Portable UV light as an alternative for decontamination

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Brief report

Portable UV light as an alternative for decontamination

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We evaluated the capability of a commercially available hand-held device that emits ultraviolet (UV) light to disinfect plain surfaces. Eight bacterial species were tested, including *Clostridium difficile* ribotype 027 and 3 other spore-forming species. Even bacterial spores could be successfully inactivated within a few seconds of irradiation. UV light may provide an alternative for the decontamination of medical products, such as mobile phones or tablet computers, that cannot be treated otherwise.

Targeted surface disinfection is a key infection control measure.[1] Usually, decontamination of surfaces is performed by wiping the surface with some kind of disinfecting agent or, in the case of auxiliary devices, submerging the entire product in a disinfecting solution. In all of these cases, the success of surface disinfection depends mainly on the type of pathogen, the type and concentration of the active chemical substances, and the overall duration of the disinfection process.[2]

Today, mobile phones and tablet PCs are often used directly at the patient's bedside. They are frequently touched and may become heavily contaminated and serve as an additional item/surface of relevance in infection control.[3,4] Using liquid disinfectants on a mobile phone or tablet PC may result in the loss of warranty protection, whereas submerging the device in fluids most likely will destroy it. Thus, new techniques for decontaminating these devices are needed.

Ultraviolet (UV) irradiation, which inactivates microorganisms by the formation of DNA/RNA dimers, is widely used for the decontamination of safety cabinets, for water decontamination, and in the food processing industry.[5] This study evaluated the capability of a new hand-held UV device to provide surface decontamination.

METHODS

UV light bulb

The Verilux CleanWave Sanitizing Wand (product VH01WW4; Verilux, Waitsfield, VT) provided the UV light source. This light bulb emits mainly UV-C light at a wavelength of approximately 265 nm and produces an irradiance of 5.5 W/cm^2 at a distance of 12.5 mm as determined by Laser Zentrum Hannover (Hannover, Germany).

Bacterial strains

The following species were tested: spores of *Geobacillus stearothermophilus* (ATCC7953), *Bacillus pumilus* (ATCC27142), *Bacillus atropheaus* (ATCC9372) and *Clostridium difficile* ribotype 027 (NCTC13366), and vegetative cells from *Staphylococcus aureus* (ATCC29213), *Enterococcus faecium* (ATCC19434), *Escherichia coli* (ATCC25922) and *Acinetobacter baumannii* (ATCC19606).

Preparation of test organisms

A suspension of bacterial spores of *G stearothermophilus*, *B pumilus*, and *B atropheaus* was produced by harshly vortexing commercially available spore-containing stripes for sterility testing of autoclaves (BAG Healthcare, Lich, Germany) in 9 mL of sterile tryptic soy broth for 1 minute. A suspension containing spores of *C difficile* was prepared and kindly provided by the Institute of Hygiene and Public Health (Bonn University, Bonn, Germany), stored at 4°C until further use, and finally diluted in 0.9% NaCl solution.

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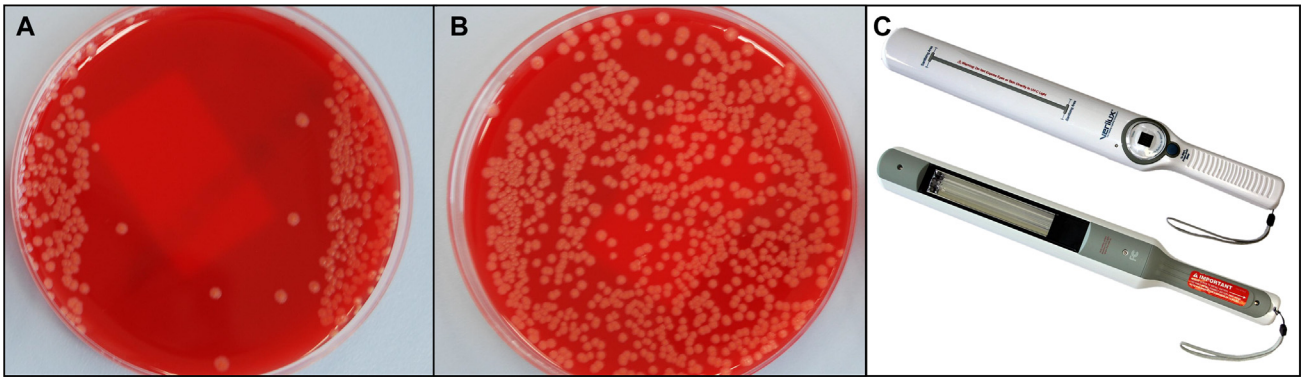

Fig 1. An overnight culture of plated bacteria suspension on Columbia 5% sheep's blood agar. (A) Growth of colonies of *B atropheaus* after the application of UV-C light for 40 seconds. (B) Plate without UV-C light treatment. (C) Top and bottom views of the hand-held device used.

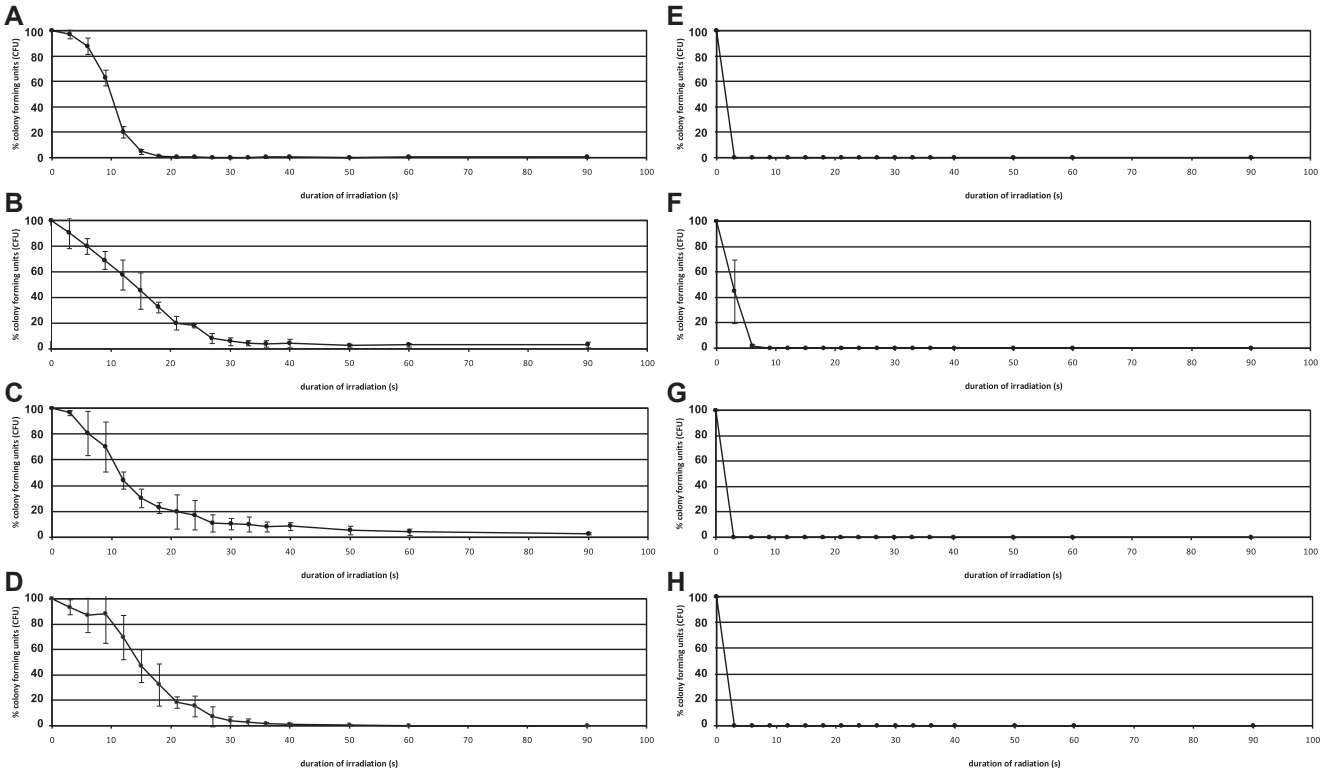

Fig 2. Killing kinetics under the influence of UV-C light of *G stearothermophilus* (A), *B pumilus* (B), *B atropheaus* (C), *C difficile* (D), *S aureus* (E), *E faecium* (F), *E coli* (G), and *A baumannii* (H).

Fresh overnight cultures were grown from all other species, and colonies were suspended in sterile 0.9% NaCl solution. Serial dilutions of the suspensions of all test organisms were then prepared so that as many separate colonies as possible were grown when plating 100 μL on solid media with an area of 56.7 cm^2.

Irradiation of test organisms

Continuous UV-C radiation was applied through a 35-cm^2 aperture at a distance of 10 cm for various intervals (0-90 seconds). *C difficile* was then grown for 48 hours at 36°C under anaerobic conditions on Brazier's *Clostridium difficile* Selective Agar (Oxoid, Wesel, Germany), which enhances transformation of spores back into vegetative cell forms. The other species were grown on Columbia 5% sheep's blood agar (BD, Heidelberg, Germany) for 24 hours at 36°C under aerobic conditions, except for *G stearothermophilus*, which was grown for 24 hours at 56°C.

The percentage reduction of bacterial growth was visually determined by counting the number of remaining colonies in the radiation area as a fraction of the number of expected growth of colonies without radiation (Fig 1). Results are based on 5 independent experiments each.

RESULTS

Figure 2 shows the killing kinetics of the bacterial spores and viable forms of bacteria under the influence of UV-C light over time. A minimum 90% reduction of viable organisms was achieved within

40 seconds for all 4 spore species (Fig 2A-D). In contrast, reproducible total (100%) inactivation of the 4 non–spore-producing species occurred in less than 5 seconds (Fig 2E-H).

DISCUSSION

There is a need for appropriate decontamination of primarily nonmedical products that were not initially produced for daily clinical practice, but nevertheless are used in that type of setting. Surfaces of electronic devices represent a rather new challenge in infection control, and nosocomial outbreaks related to contaminated cellular phones have been reported.[3,6] Thus, we need to provide some kind of decontamination of such surfaces to prevent pathogen spread within the hospital.

Along with the successful elimination of nosocomially relevant pathogens in principle, the distance for and the time of the UV light application to the surface should also be practicable for daily routine clinical practice. Katara et al recently showed that germicidal UV tubes hanging from the central area of the ceiling may be efficient for disinfecting an entire patient room when emitting UV light at a distance of 2.44 m (8 ft) over an exposure time of 30 minutes.[7] The distance of 10 cm as chosen for our present experiments and the mobility of the device used may best reflect the actual situation on the ward. We found a significant reduction of the bacterial load, including spores, within few seconds at this distance.

In our view, a major issue in this context is *C difficile*. The incidence of *C difficile*–associated infections continues to increase, and the clinical and economical burden of these infections is enormous already.[8] Patients with *C difficile* infection excrete large amount of both viable bacteria and spores. Verity at al. showed by environmental sampling that an infected patient's room can remain heavily contaminated for weeks if appropriate disinfection measures are not carried out.[9] One would assume that an electronic device will likely come into contact with spores in such a highly contaminated area. However, our data show that spores of *C difficile* also can be successfully inactivated by UV-C light irradiation.

Some limitations to our approach should be kept in mind. Whether the electronic device may be damaged by multiple exposures to UV-C light is not known. Furthermore, safety issues for human health must be accounted for and investigated, including, but not limited to, potential skin and eye irritation or even damage from UV light, as well as inhalation of ozone that may be produced during the disinfection process.[10] These issues need to be addressed in further studies.

CONCLUSION

At present, it seems that application of UV-C light with a handheld device may be a reasonable alternative for disinfecting plain surfaces that cannot be safely disinfected using standard chemicals in daily routine practice. The reliability, practicability, safety, and cost-effectiveness of this technique require further investigation to provide relevant data to the infection control immunity.

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