Hospital indoor air microbial quality: Importance and monitoring

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ABSTRACT

Indoor microbial air flora is a cause of tremendous health concern in developing countries. A number of allergic and infective illnesses are linked to poor microbiological quality of indoor air in the hospital, like Bronchopulmonary aspergillosis, sick building syndrome and pneumonia. This air quality needs to be assessed by one or more of many standard methods available, old and new, and is very important to be studied and researched. Our article highlights these issues by literature search in the appropriate field.

Keywords: Microbial load, settle plate, slit sampler, impactor.

INTRODUCTION

Since time immemorial, human beings have tried to associate infectious diseases with bad air quality, with the famous miasma theory coming up[1]. It stated that under certain circumstances, ambient air became charged with an “epidemic influence” which in turn became malignant when combined with the emissions of organic decomposition from the earth[1]. The very term “malaria” literally means “bad air”, since it was believed that it was principally caused by substandard indoor air and associated it with marshes and low-lying swamps[2]. The relationship between microbes in air and infections was first shown by Louis Pasteur, who also stated the germ theory of disease[3]. Airborne pathogens are reportedly a major cause of illnesses like respiratory ailments, causing allergy, asthma and pathological involvement of respiratory tract[4]. We compile all these methods and their applications by literature search.

MATERIALS AND METHODS

Literature search was done to study and accumulate the various existing and upcoming methods to study microbial flora.

Sick building syndrome

The association between poor air quality and human diseases can be exemplified by the sick building syndrome (SBS), which comprises of various nonspecific symptoms that occur in the occupants of a building[5]. One of the etiologies of SBS is bacterial or fungal contamination, besides other contributing factors[5]. Legionnaire’s disease is also a part of this building related spectrum of illnesses, that also includes humidifier fever, caused by droplets containing bacteria present in humidifiers and resulting in extrinsic allergic alveolitis[5]. This is also sometimes called “Monday fever”[5].

Legionnaire’s disease

Legionellosis is a type of severe interstitial pneumonia caused by the Gram negative bacterium Legionella pneumonia, which is naturally present in water of cooling towers of air conditioners, and disseminated in the form of small droplets called aerosols[6]. Difficult to diagnose clinically and in the laboratory, Legionellosis is now a
Principal reason of community acquired as well as nosocomial pneumonia in developed countries like the USA and Germany[7].

**Pulmonary tuberculosis**

*M. tuberculosis* is most frequently transmitted with the help of small aerosols, 1-5 µm diameter[8]. Infectious droplet nuclei are generated when persons who have pulmonary or laryngeal tuberculosis cough, sneeze, shout, or sing; transmission occurs when a person inhales droplet nuclei containing *M. tuberculosis*, and the droplet nuclei traverse the mouth or nasal passages, upper respiratory tract, and bronchi to reach the alveoli of the lungs[8].

**Other bacteria spreading by air**

Methicillin resistant *Staphylococcus aureus* (MRSA) can also spread by aerial route as noted by researchers[8]. In a Japanese study, 20% of the MRSA particles were within the respirable range, of less than 4 µm[9]. According to another Turkish study, the two most common bacterial pathogens transmissible by air were MRSA and *Acinetobacter* spp[10]. There was also a proven association between concentration of these two airborne bacteria and colonisation in patients[10]. Another very important bacterial pathogen which can be spread by aerial route is *Mycobacterium tuberculosis*, and lesser concentration of this bacterium can cause infection than MRSA or other bacteria[11]. Recent scientific research has also indicated that even anaerobic bacteria like *Clostridium difficile* can spread by aerosolisation, as found by slit sampling[12].

**Fungi in air**

Both yeasts and mycelia fungi can easily disseminate from one place to another with the help of air, and fungi have been found to constitute 4-11% of total microbial mass in urban air[13]. As per recent research, basidiomycetous fungi are relatively more ubiquitous in air than ascomycetous fungi[13]. Fungi are very common in indoor and outdoor environments, and nearly 10% of people worldwide have some form of fungal allergy or another[14]. Fungi like *Alternaria* spp., *Aspergillus* spp., *Botrytis* spp., *Cladosporium* spp., *Penicillium* spp. and *Scopulariopsis* spp. are very common in air and are released by coughing, sneezing, carpets, plants and other sources[14]. Non-culturable fungi like *Pneumocystis* spp. have also been demonstrated to be transmissible by aerial route, as studied by researchers in France using air samplers near infected patient's head[15].

**Viruses spreading by air:**

Viruses like Measles virus, Ebola virus can also spread effectively by aerosol formation from one person to another[16]. However, Ebola virus transmission needs a large number of droplet nuclei[16].

**Methods for detection of microbes in air**

a) Older methods:

Old methods existed for air microbial sampling, like collection of bacteria on porous solid filters, or in a fluid medium by bubbling, also known as “aeroscope”[17].

b) Settle plate method:

In the settle plate method, petri dish having agar-base medium like Blood agar is kept open for 10-60 minutes about 1 metre above the ground, and incubated at 37 deg C for 24 hours for bacteria and 1-2 weeks for fungi[11]. This is an easy method, and the optimum duration of exposure in occupied room and hospital wards was introduced by Russell *et al* in 1984, and result is expressed by number of bacteria-carrying particles settling over a given area in a fixed period of time[11].

c) Slit sampler:

This is a more advanced method, proposed by Bourdelion *et al* in 1994, which detects about 95% of small bacteria in air[11]. In this case, air is sampled at a rate of about 1 cubic foot per minute. A Petri dish containing blood agar is held on a slowly rotating platform in a box closed by air-tight door; the box is connected to a suction pump having negative pressure for sucking in air. The slit is placed about 2 mm from top of surface of centre of agar plate. Suspended particles are centrifuged on surface, where they adhere. After similar incubation, colonies are counted. The main disadvantage is that it is noisy and cumbersome[11].

d) Centrifugal air samplers:

A new modification for air sampling is the centrifugal sampler in which air is centrifuged into a hollow chamber, with its inner walls containing the culture media in strips, which are then removed and incubated for colony count[11].
Estimation of load:
In case of bacteria and fungi, the microbial load is measured by the formula:

\[ B = \frac{1000 \times N}{RT} \text{ bcp/m}^3 \]

where B is the bioload, N is the number of colonies on plate, R is rate of sampling and T is the time given for sampling[11].

Methods for sampling and monitoring airborne viruses:
Viral load in air can also be measured, using methodologies like filters, liquid impactors and solid impactors to collect ambient air; the collected air is then subjected to molecular tests like PCR and tissue culture for viral detection[18].

Prevention:
Air changes are mandatory (minimum of 20 changes per hour) for indoor wards and operation theatres, as is air filter[19]. Ultraviolet radiations are microbicidal in nature, and hence irradiation of unoccupied rooms also effectively reduces the aerosolised microflora[20].

RESULTS AND DISCUSSION

Microbial load in ambient air needs to be monitored since it is very important. Indoor air is more dangerous in this regard as the air in it allows aerosols to build up[20]. All these things need to be monitored and studied further meticulously, since this is a very interesting area of research.

CONCLUSION

Microbiological flora of air is very important with regards to diseases, and need to be studied and substantial research needs to be done in relation to newer methods to assess microflora of air.

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REFERENCES