

INTRODUCTION

Pneumonia is the leading infectious cause of death in developed countries^{1, 2}. Though the fungal cause of pneumonia occupies a minor portion in the immune-competent patients, but it causes a major role in immune-deficient populations.

Fungi may colonize body sites without producing disease or they may be a true pathogen, generating a broad variety of clinical syndromes.

Fungal infections of the lung are less common than bacterial and viral infections and very difficult for diagnosis and treatment purposes. Their virulence varies from causing no symptoms to death. Out of more than 1 lakh species only few fungi cause human infection and the most vulnerable organs are skin and lungs^{3,4}.

RISK FACTORS

Workers or farmers with heavy exposure to bird, bat, or rodent droppings or other animal excreta in endemic areas are predisposed to any of the endemic fungal pneumonias, such as histoplasmosis, in which the environmental exposure to avian or bat feces encourages the growth of the organism. In addition, farmers and gardeners are at higher risk of acquiring sporotrichosis because of their chance of cuts or puncture wounds while working with soil.

With advances in critical care medicine and introduction of broad-spectrum antibiotics, the incidence of invasive fungal infections in intensive care is on the rise, especially in patients with immunosuppression⁵.

Table 1: Fungi causing Pneumonia

Endemic fungal pneumonia pathogen
Histoplasma capsulatum causing histoplasmosis.
Coccidioides immitis causing coccidioidomycosis.
Blastomyces dermatitidis causing blastomycosis.
Paracoccidioides brasiliensis causing paracoccidioidomycosis
Opportunistic fungal pneumonia pathogen
Candida spp. causing candidiasis
Aspergillus spp. causing aspergillosis
Mucor spp. causing mucormycosis
Cryptococcus neoformans causing cryptococcosis
Zygomycetes

The following risk factors may predispose to develop fungal infections in the lungs⁶

1. Acute leukemia or lymphoma during myeloablative chemotherapy
2. Bone marrow or peripheral blood stem cell transplantation
3. Solid organ transplantation on immunosuppressive treatment
4. Prolonged corticosteroid therapy
5. Acquired immunodeficiency syndrome
6. Prolonged neutropenia from various causes
7. Congenital immune deficiency syndromes
8. Postsplenectomy state
9. Genetic predisposition

EPIDEMIOLOGY OF FUNGAL PNEUMONIA

The incidences of invasive fungal infections have increased during recent decades, largely because of the increasing size of the population at risk. This population includes the patients of cancers of immune cells of the blood, bone marrow, and lymph nodes, and those with human immunodeficiency virus (HIV) infection, as they are immunosuppressed.

The basic pulmonary pathologic process again can be broadly classified as (a) allergic manifestation or (b) actual infection^{5,7}

TLR1 (Toll like receptors) and TLR6 polymorphisms in the recipient have been associated with susceptibility to invasive aspergillosis after allogeneic stem cell transplantation.⁵

The invasive fungal infections (termed mycoses) can be divided into two broad categories: endemic mycoses and opportunistic mycoses (Table 1).

True pathogenic or endemic fungi

The endemic pathogens that most frequently infect healthy individuals. True pathogenic fungi produce a different form in tissue or at 37°C in contrast to mycelial form in culture at 25-30°C. These fungi are referred to as dimorphic fungi and include Histoplasma capsulatum, Blastomyces dermatitidis, Coccidioides immitis, Paracoccidioides brasiliensis, Penicillium marneffeii and Sporothrix schenckii. Fortunately, they are not commonly found in the Indian subcontinent and are natural inhabitants

Table 2: ISHAM Diagnostic Criteria for ABPA

Predisposing conditions (one must be present):
Asthma
Cystic fibrosis (CF)
Obligatory criteria (both must be present):
Aspergillus skin test positivity or detectable IgE levels against <i>Aspergillus fumigatus</i>
Elevated total serum IgE concentration (typically >1000 IU/mL, but if the patient meets all other criteria, an IgE value <1000 IU/mL may be acceptable)
Other criteria (at least two must be present):
Precipitating serum antibodies to <i>A. fumigatus</i>
Radiographic pulmonary opacities consistent with ABPA
Total eosinophil count >500 cells/microL in glucocorticoid-naïve patients (may be historical)

of North and South America. *H. capsulatum* and *B. dermatitidis* have a worldwide distribution.

In India, histoplasmosis and blastomycosis are reported from different states, but *Penicilliosis marneffei* is restricted to Manipur state. There is only one report of systemic sporotrichosis due to *S. schenckii* var. *luriei* and represents the only report from an Asian country^{7,8}. *P. marneffei* is restricted to south-east Asia possibly remaining with its habitat bamboo rats^{9,10}. Along with emergence of AIDS in India, histoplasmosis is increasingly reported.

Opportunistic fungal infections involve ubiquitous fungi and occur predominantly in individuals whose immune systems are compromised. These include species like *Aspergillus*, *Candida*, *Cryptococcus* and *Zygomycetes* (big four).^{6,11} Invasive pulmonary aspergillosis and systemic candidiasis are the most prevalent opportunistic fungal infections. These infections do not follow any particular geographic distribution and are seen with increasing frequency worldwide.

However, recently changes have occurred, and newer pathogens are being recognized especially with the emergence of AIDS. Sometimes, it is not just a single fungus, but rather a combination of fungi i.e. species under *Candida*, *Cryptococcus*, *Pneumocystis*, *Histoplasma*, *Coccidioides*, *Aspergillus* and *zygomycetes*, which may produce concomitant and/or successive opportunistic systemic fungal infections.

Diagnosis of fungal infections

The diagnosis of this disease entity is based on indirect evidences like

- Skin hypersensitivity test
- Serological evidence of raised antibody titre
- Convincing demonstration of fungi from body fluids or tissue specimens.

These are the most common fungal infections in lung in our country-

PULMONARY ASPERGILLOSIS

According to the lung invasion or allergic response of lung to aspergillus species, the pathogenic reactions in human beings can be varied like⁴

- Allergic alveolitis - by inhalation of high density of spores
- Allergic broncho pulmonary aspergillosis (ABPA).
- Aspergilloma - Colonisation in damaged lung parenchyma.
- Invasive Aspergillosis - in immunodeficient individuals.
- Mixed syndromes

ABPA

This is an immune mediated bronchial pathology, manifested in susceptible individual.

Manifestations are haemoptysis and episodic wheezing, mimicking acute asthmatic episode.

Diagnostic criteria of ABPA¹¹

Although not prospectively validated, we favor the following diagnostic criteria proposed by the International Society for Human and Animal Mycology (ISHAM) working group for ABPA that simplify prior diagnostic schema (Table 2):

Stages of ABPA^{4,13-15}

- acute stage
- stage of remission
- stage of exacerbation
- stage of steroid dependent asthma
- stage of fibrosis

RADIOLOGICAL PICTURE^{4,16-18}

Chest Xray

Massive areas of consolidation

Inflamed vascular and bronchial walls (Tram line shadows)

Blocked bronchi with fungal debris (Tooth paste shadows) & gloved finger appearance)

Ring shadows (Bronchiectasis)

Parenchymal appearance (Nodular shadows)

Local areas of atelectasis & emphysema

CT scan bronchogram:

Hallmark is proximal bronchiectasis with distal sparing.

Management of ABPA^{16,19,20}

Steroid and Antifungal (Itraconazole or Amphotericin B).

Steroid is used in acute phase with tapering dose till the resolution.

Typically resolution has been defined as-

1. Control of asthmatic attacks
2. Reduction of IGE level more than 35% with reduction of peripheral eosinophilia
3. Disappearance of pulmonary opacities

Aspergilloma⁴

Growth of aspergillus fungal ball inside pre existing pulmonary cavities (e.g. TB, sarcoid, cavities in RA). Clinical features are characterised by-

Recurrent Hemoptysis with recurrent respiratory tract infection.

Diagnosis: confirmed by

Chest X ray-mass within cavity with air crescent level on the top, especially in upper lobe (Monods sign)

Positive precipitin test to Aspergillus antigen

Demonstration of fungal hyphae in respiratory secretions or from tissue specimen.

Raised IgE levels.

Treatment

Only observations for asymptomatic individuals and interventions like bronchial artery embolisation & surgical resection, radiotherapy, systemic antifungal for rest of the patients.

Invasive Aspergillosis^{4,16,21}

It is the dissemination of the fungus aspergillus especially in immune-compromised host by invasion into viable tissue or blood vessels. Clinically characterized by tracheitis, bronchitis and pneumonia.

Diagnosis is confirmed by Chest X-ray (round pneumonia, cavitations) & by broncho alveolar lavage.

Treatment is systemic antifungal drugs (Amphotericin B).

Chronic necrotising Aspergillosis

It is intermediate form of aspergilloma in immune-competent patients.

Pulmonary Candidiasis^{16,22}

Opportunistic fungal infections especially in immune-compromised patients, like old mal nourished diabetic patients or in patients with prolonged steroid therapy.

For last 2 decades, there is a change in the distribution of *Candida* spp. causing

nosocomial infections frequently a life threatening complication in patients admitted in ICUs and emerging species are *C. tropicalis*, *C. glabrata*, *C. parapsilosis*, *C. krusei*, and *C. lusitanae*.

Diagnosis is by demonstration of fungus by fibre optic bronchoscopy.

Treatment is by systemic antifungals like ketoconazole, fluconazole and amphotericin B.

Pneumocystis jiroveci Pneumonia^{23,24}

Pneumocystis is a unicellular fungus.

Pneumocystis jiroveci pneumonia (PJP), previously known as *Pneumocystis carinii* pneumonia (PCP), is still the most common opportunistic infection in HIV positive patients, though the incidence is decreasing.

Before the widespread use of prophylaxis for *P. jiroveci* pneumonia (PJP), the frequency of *Pneumocystis* infection in lung transplant patients and HIV patients before starting HAART was very high.

The taxonomic classification of the *Pneumocystis* genus was debated and previously thought to be a protozoan but biochemical analysis of the nucleic acid composition of *Pneumocystis* rRNA and mitochondrial DNA identified it as a unicellular fungus rather than a protozoan.

Symptoms of PJP includes progressive exertional dyspnea, fever, nonproductive cough, chest discomfort

The physical examination findings of PJP are nonspecific and includes tachypnea, tachycardia, and pulmonary symptoms are few mild crackles and rhonchi but otherwise normal findings

Diagnosis is done from chest x-ray CT scan thorax, induced sputum by hypertonic saline, broncho alveolar lavage or from tissue specimen. Sputum induction is the quickest and least-invasive method

Though it is fungal pneumonia, *P. jiroveci* pneumonia (PJP) does not respond to antifungal treatment. The treatment of choice is TMP-SMX, with second-line agents including pentamidine, dapsone, pyrimethamine, or atovaquone.

Pulmonary mucormycosis⁴

Occurs specially in immunocompromised and diabetic patients by granulomatous invasion into upper airways and sinuses with high mortality rate.

Pulmonary Cryptococcosis⁴

Invasive fungal pneumonia of immunocompromised patients from avian excreta through aerosols.

Other invasive pulmonary mycoses which are not very common in our country are histoplasmosis, coccidioidomycosis and para coccidioidosis occurs mainly in laboratory workers, diagnosed by atypical pneumonia with demonstration fungi from broncho alveolar lavage or precipitin tests. Treatment is systemic antifungals.

CONCLUSION

Incidence of fungal pneumonia is increasing in not only immune-deficient but also in immune-competent patients. Though it is very difficult to diagnose fungal pneumonia by routine investigations, but it should be kept in mind that the known risk factors, history & clinical profile and early treatment may help to prevent significant morbidity and mortality also.

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