Evaluation of airborne fungal pollution in the burn ward of Imam Khomeini hospital, the referral burn center in the west of Iran

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ABSTRACT

Background and Objective: In hospital facilities the quality of indoor air is a critical factor in the prevention of infections. Poor quality air inside hospitals may lead to hospital-acquired infections, sick building syndrome, and various occupational risks. The aim of this study was to determine the level of airborne fungal contamination in a referral burn center in Western Iran, affiliated to Kermanshah University in Medical Sciences.

Methods: This study was performed in the burn ward of Imam Khomeini Hospital of Kermanshah University of Medical Sciences, in July 2013. Samples were collected from four different parts of the ward, including; public rooms (31 samples), corridor (10 samples), toilet (9 samples), and dressing room (8 samples). Open lid petri dishes, containing Sabouraud dextrose agar medium, were held approximately 1.5 meters from the floor for 15 minutes. The airborne fungi were identified using mycological methods. Descriptive analysis of data was performed using SPSS software (version 16).

Results: Out of a total of 58 culture samples, 38 were positive for fungi. There were 54 colonies from six fungal genera. The most prevalent fungal species were Penicillium spp. with 18 colonies (33.3%), followed by Aspergillus spp. with 13 (24%) colonies. Public rooms were the most contaminated areas (93.5%), while the dressing room (25%) was the cleanest area. The rate of contamination in the dressing room and other areas of the burn ward were statistically significant (P<0.01).

Conclusion: The results of this study indicated a high frequency of fungal contamination in the burn ward, particularly in the public rooms. Our data suggested that this ward -with its high risk patients- needs to be equipped with disinfectant equipment such as a HEPA filter.

Keywords: Airborne Fungi, Contamination rate, Nosocomial infection, Burn ward
**Introduction**

In modern hospitals, facilities such as indoor air quality (IAQ) are a critical factor for preventing infections. Inappropriate hospital IAQ can lead to hospital-acquired infections, sick building syndrome, and various occupational risks (1). Fungal air quality in the hospital environment is affected by various factors, such as the presence of construction activities and a favorable microclimate. Because exposure to fungi can cause serious health problems, it is clearly essential to determine the level of contamination in hospital environments. The data from these evaluations will help to determine the risk of infection for patients and staff, as well as the appropriate function of air conditioning systems for protection against fungi infections (2-5).

Many previous studies have shown that a number of hospital acquired infections can be caused by fungi, such as *Candida albicans* and diverse species of *Aspergillus, Cladosporium* and *Penicillium* (3-5). *Aspergillus* species are ubiquitous thermotolerant molds that produce numerous conidia of 2–4 mm in diameter. The small size of these fungal spores easily allows dispersion into the air currents and deposition into human alveoli. However, despite the routine inhalation of these spores, *Aspergillus* species remain an uncommon agent of disease (6-8). These fungi are only occasionally associated with colonizing syndromes, such as; aspergilloma, allergic bronchopulmonary aspergillosis, and rarely cause invasive infections. Individuals who are at particular risk for invasive fungal diseases include; patients with protein-calorie malnutrition, patients receiving chemotherapy for malignancy, recipients of organ transplants, patients with immune deficiency disorders or taking immunosuppressive drugs, and patients with extensive wounds or widespread burned tissues (1, 5). Given the fact that many of these high risk groups can be found in hospitals, clean hospital air remains a crucial factor for the prevention of fungal diseases. The aim of this study was to determine the level of airborne fungal pollution in the burn ward of Imam Khomeini Hospital, the referral burn center located in the west of Iran.

**Material and Methods**

This study was performed in the burn ward of Imam Khomeini Hospital of Kermanshah University of Medical Sciences in July 2013. Samples were collected in four different parts of this ward including; public rooms (31 samples), corridor (10 samples), toilet (9 samples), and dressing room (8 samples). The dressing room is an isolated room for dressing burn patient wounds and it is disinfected by ultraviolet light (UV) twice daily. Air samples were collected approximately 1.5 meters from the floor for 15 minutes using open lid Petri dishes that contained Sabouraud dextrose agar medium, supplemented with chloramphenicol. The Petri dishes were closed and delivered to the Central Laboratory of the Paramedicine School, Kermanshah University of Medical Sciences.

**Incubation and identification of fungi**

The incubation and identification of fungi were done as previously described (2). In brief, the plates were incubated at 25°C and the grown colonies counted after 72-
120 hours. When suspect colonies were detected, they were isolated with plates containing Sabouraud plus chloramphenicol medium. The incubation temperature was 25°C. The airborne fungi were identified using both microscopic and macroscopic methods for each isolated colony. Finally, the data were inserted into an Excel file and statistically analyzed using SPSS software (version 16).

Results

We identified 38 fungal-positive plates among the 58 plates used for the collection of burn ward air pollution. There were 54 colonies for six fungal genera. The most prevalent fungal genera were *Penicillium* spp. with 18 (33.3%) colonies. *Aspergillus* spp. was the second most frequent airborne fungi with 13 (24%) colonies. The most frequent species of *Aspergillus* genus was *Aspergillus niger* (61.5%), followed by *Aspergillus parasiticus* (23%) (Figure 1). Other frequent airborne fungi were *Mucor* (16.6%) and *Sepedonium* (11.1%) (Table 1). Public rooms were the most polluted area (93.5%), whereas the dressing room (25%) was the cleanest area in the burn ward (Table 2). There was no significant difference between the type of fungi genus and the sampling area (P=0.1). Accordingly, the most frequent fungi genus in all areas of the burn ward was *Penicillium* spp. followed by *Aspergillus* spp. There was a significant difference found between the frequency of airborne fungi in the dressing room and other areas of the burn ward (P<0.01).

![Figure 1. Frequency of *Aspergillus* spp. in the Burn Ward.](image)

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**Fungal contamination in the Hospital environment**
Table 1. Frequency of airborne fungal species in the Burn Ward

<table>
<thead>
<tr>
<th>Fungi Isolated</th>
<th>Number of Colonies (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillium spp.</td>
<td>18 (33.3)</td>
</tr>
<tr>
<td>Aspergillus spp.</td>
<td>13 (24)</td>
</tr>
<tr>
<td>Mucor</td>
<td>9 (16.6)</td>
</tr>
<tr>
<td>Sepedonium</td>
<td>6 (11.1)</td>
</tr>
<tr>
<td>Yeast</td>
<td>5 (9.2)</td>
</tr>
<tr>
<td>Candida spp.</td>
<td>3 (5.5)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54 (100)</strong></td>
</tr>
</tbody>
</table>

Table 2. Places sampled in the Burn Ward

<table>
<thead>
<tr>
<th>Place of sampling</th>
<th>Number of sampling</th>
<th>Positive cultures (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public rooms</td>
<td>31</td>
<td>29 (93.5)</td>
</tr>
<tr>
<td>Corridor</td>
<td>10</td>
<td>9 (90)</td>
</tr>
<tr>
<td>Toilet</td>
<td>9</td>
<td>7 (77.7)</td>
</tr>
<tr>
<td>Dressing room</td>
<td>8</td>
<td>2 (25)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>58</strong></td>
<td><strong>38 (100)</strong></td>
</tr>
</tbody>
</table>

Discussion

The microbiological quality of indoor air in modern hospitals is an important issue since it can cause potential risks for nosocomial infections. Many patients – in particular burn patients - are actually at increased risk of infection while in the hospital. The importance of preventing infection has been recognized in burn care units. Strategies include: accurate aseptic methods, use of sterile gloves and dressing materials, wearing masks for dressing changes, and special separation of patients, using either private rooms or cubicles (9-12). In burn patients the primary mode of contamination is direct or indirect contact, either via the hands of the personnel caring for the patient or from contact with inappropriately decontaminated equipment. Burn patients are unique in their susceptibility to colonization from organisms in the environment, as well as in their propensity to disperse organisms into the surrounding environment (13-15). In general, the larger the burn injury area, the greater the volume of organisms the patient will disperse into the environment. From the infectious agents, fungal organisms, especially *Candida* spp (yeast) and true fungi (molds), such as *Aspergillus*, *Mucor* and *Rhizopus*, have been associated with serious infections in burn patients (1-6).

In the present study, the most frequent airborne fungal contamination was *Penicillium* spp. followed by *Aspergillus* spp. In comparison with our study, a study carried out by Sautour *et al.* (16) in France, investigated indoor fungal contamination over an 18-month period. They found the most frequently detected airborne fungi were *Penicillium* spp. (27-38%) and *Aspergillus* spp. *Arab* *et al.* (17) in three hospitals of Kerman City, Iran, reported that the most prevalent airborne contamination was *Penicillium* spp. Furthermore, *Azizifar* *et al.* (18), in an evaluation of airborne fungal contamination in Tehran City, Iran, reported *Penicillium* spp. was the most frequent fungal spore. Nosocomial transmission of *Aspergillus* infection occurs most frequently during or after hospital construction or renovation, and it usually affects severely immunocompromised patients. However, the development of burn site invasive *Aspergillus* infection is unusual, as most burn-associated infections arise from contaminated dressings (19, 20).

In this study, the most polluted area with airborne fungi was the public room, which has the greatest number of people including patients and relatives visiting the ward. Confirming our results, *Azizifar* *et al.* (18) showed a significant correlation between airborne fungal pollution and
crowded areas. Also, we showed the cleanest area with airborne fungi was the dressing room which had the lowest number of people passing through and it is also disinfected by ultraviolet light twice daily and before patient entrance. Our results showed that there was a significant difference between dressing rooms and other areas which indicated the influence of lower numbers of people using the area and disinfectant methods. In summary, the results of this study showed a high frequency of fungal contamination in burn wards, especially in public rooms. These data showed this ward posed a high risk to patients, and needs to have new disinfectant equipment, like HEPA filters, installed.

Acknowledgment

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References


