

Advancing Infection Prevention: New Research and Innovations in Disinfection and Sterilization

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Disclosure: Ideate Medical

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Advancing Infection Prevention: New Research and Innovations in Disinfection and Sterilization

- Fifteen articles/topics were selected for presentation as they represented current issues, new research and/or new technologies
 - PubMed data was searched for all studies on disinfection and sterilization in healthcare in past 5 years
 - About 2,500 abstracts reviewed
- Most significant change to reduce infection risk-sterilization of flexible endoscopes

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Disinfection and Sterilization

Rutala, Weber, HICPAC. November 2008. www.cdc.gov. Rutala, Weber, Boyce. AJIC 2026

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 but high numbers of bacterial spores.

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

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Infection Control & Hospital Epidemiology (2025), 1-23
doi:10.1017/ice.2025.41



SHEA Expert Guidance

Multisociety guidance for sterilization and high-level disinfection

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Abstract

SHEA, in partnership with ASGE, APIC, AAMI, AORN, HSPA, IDSA, SGNA, and The Joint Commission, developed this multisociety infection prevention guidance document for individuals and organizations that engage in sterilization or high-level disinfection (HLD). This document follows the CDC Guideline for Disinfection and Sterilization in Healthcare Facilities. This guidance is based on a synthesis of

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Infection Control & Hospital Epidemiology (2025), 1-23
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SHEA Expert Guidance

Multisociety guidance for sterilization and high-level disinfection

- SHEA, in partnership with ASGE, APIC, AORN, HSPA, IDSA, SGNA, TJC developed this multi-society infection prevention guidance document
- Based on synthesis of published scientific evidence, theoretical rationale, current practices, practical considerations, written group consensus, and consideration of potential harm
- Addresses 45 topics-transition to endoscope sterilization

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Infection Control & Hospital Epidemiology (2025), 1-23
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SHEA Expert Guidance

Multisociety guidance for sterilization and high-level disinfection

Table 1
Summary of recommendations in the SHEA Multisociety Guideline⁴

Topic	Recommendation
Point-of-use Verify mechanical washers working effectively	Treat with a process designed to begin cleaning and/or to keep devices moist until processing Verification tests should monitor at the point-of-use, generate immediate results, all stages of cycle meet cleaning parameters
How to monitor cleanliness before HLD, sterilization How to monitor effectiveness of sterilization When may RSS be used Does a single-use sheath or probe cover allow LLD Sterilization or HLD for ultrasound probes Requirements for germicidal flow through lumened devices Automated versus manual HLD Maximum storage time for devices Evidence to support additional cycles of HLD to reduce risk	No recommendations beyond external visual inspection Use combination of physical, chemical and biological indicators As last resort when standard sterilization cannot be performed Sheaths do not eliminate need for HLD for semicritical reusable medical devices unless specified by MIFU Not required for ultrasound probes applied to intact skin for intended use of guiding percutaneous procedures Ensure germicidal flow through lumened medical devices Automated processing preferred over manual HLD No recommendations can be made for a maximum time after which facilities should repeat HLD for devices No recommendation for use of more than one cycle of HLD for the purpose of reducing microbial contamination
Should certain semicritical devices be sterilized	When sterilization technologies are effective and validated, facilities should convert from HLD to sterilization for devices with high risk of infection
What visual inspection methods are recommended Should HCP be educated, trained and assessed	No standardized method exists for routine, internal visual inspection of endoscope channels Ensure HCP are educated, trained and assessed for competency in sterilization <i>before</i> they based on job responsibilities

HCP, health care personnel; HLD, high-level disinfection; RSS, immediate use steam sterilization; LLD, low-level disinfection; MIFU, manufacturer's instruction for use; SHEA, Society of Healthcare Epidemiology of America.

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Mobile UVC Robotic Systems

Astrid et al *Anti Resist IC*. 2021; Russo et al *Int J Env Res Pub Hlt* 2021; Casini et al. *Int J Env Res Publ Hlt* 2023; Bratu et al. *Sensors*. 2024.

- Contaminated hospital environment is a reservoir for various pathogens
- May serve as a source of HAIs
- Conventional manual CD are not always sufficient to eliminate risk posed by contaminated surfaces
- Humans are a contributing factor
- UVC, now UVC robots developed to overcome shortcomings
- AI driven; microbial reductions > manual CD; huge potential but needs further development



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Yuan et al. *BMC Health Services Research* (2026) 26:564
https://doi.org/10.1186/s12913-026-14366-9

BMC Health Services Research

RESEARCH

Open Access

Effectiveness of an artificial intelligence-assisted training program on cleaning competency among hospital environmental service staff

Yuhua Yuan¹, Bin Liu¹, Xiaoxia Wei¹, Lihong Ye¹ and Baihuan Feng^{1*}

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Abstract

Background Healthcare-associated infections remain a major patient-safety threat, and environmental contamination is a key driver. Hospital cleaning staff are essential for prevention, yet conventional training lacks standardization and real-time feedback. We evaluated whether an artificial intelligence (AI) system with live monitoring and voice prompts improves terminal cleaning competency.

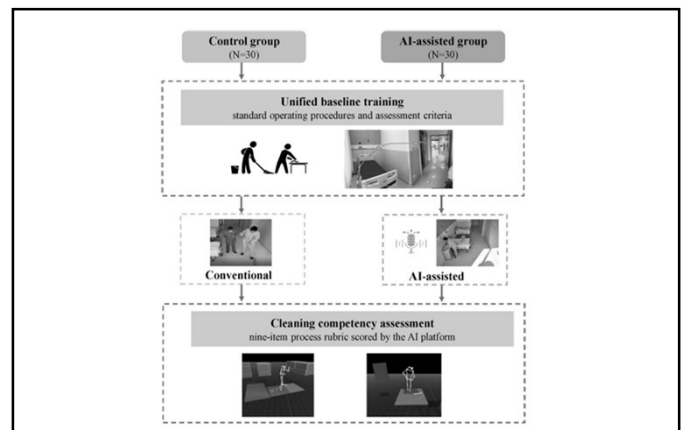
Methods We randomly assigned 60 environmental service staff from Sir Run Run Shaw Hospital, Hangzhou, China, to either conventional instruction or AI-assisted training. The AI platform used computer vision and deep-learning algorithms to track cleaning tasks in real time against a predefined nine-item procedure and provided instant voice corrections when deviations occurred. Competency was assessed post-training under identical, feedback-free conditions, and a score of ≥ 7 was required to pass.

Results Median competency scores were 7.8 (IQR: 7.4–8.4) in the AI group versus 5.8 (IQR: 5.4–7.4) in controls. All 30 AI-trained staff passed, compared with 9 (30%) controls. Largest gains occurred in edge cleaning, S-pattern mopping and high-touch surface disinfection.

Conclusions Real-time AI supervision significantly enhances cleaning competency and procedure adherence, offering a scalable and standardized approach to improve environmental hygiene and infection prevention.

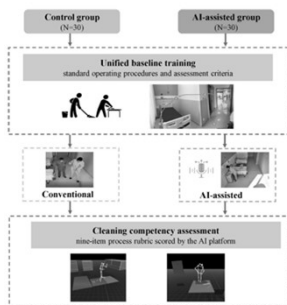
Keywords Healthcare-associated infections, Artificial intelligence, Cleaning competency, Environmental service, Hospital training

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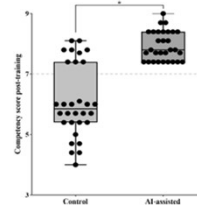
Artificial Intelligence-Assisted Training



- AI platform used computer vision and deep-learning algorithms to track tasks in real time against a predetermined nine-item procedure and provided instant voice corrections when deviations occurred.
- Competency assessed, score of 7 required to pass.

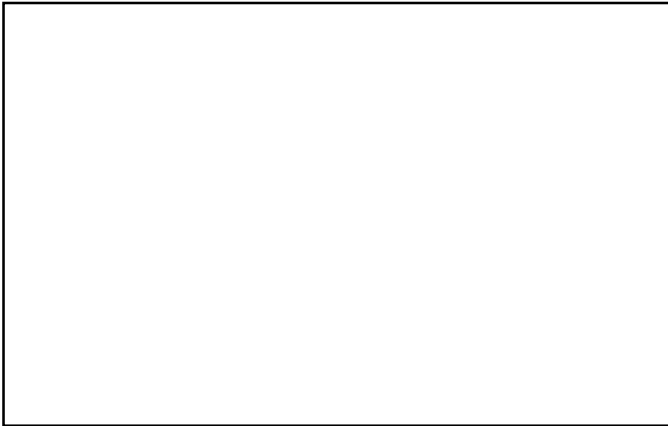
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Artificial Intelligence-Assisted Training

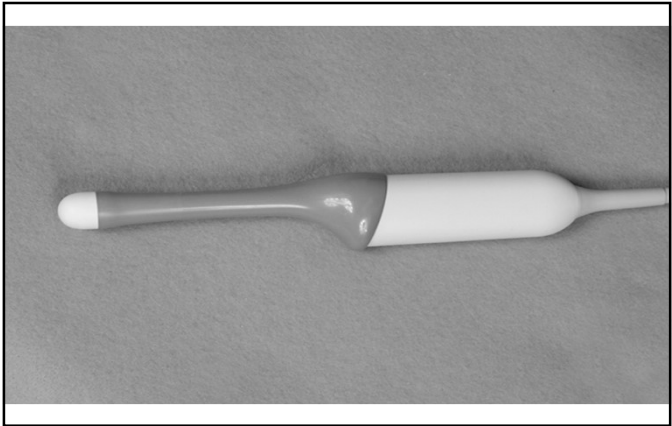


- Median competency scores were 7.8 in the AI group versus 5.8 in controls
- All 30 AI trained staff passed, compared to with 9 (30%) controls
- Real-time AI supervision significantly enhances cleaning competency and procedure adherence, offering a standardized approach to improve environmental hygiene

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New HLD Reprocessing Technologies for Endocavitary Probes

Rutala, Weber 2026;54:S106-S119

- HLD with FDA-cleared HL disinfectant
- Hydrogen Peroxide mist
- Chlorine dioxide
- UV

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Reprocessing Endocavitary Probes

Rutala et al. ICHE. 2016; Rutala et al. AJIC. 2023

- HLD with FDA-cleared high-level disinfectant
- Vapor control
- Alternative to HLD
- Hydrogen peroxide mist

TABLE 1. Proportion of Surface and Endocavitary Probes Positive After Tophane System Processing According to the Presence or Absence of an Organic Challenge*

	Probes with vancomycin-resistant <i>Enterococcus</i> (VRE), No./Total	Probes with <i>CR Klebsiella pneumoniae</i> , No./Total	Probes with <i>Mycobacterium</i> spp., No./Total (mean log ₁₀ reduction and 95% CI)	Probes with <i>Clostridium difficile</i> spores, No./Total (mean log ₁₀ reductions and 95% CI)
Present	0/7	0/6	4/9 (5.19 [4.61-5.76])	3/6 (5.12 [4.42-5.83])
Absent	0/6	0/6	1/6 (4.62 [4.07-5.17])	1/9 (6.23 [6.02-6.43])

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Hydrogen Peroxide Mist

(uses HP mist to achieve HLD in 7m)

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Effectiveness of HP Mist System in Inactivating Healthcare Pathogens on Probes

Rutala, Gergen, Sickbert-Bennett. ICHE 2016;37:613-614

TABLE 1. Proportion of Surface and Endocavitary Probes Positive After [] System Processing According to the Presence or Absence of an Organic Challenge*

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Present	0/7	0/6	4/9 (5.19 [4.61-5.76])	3/6 (5.12 [4.42-5.83])
Absent	0/6	0/6	1/6 (4.62 [4.07-5.17])	1/9 (6.23 [6.02-6.43])

- Automated, closed system that uses HP mist for HLD of ultrasound probes
- >10⁶ pathogens inoculated onto probe at 2-3 sites
- Inactivated bacteria and good but not complete kill of mycobacteria, spores
- Alternative to high-level disinfection by high-level disinfectants

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Two New Chlorine Dioxide Products-HLD

(not exact same product-difference is intended application and regulatory clearance; 320ppm)
Rutala Weber 2025;54:S105-S119

- Ophthalmic Devices (OPH)-
- OPH-duo contains base (citric acid) and activator (sodium chlorite). 2m contact time.
- Mixed when press foam pump.
- Ultrasound Probes (ULT)-endocavitary (transvaginal/transrectal) and skin surface transducer
- ULT uses foam with specific wipes
- Clean-dispense-wipe-wait 2m-remove residue



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Disposable Chlorine Dioxide Wipes

Tofanelli et al. Am J Otolaryngol 2020

- 320ppm chlorine dioxide
- Registered as HLD for manual application using wipes; 2 min at 20°C
- FDA-cleared, for processing endocavity transvaginal, transrectal and skin surface transducers only

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FDA-Cleared UVC HLD for External and Endocavitary Ultrasound



- Multiple UVC lamps and reflective walls
- Automated cycle ~90s
- HLD of surfaces of external, transvaginal, transrectal ultrasound probes that do not contain lumens

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Comparison of the Sporicidal Activity of UV Disinfection Process with Three FDA-Cleared Sterilants

Pineau et al. AJIC 2022;50:1316

UV disinfection showed a rapid killing of *B. subtilis* spores.

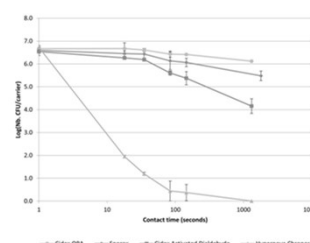


Fig 2. Main text: Evaluation of the number of viable spores of *Bacillus subtilis* ATCC 19638 on the silicone carrier trials according to contact time in the UV disinfection unit (Hypermina Chromex CBRMTEC) or with high level disinfectants (Sporicide S, Cidex Activated Disinfectant Solution, Cidex OPA).

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Rapid Environmental Contamination with *Candida auris* and MRDO Near Colonized Patients

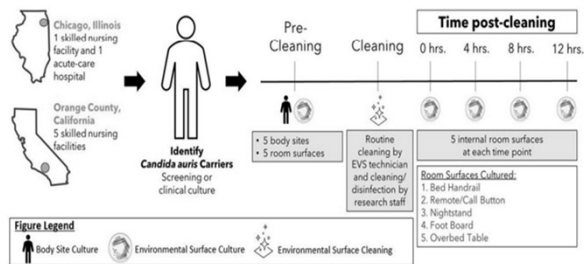
Sansom et al. Clin Infect Dis 2024

- Environmental contamination is suspected to play an important role in *C. auris* and MDRO transmission
- Understanding how *C. auris* colonization contributes to environmental contamination is critical to inform infection prevention and outbreak response.
- This study measured time to environmental contamination to determine whether more cleaning/disinfection of high touch objects should be recommended to reduce transmission risk from *C. auris* and MDRO carriers

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Rapid Environmental Contamination with *Candida auris* and MRDO Near Colonized Patients

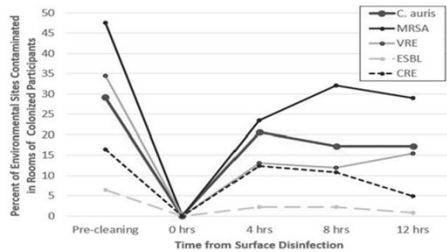
Sansom et al. Clin Infect Dis 2024



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Rapid Environmental Contamination with *Candida auris* and MRDO Near Colonized Patients

Sansom et al. Clin Infect Dis 2024



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Environmental Contamination Leads to HAIs

Rutala Weber AJIC 2026

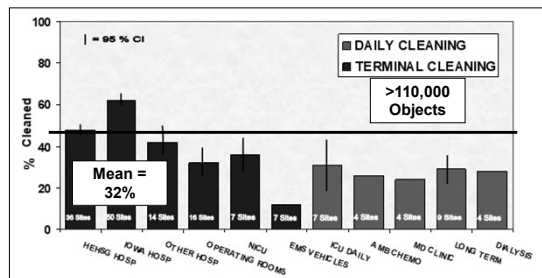


- Evidence environment contributes
- Role-MRSA, VRE, *C. difficile*
- Surfaces are contaminated~25%
- EIP survive days, weeks, months
- Contact with surfaces results in hand contamination
- Disinfection reduces contamination
- Disinfection (daily) reduces HAIs
- Rooms not adequately cleaned

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Thoroughness of Environmental Cleaning

Carling P. AJIC 2013;41:S20-S25



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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%)(Shaughnessy ICHE 2011;32:201)
- 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)

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Antimicrobial Stewardship & Healthcare Epidemiology (2024), 4, e123, 1-3
doi:10.1017/ash.2024.388



Concise Communication

A novel approach for safe and automated implementation of far ultraviolet-C light decontamination in clinical areas

Samir Memic BS^{1,2}, Jennifer L. Cadnum BS¹, Andrew Osborne BS³, William A. Rutala PhD^{4,5} and Curtis J. Donskey MD^{3,6}

¹Department of Systems Biology, Case Western Reserve University School of Medicine, Cleveland, OH, USA, ²Research Service, Louis Stokes Cleveland VA Medical Center, Cleveland, OH, USA, ³Department of Medicine, Case Western Reserve University School of Medicine, Cleveland, OH, USA, ⁴Statewide Program for Infection Control and Epidemiology, University of North Carolina School of Medicine, Chapel Hill, NC, USA, ⁵Division of Infectious Diseases, UNC School of Medicine, Chapel Hill, NC, USA and ⁶Geriatric Research, Education, and Clinical Center, Louis Stokes Cleveland VA Medical Center, Cleveland, OH, USA

Abstract

A novel wall-mounted far ultraviolet-C (UV-C) light technology providing automated delivery of far UV-C only when people are not present reduced methicillin-resistant *Staphylococcus aureus* in a patient room and equipment room. The safety feature that discontinues far UV-C output when people are detected was effective in preventing far UV-C exposure.

(Received 7 February 2024; accepted 30 May 2024)

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Far UV-C 222

Continuous decontamination of air and surfaces



- Filters block >230nm
- Placed on wall
- Kill microbes (3 log₁₀ reduction in 45m) in air and on surfaces when within 2-3meter
- Safe for occupied areas
- Skin/Eye tissue penetration-UVC 254nm-layers; Far UVC 222nm-µm
- Proposed as continuous, safe decontamination for air and surface contamination in occupied spaces
- Long-term safety needs to be investigated

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Far Ultraviolet-C

Memic et al. Antimicrob Steward Healthcare Epidemiol. 2024

- Pictures of a patient room with 2 Far UVC devices positioned at opposite sides of the room on each side of the bed. Motion detector that discontinues Far UVC output when people in the room, which prevents exposure.

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Far Ultraviolet-C

Memic et al. Antimicrob Steward Healthcare Epidemiol. 2024

- Reductions in MRSA after 45m of exposure ~2.5 log₁₀ reduction

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Disinfectants kill microbes when applied to a surface but no sustained microbicidal activity

Persistent disinfectants

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Continuously Active Disinfectant Inactivates SARS-CoV-2 and Human Coronavirus 229E two days after the Disinfectant Was Applied and Following Wear Exposures

Rutala et al. Infect Control Hosp Epidemiol. 2023;44:507-509

A novel disinfectant studied using an EPA protocol (wears/re-inoculations) demonstrated excellent continuous antiviral activity following a 48h period of wear and abrasion exposures with reinoculations. Reduction >4.5-log₁₀ were achieved within a minute contact time for a human coronavirus, 229E, and SARS-CoV-2.

Table 1. Inactivation of SARS-CoV-2 and the Human Coronavirus 229E by a Continuously Active Disinfectant Following a 48-Hour Period of Wear and Abrasion Exposures

Carrier Treatment with Wears and Reinoculations	HCoV 229E Mean Viral Recovery per Carrier (Log ₁₀ ± S.D.)	SARS-CoV-2 Mean Viral Recovery per Carrier (Log ₁₀ ± S.D.)	HCoV 229E Log ₁₀ Reduction	SARS-CoV-2 Log ₁₀ Reduction
Control (sterile NP water, n=3)	6.00 ± 0.25	5.72 ± 0.08	NA	NA
Continuously acting disinfectant (n=3)	≤1.50 ± 0.00	≤1.50 ± 0.00	≥4.50	≥4.22

Notes: Contact time = 1 minute; NA = not applicable.

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Enhanced Disinfection Reduces HAIs

Browne et al. Lancet. 2024

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Enhanced Disinfection (UVC) Leading to Reduction of Microbial Contamination and a Decrease in Patient Col/Inf

Anderson et al. Lancet 2017;289:805; Rutala et al. ICHE 2018;39:1118

	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) ^b	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.

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Investigating the effect of enhanced cleaning and disinfection of shared medical equipment on health-care-associated infections in Australia (CLEEN): a stepped-wedge, cluster randomised, controlled trial



Katrina Browne, Nicole M White, Philip L Russo, Allen C Cheng, Andrew J Stewardson, Georgia Matterson, Peta E Tehan, Kirsty Graham, Maham Amin, Maria Northcote, Martin Kiernan, Jennie King, David Brain, Brett G Mitchell

Summary

Background There is a paucity of high-quality evidence based on clinical endpoints for routine cleaning of shared medical equipment. We assessed the effect of enhanced cleaning and disinfection of shared medical equipment on health-care-associated infections (HAIs) in hospitalised patients.

Lancet Infect Dis 2024

Published Online

August 13, 2024

[https://doi.org/10.1016/S1473-3099\(24\)00399-2](https://doi.org/10.1016/S1473-3099(24)00399-2)

Methods We conducted a standardised, cluster randomised, controlled trial in ten wards of a clinical hospital located

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Enhanced Disinfection of Shared Medical Equipment Reduces HAIs

Browne et al. Lancet. 2024

- Cluster randomized, controlled trial in ten ward, single hospital in Australia
- Each cluster, 2 randomly allocated wards (March–November 2023)
- Control phase, no change to CD (no requirement for cleaning staff; responsibility of HCWs to CD after use)
- Intervention phase, CD bundle included additional 3h per weekday for dedicated CD of noncritical, shared medical equipment (BP, pumps, infusion drip stands) by 21 dedicated CD staff
- Primary outcome HAIs as assessed by fortnightly point prevalence survey

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Enhanced CD of Shared Medical Equipment

Browne et al. Lancet 2024

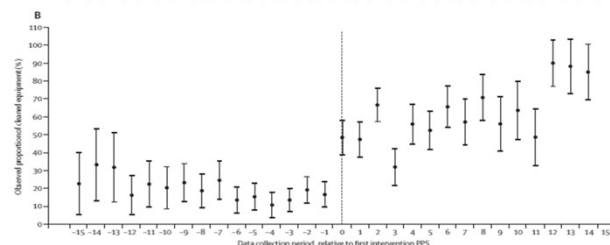
- Clinell universal and sporicidal wipes
- Dual detergent-disinfectant wipes, GAMA Healthcare
- 1-h training session with 21 dedicated cleaning staff
- Cleaning thoroughness <50% refresher training
- Fluorescent marker gel, randomized list of 12 items for each audit
- 1786 shared equip audited. CD increased from $\geq 18\%$ to $\geq 57\%$
- No policy changes, such as screening, isolation or outbreaks
- Hand hygiene compliance, colonization pressure-no change

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Enhanced CD of Shared Medical Equipment

Browne et al. Lancet 2024

- Proportion of cleaned equipment in intervention and control phase

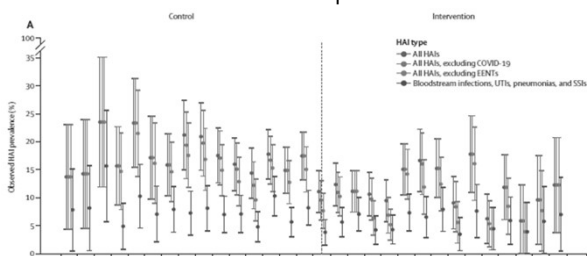


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Enhanced CD of Shared Medical Equipment

Browne et al. Lancet 2024

- HAIs in intervention and control phase



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Enhanced Cleaning/Disinfection (CD) of Shared Medical Equipment

Browne et al. Lancet 2024

- Intervention reduced HAIs

	Control			Intervention		
	Patients	HAIs	HAI prevalence, % (95% CI)	Patients	HAIs	HAI prevalence, % (95% CI)
1	189	23	12.2% (7.5–16.8)	359	37	10.3% (7.3–13.5)
2	276	58	21.0% (16.2–25.8)	275	32	11.6% (7.9–15.4)
3	82	9	11.0% (4.2–17.7)	393	36	9.2% (6.3–12.0)
4*	314	37	11.8% (8.2–15.4)	278	29	10.4% (6.8–14.0)
5	161	24	14.9% (9.4–20.4)	314	48	15.3% (11.3–19.3)
6	401	60	15.0% (11.5–18.5)	73	11	15.1% (6.9–23.2)
7	91	18	19.8% (11.6–28.0)	430	44	10.2% (7.4–13.1)
8	340	54	15.9% (12.0–19.8)	65	12	18.5% (9.0–27.9)
9	321	96	29.9% (24.9–34.9)	160	32	20.0% (13.8–26.2)
10	322	54	16.8% (12.7–20.9)	161	20	12.4% (7.3–17.5)
All wards	2497†	433	17.3% (15.9–18.8)	2508	301	12.0% (10.7–13.3)

HAI, health care-associated infection. *Ward 4 was relocated in the last week of the study to a new area in the hospital. The ward and patients on the ward were excluded from the final 2 weeks of the study. †These patients had two separate admissions each, and are therefore counted twice here.

Table 2: Unadjusted prevalence of HAIs in control and intervention phases by ward

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Enhanced CD of Shared Medical Equipment

Browne et al. Lancet 2024
Conclusions

- The prevalence of HAIs was reduced from 14.9% to 9.8% when CD of shared equipment was initiated
- Supports the role of CD shared medical equipment as a key intervention strategy
- Might be due to reduced burden of infectious pathogens

Wipes

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



Disinfectant Towelettes Used

Voorn et al. 2023. Scientific Reports

Table 1 Description of disinfectant towelettes

Disinfectant Products ^a	Active Ingredients ^b	Dilution at Use	Label Contact Time ^c
HP1	0.5% hydrogen peroxide	RTU ^d	1 min
QAC1	0.25% n-Alkyl (68% C ₁₂ , 32% C ₁₄) dimethyl ethylbenzyl ammonium chlorides, 0.25% n-Alkyl (60% C ₁₄ , 30% C ₁₆ , 5% C ₁₂ , 5% C ₁₀) dimethyl benzyl ammonium chlorides, 55% isopropyl alcohol	RTU	2 min
QAC2	0.125% n-Alkyl (68% C ₁₂ , 32% C ₁₄) dimethyl ethylbenzyl ammonium chlorides, 0.125% n-Alkyl (60% C ₁₄ , 30% C ₁₆ , 5% C ₁₂ , 5% C ₁₀) dimethyl benzyl ammonium chlorides	RTU	3 min
QAC3	0.14% n-Alkyl (68% C ₁₂ , 32% C ₁₄) dimethyl ethylbenzyl ammonium chlorides, 0.14% n-Alkyl (60% C ₁₄ , 30% C ₁₆ , 5% C ₁₂ , 5% C ₁₀) dimethyl benzyl ammonium chlorides	RTU	3 min
QAC4	Octyl decyl dimethyl ammonium chloride, dioctyl dimethyl ammonium chloride, didecyl dimethyl ammonium chloride, n-Alkyl (50% C ₁₄ , 40% C ₁₂ , 10% C ₁₆) dimethyl benzyl ammonium chloride (848 ppm active at 1:256 use-dilution)	1:256	10 min

^a Abbreviated naming scheme for commercially available EPA-registered disinfectants used in this study;

^b Concentrations of active ingredients at use-dilution;

^c Ready-to-use;

^d Recommended label contact time for standard use.

Contact time and disinfectant formulation significantly impact the efficacies of disinfectant towelettes against *Candida auris* on hard, non-porous surfaces

Maxwell G. Voorn¹, Alyssa M. Kelley¹, Gurpreet K. Chaggar¹, Xiaobao Li², Peter J. Teska² & Haley F. Oliver^{1,3}

Disinfectant Towelettes Vary in their Fungicidal Efficacies Against *C. auris*

Voorn et al. Scientific Reports. 2023

HP and QAC1 (Quat-alcohol) exhibited significantly higher fungal (*C. auris*) mean reductions

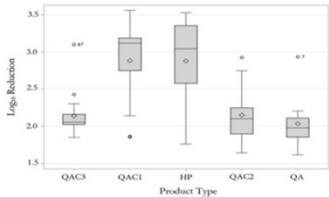


Figure 2. Mean log₁₀ reductions for each product type against *C. auris* regardless of contact time. HP had the highest variability among products tested followed closely by QAC1. HP and QAC1 had significantly higher levels of fungicidal disinfect efficacies compared to QAC2, QAC3, and QAC-alcohol; ($\alpha = 0.05$). ◇ Mean, — Median, ± Q1–1.5 IQR, T Q3 + 1.5 IQR, ○ Outlier.

Disinfectant Towelettes and Contact Time

After one minute disinfection is achieved. No significant difference in disinfectant efficacy between 1 and 10m. 30s not same disinfection as 1m
Voorn et al. Scientific Reports. 2023

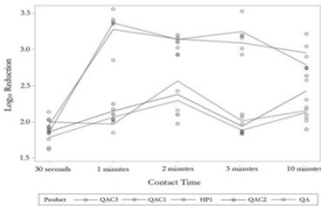
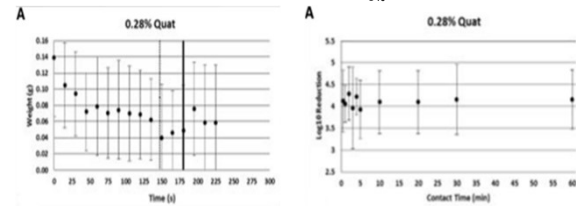


Figure 4. Interaction plot showing the relationship between contact time i.e., 30 s, one-min, two-min, three-min, and 10-min for each product (HP, QAC1, QAC2, QAC3, and QA) and mean log₁₀ reductions against *C. auris*.

Bactericidal (*S. aureus*) Efficacy of EPA-Registered Towelettes West, Teska, Oliver, AJIC, 2019

Drying time curve based on surface wetness;
bold-contact time (180s); dashed-dry (~145s)

Wet time is not crucial for complete
disinfection (wet or dry ~4 log₁₀ reduction);
30s for log₁₀ reduction



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Approach for Assessing Compliance Infection Prevention and Control Requirements

S. Garcia-Houchins / American Journal of Infection Control 51 (2023) 1182–1184



Modified from April 2019 Perspectives (available at <https://www.jointcommission.org/media/tic/documents/resources/patient-safety-topics/infection-prevention-and-hygiene-hierarchical-approach-to-setting-standards-april-2019-perspectives.pdf>) © The Joint Commission. Used with permission.

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American Journal of Infection Control 54 (2028) S147–S155

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Major Article

Environmental disinfection: Strategies to keep pediatric patients safe

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Key Words:
Disinfection
Pediatrics
Surfaces
Decontamination
Infection prevention

Background: Environmental contamination in children's hospitals contributes to the infection risk because microbes survive on surfaces and are easily transferred via staff/patients/visitors' hands to sick children via contaminated hands.

Methods: The published English literature was searched on environmental disinfection strategies to keep infant and pediatric patients safe from healthcare pathogens.

Results: This paper presents evidence-based disinfection practices, using safe and effective disinfectants, to reduce the risk to children from toys, games, stuffed animals, and environmental surfaces.

Conclusions: Maintaining a hygienic environment significantly reduces the risk of transmission of pathogens to pediatric patients and improves patient safety.

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Recommendations for reducing pathogens on fomites in a pediatric health care facility	
Item/surface/patient equipment	Recommendation
Disinfecting noncritical patient care items	Disinfect minimally when visibly soiled and on a regular basis (such as after each patient's use or once daily).
Disinfecting noncritical environmental surfaces	Disinfect hand contact/touchable surfaces on a daily basis, when spills occur and when surfaces are visibly soiled.
Playroom surfaces	Disinfect minimally when visibly soiled and on a regular basis (such as after each patient's use or once daily).
Toys, games, and stuffed animals	Options: • Clean and disinfect (eg, hard surface, washable toys) between patient use. • Discard (eg, nonwashable toys). • Gifts to patients (eg, stuffed animals). • Sterilize (eg, low-temperature sterilization for heat-sensitive items—ensure item compatible, steam for heat-resistant items). • Dishwasher (eg, washable toys like plastic blocks). • Store to 6 mo to reduce infection risk (eg, games). • Items used by younger children (who have a tendency to put things in their mouth) should be made of washable material.
Toys	• Used washable toys are cleaned with soap and water and rinsed with tapwater or wiped with 70% alcohol when soiled. • Nonwashable toys (eg, puzzles) may be used by older children. • Nonwashable toys are sterilized or disposed of when soiled. • New toys brought into the play areas do not need to be sterilized or disinfected. • If an item (eg, toy) is discovered to be broken, cracked, or unable to be cleaned/disinfected (CD), it will be discarded. • Playing cards should be decontaminated using a disinfectant, stored for 6 mo, or sterilized. • Games, puzzles, and books that cannot be disinfected, stored for 6 mo, sterilized, or should be given to the patient. • Pool table felt does not have to be disinfected, but cue sticks, balls, chalk, and racking triangle should be disinfected. • Hand hygiene should be performed before and after utilizing shared puzzles, books, and games in common areas. • Preferably, a child on isolation precaution will have his/her own toys or be given toys he/she may keep. • Robotic pets may not be used for patients on Contact or Enteric Precautions, or patients with draining wounds. Patients should perform hand hygiene before and after robotic pet use. • Robotic pets used for therapy should be disinfected between each patient's use and on a routine basis (eg, daily, 3x per week), and if visibly soiled, with an EPA-registered disinfectant per manufacturer's instructions for use (MIFU).
Toys-isolation/precaution rooms	• Toys that are not washable should not be taken into the room of a patient on Isolation Precautions unless they can be sterilized. Preferably, the child should have his own toys or be given toys he can keep. • Washable toys used by a patient on Isolation Precautions should be washed with soap and water followed by 70% alcohol before being returned to the play area for use by other children. • Washing plastic/vinyl toys in the dishwasher with chlorine bleach detergent is acceptable, on the hottest water setting. • Mobile or laptop computers and other electronic devices shared between patients must be disinfected between patient uses with EPA-registered hospital disinfectants (eg, alcohol) per manufacturer's recommendations. Prefer plastic cover over keyboard to prevent damage. Disinfectant may be followed with plain water to remove any "film" that may be caused by the disinfectant. Shared devices that cannot be disinfected with bleach per MIFU cannot be used by patients on Enteric Precautions.
Computers, gaming systems, touch screen devices, or personal DVD players	• Mobile or laptop computers and other electronic devices shared between patients must be disinfected between patient uses with EPA-registered hospital disinfectants (eg, alcohol) per manufacturer's recommendations. Prefer plastic cover over keyboard to prevent damage. Disinfectant may be followed with plain water to remove any "film" that may be caused by the disinfectant. Shared devices that cannot be disinfected with bleach per MIFU cannot be used by patients on Enteric Precautions.

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Safety precautions for minimizing risks of disinfectants in pediatric health care facilities

- Use disinfectants according to manufacturer's instructions
- Children should not come in direct contact with disinfectants
- Avoid mixing disinfectants (eg, never mix chlorine with other disinfectants/cleaners)
- Opt for fragrance-free and dye-free products
- Choose appropriate products such as EPA-registered disinfectants or diluted bleach solution
- Use disinfectants with the safest breakdown components, such as improved hydrogen peroxide to oxygen and water. Ensure all items are dry prior to placing back in use
- Use disinfectants that are lower in toxicity (eg, Category IV) but still effective
- Store disinfectants safely out of children's reach
- Wear personal protective equipment (eg, gloves, gowns) as recommended
- Disinfectants should not be sprayed when children are close to avoid inhalation and exposing skin and eyes
- Allow surfaces to dry completely before they are used
- Operate HVAC systems per ANSI/ASHRAE/ASHE standard 170

CDC Guideline for Disinfection and Sterilization in Healthcare Facilities⁴⁰; National Pesticide Information Center.¹⁰⁵

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Disinfecting a computer screen and keyboard

- Power off and unplug the device.
- Both Apple and Lenovo recommend using a soft, lint-free cloth moistened with 70% isopropyl solution, provided you apply the alcohol to the cloth first, avoid moisture in any openings, and do not use products containing bleach or abrasives.

Hospital school textbooks

- Preferably, materials needed will be copied and will be given to the patient to keep instead of using a textbook.
- If study materials that cannot be CD become soiled, they should be discarded.
- Books returned to the school library after use by a patient in their room will be isolated in storage for 6 mo, thrown away, or be given to the patient to keep.

Shared pediatric patient equipment

- Contaminated textbooks used by a patient on isolation precautions may be isolated in storage for 6 mo, allowing time for the organism to become incapable to transmit infection.
- Monitor leads, transducer cables, dopplers, skin probes, alligator clamps, nondisposable blood pressure cuffs are CD with 70% alcohol, a bleach solution, or a disinfectant (eg, improved hydrogen peroxide [H₂O₂, quat] solution) when obviously soiled and between use for different patients.
- Rolling blood pressure monitors should be disinfected daily, after using on noncontact skin, after use with a patient on Contact Precautions, and when visibly soiled.
- Infusion pumps, monitors, and IV poles are disinfected with a bleach or disinfectant (eg, H₂O₂, quat) solution at least weekly and between use for different patients.
- Scales are disinfected with an EPA-registered disinfectant-detergent or bleach wipe on a routine basis (eg, daily, weekly), when obviously soiled and after use for a patient on Contact Precautions.
- Electronic thermometer probe units and cords are disinfected daily and when visibly soiled with a 70%–90% alcohol single-use pledget. A new plastic sheath is used for each temperature.
- Mobile equipment (eg, portable x-ray, EKG, and ultrasound) in patient's room will be disinfected between patients using EPA-registered hospital disinfectants.
- Shared equipment that has contact with the patient's intact skin must be CD between uses on different patients. An EPA-approved disinfectant or 70% alcohol should be used.
- If shared equipment is taken into the Isolation Room, it is best to leave it with the patient until no longer needed.
- If removed from the Isolation Room, it should be thoroughly cleaned with soap and water (if visibly soiled) and wiped with EPA-registered disinfectants or 70% alcohol.

Shared pediatric patient equipment—Isolation

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Recommendations for Reducing Pathogens on Fomites is a Pediatric HCF

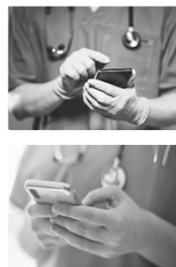
Rutala Weber. AJIC;54:S147-S155

- Options
 - Clean and disinfect (e.g. hard surface, washable toys) between patient use
 - Discard (e.g., nonwashable toys)
 - Sterilize (e.g., LTST for heat-sensitive items-ensure item compatible; steam for heat resistant items)
 - Dishwasher (e.g., washable toys like plastic blocks)
 - Store to 6 mo to reduce infection risk (e.g., games)

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MDR Contamination of HCW Phones

El-Dahshan et al. Sci Reports 2026;16:24547



- Phones-indispensable clinical tools
- May serve as MDR reservoirs
- Overall, 270/300 (90%) contaminated
- 60% (179/300) carried MDR
- CONS (29%) and Sa (25%)
- NaOCl wipes greatest bacterial load reduction (96%)
- Only 9% HCW reported daily phone disinfection; integrate phone disinfection

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MDR Contamination of HCW Phones

El-Dahshan et al. Sci Rpts 2026;16:24547

Bacterial Species	Total Isolates (n)	% of All Isolates	MDR (n)	MDR within Species (%)
Coagulase-negative staphylococci (CoNS)	110	29.4	53	48.2
<i>Staphylococcus aureus</i> (including MRSA)	95	25.4	55	57.9
<i>Klebsiella pneumoniae</i>	60	16.0	37	61.7
<i>Escherichia coli</i>	45	12.0	25	55.6
<i>Pseudomonas aeruginosa</i>	35	9.4	24	68.6
<i>Acinetobacter baumannii</i>	29	7.8	21	72.4
Total	374	100.0	215	57.5

Disinfection Method	Phones (n)	CFU Before Mean $\pm$ SD	CFU After Mean $\pm$ SD	Reduction (%)	p-value†
Sodium hypochlorite-impregnated wipes	75	228.3 $\pm$ 40.1	8.3 $\pm$ 4.2	96.5	<0.001
70% isopropyl alcohol	75	230.5 $\pm$ 45.4	12.7 $\pm$ 5.5	94.8	<0.001
Quaternary ammonium compound	75	225.1 $\pm$ 38.2	18.8 $\pm$ 6.6	92.0	<0.001
Electronic-safe wipes	75	220.3 $\pm$ 42.5	40.1 $\pm$ 10.2	81.8	<0.01

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Am J Infect Control. 2020 Aug; 48(8): 951–954.

Published online 2020 Jun 6. doi: 10.1016/j.ajic.2020.06.002

PMCID: PMC7275188

PMID: 32522608

Evaluation of an electrostatic spray disinfectant technology for rapid decontamination of portable equipment and large open areas in the era of SARS-CoV-2

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This article has been cited by other articles in PMC.

Abstract

Go to:

In the setting of the coronavirus disease 2019 pandemic, efficient methods are needed to decontaminate shared portable devices and large open areas such as waiting rooms. We found that wheelchairs, portable equipment, and waiting room chairs were frequently contaminated with potential pathogens. After minimal manual pre-cleaning of areas with visible soiling, application of a dilute sodium hypochlorite disinfectant using an electrostatic sprayer provided rapid and effective decontamination and eliminated the benign virus bacteriophage MS2 from inoculated surfaces.

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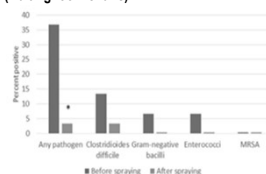
Efficacy of Disinfectant Electrostatic Spray (positively charged droplets attracted to negatively charged surfaces or microbes) in Reducing Pathogen Contamination

Cadnum et al. AJIC 2020

Picture of electrostatic sprayer (0.25% sodium hypochlorite)



Efficacy of disinfectant spray (waiting room chairs)



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

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

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

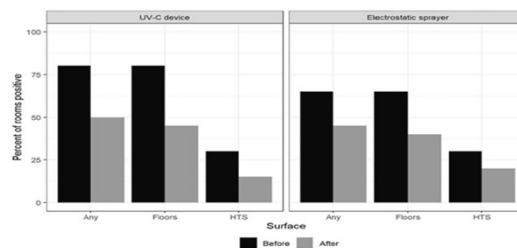


Fig. 1. Percentages of rooms with positive cultures for 1 or more healthcare-associated pathogens before versus after treatment with the ultraviolet-C (UVC) light device or the electrostatic sprayer. Note: HTS, high-touch surface.

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Summary of Electrostatic Sprayer Issues Include

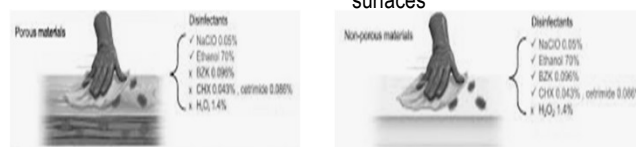
- Optimal **droplet size is between 40-70µ**; what is the droplet size of the proposed unit
- **Spray patterns** vary tremendously across vendors and even across products from a single vendor
- EPA demands that all surfaces being disinfected be thoroughly **wetted for the contact time of the specific 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
- 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)

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Efficacy of Disinfectants for Mpox Inactivation

(mpox outbreak highlights the need intervention-disinfection, transmission via surfaces)
Pitol et al. Environ Sci Technol 2024;58:19981

- Conducted on porous carriers (ceramic, wood); wiped in triplicate; 1 min contact
- NaOCl and ethanol effective
- Conducted on non-porous carriers (SS, glass, plastic, latex)
- 99.97% reduction except HP
- Use NaOCl or ethanol on clean surfaces



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Dry Biofilms on Healthcare Surfaces

Examples of “Dry” Biofilms Recovered from Surfaces
Ledwoch et al. J Hosp Infect 2018;100:e47-e56

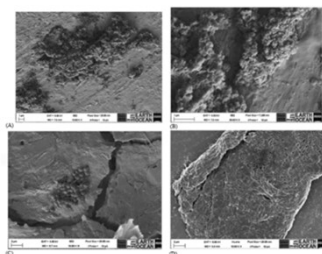


Figure 1. Examples of “dry” biofilms recovered from surfaces: (A) biofilm on a surface, (B) biofilm on a surface, (C) biofilm on a surface, (D) biofilm on a surface. Images were colorized to help visualization and contrast using GIMP image manipulation program (GIMP 2.8.18). Images were not otherwise altered.

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Biofilms on Instruments and Environmental Surfaces

Alfa, AJIC 2019. 47:A39

- Three types of biofilm-represent various types of microbial reservoirs that may act as sources of microbes
 - Traditional hydrated biofilm (water content 90%)
 - Build-up biofilm—occurs in endoscope channels
 - Dry surface biofilm-heterogenous accumulation of organisms and other material in a dry matrix (water content 61%)
 - ◆ Raises questions about the inactivation of microbes with a dry surface biofilm by currently used cleaning/disinfecting methods
 - ◆ Viable as well as viable non-culturable bacteria that exist in a matrix extra-cellular glycoconjugate, protein and DNA

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Dry Surface Biofilms

Key Points

Ledwoch et al, Br J Hosp Med 2022; Schapira et al. JHI 2024

- Dry surface biofilms are widespread on dry environmental surfaces in healthcare settings (as high as 96% of surfaces)
- Dry surface biofilms can harbor bacterial pathogens including MDROs
- Dry surface biofilms cannot be detected by routine wet swabbing
- Dry surface biofilms are less susceptible to disinfection
- Bacterial pathogens in dry surface biofilms are transferable by direct and indirect contact (gloves) following cleaning/disinfection
- Role dry surface biofilms play in HAIs is unclear

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Endoscopes: Shift from Disinfection to Sterilization

Rutala, Weber. JAMA 2014. 312:1405-1406; Rutala, Weber. Am J Infect Control. 2016;44:e1-e6; Rutala, Weber ICHE. 2015;36:643; Rutala, Weber. AJIC 2023;51:A96-A106

EDITORIAL

Editorials represent the opinions of the authors and JAMA and not those of the American Medical Association.

Gastrointestinal Endoscopes A Need to Shift From Disinfection to Sterilization?

William A. Rutala, PhD, MPH, David J. Weber, MD, MPH

More than 10 million gastrointestinal endoscopic procedures are performed annually in the United States for diagnostic purposes, therapeutic interventions, or both.¹ Because gastrointestinal endoscopes contact mucosal surfaces, use of a contaminated endoscope may lead to patient-to-patient transmission of potential pathogens with a subsequent risk of infection.² In this issue of JAMA, Epstein and colleagues³ report findings from their investigation of a cluster of New Delhi metallo-β-lactamase (NDM)-producing *Escherichia coli* associated with gastrointestinal endoscopy that occurred from March 2013 to July 2013 in a single hospital in northeastern Illinois. During the 5-month period, 9 pa-

First, endoscopes are semicritical devices, which contact mucous membranes or nonintact skin, and require at least high-level disinfection.^{4,5} High-level disinfection achieves complete elimination of all microorganisms, except for small numbers of bacterial spores. Because flexible gastrointestinal endoscopic instruments are heat labile, only high-level disinfection with chemical agents or low-temperature sterilization technologies are possible.⁶ However, no low-temperature sterilization technology is US Food and Drug Administration (FDA)-cleared for gastrointestinal endoscopes such as duodenoscopes. Second, more health care-associated outbreaks and clusters of infection have been linked to contaminated endoscopes than to any other medical device.^{3,7} However, until now,

Related article page 1447

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Why Shift from HLD to Sterilization

Rutala, Weber. AJIC 2023;51:A96-A106; Rutala, Weber. AJIC 2026.

Many reasons sterilization is superior to standard HLD in reducing the risk of microbial contamination and infection to include:

- Comply with Spaulding classification scheme
- Evidence-based recommendation as more than 150 outbreaks; 70,000 infections
- No margin of safety associated with HLD (10^{10} microbes vs $\geq 10^6$ C and HLD)
- Sterilization can improve outcomes as it can be validated (BI) and provides a SAL
- Some HLD are relatively resistant to atypical mycobacteria
- No toxicity or anaphylactic reaction
- HLD is a complex process and prone to errors and challenges (1.4% compliance)
- HLD items unpackaged; terminal sterilization items packaged, prevent contamination

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Sterile Endoscope Technologies

FDA-Cleared LTST Reusable Scopes

- ASP-HPGP
- Andersen Products-ETO
- Ideate Medical-HPGP

Sterile, Single Use Endoscopes (12)

- MacroLux Medical [bronchoscopes]
- Ambu [bronchoscopes, gastroscopes, duodenoscopes, cystoscopes]
- EvoEndo [gastroscope]
- Fujifilm [gastroscope]
- Boston Scientific [cystoscopes, duodenoscopes]
- PENTAX [bronchoscopes]
- Olympus [bronchoscopes].

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> Infect Control Hosp Epidemiol. 2025 Jan 27;1-3. doi: 10.1017/ice.2024.236. Online ahead of print.

Evaluation of a new technology for terminal sterilization of flexible endoscopes using hydrogen peroxide gas plasma

Martin M Varghese ¹, Samir Memic ¹, Maria M Torres-Teran ¹, Jennifer L Cadnum ¹, William A Rutala ², Curtis J Donskey ^{1 3 4}

Affiliations + expand

PMID: 39865764 DOI: 10.1017/ice.2024.236

Abstract

In laboratory testing, a novel hydrogen peroxide gas plasma endoscope sterilizer consistently reduced vegetative organisms, but not bacterial spores, to undetectable levels in the presence of high organism load ($\geq 6.5 \log_{10}$) and organic material and salts. These findings highlight the importance of meticulous cleaning of endoscopes prior to sterilization.

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Background

- Contaminated endoscopes have been linked to more infections than any other medical/surgical device in healthcare
- Evidence from outbreaks and contamination studies after HLD has compelled the FDA and professional organizations (e.g., APIC, SHEA, AORN, AAMI) to promote a transition from HLD to sterilization

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Background

- The aim of this study is to evaluate the effectiveness of a new hydrogen peroxide gas plasma endoscope sterilizer that recently received FDA 510k clearance
- We tested the hypothesis that the effectiveness of the sterilizer would be reduced in the presence of organic material and/or salt that might be present in the setting of suboptimal manual cleaning

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Scope Sterilization

Scope sterilizer and container

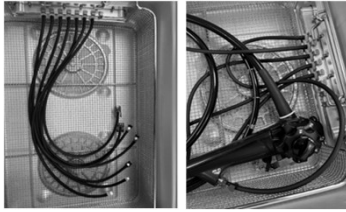
- The hydrogen peroxide gas plasma sterilizer is designed for terminal sterilization of flexible endoscopes with as many as 8 internal channels
- The endoscope is placed inside a container that interfaces with the sterilizer and subsequently provides a sterile storage container.



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Scope Sterilizer

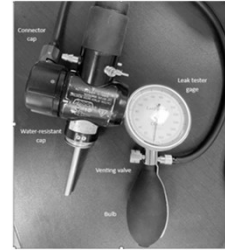
- It uses a pressure differential in each internal channel and single-use channel connector to rapidly diffuse VHP to endoscope channels



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Scope Sterilizer

- Sterilization occurs after manual cleaning and drying with filtered forced air for ≥ 10 minutes
- Cycle: 44 minutes total with 2 injections of hydrogen peroxide gas plasma 16 minutes apart
- The water-resistant cap must be removed from video endoscopes
- Leak test is done to ensure that there is no leak which could cause fluid invasion



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Objective

- Evaluated the effectiveness of the sterilizer against spores and vegetative organisms with and without organic material and salt to simulate a worst-case scenario with inadequate cleaning
- Evaluated the efficacy of the endoscope sterilizer against spore-forming and vegetative organisms using three methods

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Method 1. Inoculated steel wires placed inside elevator channel



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Method 2. Inoculation into the elevator recess and instrument channel with 5% serum



Flush with ~100 mL of sterile water to allow the inoculum to reach the center of the channel

Molloy-Simard V. Elevating the standard of endoscope processing: Terminal sterilization of duodenoscopes using a hydrogen peroxide-ozone sterilizer. AJIC 2019;47:243 - 250

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Method 3. Inoculation throughout the lumen using a brush

- Brush inserted into the biopsy port to the distal tip of the endoscope
- With brush in place, immerse the distal tip of the duodenoscope in 20 mL of test organism suspension
- Elevator mechanism articulated 3 times
- Brush withdrawn from the biopsy port
- Process repeated 3 times
- Soil: 5% serum or ATS-2015



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Test organisms

- Vegetative organisms
 - *Escherichia coli*, vancomycin-resistant *Enterococcus faecium* (VRE), *Candida auris*
 - Soil included for all tests
 - Inoculum: 8 to 9 log₁₀ CFU
- Spores
 - *Bacillus atrophaeus*, *Clostridioides difficile*, *Clostridium sporogenes*
 - Inoculum: 6 to 9.7 log₁₀ CFU

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Test Soils

- 5% fetal calf serum
- RPMI 1640 with ~0.65% salt and 10% fetal calf serum
- Artificial Test Soil (ATS)-2015
 - Intended to simulate a "worst case" challenge
 - Salt base with mucin, insoluble cellulose fiber, reconstituted dried egg yolk, and 20% sterile sheep blood

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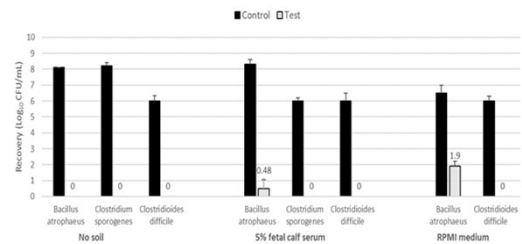
Results Vegetative Organisms

- For each test method and for all 3 test organisms, (*E. coli*, *E. faecium*, *C. auris*) no organisms were recovered after sterilization
- Inoculum: 7.9 to 9.1 log₁₀ CFU
- Soil: 5% serum, ATS-2015, and RPMI

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Inoculated steel wires

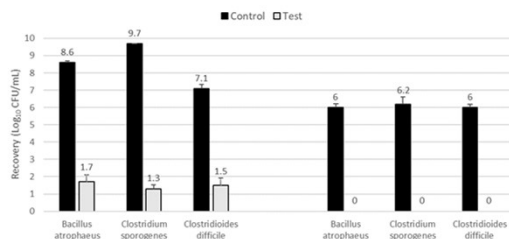
No spores recovered from wires in absence of soil. In presence of soil, no spores were recovered when inoculum ≤6.2 log₁₀ CFU but low levels of spores recovered when ≥6.5 log₁₀ CFU recovered from control endoscopes.



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Inoculation of the elevator recess and instrument channel with 5% serum

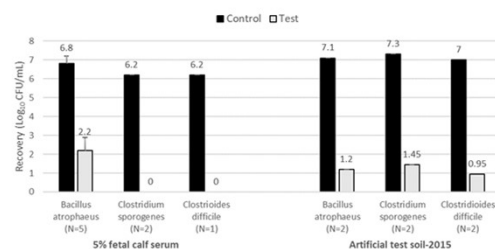
~6 log₁₀ or greater reduction of spores with 5% serum



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Inoculation throughout the lumen using a brush

~6 log₁₀ reduction of spores in most tests



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Chemical and Biological Indicators

- 3M Attest Vaporized Hydrogen Peroxide Type 4 Tri-Metric Chemical Indicators
 - All indicated appropriate exposure time, temperature, and amount of hydrogen peroxide
- 3M Attest Super Rapid Vaporized Hydrogen Peroxide Biological Indicators (24 min)
 - All with no surviving *G. stearothermophilus* spores



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FDA-Clearance for Endoscope Sterilization

Requires evidence that half-cycle eliminated 6 log₁₀ CFU of *G. stearothermophilus* spores with no soil and a full cycle eliminated 6 log₁₀ CFU of spores in simulated-use testing with soil

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The XXXXXScope Sterilization Technology System is indicated for the terminal sterilization of cleaned reusable flexible endoscopes with up to 8 internal lumens with lumen dimensions of:

- ID of 1.0 mm or larger and a length of 3580 mm or shorter and
- ID of 1.2 mm or larger and a length of 4095 mm or shorter

These dimensions capture 99% of the flexible endoscopes in the marketplace.

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Sterilize reusable flexible endoscopes that are manufacturer validated for sterilization when possible. [Recommendation]



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With the infection risk that endoscopes present to the patient, sterilization is the preferred method of microbial inactivation and the only option for instruments to be used in "critical" uses entering sterile body cavities, tissues, or vascular spaces. Sterilization continues to be recommended for endoscopes. Terminal sterilization is also required for all endoscope accessories that penetrate the mucosa, such as biopsy forceps, sphincterotomies, etc. When sterilization is required, most endoscopes require low temperature sterilization. Compatibility with low-temperature sterilization processes varies with endoscope make and model. Compatible processes can include ethylene oxide (EO), hydrogen



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34. Instead of HLD, should certain semi-critical devices preferentially be sterilized?
Recommendation:

1. When sterilization technologies are shown to be effective in clinical settings and cycle specifications are validated and included in the MIFU, facilities should begin developing an institutional process for converting from HLD to sterilization for semi-critical medical devices that are associated with a high risk of transmission of infection to patients.

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SHEA Expert Guidance

Multisociety guidance for sterilization and high-level disinfection

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Abstract

SHEA, in partnership with ASGE, APIC, AAMI, AORN, HSPA, IDSA, SGNA, and The Joint Commission, developed this multisociety

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Sterilization of Flexible Endoscopes

Rutala, Weber. Am J Infect Control 2026;54:S105-S119

- Endorsed/recommended by:
 - SHEA-Society of Healthcare Epidemiology of America
 - APIC-Assoc for Professionals in Infection Control and Epidemiology
 - AORN-Association for perioperative Registered Nurses
 - SGNA-Society of Gastrointestinal Nurse Association
 - ASGE-American Society of Gastrointestinal Endoscopist
 - TJC-The Joint Commission
 - IDSA-Infectious Disease Society of America
 - AAMI-Association for the Advancement of Medical Instrumentation

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Why Shift from HLD to Sterilization

Rutala Weber, JAMA 2014; 312:1405-1406; Rutala, Weber. AJIC 2023;51:A96-A106

- National/international guidelines recommend sterilization for lumened endoscopic devices (AORN; AAMI)
- FDA has recommended sterilization for bronchoscopes rather than HLD when feasible (FDA, 2021)
- FDA has recommended sterilization for duodenoscopes (FDA Panel, 2015)
- FDA has precluded use of HLD for certain urologic endoscopes due to HLD failure...FDA recommends sterilization (FDA, 2022)
- FDA has promoted innovation to enhance safety (e.g., use of fully disposable, sterile duodenoscopes) (FDA, 2022)

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Summary

- The endoscope sterilizer consistently reduced vegetative organisms to undetectable levels even under “worst case” conditions including high organism load ($>10^9$) and presence of organic material and salts
- The technology consistently eliminated 6 to 6.2 $\log_{10}$ CFU of spores in the presence of soils/salts
- These findings highlight the importance of meticulous cleaning of endoscopes prior to use of the sterilizer
- The endoscope sterilizer is a promising technology that provides one means to transition from HLD to sterilization of endoscopes

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Advancing Infection Prevention:

New Research and Innovations in Disinfection and Sterilization

- Shift from HLD to sterilization for flexible endoscopes
- New HLD technologies- UVC, chlorine dioxide
- AI driven decontamination/training and continuous room decontamination (Far UV 220nm with motion detectors) offer huge potential
- Enhanced disinfection of shared medical equipment reduced HAIs
 - ◆ An additional 3h per workday for dedicated CD of shared medical equipment by 21 dedicated CD staff
- Biofilms are less susceptible to disinfectants (oxidizing agents more effective)

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THANK YOU!

www.disinfectionandsterilization.org



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Other Issues

- Can probiotics (principle of competitive exclusion, beneficial bacteria replace pathogens) trigger a paradigm shift. Requires further research. Denkel et al. Anti Resist IC 2024.
- Novel color additive in disinfectant wipes improves the thoroughness of CD (reduction in surface bioburden). Oremade et al. AJIC. 2024.
- Electrolyzed water (EW) generated on-site as a disinfectant (hypochlorous acid). Effect of EW on pathogens requires further investigation. Krishnan et al. Gerodont 2023.

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