Antimicrobial proof-of-concept: a novel device combining UV light and ozone for human skin antisepsis

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INTRODUCTION

- Hand hygiene (HH) remains a cornerstone for the prevention of microbial transmission, both in the community and healthcare setting
- While hand-washing with plain soap and warm water remains the "gold standard" for HH, the process is less than standardized in practice (10 sec to 2 min) and the microbial reduction variable (0.5 to 3.3 log reduction)
- Alcohol-based hand rubs (ABHR) and wipes offer an ostensibly more rapid and convenient alternative with satisfactory efficacy against vegetative microbes (up to 3 log reduction), but the effect against *Clostridioides difficile* spores limits their use
- Ultraviolet (UV) light has well-established antimicrobial effect (AME), including sporicidal activity
- Likewise, ozone (O_3) has potent AME and is commonly utilized in the field of dentistry
- In this study, we report proof-of-concept data on the AME of a novel investigational device, HyLuxO3 (GMI, LLC, Nashville, TN, USA; Fig. 1), that is engineered to synergistically combine UV-C light energy and high velocity O_3 airflow to not only decontaminate environmental surfaces and fomites, but also to safely achieve human skin antisepsis within regulatory limits

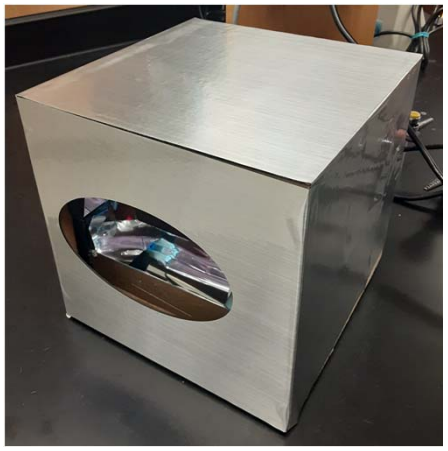

Figure 1: HyLuxO3 prototype device. 222 nm UV-C light beams are directed centrally from above and below at a fixed UV irradiance (0.6 mW/cm2), [O_3] output (0.1 ppm), and sample-to-device distance (5 cm). The only user-defined variable for this prototype device is exposure time.

METHODS

- HyLuxO3 was tested on LB agar to titrate device variables to ascertain intensities for optimal AME; later testing was performed on VITRO-SKIN (Florida Suncare Testing, Bunnell, FL), a human glabrous skin surrogate
- ATCC strains of MRSA, *Staphylococcus epidermidis, Klebsiella pneumoniae, Escherichia coli, Pseudomonas aeruginosa, and Candida albicans* were used to test AME vs. vegetative microbes; *Bacillus atrophaeus* spores were used as a surrogate for *C. difficile*
- Tested variables included time under device, [O_3], airflow velocity, 222 and/or 254 nm UV light, sample distance from UV lamp, and UV beam width. Positive controls were used to calculate log-kill curves for AME

RESULTS

Microbe (exposure time)	CFU inoculated onto plate	CFU after exposure (mean)	CFU after exposure (std dev)	Log-kill (mean)
B. atrophaeus (5 sec)	2,000,000	88	52	**4.36**
B. atrophaeus (30 sec)	2,000,000	14	8.7	**5.14**
B. atrophaeus (60 sec)	2,000,000	6.7	5.6	**5.47**
C. albicans (5 sec)	160,000	2.1	1.2	**4.88**
C. albicans (30 sec)	160,000	0.4	0.5	**5.19**
C. albicans (60 sec)	160,000	0	0	**5.20**
E. coli (5 sec)	2,000,000	7.3	5.6	**5.44**
E. coli (30 sec)	2,000,000	1.3	1.4	**6.19**
E. coli (60 sec)	2,000,000	1.0	1.3	**6.30**
K. pneumoniae (5 sec)	3,200,000	18	13	**5.26**
K. pneumoniae (30 sec)	3,200,000	5.2	3.8	**5.79**
K. pneumoniae (60 sec)	3,200,000	2.0	1.9	**6.20**
MRSA (5 sec)	16,000,000	42	24	**5.58**
MRSA (30 sec)	16,000,000	7.3	12	**6.34**
MRSA (60 sec)	16,000,000	1.3	1.4	**7.09**
P. aeruginosa (5 sec)	2,400,000	17	9.7	**5.14**
P. aeruginosa (30 sec)	2,400,000	7.9	4.4	**5.48**
P. aeruginosa (60 sec)	2,400,000	3.1	1.8	**5.89**
S. epidermidis (5 sec)	4,000,000	13	5.3	**5.48**
S. epidermidis (30 sec)	4,000,000	1.8	3.8	**6.35**
S. epidermidis (60 sec)	4,000,000	0.9	2.1	**6.60**

- Log-kill data for the HyLuxO3 device against spores and vegetative microbes as a function of exposure time are presented in Table 1
- **4.36 log-kill against spores was achieved in 5 sec**; a >5 log-kill was achieved by extending sample exposure to 30 sec (Fig. 2)
- **>5 log-kill against all vegetative bacteria was achieved in 5 sec**; ≥6 log-kill was achieved by extending sample exposure to 30-60 sec

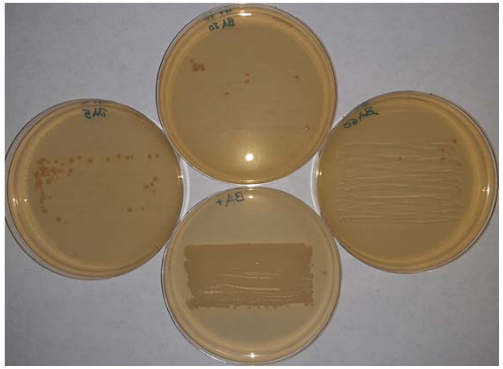

Figure 2: HyLuxO3 device AME vs. *B. atrophaeus* spores. Plates were inoculated with 2.0 x 10^6 CFU. Positive control (bottom) was not exposed; the 5 sec (left), 30 sec (top), and 60 sec (right) plates were exposed to the device for their respective time durations.

CONCLUSIONS

- HyLuxO3 combines 222 nm UV-C light and O_3 to achieve >4 log-kill against spores in 5 sec and >5 log-kill against spores in 30 sec
- This device showed a >5 log-kill against common pathogenic vegetative microbes in 5 sec and >6 log-kill in 30-60 sec.
- These AME results rival those of hand-washing and ABHRs by 2-4 logs while decreasing the necessary exposure time from minutes to seconds. Moreover, similar efficacy was shown on agar as on VITRO-SKIN, a well-studied glabrous human skin surrogate
- Studies on human hands are needed to confirm the efficacy and safety of HyLuxO3 under OSHA and EPA regulations

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Nothing to disclose