Effect of Least Concentration of Hydrogen Peroxide (H_2O_2) Against Airborne Fungi

M. Anitha[1] J. Hemapriya[2] S. R. Swathy[3] G. B. Pavithra[4]
[1,2,3,4]Department of Microbiology
[1,2,3,4]Shri Sathya Sai Medical College & Research Institute Thiruporur, Sri Balaji Vidyapeeth University, Tamil Nadu, India

Abstract— Airborne indoor fungi were assessed during the winter season using open plate technique, SDA were used for isolation of fungi. The air samples were collected during December -February from different locations in the hospital. Air samples were taken in three months period during pre and post cleaning of the hospital wards. In all of the tested places a significant increase of mould spores was observed in pre cleaning but in post cleaning with 0.3% Hydrogen peroxide, there was no fungal growth and majority of the plates were sterile. Six genera of fungi, mainly members of the genus Aspergillus spp, Mucor spp, Rhizopus spp, Fusarium spp, Penicillium spp and Candida spp were isolated. Aspergillus spp showed highest growth numbers. This study could make a contribution not only using the least concentration of disinfectant in the hospital personnel but also in detection of preventive measure to be taken against hospital infections.

Key words: Airborne Fungi, Disinfectant, Hospital Personnel, Hospital Wards, Indoor Air and Infection

I. INTRODUCTION

Microorganisms such as bacterial and fungal spores are almost always present in the air. The quality of indoor environment, however, is not easily defined or readily controlled and can potentially place human occupants at risk1. Airborne transmission is one of the routes of spreading diseases responsible for a number of nosocomial infections2.

There is growing concern about adverse health effects of fungal contamination on occupants of Hospital buildings since nineteenth century. Then, as now, the morbidity and mortality resulting from microbial exposure encouraged the advancement of general disinfection, aseptic technique, and a variety of practices and procedures to control patient exposure to exogenous microflora. Fungal contamination in indoor environments has been shown to produce allergic and toxigenic effects in occupants of this buildings3 & 4.

Fungi (mold) are present almost everywhere. In an indoor environment hundreds of different kinds of mold are able to grow wherever there is moisture and an organic substrate (food source). They can grow on building and other materials, including: the paper on gypsum wallboard (drywall), ceiling tiles, wood products, paint, wallpaper, carpet, some furnishings, books/papers, clothes and other fabrics. Mold can also grow on moist, dirty surfaces such as concrete, fiberglass insulation, and ceramic tiles5.

Stabilized hydrogen peroxides can be used to disinfect environmental surfaces. The literature contains several accounts of the properties, germicidal effectiveness, and potential uses for stabilized hydrogen peroxide in the hospital setting. Stabilized hydrogen peroxides are effective against a broad range of pathogens including both enveloped and non-enveloped viruses, vegetative bacteria, fungi and bacterial spores6. Hydrogen peroxide, or other oxygen therapies, are one of the most widely used cancer therapies world-wide because they provide oxygen to the cancer cells. They are safe and effective. H2O2 is also used for a host of other ailments, including AIDS and any other virus based illness7.

Although airborne microorganisms encountered in hospital lobbies are apparently harmless to healthy people, they can cause adverse health effects in immunocompromised people. Many of those who pass through hospital lobbies belong to the vulnerable group of weak, elderly, and infirm people, and thus may be very sensitive to biological hazards. In particular, hospitalized patients could be at significantly increased risk of bio-aerosol exposure8. Airborne microorganisms originate not only from people (including patients), but are also spawned by various indoor hospital and outdoor environmental sources. There are a number of such factors that may be related to the generation of bio-aerosols in the lobby of a hospital.

The present study was conducted to determine the level of microbial control possible by the comprehensive use of the least concentration of hydrogen peroxide in a severely fungal contaminated hospital wards and to assess the duration of effective control. The disinfectant recommendations here is to provide guidance to minimize the risk and to prevent the transmission of fungal airborne in the indoor environment.

II. MATERIAL AND METHODS

A. Air Sampling Location:

The project was initiated after getting the approval from Ethical committee of the institution.
This study was done over a 3-month period from December 2014 through February 2015 at Shri Sathya Sai Medical College and Research Institute located in Thiruporur, Chennai. Samples were collected from specified areas in the hospital and processed in the Microbiology lab.

B. Settle Plate Method:

The samples were collected by settle plate method by placing the petri plates in the targeted areas in the hospital wards according to 1/1/1 rule (petri dishes that will be left open for one hour, placed at a height of 1 meter from the floor and at a distance of 1 meter from the wall or any object) . Air sampling was done by settle plate technique during, before and after disinfection of the hospital wards which were earmarked for the project. The medium used was Sabouraud's dextrose agar(SDA) containing streptomycin or neomycin to suppress bacterial growth, plates were incubated at 37°C but sometimes room

temperature (20-25° C) for 72 hours as per the standard protocol9.

C. Disinfectant Used:

The present study was carried out to evaluate the effectiveness of 0.3% hydrogen peroxide.

D. Pre Disinfection:

Pre disinfection was performed to detect the fungal contamination in the different hospital wards.

E. Post Disinfection:

In our study 0.3% hydrogen peroxide was applied by spraying, using a low pressure washer bottle-type sprayer. The patient wards can serve as a reservoir for pathogens and should therefore be sprayed in selected areas thoroughly and then it is allowed to dry, SDA plates were kept open as per standard protocol. To achieve effective disinfection, disinfectant at the correct concentration(0.3% H_2O_2) was applied to approximately 100-150 square feet (9-14 m2) of surface area. Disinfectant should remain for the appropriate contact time[10].

III. RESULTS

S.No	Ward Name	Pre- Cleaning	Post-cleaning with H_2O_2
1	Male surgical ward	Aspergillus spp, Mucor spp	No growth
2	Male TBCD ward	Aspergillus spp, Mucor spp	No growth
3	Female TBCD ward	Aspergillus spp, Mucor spp,	No growth
4	Male medical ward	Aspergillus spp, Mucor spp	No growth
5	Dermatology ward	Aspergillus spp, Fusarium spp	No growth
6	Male ortho ward	Aspergillus spp,Fusarium spp	No growth
7	OG Ward	Rhizopus spp, Candida spp	No growth
8	Female Ortho Ward	,Aspergillus spp, Fusarium spp	No growth
9	ENT- OP	Aspergillus spp,Rhizopus spp	No growth
10	Ophthalmology – OP	Aspergillus spp,Penicillium spp	No growth
11	Medical ICU	Sterile	Sterile
12	Microbiology - central lab	Penicillium spp, Mucor spp	No growth
13	Biochemistry - central lab	Rhizopus spp	No growth
14	Pathology central-lab	Mucor spp	No growth
15	Blood bank	Rhizopus spp	No growth

Table 1: Area Screened For Indoor Air by Open Plate Technique Pre and Post Cleaning

Fungal isolates	Number of fungal isolates	Percentage of Fungi
Aspergillus spp	9	36%
Mucor spp	6	24%
Rhizopus spp	4	16%
Fusarium spp	3	12%
Penicillium spp	2	8%
Candida spp	1	4%

Table 2: Showing Prevalence of Fungal Isolates in Hospital Wards

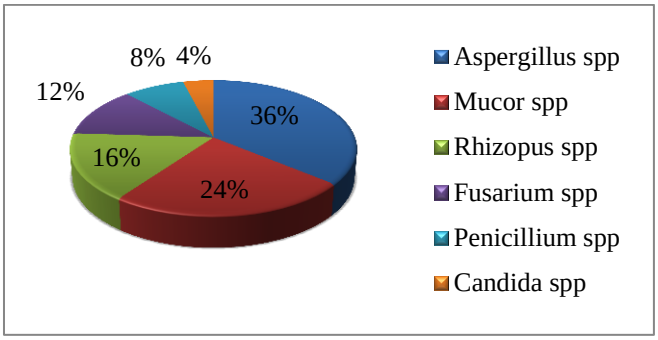

Fig. 1: Percentage of Fungal Growth In Pre Cleaning

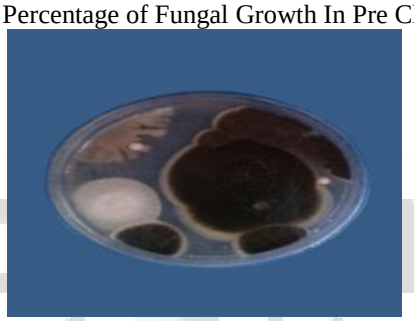

Fig. 2: Showing Fungal Growth in SDA Obtained From Pre Cleaning

Fig. 3: Showing No Growth in Post Cleaning With 0.3%Hydrogen Peroxide

A total of 25 fungal isolates were identified to the generic level from 15 hospital wards, which included Aspergillus niger, Mucor spp, Rhizopus spp Fusarium spp, Penicillium spp and ,Candida spp. Among these fungal isolates Aspergillus spp was the most frequently occurring airborne fungal isolates in the hospital wards. Followed by Mucor spp, Rhizopus spp,Fusarium spp ,Penicillium spp and Candida spp were detected in our study(Table1).

In this investigation , 36 % of Aspergillus spp were isolated from Male surgical ward, Male TBCD ward, Female TBCD ward, Male medical ward, Dermatology ward, ENT-OP, Male Ortho ward, Female Ortho Ward and ophthalmology-OP, 24% of Mucor spp were isolated from Male surgical ward, Male TBCD ward, Female TBCD ward, Male medical

ward, Pathology and Microbiology lab, 16% Rhizopus spp were isolated from OG ward, Biochemistry Central lab, Blood bank and ENT- OP, where as 12 % of Fusarium spp were isolated from Dermatology ward, Male ortho ward and Female Ortho ward, 8% of Penicillium spp from Microbiology Central lab and ophthalmology OP and 4% of Candida spp from OG ward alone but our investigation showed no growth in Medical ICU during pre and post cleaning(Table 2 & Fig 1).

Our study confirms the presence of fungus in the hospital environment during pre cleaning as shown in (Fig 2), but in post cleaning fungus can be removed with effective disinfection techniques and in our analysis we have found that the least concentration of 0.3% Hydrogen peroxide was the most effective disinfection. In hospital areas it becomes mandatory to control hospital borne infection among the inpatients who require prolonged hospital stay for treatment. This in turn will reduce the morbidity and mortality of the sick patients(Fig 3).

The finding of this study demonstrates that 0.3% hydrogen peroxide provides an adequate disinfectant concentration and exposure time against fungus in the hospital environment. Selection of the proper disinfectant will depend on the microorganism suspected, cost effective, as well as environmental factors (e.g. temperature, pH, and safety issues).

In our previous study we have found out, 2% sodium hypochlorite was more effective than phenol for destroying bacterial and fungal spores, but in the present study the best results were obtained from one spray bottle of 0.3% hydrogen peroxide. This method is several times more effective for killing fungal spores than using either by phenol nor by 2% sodium hypochlorite(9). The sprays of hydrogen peroxide are more effective in destroying these fungal spores than any commercially available disinfectant like phenol and chlorine bleach.

The results are obtained by pre and post cleaning of disinfection with 0.3% hydrogen peroxide.This study has proven the utility of the least concentration of 0.3% hydrogen peroxide disinfection in controlling the fungal contamination in the hospital wards.The destruction of airborne microorganisms upon contact with antimicrobial surfaces would further reduce human exposure potential, producing an environment with lowered risk of allergic, infective, or toxigenic consequences for hospital occupants.

IV. DISCUSSIONS

Chemical disinfection is a vital part of the contamination control program in aseptic processing critical areas. Since there are numerous ways that patient rooms can become contaminated with fungi. So the selection and use of an agent with fungicidal activity is extremely important. This study can make a benefaction towards the reduction in the incidence of nosocomial infection which is associated with microbes and the application of least concentration of 0.3% Hydrogen peroxide disinfectant in the hospital wards.

Hydrogen peroxide is active against a wide range of microorganisms, including bacteria, yeasts, fungi, viruses, and spores11 . The efficacy of hydrogen peroxide depends on many factors, for example: concentration, pH, temperature, reaction time, use in combination with physical agents.

Aspergillus spp were the most frequently isolated fungal isolates in this study. This is similar to that obtained by Jaffal et al.,(1997)1 who isolated seven fungal isolates, from indoor and outdoor environment of houses in the United Arab Emirates. Ekhaise et al.,(2010)12 also isolated Aspergillus spp, Penicillium spp., Mucor spp., and Candida spp., Verticillium spp. with Aspergillus spp and Penicillium spp from University of Benin Teaching Hospital, one of the study areas. Environmental surveillance of filamentous fungi in three tertiary care hospitals in Greece and indicated that Aspergillus flavus and Aspergillus fumigatus were the most prevalent species (Panagopoulou et al.,(2002) 13. Although, Aspergillus may be tolerable for healthy individuals, it may be dangerous for high risk patients. The spores readily invade the airways and could lead to aspergillosis in immunocompromised hosts (Gangneux JP.,(2004) 14, Bhatia and Vishwakarma.,(2010)15.

Rhame et al.,16 has shown a direct correlation between the concentration of airborne Aspergillus spores in hospital air and the incidence of aspergillosis among immunosuppressed patients; Arnow et al.,17report “our findings strongly suggest that the inanimate hospital environment is a major determinant of the risk of endemic or epidemic nosocomial aspergillosis”. F.S. Rhame, et al.,18 reported Airborne transmission may lead to aspergillosis in the patients with immune deficiency. Mucor spp., Rhizopus spp., Acremonium spp., Fusarium spp., Pseudoallescheria boydii (Scedosporium apiospermum), Scedosporium spp. and Sporothrix cyanescens have been shown to be other hospital acquired fungal infectious agents related to airborne transmission. It is expressed that airborne fungal infections may lead to opportunist infections in immune deficient subjects and may trigger asthma attacks in immune competent subjects.19 These findings were almost correlates with our study.

Our results were similar to that obtained by Beggs.,(2003)20 who reported the common genera of fungi that are frequently isolated from the hospitals air are Aspergillus, Penicillium, Mucor, Rhizopus, Graphium, Geotrichum, Trichophyton, Scopulariopsis, Fusarium and Microsporum spp. However, the common genera of yeasts that are frequently isolated from hospitals are Candida spp. and Blastomyces spp. (Lugauska and Krikstaponis.,(2004)21. Aspergillus spp. and C. albicans as reported in different studies(Ahmad et al.,(2003)22, Weinberger et al.,(1997) 23, Overberger et al.,(1995) 24, Harvey and Hyers.,(1987)25 and were considered as the major source of hospital fungal infections. Manuel and Kibbler.,(1998), Overberger et al.,(1995)24 found that 70-80% of the fungi in hospitals air were Aspergillus spp. This study also showed similar distribution of the mold and yeast species.

V. CONCLUSION

Disinfectants are seldom needed to perform an effective remediation because removal of fungal growth remains the most effective way to prevent exposure. In our study, we have concluded that the least concentration of 0.3% hydrogen peroxide is recommended to limit microbial dispersals within the hospitals. Usage of proper concentration of the disinfectant is important to achieve best results. 0.3% hydrogen peroxide has effectively

eradicated the fungal growth. Moreover, efforts should also be made to minimize the generation and migration of any dust and mold. Using personal protective equipment such as gloves and respiratory protection (e.g. N-95 disposable respirator) should be considered to prevent fungal infections in hospital environment.

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