Fumigation With a Combined Quaternary Ammonium Compound and 2 Alcohols After Detection of Bacterial and Fungal Air Bioburden

To the Editor—How best to evaluate the effect of quaternary ammonium compound–based products after detection of postflood bacterial and fungal air bioburden remains uncertain. Thammasat University Hospital (Thailand) closed after severe black-water flooding in 2011; significant resources and costs were associated with hospital closure, reparations, and tiered reopening of select units [1]. In addition, an infection-control surveillance program was created to optimize patient and healthcare worker safety [1]. After flood waters reached a maximum 3-foot height between 14 October and 2 November 2011, hospital units were inspected and reopened during the interval from 2 November 2011 to 31 August 2012. An infection-control protocol for cleaning and area decontamination was performed in accordance with a checklist from the US Centers for Disease Control and Prevention (CDC) [2]. Despite thorough manual environmental cleaning, several units had high bacterial and fungal air bioburden, defined as measurements >500 colony-forming units (CFU)/m³ [1]. Special area decontamination was then employed on all units that had subsequent high bacterial or fungal air bioburden after thorough manual environmental cleaning, using a nontouch technique of either a hydrogen peroxide vapor or a quaternary ammonium compound–based product [1].

Routine air sampling on a negative-pressure hospital unit detected a high bacterial and fungal air bioburden on 1 August 2012, despite special area decontamination with repeated manual cleaning (Table 1). We designed a fumigation protocol, comprised of 2.5% isopropyltridecyl-dimethyl-ammonium (Umonium, Huckert's International, Nivelles, Belgium),
according to the manufacturer’s recommendation. After fumigation of the 4 patient rooms and the nursing station of this unit, the air bioburden for bacteria and fungi was monitored via passive air sampling using the settle plate method [3, 4]. Each sampling entailed 30-minute air exposure of two 90-mm Petri dishes containing sheep blood agar and Sabouraud dextrose agar medium [3, 4]. The Petri dishes were incubated and inspected on day 5 for fungal quantification and identification in accordance with a standard clinical microbiology method; total fungal or bacterial bioburden <500 CFU/m³ was the upper limit of normal [1, 4, 5]. The number of fungal and bacterial colonies expressed as CFU/m³ were estimated using Koch sedimentation method according to Polish Standard PN 89/Z-04008/08, per the following equation: CFU/m³ = (the number of colonies on the Petri plate × 1000)/(the surface area of the Petri plate in cm² × the time of Petri plate exposure in minutes × 0.2) [6].

After fumigation, there was a clear reduction in both bacterial and fungal air bioburden at 6 hours, day 1, and day 7. There was a slightly increased air bioburden level of bacteria and fungi on day 14 in some patient rooms, yet these measurements were well below 500 CFU/m³ in all areas (Table 1). The most common fungal species identified were Penicillium, Aspergillus, Phialophora, and Syncephalastrum. No aerolized bacteria were identified, and all environmental surface cultures were negative.

A prior report suggests that 2.5% quaternary ammonium–based compounds have broad-spectrum disinfectant activity for microorganisms on surfaces under clean and dry experimental conditions [7]. The list of microorganisms eradicated after environmental cleaning with 2.5% quaternary ammonium–based compounds included Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Candida albicans, Aspergillus niger, Mycobacterium avium, Mycobacterium terrae, poliovirus, adenovirus, hepatitis B virus, and human immunodeficiency virus [7, 8]. To date, our findings provide the first report of an association of environmental cleaning with this agent and eradication of aerosolized fungal bioburden. Although our study was limited to air sampling, without initial environmental surface cultures, our data suggest that fumigation with 2.5% quaternary ammonium salt solution, combined with isopropyl alcohol, benzalkonium chloride, and tridecyl ceteth alcohol pH 7, at a concentration of 32 g per 100 mL, may provide an alternative approach to reduce, if not eradicate, bacterial and fungal air bioburden in a closed hospital unit after black-water flood exposure. Given the relatively inexpensive capital cost of this method, relative to other nontouch technologies, further studies that evaluate the effectiveness and safety of this method are needed in other at-risk settings.

**Table 1. Serial Air Bioburden Measurements of Bacteria and Fungi in the Patient Rooms and Nursing Station of a Hospital’s Negative-Pressure Unit After Fumigation With a Quaternary Ammonium Salt–Based Solution Combined With 2 Alcohols**

<table>
<thead>
<tr>
<th>Duration After Fumigation</th>
<th>Bacterial Air Bioburden (CFU/m³)</th>
<th>Fungal Air Bioburden (CFU/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PR 1</td>
<td>PR 2</td>
</tr>
<tr>
<td>6 hours</td>
<td>840</td>
<td>660</td>
</tr>
<tr>
<td>Day 1</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>Day 7</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>Day 14</td>
<td>30</td>
<td>90</td>
</tr>
</tbody>
</table>

Abbreviations: CFU, colony-forming unit; NS, nursing station; PR, patient room.

**Notes**

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All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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**References**

Second, the authors interpret the data to mean that untreated patients had less severe disease. I disagree with this. Patients in the untreated group had a shorter hospital stay, probably due to the higher case fatality in this group. Paradoxically, the authors interpret this as an indication of less-severe disease.