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Sterilization using Germicidal UV Light

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Abstract

Healthcare-associated infections (HAIs) can be caused by microorganisms present in common practice instruments generating major health problems in the hospital environment. The aim of this work was to utilize the disinfection capacity of a portable ultraviolet C equipment (UV Sanitizer Box and UV-C Sterilization Torch) developed to disinfect different objects. Pollution of the macro and micro environment has caused concerns for decades and in recent times the macro consequences have been subjected to agreed international protocols, aimed at reducing pollution.
As conclusion, UV-C Sanitizer Box and UV-C Sterilization Torch was effective disinfecting the most contaminated surfaces, being a promising alternative for disinfecting hospital materials and inanimate objects that cannot be immersed in liquid biocides, reducing the risk of pathogen transmission.

Keyword: Disinfection, Healthcare-associated infections (HAIs), UV Sanitizer Box, UV-C Sterilization Torch, Macro and Micro Pollution, UV Purification.

Research Article

1. Introduction

Micro-organisms are primitive forms of life. Their small dimensions not only constituted the original reason for classifying them separately from animals and plants but are also relevant to their morphology, the activity and flexibility of their metabolism and their ecological distribution. They include protozoa, bacteria and molds. Healthcare-associated infections (HAIs) prolong hospital stay, cause long-term disability and additional costs for health systems, patients and their families, and preventable deaths [1]. Furthermore, HAIs increase the possibility of selecting multi drug resistant microorganisms. Microorganisms causing HAIs belong to different groups, such as Gram-negative (Escherichia coli) and Gram-positive bacteria (Staphylococcus aureus), spore-producing bacteria (Bacillus spp.) and yeasts (Candida albicans) [1,2]. These pathogens can be spread by the hands of health care personnel and by patient-to-patient contact [3,4]. While medical equipment disinfection is a common practice, to establish hard surfaces disinfection measures could be of great importance for inanimate objects in contact with highly colonized areas of the patient, such as hands, mouth, nose and ears that could be potential sources of HAIs and community infections. To avoid this microbial colonization and persistence on both fomites and hard surfaces, routine chemical and physical decontamination approaches have been introduced [4]. Ethanol and other alcohols, and biguanides like chlorhexidine, are widely used in hospitals and laboratories to disinfect surfaces and to prevent nosocomial

infections. However, not all the above-mentioned objects can be treated with chemical biocides due to possible deterioration of the material or the electronics [3,4]. Among physical methods or no touch technologies, ultraviolet C radiation (UVC) is widely used in disinfecting materials and hospitals wards, operating rooms and ICUs. DNA exposure to UVC inhibits cellular replications incest damages the cell by photohydration, photo splitting, photodimerization, and photo cross linking [5]. Therefore, based on the UVC microbicide effect, a new portable, automated, easy to use and safe equipment, UV Sanitizer Box and Torch, has been designed for disinfecting inanimate objects and devices in the hospital environment that could act like fomites, including sanitary materials such as phonendoscopes, thermometers, sphygmomanometer, otoscopes, etc.

The aim of this study was to utilize the capacity of UVC to disinfect different materials contaminated with HAI-associated microorganisms in comparison to ethanol and chlorhexidine. Apart from this, the other objective includes:

a) To avoid this microbial colonization and persistence on both fomites and hard surfaces.
b) Maximizes biosecurity protocols.
c) Provide an effective disinfection operation where no other method exists.
d) Chemical free and rapid disinfection.

2. Materials and Methods

TUV TL Mini lamps are slim double-ended UVC (germicidal) lamps used in residential water and air disinfection units. The small 16 mm diameter of the lamp allows for a small system design and design flexibility. TUV TL Mini lamps offer almost constant UV output over their complete lifetime, for maximum security of disinfection and high system efficacy.

Product Data

Cap-Base	G5
Main Application	Disinfection
Useful Life (Nom)	11000 h
Color Code	TUV
Depreciation (lifetime)	15%
Power (Nom)	11.5 W
Lamp Current (Nom)	0.4 A
Voltage (Nom)	34 V
Hg Content	4.4 mg
UV-C radiation 100 hr.	2.6 W
Net Weight (Piece)	22.000 g
Remark	Use only in enclosed environment which shields user from the radiation.

UV Irradiance value

The irradiance E on a small surface in point P on a distance a from an ideal linear radiation source AB of length 1 amounts to:

$$E=\frac{\phi}{2.\pi 2.l.a}(2\alpha+\sin 2\alpha)$$

ϕ is the total radiation flux (in W). This formula is taken from: H. Keitz, Light calculations and measurements, Philips Technical Library, MacMillan and Co Ltd, 1971.

Effect of UV light exposure on different organisms

The distance from the UV source (UV Torch) was kept at 4 feet and the time of exposure was 1 minute. Two samples of dry yeast were taken. 1st sample was exposed to UV-C light and 2nd sample was left as it is. The samples were incubated at room temperature for 24

hours. All the experiments were repeated thrice and observations and interpretations were as in experiment one.

3. Result

UVC has advantages over chlorinating techniques, because it produces far fewer noxious by-products and is it unaffected by the temperature. Note that the latter comment refers to the radiation, not to the lamp, or its environment as described earlier. Micro-organisms are far more difficult to kill in humid air, or in a liquid environment, than in dry air. This is because they limit transmission of 254 nm radiation.

4. Discussion and Conclusion

In the present study, a simple model is described to check the surface inactivation of microbes exposed to UV-C light. The preliminary observations had suggested the germicidal UV Torch is good up to a distance of eight feet with an exposure time of 30 to 45 seconds. Sanitization through the UV-C box which have tubes fixed inside the box were found to be more efficient.

The maximum advantage of UV light disinfection is for places like hospitals, schools, colleges and other public places. While recommending the use of UV light at appropriate distance and for appropriate time we wish to emphasize that standard safety guidelines need to be observed during usage of UV light.

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Conflict of interest

The author declares no conflict of interest.

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