Infection Control & Hospital Epidemiology (2019), **40**, 1323–1331
doi:10.1017/ice.2019.225

Letter to the Editor

Is UV-C "light wand" mobile disinfection in air ambulance helicopters effective?

Sebastian Schulz-Stübner, Privatdozent Dr Med[1], Raimund Kosa, Stv. Koordinator Hygienemanagement Medizin[2], Jürgen Henker, Koordinator Hygienemanagement Medizin[2], Frauke Mattner, Prof Dr Med[3] and Andreas Friedrich Wendel Dr Med[3]

[1]German Consulting Center for Infection Prevention and Control [Deutsches Beratungszentrum für Hygiene (BZH GmbH)], Freiburg, Germany, [2]DRF Stiftung Luftrettung gemeinnützige AG, Filderstadt, Germany and [3]Institute of Hygiene, Cologne Merheim Medical Centre, University Hospital of Witten/Herdecke, Cologne, Germany

To the Editor—The emergence of multidrug-resistant organisms is a threat to healthcare systems worldwide. As the inanimate patient environment is a major reservoir interest in UV-C-disinfection techniques has increased recently.[1,2] Petersson et al[3] tested a mobile UV-C device and demonstrated that 4 bacterial species could be successfully inactivated on agar plates within a few seconds of irradiation, whereas longer time periods were needed for bacterial spores. Based on their conclusion ultraviolet (UV) light may provide an alternative for the decontamination of medical products, which cannot be treated otherwise. In this study, we examined the effectiveness of 2 UV-C devices on difficult-to-disinfect surfaces in air ambulance helicopters where additional mandatory air worthiness requirements related to material degradation limit the use of some chemical disinfectants.

Material and Methods

In a pretest, 1 test organism (*Enterococcus faecium* ATCC 6057) was plated in concentrations of 10^1 to 10^5 colony-forming units (CFU)/mL on Columbia 5% sheep blood agar plates (Becton Dickinson, Heidelberg, Germany). Serial dilutions were prepared in in sterile 0.9% sodium chloride. Irradiation was performed at a light wand-plate distance of 6 cm with 2 different mobile UV-C devices: (1) the commercially available Verilux CleanWaveSanitizing Wand (Verilux, Waitsfield, Vermont) and (2) a portable light wand prototype (courtesy of Dinies Technologies, Villingendorf, Germany) for 3, 5, and 10 seconds. Plates were incubated for 24 hours at 36°C under aerobic conditions, and the colony-forming units were visually determined. Untreated plates served as a negative control. We observed a reduction factor of >5 $\log_{10}$ units.

Overall, 6 representative difficult-to-disinfect surfaces from high-touch sites extracted from air ambulance helicopters were evaluated (Table 1). Then, 100 µL of the test strains (10^6 to 10^7 CFU) were inoculated. After air drying and irradiation, the surface was sampled with flocked swabs (Swab Rinse Kits, Copan, Italy), and serial dilutions were prepared and inoculated on blood agar. *Enterococcus faecium* ATCC 6057 was tested at irradiation intervals of 3, 5, and 10 seconds on all samples; *Acinetobacter baumannii* ATCC 19606 was tested only on 2 samples (surface 1, plastic, and surface 6, metal). Additionally, 2 surface samples were tested at a long irradiation of 60 seconds (surfaces 1 and 6). The experiment was repeated 3 times. After each contamination, the surface was disinfected with 70% alcohol. Untreated but contaminated probes served as controls to calculate the reduction factor.

Results

Table 1 shows the detailed reduction factors that were heterogeneous for the different surfaces and the 2 chosen species. Reduction factors of ≥3 $\log_{10}$ units were achieved for *E. faecium* with the Dinies prototype after 60 seconds irradiation and for *A. baumannii* with both light wands after a much shorter irradiation time. Despite a highly standardized irradiation procedure, there was large variation between individual tests and devices.

Discussion

In an air ambulance helicopter, surface materials are heterogeneous (metal, plastic, and others) and by design often difficult to clean. Due to air worthiness regulations and material degradation, not all chemical disinfectants can be used. A mobile, nonchemical device would therefore be a valuable alternative for a targeted surface disinfection. Cadnum et al[4] compared multiple UV decontamination devices in a radiology suite. Moreover, 4 standard, vertical-tower, low-pressure, mercury devices achieved reductions of VRE or MRSA ≥2 $\log_{10}$ units and of *C. difficile* at ~1 $\log_{10}$ unit, whereas a pulsed-xenon device resulted in less reduction of the pathogens. Compared with the vertical tower low-pressure mercury devices, equal or greater reductions of the pathogens were achieved by 3 nonstandard low-pressure mercury devices that included either adjustable bulbs that could be oriented directly over the exam table or 3 vertical towers operated simultaneously.[4] Our results in achievable reduction factors in a test environment simulating real-life conditions of manual application are comparable to those of Cadnum et al. However, 60 seconds were needed with our surfaces compared to the fast reduction achieved on agar plates by Petersson et al[3] and in our pretest. The large variability of $\log_{10}$ unit reduction between tests and devices might be due to unavoidable differences in

Author for correspondence: Dr Sebastian Schulz-Stübner, German Consulting Center for Infection Prevention and Control [Deutsches Beratungszentrum für Hygiene (BZH GmbH)], Schnewlinstr. 4, 79098 Freiburg im Breisgau, Germany. E-mail: Schulz-stuebner@bzh-freiburg.de

Cite this article: Schulz-Stübner S, *et al.* (2019). Is UV-C "light wand" mobile disinfection in air ambulance helicopters effective? *Infection Control & Hospital Epidemiology*, 40: 1323–1326, https://doi.org/10.1017/ice.2019.225

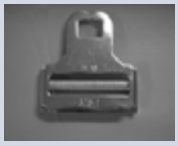
Table 1. Reduction Factors with 2 Different UV-C Devices and 2 Test Organisms on 6 Problematic Test Surfaces of an Air Ambulance Helicopter When Used for 3, 5, 10, or 60 Seconds, Simulating Real-Life Application Conditions

Test organism	*Enterococcus faecium* ATCC 6057					
UV-C device	Verilux CleanWave Sanitizing Wand					
Test surface	1	2	3	4	5	6
Duration	RF	RF	RF	RF	RF	RF
3 s	0.66	0.67	1.63	0.90	0.74	1.10
	0.77	0.34	0.50	0.40	0.53	0.38
	<1	<1	<1	<1	<1	<1
5 s	0.77	0.76	0.56	0.95	1.08	1.02
	0.53	0.70	<1	0.56	0.71	0.47
	<1	<1	<1	<1	<1	<1
10 s	1.02	1.19	1.33	1.06	1.28	1.19
	0.57	0.67	<1	0.81	1.10	1.10
	<1	<1	<1	1.45	<1	<1
60 s	1.91					0.54
	1.46					1.06
	1.19					1.32
	1.39					1.64
	1.29					1.15
Test organism	*Enterococcus faecium* ATCC 6057					
UV-C device	Portable wand prototype Dinies					
Test surface	1	2	3	4	5	6
Duration	RF	RF	RF	RF	RF	RF
3 s	1.17	0.84	1.72	2.16	1.48	1.17
	1.77	1.63	2.33	0.11	0.64	0.01
	<1	<1	1.26	<1	<1	<1
5 s	0.09	1.02	3.29	2.06	1.87	1.70
	2.00	1.70	1.65	0.98	1.31	0.09
	<1	1.28	1.50	<1	<1	<1
10 s	1.02	1.37	2.64	3.01	0.99	1.99
	2.38	2.24	2.27	1.21	1.30	0.13
	1.19	1.92	2.49	1.24	1.20	<1
60 s	3.51					5.27
	1.32					2.68
	2.56					1.31
	3.37					3.23
	3.73					4.32
Test organism	*Acinetobacter baumannii* ATCC 19606					
UV-C device	Verilux CleanWave Sanitizing Wand					
Test surface	1	2	3	4	5	6
Duration	RF	RF	RF	RF	RF	RF
3 s	1.26					<1
	2.75					3.01
	3.29					1.92

(*Continued*)

https://doi.org/10.1017/ice.2019.225 Published online by Cambridge University Press

(*Continued*)

Test organism	*Acinetobacter baumannii* ATCC 19606					
UV-C device	Verilux CleanWave Sanitizing Wand					
Test surface	1	2	3	4	5	6
Duration	RF	RF	RF	RF	RF	RF
5 s	1.96					<1
	3.74					2.77
	3.04					1.12
10 s	1.14					<1
	1.74					3.38
	2.85					0.49
60 s	2.29					<1
	4.40					1.66
	3.99					<1
Test organism	*Acinetobacter baumannii* ATCC 19606					
UV-C device	Portable wand prototype Dinies					
Test surface	1	2	3	4	5	6
Duration	RF	RF	RF	RF	RF	RF
3 s	2.94					4.52
	3.83					1.22
	4.09					5.16
5 s	3.50					4.02
	2.46					1.90
	>5.19					1.94
10 s	3.24					3.32
	3.07					3.87
	5.19					5.16
60 s	3.94					4.64
	3.48					<1
	4.30					4.26
Test surfaces:						
Photo						
Surface	plastic	plastic	metall	metall	metall	metall
Number	1 buckle	2 buckle	3 buckle	4 adjuster	5 latch	6 snap hook

Empty squares: Not analyzed.
Note. ATCC, American Type Culture Collection; RF, reduction factor.

angulation of the device toward the surface, changing reflection artefacts, and/or the different surfaces, which are to be expected in a real-life environment. Even in a hospital setting, the efficiency of UV-C devices remains controversial. Ontario Health concludes in a health technology assessment report: "We are unable to make a firm conclusion about the effectiveness of this technology on HAIs given the very low to low quality of evidence."[5]

This study has several limitations. We analyzed only 2 bacterial species and only a few representative surfaces. Based on our experiments and the reviewed literature UV-C disinfection with mobile

https://doi.org/10.1017/ice.2019.225 Published online by Cambridge University Press

light wand devices should only be used as an add-on technique after thorough cleaning and requires a prolonged application time for some bacterial species. No experiment showed a reduction >5 $\log_{10}$ units defining disinfection. However, after cleaning, a low-level reduction may be acceptable because fewer CFU can be expected on the surface than in our experiment. The light wand device can also be used as an extra disinfection after terminal cleaning and disinfection for complex surfaces (eg, buttons of the endotracheal suction system), as shown by Wendel et al.[6] Additional material degradation testing is needed before air worthiness approval in an air ambulance. Occupational safety regulations regarding UV-C use need to be observed with manual application procedures.

Acknowledgments. We thank Mr Cajus Dinies (Dinies Technologies GmbH, Gewerbestr. 5, D-78667 Villingendorf) for letting us use his prototype device. We also thank Ingo Winterfeld (Institute of Hygiene, Cologne) for technical assistance.

Financial support. This research was funded by institutional funds only.

Conflicts of interest. S.S.S. is shareholder of Deutsches Beratungszentrum für Hygiene (BZH GmbH) and receives royalties from Springer, Thieme, Deutsche Krankenhausverlagsgesellschaft and Consilium Infectiorum. All other authors report no conflicts of interest relevant to this article.

References

1. Kanamori H, Rutala WA, Gergen MF, Weber DJ. Patient room decontamination against carbapenem-resistant Enterobacteriaceae and methicillin-resistant *Staphylococcus aureus* using a fixed cycle-time ultraviolet-C device and two different radiation designs. *Infect Control Hosp Epidemiol* 2016;37:994–996.
2. Rock C, Curless MS, Nowakowski E, *et al.* UV-C light disinfection of carbapenem-resistant Enterobacteriaceae from high-touch surfaces in a patient room and bathroom. *Infect Control Hosp Epidemiol* 2016; 37:996–997.
3. Petersson LP, Albrecht UV, Sedlacek L, Gemein S, Gebel J, Vonberg RP. Portable UV light as an alternative for decontamination. *Am J Infect Control* 2014;42:1334–1336.
4. Cadnum JL, Jencson AL, Gestrich SA, *et al.* A comparison of the efficacy of multiple ultraviolet light room decontamination devices in a radiology procedure room. *Infect Control Hosp Epidemiol* 2019;40: 158–163.
5. Health Quality Ontario. Portable ultraviolet light surface-disinfecting devices for prevention of hospital-acquired infections: a health technology assessment. *Ont Health Technol Assess Ser* 2018;18:1–73.
6. Wendel AF, Malecki M, Otchwemah R, Tellez-Castillo CJ, Sakka SG, Mattner F. One-year molecular surveillance of carbapenem-susceptible *A. baumannii* on a German intensive care unit: diversity or clonality. *Antimicrob Resist Infect Control* 2018;7:145.

‘Chemical-free’ cleaning—Need for a closer look

Syed A. Sattar PhD

University of Ottawa, Ottawa, Canada and CREM Co Labs, Mississauga, Ontario, Canada

To the Editor—I read with interest the letter “Smarter cleaning is safer for health” by EE Gillespie[1] in this journal. Although the motive behind ‘chemical-free’ cleaning is laudable, the approach needs a closer look. Repeated laundering of microfiber-based fabrics (MFBFs) will add chemicals to the liquid waste stream. Such laundering will also increase water consumption, potentially negating the water saved in cleaning. In addition, proper decontamination of MFBFs is more difficult due to their microstructure.[2] The use of disposable microfiber fabrics may be an option, but their routine disposal will contribute to the load of nonbiodegradable materials in the solid-waste stream.

Assumedly, municipally treated tap water was used in the reported ‘chemical-free’ process. Although the primary objective of adding disinfectant chemicals (eg, chlorine or monochloramine) to tap water is to make it potable, residues of such chemicals may contribute to the pathogen reductions recorded. This factor could be checked using distilled water or tap water with no disinfectant residual, though the use of such water may compromise the field relevance of the regular surface decontamination process.

Undoubtedly, the physical action of wiping environmental surfaces can enhance their decontamination.[3] However, wiping with no or an ineffective disinfectant also runs the risk of spreading localized pathogen contamination over a wider area.[4] Therefore, proper wiping using an effective, safe, and compatible disinfectant may be more desirable. Formulations based on oxidizers (with or without halogens) can be fast acting, broad spectrum, surface compatible, and residue free while being safe for humans and the environment.[5] Combining the use of such chemicals with biodegradable or compostable wipes would further enhance their sustainability and overall acceptance.

Recognition of high-touch environmental surfaces (HITES) as vehicles of healthcare-associated pathogens is increasing,[6] and subsequently, the emphasis on their proper decontamination for infection prevention and control is also increasing. Despite the recent advances in environmental decontamination (eg, no-touch technologies), wiping remains an essential and universal means of reducing the risk of spread of HITES-carried pathogens. Therefore, our focus must be on efficient and sustainable ways of achieving HITES decontamination using wiping with properly formulated oxidizers and biodegradable applicators.

References

1. Gillespie, EE. Smarter cleaning is safer for health. *Infect Control Hosp Epidemiol* 2019;40:947.

Author for correspondence: Syed A. Sattar PhD, Email: ssattar@uottawa.ca

Cite this article: Sattar SA. (2019). ‘Chemical-free’ cleaning—Need for a closer look. *Infection Control & Hospital Epidemiology*, 40: 1326–1327, https://doi.org/10.1017/ice.2019.239