Antimicrobial Activity of a Continuous Visible Light Disinfection System
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Background
Recent evidence has demonstrated that the contaminated hospital environment is an important source for transmission of epidemiologically important pathogens (EP) such as MRSA and VRE. An over-head light fixture technology, which continuously and safely disinfects the environment using light-emitting diodes (LEDs) that emit a high-intensity, narrow spectrum (HNS) light has been proposed as an infection prevention strategy. This technology uses LEDs to create a narrow bandwidth of high-intensity visible violet light with a peak output of 400mW/cm² that react with porphyrin molecules to generate reactive oxygen species that kill microorganisms. The purpose of this evaluation was to determine the effectiveness of HNS-light for the reduction of epidemiologically-important pathogens.

Methods
The new technology was evaluated in two different clinical scenarios (White Disinfection Mode and Supplemental Blue Disinfection Mode)

In Phase 1, two 2x2 bladed white, ceiling-mounted fixtures were used which provided both disinfection and ambient white illumination for use in normal clinical conditions in an occupied room (surface irradiance=0.12-0.16mW/cm²) measured at the pathogen location.

In Phase 2, a higher-level of disinfection was studied with a 2x4 overhead. This fixture emits only disinfecting (blue) light (surface irradiance=0.34-0.44mW/cm²).

The four test organisms were C. difficile spores (B), MRSA (ATCC 43300), VRE (ATCC 51299), and MDR Acinetobacter baumannii (MDRA). Formica test surfaces were inoculated with 100,000 CFU/surface of test organisms.

Once dry, triplicate samples were collected with Horiba plates containing DE Neutralizing Agar at times 0, 1hr, 3hr, 5hr, 7hr, 24hr, 48hr, and 72hr and then appropriately incubated.

To accommodate the natural die-off of vegetative bacteria, a control test surface (Formica) was placed in an adjacent area but not exposed to the light disinfection.

Results

Table 1. Time to specified percent reductions of epidemiologically-important pathogens with “blue” light and “white” light.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pathogen</th>
<th>Time (least number of hours) to achieve microbial reduction</th>
<th>Maximum reduction achieved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue light</td>
<td>MRSA</td>
<td>3 48 48 100</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>VRE</td>
<td>5 24 24 48</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>MDRA-Acinetobacter</td>
<td>1 5 NA NA</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>C. difficile</td>
<td>5 72 NA NA</td>
<td>65</td>
</tr>
<tr>
<td>White light</td>
<td>MRSA</td>
<td>7 24 48 72</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>VRE</td>
<td>24 NA NA NA</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>MDRA-Acinetobacter</td>
<td>6 24 48 72</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>C. difficile</td>
<td>NA NA NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Results Summary

- These results demonstrated that the 405nm light inactivated three vegetative bacteria (MRSA, VRE, MDRA) on surfaces with contact times of 1-72hr.
- Statistical differences (p<0.05) were observed using “blue” light for VRE at 24 and 48 hours, for MRSA at 3, 5, 6, and 7 hours, for MDRA-Acinetobacter at 5, 6, 7, and 24 hours, and for C. difficile spores at 5 and 72 hours.

Conclusions
We demonstrated that the “blue” light significantly reduced both vegetative bacteria and spores at some time points over a 72 hour exposure period.

- In addition to episodic disinfection (e.g., UV), this continuous light disinfection technology could be considered for several healthcare decontamination applications (e.g., OR).
- Given that environmental surfaces in a patient’s room are often not thoroughly disinfected plus that recontamination occurs rapidly it is important to develop either methods of continuous disinfection that reduce the risk of infection associated with persistent antimicrobial effectiveness.
- Whether these reductions are sufficient to reduce healthcare-associated infections requires further studies.

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