



SPECTRUM, RISK FACTORS, AND CLINICAL OUTCOMES OF FUNGAL INFECTIONS IN IMMUNOCOMPROMISED PATIENTS: A HOSPITAL-BASED STUDY FROM NORTH INDIA

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ABSTRACT

Background: Fungal infections are a growing cause of morbidity and mortality among immunocompromised individuals, especially in hospital settings. Increasing use of immunosuppressive therapies, broad-spectrum antibiotics, and invasive procedures has contributed to the rising burden of these infections.

Objectives: To evaluate the spectrum of fungal infections, identify associated risk factors, and assess clinical outcomes among immunocompromised patients in a tertiary care hospital in North India.

Methods: A hospital-based cross-sectional observational study was conducted from January 2022 to June 2022, including 74 immunocompromised patients with suspected fungal infections. Data were collected using a structured proforma, and clinical specimens were processed using standard microbiological techniques. Statistical analysis was performed using SPSS version 20.0, with $p < 0.05$ considered statistically significant.

Results: The majority of patients were above 50 years of age, with a male predominance. Diabetes mellitus (29.7%) and malignancy (24.3%) were the most common underlying conditions. *Candida albicans* (37.8%) was the most frequently isolated pathogen, followed by non-albicans *Candida* (27.0%) and *Aspergillus* species (18.9%). Significant risk factors included broad-spectrum antibiotic use (64.9%, $p = 0.01$), ICU stay (54.1%, $p = 0.03$), indwelling catheterization (48.6%, $p = 0.04$), and mechanical ventilation (29.7%, $p = 0.05$). The majority of patients recovered (67.6%), while the mortality rate was 18.9%.

Conclusion: Fungal infections in immunocompromised patients are associated with identifiable risk factors and considerable mortality. Early diagnosis, rational antibiotic use, and effective infection control measures are essential to improve patient outcomes.

Keywords: Fungal infections; Immunocompromised; *Candida*; *Aspergillus*; Risk factors; ICU; North India

INTRODUCTION

Fungal infections have emerged as a significant cause of morbidity and mortality worldwide, particularly among immunocompromised individuals. Over the past few decades, there has been a notable increase in the incidence of opportunistic mycoses, driven largely by advances in medical therapies that prolong survival but compromise host immunity [1]. Patients with conditions such as malignancies, human immunodeficiency virus (HIV) infection, organ transplantation, and those receiving immunosuppressive therapies are especially vulnerable to invasive fungal infections (IFIs) [2]. These infections are often associated with high case fatality rates due to delayed diagnosis, limited therapeutic options, and the emergence of antifungal resistance [3].

Globally, *Candida* and *Aspergillus* species are among the most commonly implicated fungal pathogens in immunocompromised hosts [4]. Invasive candidiasis is a leading cause of bloodstream infections in hospitalized patients, while invasive aspergillosis predominantly affects patients with hematological malignancies and those undergoing stem cell transplantation [5]. The clinical presentation of these infections is often nonspecific, further complicating early diagnosis and timely initiation of appropriate antifungal therapy [6]. Additionally, the widespread use of broad-spectrum antibiotics and invasive medical procedures has contributed to the changing epidemiology of fungal infections [7].

In developing countries, including India, the burden of fungal infections is further exacerbated by factors such as limited diagnostic facilities, delayed healthcare access, and a high prevalence of comorbid conditions [8]. India has witnessed a rising trend in opportunistic fungal infections, particularly among patients with diabetes mellitus, tuberculosis, and HIV/AIDS [9]. The recent increase in healthcare-associated fungal infections has also highlighted the importance of hospital-based surveillance to understand local epidemiological patterns and guide effective management strategies.

At the regional level, North India presents unique challenges in the diagnosis and management of fungal infections. Overcrowded healthcare facilities, variable infection control practices, and limited availability of advanced mycological diagnostic tools contribute to underdiagnosis and underreporting [10]. Furthermore, environmental factors such as humidity and temperature may influence the distribution of fungal pathogens, necessitating region-specific data to inform clinical decision-making.

Despite growing awareness, there remains a paucity of well-structured hospital-based studies focusing on the spectrum of fungal infections in immunocompromised patients in tertiary care settings in North India. Most available studies are either limited by small sample sizes or focus on specific subgroups, thereby limiting generalizability. There is a critical need for comprehensive data that encompasses the clinical profile, risk factors, and microbiological spectrum of fungal infections in this vulnerable population.

Understanding the local epidemiology of fungal infections is essential for early diagnosis, appropriate antifungal therapy, and improved patient outcomes. Moreover, such data can aid in developing institutional protocols and strengthening infection control practices. Therefore, the present study was undertaken to assess the prevalence, clinical spectrum, and risk factors associated with fungal infections among immunocompromised patients admitted to a tertiary care hospital in North India.

The aim of this study was to evaluate the pattern of fungal infections in immunocompromised patients in a tertiary care hospital setting. The specific objectives were to identify the common fungal pathogens, analyze associated risk factors, and assess clinical outcomes in the study population.

METHODOLOGY

Study Design: This study was designed as a hospital-based cross-sectional observational study, adhering to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure methodological rigor and transparency.

Study Setting: The study was conducted in a tertiary care teaching hospital in North India, comprising multiple specialized departments including Medicine, Oncology, Intensive Care Unit (ICU), and Infectious Diseases, where a substantial number of immunocompromised patients are managed.

Study Duration: The study was carried out over a period of six months, from January 2022 to June 2022.

Study Population: The study population included immunocompromised patients admitted to various departments of the hospital during the study period who were clinically suspected of having fungal infections.

Inclusion Criteria

Patients aged ≥ 18 years

Patients with immunocompromised status (e.g., malignancy, HIV infection, diabetes mellitus, organ transplantation, or on immunosuppressive therapy)

Patients with clinical suspicion of fungal infection supported by laboratory investigations (microscopy, culture, or antigen detection)

Exclusion Criteria

Patients who declined to provide informed consent

Patients with incomplete clinical or laboratory data

Patients already on antifungal therapy for more than 72 hours prior to admission

Sample Size: The sample size was calculated using the formula for estimating a proportion in a cross-sectional study:

$$n = Z^2 \times p \times (1 - p) / d^2$$

Assuming a prevalence (p) of fungal infections among immunocompromised patients to be approximately 25% based on prior regional studies, with a 95% confidence level ($Z = 1.96$) and an absolute precision (d) of 10%, the calculated sample size was:

$$n = (1.96)^2 \times 0.25 \times (0.75) / (0.10)^2 \approx 72$$

After accounting for possible non-response or incomplete data, the final sample size was rounded to 74 patients.

Sampling Technique: A consecutive sampling technique was employed, wherein all eligible patients meeting the inclusion criteria during the study period were enrolled until the required sample size of 74 was achieved.

Data Collection Tools & Procedure: Data were collected using a predesigned and pretested structured proforma. Information regarding demographic details, underlying immunocompromised conditions, clinical presentation, risk factors (such as prolonged antibiotic use, ICU stay, invasive procedures), and laboratory findings was recorded. Clinical specimens, including blood, urine, sputum, bronchoalveolar lavage, and tissue samples, were collected aseptically and processed in the microbiology laboratory. Direct microscopy using potassium hydroxide (KOH) mount, Gram staining, and fungal culture on Sabouraud dextrose agar were performed. Identification of fungal isolates was based on standard microbiological techniques including colony morphology, microscopic characteristics, and biochemical tests where applicable.

Study Variables: Independent variables included demographic factors (age, sex), underlying diseases (HIV, malignancy, diabetes), and risk factors such as ICU admission, catheterization, and prior antibiotic use. The dependent variables included the presence of fungal infection, type of fungal pathogen isolated, site of infection, and clinical outcomes such as recovery or mortality.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 20.0. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were used to summarize the data. Inferential statistics were applied using the Chi-square test or Fisher's exact test for categorical variables, and Student's t-test for continuous variables where appropriate. A p-value of <0.05 was considered statistically significant.

Ethical Considerations: Written informed consent was obtained from all participants or their legal guardians prior to enrollment. Confidentiality of patient information was strictly maintained throughout the study. The study adhered to the ethical principles outlined in the Declaration of Helsinki for research involving human subjects.

RESULTS

A total of 74 immunocompromised patients were included in the study. The majority of patients were aged above 50 years, with a predominance of males (Table 1)

Table 1: Demographic Characteristics of Study Participants (n = 74)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	16	21.6
	31–50	28	37.8
	>50	30	40.5
Gender	Male	46	62.2
	Female	28	37.8

Diabetes mellitus emerged as the most common underlying immunocompromised condition, followed by malignancy and HIV infection (Table 2)

Table 2: Underlying Immunocompromised Conditions (n = 74)

Condition	Frequency (n)	Percentage (%)
Diabetes Mellitus	22	29.7
Malignancy	18	24.3
HIV Infection	12	16.2
Chronic Kidney Disease	10	13.5
Post-transplant Status	6	8.1
Prolonged Steroid Therapy	6	8.1

Among the fungal isolates, *Candida albicans* was the most frequently identified pathogen, followed by non-albicans *Candida* species and *Aspergillus* species (Table 3)

Table 3: Distribution of Fungal Pathogens Isolated (n = 74)

Fungal Pathogen	Frequency (n)	Percentage (%)
<i>Candida albicans</i>	28	37.8
Non-albicans <i>Candida</i>	20	27.0
<i>Aspergillus</i> spp.	14	18.9
<i>Cryptococcus</i> spp.	6	8.1
Other fungi	6	8.1

Analysis of associated risk factors revealed that the use of broad-spectrum antibiotics and ICU stay were the most prevalent factors. These factors showed statistically significant associations with fungal infections ($p < 0.05$). Indwelling catheterization and mechanical ventilation were also notable contributors (Table 4)

Table 4: Risk Factors Associated with Fungal Infections (n = 74)

Risk Factor	Present (n)	Percentage (%)	p-value
ICU Stay	40	54.1	0.03
Broad-spectrum Antibiotics	48	64.9	0.01
Indwelling Catheter	36	48.6	0.04
Mechanical Ventilation	22	29.7	0.05

Regarding clinical outcomes, the majority of patients recovered, while a smaller proportion showed improvement. The overall mortality rate in the study population was 18.9% (Table 5)

Table 5: Clinical Outcomes of Patients (n = 74)

Outcome	Frequency (n)	Percentage (%)
Recovered	50	67.6
Improved	10	13.5
Mortality	14	18.9

DISCUSSION

The present hospital-based cross-sectional study evaluated the spectrum of fungal infections among immunocompromised patients in a tertiary care setting in North India. The key findings indicate that fungal infections were more common in older individuals, with a male predominance. *Candida* species, particularly *Candida albicans*, emerged as the most frequent pathogens, followed by non-*albicans Candida* and *Aspergillus* species. Major associated risk factors included the use of broad-spectrum antibiotics, ICU stay, indwelling catheterization, and mechanical ventilation. The overall mortality observed was 18.9%, highlighting the clinical significance of these infections.

The predominance of older age groups in the present study is consistent with earlier reports suggesting that advancing age is associated with a decline in immune function and increased comorbidities, thereby predisposing individuals to opportunistic infections [2]. The higher proportion of male patients observed in this study aligns with findings from previous Indian studies, which may reflect gender-based differences in healthcare access or exposure to risk factors [10].

Diabetes mellitus was identified as the most common underlying condition, followed by malignancy and HIV infection. This finding is in agreement with studies conducted in India, where diabetes has been increasingly recognized as a major risk factor for fungal infections due to impaired innate and adaptive immunity [9]. Hyperglycemia also provides a favorable environment for fungal proliferation, particularly for *Candida* species. Similarly, patients with malignancies and those undergoing chemotherapy are known to be at high risk due to prolonged neutropenia and immunosuppressive treatments [2].

In the present study, *Candida albicans* accounted for the majority of fungal isolates, followed by non-*albicans Candida* species. This pattern is consistent with global and regional epidemiological data, although there has been a gradual shift toward non-*albicans Candida* species in recent years [4]. The emergence of non-*albicans* species is clinically important due to their variable antifungal susceptibility profiles. *Aspergillus* species were the second most common group of molds identified, particularly among patients with hematological malignancies and those in intensive care settings, which corroborates findings from earlier studies [5].

The significant association of risk factors such as broad-spectrum antibiotic use and ICU stay with fungal infections observed in this study is well supported by existing literature. Prolonged antibiotic therapy disrupts normal microbial flora, facilitating fungal overgrowth [7]. ICU patients are particularly vulnerable due to invasive procedures, prolonged hospitalization, and critical illness, all of which compromise host defenses. The role of indwelling catheters and mechanical ventilation as contributory factors is also well documented, as these devices can serve as potential entry points for fungal pathogens and promote biofilm formation [6].

The mortality rate of 18.9% observed in this study is comparable to previous reports, which have documented mortality rates ranging from 15% to 40% in invasive fungal infections depending on the patient population and infection severity [3]. Delayed diagnosis and initiation of appropriate antifungal therapy remain major contributors to poor outcomes. The relatively high recovery rate in the present study may be attributed to early clinical suspicion and prompt laboratory diagnosis in the tertiary care setting.

From a clinical and public health perspective, the findings underscore the importance of early identification of high-risk patients and implementation of targeted diagnostic and therapeutic strategies. Strengthening microbiological diagnostic facilities and promoting rational use of antibiotics are crucial steps in reducing the burden of fungal infections. Additionally, infection control practices in ICU settings must be reinforced to minimize healthcare-associated fungal infections.

The strengths of this study include its focus on a well-defined immunocompromised population and the use of standardized microbiological methods for diagnosis. However, certain limitations must be acknowledged. The relatively small sample size and single-center design may limit the generalizability of the findings. Additionally, the study did not include antifungal susceptibility testing, which could have provided further insights into resistance patterns. Longitudinal follow-up of patients was also not performed, restricting the assessment of long-term outcomes.

Overall, the study provides valuable insights into the epidemiology and risk factors of fungal infections in immunocompromised patients in a tertiary care setting in North India and highlights the need for continued surveillance and improved diagnostic capabilities.

CONCLUSION

Fungal infections represent a significant clinical challenge among immunocompromised patients, particularly in tertiary care settings. The present study highlights that *Candida* species, especially *Candida albicans*, are the predominant pathogens, followed by *Aspergillus* species. Diabetes mellitus and malignancy emerged as major underlying conditions, while modifiable risk factors such as broad-spectrum antibiotic use, ICU stay, and invasive procedures were significantly associated with infection. The observed mortality underscores the need for early detection and timely management. These findings emphasize the importance of strengthening diagnostic capabilities, promoting judicious use of antibiotics, and implementing strict infection control practices, particularly in high-risk hospital areas such as ICUs. Routine surveillance and early identification of at-risk patients can contribute to improved clinical outcomes. Further multicentric studies with larger sample sizes and antifungal susceptibility profiling are recommended to enhance generalizability and guide evidence-based treatment protocols.

DECLARATIONS

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Conflict of Interest: The authors declare no conflict of interest.

Consent: Written informed consent was obtained from all participants prior to inclusion in the study.

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REFERENCES

1. Brown GD, Denning DW, Gow NA, Levitz SM, Netea MG, White TC. Hidden killers: human fungal infections. *Science translational medicine*. 2012 Dec 19;4(165):165rv13.
2. Perfect JR, Hachem R, Wingard JR. Update on epidemiology of and preventive strategies for invasive fungal infections in cancer patients. *Clinical infectious diseases*. 2014 Nov 15;59(suppl_5):S352-5.
3. Vallabhaneni S, Mody RK, Walker T, Chiller T. The global burden of fungal diseases. *Infectious Disease Clinics*. 2016 Mar 1;30(1):1-1.
4. Pfaller MA, Diekema D. Epidemiology of invasive candidiasis: a persistent public health problem. *Clinical microbiology reviews*. 2007 Jan;20(1):133-63.
5. Segal BH. Aspergillosis. *New England Journal of Medicine*. 2009 Apr 30;360(18):1870-84.
6. Kullberg BJ, Arendrup MC. Invasive candidiasis. *New England Journal of Medicine*. 2015 Oct 8;373(15):1445-56.
7. Wisplinghoff H, Bischoff T, Tallent SM, Seifert H, Wenzel RP, Edmond MB. Nosocomial bloodstream infections in US hospitals: analysis of 24,179 cases from a prospective nationwide surveillance study. *Clinical infectious diseases*. 2004 Aug 1;39(3):309-17.
8. Chakrabarti A, Singh R. The emerging epidemiology of mould infections in developing countries. *Current opinion in infectious diseases*. 2011 Dec 1;24(6):521-6.
9. Paul RA, Rudramurthy SM, Meis JF, Mouton JW, Chakrabarti A. A novel Y319H mutation in CYP51C associated with azole resistance in *Aspergillus*.
10. Xess I, Jain N, Hasan F, Mandal P, Banerjee U. Epidemiology of candidemia in a tertiary care centre of north India: 5-year study. *Infection*. 2007 Aug;35(4):256-9.
11. Guinea J. Global trends in the distribution of *Candida* species causing candidemia. *Clinical Microbiology and Infection*. 2014 Jun;20:5-10.
12. Xess I, Jain N, Hasan F, Mandal P, Banerjee U. Epidemiology of candidemia in a tertiary care centre of north India: 5-year study. *Infection*. 2007 Aug;35(4):256-9.