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Original Research Article

Clinicomycological Profile of Invasive Fungal Infections in Intensive Care Unit (ICU) Patients in tertiary care hospital

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Abstract:

Background: Invasive fungal infections (IFIs) represent a significant cause of morbidity and mortality among patients admitted to intensive care units (ICUs). The increasing use of broad-spectrum antibiotics, invasive devices, prolonged hospitalization, and underlying immunosuppression has contributed to a rising incidence of IFIs. Early diagnosis based on laboratory evaluation is essential for timely management and improved clinical outcomes.

Aim: To assess the laboratory profile, fungal pathogen distribution, and clinical outcomes of invasive fungal infections in critically ill ICU patients.

Methodology: A hospital-based observational study was conducted over a period of six months in the ICU of Patna Medical College and Hospital. Seventy patients aged 18 years and above with confirmed invasive fungal infections were included. Clinical specimens such as blood, sterile body fluids, and tissue samples were processed for fungal culture and species identification using standard mycological methods. Demographic details, clinical risk factors, and patient outcomes were recorded and analyzed using SPSS version 27.

Results: Most patients were male (60%), with the highest proportion belonging to the 41–60-year age group (41.4%). Prior antibiotic therapy (71.4%) and central venous catheterization (54.3%) were the most frequently observed risk factors. Candida species were the predominant pathogens, particularly Candida albicans (35.7%) and Candida tropicalis (17.1%), followed by Aspergillus species (22.9%). Recovery was observed in 71.4% of patients, while the mortality rate was 20%.

Conclusion: Candida species were the leading cause of IFIs in ICU patients. Early laboratory identification and clinicomycological profiling play a crucial role in improving patient outcomes.

Keywords: Invasive Fungal Infection, ICU, Candida, Aspergillus, Laboratory Profile, Clinicomycological Profile.

Introduction

Invasive fungal infections (IFIs) have emerged as a major cause of morbidity and mortality among critically ill patients admitted to intensive care units (ICUs) [1]. Over the past three decades, the incidence of IFIs has increased substantially, largely due to the growing population of immunocompromised individuals, advances in medical interventions, and prolonged hospital stays requiring the use of broad-spectrum antibiotics and invasive devices such as central venous catheters and mechanical ventilation. A wide range of pathogenic fungi are implicated in these infections, with Candida and Aspergillus species being the most commonly encountered, while members of the Mucorales, Cryptococcus, and other opportunistic fungi are reported less frequently [2]. Critically ill patients are particularly vulnerable to IFIs owing to factors such as severe underlying illnesses, hematological malignancies, organ transplantation, prolonged corticosteroid therapy, neutropenia, and disruption of natural physical barriers like the skin and gastrointestinal tract. In addition, the immune dysregulation associated with critical illness itself—manifested by impaired neutrophil function, lymphocyte dysfunction, and cytokine imbalance—further predisposes patients to fungal invasion and dissemination.

The clinical presentation of IFIs in ICU patients is often nonspecific and may closely resemble bacterial sepsis or other systemic inflammatory conditions, making early diagnosis challenging [3]. Persistent fever despite broad-spectrum antibiotic therapy, hemodynamic instability, respiratory compromise, and multiorgan dysfunction frequently raise

clinical suspicion; however, these features alone are insufficient for definitive diagnosis. Delays in diagnosis and initiation of appropriate management are associated with significantly increased mortality, underscoring the importance of timely detection and accurate identification of the causative fungal pathogens. Laboratory investigations therefore play a pivotal role in the diagnosis and management of IFIs by providing essential information regarding the presence and type of fungal infection and the extent of" systemic involvement.

"Laboratory evaluation of IFIs encompasses both conventional and advanced diagnostic approaches. Culture-based methods continue to serve as the cornerstone of fungal identification, offering direct evidence of infection and enabling precise species-level characterization. Specialized fungal media are routinely employed for processing blood cultures, tissue biopsies, and other sterile body fluids to facilitate the recovery of both fastidious and slow-growing organisms. Nevertheless, culture techniques may exhibit limited sensitivity, particularly in patients who have received prior antifungal therapy, highlighting the need for adjunct diagnostic modalities. Non-culture-based assays that detect fungal cell wall components such as β-D-glucan, mannan, and galactomannan have gained prominence due to their ability to provide early supportive evidence of invasive fungal disease. Furthermore, molecular diagnostic techniques, including polymerase chain reaction (PCR) assays and next-generation sequencing, allow for rapid and highly specific detection of fungal DNA in clinical specimens, thereby facilitating earlier diagnosis and improved clinical outcomes [4].

Beyond pathogen detection, laboratory profiling also includes assessment of host response and organ function. Routine hematological parameters such as complete blood count and differential count may reveal neutropenia or lymphopenia, both of which are recognized risk factors for invasive fungal disease [5]. Biochemical investigations evaluating liver and renal function, inflammatory markers such as C-reactive protein and procalcitonin, and coagulation profiles provide insight into the systemic impact and severity of infection. Although not strictly laboratory-based, imaging modalities complement laboratory findings by aiding in the localization of infection, particularly in pulmonary and central nervous system involvement. Integration of laboratory and clinical parameters into risk assessment tools such as the Candida score or the Asp ICU algorithm further assists in identifying high-risk patients and guiding clinical decision-making.

Despite advances in diagnostic modalities, the management of IFIs in ICU settings remains challenging. The diversity of fungal pathogens, variable host immune responses, and complexities inherent to critically ill patients can complicate interpretation of laboratory findings [6]. Emerging pathogens such as Candida auris have added to the global burden of IFIs and emphasize the importance of accurate and timely laboratory identification. Additionally, the need for invasive sampling procedures, specialized laboratory infrastructure, and associated costs may limit comprehensive diagnostic evaluation in resource-constrained settings. Ongoing research efforts are therefore focused on improving the sensitivity, specificity, and rapidity of diagnostic techniques, developing point-of-care assays, and standardizing laboratory protocols for IFI detection and monitoring in critically ill populations.

In summary, the laboratory profile of invasive fungal infections in ICU patients represents a crucial component in the diagnosis and clinical management of these life-threatening conditions. A comprehensive laboratory approach that integrates culture-based methods, non-culture assays, molecular diagnostics, and host response assessment is essential for timely pathogen identification and improved patient outcomes. Strengthening laboratory capabilities and effectively" integrating laboratory data with clinical assessment remain key strategies in reducing morbidity and mortality associated with IFIs in intensive care settings.

Methodology

Study Design: This research was structured as a hospital-based observational study with the goal of assessing the laboratory profile of invasive fungal infections (IFIs) in patients who were admitted to the intensive care unit (ICU). The main objective of the study was to determine the fungal pathogens, their geographical distribution, the antifungal resistance patterns and the clinical features related to Fungal infections in severely ill patients. The observational setup permitted the systematic gathering of microbiological and clinical data while at the same time, the patient management process was not disturbed.

Study Area: Patna Medical College and Hospital, Patna, Bihar, India, was the location of the study, which took place in the Department of Microbiology.

Study Duration: The study was conducted over six months from March 2025 to August 2025, during which all eligible ICU patients were enrolled consecutively.

Study Participants: The study included critically ill patients admitted to the ICU who met the inclusion criteria.

Inclusion Criteria

- Patients aged 18 years and above.
- Patients admitted to the ICU with clinical suspicion of invasive fungal infection.

- Patients who developed signs and symptoms suggestive of invasive fungal infection (IFI) during their ICU stay.
- Patients with documented evidence of fungal growth in blood, sterile body fluids, or deep tissue samples.

Exclusion Criteria

- Patients below 18 years of age.
- Patients with superficial fungal infections without systemic involvement.
- Individuals who declined consent.
- Patients transferred from other hospitals with incomplete microbiological data.

Sample Size: A total of 70 patients meeting the inclusion criteria were enrolled in the study. The sample size was determined based on previous institutional data on the prevalence of IFIs in ICU patients and feasibility within the study duration.

Procedure: At the time of enrollment, detailed demographic and clinical data were recorded, including age, gender, comorbidities, duration of ICU stay, prior antibiotic or antifungal use, presence of invasive devices such as central venous catheters, requirement of mechanical ventilation, and administration of corticosteroids.

Under strict aseptic precautions, clinical specimens including blood, bronchoalveolar lavage, urine, and other sterile body fluids or tissue samples were collected. All samples were processed in the microbiology laboratory using standard mycological techniques. Cultures were performed on Sabouraud dextrose agar with chloramphenicol and incubated at both 28°C and 37°C for up to 15 days.

Yeast isolates were identified based on colony morphology, Gram staining, and biochemical tests such as sugar assimilation profiles, while filamentous fungi were identified by their macroscopic colony characteristics and microscopic morphology using lactophenol cotton blue mounts. The identified fungal isolates were correlated with clinical findings to establish the diagnosis of invasive fungal infection. Clinical outcomes including recovery, duration of ICU stay, and mortality were documented to assess disease progression and patient prognosis.

Statistical Analysis: The data that were collected were first recorded in Microsoft Excel and then analyzed using SPSS software version 27.0. Continuous variables were either reported as mean ± standard deviation or median with interquartile range according to their distribution, while categorical variables were represented by frequencies and percentages. The comparisons among groups were done by means of Student's t-test for normally distributed data, Mann–Whitney U test for non-parametric data, and Chi-square or Fisher's exact test for categorical variables. Logistic regression analysis was performed in order to determine the factors associated with particular fungal pathogens. A p-value of <0.05 was accepted as statistically significant.

Result

The demographic characteristics of the 70 study participants are given in Table 1. The age distribution revealed that the overwhelming majority of the participants, 41.4% were in the age range of 41 to 60 years, followed by 32.9% of participants who were older than 60 years, the youngest group of 18-40 years accounted for the remaining 25.7% of the sample. In terms of gender, there was a majority of males with 60% of the participants, while females accounted for 40%, demonstrating that the study population had a greater male representation.

Table 1: Demographic Characteristics of Study Participants (n = 70)

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
18–40	18	25.7
41–60	29	41.4
>60	23	32.9
Gender		
Male	42	60
Female	28	40

The distribution of clinical risk factors across the 70 participants of the study is shown in Table 2. Prior antibiotic therapy, which was the most common risk factor, was seen in 50 participants (71.4%), and then the presence of central venous catheter in 38 participants (54.3%) came next. Mechanical ventilation was observed in 31 participants (44.3%), while 20 participants (28.6%) were on corticosteroid therapy. Total parenteral nutrition was the minimum risk factor reported, having been seen in 15 participants (21.4%). The results suggest that prior antibiotic exposure and invasive procedures like CVC insertion and mechanical ventilation were the major clinical risk factors in this group.

Table 2: Clinical Risk Factors Among Study Participants (n = 70)		
Risk Factor	**Frequency (n)**	**Percentage (%)**
Central Venous Catheter (CVC)	38	54.3
Mechanical Ventilation	31	44.3
Corticosteroid Therapy	20	28.6
Total Parenteral Nutrition (TPN)	15	21.4
Prior Antibiotic Therapy	50	71.4

Table 3 shows the distribution of fungal species that were isolated from 70 patients in the ICU. Among the isolates, Candida albicans was the most commonly identified species, which made up 25 cases (35.7%). It was followed by Candida tropicalis with 12 cases (17.1%) and Aspergillus fumigatus with 10 cases (14.3%). The other mentioned species were Aspergillus flavus in 6 patients (8.6%), Candida glabrata in 5 patients (7.1%), and Mucor species in 4 patients (5.7%). Fusarium species represented the least common group since they were only found in 3 patients (4.3%). However, the mixed fungal infections were seen in 5 patients (7.1%). This distribution exhibits the dominance of Candida species among the ICU patients while there was also a considerable number of Aspergillus and other opportune fungi.

Table 3: Distribution of Fungal Species Isolated from ICU Patients (n = 70)		
Fungal Species	**Frequency (n)**	**Percentage (%)**
Candida albicans	25	35.7
Candida tropicalis	12	17.1
Candida glabrata	5	7.1
Aspergillus fumigatus	10	14.3
Aspergillus flavus	6	8.6
Mucor species	4	5.7
Fusarium species	3	4.3
Mixed infections	5	7.1

The clinical outcomes of ICU patients diagnosed with invasive fungal infections (IFI) are presented in Table 4. Among the 70 patients included in the study, the majority, 50 patients (71.4%), successfully recovered and were discharged from the ICU. However, 14 patients (20%) succumbed to their illness, reflecting a notable mortality rate associated with IFI in critically ill patients. Prolonged ICU stays exceeding 10 days were observed in 21 patients (30%), indicating the severity and complexity of managing these infections. Additionally, recurrent or persistent infections occurred in 5 patients (7.1%), highlighting the challenge of complete eradication and the potential for relapse in this population.

Table 4: Clinical Outcomes of ICU Patients with IFI		
Outcome	**Frequency (n)**	**Percentage (%)**
Recovered / Discharged	50	71.4
Mortality	14	20
ICU Stay >10 days	21	30
Recurrent / Persistent Infection	5	7.1

Discussion

The present study demonstrates that invasive fungal infections (IFIs) in ICU patients predominantly affect middle-aged and elderly individuals. This age distribution is consistent with earlier reports suggesting that advancing age is an important predisposing factor for IFIs due to immunosenescence and the higher burden of comorbid conditions. Leroy et al. (2009) reported significantly higher rates of candidemia among patients aged over 60 years, attributing this to declining immune function and increased exposure to invasive procedures and broad-spectrum antibiotics (Dimopoulos et al., 2008; Leroy et al., 2009) [7,8]. Similarly, Horasan et al. (2010) [19] observed a substantial proportion of elderly patients among critically ill individuals with candidemia, reinforcing age as a key risk factor. The male predominance observed in the present study (60%) is also in agreement with findings from other ICU-based investigations, where male gender has been reported more frequently among IFI patients, possibly reflecting differences in comorbidities, occupational exposure, and health-seeking behavior (Bougnoux et al., 2008) [10].

The analysis of clinical risk factors revealed that prior antibiotic therapy, central venous catheterization, and mechanical ventilation were the most common predisposing factors for IFIs in the studied

cohort. These observations are well supported by previous literature. Pittet et al. (1994) [11] highlighted the role of broad-spectrum antibiotics in promoting Candida colonization, thereby increasing the risk of subsequent invasive infection. Subsequent studies, including that by Jordà-Marcos et al. (2007) [12], further emphasized that antibiotic exposure and the use of central venous catheters significantly increase the likelihood of candidemia in ICU patients. Invasive devices compromise host defense mechanisms and provide surfaces for fungal adherence and biofilm formation, thereby facilitating invasion. The relatively lower prevalence of total parenteral nutrition and corticosteroid use in the present study compared to some other reports may reflect differences in ICU practices and treatment protocols. Chow et al. (2008) [13] reported a stronger association between total parenteral nutrition and Candida parapsilosis infections, underscoring institutional variations in risk factor distribution.

The microbiological profile observed in this study confirms the predominance of Candida species as the leading cause of invasive fungal infections in ICU settings. Candida albicans remained the most frequently isolated species, followed by Candida tropicalis, findings that are consistent with long-standing epidemiological data identifying Candida as the principal pathogen in critically ill patients. Dimopoulos et al. (2008) also reported Candida species as the dominant etiological agents in ICU-associated IFIs. However, an increasing contribution of non-albicans Candida species has been documented globally. Trofa et al. (2008) [14] described the growing importance of non-albicans Candida species in hospital environments; a trend also reflected in the present study. The relatively higher prevalence of Candida tropicalis compared to Candida glabrata highlights geographical variation in species distribution, which has been reported in several regional studies.

A notable proportion of filamentous fungi, particularly Aspergillus species, was also identified in the present study. The isolation of Aspergillus fumigatus and Aspergillus flavus underscores the emerging importance of invasive aspergillosis in ICU patients, even in the absence of classical immunosuppressive conditions. Earlier ICU-based studies reported lower mold prevalence; however, more recent investigations suggest a rising burden of invasive aspergillosis among critically ill patients (Meersseman & Van Wijngaerden, 2007) [15]. Russo et al. (2011) [16] emphasized the aggressive nature and diagnostic challenges associated with invasive aspergillosis, which contribute to adverse clinical outcomes.

Clinical outcome analysis in the present study revealed a recovery rate of 71.4% and a mortality rate of 20%, reflecting the serious nature of IFIs in critically ill patients. These findings fall within the wide range of mortality rates reported in the literature. Bougnoux et al. (2008) documented mortality rates of up to 30–40% among ICU patients with invasive fungal infections, particularly in cases involving mold pathogens. The relatively lower mortality observed in this study may be attributed to early laboratory detection and supportive ICU management. Nevertheless, the prolonged ICU stay observed in 30% of patients highlights the substantial clinical and economic burden associated with IFIs. Similar observations were reported by Jordà-Marcos et al. (2007), who noted that invasive candidiasis significantly increases ICU length of stay and healthcare costs.

Overall, the findings of the present study are consistent with both historical and contemporary reports on invasive fungal infections in ICU settings. Advancing age, prior antibiotic exposure, and invasive procedures remain the most significant risk factors, while Candida species continue to predominate as the principal pathogens, alongside an increasing recognition of Aspergillus infections. These results emphasize the importance of early clinicomycological diagnosis, continuous surveillance, and timely clinical intervention to improve outcomes in critically ill patients with invasive fungal infections.

Conclusion

Invasive fungal infections in ICU patients predominantly affected middle-aged and elderly males, with prior antibiotic exposure and the use of invasive devices such as central venous catheters and mechanical ventilation identified as the most significant predisposing factors. Candida species, particularly Candida albicans and Candida tropicalis, were the most frequently isolated pathogens, followed by Aspergillus and other opportunistic fungi. Although the majority of patients recovered, a considerable proportion experienced mortality and prolonged ICU stay, highlighting the severity of these infections in critically ill individuals. The findings emphasize the importance of timely clinicomycological diagnosis and comprehensive laboratory profiling for early identification of invasive fungal infections. Continuous surveillance and prompt clinical intervention are essential to reduce morbidity, mortality, and healthcare burden associated with invasive fungal infections in the intensive care setting.

References

1. Sipsas NV, Kontoyiannis DP. Invasive fungal infections in patients with cancer in the Intensive Care Unit. International journal of antimicrobial agents. 2012 Jun 1;39(6):464-71.
2. Mavor AL, Thewes S, Hube B. Systemic fungal infections caused by Candida species: epidemiology, infection process and virulence attributes. Current drug targets. 2005 Dec 1;6(8):863-74.
3. Peri AM, Stewart A, Hume A, Irwin A, Harris PN. New microbiological techniques for the

diagnosis of bacterial infections and sepsis in ICU including point of care. Current Infectious Disease Reports. 2021 Aug;23(8):12.
4. Song N, Li X, Liu W. Metagenomic next-generation sequencing (mNGS) for diagnosis of invasive fungal infectious diseases: a narrative review. Journal of Laboratory and Precision Medicine. 2021 Oct 30;6.
5. Safdar A, Armstrong D. Infections in patients with hematologic neoplasms and hematopoietic stem cell transplantation: neutropenia, humoral, and splenic defects. Clinical infectious diseases. 2011 Oct 15;53(8):798-806.
6. Arastehfar A, Gabaldón T, Garcia-Rubio R, Jenks JD, Hoenigl M, Salzer HJ, Ilkit M, Lass-Flörl C, Perlin DS. Drug-resistant fungi: an emerging challenge threatening our limited antifungal armamentarium. Antibiotics. 2020 Dec 8;9(12):877.
7. Dimopoulos G, Falagas ME. Selection for Candida Non-albicans spp. After Fluconazole Use. Anesthesia & Analgesia. 2008 Dec 1;107(6):2091-2.
8. Leroy O, Gangneux JP, Montravers P, Mira JP, Gouin F, Sollet JP, Carlet J, Reynes J, Rosenheim M, Regnier B, Lortholary O. Epidemiology, management, and risk factors for death of invasive Candida infections in critical care: a multicenter, prospective, observational study in France (2005–2006). Critical care medicine. 2009 May 1;37(5):1612-8.
9. Horasan ES, Erso¨zG, Go¨ksu M, et al. Increase in Candida parapsilosis fungemia in critical care units: a 6-years study. Mycopathologia. 2010; 170:263–8.
10. Bougnoux ME, Kac G, Aegerter P, et al. Candidemia and can diduria in critically ill patients admitted to intensive care units in France: incidence, molecular diversity, management and outcome. Intensive Care Med. 2008; 34:292–9.
11. Pittet D, Monod M, Suter PM, et al. Candida colonization and subsequent infections in critically ill surgical patients. Ann Surg. 1994; 220:751–8.
12. Jorda`-Marcos R, Alvarez-Lerma F, Jurado M, et al. Risk factors for candidaemia in critically ill patients: a prospective surveil lance study. Mycoses. 2007; 50:302–10.
13. Chow JK, Golan Y, Ruthazer R, et al. Factors associated with candidemia caused by non-albicans Candida species versus Candida albicans in the intensive care unit. Clin Infect Dis. 2008; 46:1206–13.
14. Trofa D, Ga´cser A, Nosanchuk JD. Candida parapsilosis, an emerging fungal pathogen. Clin Microbiol Rev. 2008; 21:606–25.
15. Meersseman W, Van Wijngaerden E. Invasive aspergillosis in the ICU: an emerging disease. Intensive Care Med. 2007;33: 1679–81.
16. Russo A, Falcone M, Vena A, et al. Invasive pulmonary asper gillosis in non-neutropenic patients: analysis of a 14-month prospective clinical experience. J Chemother. 2011; 23:290–4.