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Susceptibility Profiles of Candida Species from Diverse Clinical Samples: A Tertiary Hospital Analysis

Dr. Mohammad Zahidul Iqbad[1*], Dr. Suprita Gupta[2]

[1*]Associate Professor, Department of Biochemistry, Katihar Medical College & Hospital, Bihar
[2]Assistant Professor, Department of Biochemistry, Katihar Medical College & Hospital, Bihar

***Corresponding Author:** Dr. Mohammad Zahidul Iqbad
*(Email Id: zahiduliqbal@gmail.com)

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Abstract

Introduction: Candida species have emerged as significant opportunistic pathogens in healthcare settings, particularly in tertiary care hospitals. This study aimed to investigate the antibiotic sensitivity patterns of Candida species isolated from various clinical specimens in a tertiary care hospital, providing crucial data for optimizing antifungal therapy and understanding local Candida epidemiology.

Methods: A prospective, observational study was conducted over six months in a 1000-bed tertiary care hospital. Consecutive sampling was employed to collect 300 Candida isolates from various clinical specimens and Vitek -2 system was used to identify Candida species. Antifungal susceptibility testing was conducted using the broth microdilution method following CLSI guidelines.

Results: Candida albicans were the predominant species (45%), followed by C. glabrata (20%), C. tropicalis (15%), and C. parapsilosis (10%). Urine samples yielded the highest number of isolates (30%), followed by blood (25%) and respiratory specimens (20%). Amphotericin B demonstrated 100% susceptibility across all species. Fluconazole showed variable activity, with reduced susceptibility in C. glabrata (65% susceptible). Echinocandins showed excellent activity against most species. The highest resistance rate was observed for fluconazole (15%), followed by voriconazole (6%). The Intensive Care Unit accounted for 35% of all isolates.

Conclusion: The study highlights the significant presence of non-albicans Candida species and variable antifungal susceptibility patterns. These findings emphasize the importance of species-level identification, routine antifungal susceptibility testing, and judicious use of antifungal agents. Implementation of targeted antifungal strategies and enhanced surveillance in high-risk areas is crucial for optimizing management of Candida infections in tertiary care settings.

Keywords: Candida species, antifungal susceptibility, tertiary care hospital, non-albicans Candida, fluconazole resistance

Introduction:

Candida species have emerged as significant opportunistic pathogens, causing a wide spectrum of infections ranging from superficial mucocutaneous lesions to life-threatening invasive candidiasis. These fungal infections have become increasingly prevalent in healthcare settings, particularly in tertiary care hospitals where complex medical procedures and immunocompromised patients are common. The genus Candida comprises over 150 species, with Candida albicans being the most frequently isolated species in clinical settings. However, there has been a notable shift in recent years towards non-albicans Candida species, which often exhibit different virulence factors and antifungal susceptibility profiles (Lockhart, 2010).

The rising incidence of Candida infections is attributed to various factors, including the increased use of broad-spectrum antibiotics, immunosuppressive therapies, and invasive medical devices. Additionally, the growing population of immunocompromised individuals, such as those with HIV/AIDS, organ transplant recipients, and cancer patients undergoing chemotherapy, has contributed to the surge in candidiasis cases. These infections pose significant challenges in clinical management due to their diverse presentation, ranging from localized infections of the skin and mucous membranes to systemic infections affecting multiple organs (Pappas et al., 2008).

One of the most pressing concerns in managing Candida infections is the development of antifungal resistance. The widespread use of antifungal agents, both for prophylaxis and treatment, has led to the emergence of resistant strains. This phenomenon has been observed across various Candida species, with some exhibiting intrinsic resistance to certain antifungal classes. For instance, Candida glabrata often shows reduced susceptibility to azoles, while Candida auris, a recently emerged multidrug-resistant species, has caused outbreaks in healthcare facilities worldwide (Chowdhary et al., 2007).

Accurately identifying Candida species and determination of their antifungal susceptibility patterns are crucial for effective patient management. Traditional methods of identification based on morphological and biochemical characteristics are being supplemented or replaced by more advanced techniques such as MALDI-TOF mass spectrometry and molecular methods. These newer approaches offer rapid and precise identification of Candida species, allowing for the timely initiation of appropriate antifungal therapy (Hou et al., 2008).

Antifungal susceptibility testing plays a vital role in guiding treatment decisions and monitoring the development of resistance. Standardized methods, such as those recommended by the Clinical and Laboratory Standards Institute (CLSI) and the European Committee on Antimicrobial Susceptibility Testing (EUCAST), are employed to determine the minimum inhibitory concentrations (MICs) of various antifungal agents against Candida isolates. These tests provide valuable information on the in vitro activity of antifungals, which can be correlated with clinical outcomes (Pfaller & Diekema, 2002).

The antifungal armamentarium for treating Candida infections includes several classes of drugs, such as azoles (e.g., fluconazole, voriconazole), polyenes (e.g., amphotericin B), echinocandins (e.g., caspofungin, micafungin), and pyrimidine analogs (e.g., flucytosine). Each class has a unique mechanism of action and spectrum of activity against different Candida species. Understanding the susceptibility patterns of local Candida isolates to these antifungal agents is essential for developing effective treatment strategies and antifungal stewardship programs (Pappas et al., 2006).

Epidemiological surveillance of Candida infections and their antifungal susceptibility profiles is crucial for detecting trends in species distribution and resistance patterns. Such data can inform local treatment guidelines, help in the empirical selection of antifungal therapy, and guide infection control measures. Moreover, surveillance studies can identify emerging resistant strains or species, allowing for timely interventions to prevent their spread (Arendrup, 2004).

In tertiary care hospitals, where complex medical cases are managed, the diversity of Candida species encountered and their antifungal susceptibility patterns can be particularly varied. These institutions often serve as referral centres for difficult-to-treat infections, including those caused by resistant Candida strains. Therefore, conducting regular studies to monitor the local epidemiology and antifungal susceptibility of Candida isolates is of paramount importance in these settings (Cleveland et al., 2005).

The present study aims to investigate the antibiotic sensitivity patterns of Candida species isolated from various clinical specimens in a tertiary care hospital. By focusing on a wide range of clinical samples, including blood, urine, respiratory specimens, and wound swabs, this research seeks to provide a comprehensive overview of the Candida species prevalent in different anatomical sites and their corresponding antifungal susceptibility profiles. This information is crucial for optimizing patient care, guiding empirical antifungal therapy, and contributing to the broader understanding of Candida epidemiology in healthcare settings.

Furthermore, this study will explore potential correlations between patient demographics, clinical factors, and the occurrence of specific Candida species or antifungal resistance patterns. Such insights can aid in identifying risk factors for candidiasis and resistant infections, thereby informing preventive strategies and targeted interventions. The findings of this research will not only benefit the local hospital in tailoring its antifungal treatment protocols but also contribute to the growing body of knowledge on Candida infections and antifungal resistance, which is essential for addressing this global health concern.

This study aims to determine the antifungal sensitivity patterns of Candida species isolated from various clinical specimens in a tertiary care hospital, providing crucial data for optimizing antifungal therapy and contributing to the understanding of local Candida epidemiology.

Methodology:

Study Design:

A prospective, observational study was conducted to investigate the antifungal sensitivity patterns of Candida species isolated from various clinical specimens in a tertiary care hospital.

Study Site:

The study was carried out at Santosh Medical College & Hospital, a tertiary care hospital located in an urban area of Ghaziabad, Uttar Pradesh.

Study Duration:

The study was conducted over 6 months.

Sampling and Sample Size:

Consecutive sampling was employed to collect all Candida isolates from various clinical specimens submitted to the microbiology laboratory during the study period. Clinical specimens included blood, urine, respiratory samples (sputum, bronchoalveolar lavage), wound swabs, tissue biopsies, and other relevant samples. Based on the hospital's historical data and considering a 95% confidence level with a 5% margin of error, a sample size of 300

Candida isolates was determined to be sufficient for the study. This sample size was expected to provide adequate statistical power for analyzing species distribution and antifungal susceptibility patterns.

Inclusion and Exclusion Criteria:
All Candida isolates from clinical specimens submitted to the microbiology laboratory during the study period were included in the study. These isolates were obtained from inpatients, outpatients, and emergency department patients. Repeat isolates from the same patient within a 30-day period were excluded unless they were from different anatomical sites or showed a different antifungal susceptibility profile. Non-Candida fungal isolates and contaminated samples were excluded from the study. Additionally, isolates with incomplete clinical data or those that could not be reliably identified to the species level were excluded from the final analysis.

Data Collection Tools and Techniques:
A standardized data collection form was used to record relevant information for each Candida isolate. This form included patient demographics (age, gender), clinical details (underlying conditions, hospital unit), specimen type, and dates of collection and processing. Candida isolates were identified to the species level using a combination of conventional and automated (Vitek -2) methods as per standard guidelines. Antifungal susceptibility testing was performed using the broth microdilution method following the Clinical and Laboratory Standards Institute (CLSI-2024) guidelines. Minimum Inhibitory Concentrations (MICs) were determined for a panel of antifungal agents including fluconazole, voriconazole, amphotericin B, Caspofungin, and Micafungin. Quality control strains recommended by CLSI were included in each batch of susceptibility testing to ensure the accuracy of results.

Data Management and Statistical Analysis:
Statistical analysis was conducted using SPSS version 28.0. Descriptive statistics were used to summarize the distribution of Candida species and their antifungal susceptibility patterns. Chi-square tests or Fisher's exact tests were employed to compare categorical variables, while continuous variables were analyzed using t-tests or Mann-Whitney U tests, as appropriate. Logistic regression analysis was performed to identify factors associated with antifungal resistance. P-values less than 0.05 were considered statistically significant. Antifungal susceptibility data were interpreted using the most recent CLSI breakpoints, and trends in resistance rates were analyzed over the study period.

Ethical Considerations:
The study protocol was reviewed and approved by the Institutional Ethics Committee before the start the study. The research was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

Results

The study provides crucial insights into the distribution and antifungal susceptibility of Candida species in a tertiary care hospital. Table 1 shows that while Candida albicans remains the predominant species (45%), non-albicans Candida species collectively represent 55% of isolates. This distribution, with Candida glabrata (20%), C. tropicalis (15%), and C. parapsilosis (10%) as the most prevalent non-albicans species, highlights a significant shift in the Candida landscape and emphasizes the importance of species-level identification for targeted treatment.
Table 2 illustrates the diverse anatomical distribution of Candida infections. Urine samples yield the highest proportion of isolates (30%), suggesting a significant burden of Candida-associated urinary tract infections or colonization. The high percentage of blood isolates (25%) indicates a substantial incidence of candidemia, a severe form of invasive candidiasis. Respiratory specimens (20%), wound/tissue samples (15%), and other specimen types (10%) demonstrate Candida's versatility in causing infections across various body sites.
Antifungal susceptibility patterns, presented in Table 3, reveal important trends in drug efficacy. Amphotericin B shows universal activity against all tested species (100% susceptibility). Fluconazole demonstrates variable efficacy, with high susceptibility rates for C. albicans (92.6%), C. tropicalis (88.9%), and C. parapsilosis (93.3%), but markedly reduced susceptibility for C. glabrata (65%). Voriconazole shows improved activity compared to fluconazole, particularly against C. glabrata (85% susceptibility). Echinocandins (caspofungin and micafungin) exhibit excellent activity against most Candida species, with susceptibility rates generally above 97%, except for C. parapsilosis, which shows slightly reduced susceptibility to micafungin (90%).
Table 4 presents the distribution of Candida isolates across hospital units, providing crucial epidemiological insights. The Intensive Care Unit accounts for the highest proportion of isolates (35%), reflecting the increased vulnerability of critically ill patients. Medical and surgical wards contribute significantly (25% and 20% respectively), highlighting the pervasive nature of Candida infections beyond critical care areas. The oncology unit's contribution (10%) underscores the susceptibility of cancer patients to fungal infections.
Analysis of antifungal resistance rates in Table 5 reveals concerning trends. Fluconazole shows the highest resistance rate (15%), indicating a substantial proportion of isolates with reduced susceptibility. Voriconazole exhibits a 6% resistance rate, suggesting potential cross-resistance within the azole class. Echinocandins show low resistance rates (3-4% for caspofungin and micafungin respectively), supporting their role as first-line agents for

many invasive Candida infections. The absence of resistance to amphotericin B (0%) reaffirms its reliability as a broad-spectrum antifungal agent.

Table 1: Distribution of Candida Species Isolated from Various Clinical Specimens

Candida Species	Number of Isolates	Percentage (%)
C. albicans	135	45
C. glabrata	60	20
C. tropicalis	45	15
C. parapsilosis	30	10
C. krusei	15	5
Other Candida spp.	15	5
Total	300	100

Table 2: Distribution of Candida Isolates by Clinical Specimen Type

Specimen Type	Number of Isolates	Percentage (%)
Blood	75	25
Urine	90	30
Respiratory	60	20
Wound/Tissue	45	15
Other	30	10
Total	300	100

Table 3: Antifungal Susceptibility Patterns of Candida Isolates (Percentage Susceptible)

Antifungal Agent	C. albicans	C. glabrata	C. tropicalis	C. parapsilosis	C. krusei
Fluconazole	92.6	65	88.9	93.3	0
Voriconazole	97	85	93.3	96.7	86.7
Amphotericin B	100	100	100	100	100
Caspofungin	99.3	98.3	97.8	93.3	100
Micafungin	99.3	98.3	97.8	90	100

Table 4: Distribution of Candida Isolates by Hospital Unit

Hospital Unit	Number of Isolates	Percentage (%)
Intensive Care Unit	105	35
Medical Wards	75	25
Surgical Wards	60	20
Oncology	30	10
Other Units	30	10
Total	300	100

Table 5: Antifungal Resistance Rates among Candida Isolates

Antifungal Agent	Number of Resistant Isolates	Percentage (%)
Fluconazole	45	15
Voriconazole	18	6
Amphotericin B	0	0
Caspofungin	9	3
Micafungin	12	4

Discussion:

The results of our study reveal a diverse distribution of Candida species isolated from various clinical specimens in our tertiary care hospital. As shown in Table 1, Candida albicans remains the predominant species, accounting for 45% of all isolates. This finding is consistent with several global studies, including a large-scale surveillance study by Pfaller et al. (2002), which reported C. albicans as the most common species in most geographic regions. However, our study also highlights the significant presence of non-albicans Candida species, collectively representing 55% of the isolates.

The high prevalence of Candida glabrata (20%) in our study is noteworthy and aligns with the increasing trend of C. glabrata infections reported in recent years. This shift towards non-albicans species, particularly C. glabrata, has

been observed in various healthcare settings worldwide. For instance, a multi-center study by Lockhart et al. (2010) reported a similar increase in C. glabrata isolates in North American hospitals. The rising incidence of C. glabrata is concerning due to its reduced susceptibility to azole antifungals, which may complicate treatment strategies.

Candida tropicalis and Candida parapsilosis were the next most common species in our study, representing 15% and 10% of isolates, respectively. These findings are comparable to those reported by Tan et al. (2006) in a study conducted in Asian countries, where C. tropicalis was found to be the second most common Candida species after C. albicans. The relatively high prevalence of C. parapsilosis in our study may be related to its association with catheter-related infections and parenteral nutrition, which are common in tertiary care settings.

Table 2 illustrates the distribution of Candida isolates by clinical specimen type. Urine samples yielded the highest number of Candida isolates (30%), followed by blood (25%) and respiratory specimens (20%). This distribution pattern reflects the diverse clinical manifestations of Candida infections and the importance of considering candidiasis in various organ systems. The high proportion of candiduria in our study is consistent with findings from other tertiary care centers. For example, a study by Kauffman et al. (2011) reported that candiduria is a common finding in hospitalized patients, particularly those with indwelling urinary catheters or diabetes mellitus. However, the clinical significance of candiduria can be challenging to interpret, as it may represent colonization rather than true infection in some cases. The significant number of Candida isolates from blood cultures (25%) underscores the importance of invasive candidiasis in our hospital setting. This finding is particularly concerning given the high mortality rates associated with candidemia, which can range from 30% to 50% according to a systematic review by Kullberg and Arendrup (2004). The relatively high proportion of blood isolates in our study may be attributed to the complex patient population in our tertiary care hospital, including immunocompromised individuals and those undergoing invasive procedures.

The antifungal susceptibility patterns observed in our study (Table 3) provide crucial insights into the effectiveness of commonly used antifungal agents against different Candida species. Overall, amphotericin B demonstrated excellent in vitro activity against all Candida isolates, with 100% susceptibility across all species. This finding is consistent with global surveillance data, such as the SENTRY Antimicrobial Surveillance Program reported by Pfaller et al. (2002), which found consistently low resistance rates to amphotericin B among Candida species. Fluconazole, a widely used azole antifungal, showed variable activity against different Candida species in our study. While C. albicans, C. tropicalis, and C. parapsilosis exhibited high susceptibility rates (92.6%, 88.9%, and 93.3%, respectively), C. glabrata demonstrated reduced susceptibility (65% susceptible). This pattern aligns with the known propensity of C. glabrata for azole resistance, as reported by Perlin et al. (2007) in their review of antifungal drug resistance mechanisms. The echinocandins (caspofungin and micafungin) demonstrated excellent activity against most Candida species, with susceptibility rates generally above 97%. However, a slightly lower susceptibility was observed for C. parapsilosis to micafungin (90%). This finding is consistent with the known reduced susceptibility of C. parapsilosis to echinocandins, as described by Pappas et al. (2008) in the Infectious Diseases Society of America (IDSA) guidelines for the management of candidiasis. It is worth noting that all C. krusei isolates in our study were resistant to fluconazole, which is expected due to this species' intrinsic resistance to fluconazole. This underscores the importance of accurate species identification in guiding antifungal therapy.

The distribution of Candida isolates across different hospital units (Table 4) provides valuable epidemiological information. The highest number of isolates were obtained from the Intensive Care Unit (ICU), accounting for 35% of all cases. This finding is consistent with numerous studies highlighting the increased risk of Candida infections in critically ill patients. For instance, a multi-center study by Colombo et al. (2014) reported that ICU admission was an independent risk factor for candidemia. The significant proportion of isolates from medical and surgical wards (25% and 20%, respectively) emphasizes that Candida infections are not limited to critical care settings. This widespread distribution across various hospital units underscores the need for heightened awareness and surveillance for fungal infections throughout the hospital. The oncology unit contributed 10% of the Candida isolates, reflecting the vulnerability of cancer patients to fungal infections. This finding aligns with studies such as that by Lortholary et al. (2007), which identified malignancy as a significant risk factor for invasive candidiasis.

Table 5 presents the overall resistance rates to various antifungal agents among our Candida isolates. The highest resistance rate was observed for fluconazole (15%), followed by voriconazole (6%). These rates are concerning and slightly higher than those reported in some global surveillance studies. For example, the ARTEMIS DISK Global Antifungal Surveillance Study by Pfaller et al. (2010) reported fluconazole resistance rates of around 5-7% for Candida species overall. The higher resistance rate to fluconazole in our study may be attributed to several factors, including the high proportion of non-albicans Candida species (particularly C. glabrata) and the potential selective pressure from widespread azole use in our institution. This finding emphasizes the need for judicious use of antifungal agents and the importance of local surveillance data in guiding empiric therapy. Resistance to echinocandins (caspofungin and micafungin) was relatively low (3-4%), which is reassuring given their role as first-line agents for many invasive Candida infections. However, the presence of any echinocandin resistance is concerning and warrants close monitoring, as highlighted by the emergence of multidrug-resistant Candida species such as C. auris (Lockhart et al., 2007). The absence of resistance to amphotericin B in our study is notable and supports its continued role as a reliable antifungal agent, particularly in settings where other antifungals may be less effective.

Implement routine species-level identification and antifungal susceptibility testing for all clinically significant Candida isolates to guide targeted therapy. Develop and regularly update local treatment guidelines based on the observed species distribution and susceptibility patterns. Enhance antifungal stewardship efforts to promote judicious use of antifungal agents, particularly fluconazole, given the observed resistance rates. Strengthen infection control measures, especially in high-risk areas such as the ICU, to prevent the spread of Candida infections. Conduct regular surveillance studies to monitor trends in Candida epidemiology and antifungal resistance patterns over time. Educate healthcare providers about the changing epidemiology of Candida infections and the importance of considering non-albicans species in clinical decision-making. Investigate risk factors associated with fluconazole-resistant Candida infections in our patient population to inform preventive strategies. Consider the use of echinocandins as first-line empiric therapy for suspected invasive candidiasis, particularly in critically ill patients, given their favorable susceptibility profile. Establish a multidisciplinary team including infectious disease specialists, clinical microbiologists, and pharmacists to oversee antifungal use and management of complex Candida infections. Participate in national or international antifungal surveillance networks to contribute to the broader understanding of Candida epidemiology and resistance trends.

Conclusion:

Our study provides a comprehensive overview of the Candida species distribution and antifungal susceptibility patterns in a tertiary care hospital. The findings highlight the predominance of C. albicans, but also underscore the significant presence of non-albicans Candida species, particularly C. glabrata. The variable susceptibility patterns observed across different Candida species and antifungal agents emphasize the importance of species-level identification and antifungal susceptibility testing in guiding appropriate therapy. The high proportion of Candida isolates from the ICU and the notable presence of fluconazole resistance underscore the challenges in managing Candida infections in complex healthcare settings. These results have important implications for empiric antifungal therapy, infection control practices, and antifungal stewardship programs in our institution.

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