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MOLD CONTAMINANTS IN THE HOSPITAL ENVIRONMENT

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ABSTRACT

INTRODUCTION: In the recent years fungal contaminants in the hospital environments are in rise and taking a critical place in human infectious diseases along with bacteria and virus. Fungi enter in to the hospital from outdoor either through failed HVAC systems or through people entering into the hospital. The aim of the study is to assess and evaluate the environmental colonization of molds in the controlled hospital environments.

MATERIALS AND METHODS: For this prospective, observational study we have chosen 9 operation theatres, 10 intensive care units, one labor room and one CSSD of this hospital. SDA contact plates and swabs streaked on SDA plates were kept for a period of one hour by closing the OT or ICU doors. Plates were incubated for 10 days at 28° ±1°C. The results were expressed as the mean of two plates in colony-forming units per square centimeter (CFU/cm^2).

RESULTS: In this study 53.4% were Cladosporium, 23.9% were Aspergillus 8.18% Fusarium, 7.5% Penicillium, 2.9% Rhizopus, 1.59% Alternaria, 1.19% Curvularia and 0.9% of Sterile mycelium isolates were observed. Highest number of Filamentous fungi CFU was noted in Cath lab and Obstetric and Gynec OT. Among ICUs predominant of CFU were observed in Acute Medical ICU and Cardiac ICU.

CONCLUSION: A contingent measures like regular HVAC systems maintenance and efficiency check, stringent hospital infection control practices adherence and strong visitor policy will help to minimize the risk of infections.

KEY WORDS: Molds, Hospital, Fungi.

INTRODUCTION

In the recent years fungal contaminants in the hospital environments are in rise and taking a critical place in human infectious diseases along with bacteria and virus. Since many years, fungi is widely distributed in the nature. At hospitals fungi are commensal or environmental saprophytic microorganisms, they survive and multiply in damp, moist and unsterile environment like during construction, renovation, or cleaning activities. Pathogenic fungi or Opportunist Fungi are source of infections in immunocompromised/susceptible individuals [1].

Fungal pathogens that have emerged in recent years are from *Candida* sp. (*C. albicans, C. glabrata, C. krusei, C. tropicalis*), *Cryptococcus* sp., *Trichosporon* sp., *Fusarium* sp., *Rhizopus* sp. and *Rhizomucor* sp. [2,3]. Invasive filamentous fungi infections resulting from inhalation of mold conidia or sporangiospores pose a major threat in immunocompromised patients.

Fungi enter in to the hospital from outdoor either through failed HVAC systems or through people entering into the hospital. These Fungi survive on moist and unsterile places, starts to multiply when there is a breach in infection control practices or improper cleaning activities. Fungi multiply on the surfaces and releases more spores in to the hospital environment. The quantity of the spores depends on the number of occupants at hospital, material load at hospital, cleanliness of environment, function of HVAC systems, age of the building, environmental factors like temperature, humidity [4]. Large number of population visits hospitals with varied clinical problems including immunocompromised patients, these spores can spread to patients and cause infections [5]. Infection also occurs through deposition of conidia in sterile anatomical locations during surgical & invasive procedures.

The extent of contamination and the genera of fungi may vary from region to region which depends on the hospital's environment and patient population. It is also important and mandatory to check the ability of air conditioning system at hospitals at a regular basis. Mold contaminants are mainly present on the surface, on ventilation systems of operation

theatres and intensive care units. This study focused on to know the mold genera of fungi commonly noted in our hospital environment where the HVAC system is continuously on to protect the vulnerable and critical patients from infections.

AIM & OBJECTIVES

To assess and evaluate the environmental colonization of molds in the controlled hospital environments.

MATERIALS AND METHODS

Study Design & settings:

This is a prospective observational study conducted during the period of 3 months, ie., from October 2024 to December 2024. The study was planned and implemented by the Department of Microbiology, Government Medical College of Anantapur which is in southern region of India. We adhered to the standard guidelines for the collection of data, study procedure and evaluation of colony count units which help us to achieve the aim of this study.

Methodology:

For this study we have chosen 9 operation theatres, 10 intensive care units, one labor room and one CSSD of this hospital. The 9 operation theatres include gastro, orthopedic, cath lab, obstetric and gynec, ENT, septic, ophthal and Medical operation theatre. The 10 intensive care units are pediatric ICU, Neonatal ICU, Step down Neonatal ICU, obstetric & gynec ICU, nephrology ICU, urology ICU, Medical ICU, Cardiac ICU, neurology ICU, and acute medical ICU. The methodology used for sample collection in these units is Surface sampling or Settle plates.

Surface Sampling:

Surface sampling was carried out by using Sabouraud Dextrose agar with Chloramphenicol media plates as per the recommendations of the European Standard - International Organization for Standardization (EN ISO 14698-1) [6]. Few samples were also collected by sterile swab and sterile saline. Samples were collected from the patient bed head end, infusion pumps, operation table, operation trolleys, ventilator equipment, circuit, bed rails, corner of the room, door knobs, dialysis ports, nursing station, humidifiers, ventilation systems. For each OT minimum of 6 culture plates were used as per the area of each OT.

SDA contact plates were kept in the predetermined locations and kept open. Those were exposed to air for a period of one hour by closing the OT or ICU doors. Settle plates or swabs streaked on SDA plates were incubated for 10 days at 28° ±1°C. The results were expressed as the mean of two plates in colony-forming units per square centimeter (CFU/cm^2).

Fungal Identification:

Identification of Filamentous fungi isolates was done based on the observation of macroscopic and microscopic morphological features. Macroscopically the form of fungus, color of fungus in both obverse and reverse was performed. The microscopic analysis was performed by lactophenol cotton blue-stained slides.

Data Collection: The data collected was entered in Microsoft excel sheet and the results were analyzed and tabulated.

RESULTS

On assessment of mold contaminants in the controlled hospital environment, the predominance of Cladosporium (53.4%) and Aspergillus (23.9%) were noted followed by other filamentous fungi. (Table 1).

In this study 53.4% were Cladosporium, 23.9% were Aspergillus 8.18% Fusarium, 7.5% Penicillium, 2.9% Rhizopus, 1.59% Alternaria, 1.19% Curvularia and 0.9% of Sterile mycelium isolates were observed. Highest number of Filamentous fungi CFU was noted in Cath lab and Obstetric and Gynec OT. Among ICUs predominant of CFU were observed in Acute Medical ICU and Cardiac ICU.

Table 1. Different types of Mold contaminants in controlled environments

Fungi	No. of CFU	Percentage
Cladosporium	268	53.49
Aspergillus	120	23.94
Fusarium	41	8.18
Penicillium	38	7.58
Rhizopus	15	2.99

Alternaria	8	1.59
Curvularia	6	1.19
Sterile mycelium	5	0.99

DISCUSSION

Fungal infections are becoming a health problem in both community and hospital level. Treatment of fungal infections is a highly challenging task for clinicians due to high cost of medications, non availability of medicines, long duration of therapy. Worldwide one of the most common cause of blood stream infections is Candidemia, Candida spp is a yeast like organism responsible for blood stream yeast infections and also source of nosocomial infection in hospitalized patients with medical and surgical procedures [7]. Mold fungi including Aspergillus, Mucorales, Fusarium, Scedosporium usually responsible for infections in patients with comorbidities such as diabetes mellitus, chronic obstructive pulmonary disease, HIV, those on high steroid usage, prolonged neutropenia, hematological malignancies and those admitted in intensive care unit with debilitating illness [8-10]. Patients with diabetes mellitus are highly susceptible to Mucorales infection, even during COVID-19 period this mucorales made a big impact on diabetes mellitus patients due to vanish of immune system by SARS CoV-2 virus [11].

In this study 53.4% were Cladosporium, 23.9% were Aspergillus, 8.18% Fusarium, 7.5% Penicillium, 2.9% Rhizopus, 1.59% Alternaria, 1.19% Curvularia and 0.9% of Sterile mycelium isolates were observed in this study. In line with this study Pini G et al [12] and Kim KY et al [13] observed Cladosporium as a most common fungal species. Caggiano G et al [14] did a similar study, among 402 CFU isolates, *Aspergillus* spp. was the most frequently recovered (369/402 CFU; 91.8%), followed by *Penicillium* spp., (24/402 CFU; 6%), *Paecilomyces* spp. (6/402 CFU; 1.5%), *Zygomycetes* (2/402 CFU; 0.5%), and *Cladosporium* spp. (1/441 CFU; 0.2%). A study from Malaysia [15] also reported the same pathogens predominance in similar to this study i.e., Aspergillus, Cladosporium and Penicillium. Few other studies are also reported the almost same filamentous fungal pathogens as most significantly isolated [16-19].

Highest number of Filamentous fungi CFU was noted in Cath lab and Obstetric and Gynec OT. Among ICUs predominant of CFU were observed in Acute Medical ICU and Cardiac ICU in the present study. Caggiano G et al [14] observed the AFLs varied from 2 to 47 CFU/m^3 in the controlled environments and from 0 to 61 CFU/m^3 in operating theaters, with the highest value reached during surgical procedures. A study from Malaysia [15] did a study in both wards and controlled environments like OT and ICU. So they found most number of the fungi species in the hospital general area (18.3%) and in wards (16.8%). Other locations in descending order were others department, emergency department, ICU, labour room, operating theatre, NICU and laboratory. Rostami et al [20] noted higher incidents of contamination by various fungi were found in all wards, indoor air in the haematology ward was the most infected. In outdoor air, the ear, nose and throat (ENT) department had the highest fungal pollution. Luksamijarulku et al [21] found the average and standard deviation of fungal counts found in four hospital laboratories were 500.8 ± 64.2 CFU/m^3, 425.0 ± 21.2 CFU/m^3, 357.0 ± 121.2 CFU/m^3 and 355.7 ± 86.8 CFU/m^3 respectively. Osman et al [22] documented that airborne environmental fungi concentrations for indoors and outdoors were in the range of 11.7–566.5 CFU/m^3 and 35–664 CFU/m^3 respectively. Araujo et al [23] noted wards with high efficiency particulate matter (HEPA) filters with positive air flow had significantly lower fungal levels. Pini et al [12] did a study in haematology wards, found extremely low concentrations of *A. fumigatus* in the rooms and corridors and no cases of invasive aspergillosis. More recently, Pokala et al [24] demonstrated a correlation between a high number of airborne fungal spores and cases of invasive aspergillosis in an onco-hematology pediatric ward that underwent building renovations.

CONCLUSION

We conclude that Mold contaminants are still survive in controlled environments during operation hours if there is a breach in hospital infection control practices and reduction in the efficiency of HVAC systems. Most of the fungi genera observed were Aspergillus, Cladosporium, Penicillium. Hospital units with more occupants and more functions had highest colony forming units and those without controlled outdoor air such as wards has highest fungal load. Environment with outdoor air acts as reservoir for conidia or spores in indoor areas. A contingent measures like regular HVAC systems maintenance and efficiency check, stringent hospital infection control practices adherence and strong visitor policy will help to minimize the risk of infections. Fungal contamination and the infection control principles remain the same, however, it is crucial to take proactive measures to prevent fungal infections in hospitals.

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