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Fungi Causing Sinusitis and Otitis: Are the Air, Temperature and Relative Humidity to Blame?

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Abstract

Fungi in air are notorious for causing allergic and invasive sinusitis. Especially fungi of the genera *Aspergillus* and *Rhizopus* are known for this. Yeasts in air can also cause sinusitis. Sometimes there is variation in load of these fungi with relevance to ambient temperature, relative humidity and temperature. These things are very important from public health viewpoint.

Keywords: Sinusitis; Otitis; Fungi; Air; Allergic rhinosinusitis

Abbreviations: NIFS: Non-Invasive Fungal Sinusitis; FB: Fungal Ball; SFS: Saprophytic Fungal Sinusitis; AFRS: Allergic Fungal Rhinosinusitis; IFS: Invasive Fungal Sinusitis; AIRS: Acute Invasive Rhinosinusitis; CIRS: Chronic Invasive Rhinosinusitis; GIFS: Granulomatous Invasive Sinusitis

Introduction

Fungi in air can be allergic or invasive. They may irritate the nasal mucosa in man and produce allergic rhinosinusitis, fungal ball or saprophytic sinusitis [1]. Others classify fungal sinusitis as invasive and non-invasive. There are three subtypes of non-invasive fungal sinusitis (FS): Fungal ball (FB), saprophytic fungal sinusitis (SFS), and allergic fungal rhinosinusitis (AFRS). Similarly, there are three subgroups of invasive fungal sinusitis (IFS), namely acute invasive rhinosinusitis (AIRS), chronic invasive rhinosinusitis (CIRS), and granulomatous invasive sinusitis (GIFS) [2].

Fungi in Air Causing Sinusitis

Fungi get disseminated in air continuously. For example, from buildings under construction, molds spread in air and can be inhaled. This spread can be enhanced by dampness. In fact, damp indoor spaces have been linked with health problems like bronchitis, asthma, cough, wheeze, and shortness of breath [3].

Urban vs Rural

Several studies have quoted that *Aspergillus* spp. in outdoor air are more common in urban than rural settings in the province of Madrid. Hence this problem of mold in air is more common in victims as compared to villages [3]. Leaky roofs and leaky pipes can lead to spread of these fungi in air, causing infections like allergic fungal sinusitis or hay fever, and hypersensitivity pneumonitis [4]. Exposure to household molds have also been linked with early onset otitis media [5]. Especially, high levels of 'other' mould (defined as total spore count minus counts for Penicillium, Cladosporium, and yeast) have been associated with early otitis media.

Yeasts in air can also cause sinusitis. However, they are rare causes of invasive paranasal sinusitis. Among yeasts, *Candida albicans* and *C. tropicalis* are relatively commoner causes of sinusitis, followed by *C. kefyr* which is rarest [6]. So otorhinolaryngologists may come in the picture for surgical treatment also. Otitis can be seen along with paranasal sinusitis.

Variation of These Molds with Respect to Temperature

Ambient temperature has a role to play in the burden of mold in air. Molds are found later in the day with an optimum temperature of 25 to 29°C. Increased use of air conditioners and air coolers to reduce room temperatures in summers also lead to increased circulation of molds, especially if these machines are not regularly serviced [7].

Variation of These Molds with Respect to Relative Humidity

Increase in relative humidity above 45 percent has been associated with increased level of fungal molds in indoor air in a study done in Canadian homes [8]. Another study in Iran has found positive correlation between number of fungi in outdoor air and rel-

ative humidity in spring and autumn seasons [9]. Urban slums in India, with their ever increasing population in newer cities, might be highly hazardous for the residents owing to damp dwellings along with high household crowding index.

Variation of these Molds with Respect to Time of the Day

Different patterns of diurnal variation have been observed for spores of different fungal species in ambient air. A study in Kolkata found *Ganoderma, Nigrospora, Ascospores*, and *Basidiospores* to have night peak patterns between 6PM and 5AM. *Periconia, Fusarium* and rust spores were found to have post-dawn peak patterns between 5AM and 10AM. *Bispora* (at forenoon), *Curvularia* (at noon) and *Cladosporium* (at afternoon) were found to have midday peak patterns between 10am and 6pm. *Aspergillus* spp., *Penicillium* spp. and *Trichosporon* spp. were found to have double peak patterns [10]. However other environmental factors like temperature, relative humidity, wind speed might have an influence on these diurnal variations and may vary from place to place depending on weather patterns.

Indian Scenario

A year-long study conducted in South India found A. fumigatus, *C. cladosporioides*, and *A. alternata*, throughout the year in ambient atmospheric aerosols. *C. cladosporioides* was the most abundant allergenic fungus present in the region. A. fumigatus and *C. cladosporioides* had higher concentrations during monsoon and summer, whereas in winters, *A. alternata* had higher concentrations [11]. Another study in industrial township of Barrackpore, West Bengal revealed temporal variation in ambient fungal spore load. Highest concentration was observed during the post-monsoon period and while it was lowest during winter. Most of the observed fungi (65%) are from ascospore, basidiospore, *Periconia* and *Aspergillus* spp. and *Penicillium* species. Wind speed, Dew point, PM2.5 concentration and NO_2 levels were found to be important predictor variables in determining atmospheric fungal concentration [12].

A study in Kolkata over a 2-year period found *Alternaria, Aspergilli, Penicilli, Bispora, Drechslera* (*Bipolaris* spp.), *Cladosporium, Nigrospora, Ganoderma, Pithomyces*, unidentified *ascospores* and *basidiospores* as the major fungal agents in ambient air. August was found to be the most spore-rich month with lower concentrations in late winter in January, February, least in March. *Bispora*, Ascospores and Basidiospores were high in monsoon months whereas *Nigrospora* were present throughout the year. Significant positive association was found between relative humidity and total aeromycota. Skin prick tests performed on patients using 20 different fungal extracts found maximum sensitization to *Aspergillus* species [10].

Our own experience shows that aseptate hyphal mods like *Rhizomucor* spp. grow well in air over a relative humidity of 50% and temperature of 29.5°C. It maybe so that more humidity favors mold growth and dissemination in closed spaces. *Aspergillus niger* was seen mostly if relative humidity exceeded 86%, but also found in a humidity as low as 45%. *Aspergillus fumigatus* was seen in indoor air in temperature as low as 22°C.

Ear Infection by Fungi by Being Present in Air

Molds present in ambient aur can also cause otitis external and even otitis media. *Aspergillus* spp. are notorious for this [13].

How to Search for These Fungi in Air

Settle plate method or active air sampling can be done to retrieve these fungi in air. In settle plate the plate has to be kept open in the area for about 1 to 2 hours and then placed in incubator for 1 to 2 days. Active air sampling takes lesser time but is costlier. We are using passive sampling by Settle plate method using Sabouraud's Dextrose agar for this purpose. Variation of flora with respect to temperature, time and relative humidity can be assessed by an instrument called Digital Hygrometer which is easily available commercially (Figure 1).

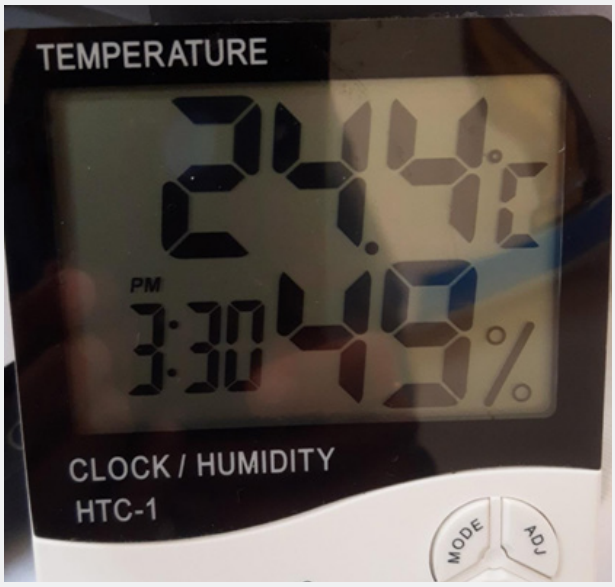

Figure 1: Digital hygrometer indicating temperature, time and Relative humidity.

Discussion

Thus, Otorhinolaryngologists may be consulted for ear and nasal sinus infections caused by these fungi in air. These fungi can cause both allergic and invasive infections. There is significant variation also in these airborne fungi, particularly with respect to temperature and relative humidity. More molds are seen indirectly with increasing relative humidity, particularly in the range of 45%-65%. This dissemination increases more if construction and repair works are happening in buildings, facilitating the dissemination of conidia and spores of fungi and resultant allergic and invasive fungal infections in man and otomycosis. These things need

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to be studied and explored more and can be termed emerging topics encompassing Microbiology, occupational health as well as public health.

Conclusion

One can time the venturing out in risky areas where spores of mold abound or should wear masks and other protective gear in such places.

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