

Species Distribution and Antifungal Susceptibility of *Candida* Bloodstream Isolates in Children: A Three-Year Study From North India

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Abstract

Background

The epidemiology of paediatric candidaemia has evolved, with non-*albicans Candida* (NAC) species accounting for an increasing proportion of bloodstream infections in many healthcare settings. This shift is particularly relevant in neonatal and paediatric intensive care units because antifungal susceptibility patterns vary among *Candida* species. This study aimed to evaluate the species distribution, antifungal susceptibility profiles and epidemiological characteristics of candidaemia at a tertiary-care paediatric hospital in northern India.

Methods

This retrospective observational study included 86 children with candidaemia, each contributing one unique bloodstream *Candida* isolate, between August 2018 and August 2021. Species were identified using the VITEK-2 automated identification system (bioMérieux, Marcy-l'Étoile, France) and confirmed by matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry (MALDI-TOF MS). Antifungal susceptibility to six agents (fluconazole, voriconazole, amphotericin B, caspofungin, micafungin and flucytosine) was evaluated using VITEK-2 AST-YS07 cards and interpreted according to applicable Clinical and Laboratory Standards Institute (CLSI) M60 clinical breakpoints. Where breakpoints were unavailable, instrument-generated susceptibility categories were reported descriptively.

Results

Candidaemia was identified in 86 children among 3,440 hospital admissions (2.5 cases per 100 admissions). Neonates accounted for 58/86 children (67.4%). NAC species accounted for 70/86 isolates (81.4%; 95% CI: 71.9-88.2%), with *C. pelliculosa* (27/86, 31.4%) and *C. parapsilosis* (22/86, 25.6%) being the most frequently identified species. All 86 isolates were classified as susceptible to amphotericin B and micafungin (100%), followed by voriconazole (84/86, 97.7%), caspofungin (83/86, 96.5%), flucytosine (82/86, 95.3%) and fluconazole (72/86, 83.7%). Fluconazole non-susceptibility was reported in 14/86 isolates (16.3%), including six *C. parapsilosis* and two *C. pelliculosa* isolates. These classifications included instrument-generated categories for species-drug combinations lacking validated CLSI clinical breakpoints. No *C. auris* isolates were identified.

Conclusions

Paediatric candidaemia at our institution was predominantly caused by NAC species, particularly *C. pelliculosa* and *C. parapsilosis*, with neonates accounting for most cases. The observed variation in fluconazole susceptibility highlights the importance of species-level identification and institution-specific antifungal susceptibility surveillance. However, automated susceptibility classifications should be interpreted cautiously for species-drug combinations lacking validated clinical breakpoints.

Categories: Public Health, Pediatrics, Infectious Disease

Keywords: antifungal susceptibility, candida pelliculosa (*wickerhamomyces anomalus*), neonatal intensive care unit (nicu), non-*albicans candida*, paediatric candidaemia

Introduction

Candida species are important causes of healthcare-associated bloodstream infections and contribute substantially to morbidity and mortality among hospitalised patients [1,2]. The epidemiology of invasive candidiasis has changed over recent decades, with an increasing contribution of non-*albicans Candida* (NAC) species in several geographic regions [3,4]. This shift has therapeutic implications because antifungal susceptibility varies among *Candida* species. Some NAC species exhibit intrinsic or acquired resistance to

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fluconazole, while the emergence of multidrug-resistant species such as *Candida auris* has further complicated the management of invasive candidiasis [5,6].

Neonates are particularly vulnerable to invasive candidiasis because of immune immaturity and frequent exposure to invasive medical devices, parenteral nutrition, broad-spectrum antibiotics and prolonged hospitalisation [7-9]. Infections in this population are associated with considerable morbidity, mortality and adverse long-term outcomes [7,8]. Indian studies have documented a predominance of NAC species among patients with candidaemia, particularly in intensive care settings [10-12].

The distribution of *Candida* species varies across institutions and patient populations. *Candida pelliculosa* (*Wickerhamomyces anomalus*) and *C. parapsilosis* have been implicated in bloodstream infections in neonatal intensive care units (NICUs) and paediatric intensive care units (PICUs) [13-15]. Their occurrence is clinically relevant because of their association with healthcare environments, indwelling devices and potential nosocomial transmission [13,14]. Reports from India have also described uncommon yeasts, including *C. blankii*, in neonatal and paediatric populations [16]. The increasing recognition of *C. auris* in Indian healthcare settings underscores the importance of continued microbiological surveillance [17].

Accurate species-level identification is essential for understanding local epidemiology and guiding antifungal management. Conventional phenotypic and biochemical identification methods may have limitations when uncommon yeasts are encountered [18]. In contrast, matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry (MALDI-TOF MS) enables the rapid and reliable identification of clinically relevant yeasts, including uncommon species [18,19].

Despite the clinical importance of paediatric candidaemia, institution-specific data from North India remain limited, particularly regarding uncommon NAC species and their antifungal susceptibility patterns. The primary objective of this descriptive study was therefore to determine the species distribution and antifungal susceptibility profiles of *Candida* bloodstream isolates at a tertiary-care paediatric referral hospital in North India. The secondary objective was to describe the demographic and clinical characteristics of affected patients over a three-year period.

Materials And Methods

Study design and setting

This retrospective observational study was conducted in the Department of Microbiology at the Post Graduate Institute of Child Health (PGICH), Noida, Uttar Pradesh, India. Laboratory records covering the three-year period from August 2018 to August 2021 were reviewed. PGICH is a tertiary-care paediatric referral institution with dedicated neonatal and paediatric intensive care facilities. A total of 3,440 admissions were recorded across the entire hospital during the study period.

Study population and eligibility criteria

Children aged <18 years admitted to the NICU, PICU or paediatric wards during the study period were eligible if their blood culture yielded a *Candida* species. Candidaemia was defined as the isolation of a *Candida* species from at least one blood culture considered clinically significant based on combined clinical and microbiological assessment. When contamination was suspected, repeat blood cultures were obtained, and isolates subsequently considered contaminants were excluded.

To avoid duplicate counting, only the first positive bloodstream isolate from each patient was included; therefore, each patient contributed one case and one isolate. Recurrent episodes following clinical resolution were not counted separately. Repeat isolates from the same patient, isolates from specimens other than blood, mixed cultures and records with insufficient microbiological information were excluded.

Data on age, sex, hospital location, prematurity, central venous catheterisation, total parenteral nutrition and prior broad-spectrum antibiotic exposure were extracted from hospital records. Neonates were defined as children aged 28 days or younger. Prematurity was defined as gestational age below 37 completed weeks and was assessed among neonates only. Clinical exposures were recorded only when documented before the first positive blood culture.

Sample collection and microbiological processing

Blood specimens obtained during the routine investigation of suspected bloodstream infection were collected aseptically from peripheral sites and inoculated into BacT/ALERT 3D aerobic blood culture bottles (bioMérieux, Lyon, France). Approximately 1-2 mL of blood was collected from neonates and 2-5 mL from older children. Bottles were processed in the automated BacT/ALERT 3D system according to the manufacturer's instructions and monitored for up to five days or until flagged positive. When a culture became positive, direct Gram staining was performed. Samples demonstrating budding yeast cells were subcultured on Sabouraud dextrose agar and incubated at 35-37°C for 24-48 hours to obtain isolated fungal colonies.

Identification of *Candida* species

Recovered yeasts were initially assessed using colony morphology and microscopic findings on Gram staining. Species identification was performed with the VITEK-2 Compact system (bioMérieux, Marcy-l'Étoile, France) using Yeast Identification (YST) cards. Identification of all 86 isolates was subsequently confirmed by MALDI-TOF MS using the Bruker Biotyper platform (Bruker Daltonics, Bremen, Germany). Colonies underwent ethanol-formic acid protein extraction, and spectra were compared with the Bruker Biotyper reference library. Species identification was accepted at a score ≥ 2.0 (species-level identification, per manufacturer).

Antifungal susceptibility testing

Antifungal susceptibility testing was performed using the automated VITEK-2 Compact system with AST-YS07 cards (bioMérieux), a commercial broth microdilution-based method. The panel comprised fluconazole, voriconazole, amphotericin B, caspofungin, micafungin and flucytosine. Inocula were prepared from fresh overnight cultures and adjusted to a 2.0 McFarland standard using a DensiChek Plus densitometer. Minimum inhibitory concentrations (MICs) were generated by the instrument software. The Clinical and Laboratory Standards Institute (CLSI) M27 reference broth microdilution method was not performed [20].

As part of routine laboratory reporting, susceptibility categories were assigned according to the species-specific clinical breakpoints in CLSI M60 [21,22], and these CLSI-interpreted categories are reported here. For species-drug combinations without a CLSI M60 clinical breakpoint, including all amphotericin B and flucytosine entries, the category generated by the VITEK-2 software is reported and marked † in the susceptibility table. Non-susceptible denotes intermediate, susceptible-dose dependent or resistant categories.

MIC values and the final susceptibility categories were transcribed from the laboratory reports into a structured worksheet, and a random 10% sample was cross-checked against the original reports for transcription accuracy. Quality control was performed with *C. parapsilosis* ATCC 22019 and *C. krusei* ATCC 6258 according to the manufacturer's recommendations.

Statistical analysis

Data were compiled in Microsoft Excel (Microsoft Corporation, Redmond, Washington, United States) and analysed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, New York, United States). Descriptive statistics were used throughout. Categorical variables are presented as frequencies and percentages, with the denominator specified for each proportion. The frequency of candidaemia was expressed as the number of cases per 100 hospital admissions during the study period ($86/3,440 \times 100 = 2.5$), using total hospital admissions as the denominator. This represents a crude descriptive frequency rather than a population-based incidence rate. Wilson score 95% confidence intervals were calculated for selected proportions. As the study was descriptive and did not include a comparison group, no hypothesis testing or risk-factor analysis was performed.

Ethics

This was a secondary analysis of retrospectively collected routine clinical and laboratory records, conducted under a protocol approved by the Institutional Ethics Committee of the Post Graduate Institute of Child Health, Noida (approval number: 2024-12-IM-05). The Institutional Ethics Committee waived the requirement for individual informed consent because of the retrospective design and the use of anonymised data.

Results

Patient demographics and clinical characteristics

During the three-year study period, 86 *Candida* bloodstream isolates from 86 children met the inclusion criteria. Fifty-eight children (67.4%; 95% CI: 57.0–76.4%) were neonates, and 28 (32.6%) were older children. Most cases occurred in the NICU (49/86, 57%), followed by the PICU (20/86, 23.3%) and paediatric wards (17/86, 19.8%). The male-to-female ratio was 1.6:1. The frequency of candidaemia was 2.5 cases per 100 hospital admissions (86/3,440). No isolate was identified as *Candida auris*. Before the first positive blood culture, broad-spectrum antibiotic exposure was documented in 72/86 patients (83.7%), central venous catheterisation in 24/86 (27.9%) and total parenteral nutrition in 22/86 (25.6%). Prematurity was documented in 32/58 neonates (55.2%). The demographic and clinical characteristics are summarised in Table 1.

Characteristic	n/N (%)
Neonatal age (≤28 days)	58/86 (67.4%)
NICU location	49/86 (57%)
PICU location	20/86 (23.3%)
Other inpatient wards	17/86 (19.8%)
Prior broad-spectrum antibiotic exposure	72/86 (83.7%)
Central venous catheterisation	24/86 (27.9%)
Total parenteral nutrition	22/86 (25.6%)
Prematurity (neonates only)	32/58 (55.2%)

TABLE 1: Demographic and clinical characteristics of children with candidaemia

Prematurity uses the neonatal denominator (N=58); all other characteristics use the full cohort (N=86). Clinical exposures were documented before the first positive blood culture.

NICU: neonatal intensive care unit; PICU: paediatric intensive care unit

Species distribution

NAC species accounted for 70/86 isolates (81.4%; 95% CI: 71.9-88.2%) and *C. albicans* for 16/86 (18.6%). The most frequent species were *C. pelliculosa* (*Wickerhamomyces anomalus*) (27/86, 31.4%; 95% CI: 22.6-41.8%) and *C. parapsilosis* (22/86, 25.6%; 95% CI: 17.5-35.7%), which together accounted for 49/86 isolates (57%). *C. albicans* ranked third, followed by *C. tropicalis* (8/86, 9.3%). The remaining 13 isolates (15.1%) comprised seven other species: *C. ciferrii* (n=4), *C. krusei* (n=3), *C. guilliermondii* (n=2), and *C. lusitaniae*, *C. famata*, *C. glabrata* and *C. lipolytica* (n=1 each). The complete species distribution is presented in Table 2.

Species	n/N (%)
<i>Candida pelliculosa</i> (<i>Wickerhamomyces anomalus</i>)	27/86 (31.4%)
<i>Candida parapsilosis</i>	22/86 (25.6%)
<i>Candida albicans</i>	16/86 (18.6%)
<i>Candida tropicalis</i>	8/86 (9.3%)
<i>Candida ciferrii</i>	4/86 (4.7%)
<i>Candida krusei</i>	3/86 (3.5%)
<i>Candida guilliermondii</i>	2/86 (2.3%)
<i>Candida lusitaniae</i>	1/86 (1.2%)
<i>Candida famata</i>	1/86 (1.2%)
<i>Candida glabrata</i>	1/86 (1.2%)
<i>Candida lipolytica</i>	1/86 (1.2%)
Total	86/86 (100%)

TABLE 2: Species distribution of Candida bloodstream isolates in children (N=86)

Antifungal susceptibility

All 86 isolates were tested against six antifungal agents (Table 3). Susceptibility was observed for amphotericin B and micafungin in 86/86 isolates (100%), voriconazole in 84/86 (97.7%), caspofungin in 83/86 (96.5%), flucytosine in 82/86 (95.3%) and fluconazole in 72/86 (83.7%). All *C. albicans* (16/16, 100%)

and C. tropicalis (8/8, 100%) isolates were susceptible to all six agents.

Table with 7 columns: Candida species (n), Fluconazole, Voriconazole, Amphotericin B, Caspofungin, Micafungin, Flucytosine. Rows include various Candida species and a Total row.

TABLE 3: Antifungal susceptibility classifications of Candida bloodstream isolates by species (N=86)
Data are presented as the number of isolates categorised as susceptible per number tested, n/N (%). Susceptibility categories were interpreted using applicable CLSI M60 species-specific clinical breakpoints [21,22]. For species-drug combinations without established CLSI M60 clinical breakpoints (†), VITEK-2-generated categories are presented descriptively. The C. glabrata isolate was categorised as susceptible-dose dependent (SDD) for fluconazole, and SDD was counted as non-susceptible.

Fluconazole non-susceptibility was observed in 14/86 isolates (16.3%): C. parapsilosis (6/22, 27.3%), C. pelliculosa (2/27, 7.4%), C. krusei (3/3, 100%), C. guilliermondii (1/2, 50%), C. lipolytica (1/1, 100%) and C. glabrata (1/1, 100%; susceptible-dose dependent). Voriconazole non-susceptibility was observed in C. parapsilosis (1/22, 4.5%) and C. guilliermondii (1/2, 50%). Caspofungin non-susceptibility was observed in C. krusei (2/3, 66.7%) and C. glabrata (1/1, 100%); all three isolates were susceptible to micafungin (3/3, 100%). Flucytosine non-susceptibility was observed in C. krusei (3/3, 100%) and C. guilliermondii (1/2, 50%).

Discussion

The present three-year, single-centre study describes the species distribution and antifungal susceptibility of 86 Candida bloodstream isolates from children at a tertiary-care referral hospital in northern India. NAC species predominated, accounting for 70/86 isolates (81.4%; 95% CI: 71.9-88.2%), and C. pelliculosa (Wickerhamomyces anomalus) and C. parapsilosis together accounted for 49/86 (57%). This is consistent with the broader shift towards NAC species described internationally [3,4] and with reports from Indian neonatal and intensive care settings [10-12]. Species distribution nevertheless varies between institutions according to patient population, clinical setting, study period and identification methods. Our findings should therefore be regarded as institution-specific rather than representative of paediatric candidaemia across India.

C. pelliculosa was the most frequent species (27/86, 31.4%; 95% CI: 22.6-41.8%). Although uncommon in broader surveillance [3,4], it has been reported in Indian PICUs, where W. anomalus was the most frequent rare yeast [13], and as the cause of a neonatal intensive care outbreak in Brazil with a possible clonal origin [15]. These reports differ in setting and design. Our isolates were confirmed by MALDI-TOF MS, supporting the reliability of species identification [18,19]. However, a high frequency of one species does not establish an outbreak or common source. Molecular typing, environmental surveillance and epidemiological linkage were not performed, so clustering could neither be confirmed nor excluded.

C. parapsilosis was the second most frequent species (22/86, 25.6%; 95% CI: 17.5-35.7%). This species is an established cause of healthcare-associated candidaemia, particularly in neonates, and has been associated with intravascular devices, parenteral nutrition, biofilm formation and transmission via healthcare workers' hands [14]. In our cohort, central venous catheterisation was documented in 24/86 children (27.9%), total parenteral nutrition in 22/86 (25.6%) and prematurity in 32/58 neonates (55.2%). Without a comparison

group or species-specific analysis, no association with candidaemia or *C. parapsilosis* infection can be established. Previous studies have identified several predisposing factors for neonatal invasive candidiasis [7-9], but these associations were not evaluated in the present study.

Neonates accounted for 58/86 cases (67.4%; 95% CI: 57.0-76.4%), 49/86 cases (57%) occurred in the NICU, and 72/86 children (83.7%) had received broad-spectrum antibiotics before the first positive blood culture. Neonates are particularly vulnerable to invasive candidiasis because of immune immaturity, prematurity and exposure to invasive supportive care [7-9]. In the NeoOBS cohort from low- and middle-income countries, 22% (28/127) of neonates with invasive candidiasis died within 28 days of enrolment [23]. We did not evaluate mortality, treatment or clinical outcomes, so the clinical consequences of our findings cannot be assessed. The frequency of 2.5 cases per 100 admissions (86/3,440) represents a crude hospital-based measure that does not account for patient-days or unit-specific exposure and should not be interpreted as an incidence rate.

Fluconazole had the lowest proportion of isolates classified as susceptible (72/86, 83.7%), while 14/86 isolates (16.3%) were non-susceptible. These comprised *C. parapsilosis* (6/22, 27.3%), *C. pelliculosa* (2/27, 7.4%), all three *C. krusei* isolates, one of two *C. guilliermondii* isolates, the single *C. lipolytica* isolate and the single *C. glabrata* isolate, which was classified as susceptible-dose dependent (SDD). Intrinsic fluconazole resistance in *C. krusei* and reduced azole susceptibility in some NAC species are well recognised [2,6]. Under CLSI criteria, *C. glabrata* is categorised as SDD or resistant to fluconazole rather than susceptible [21,22]. Fluconazole non-susceptibility in *C. parapsilosis* is particularly relevant because azole resistance in this species has been increasingly recognised [6]. In the NeoOBS cohort, 59% of *C. parapsilosis* isolates were reported as fluconazole-resistant [23]. However, differences in patient populations, susceptibility testing methods and interpretive categories, particularly resistance versus non-susceptibility, limit direct comparison between studies.

All 86 isolates were classified as susceptible to micafungin and amphotericin B, while 84/86 (97.7%) were susceptible to voriconazole. Two of three *C. krusei* isolates and the single *C. glabrata* isolate were non-susceptible to caspofungin but susceptible to micafungin. CLSI clinical breakpoints are available for both echinocandins in these species [21,22]. However, the discordance involved only three isolates and was not confirmed by reference broth microdilution. It remains unclear whether these findings reflect genuine differences in activity in vitro or variability associated with automated susceptibility testing [24]. Confirmation using a reference susceptibility method would be necessary before drawing further conclusions [20].

The susceptibility findings require cautious interpretation. CLSI M60 does not provide clinical breakpoints for amphotericin B, flucytosine or several uncommon species-drug combinations [21,22]. For these combinations, VITEK-2-generated susceptibility categories are descriptive and are not equivalent to classifications based on validated clinical breakpoints. Automated susceptibility results should also be interpreted with consideration of the limitations of the testing method [24]. Although the automated system generated MIC values, only susceptibility categories were analysed. These findings describe local in vitro susceptibility patterns; however, classifications for species-drug combinations without validated clinical breakpoints cannot establish clinical resistance or reliably predict treatment outcomes.

No *C. auris* isolates were identified during the study period. This species is an emerging multidrug-resistant yeast [5] reported in Indian neonatal and paediatric populations [17], and its absence from our cohort does not exclude its occurrence at other times or in other healthcare settings. Continued species-level surveillance remains important for identifying changes in the distribution of uncommon and emerging yeasts. These descriptive findings alone do not justify changes to empirical antifungal treatment policies; clinical management should continue to follow established guidelines and individual patient assessment [2].

This study has several limitations. Its retrospective, single-centre design and relatively small sample size restrict generalisability, particularly for species represented by only one to four isolates. The absence of a comparison group prevented the assessment of risk factors, while the lack of species-specific exposure analysis limited the evaluation of potential associations. Clinical documentation may have been incomplete, and antifungal treatment and patient outcomes were not assessed. Molecular sequencing and strain typing were not performed, preventing the investigation of possible transmission or clustering. Susceptibility testing was not confirmed by reference broth microdilution, and established clinical breakpoints were unavailable for several species-drug combinations. Furthermore, the relatively small blood volumes collected from neonates may have affected blood culture sensitivity.

Conclusions

This single-centre study highlights the predominance of NAC species in paediatric candidaemia at a tertiary-care hospital in northern India, particularly *C. pelliculosa* and *C. parapsilosis*, with neonates accounting for the majority of cases. Fluconazole showed the lowest proportion of susceptible isolates, whereas all isolates were categorised as susceptible to micafungin and amphotericin B; interpretation was limited by the absence of validated clinical breakpoints for certain species-drug combinations. These institution-specific findings underscore the importance of accurate species identification, cautious interpretation of antifungal

susceptibility results and continued local surveillance. Larger multicentre studies incorporating reference susceptibility testing and clinical outcomes are warranted.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee of the Post Graduate Institute of Child Health issued approval 2024-12-IM-05. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. 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. *Clin Infect Dis*. 2004, 39:309-17. [10.1086/421946](#)
2. Pappas PG, Kauffman CA, Andes DR, et al.: Clinical practice guideline for the management of candidiasis: 2016 update by the Infectious Diseases Society of America. *Clin Infect Dis*. 2016, 62:e1-50. [10.1093/cid/civ933](#)
3. Pfaller MA, Diekema DJ: Epidemiology of invasive candidiasis: a persistent public health problem. *Clin Microbiol Rev*. 2007, 20:133-63. [10.1128/CMR.00029-06](#)
4. Guinea J: Global trends in the distribution of *Candida* species causing candidemia. *Clin Microbiol Infect*. 2014, 20:5-10. [10.1111/1469-0691.12539](#)
5. Arendrup MC, Patterson TF: Multidrug-resistant *Candida*: epidemiology, molecular mechanisms, and treatment. *J Infect Dis*. 2017, 216:S445-51. [10.1093/infdis/jix131](#)
6. Pristov KE, Ghannoum MA: Resistance of *Candida* to azoles and echinocandins worldwide. *Clin Microbiol Infect*. 2019, 25:792-8. [10.1016/j.cmi.2019.03.028](#)
7. Benjamin DK Jr, Stoll BJ, Gantz MG, et al.: Neonatal candidiasis: epidemiology, risk factors, and clinical judgment. *Pediatrics*. 2010, 126:e865-73. [10.1542/peds.2009-3412](#)
8. Kilpatrick R, Scarrow E, Hornik C, Greenberg RG: Neonatal invasive candidiasis: updates on clinical management and prevention. *Lancet Child Adolesc Health*. 2022, 6:60-70. [10.1016/S2352-4642\(21\)00272-8](#)
9. Pana ZD, Roilides E, Warris A, Groll AH, Zaoutis T: Epidemiology of invasive fungal disease in children. *J Pediatric Infect Dis Soc*. 2017, 6:S3-S11. [10.1093/jpids/pix046](#)
10. Basu S, Kumar R, Tilak R, Kumar A: *Candida* blood stream infection in neonates: experience from a tertiary care teaching hospital of central India. *Indian Pediatr*. 2017, 54:556-9. [10.1007/s13312-017-1067-5](#)
11. Chakrabarti A, Sood P, Rudramurthy SM, et al.: Incidence, characteristics and outcome of ICU-acquired candidemia in India. *Intensive Care Med*. 2015, 41:285-95. [10.1007/s00134-014-3603-2](#)
12. Gautam G, Rawat D, Kaur R, Nathani M: Candidemia: changing dynamics from a tertiary care hospital in North India. *Curr Med Mycol*. 2022, 8:20-5. [10.18502/cmm.8.1.9210](#)
13. Kaur H, Singh S, Rudramurthy SM, et al.: Fungaemia due to rare yeasts in paediatric intensive care units: a prospective study. *Mycoses*. 2021, 64:1387-95. [10.1111/myc.13297](#)
14. Trofa D, Gácser A, Nosanchuk JD: *Candida* parapsilosis, an emerging fungal pathogen. *Clin Microbiol Rev*. 2008, 21:606-25. [10.1128/CMR.00013-08](#)
15. da Silva CM, de Carvalho Parahym AM, Leão MP, de Oliveira NT, de Jesus Machado Amorim R, Neves RP: Fungemia by *Candida pelliculosa* (*Pichia anomala*) in a neonatal intensive care unit: a possible clonal origin. *Mycopathologia*. 2013, 175:175-9. [10.1007/s11046-012-9605-0](#)
16. Chowdhary A, Stielow JB, Upadhyaya G, Singh PK, Singh A, Meis JF: *Candida blankii*: an emerging yeast in

an outbreak of fungaemia in neonates in Delhi, India. *Clin Microbiol Infect.* 2020, 26:648.e5-8. [10.1016/j.cmi.2020.01.001](https://doi.org/10.1016/j.cmi.2020.01.001)

17. Singhal T, Shah S, Thakkar P, Ladi S: Candida auris as the predominant species causing invasive candidiasis in neonates and children. *Indian J Pediatr.* 2023, 90:946. [10.1007/s12098-023-04672-z](https://doi.org/10.1007/s12098-023-04672-z)
18. Buchan BW, Ledeboer NA: Advances in identification of clinical yeast isolates by use of matrix-assisted laser desorption ionization-time of flight mass spectrometry. *J Clin Microbiol.* 2013, 51:1359-66. [10.1128/JCM.03105-12](https://doi.org/10.1128/JCM.03105-12)
19. Posteraro B, De Carolis E, Vella A, Sanguinetti M: MALDI-TOF mass spectrometry in the clinical mycology laboratory: identification of fungi and beyond. *Expert Rev Proteomics.* 2013, 10:151-64. [10.1586/epr.13.8](https://doi.org/10.1586/epr.13.8)
20. Reference Method for Broth Dilution Antifungal Susceptibility Testing of Yeasts . Clinical and Laboratory Standards Institute, Wayne (PA); 2017.
21. Performance Standards for Antifungal Susceptibility Testing of Yeasts - 1st Edition . Clinical and Laboratory Standards Institute, Wayne (PA); 2017.
22. Performance Standards for Antifungal Susceptibility Testing of Yeasts - 2nd Edition . Clinical and Laboratory Standards Institute, Wayne (PA); 2020. <https://webstore.ansi.org/standards/cls/clsim60ed2/>.
23. Cook A, Ferreras-Antolin L, Adhisivam B, et al.: Neonatal invasive candidiasis in low- and middle-income countries: data from the NeoOBS study. *Med Mycol.* 2023, 61:myad010. [10.1093/mmy/myad010](https://doi.org/10.1093/mmy/myad010)
24. Berkow EL, Lockhart SR, Ostrosky-Zeichner L: Antifungal susceptibility testing: current approaches . *Clin Microbiol Rev.* 2020, 33:e00069-19. [10.1128/CMR.00069-19](https://doi.org/10.1128/CMR.00069-19)