Continuously Active Disinfectant that Inactivates the Human Coronavirus 229E after 48h

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DISCLOSURES

2020-2021

- WA Rutala-PDI
- LA Ikner-Allied BioScience
- CJ Donskey-Clorox, PDI, Pfizer
- DJ Weber-PDI, UV Innovators
- CP Gerba-Allied BioScience

Objectives

- Role of environment in disease transmission
- Why we need continuous room decontamination
  - Continuously active disinfectants
- Evaluation of a continuously active disinfectant to inactivate coronavirus 229E

Environmental Contamination Leads to HAIs

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



- Epidemiologically-important pathogens (EIP)-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

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

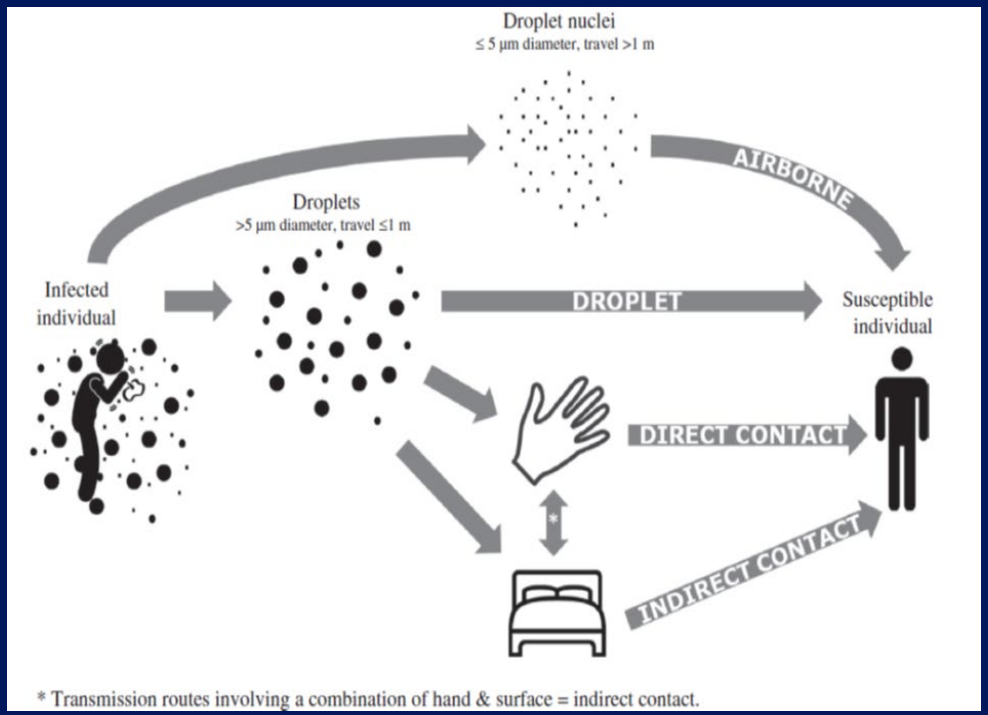




Acquisition of EIP on Hands of Patient after Contact with Contaminated Environmental Sites and Transfers EIP to Eyes/Nose/Mouth



Transmission of SARS-CoV-2



- Aerosol (generally < 6 feet)
- Direct-person-to-person via respiratory aerosols
- Indirect (via the contaminated environment); not the main route
- Asymptomatic/pre-symptomatic (infection transmission demonstrated)

Relationship Between Microbial Burden and HAIs

Rutala WA et al. ICHE 2018;38:1118-1121; Salgado CD, et al. ICHE 2013;34:479-86

Table 2. Relationship between microbial reduction of epidemiologically-important pathogens (EIP) and colonization/infection in a patient subsequently admitted to a room of a patient colonized/infected with an EIP by decontamination method.

	Standard Method		Enhanced method	
	Quat	Quat/UV	Bleach	Bleach/UV
EIP (mean CFU per room)[a]	60.8	3.4	1.7	6.3
Reduction (%)		94	1	90
Colonization/Infection (rate)[a]	2.3	1.5	.9	2.2
Reduction (%)		35	7	4

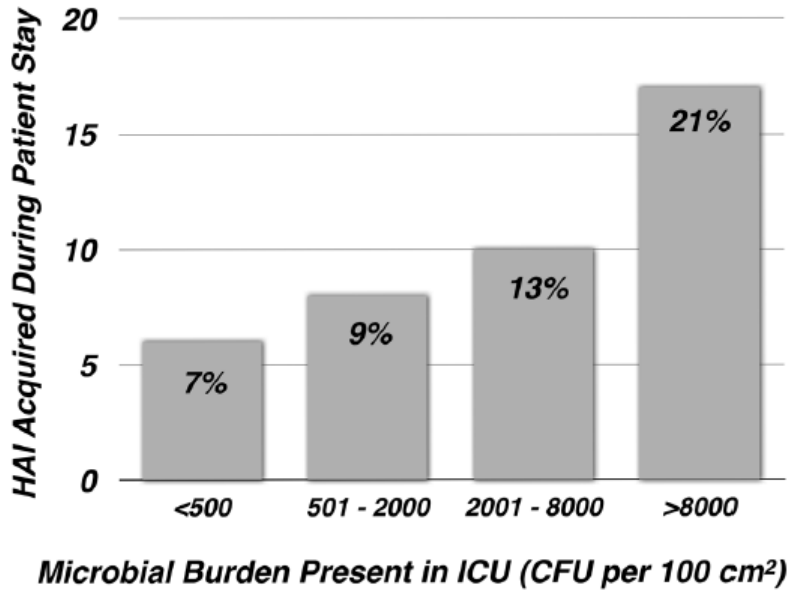


FIGURE 2. Quartile distribution of healthcare-acquired infections (HAIs) stratified by microbial burden measured in the intensive care unit (ICU) room during the patient's stay. There was a significant association between burden and HAI risk ($P = .038$), with 89% of HAIs occurring among patients cared for in a room with a burden of more than 500 colony-forming units (CFUs)/100 cm².

Effective Surface Decontamination Reduces Microbial Contamination

Product and Practice = Perfection

Clean/Disinfect at Least Daily (surfaces not wiped)



Effective Surface Decontamination Reduces Microbial Contamination (all touchable surfaces not just high-touch)

Product and Practice = Perfection

Evidence That All Touchable Room Surfaces Are Equally Contaminated

Huslage K, Rutala W, Gergen M, Sickbert-Bennett E, Weber D. ICHE 2013;34:211-2

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

	Mean CFUs/RODAC (95% CI)	
Surface (no. of samples)	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.

Environmental Contamination Leads to HAIs

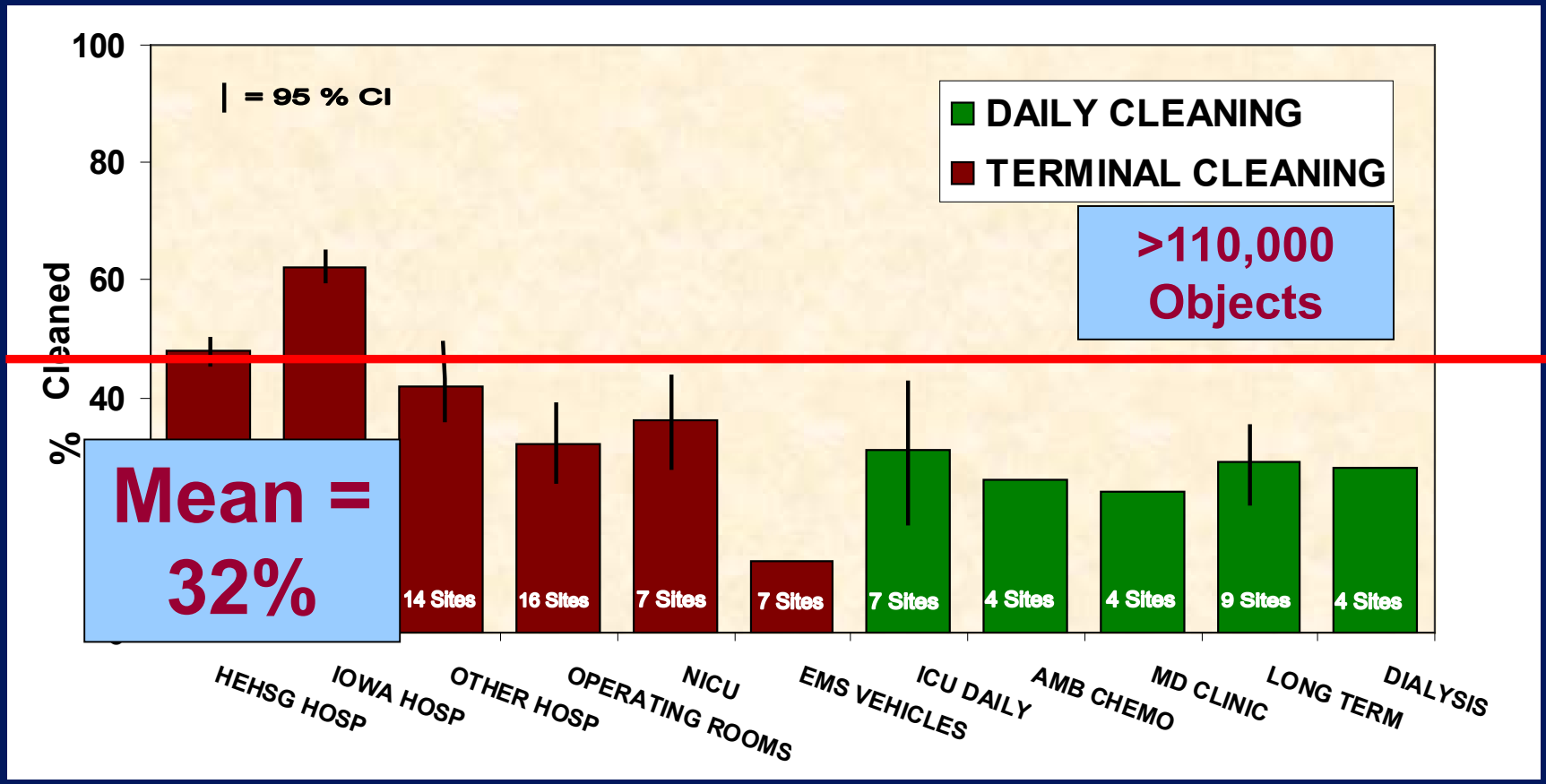
Weber, Kanamori, Rutala. Curr Op Infect Dis .2016.29:424-431



- EIP-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

Thoroughness of Environmental Cleaning

P Carling. AJIC. 2013



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 previous patient's pathogen by 39-353%
- For example, increased risk for *C. difficile* is 235% (11.0% vs 4.6%)
- 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)

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

No Touch

(supplements but does not replace surface cleaning/disinfection)

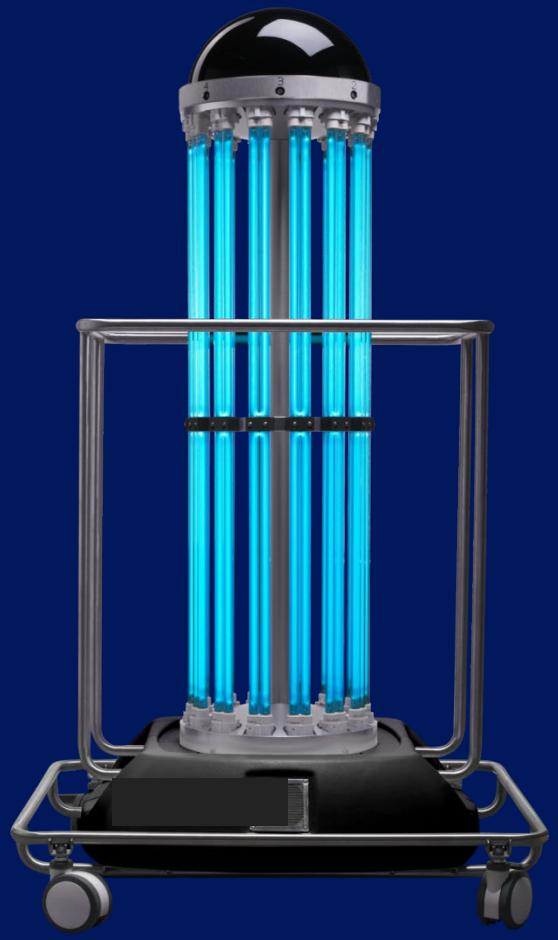
Environmental Contamination Leads to HAIs

- By contaminating hands/gloves via contact with the environment and transfer to patient or patient self inoculation
- Surfaces 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

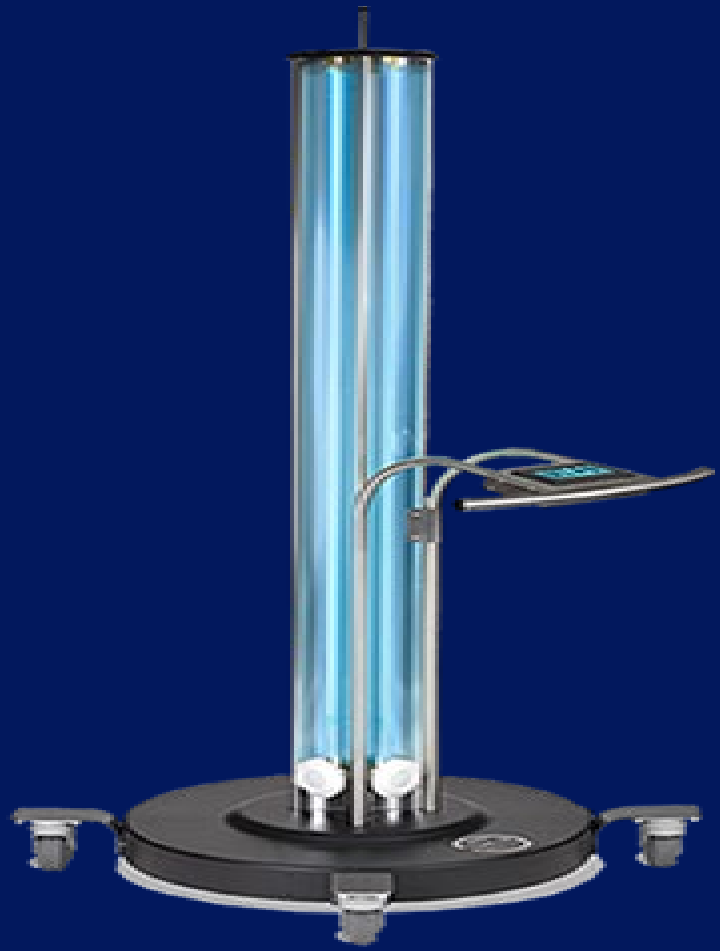
“No Touch” Approaches To Room Decontamination

(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.







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

Anderson et al. Lancet 2017;289:805; Rutala et al. ICHE 2018;38:1118-1121

	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

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.

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-new patient in room
  - Daily room decontamination (referred to “trash and dash”) and recontamination

Why do we need to consider continuous room decontamination technology?

To reduce microbial contamination

(associated with suboptimal CD practices and recontamination)

Continuous Room Decontamination Technologies for Disinfection of the Healthcare Environment

Weber, Rutala et al. AJIC. 2019;47:A72; Rutala et al. ICHE 2019

- Visible light disinfection through LEDs
- Dry/dilute hydrogen peroxide
- Self-disinfecting surfaces (e.g., copper)
- 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

Efficacy of a Continuously Active Disinfectant Against Healthcare Pathogens

Rutala WA, Gergen M, Sickbert-Bennett E, Anderson D, Weber D. ICHE 2019;40:1284

4-5 $\log_{10}$ reduction in 5min over 24hr for most pathogens; ~99% reduction with *Klebsiella* and CRE *Enterobacter*.

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

*Test surface glass unless otherwise specified

Will the continuously active disinfectant kill viruses like coronaviruses?

Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, 2020

Contamination of SARS-CoV-2 RNA by PCR on environmental surfaces and medical devices has been documented. Rate varies from 0-75% (median 12.1%).

Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

SARS-CoV-2 RNA				
Bed rail	Sink	BP monitor	Infusion pump	Keyboard
Bedside table	Floor	ECG monitor	Fluid stand	Phone
Chair	Toilet seat	Oxygen regulator	Hand sanitizer	Computer mouse
Doorknob	Toilet bowl	Oxygen mask	Trash can	Door
Light switches	Stethoscope	CT scanner	Self-service printer	Glass window
Call button	Pulse oximetry	Ventilator	Desktop	PPE storage area
Centrifuge	Biosafety cabinet	Infant bed	Air outlet	Ambu bag
TV remote	Bed sheet	Urinary catheters	TV	Beepers
Elevator buttons	Ventilator tubing	Glove boxes	Touch screen	All surfaces in nurse's station

Environmental Contamination in COVID-19 Rooms with Severe Pneumonia

Ahn et al. J Hosp Infect 2020;106:570

Pt 1 and 2-2/48-4% (closed suction to ventilator) pt 3-13/28-46% (high-flow oxygen therapy via nasal cannula, non-invasive ventilation). Found viable virus (7/28-25%) only on surfaces within droplet distance (bedside table, remote control, bed rails, bedsheets, mask, nasal prongs, floor near patient). All air samples negative.

Sample	Patient 1				Patient 2				Patient 3			
	PCR	C_T value		Culture	PCR	C_T value		Culture	PCR	C_T value		Culture
		E gene	RdRp			E gene	RdRp			E gene	RdRp	
Air	−			ND	−			ND	−			ND
Air outlet fan	−			ND	−			ND	+	33.93	34.99	−
Air inlet fan	−			ND	−			ND	−			ND
Nasal prong/endotracheal tube	+	30.95	31.36	+	+	32.33	33.02	−	+	31.78	34.28	+
Intravenous pole	−			ND	−			ND	−			ND
Computer	−			ND	−			ND	−			ND
Medication cart	−			ND	−			ND	−			ND
Window	−			ND	−			ND	U	U	U	−
Window frame	−			ND	−			ND	−	34.23	36.04	−
Blind curtain	−			ND	−			ND	−			ND
Wall 1	−			ND	−			ND	−			ND
Wall 2	−			ND	−			ND	−			ND
Floor near the patient[a]	−			ND	−			ND	+	30.38	33.07	+
Floor far from the patient[b]	−			ND	−			ND	+	31.97	34.28	−
Bed rails	−			ND	−			ND	+	30.22	30.13	+
Bedsheet	−			ND	−			ND	+	31.54	31.99	+
Pillows	−			ND	−			ND	ND			ND
Faucet handle	−			ND	−			ND	ND			ND
Door knob	−			ND	−			ND	−			ND
Call button	−			ND	−			ND	−			ND
Restraint	−			ND	−			ND	+	34.08	35.18	−
Blood pressure cuff	−			ND	−			ND	−			ND
Ambu mask/NIV mask	−			ND	−			ND	+	28.85	28.94	+
Ventilator	−			ND	−			ND	−			ND
Patient monitor	−			ND	−			ND	−			ND
Bedside table	ND			ND	ND			ND	U	33.09	U	+
High-flow oxygen generator	ND			ND	ND			ND	+	30.56	33.12	−
Telephone	ND			ND	ND			ND	+	31.39	33.42	−
Remote controller	ND			ND	ND			ND	+	29.48	29.66	+
Thermometer	ND			ND	ND			ND	+	31.56	32.13	−
Cup	ND			ND	ND			ND	+	32.32	33.55	−

Decreasing Order of Resistance of Microorganisms to Disinfectants/Sterilants

Rutala, Weber, CDC DS Guideline 2008. www.cdc.gov

Most Resistant



Most Susceptible

Prions

Spores (*C. difficile*)

Mycobacteria

Non-Enveloped Viruses (norovirus, adeno)

Fungi

Bacteria (MRSA, VRE, *Acinetobacter*)

Enveloped Viruses (SARS-CoV-2)

Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

- CDC recommends that an EPA-registered disinfectant on the EPA's List N that has qualified under the emerging pathogen program for use against SARS-CoV-2 be chosen for the COVID-19 patient care.
- List N has >500 entries and >30 different active ingredients (Quats, chlorine, etc.)

Role of Healthcare Surface Environment in SARS-CoV-2 Transmission

Kanamori, Weber, Rutala, Clin Infect Dis, https://doi.org/10.1093/cid/ciaa1467, 28 September 2020

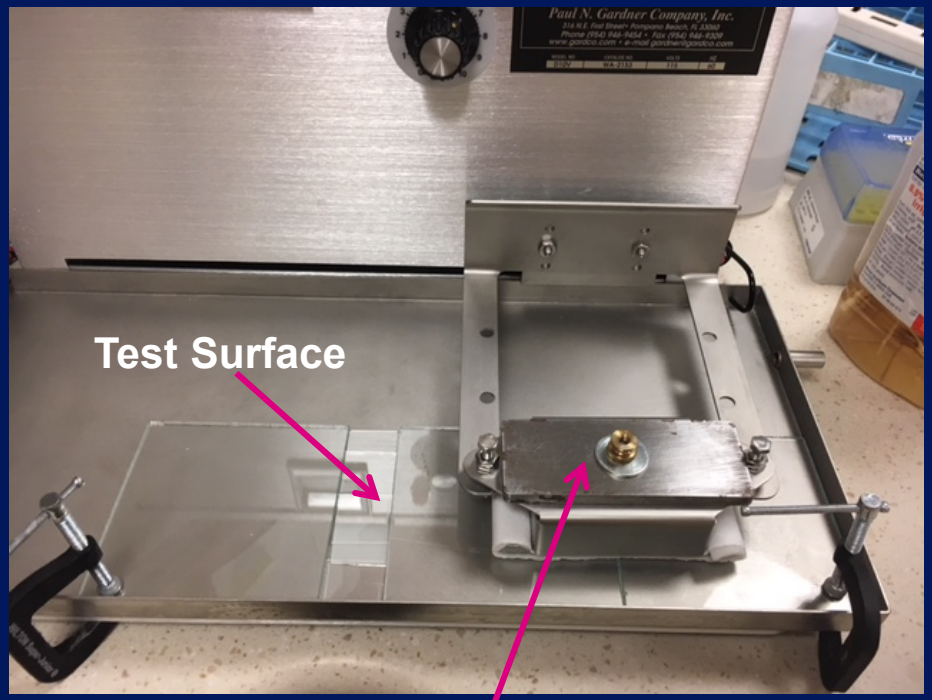
- Survival on environmental surfaces
  - SARS-CoV-2 can be viable on surfaces for hours to days (plastic, stainless steel ~2-3 days, cardboard ~24h)
  - Depends on experimental conditions (titer, RH, surface, temperature, suspending medium)
  - Suggest transmission of SARS-CoV-2 may occur
  - Tested the ability of a continuously active disinfectants against human coronavirus 229E, surrogate for SARS-CoV-2

Evaluation of a Continuously Active Disinfectant

"EPA Protocol for Residual Self-Sanitizing Activity of Dried Chemical Residuals on Hard, Non-Porous Surfaces"

Abrasion Tester

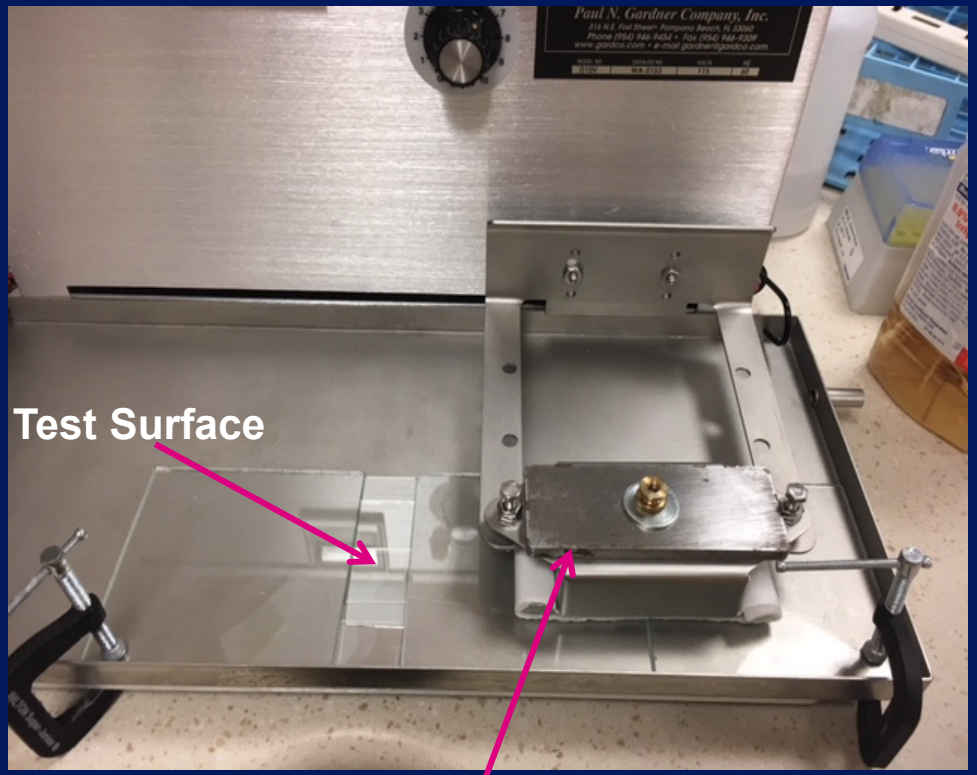




Evaluation of a Continuously Active Disinfectant

"EPA Protocol for Residual Self-Sanitizing Activity of Dried Chemical Residuals on Hard, Non-Porous Surfaces"

- Test surface inoculated (>10^5, 5.63-$\log_{10}$), 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 (10^3, 30min dry) over 48hr
- At the end of the study and 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, 6.13-$\log_{10}$)



Efficacy of a Continuously Active Disinfectant Against a Human Coronavirus, 229E, Evaluated after 48 hours

Rutala WA et al. Unpublished data, September 2020

A novel disinfectant studied using an EPA protocol (wears/re-inoculations) demonstrated excellent continuous antiviral activity (i.e., >4.5-log_{10} reduction) in 1 minute after **48** hours for a human coronavirus, 229E

Carrier Treatment with Wears and Re-inoculations	Contact Time	Mean Viral Recovery Titer per Carrier (log_{10})	Log_{10} Reduction
Control (sterile water, n=3)	1 minute	6.00 ± 0.25	N.A.
Test disinfectant (n=3)	1 minute	≤ 1.50 ± 0.00	>4.50

Objectives

- Role of environment in disease transmission
- Why we need continuous room decontamination
  - Continuously active disinfectant
- Evaluation of a continuously active disinfectant to inactivate coronavirus 229E

Efficacy of a Continuously Active Disinfectant

Summary

A continuously active disinfectant may reduce or eliminate the problem of recontamination and the role of contaminated environmental surfaces and equipment in transmission of healthcare pathogens including SARS-CoV-2.

THANK YOU!
www.disinfectionandsterilization.org

Environmental Contamination Leads to HAIs

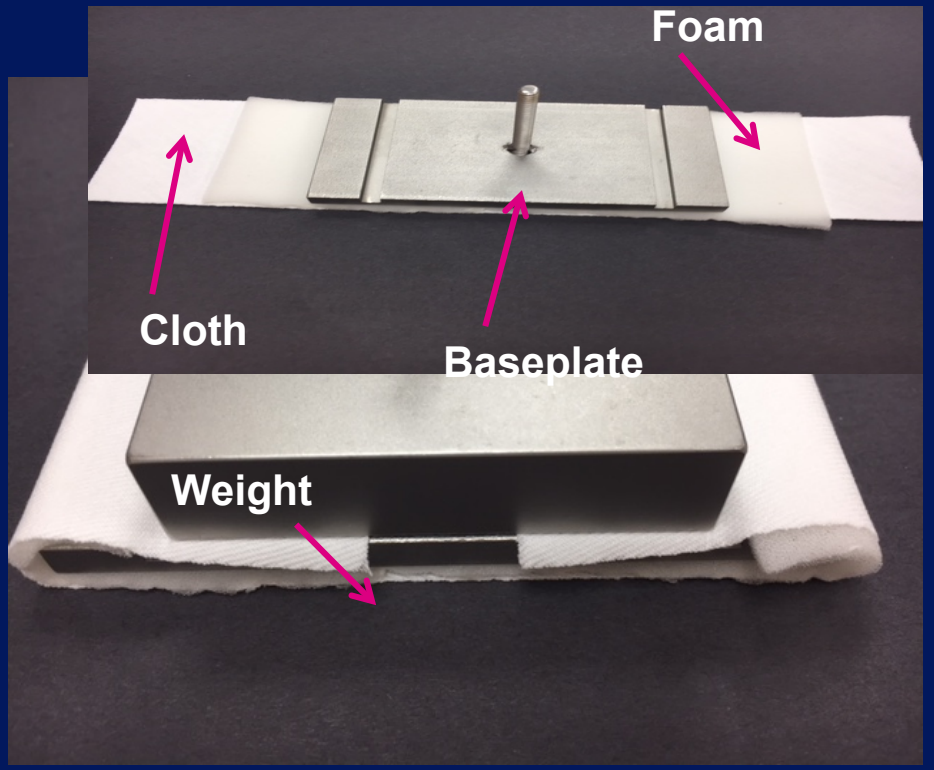
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  - Discharge/terminal-new patient in room
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