Assessment of an innovative antimicrobial surface disinfectant in the operating room environment using adenosine triphosphate bioluminescence assay

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The role of terminal cleaning is to reduce the risk of microbial contamination within the operating room (OR) environment. Previous studies have suggested that ineffective cleaning processes can result in the contamination or transmission of health care–associated pathogens throughout the health care environment. The present investigation assesses the level of residual bioburden contamination in 4 ORs after routine terminal cleaning and the efficacy of a novel antimicrobial isopropyl alcohol/organofunctional silane solution (ISO) to reduce microbial contamination on ISO-treated surfaces compared with controls. Further studies are warranted to validate the persistent disinfectant activity of ISO within selective health care settings.

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METHODS

OR environment

Four ORs (out of 18) were randomly selected for study: a hybrid OR (A) where open and endovascular procedures are performed; an OR used for kidney and liver transplantation (B); and 2 general surgical ORs (C and D).

Baseline ATP bioluminescence testing

Prior to IOS treatment of study surfaces, baseline ATP bioluminescence analysis of residual surface bioburden (Getinge SafeStep Handheld Luminometer, Getinge USA, Rochester, NY) was conducted on multiple sites (10) in 4 randomly selected ORs (A-D) twice a week for 2 weeks (160 samples) immediately after terminal cleaning (quaternary disinfectant). Testing protocol involved sampling a uniform 2 cm² surface area (SafeStep Test Swabs, Getinge USA, Rochester, NY) by rubbing test swabs back and forth using a rotating motion for 15 seconds. A value ≤46 RLUs reflected a surface containing little or no bioburden (designated clean), whereas a value ≥46 RLUs was designated as dirty. During baseline testing, 5 individual touch surfaces common to all study ORs documenting high RLU (≥46) values after terminal cleaning were selected for
Table 1

<table>
<thead>
<tr>
<th>Operating room</th>
<th>Relative light values (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>137.5 (15.0-176.2)</td>
</tr>
<tr>
<td>B</td>
<td>298.4 (4.0-543.6)</td>
</tr>
<tr>
<td>C</td>
<td>994.2 (18.2-2,112.3)</td>
</tr>
<tr>
<td>D</td>
<td>167.8 (9.3-269.7)</td>
</tr>
</tbody>
</table>

*There were 160 total baseline samples; 40 samples per operating room.

Table 2

<table>
<thead>
<tr>
<th>Sites*</th>
<th>Mean RLU/mean RCC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operating room A</td>
</tr>
<tr>
<td>Monitor</td>
<td>Nontreated surfaces</td>
</tr>
<tr>
<td></td>
<td>Treated surfaces</td>
</tr>
<tr>
<td>Keyboard</td>
<td>Nontreated surfaces</td>
</tr>
<tr>
<td></td>
<td>Treated surfaces</td>
</tr>
<tr>
<td>Monitor flat screen</td>
<td>Nontreated surfaces</td>
</tr>
<tr>
<td></td>
<td>Treated surfaces</td>
</tr>
<tr>
<td>Room phones</td>
<td>Nontreated surfaces</td>
</tr>
<tr>
<td></td>
<td>Treated surfaces</td>
</tr>
<tr>
<td>Back table</td>
<td>Nontreated surfaces</td>
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<tr>
<td></td>
<td>Treated surfaces</td>
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</tbody>
</table>

*Surfaces with >46 RLUs are designated as dirty.

**P < .001, IOS-treated surfaces compared with nontreated by BBL RODAC plate culture.

**P = .048, IOS-treated surfaces compared with nontreated by ATP bioluminescence.

**Surfaces with ≤45 RLUs are designated as clean.

**Significant degradation of antimicrobial activity based on BBL RODAC plate cultures was noted in the IOS-treated sites over the 6-week test interval.

CONCLUSION

The terminal cleaning process is a critical step in preventing the transmission of health care–associated pathogens. Baseline analysis (Table 1) documented multiple sites within the sampled ORs with ≥46 RLUs, suggesting inadequate terminal cleaning. ATP bioluminescence assay has been proposed as a surrogate marker for measuring the effectiveness of the routine cleaning process by documenting the presence of residual ATP. In the present study, ATP bioluminescence assay demonstrated a significant reduction (P = .048) in RLUs on inert surfaces treated with an innovative antimicrobial IOS compared with nontreated control surfaces. However, ATP bioluminescence does not differentiate between microbial and nonmicrobial (blood and tissue protein) surface bioburden. Therefore, ATL RODAC plates were used to validate the infectant activity of IOS, demonstrating a significant reduction (P < .001) in microbial surface contamination on all test surfaces over the 6-week study period compared with control surfaces. Selective IOS-treated OR surfaces (ie, monitors, keyboards) revealed mean RLU readings ≥46, which would designate the surface as dirty. However, these elevated RLU values likely represented residual nonmicrobial (blood and body fluid) bioburden. ATP bioluminescence technology was effective in assessing surface bioburden contamination after routine terminal cleaning. These results are in agreement with previous published studies documenting the benefit of ATP bioluminescence technology to assess the efficacy of surface cleanliness within the health care environment.

The findings of this study suggest that a single application of IOS provides a persistent infectant activity, minimizing microbial surface contamination in an environment where terminal cleaning may be inadequate or have limited effectiveness. These results, however, are in contrast with a recently published article by Boyce.
suggesting that selective organosilane compounds may not provide a sustained antimicrobial activity when applied to high-touch surfaces within the hospital environment. Unfortunately, these agents were not available to the authors for comparative analysis. Further studies are warranted to validate the persistent disinfectant activity of IOS within selective health care settings.

References