peracetic acid
  - Cidex, 2.4% glutaraldehyde
  - Cidex-OPA, 0.55% OPA
  - Wavicide, 2.65% glutaraldehyde
  - Aldahol, 3.4% glutaraldehyde and 26% alcohol

43

DISINFECTANTS

No measurable activity (1 _C. difficile_ strain, J9; spores at 20 min)

- 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)

Rutala W, Weber D, et al. 2020

44

A Targeted Strategy for *C. difficile*

Orenstein et al. 2011. ICHE;32:1137

Daily cleaning with bleach wipes on high incidence wards reduced CDI 85% (24.2 to 3.6 cases/10,000 patient days) and prolonged median time between HA CDI from 8 to 80 days

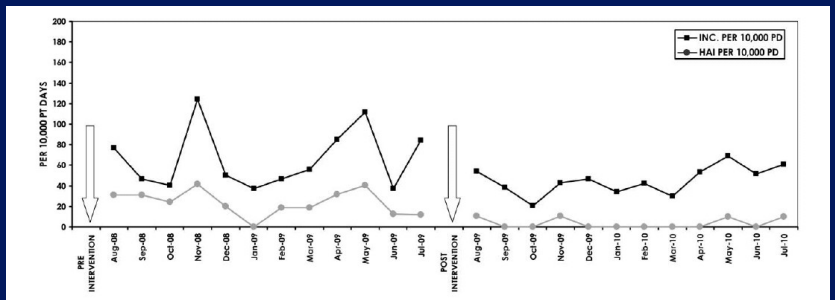


FIGURE 1. *Clostridium difficile* infection incidence for units A and B combined before the intervention (August 1, 2008–July 31, 2009) and after the intervention (August 1, 2009–July 31, 2010). HAI, hospital-acquired infection; INC, overall infection incidence; PD, patient days; PT, patient.

45

C. difficile CONTROL MEASURES

Orenstein et al. ICHE 2011;32:1137

- 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).
- We now use chlorine solution in all CDI rooms for routine daily and terminal cleaning (did use QUAT in patient rooms with sporadic CDI). One application of an effective product covering all surfaces to allow a sufficient wetness for >1 minute contact time. Chlorine solution normally takes 1-3 minutes to dry.
- For semicritical equipment, glutaraldehyde (20m), OPA (12m) and peracetic acid (12m) reliably kills *C. difficile* spores using normal exposure times

46

INACTIVATION OF MURINE AND HUMAN NOROVIRUES

Disinfectant, 1 min	MNV Log_{10} Reduction	HNV Log_{10} Reduction
70% Ethanol	>4 (3.3 at 15sec)	2
70% Isopropyl alcohol	4.2	2.2
65% Ethanol + QUAT	>2	3.6
79% Ethanol + QUAT	3.4	3.6
Chlorine (5,000ppm)	4	3
Chlorine (24,000ppm)	2.4	4.3
Phenolic, QUAT, Ag, 3% H_2O_2	≤1	≤1 (2.1 QUAT)
0.5% Accel H_2O_2	3.9	2.8

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

47

GUIDELINE FOR THE PREVENTION OF NOROVIRUS OUTBREAKS IN HEALTHCARE, HICPAC, 2011

- Avoid exposure to vomitus or diarrhea. Place patients with suspected norovirus on Contact Precautions in a single room (IB)
  - Continue Precautions for at least 48 hours after symptom resolution (IB)
  - Use longer isolation times for patients with comorbidities (II) or <2 yrs (II)
- Consider minimizing patient movements within a ward (II)
  - Consider restricting movement outside the involved ward unless essential (II)
  - Consider closure of wards to new admissions (II)
- Exclude ill personnel (IB)
- During outbreaks, use soap and water for hand hygiene (IB)
- Clean and disinfect patient care areas and frequently touched surfaces during outbreaks 3x daily using EPA-approved healthcare product (IB)
- Clean surfaces and patient equipment prior to disinfection. Use product with an EPA approved claim against norovirus (IC)

MacCannell T, et al. http://www.cdc.gov/hicpac/pdf/norovirus/Norovirus-Guideline-2011.pdf

48

Disinfection of Noncritical Surfaces Bundle

NL Havill AJIC 2013;41:S26-30

- Develop policies and procedures
- Select cleaning and disinfecting products
- Educate staff to include environmental services and nursing
- Monitor compliance (thoroughness of cleaning, product use) and feedback
- Implement "no touch" room decontamination technology and monitor compliance

49

EFFECTIVENESS OF DISINFECTANTS AGAINST MRSA AND VRE

Rutala WA, et al. *Infect Control Hosp Epidemiol* 2000;21:33-38

TABLE 2
DISINFECTANT ACTIVITY AGAINST ANTIBIOTIC-SUSCEPTIBLE AND ANTIBIOTIC-RESISTANT BACTERIA

	Log_{10} Reductions							
	VSE		VRE		MSSA		MRSA	
Product	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min
Vesphene IIse	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Clorox	>5.4	>5.4	>4.9	>4.9	>5.0	>5.0	>4.6	>4.6
Lysol Disinfectant	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Lysol Antibacterial	>5.5	>5.5	>5.5	>5.5	>5.1	>5.1	>4.6	>4.6
Vinegar	0.1	5.3	1.0	3.7	+1.1	+0.9	+0.6	2.3

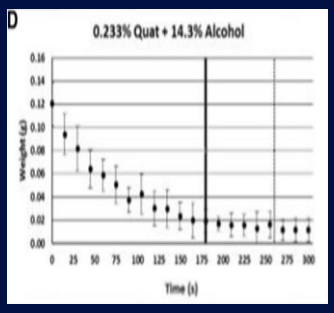
Abbreviations: MRSA, methicillin-resistant *Staphylococcus aureus;* MSSA, methicillin-susceptible *S aureus;* VRE, vancomycin-resistant *Enterococcus;* VSE, vancomycin-susceptible *Enterococcus.*
Data represent mean of two trials (n=2). Values preceded by ">" represent the limit of detection of the assay. Assays were conducted at a temperature of 20°C and a relative humidity of 45%. Results were calculated as the log of Nd/No, where Nd is the titer of bacteria surviving after exposure and No is the titer of the control.

50

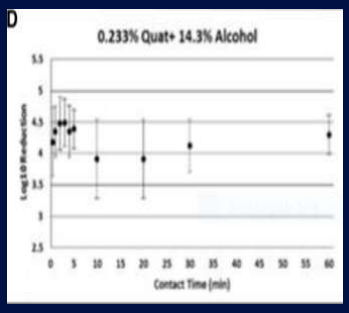
Bactericidal (*S. aureus*) Efficacy of EPA-Registered Towelettes

West, Teska, Oliver, AJIC, 2018

- Drying time curve based on surface wetness; bold-contact time (180s); dashed-dry (~260s)



- Wet time Is not crucial for complete disinfection (wet or dry ~4.5 log_{10} reduction); 30s for log_{10} reduction



51

Effective Surface Decontamination

Product and Practice = Perfection

52

Disinfection of Noncritical Surfaces Bundle

- Develop policies and procedures
  - Environmental cleaning and disinfection is an integral part of preventing transmission of pathogens
  - In addition to identifying products and procedures, ensure standardization of cleaning throughout the hospital
    - **Some units utilize ES to clean pieces of equipment (e.g., vital sign machines, IV pumps); some units use patient equipment, and some units utilize nursing staff.**
    - **Multidisciplinary group to create a standardized plan for cleaning patient rooms and pieces of patient equipment throughout the hospital**

53

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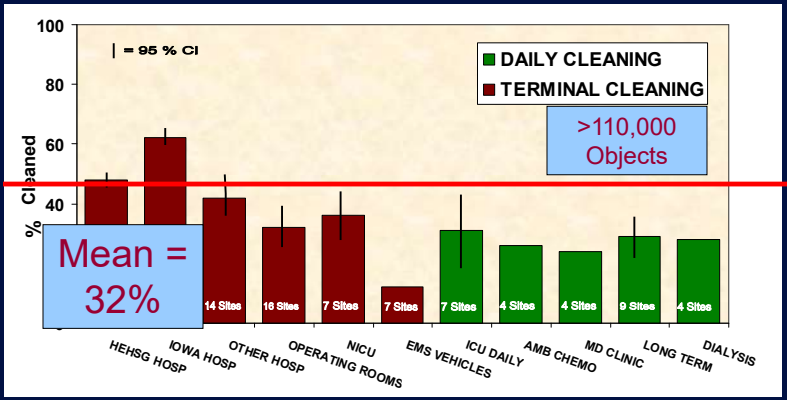
54

Thoroughness of Environmental Cleaning

Carling et al. ECCMID, Milan, Italy, May 2011



55

MONITORING THE EFFECTIVENESS OF CLEANING

Cooper et al. AJIC 2007;35:338

- Visual assessment-not a reliable indicator of surface cleanliness
- ATP bioluminescence-measures organic debris (each unit has own reading scale, <250-500 RLU)
- Microbiological methods-<2.5CFUs/cm^2-pass; can be costly and pathogen specific
- Fluorescent marker-transparent, easily cleaned, environmentally stable marking solution that fluoresces when exposed to an ultraviolet light (applied by IP unbeknown to EVS, after EVS cleaning, markings are reassessed)

56

DAZO Solution (AKA – Goo)

57

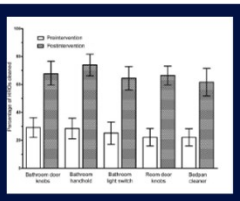
TARGET ENHANCED

58

TERMINAL ROOM CLEANING: DEMONSTRATION OF IMPROVED CLEANING

- Evaluated cleaning before and after an intervention to improve cleaning
- 36 US acute care hospitals
- Assessed cleaning using a fluorescent dye
- Interventions
  - Increased education of environmental service workers
  - Feedback to environmental service workers

†Regularly change "dotted" items to prevent targeting objects



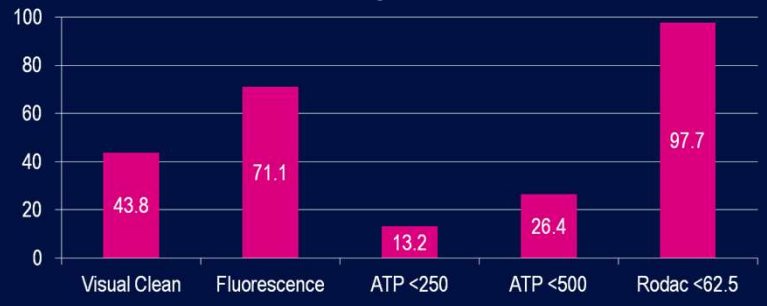
Carling PC, et al. ICHE 2008;29:1035-41

59

Percentage of Surfaces Clean by Different Measurement Methods

Rutala, Gergen, Sickbert-Bennett, Huslage, Weber. 2013

Fluorescent marker is a useful tool in determining how thoroughly a surface is wiped and mimics the microbiological data better than ATP



60

ALL "TOUCHABLE" (HAND CONTACT) SURFACES SHOULD BE WIPED WITH DISINFECTANT

"High touch" objects only recently defined (no significant differences in microbial contamination of different surfaces) and "high risk" objects not epidemiologically defined.

61

MICROBIAL BURDEN ON ROOM SURFACES AS A FUNCTION OF FREQUENCY OF TOUCHING

Surface	Prior to Cleaning Mean CFU/RODAC (95% CI)	Post Cleaning (mean) Mean CFU/RODAC (95% CI)
High	71.9 (46.5-97.3)	9.6
Medium	44.2 (28.1-60.2)	9.3
Low	56.7 (34.2-79.2)	5.7

- The level of microbial contamination of room surfaces is similar regardless of how often they are touched both before and after cleaning
- Therefore, all surfaces that are touched must be cleaned and disinfected

Huslage K, Rutala WA, Weber DJ. ICHE. 2013;34:211-212

62

Disinfection of Noncritical Surfaces Bundle

NL Havill AJIC 2013;41:S26-30

- Develop policies and procedures
- Select cleaning and disinfecting products
- Educate staff to environmental services and nursing
- Monitor compliance (thoroughness of cleaning, product use) and feedback
- Implement “no touch” room decontamination technology and monitor compliance

63

These interventions (effective surface disinfection, thoroughness indicators) not enough to achieve consistent and high rates of cleaning/disinfection

No Touch

(supplements but do not replace surface cleaning/disinfection)

64

New Technologies for Room/Surface Decontamination
Assessment Parameters

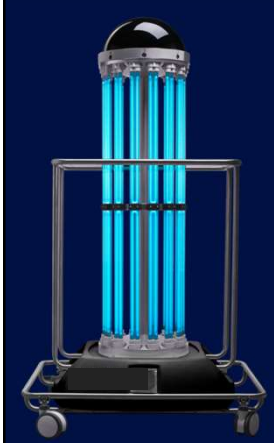
- Safe
- Microbicidal
- Reduction of HAIs
- Cost-effective

65

"NO TOUCH" APPROACHES TO ROOM DECONTAMINATION

(UV/VHP~20 microbicidal studies, 12 HAI reduction studies; will not discuss technology with limited data)

Weber, Kanamori, Rutala. Curr Op Infect Dis 2016;29:424-431; Weber, Rutala et al. AJIC; 2016:44: e77-e84; Anderson et al. Lancet 2017;389:805-14; Anderson et al. Lancet Infect Dis 2018;June 2018.



66

Enhanced Disinfection Leading to Reduction of Microbial Contamination and a Decrease in Patient Col/Infection

Anderson et al. Lancet 2017;289:805; Rutala et al. ICHE In press.

	Standard Method	Enhanced method		
	Quat	Quat/UV	Bleach	Bleach/UV
EIP (mean CFU per room)[a]	60.8	3.4	11.7	6.3
Reduction (%)		94	81	90
Colonization/Infection (rate)[a]	2.3	1.5	1.9	2.2
Reduction (%)		35	17	4

All enhanced disinfection technologies were significantly superior to Quat alone in reducing EIPs. Comparing the best strategy with the worst strategy (i.e., Quat vs Quat/UV) revealed that a reduction of 94% in EIP (60.8 vs 3.4) led to a 35% decrease in colonization/infection (2.3% vs 1.5%). Our data demonstrated that a decrease in room contamination was associated with a decrease in patient colonization/infection. First study which quantitatively described the entire pathway whereby improved disinfection decreases microbial contamination which in-turn reduced patient colonization/infection.

67

This technology ("no touch"-microbicidal and ideally, HAI reduction per peer-reviewed literature) should be used (capital equipment budget) for terminal room disinfection (e.g., after discharge of patients on Contact Precautions).

68

Disinfection of Noncritical Surfaces Bundle

NL Havill AJIC 2013;41:S26-30

- Develop policies and procedures
- Select cleaning and disinfecting products
- Educate staff to environmental services and nursing
- Monitor compliance (thoroughness of cleaning, product use) and feedback
- Implement "no touch" room decontamination technology and monitor compliance

69

How Will We Prevent Infections Associated with the Environment?

- **Implement evidence-based practices for surface disinfection**
  - **Evidence-based policies**
  - **Ensure use of safe and effective (against emerging pathogens such as *C. auris* and CRE) low-level disinfectants**
  - **Ensure thoroughness of cleaning (new thoroughness technology)**
- **Use "no touch" room decontamination technology proven to reduce microbial contamination on surfaces and reduction of HAIs at terminal/discharge cleaning**

70

LECTURE OBJECTIVES

- Review the CDC Guideline for Disinfection and Sterilization: Focus on role of environmental surfaces
- Review "best" practices for environmental cleaning and disinfection
- Review the use of low-level disinfectants and the activity of disinfectants on key hospital pathogens
- Review medical waste management

71

Medical Waste Problem

- Perceived threat of AIDS via medical waste
- Beach wash-ups of "medical waste"
- Overly restrictive medical waste rules and increase in volume of regulated medical waste
- Options for medical waste treatment and disposal diminishing

72

Definitions

- Hospital waste (solid waste) refers to all waste (biological or nonbiological) which are discarded and not intended for further use (e.g., administrative waste, dietary waste)
- Medical waste refers to materials generated as a result of patient diagnosis, treatment, or immunization (e.g., soiled dressing, intravenous tubing)
- Regulated medical waste ("infectious" waste) refers to that portion of medical waste which could transmit an infectious disease (e.g., microbiological waste, sharps)

73

Total Hospital Waste Generated per Patient by Bed Size

Rutala, Odette, Samsa. JAMA. 1989; 262:1635-1640

Hospital Beds	Median lb/Bed/Day		Median lb/Patient/Day	
	N	Total	N	Total
<100	90	5.72	69	11.30
100-299	108	10.36	84	15.79
300-499	40	12.51	32	18.47
>500	27	12.86	23	16.95
Combined	265	9.21	208	15.28

74

Regulated Medical Waste

The CDC, EPA, and states define medical waste as regulated ("infectious")

When it is suspected to contain potentially hazardous levels of microorganisms

75

Factors Necessary for Induction of Disease

- Dose
- Resistance of host
- Portal of entry
- Presence of a pathogen
- Virulence

76

Medical Waste
Plausible Transmission Routes
Rutala, Mayhall. Infect Control Hosp Epidemiol 1992;13:38-48

- Risk virtually nonexistent - respiratory, urinary or gastrointestinal tract or mucous membrane of the mouth, eyes, nose.
- Why? Waste must contain pathogens →person must come in direct contact→ inject, ingest, or injury must follow the contact thereby creating portal of entry→ an infectious dose must enter susceptible host via portal of entry→agent causes infection.
- Rare - "Sharps" have an intrinsic capability to disrupt the skin's integrity and introduce infectious agents.

77

Public Health Implications of Medical Waste
Rutala, Mayhall. Infect Control Hosp Epidemiol 1992;13:38-48

Epidemiologic Evidence

- Only medical waste associated with infectious disease transmission is contaminated sharps.
- All reports of transmission of infectious agents by sharps occurred in health care setting.
- No evidence that a member of the public or a waste industry worker has ever acquired infection from medical waste (one exception).
- No infectious risks associated with any type of medical waste treatment method to include sanitary landfill disposal.

78

Public Health Implications of Medical Waste

Rutala, Mayhall. Infect Control Hosp Epidemiol 1992;13:38-48

Microbiologic Quality

- Household waste contains on average 100x more microorganisms with pathogenic potential for humans than medical waste.
- Common nosocomial pathogens (i.e. *P. aeruginosa, Klebsiella* spp, *Enterobacter* spp, *Proteus* spp) were detected more frequently from household waste than from hospital waste.

79

Regulated Medical Waste

The CDC, EPA, and states define medical waste as regulated ("infectious")

When it is suspected to contain potentially hazardous levels of microorganisms

80

Medical Waste Regulations

- State - designation, transportation, storage and treatment
- Federal (OSHA) - education, labeling, use of PPE

81

Types of Solid Waste Designated as Infectious and Recommended Disposal Methods

Rutala, Mayhall. Infect Control Hosp Epidemiol 1992;13:38-48

	Centers for Disease Control	
Source/Type	**Infectious Waste**	**Disposal Method**
Microbiological	Yes	S,I
Blood and blood products	Yes	S,I, Sew
Pathological	Yes	Yes
Sharps (especially needles)	Yes	S,I
Contaminated animal carcasses (carcasses)	Yes	S,I
Isolation	No	---
Other (surgical waste, dialysis, contaminated lab waste)	No	---

Abbreviations: S-steam; I-incineration; Sew-sanitary sewer.

82

Compliance with CDC and EPA Recommendations for Treatment of Regulated Medical Waste

Rutala, Odette, Samsa. JAMA. 1989. 262:1635-1640

Type of Medical Waste	CDC	USH%	EPA	USH%
Microbiological	S,I	98.1	S,I,TI,C	98.1
Blood	S,I,SEW	95.9	S,I,SEW,C	95.9
Pathology	I	92.6	I,SW,CB	92.6
Sharps	S,I	92.5	S,I	92.5
Isolation	---	---	S,I	85.9
Cont. animal carcasses	I	89.1	I,SW	89.1
Contaminated laboratory	---	---	Optional	87.0
Surgery	---	---	Optional	78.2
Autopsy	---	---	Optional	89.9
Dialysis	---	---	Optional	68.6
Contaminated equipment	---	---	Optional	ND
Overall		82.3		75.1

83

North Carolina Medical Waste Rules

Regulated Medical Waste Definitions

Microbiological - cultures and stocks of infectious agents

Pathological - human tissues, organs and body parts; carcasses and body parts of animals exposed to pathogens

Blood - liquid blood, serum, plasma, other blood products, emulsified human tissue, spinal fluids, and pleural and peritoneal fluids; in individual containers in volumes greater than 20 ml (bloody gauze, used gloves, tubing and dressings are not regulated medical waste).

84

Regulated Waste: OSHA

- Contaminated sharps
- Pathological and microbiological wastes containing blood or OPIM
- Liquid or semi-liquid blood or OPIM
- Contaminated items that would release blood or OPIM in a liquid or semi-liquid state if compressed
- Items caked with dried blood or OPIM that are capable of releasing these materials during handling

85

Regulated Waste: OSHA

- Can OSHA and states adopt uniform definitions of RMW?
  - OSHA rules and state rules address two different concerns
  - OSHA rule addresses waste management in the workplace to ensure worker safety
  - State waste management rules ensure storage, shipping, and treatment/disposal practices that protect the environment and public health

86

Segregation of Medical Waste by US Hospitals

95% segregate regulated medical waste from non-regulated medical waste

96% use labeled or color-coded bags

87

Collection and Containment of US Hospital Waste

Collection	
Housekeeping (82%), maintenance (4%) or both (7%) transfer wastes to on-site storage or processing site (at least daily)	92%
Container	
Leakproof wastebaskets	95%
Plastic bags as wastebasket liners	99%

88

Transporting Waste Within US Hospitals

Transfer Carts - used to transport waste within the hospital	95%
Gravity Chutes - allows for vertical transfer	13%
Pneumatic chutes - vacuum source to propel wastes	2%

89

Storage

- No single requirement for storage of infectious waste in terms of time and temperature but most states do have regulations
- NC - if not shipped within seven days of generation, medical waste must be refrigerated.

90

Compaction

- Advantages
  - Decreases the volume of waste 4-5 times
  - Decreases size of storage facilities
  - Decreases cost of transporting waste
- Disadvantage
  - May interfere with the effectiveness of certain treatment processes

91

Medical Waste Management:
Environmentally Responsible Healthcare

- Treatment of regulated medical waste (RMW)
  - Properly define RMW
  - Rational definition could save millions in treatment costs
  - Reduce waste now treated as RMW (e.g., incineration)
    - Know what happens to facility's wastes and how treated
    - Locate "red bags" strategically to capture RMW
  - Encourage segregation of properly defined RMW

92

Treatment of Medical Waste by US Hospitals

Rutala, Odette, Samsa. JAMA. 1989. 262:1635-1640

	Infectious (%)		Treatment/Disposal Methods (%)				
Waste Category	Yes	No	I	SL	S	Sew	Other
Microbiological	99	1	70	11	38	2	1
Human blood	94	6	64	11	21	26	1
Pathological	96	4	93	3	6	2	1
Isolation	94	6	79	17	9	2	0
Sharps	99	1	82	15	13	0	1

93

Incineration

Ash Residue: Controlled-air incinerators produce a sterile ash

Air Emissions: No difference between bacteria in stack emissions and ambient air. Chemicals (CO, metals, acid gases, dioxins, furans) emitted from hospital or municipal incinerators

94

EPA's Proposed Incineration Emission Limits

- New set of medical waste incineration regulations
- Regulates Hosp/Med/Inf Waste Incinerators
- Mandated by the Clean Air Act Amendments of 1990
- Regulations substantially reduced emissions (dioxins, CO, Pb, Hg)
- EPA estimates regulations would close 50-80% of existing medical waste incinerators.

95

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96

North Carolina Medical Waste Rules

Regulated Medical Waste Treatment*

Microbiological - incineration, steam sterilization or chemical treatment

Pathological - incineration

Blood and body fluids in individual containers in volumes greater than 20 ml - incineration or sanitary sewage systems, provided the sewage treatment authority is notified.

*Other methods of treatment shall require approval by the Division of Solid Waste Management

97

North Carolina Medical Waste Rules

Steam Sterilization

- 250°F for 45 min or other effective combination.
- Unit should have time-temperature recorder and pressure gauge.
- Biological monitoring at least weekly; log maintained and shall include type of indicator used, date, time and result of test.

98

North Carolina Medical Waste Rules

- Definition - “sharps” means and includes needles, syringes with attached needles, capillary tubes, slides, cover slips and scalpel blades.
- Requirement - sharps will be placed in a container which is rigid, leakproof when in an upright position and puncture-resistant. Contained sharps shall not be compacted prior to off-site transportation.
- Treatment - none required. The package may be disposed with general solid waste.

99

Needle Disposal

“Needles should not be recapped, purposely bent or broken by hand, removed from disposal syringes, or otherwise manipulated by hand. After they are used, disposable syringes and needles, scalpel blades, and other sharp items should be placed in puncture-resistant containers for disposal; the puncture-resistant containers should be located as close as practical to the use area.”

Centers for Disease Control, MMWR August 21, 1987

100

Sanitary Landfill

- Untreated medical waste could be discarded in sanitary landfills provided workers do not have contact
- Studies demonstrate
  - Bacteria and viruses are reduced by thermal inactivation, antimicrobial characteristics of leachate and absorption to organic material
  - Household waste is more microbially contaminated and it is discarded in sanitary landfills
- Unavailable, reaching capacity, or restricted to untreated medical waste

101

Suctioned Fluids Disposal Treatment

Sanitary sewer - suctioned fluids may be carefully poured down a drain connected to a sanitary sewer (CDC, 1985)

Incineration - suction canister may be tightly capped, bagged (coded) and incinerated.

Sanitary landfill - suction canister fluid may be treated with liquid treatment system and sent to sanitary landfill (2/3 states)

Sanitary landfill - suction canisters may be tightly capped, bagged and sent to a sanitary landfill (a few states).

102

Medical Waste Management: Treatment

- Goal of treatment is to reduce microbial load
- Changes that impact treatment of RMW
  - Incineration (new emission standards)
  - Alternative treatment technologies

    Some states allow alternatives (e.g., microwave, electrothermal radiation, shredding/chemical, gamma, electron beam) other states not
  - Autoclave

103

Medical Waste Regulations

- State - designation, transportation, storage and treatment
- Federal (OSHA) - education, labeling, use of PPE

104

Medical Waste Minimization

Recycling/Reuse/Reduction

- Corrugated boxes and paper products
- Aluminum, glass, and plastic from defined areas
- Recovery/redistillation of laboratory solvents (e.g., alcohol, xylene, toluene)
- Source reduction-replace single use items with reusable items

105

Infectious Risks Associated with Recycling Hospital Waste

- No infectious risks associated with recycling hospital waste
- Presently, recycling efforts have generally focused on nonpatient contact sources of waste such as glass, scrap metal, aluminum cans, cardboard and packaging material
- From an infectious disease perspective, only a few items generated in the health-care setting are not likely candidates for recycling (e.g. sharps)

106

Waste Management:
How to be Friendly to the Environment

- Recycling in healthcare
  - Internal forces: employee requests, environment, public image, proactive posture
  - External forces: state/national solid waste laws, local government regulations, air quality regulations
  - Example: NC
    - 1989-GS established recycling goal of 25% by 1993
    - 1991-Amended to waste reduction and 40% by 2001
    - 1995-Amended so County government selects own goal
    - Orange county selected a reduction goal of 45%

107

LECTURE OBJECTIVES

- Review the CDC Guideline for Disinfection and Sterilization: Focus on role of environmental surfaces
- Review “best” practices for environmental cleaning and disinfection
- Review the use of low-level disinfectants and the activity of disinfectants on key hospital pathogens
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108

BEST PRACTICES FOR SURFACE DISINFECTION AND MEDICAL WASTE

Summary

- The contaminated surface environment in hospital rooms is important in the transmission of healthcare-associated pathogens (MRSA, VRE, *C. difficile*, *Acinetobacter*).
- Disinfection of noncritical environmental surfaces/equipment is an essential component of Infection prevention
- Disinfection should render surfaces and equipment free of pathogens in sufficient numbers to cause human disease. Follow CDC D/S guideline.
- When determining the optimal disinfecting product, consider the 5 components (kill claims/time, safety, ease of use, others)
- Comply with federal (OSHA) and state medical waste regulations

109

THANK YOU!

www.disinfectionandsterilization.org

110