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Original Research Article

Retrospective Surveillance of Candidemia: Species Distribution and Antifungal Susceptibility Patterns

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Abstract:

Background: Candidemia is a serious healthcare-associated bloodstream infection with high morbidity and mortality, particularly among critically ill and immunocompromised patients. Changing species epidemiology and rising antifungal resistance necessitate continuous local surveillance.

Aim: To analyze the epidemiology, risk factors, species distribution, antifungal susceptibility patterns, and clinical outcomes of candidemia cases in a tertiary care hospital.

Methodology: A retrospective observational study was conducted on 90 laboratory-confirmed candidemia cases at Department of Microbiology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India. Demographic details, risk factors, Candida species identification, antifungal susceptibility profiles, and clinical outcomes were analyzed using descriptive statistics.

Results: Most patients were aged 41–60 years (34.4%) and admitted to the ICU (57.8%). *Candida albicans* was the most common isolate (37.8%), while non-albicans Candida species collectively predominated. Prolonged antibiotic use (67.8%) and central venous catheterization (53.3%) were major risk factors. Echinocandins and amphotericin B showed high susceptibility (>90%), whereas azole resistance was notable. Recovery occurred in 63.3% of patients, while mortality was 21.1%.

Conclusion: Candidemia remains a life-threatening infection with shifting species patterns and significant azole resistance, underscoring the need for early diagnosis, species identification, and antifungal stewardship.

Keywords: Candidemia, *Candida* species, antifungal susceptibility, echinocandins, bloodstream infection.

Introduction

Candidemia, defined as the presence of Candida species in the bloodstream, represents one of the most serious forms of invasive fungal infections and continues to be a major cause of morbidity and mortality in hospitalized patients worldwide [1]. The incidence of candidemia has increased significantly during the last several decades because medical advancements have created more immunocompromised patients who require treatment. Patients who require intensive care, those who need major surgical procedures, people who take broad-spectrum antibiotics, and patients who have indwelling intravascular devices represent the groups who show increased risk. The need for ongoing monitoring and development of effective treatment methods becomes necessary because current diagnostic methods and antifungal treatments have not reduced the high case-fatality rates and extended hospital stays and rising healthcare expenses associated with candidemia.

Conventionally, Candida albicans has been seen to be the most frequent etiological agent of candidemia [2]. Nonetheless, in recent epidemiological trends, there has been a significant change to non-albicans species of Candida, which include Candida tropicalis, Candida glabrata, Candida parapsilosis, and Candida krusei. Such shift in the distribution of species is of clinical importance because various Candida species are characterized by different levels of virulence and antifungal resistance. Intrinsically resistant species have developed and the rising incidence of acquired resistance has complicated empirical antifungal therapy and species-level identification and susceptibility testing have become essential elements of patient management [3]. Moreover, the geographical differences in the distribution of

species also emphasize the significance of local information to inform the treatment guidelines at the local level.

Candida albicans antifungal resistance has become an increasing problem around the world. The extensive and occasionally unsuitable use of antifungal agents, specifically, azoles, has led to the emergence of resistance mechanisms which include; efflux pumps overexpression, alteration of the target enzymes, and biofilm formation [4]. Other adverse effects associated with resistance to commonly used antifungal drugs are failure to cure, persistent bloodstream infection, and poor clinical outcome. The therapeutic choices have been increased with the introduction of Echinocandins and polyenes but resistance to such agents has also been reported to increase. Surveillance of antifungal resistance trends is consequently necessary to support best treatment decisions and to inhibit the increase of the resistant strains further spread [5].

The timely initiation of proper antifungal treatment and early realization of candidemia is the major determinant of survival in candidemia [6]. Nevertheless, the symptoms of candidemia in the clinic are usually unspecific and not differentiated with bacterial sepsis, which results in delays in diagnosis. The gold standard in diagnosis is blood culture which has a low sensitivity and needs time before identification of species. In this regard, the retrospective studies of candidemia cases are very helpful in revealing the demographics of patients, risk determinants, their clinical outcomes, distribution of species, and the trends in antifungal susceptibility. These types of studies assist in finding the trends that may not be apparent in the individual cases and enable clinicians to determine the efficacy of the current diagnostic and therapeutic strategies.

It is at its best that retrospective studies are done in an environment where there is a limit on the resources available, and it may be impossible to do prospective surveillance. These studies help to study the local epidemiology of candidemia and the impact of this problem on the healthcare systems by exploring available laboratory and clinical data. They are also useful in identifying high-risk groups of patients, frequent predisposing factors, and institutional practices that can potentially affect the rates of infections. Notably, retrospective studies can demonstrate time-related changes in antifungal resistance, which is important to revise the empirical treatment guidelines and the infection control policy.

Candidemia is a particularly challenging problem in developing nations, such as India, because of the congestive healthcare facilities, insufficient diagnostic tools, and inconsistent access to antifungal medications. Research conducted in these environments has shown that there were increased prevalence of non-albicans Candida species and resistance to frequently used antifungals. Effective antifungal stewardship programs can then not be designed without local epidemiological data. The knowledge of institution-related patterns of weaknesses could help clinicians to choose the most effective first therapy, which would result in better patient outcomes and less unnecessary exposure to drugs.

Considering the changing epidemiology of candidemia and increasing risk of antifungal resistance, there is an urgent need to undergo ongoing assessment of candidemia incidences and their susceptibility patterns. Retrospective studies on the incidences of candidemia and antimicrobial susceptibility patterns allow evaluating the current trends in a health facility, discovering new resistant strains, and assessing the suitability of the existing treatment patterns. This data is essential in clinical management optimization, antifungal stewardship initiatives, and, ultimately, decreasing the morbidity and mortality of candidemia.

Methodology

Study Design: The present study was a retrospective observational analysis conducted to evaluate the epidemiology of candidemia and the antifungal susceptibility patterns of Candida species isolated from blood culture–positive patients. Medical records and laboratory data of confirmed candidemia cases were reviewed systematically to assess species distribution and antifungal resistance trends.

Study Area: The study was carried out in the Department of Microbiology, Darbhanga Medical College and Hospital (DMCH), Laheriasarai, Darbhanga, Bihar, India.

Study Duration: The study was conducted over a period of 7 months from March 2025 to September 2025

Study Participants: The study population consisted of hospitalized patients of all age groups who had at least one blood culture positive for Candida species during the defined study period.

Inclusion Criteria

- Patients admitted to DMCH with laboratory-confirmed candidemia
- Patients with at least one positive blood culture for Candida species
- Patients of all age groups and both sexes
- Availability of complete microbiological and antifungal susceptibility data

Exclusion Criteria

- Patients with incomplete clinical or laboratory records
- Duplicate isolates from the same patient with identical species and antifungal profile

- Patients with polymicrobial bloodstream infections where Candida was not the primary isolate
- Repeat positive cultures within two weeks of the same candidemia episode

Sample Size: A total of 90 candidemia cases fulfilling the inclusion criteria were included in the study.

Procedure: The microbiology laboratory records and the hospital medical record section were used as the retrospective source of data. The samples of blood cultures were collected aseptically in patients suspected of having blood infection or belonging to high-risk groups like patients of the intensive care unit, immunodeficient patients, those under persistent antibiotic treatment, and patients with indwelling devices.

An automated blood culture system was used to incubate the blood culture bottles. The positive bottles with fungal growth were subcultured in the right fungal media. The Candida species were identified by the conventional laboratory methods in the form of colony morphology, Gram staining, and identification at species level by the use of Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry (MALDI-TOF MS) where possible.

The antifungal susceptibility test was conducted using the standardized procedures, including the broth microdilution technique, according to the instructions given by the manufacturer as well as the recommended guidelines. The antifungal agents were tested; they were fluconazole, itraconazole, voriconazole, amphotericin B, caspofungin, micafungin, anidulafungin and flucytosine. Minimum inhibitory concentrations were interpreted using the epidemiological cutoff values.

Demographic data, clinical data, risk factors, distribution of Candida species and antifungal susceptibility profile was imported and includes into a structured data collection sheet. The episodes of candidemia were treated as independent variables and duplicates were eliminated to prevent the overrepresentation of the candidemia isolates. Laws concerning patient confidentiality were observed careful and the analysis of data was anonymized before any form of analysis was done.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 27.0. Descriptive statistics were used to calculate frequencies, percentages, means, and standard deviations. Categorical variables were expressed as numbers and percentages. Associations between variables were assessed using appropriate statistical tests such as the chi-square test. A p value of less than 0.05 was considered statistically significant.

Result

Table 1 presents the demographic and clinical characteristics of the 90 study participants. The majority of patients belonged to the 41–60 years age group (34.4%), followed by those aged 18–40 years (28.9%) and above 60 years (23.4%), while a smaller proportion were below 18 years (13.3%). Males constituted a higher percentage of the study population (60%) compared to females (40%). With respect to hospital location, more than half of the participants were admitted to the ICU (57.8%), whereas 42.2% were managed in general wards. Regarding underlying conditions, diabetes mellitus and absence of comorbidity were equally common, each observed in 32.2% of patients, followed by malignancy (20%) and chronic kidney disease (15.6%), indicating a substantial burden of comorbid illnesses among the study population.

Table 1: Demographic and Clinical Characteristics of Study Participants (n = 90)

Variable	Category	Number (n)	Percentage (%)
Age group (years)	<18	12	13.3
	18–40	26	28.9
	41–60	31	34.4
	>60	21	23.4
Gender	Male	54	60
	Female	36	40
Hospital location	ICU	52	57.8
	General wards	38	42.2
Underlying condition	Diabetes mellitus	29	32.2
	Malignancy	18	20
	Chronic kidney disease	14	15.6
	No comorbidity	29	32.2

Table 2 shows the distribution of Candida species isolated from blood cultures among the 90 study subjects, highlighting Candida albicans as the most frequently identified species, accounting for 34 isolates (37.8%). This was followed by Candida tropicalis with 26 isolates (28.9%), indicating a substantial contribution of non-albicans Candida species to bloodstream infections. Candida parapsilosis

was isolated in 14 cases (15.6%), while Candida glabrata constituted 9 isolates (10%). Less commonly isolated species included Candida krusei in 5 cases (5.6%) and Candida auris in 2 cases (2.2%). Overall, the findings demonstrate a diverse species distribution, with non-albicans Candida collectively forming a significant proportion of candidemia cases in the study population.

Table 2: Distribution of Candida Species Isolated from Blood Cultures (n = 90)		
Candida species	**Number (n)**	**Percentage (%)**
Candida albicans	34	37.8
Candida tropicalis	26	28.9
Candida parapsilosis	14	15.6
Candida glabrata	9	10
Candida krusei	5	5.6
Candida auris	2	2.2
Total	**90**	**100**

Table 3 illustrates the distribution of major risk factors associated with candidemia among the study participants, highlighting that prolonged antibiotic use for more than seven days was the most common risk factor, observed in 67.8% of cases. This was followed by ICU stay exceeding five days in 57.8% of patients and the presence of a central venous catheter in 53.3%, emphasizing the role of prolonged hospitalization and invasive procedures in the development of candidemia. Mechanical ventilation was noted in 43.3% of participants, suggesting a substantial association with critical illness. Recent surgery was identified in 30% of cases, while total parenteral nutrition was the least common risk factor, present in 23.3% of patients. Overall, the table underscores that prolonged antibiotic exposure, intensive care–related factors, and invasive medical interventions are key contributors to the risk of candidemia in the studied population.

Table 3: Risk Factors Associated with Candidemia among Study Participants		
Risk factor	**Number (n)**	**Percentage (%)**
Prolonged antibiotic use (>7 days)	61	67.8
Central venous catheter	48	53.3
ICU stay >5 days	52	57.8
Mechanical ventilation	39	43.3
Total parenteral nutrition	21	23.3
Recent surgery	27	30

Table 4 depicts the antifungal susceptibility pattern of 90 Candida isolates, showing varying levels of sensitivity and resistance across different antifungal agents. The highest sensitivity was observed with echinocandins, particularly anidulafungin (97.8%), micafungin (96.7%), and caspofungin (94.4%), indicating their strong efficacy against Candida species. Amphotericin B also demonstrated high sensitivity (91.1%) with minimal resistance. Among azoles, voriconazole showed better activity (76.7% sensitivity) compared to fluconazole (64.4%) and itraconazole (60.0%), which exhibited relatively higher resistance rates. Flucytosine showed moderate effectiveness with 80.0% sensitivity. Overall, the table highlights superior susceptibility of Candida isolates to echinocandins and amphotericin B, while notable resistance was observed with commonly used azole antifungals.

Table 4: Antifungal Susceptibility Pattern of Candida Isolates (n = 90)		
Antifungal agent	**Sensitive n (%)**	**Resistant n (%)**
Fluconazole	58 (64.4)	32 (35.6)
Itraconazole	54 (60.0)	36 (40.0)
Voriconazole	69 (76.7)	21 (23.3)
Amphotericin B	82 (91.1)	8 (8.9)
Caspofungin	85 (94.4)	5 (5.6)
Micafungin	87 (96.7)	3 (3.3)
Anidulafungin	88 (97.8)	2 (2.2)
Flucytosine	72 (80.0)	18 (20.0)

Table 5 shows the clinical outcomes of 90 patients diagnosed with candidemia, indicating that the majority of patients had a favorable outcome. Out of the total study population, 57 patients (63.3%) recovered following treatment, reflecting effective clinical management in nearly two-thirds of cases.

However, persistent infection was observed in 14 patients (15.6%), suggesting ongoing disease despite therapy and highlighting the challenges in complete eradication of infection in a subset of patients. Mortality was reported in 19 patients (21.1%), underscoring the serious and life-threatening nature of candidemia. Overall, while recovery was the most common outcome, a considerable proportion of patients experienced persistent infection or death, emphasizing the need for early diagnosis and optimal treatment strategies.

Table 5: Clinical Outcome of Patients with Candidemia (n = 90)

Outcome	Number (n)	Percentage (%)
Recovered	57	63.3
Persistent infection	14	15.6
Mortality	19	21.1
Total	**90**	**100**

Discussion

The present retrospective analysis highlights candidemia as a significant healthcare-associated bloodstream infection with considerable morbidity and mortality, reflecting trends observed globally. The demographic profile in our study, characterized by a predominance of middle-aged and elderly patients and male preponderance, aligns with earlier reports from India, the Middle East, and Western countries. Pfaller and Diekema (2007) [7] reported that the majority of candidemia cases occurred in adults above 40 years, with males constituting nearly 55–60% of cases, comparable to the male predominance observed in our cohort. Similarly, Barchiesi et al. (2017) [8] documented increased vulnerability among older adults, attributing this to multiple comorbidities and age-related immune dysfunction, which likely contributed to adverse outcomes in our study population.

The ICU predominance observed in the present study is consistent with global epidemiological trends. Epelbaum and Chasan (2017) [9] reported ICU admission rates exceeding 60% among candidemia patients, closely mirroring our findings. Prolonged ICU stay, frequent invasive procedures, and extensive antimicrobial exposure create an ideal milieu for Candida bloodstream invasion. Logan et al. (2020) [10] further emphasized that candidemia incidence in critical care settings is two to three times higher than in general wards, underscoring the importance of targeted surveillance in high-risk units.

Comorbid conditions played a crucial role in the pathogenesis of candidemia in our study. Diabetes mellitus emerged as the most frequent underlying condition, consistent with findings by Guimarães et al. (2012) [11], who reported diabetes in nearly 35–40% of candidemia cases. Chronic kidney disease and malignancy were also common, echoing results from Wang et al. (2014) [12], where renal disease and immunosuppression significantly increased mortality risk. Notably, approximately one-third of patients in our cohort lacked documented comorbidities, supporting observations by Poissy et al. (2020) [13] that invasive candidiasis can develop in patients without classical risk factors, particularly in the context of prolonged hospitalization and invasive medical care.

Species distribution in the present study revealed that Candida albicans remained the single most common isolate; however, non-albicans Candida species collectively predominated. This epidemiological shift has been well documented. Pfaller et al. (2019) [14], through the SENTRY surveillance program, reported non-albicans Candida accounting for nearly 60% of candidemia cases worldwide. The high prevalence of C. tropicalis and C. parapsilosis in our study mirrors trends reported from Asia and Southern Europe. Song et al. (2020) [15] documented C. tropicalis as the leading non-albicans species in China, accounting for over 30% of bloodstream isolates, similar to proportions observed in our data.

The isolation of intrinsically resistant species such as C. glabrata and the emerging pathogen C. auris—although less frequent—carries important clinical implications. Chakrabarti and Sood (2021) [16] highlighted the rapid global spread of C. auris, associating it with healthcare outbreaks and high resistance rates. While the proportion of C. auris in our study was lower than that reported in outbreak-prone regions, its presence signals an urgent need for enhanced infection control and diagnostic vigilance.

Risk factor analysis demonstrated that broad-spectrum antibiotic exposure, central venous catheterization, prolonged ICU stay, and parenteral nutrition were the most consistent predisposing factors. These findings strongly correlate with the prospective case–control study by Poissy et al. (2020), who reported antibiotic exposure in over 90% and CVC use in nearly 85% of candidemia cases. The high frequency of catheter-related risk factors in our cohort supports the biofilm-mediated pathogenesis described in earlier studies, emphasizing the importance of timely catheter removal.

Antifungal susceptibility patterns observed in the present study have significant therapeutic relevance. Echinocandins demonstrated the highest overall susceptibility across Candida species, consistent with

IDSA recommendations and international data. Pfaller et al. (2019) reported echinocandin susceptibility exceeding 95% for most Candida isolates, closely paralleling our findings. In contrast, azole resistance (particularly to fluconazole) was notably higher, especially among non-albicans species. Song et al. (2020) reported fluconazole resistance rates exceeding 40% among C. tropicalis isolates, which is comparable to the reduced susceptibility observed in our study. This trend likely reflects extensive azole use and underscores the need for antifungal stewardship.

Clinical outcomes in our study demonstrated recovery in nearly two-thirds of patients, while mortality remained substantial. Logan et al. (2020) reported global candidemia mortality rates ranging from 30–60%, depending on patient population and timeliness of therapy. Although our mortality rate falls within this range, it reinforces candidemia as a life-threatening infection, particularly in critically ill patients with delayed diagnosis or resistant isolates.

In summary, the present study corroborates global evidence that candidemia is a multifactorial infection predominantly associated with critical care exposure, invasive devices, and shifting species epidemiology. The rising dominance of non-albicans Candida species and declining azole susceptibility emphasize the necessity of routine species identification, antifungal susceptibility testing, and early initiation of appropriate therapy. Strengthening infection control practices, optimizing antimicrobial use, and improving early diagnostic strategies remain pivotal in reducing the burden and mortality of candidemia.

Conclusion

The present study highlights candidemia as a serious healthcare-associated bloodstream infection with substantial morbidity and mortality in a tertiary care setting. A predominance of ICU patients, frequent exposure to prolonged antibiotics, central venous catheterization, and invasive interventions underscores the critical role of hospital-related risk factors. Although Candida albicans remained the most common isolate, non-albicans Candida species collectively constituted a significant proportion, reflecting an ongoing epidemiological shift with important therapeutic implications. Antifungal susceptibility results demonstrated excellent activity of echinocandins and amphotericin B, while reduced susceptibility to azoles was notable, emphasizing the need for cautious empirical therapy. Despite recovery in nearly two-thirds of patients, the observed mortality rate reinforces the life-threatening nature of candidemia. Continuous surveillance, early diagnosis, species-level identification, and robust antifungal stewardship are essential to improve outcomes and reduce the burden of candidemia.

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