

Environmental Hygiene:

Surface Disinfection Bundle; MRDOs; Wipes; Electrostatic Sprayers; Continuously Active Disinfectants

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Disclosures: PDI, Kinnos

Environmental Hygiene

- Surface disinfection bundle (includes low-level disinfectants)
- Emerging pathogens-CRE/*C. auris*
- Wipes vs sprays
- New technology
 - Electrostatic sprayers
 - Continuous room disinfection

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

Disinfection of Noncritical Surfaces Bundle

Rutala, Weber AJIC 2019;47:A96-A105

- 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).

Effective Surface Decontamination

Product and Practice =
Perfection



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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 $\geq$ 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 (<i>C. difficile</i>)	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)

Wipes

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

Wipe should have sufficient wetness to achieve the disinfectant contact time (e.g. >1 minute)



SURFACE DISINFECTION

Effectiveness of Different Methods

Rutala, Gergen, Weber. ICHE 2012;33:1255-58

Technique (with cotton)	<i>C. difficile</i> Log ₁₀ Reduction (1:10 Bleach)
Saturated cloth	3.90
Spray (10s) and wipe	4.48
Spray, wipe, spray (1m), wipe	4.48
Spray	3.44
Spray, wipe, spray (until dry)	4.48
5500 ppm chlorine pop-up wipe	3.98
Non-sporicidal wipe	≥2.9

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 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

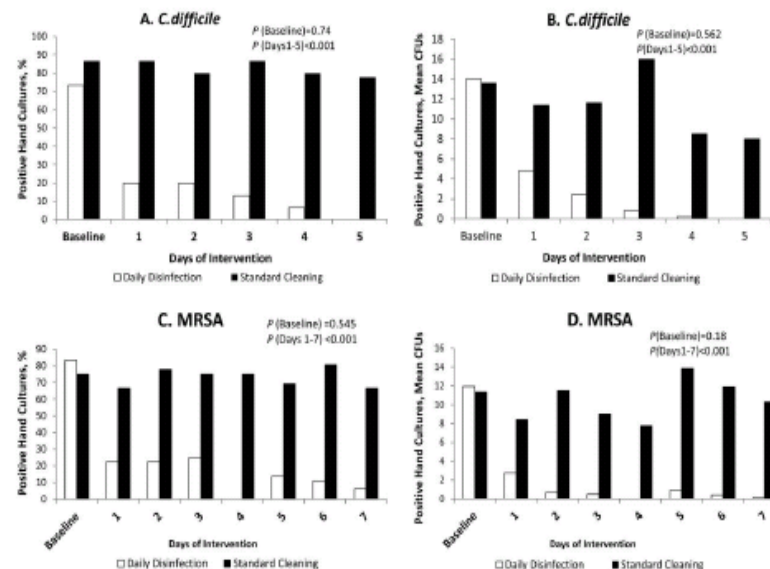


FIGURE 1. Effect of daily disinfection of high-touch environmental surfaces on acquisition of *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus* (MRSA) on gloved hands of investigators after contact with the surfaces. A, Percentage of positive *C. difficile* cultures; B, mean number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

Microbiological Disinfectant Hierarchy

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

Most Resistant

Spores (*C. difficile*)

Mycobacteria (*M. tuberculosis*)

Non-Enveloped Viruses (norovirus, HAV, polio)

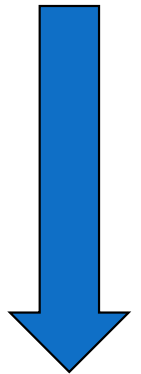
Fungi (*Candida*, *Trichophyton*)

Bacteria (MRSA, VRE, *Acinetobacter*)

Enveloped Viruses (HIV, HSV, Flu)

Most Susceptible

LLD



Multidrug Resistant Pathogens

Antibiotic resistant microbes are disinfectant sensitive

- *Candida auris*
- CRE
- MRSA
- VRE

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

Product	Log ₁₀ Reductions							
	VSE		VRE		MSSA		MRSA	
	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.



Germicidal Activity against Carbapenem/Colistin-Resistant *Enterobacteriaceae* Using a Quantitative Carrier Test Method

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ABSTRACT Susceptibility to germicides for carbapenem/colistin-resistant *Enterobacteriaceae* is poorly described. We investigated the efficacy of multiple germicides against these emerging antibiotic-resistant pathogens using the disc-based quantitative carrier test method that can produce results more similar to those encountered in health care settings than a suspension test. Our study results demonstrated that germicides commonly used in health care facilities likely will be effective against carbapenem/colistin-resistant *Enterobacteriaceae* when used appropriately in health care facilities.

KEYWORDS carbapenem-resistant *Enterobacteriaceae*, *Klebsiella pneumoniae* carbapenemase, colistin-resistant *Enterobacteriaceae*, *mcr-1*, germicides, disinfectants, antiseptics, efficacy

Efficacy of Disinfectants and Antiseptics against Carbapenem-Resistant *Enterobacterales*

Rutala, Kanamori, Gergen, Sickbert-Bennett, Weber, 2017 ID Week;
Kanamori et al Antimicrob. Agents Chemother 2018.

- $\geq 3 \log_{10}$ reduction (CRE, 1m, 5% FCS, QCT)
 - 0.20% peracetic acid
 - 2.4% glutaraldehyde
 - 0.5% Quat, 55% isopropyl alcohol
 - 58% ethanol, 0.1% QUAT
 - 28.7% isopropyl alcohol, 27.3% ethyl alcohol, 0.61% QAC
 - 0.07% o-phenylphenol, 0.06% p-tertiary amylphenol
 - ~5,250 ppm chlorine
 - 70% isopropyl alcohol
 - Ethanol hand rub (70% ethanol)
 - 0.65% hydrogen peroxide, 0.15% peroxyacetic acid
 - Accelerated hydrogen peroxide, 1.4% and 2.0%
 - Quat, (0.085% QACs; not *K. pneumoniae*)

CANDIDA AURIS: AN OVERVIEW, CDC

- *Candida auris* is an emerging fungus that presents a serious global health threat for the following reasons:
 - *C. auris* is spreading geographically and increasing in incidence.
 - From 2019 to 2021, 17 states reported their first *C. auris* case and cases resistant to antifungal drugs tripled...now 35 states
 - *C. auris* may colonize patients for months to years (no method of decolonization). Infection (usually candidemia) has a high mortality (~60%).
 - It is often multidrug-resistant (e.g., echinocandins, triazoles, polyene [amphotericin B]). Some strains are resistant to all three available classes of antifungals.
 - It is difficult to identify with standard laboratory methods, and it can be misidentified in labs without specific technology. Misidentification may lead to inappropriate management.
 - It has caused multiple outbreaks in healthcare settings. For this reason, it is important to quickly identify *C. auris* in a hospitalized patient so that healthcare facilities can take special precautions to stop its spread.
- May 11, 2021: Updated tracking *C. auris* to include historical and current U.S. interactive maps and downloadable datasets
- July 19, 2021: Environmental Protection Agency (EPA) has created List P, a list of EPA-registered disinfectants effective against *C. auris*
- Current needs: (1) rapid diagnostics; (2) new drugs; (3) decolonization methods; (4) registered, easy to use and effective disinfectants; (5) other tools or protocols for treatment and prevention

<https://www.cdc.gov/fungal/candida-auris/index.html>

<https://www.cdc.gov/fungal/candida-auris/researchers-and-industry-professionals.html>

List P: Antimicrobial Products Registered with EPA for Claims Against *Candida auris* (contact times, product dependent)

- Sodium Hypochlorite (1-3 min)
- Hydrogen peroxide and peracetic acid (1-3 min)
- Hydrogen Peroxide, Peracetic Acid and Octanoic Acid (4 min)
- Dodecylbenzenesulfonic acid (1-1.25 min)
- Isopropyl Alcohol and Quaternary Ammonium Compound (1 min)
- Isopropyl Alcohol, DDAC and ADBAC (2 min)
- Hydrogen Peroxide (1-5 min)
- Quaternary Ammonium Compounds (10 min)
- Sodium dichloro-s-triazinetriene (2 min)
- Ethanol, Isopropyl Alcohol and DDAC (1 min)
- Isopropyl Alcohol and Quaternary Ammonium Compounds (2 min)

Caveats

- List P displays 30 approved products
- All products are ONLY approved for “hard non-porous surfaces”
- Contact times vary by class and specific product
- Products include sprays, wipes and liquids
- Some products are ready to use; others may require dilution
- Per CDC, if products on List P are not accessible or otherwise suitable, interim guidance permits use of an EPA-registered disinfectant active against *C. difficile* (List K)
- Follow manufacturer’s use recommendations

<https://www.epa.gov/pesticide-registration/list-p-antimicrobial-products-registered-epa-claims-against-candida-auris>
<https://www.cdc.gov/fungal/candida-auris/c-auris-infection-control.html>

Susceptibility of *C. auris* and *C. albicans* to 21 germicides used in healthcare facilities

- Goal: Assess susceptibility of *C. auris* to germicides
- Methods: Disc-based quantitative carrier testing
- Results: All of the FDA-cleared high-level disinfectants have a registration claim >1 minute (e.g., 8–45 minutes). **In summary, with the exception of a water-based QAC and a 1:50 dilution of sodium hypochlorite, our data demonstrate that most disinfectants (10 of 13, 77%) used in healthcare facilities are effective (>3-log₁₀ reduction) against *C. auris*.**

Germicide name	Manufacturer, Location	Active Ingredient	Formulation Tested	Classification	<i>C. auris</i> ^a	<i>C. albicans</i> ^a
Purell Advanced instant hand sanitizer	GOJO, Akron, OH	70% ethanol	Undiluted	Antiseptic	4.0	2.5
Betadine solution	Purdue Products, Stamford, CT	10% povidone-iodine/1% iodine	Undiluted	Antiseptic	2.5	2.3
Medicated Soft 'N Sure	Steris, St. Louis, MO	0.5% triclosan	Undiluted	Antiseptic/Handwash	1.4	1.7
Soft Care Defend	Diversey, Charlotte, NC	1% chloroxylonol	Undiluted	Antiseptic/Handwash	2.8	3.9
Avagard	3M, St Paul, MN	1% chlorhexidine gluconate solution, 61% ethyl alcohol	Undiluted	Antiseptic/Surgical hand scrub	2.0	1.9
Scrub-Stat 2%	Ecolab, St Paul, MN	2% chlorhexidine gluconate solution	Undiluted	Antiseptic/Surgical hand scrub/handwash	1.6	2.8
Scrub-Stat 4%	Ecolab, St Paul, MN	4% chlorhexidine gluconate solution	Undiluted	Antiseptic/Surgical hand scrub/handwash	1.9	3.5
Isopropyl rubbing alcohol 70% USP	Medichoice, Mechanicsville, VA	70% isopropyl alcohol	Undiluted	Antiseptic/Disinfectant	3.8	4.1
Solution of hydrogen peroxide 3% USP	Medichoice, Mechanicsville, VA	3% hydrogen peroxide	Undiluted	Antiseptic	1.4	1.8
Austin's A-1 bleach 1:10	James Austin Co, Mars, PA	5.25% sodium hypochlorite (~6,100–6,700 ppm)	1:10 dilution	Disinfectant	4.1	4.0
Austin's A-1 bleach 1:50	James Austin Co, Mars, PA	5.25% sodium hypochlorite (~1,245 ppm)	1:50 dilution	Disinfectant	1.6	1.5
Vesphene IIse	Steris, St Louis, MO	9.09% o-phenylphenol, 7.66% p-tertiary amylphenol	1:128 dilution	Disinfectant	4.1	3.6
Hydrogen peroxide cleaner disinfectant	Clorox, Oakland, CA	1.4% hydrogen peroxide	Undiluted	Disinfectant	4.1	4.1
Lysol disinfectant spray	Reckitt Benckiser, Parsippany, NJ	58% ethanol, 0.1% QAC ^b	Undiluted	Disinfectant	3.8	4.1
A-456 II disinfectant cleaner	Ecolab, St Paul, MN	21.7% QAC ^c	1:256 dilution	Disinfectant	1.7	1.5
Super Sani-Cloth wipe	PDI, Orangeburg, NY	55% isopropyl alcohol, 0.5% QAC ^d	Undiluted ^f	Disinfectant	3.9	4.1
Prime Sani-Cloth wipe	PDI, Orangeburg, NY	28.7% isopropyl alcohol, 27.3% ethyl alcohol, 0.61% QAC ^e	Undiluted ^f	Disinfectant	4.1	4.1

Rutala WA, et al. ICHE 2019;40:380-382

Effective Surface Decontamination

Product and Practice =
Perfection



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EVIDENCE THAT ALL TOUCHABLE ROOM SURFACES ARE EQUALLY CONTAMINATED

TABLE 1. Precleaning and Postcleaning Bacterial Load Measurements for High-, Medium-, and Low-Touch Surfaces

Surface (no. of samples)	Mean CFUs/RODAC (95% CI)	
	Precleaning	Postcleaning
High ($n = 40$)	71.9 (46.5–97.3)	9.6 (3.8–15.4)
Medium ($n = 42$)	44.2 (28.1–60.2)	9.3 (1.2–17.5)
Low ($n = 37$)	56.7 (34.2–79.2)	5.7 (2.01–9.4)

NOTE. CFU, colony-forming unit; CI, confidence interval.

Number of culture sites and prevalence of contamination with nosocomial pathogens in intensive care units ($N=523$)

Ward	Culture sites ^a			
	HCWs' hands	Surfaces distant from patients	Surfaces close to patients	Prevalence of contamination
A	3/10 (30%)	0/22 (0%)	6/25 (24.0%)	9/57 (15.8%)
B	2/9 (22.2%)	4/19 (21.1%)	5/48 (10.4%)	11/76 (14.5%)
C	2/10 (20%)	2/26 (7.7%)	7/49 (14.3%)	11/85 (12.9%)
D	1/9 (11.1%)	2/24 (8.2%)	7/45 (15.6%)	10/78 (12.8%)
E	0/5 (0%)	4/22 (18.2%)	3/30 (10%)	7/57 (12.3%)
F	1/10 (10%)	0/11 (0%)	4/31 (12.9%)	5/52 (9.6%)
G	0/3 (0%)	2/14 (14.3%)	0/20 (0%)	2/37 (5.4%)
H	1/10 (10%)	0/16 (0%)	1/55 (1.8%)	2/81 (2.5%)
Total	10/66 (15.2%)	14/154 (9.1%)	33/303 (10.9%)	57/523 (10.9%)

HCW, healthcare worker.

^a Number of contaminated samples/number of samples obtained.

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.**



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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 (e.g., fluorescent marker, ATP)**
- **Implement “no touch” room decontamination technology and monitor compliance**

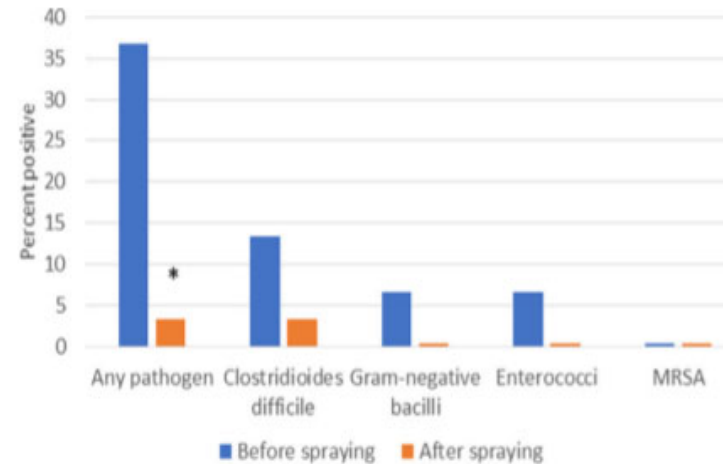
Efficacy of Disinfectant Electrostatic Spray (positive charged droplets attracted to negatively charged surfaces or microbes) in Reducing Pathogen Contamination

Cadnum et al. AJIC 2020

**Picture of electrostatic sprayer
(0.25% sodium hypochlorite)**



**Efficacy of disinfectant spray
(waiting room chairs)**



UVC vs Electrostatic Sprayer (0.25% NaOCl) for Adjunctive Room Decontamination

Carlisle MG, Rutala WA...Donskey CJ. ICHE. 2022. doi:10.1017/ice.2022.132

ES Sprayer and UVC similarly effective in reducing pathogen contamination on floors and high-touch surfaces

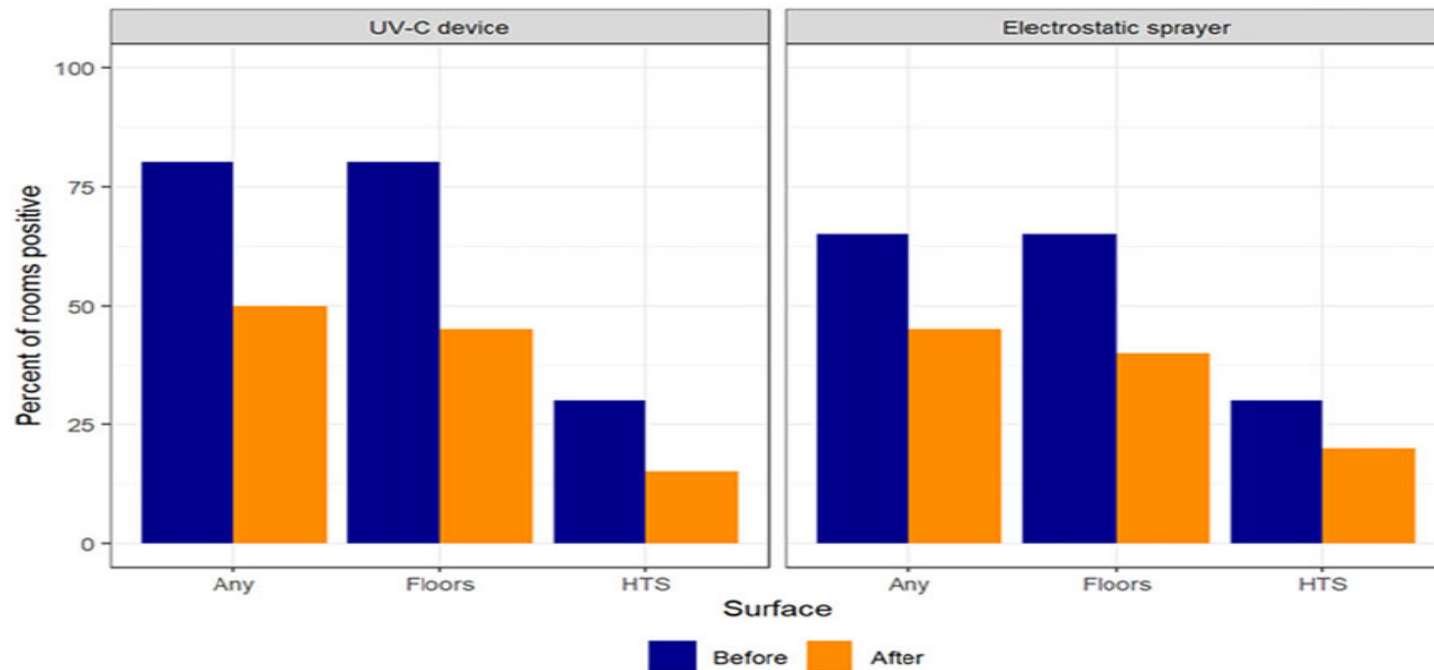


Fig. 1. Percentages of rooms with positive cultures for 1 or more healthcare-associated pathogens before versus after treatment with the ultraviolet-C (UV-C) light device or the electrostatic sprayer. Note. HTS, high-touch surface.

Summary of Electrostatic Sprayer Issues Include

- Optimal droplet size is between 40-70u; what is the droplet size of the proposed unit
- Spray patterns vary tremendously across vendors and even across products from a single vendor
- EPA demands that all surfaces being disinfected be thoroughly wetted for the contact time of the specific disinfectant
- Person applying the disinfectant may need to wear full PPE because of inhalation concerns
- Electrostatic sprayer does not replace the initial cleaning and disinfecting that EVS performs
- Cadnum/Donskey study used sporicidal disinfectant alone with no pre-cleaning or wiping
- Electrostatic sprayers might be most useful for items and areas that are not amenable to standard cleaning and disinfection (Cadnum/Donskey)
- Effectiveness on soft surfaces?
- Considerations for purchase include: coverage requirements, weight of loaded device; ease of handling; effective distance; particulate size; and disinfectant safety
- Electrostatic sprayers are promoted as a “get in” and “get out” time saving technology
- How many seconds per square foot with a sprayer to properly treat the surface; spray pattern
- Equipment can be easily misused (must prevent misuse and consider sprayer, time allotted to perform, disinfectant, surface [soft v hard], space/area to disinfect, level of cleaning prior to application, user training)

Environmental Contamination Leads to HAIs

- By contaminating hands/gloves via contact with the environment and transfer to patient or patient self inoculation
- Surface should be hygienically clean (not sterile)-free of pathogens in sufficient numbers to prevent human disease
- Two environmental surface concerns
 - Discharge/terminal-prevent infection to new patient in room
 - Daily room decontamination (referred to “trash and dash”) suboptimal C/D and recontamination

Microbial Assessment of Recontamination with *Acinetobacter* in Patient Room Environment in Burn Units

Rutala et al. AJIC. 2020; 48 Suppl;S20

- Purpose: assess how much environmental sites (e.g., chair, bedrail, overbed table, stock cabinet, IV pump, etc.) become re-contaminated with *Acinetobacter* over time after cleaning/disinfection
- Results:
 - At baseline all environmental sites sampled except overbed table were contaminated with *Acinetobacter*.
 - No *Acinetobacter* were detected except bed rail just after cleaning/disinfection.
 - First time to recontamination with *Acinetobacter* was 3 hours at chair, 2 hours at overbed table, 3 hours at stock cabinet, and 2 hours at IV pump. No recontamination was observed at the monitor.
 - The level of *Acinetobacter* contamination on surfaces was occasionally high (e.g., when a stock cabinet was sampled at 5 hours, 75 of 96 CFU were *Acinetobacter*).
 - The amount of recontamination with aerobes and *Acinetobacter* on some surfaces tended to increase over time.

Hygienically clean (not sterile)-free
of pathogens in sufficient numbers
to prevent human disease



Continuous Room Decontamination Technologies for Disinfection of the Healthcare Environment

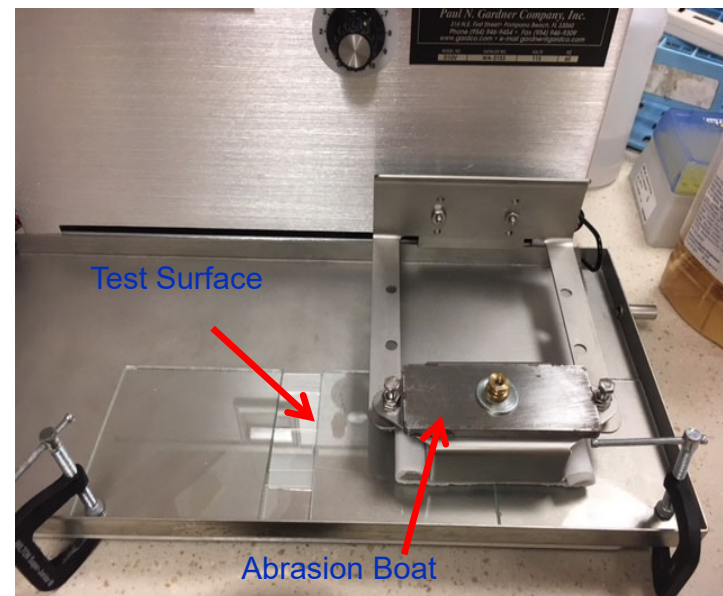
Weber, Rutala et al. AJIC. 2019;47:A72; Rutala et al. ICHE 2019; Weber D, Rutala W. AJIC 2013;41:S31

- Visible light disinfection through LEDs
- Dry/dilute hydrogen peroxide; hydroxyl radicals, free reactive oxygen
- Self-disinfecting surfaces (e.g., heavy metals-copper, silver)
- Far UV 222 nm
- Bipolar ionization
- Multijet cold air plasma
- Continuously active disinfectant (CAD) or persistent disinfectant that provides continuous disinfection action
 - Allows continued disinfection and may eliminate the problem of recontamination
 - Patients, staff and visitors can remain in the room

Evaluation of a Continuously Active Disinfectant
“EPA Protocol for Residual Self-Sanitizing Activity of Dried Chemical Residuals on
Hard, Non-Porous Surfaces”

Rutala et al. ICHE;2021: doi:10.1017/ice.2021.481; Rutala et al. ICHE 2019;40:1284

- Test surface inoculated (10^5), treated with test disinfectant, allowed to dry.
- Surface will undergo “wears” (abraded under alternating wet and dry conditions [24 passes, 12 cycles]) and 6 re-inoculations ($10^{\geq 3.75}$, 30min dry) over 48hr
- At the end of the study and at least 48 hours later, the ability of the test surface to kill microbes (99.9%) within 1 min is measured using the last inoculation (10^6)



Efficacy of a Continuously Active Disinfectant Against Healthcare Pathogens

Rutala WA et al. ICHE 2019;40:1284; Redmond et al. ICHE 2021, <https://doi.org/10.1017/ice.2021.66>

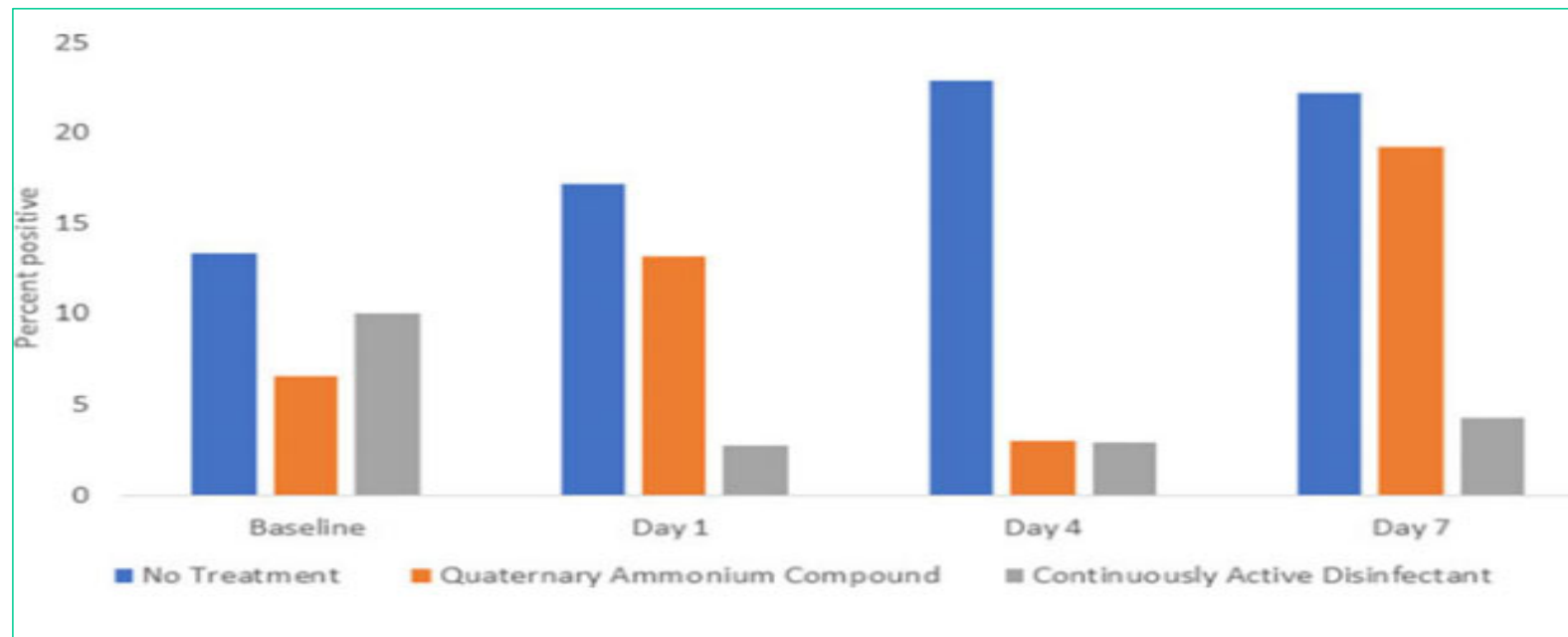
4-5 log₁₀ reduction in 5 min over 24hr for HA pathogens; ~99% reduction with *Klebsiella* and CRE *Enterobacter*. Redmond et al. found 5 log₁₀ reduction for CRE *Enterobacter*, *K. pneumoniae*, MRSA, VRE, and *C. auris*

Test Pathogen	Mean Log ₁₀ Reduction , 95% CI n=4
<i>S.aureus</i> *	4.4 (3.9, 5.0)
<i>S.aureus</i> (formica)	4.1 (3.8, 4.4)
<i>S.aureus</i> (stainless steel)	5.5 (5.2, 5.9)
VRE	≥4.5
<i>E.Coli</i>	4.8 (4.6, 5.0)
<i>Enterobacter</i> sp.	4.1 (3.5, 4.6)
<i>Candida auris</i>	≥5.0
<i>K pneumoniae</i>	1.5 (1.4, 1.6)
CRE <i>E.coli</i>	3.0 (2.6, 3.4)
CRE <i>Enterobacter</i>	2.0 (1.6, 2.4)
CRE <i>K pneumoniae</i>	2.1 (1.8, 2.4)

Efficacy of Continuously Active Disinfectant for Portable Medical Equipment (PME)

Redmond et al. ICHE 2021, <https://doi.org/10.1017/ice.2021.66>

Comparison of *S. aureus* and enterococci recovered from PME at baseline, 1, 4, 7days. The percentage of sites positive for *S. aureus* and/or enterococci was significantly reduced on days 1-7 in the continuously active group (3 of 93, 3%) versus both the no treatment group (20 of 97, 21%) and the Quat group (11 of 97, 11%)



Environmental Hygiene

- The contaminated surface environment in hospital rooms is important in the transmission of healthcare-associated pathogens (MRSA, VRE, *C. difficile*, *Acinetobacter*)
- Surface disinfection bundle: policies, products, educate staff; compliance; “no touch”.
- In general, emerging pathogens are susceptible to currently available disinfectants and technologies (e.g., disinfectants, antiseptics, UV).
- New D/S technologies (e.g., continuously active disinfectant, electrostatic sprayers) and practices (e.g., monitoring cleaning/disinfection) could reduce risk of infection associated with devices and surfaces.

THANK YOU!
www.disinfectionandsterilization.org

