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Brief Report

Monitoring of Airborne Fungi in Two General Hospitals in Shiraz, Southern Iran

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Abstract

Hospitalized patients have a potential risk for nosocomial infections. Airborne fungi are one of the main causes of fungal infections in this group. The objective of this study was to investigate the concentrations and species of airborne fungi in two general hospitals in Shiraz, southern Iran. Air samples were collected from high-risk wards, using settle plate method. Fungal colonies were identified, enumerated, and reported. A total of 1075 microbial colonies were detected, 419 of which were fungi. Fungal isolates from two hospitals, belonged to 15 genera. 4.25% of rooms in hospital A and 16% in hospital B were clean rooms. *Cladosporium* followed by *Aspergillus spp* were the predominant genus in two hospitals studied. The highest fungal deposition rates were 1016 and 1797 CFU/m^2 in Emergency and Surgery rooms. Monitoring airborne fungi is one of the best ways for prevention and control of these infections. Caring for high-risk patients in hospital rooms has lead to reduced rates of nosocomial fungal infections.

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Keywords ● Fungi ● cross infection ● *cladosporium* ● *aspergillus* ● Iran ● hospital

Introduction

The importance of bioaerosols has been emphasized in the last decades.[1] Exposure to fungi has been reported to cause several types of human health problems, primarily irritations, infections, allergies, and toxic effects. Fungus spores floating in the air inside hospitals have been blamed for many deaths annually worldwide.[2,3] Monitoring bioaerosols may provide epidemiological information regarding the microorganisms involved in nosocomial infections.[1]

Many species of fungi may act as pathogens by means of invasive growth in human tissues, especially those of immunocompromised patients.[4] The presence of aspergilli in the hospital environment is a major extrinsic risk factor for the occurrence of nosocomial invasive aspergillosis.[5,6] Improper operation or poor maintenance of even the most elaborate ventilation system can lead to nosocomial outbreak of fungal infection.[7] The presence of fungi in critical wards of hospitals is alarming and demands immediate action.[8]

Several methods for the detection and isolation of indoor bioaerosols have been employed. The sample plates, known as sedimentation plates, settle plates or gravity plates are only recommended to obtain preliminary or qualitative information.[9] Shiraz is the capital of Fars province, southern Iran. There are many general hospitals with many critical wards which have a potential for nosocomial infections.

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The objective of this study was to determine the species and concentration of airborne fungi in high-risk wards of two hospitals in Shiraz.

Material and Methods

Samples were taken between 10:00 am and 2:00 pm, using settle plate method. The air samples of 47 rooms from different wards of hospital A and 25 rooms from hospital B were examined. The wards included were Surgery, Trauma, Emergency, Transplantation, ICU, CCU, Induction and Scrub. Petri dishes, 90-mm in diameter, containing Sabouraud dextrose agar and malt extract agar media,[1,7,10,11] were opened and exposed to air about one meter above the ground in different parts of the rooms where there were poor or absent air turbulences. After one hour, the Petri dishes were closed, collected and transferred to the laboratory and incubated at 25°C for at least five days. The colonies were then counted and the results were expressed as colony forming unit (CFU) per one square meter. Fungal isolates were identified by conventional methods including the gross morphology of the fungal colony (i.e., texture, color, obverse and reverse pigment, and topography), tease mount, tape mount and slide culture for microscopic characterization of reproductive structure (i.e., fruiting body, type of macroconidia, shape and size of microconidia), accessory structures, germ tube and chlamidoconidia test. Microsoft Excel 8.0 was used for data processing.

Results

A total of 1075 microbial colonies (419 fungi and 656 bacteria) were isolated from two hospitals. No genus of *Candida* was identified in this study. In hospital A, 528 microbial colonies from 66 air samples were isolated; 223 (42.2%) of those colonies yielded fungi. Four and twenty-five-hundredth percent of rooms were "clean room." The isolates belonged to 12 genera (table 1). *Cladosporium* was the most dominant fungal isolate followed by dematiaceous and hyaline fungi. The contamination rates are shown in table 2. The highest fungal concentration was 1016 CFU/m^2 in Emergency room; the lowest was zero and belonged to the transplantation room.

In hospital B, 547 microbial colonies from 56 air samples were isolated; 196 (35.8%) of those colonies yielded fungi. Sixteen percent of all rooms had no fungal contamination. However, all rooms had microbial contamination. *Cladosporium* was the predominant genus followed by *Penicillium* and *Aspergillus niger* (table 1). The highest fungal concentration was 1797 CFU/m^2 in Surgery room; the lowest was zero and belonged to the operating room (table 3). Sixty-six and six-tenth percent of operation rooms were clean from airborne fungi but all had bacterial contamination.

Discussion

Hospital environment is often contaminated with fungal spores. This has contributed to the widespread perception that most cases of fungal

Table 1: Frequency of airborne fungi isolated from high risk wards of Shiraz hospitals.

	Hospital A		Hospital B	
Fungi isolated	**Number**	**%**	**Number**	**%**
Cladosporium	72	32.3	33	16.8
Penicillium	22	9.9	25	12.8
Aspergillus niger	22	9.9	22	11.2
Aspergillus flavus	11	4.9	14	7.1
Aspergillus spp	15	6.7	10	5.1
Aspergillus nidulans	4	1.8	4	2.0
Aspergillus terreus	1	0.4	3	1.5
Hyaline *hyphomycetes*	23	10.3	20	10.2
Dematiaceous fungi	23	10.3	16	8.2
Curvularia	3	1.3	2	1.0
Bipolaris	2	0.9	1	0.5
Alternaria	6	2.7	6	3.1
Mucor	1	0.4	4	2.0
Rhizopus	3	1.3	1	0.5
Chrysosporium	2	0.9	1	0.5
Mycelium sterila	1	0.4	5	2.6
Stemphylium	1	0.4	2	1.0
Acremonium	1	0.4	3	1.5
Aureobasidium	-	–	3	1.5
Trichotechium	-	–	3	1.5
Stachybotrys	1	0.4	-	–
Trichosporon	-	–	3	1.5
Yeast	9	4.0	10	5.1
Total	223	100	196	100

Table 2: Deposition rate of airborne microorganism and fungi in high-risk rooms of hospital A

Location	Number of rooms	Highest concentration of Microorganisms CFU/m^2	Mean concentration of Microorganism CFU/m^2	Highest concentration of fungi CFU/m^2	Mean concentration of fungi CFU/m^2	Dominant fungus
Surgery	5	2266	1468.7	860	609.34	*Penicillium*
Trauma	3	2813	1614.53	625	446.03	*Cladosporium*
Emergency (Men)	3	10312	4065.13	1016	937.46	*Aspergillus niger*
Organ implant	6	2813	1380	938	429.6	*Cladosporium*
Bone marrow implant	11	1250	526.5	938	362.15	*Cladosporium*
ICU	6	1407	1067.73	782	520.81	*Cladosporium*
CCU	5	1563	749.98	1016	531.3	*Cladosporium*
Plastic surgery	4	1250	1093.72	938	585.9	*Cladosporium*
Induction	2	704	703.1	235	234.3	*Aspergillus flavus*
Scrub	2	1016	937.75	323	200.3	*Aspergillus flavus*

Table 3: Deposition rate of airborne microorganism and fungi in high-risk rooms of hospital B

Location	Number of the rooms	Highest concentration of Microorganisms CFU/m^2	Mean concentration of Microorganisms CFU/m^2	Highest concentration of fungi CFU/m^2	Mean concentration of fungi CFU/m^2	Dominant fungus
Operation	6	1640	787.6	156.2	39.05	Aspergillus niger
Oncology(children)	3	1500	1020.8	235	223.9	*Aspergillus spp*
ICU	1	469	468.7	94	93.7	*Cladosporium*
Post ICU	1	860	859.3	235	234.3	*Aspergillus niger*
Surgery (urology)	3	3516	2265.6	1329	1015.6	*Aspergillus flavus*
Surgery	5	2813	1453.04	1797	884.32	*Cladosporium*
Surgery (women)	3	2579	2369.76	1016	807.43	*Aspergillus niger*
Heart surgery	2	4219	2601.5	547	507.75	*Cladosporium*
Recovery	1	1250	1250	782	781.2	*Penicillium spp*

infections in immunocompromised hosts are hospital-acquired.[1,2,5,7,10] In Iran, nosocomial infection is a serious health and financial problem and many studies have been undertaken to determine the incidence of these infections.[12,13,14] There is increased awareness of importance of hospital-acquired infections and the need to allocate more financial resources to infections control programmes.[15,16] Moreover, many kinds of antibiotics are administered for patients during their hospitalization course which can increase the risk of nosocomial fungal infections.[6,7,10,15] Testing for airborne fungi is a common practice during an indoor air quality control.[9,17,18] Many fungi, such as *Aspergillus spp* or *Fusarium moliniform* are common indoors and outdoors, and can cause opportunistic infections in immunodeficient people.[9] Fungi usually enter a building through outdoor air canals of the heating, ventilation, and air conditioning systems. Outdoor air often is the dominant source of indoor fungi and the fungal types and species isolated from indoors and outdoors should generally be similar.[2,9,16]

Cladosporium spp are common outdoors. However, they grow well indoors in fiberglass insulation or highly humid surfaces.[1,18-20] Many reports indicated that this genus is the predominant fungus and one of the most common isolates cultured from inside the hospitals,[8,10,16] which is in keeping with our results. Our findings were also similar to other reports from Iran which indicated that *Cladosporium*, *Aspergillus* and *Penicillium* are dominant isolates.[21-24] Although *Cladosporium* is responsible for many fungal infections, it is a relatively uncommon cause of nosocomial infections.[25] *Aspergillus spp* were the second dominant fungi detected in our study; this is not similar with Panagopoulou et al report,[26] which is probably for the differences between sampling methods employed.

Reservoirs in hospitals for *Aspergillus* is unfiltered air ventilation system, dust dislodged during construction, carpeting, food and ornamental plants.[25]

We could not identify any species of *Candida* because the medically important *Candida* such as *C. albicans* could not exist in the environment. They are normal flora of human and animal body. This finding is also in agreement with the observations of Martin-Deniz and the other studies.[10,18,21-23,27]

Trichosporon genus is considered as an emergent causative agent of hospital infections

and causes opportunistic infections, especially in bone marrow transplanted patients and was isolated from environmental surfaces in hospitals.[1,28] In our study, we isolated *Trichosporon* in 1.5% of isolates which belonged to Surgery rooms of hospital B. Appropriate measures must be instituted for controlling this pathogen such as using UV radiation or air filtration.[7,17]

Since the air conditioning and water systems are a potential source of fungal air contamination in old hospitals and buildings, the most effective but expensive method of protecting these individuals against nosocomial infection is to confine the fungi to hospital rooms provided with high-efficiency special air filtration systems (HEPA).[7,29]

In spite of using settle plate method, this study revealed that most of the rooms, especially in Surgery and Transplantation wards were contaminated with airborne fungi. These rooms require great cares. We think the rates of contamination would be even higher if we used vacuum devices. Although a period of one hour for inserting settle plates indoor seems to be enough for collecting the fungal spores, we highly recommend using bioaerosols sampling devices in these hospitals. Recently, there has been interest in the use of germicidal UV irradiation to disinfect indoor environments for control of infectious diseases in hospitals. A study in California indicated that germicidal UV irradiation may be an effective approach for reducing fungal contamination.[17] Moreover, components of a protected hospital environment should include a well-sealed room, HEPA filtration of incoming air, direct or laminar airflow within the room, positive room air pressure relative to the corridor and high rates of room air exchange.[7]

These two hospitals have old ventilation systems. They are surrounded by trees and gardens which are constantly overcrowded with patients and visitors. These factors increase the indoor air contamination and make a high potential risk for nosocomial infections. Poor sanitary management and no routine plan for aerobiology sampling for alarming the airborne microflora and bioaerosols concentrations might be the other problems in this regard.

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