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ORIGINAL RESEARCH

Epidemiological Characteristics, Antifungal Susceptibility, Risk Factors, and Outcomes of *Candida* Bloodstream Infection: A Ten-Year Surveillance in a Teaching Hospital in China

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Background: *Candida* is one of the most important pathogens of hospital-acquired bloodstream infections. Its morbidity and mortality are still high, which is a serious global public problem.

Purpose: To investigate the strain distribution, drug susceptibility, clinical characteristics of patients, and risk factors affecting the prognosis of *Candida* bloodstream infection (BSI).

Materials and Methods: We retrospectively collected the clinical data, infection-related indicators, prognosis, strain prevalence and drug susceptibility of 163 patients with *Candida* BSI in a teaching hospital from January 2012 to December 2022. Univariate and multivariate logistic regression were used to analyze the risk factors affecting the prognosis.

Results: In 163 cases of *Candida* BSI, *Candida albicans* accounted for 48.47%, and *Candida* non-*albicans* accounted for 51.53%. A total of 163 patients with *Candida* BSI were mainly distributed in intensive care unit (ICU) and emergency department, accounting for 40.49% and 14.72%, respectively. The resistance rate of *Candida albicans* to fluconazole, itraconazole and voriconazole was less than 10%, and the sensitivity rate of *Candida tropicalis* to fluconazole, itraconazole and voriconazole was less than 80%. The mortality rate of 163 patients with *Candida* BSI was 33.13%, with *Candida* non-*albicans* higher than that of *Candida albicans* (p = 0.04). Multivariate analysis showed that hemodialysis (OR = 0.199, 95% CI: 0.059–0.673, P = 0.009), arteriovenous catheters (OR = 0.344, 95% CI: 0.130–0.913, P = 0.032), elevated neutrophil count (OR = 0.409, 95% CI: 0.194–0.862, P = 0.019) and APACHE II score (OR = 0.848, 95% CI: 0.789~0.911, P < 0.001) were independent risk factors for death in patients with candidemia.

Conclusion: The blood flow infection rate of *Candida* non-*albicans* is increasing, and the mortality rate and resistance to antifungal drugs are higher than that of *Candida albicans*. Hemodialysis, arteriovenous catheters, elevated neutrophil count and APACHE II score were associated with death in patients with *Candida* BSI.

Keywords: *Candida*, bloodstream infection, clinical features, prognosis

Introduction

Candida exists widely in nature, is one of the conditioned pathogens of human body, and is also the most common pathogen causing fungal bloodstream infections.[1,2] *Candida*-caused bloodstream infections significantly prolong the length of hospital stay and cost, increase the mortality rate, and pose a serious threat to the health of patients.[3] Studies have found that there are differences in *Candida* species and epidemiological characteristics of bloodstream infections caused by different regions. Different from the results of studies in European countries,[4] the incidence of *Candida* non-*albicans* is on the rise in some parts of Asia,[5–7] and the resistance rate to antifungal drugs is also on the rise, resulting in

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poor efficacy and increased mortality. In addition, different species of *Candida* also have different prognoses in patients with bloodstream infection. Al-Dorzi et al,[8] in monitoring 174 patients with fungal bloodstream infections at a Saudi hospital ICU, found higher mortality for *C. albicans* compared with C. non-*albicans*. However, in a study in a Thai hospital, *Candida tropicalis* caused a higher mortality.[9] This regional difference suggests that we need to conduct necessary studies on *Candida* BSI in local hospitals.

Recent studies have shown that risk factors for *Candida* BSI vary with time and region. Currently reported risk factors include old age, more underlying diseases, surgical operations, history of use of broad-spectrum antibiotics, APACHE II score ≥20, and history of invasive procedures (central venous catheters, mechanical ventilation, etc.).[10,11] Due to lack of characteristic clinical manifestations, early diagnosis and antifungal therapy are difficult for patients with candidemia. The factors related to infection and prognosis of patients are not well defined. Therefore, it is essential to improve patient survival by investigating local epidemiology, monitoring antifungal susceptibility, and identifying risk factors for morbidity and mortality.

By reviewing the clinical data of patients with *Candida* BSI in our hospital in the past 10 years, this study analyzed the epidemiological characteristics, antifungal drug sensitivity and prognostic factors related to patients with *Candida* BSI, so as to provide evidence for early identification and treatment of patients with candidemia, so as to improve the clinical outcome of patients.

Materials and Methods

Research Object

A total of 163 patients with *Candida* BSI admitted to the First Affiliated Hospital of Bengbu Medical College from January 1, 2012 to December 31, 2022 were included. The hospital is a tertiary teaching hospital with 3800 beds. Inclusion criteria: The patient was diagnosed with bloodstream infection, and *Candida* was cultured at least once in the blood culture samples submitted for examination. The same patient was cultured with the same *Candida* multiple times, and the results of the first culture were adopted. Exclude patients with incomplete medical records. Previous treatment was defined as: (1) surgery within the past 3 months; (2) broad-spectrum antimicrobial use for more than 5 days within 30 days of the first pathogen detection; (3) antifungal use within 3 months after diagnosis; (4) immunosuppressive use for 3 weeks within 2 months after diagnosis. This study was approved by the Ethics Committee of the First Affiliated Hospital of Bengbu Medical College (No.: 2022208). The study was conducted in accordance with the Declaration of Helsinki.

Clinical and Epidemiological Data

For each case, we recorded demographics (age, sex, department, length of stay) and analyzed the APACHE II score of the patients. The laboratory tests (neutrophil count, hemoglobin, platelet count, PCT, CRP, 1, 3-β-D glucan, etc.) during the occurrence of *Candida* bloodstream infection and the risk factors of candidemia (including invasive procedures (urinary catheter, stomach tube, body cavity drainage tube, arteriovenous catheters, mechanical ventilation, hemodialysis), ICU admission, underlying diseases, use of broad-spectrum antibiotics, etc.). We discussed the epidemiology of this cohort, including the department distribution of candidemia and susceptibility to antifungal drugs. Next, patients were assessed for infection and prognostic risk factors.

Microbiological Tests

Blood samples were collected under sterile conditions, species identification was performed using VITEK 2 microbial identification instrument and VITEK MS (France Merieux Company), drug sensitivity test was performed using ATB FUNGUS 3 yeast reagent strip (France Merieux company), operation was strictly in accordance with the instructions of the kit. *Candida* isolates were classified as susceptible (S), intermediate (I), and resistant (R) based on the minimum inhibitory concentrations (MIC) of clinical breakpoints (CBPs) of antifungal agents. CBPs for fluconazole and voriconazole were determined according to the Clinical and Laboratory Standards Institute (CLSI M60), and CBPs for itraconazole susceptibility were determined according to the European Committee for Antimicrobial Susceptibility

Testing (EUCAST 10.0) and epidemiological cut-off values (ECVs). The definition of CBPs for amphotericin B was based on EUCAST 10.0 criteria. 5-Flucytosine currently lacks CBPs in CLSI or EUCAST.[12,13]

Statistical Analysis

SPSS25.0 statistical analysis was used. The measurement data of normal distribution were expressed by ($\overline{X} \pm s$) and *t*-test was used. The non-normal distribution was expressed as median and quartile, and Mann–Whitney *U*-test was used. Counting data were compared between groups using Chi-square test or Fisher's exact probability method. Statistically significant indicators in univariate analysis were included in multivariate logistic regression analysis. $P < 0.05$ was considered statistically significant.

Results

Species and Department Distribution

A total of 257 *Candida* strains were isolated from 163 blood samples of patients with *Candida* bloodstream infection. Among them, 143 cases were positive in one culture, and 20 cases were positive in two or more cultures. A total of 109 cases were positive in one vial, and 74 cases were positive in two vials. After removing duplicate strains from the same patient, a total of 163 strains were obtained. *Candida albicans* accounted for 48.47% (79/163), and *Candida* non-*albicans* accounted for 51.53% (84/163). Among the 163 strains of fungal BSI, 66 cases (40.49%) were from intensive care, 24 cases (14.72%) were from emergency department, and 21 cases (12.88%) were from hematology department (Figures 1 and 2).

Clinical Characteristics

Among 163 patients with *Candida* BSI, 94 cases (57.67%) were male, with an average age of 61.25 ± 18.11 years old, and the infection rate of elderly patients ≥60 years old was 56.44%. Most patients (96.93%, 158/163) had underlying diseases, and the common underlying diseases were lung infection (61.35%), heart disease (31.90%), hypertension (31.90%), solid-organ cancer (23.31%), diabetes (22.09%), hematological malignancies (15.34%), etc. Among them, 133

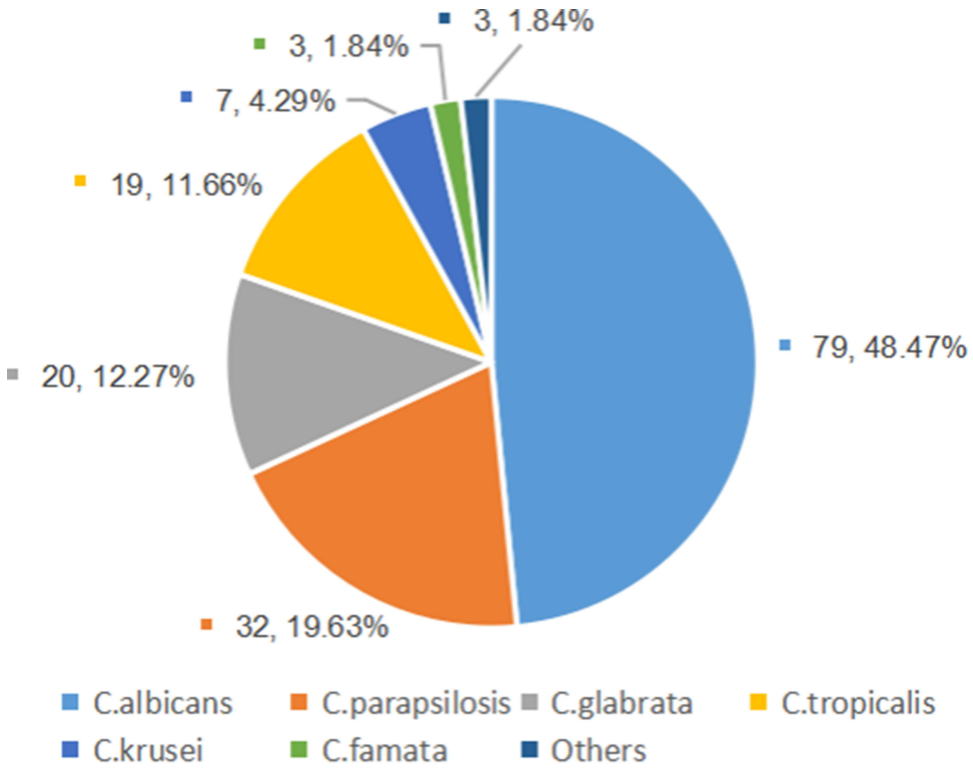

Figure 1 Constituent ratio of 163 cases of fungal bloodstream infection in strains (%).

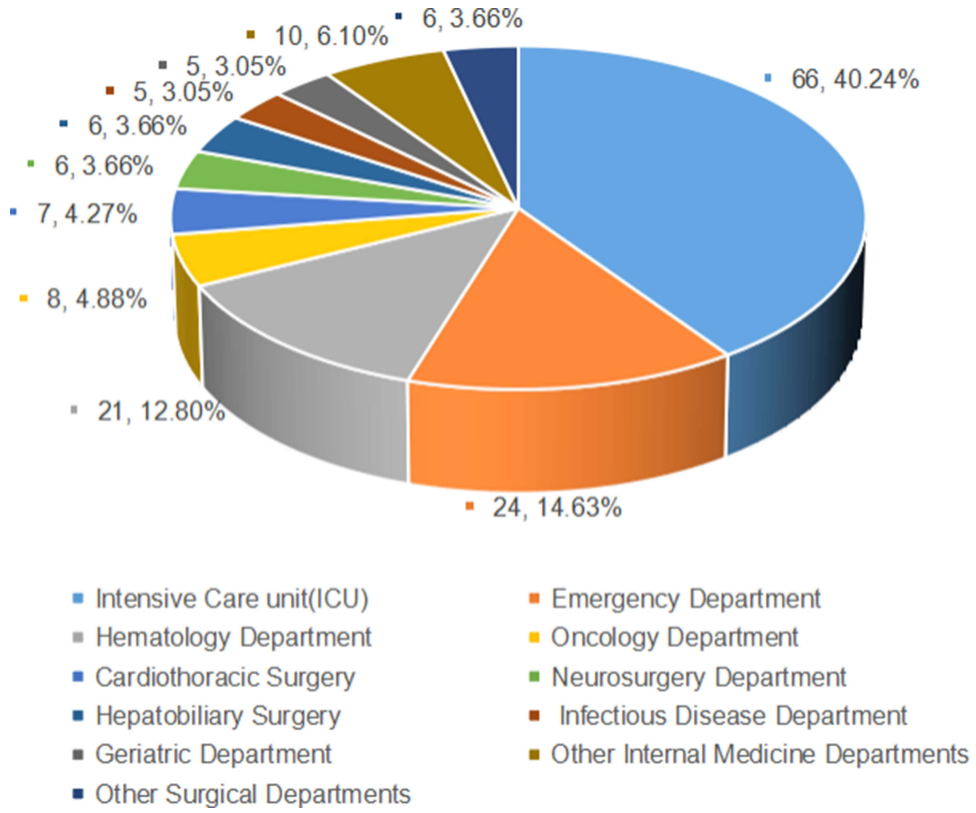

Figure 2 Constituent ratio of 163 cases of fungal bloodstream infection in departments (%).

patients (81.60%) had two or more underlying diseases. Among the patients with candidiasis, 103 cases (63.19%) were treated with catheter, 85 cases (52.15%) with mechanical ventilation, 74 cases (45.40%) with ICU admission, 69 cases (42.33%) with arteriovenous catheterization, 61 cases (37.42%) with stomach tube, and 58 cases (35.58%) with body cavity drainage tube. We further compare and analyze the clinical characteristics of patients with *Candida albicans* and *Candida* non-*albicans* bloodstream infection. The differences between *C. albicans* and *C*. non-*albicans* group in length of stay, prognosis, ICU admission, previous surgery, hemodialysis, invasive operation (urinary catheter, arteriovenous catheters, stomach tube, body cavity drainage tube, mechanical ventilation), use of immunosuppressive agents, pulmonary infection, combined with other fungal infection, solid malignant tumor, hematological malignancy, elevated neutrophil count, and decreased platelet count are statistically significant ($P < 0.05$). See Table 1.

Drug Susceptibility

All 163 strains were tested for antifungal susceptibility in vitro. The sensitivity of *Candida tropicalis* to fluconazole, itraconazole and voriconazole was 70%–80%. In Table 2, except for the natural resistance of *Candida krusei* to fluconazole, the resistance rate of *Candida tropicalis* to azole drugs was the highest (4/19, 21.05%).

Characterization of Deceased Patients

Among 163 patients with *Candida* BSI, 54 died, with a mortality rate of 33.13% (54/163). In Figure 3, the mortality rate of patients with *Candida albicans* BSI was 25.32% (20/79), and that of patients without *Candida albicans* infection was 40.38% (34/84). The rates of ICU admission, hemodialysis, invasive procedures (urinary catheter, arteriovenous catheter, stomach tube, body cavity drainage tube, mechanical ventilation), hematological malignancy, elevated neutrophil count, decreased hemoglobin and APACHE II score were all higher in death patients than in survival group ($P < 0.05$). Multivariate analysis was performed for statistically significant factors, and the results showed that hemodialysis (OR = 0.199, 95% CI: 0.059–0.673, $P = 0.009$), arteriovenous catheters (OR = 0.344, 95% CI: 0.130–0.913, $P = 0.032$),

Table 1 Clinical Characteristics of 163 Patients with *Candida* BSI

Characteristics [n (%)]	*C. albicans* (n = 79)	*C. non-albicans* (n = 84)	χ^2	*P*
Age≥60 years old	41 (51.90)	51 (60.71)	0.659	0.257
Sex (male/female)	43/36	51/33	1.287	0.417
LOS (days)	31.34±26.18	38.06±46.79	0.219	0.014*
Hypertension	23 (29.11)	29 (34.52)	0.548	0.459
Diabetes	19 (24.05)	17 (20.24)	0.344	0.558
Hematological malignancy	17 (21.52)	8 (9.52)	4.511	0.034*
Solid-organ cancer	13 (16.46)	25 (29.76)	4.032	0.045*
Lung infection	39 (49.37)	61 (72.62)	9.283	<0.001*
Heart disease	31 (39.24)	21 (25.00)	3.800	0.051
Nervous system disease	28 (35.44)	25 (29.76)	0.599	0.439
Digestive system disease	32 (40.51)	28 (33.33)	0.901	0.343
Chronic kidney disease	25 (31.65)	22 (26.19)	0.590	0.442
Chronic liver disease	19 (24.05)	25 (29.76)	0.674	0.412
Urinary catheter	37 (46.84)	66 (78.57)	17.628	<0.001*
Stomach tube	13 (16.46)	48 (57.14)	28.779	<0.001*
Body cavity drainage tube	10 (12.66)	48 (57.14)	38.148	<0.001*
Arteriovenous catheters	17 (21.52)	54 (64.29)	30.287	<0.001*
Mechanical ventilation	26 (32.91)	59 (70.24)	22.731	<0.001*
Tracheotomy	15 (18.99)	26 (30.95)	3.096	0.078
Puncture	17 (21.52)	27 (32.14)	2.332	0.127
Hemodialysis	3 (3.80)	11 (13.10)	4.483	0.034*
Immunosuppressant use	63 (79.75)	55 (65.48)	4.148	0.042*
ICU admission	19 (24.05)	55 (65.48)	28.184	<0.001*
History of department transfer	9 (11.39)	18 (21.43)	2.967	0.058
Previous surgery	21 (26.58)	50 (59.52)	17.969	<0.001*
Combined with other fungal infection	4 (5.06)	17 (20.24)	8.353	0.004*
Combined with other bacterial infection	56 (70.89)	51 (60.71)	1.868	0.172
Mortality	20 (25.32)	34 (40.48)	4.223	0.040*
Neutrophil count	6.72±7.32	10.76±11.37	6.820	0.009*
Hemoglobin	103.46±26.25	106.94±25.80	0.346	0.556
Platelet count	162.20±117.48	187.19±104.68	6.968	0.008*
CRP	79.00±79.35	89.43±86.30	0.013	0.909
Procalcitonin	11.33±24.32	6.90±11.92	0.403	0.526
1, 3-β-D glucan	408.90±314.87	210.48±173.86	2.201	0.138

Note: *Significant statistical difference (*P*<0.05).
Abbreviations: BSI, bloodstream infection; LOS, length of stay; ICU, intensive care unit; CRP, C-reactive protein; χ^2, chi-square value; *P*, significance.

elevated neutrophil count (OR = 0.409, 95% CI: 0.194–0.862, $P = 0.019$) and APACHE II score (*OR* = 0.848, 95% CI: 0.789~0.911, $P < 0.001$) were independent risk factors for death in patients with candidemia (Table 3 and Table 4).

Discussions

Candida is a common pathogen causing human invasive mycosis. In recent years, with the extensive clinical application of invasive medical procedures, new broad-spectrum antibacterial drugs and transplantation and other advanced medical technologies, the incidence of *Candida* BSI is on the rise, and there are epidemiological differences in bloodstream infections caused by C*andida* in different regions.[14] Koehler[15] et al conducted a meta-analysis of candidemia in European countries and found that there were considerable differences among different central strains, with *Candida* non-*albicans* strains generally dominating. The results of this study show that C*andidia* non-*albicans* accounted for more than half of the *Candida* bloodstream infections in our hospital, which were similar to domestic reports, but showed different results reported for a university teaching hospital in Saudi Arabia by Tariq et al.[8,16] This may be related to the

Table 2 Drug Susceptibility of 157 Strains of *Candida* to 4 Antifungal Drugs

Antifungal Drugs	Antibiotics Sensitivity Test	*C. albicans* (n = 79)	*C. parapsilosis* (n = 32)	*C. glabrata* (n = 20)	*C. tropicals* (n = 19)	*C. krusei* (n = 7)
Fluconazole	S	74 (93.67%)	30 (93.75%)	NA	14 (73.68)	NA
	SDD	1 (1.27%)	0 (0.00%)	20 (100.00%)	1 (5.26%)	NA
	R	4 (5.06%)	2 (6.25%)	0 (0.00%)	4 (21.05%)	NA
Voriconazole	S	74 (93.67%)	30 (93.75%)	NA	14 (73.68%)	6 (85.71%)
	I	3 (3.80%)	1 (3.13%)	NA	2 (10.53%)	1 (14.29%)
	R	2 (2.53%)	1 (3.13%)	NA	3 (15.79%)	0 (0.00%)
	WT	NA	NA	17 (85.00%)	NA	NA
	NWT	NA	NA	3 (15.00%)	NA	NA
Itraconazole	WT	74 (93.67%)	31 (96.87%)	20 (100.00%)	15 (78.95%)	7 (100.00%)
	NWT	5 (6.33%)	1 (3.13%)	0 (0.00%)	4 (21.05%)	0 (0.00%)
Amphotericin B	WT	79 (100.00%)	31 (96.87%)	20 (100.00%)	19 (100.00%)	7 (100.00%)
	NWT	0 (0.00%)	1 (3.13%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

Abbreviations: S, sensitive; I, intermediary; R, resistance to drugs; SDD, dose-dependent sensitivity; WT, wild type; NWT, non-wild type; NA, no date.

geographical environment and climate of different regions, the underlying diseases of patients and the medical measures taken, so as to cause different *Candida* infections. *Candida parapsilosis* infection is mostly associated with indwelling deep venous catheter and parenteral nutrition. Patients with hematological malignancies are susceptible to *Candida tropicalis*, and exposure to antifungal agents is associated with *Candida glabrata* infection.[17–19]

Current studies have found that the main causes of *Candida* BSI are low immunity and impaired mucosal barrier in patients.[20,21] Chen Xia[22] et al reported that the incidence of *Candida* BSI in ICU patients over 60 years old was the

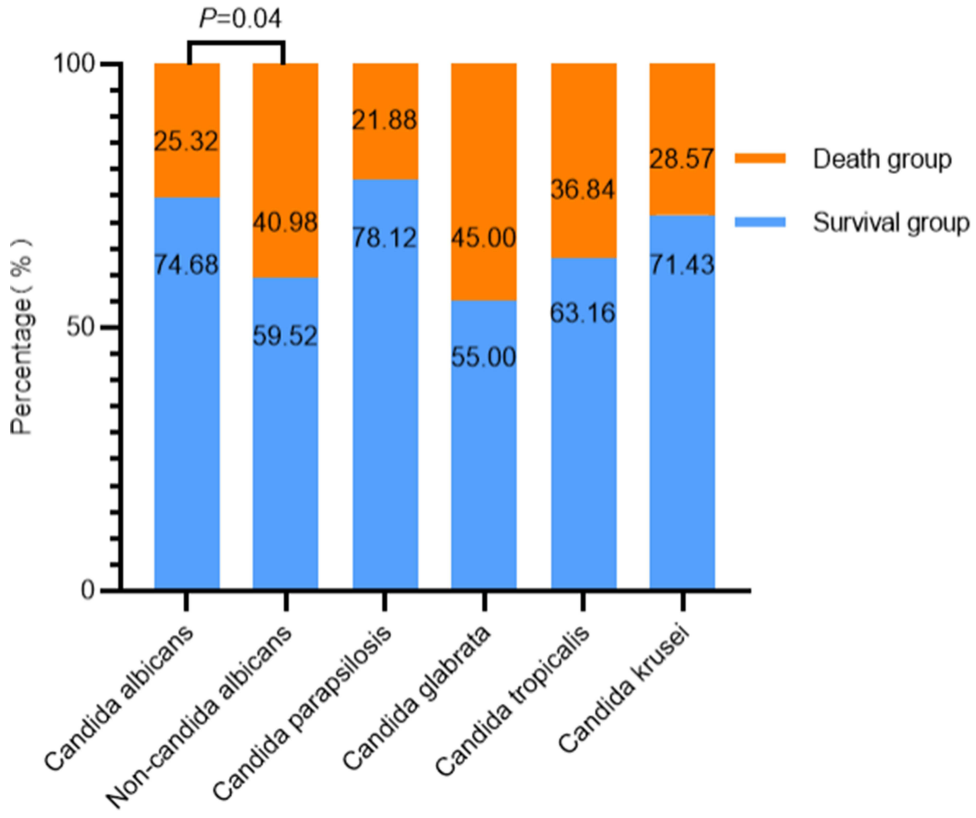

Figure 3 Death rate of patients with candida bloodstream infection.
Note: *P*, significance.

Table 3 Univariate Analysis of Characteristics of 54 Dead Patients with *Candida* BSI

Factors	Survival n = 109	Death n = 54	χ^2	*P*
Age≥60 years old (IQR)	57 (52.29)	35 (64.81)	2.303	0.129
Sex (male/female)	60/49	34/20	0.927	0.336
LOS (days)	38.52±44.68	27.30±18.12	2.749	0.097
Hypertension	30 (27.52)	22 (40.74)	2.904	0.088
Diabetes	20 (18.35)	16 (29.63)	2.671	0.102
Hematological malignancy	23 (21.10)	2 (3.70)	8.417	0.004*
Solid-organ cancer	29 (26.61)	9 (16.67)	1.995	0.158
Lung infection	62 (56.88)	38 (70.37)	2.771	0.096
Heart disease	35 (32.11)	17 (31.48)	0.007	0.935
Nervous system disease	36 (33.03)	17 (31.48)	0.039	0.843
Digestive system disease	35 (32.11)	25 (46.30)	3.124	0.077
Chronic kidney disease	33 (30.28)	14 (25.92)	0.333	0.564
Chronic liver disease	28 (25.69)	16 (29.63)	0.285	0.594
Urinary catheter	59 (54.13)	44 (81.48)	11.615	<0.001*
Stomach tube	32 (29.36)	29 (53.70)	9.140	0.003*
Body cavity drainage tube	33 (30.28)	25 (46.30)	4.044	0.044*
Arteriovenous catheters	32 (29.36)	37 (68.52)	22.685	<0.001*
Mechanical ventilation	44 (40.37)	41 (75.93)	18.298	<0.001*
Tracheotomy	25 (22.94)	16 (29.63)	0.859	0.354
Hemodialysis	3 (2.75)	11 (20.37)	16.904	<0.001*
Immunosuppressant use	77 (70.64)	41 (75.93)	0.504	0.478
ICU admission	38 (34.86)	36 (66.67)	14.735	<0.001*
History of department transfer	19 (17.43)	8 (14.81)	0.179	0.672
Previous surgery	48 (44.04)	23 (42.59)	0.031	0.861
Combined with other fungal infection	9 (8.26)	12 (22.22)	6.275	0.012*
Combined with other bacterial infection	73 (66.97)	34 (62.96)	0.257	0.612
APACHE II score	12.72±6.14	18.85±6.30	5.945	<0.001*
Neutrophil count	7.72±8.08	11.08±12.39	4.681	0.030*
Hemoglobin	106.27±25.25	102.69±27.40	18.980	<0.001*
Platelet count	179.50±112.82	167.61±108.79	0.319	0.572
CRP	73.40±80.12	106.95±85.13	0.933	0.334
Procalcitonin	9.41±20.81	13.70±29.00	1.257	0.262
1, 3-β-D-glucan	231.58±246.09	375.49±250.11	3.600	0.058

Note: *Significant statistical difference (*P*<0.05).
Abbreviations: IQR, interquartile range; BSI, bloodstream infection; LOS, length of stay; ICU, intensive care unit; CRP, C-reactive protein; χ^2, chi-square value; *P*, significance.

highest, accounting for 47.5%. Our data show that the infection rate of *Candida* bloodstream infection in patients ≥60 years old was 55.83%, and the infection rate gradually increased with increasing age, which was similar to that report. The intensive care unit, oncology department and hematology department of our hospital were the departments with high incidence of candidemia. The patients in ICU were critically ill and had low immunity. Most patients underwent urinary catheter, stomach tube, arteriovenous catheters, mechanical ventilation, and other invasive procedures. *Candida* BSI in patients from departments of oncology and hematology may be related to immune dysfunction caused by tumor cell infiltration, radiotherapy and chemotherapy.[23] In this study, 80% of patients with *Candida* BSI were complicated with two or more underlying diseases, mainly pulmonary infection, cardiovascular disease, hypertension and diabetes. More than 50% of the patients had a history of invasive procedures such as catheterization and arteriovenous catheterization. Invasive procedures destroy mucosal integrity. Catheter colonization and biofilm formation may be the important reasons for *Candida* entering the bloodstream and leading to bloodstream infection. At the same time, complicated with a variety of underlying diseases will further decrease the patient's immune function, prolong the length of hospital stay, and increase the chance of hospital-acquired *Candida* infection. Further analysis found that patients with *Candida* non-

Table 4 Multivariate Logistic Analysis of 54 Dead Patients with *Candida* BSI

Risk Factors	β	SE	Wald	OR	95% CI	*p*
ICU admission	0.990	0.651	2.313	2.691	0.751~9.635	0.128
Hemodialysis	−1.724	0.863	3.989	0.178	0.033~0.968	0.046*
Urinary catheter	0.263	0.704	0.140	1.301	0.328~5.168	0.708
Arteriovenous catheters	−1.373	0.617	4.955	0.253	0.076~0.849	0.026*
Stomach tube	−0.258	0.537	0.231	0.773	0.270~2.212	0.631
Body cavity drainage tube	0.013	0.505	0.001	1.013	0.376~2.727	0.980
Mechanical ventilation	−0.904	0.673	1.804	0.405	0.108~1.514	0.179
Combined with other fungal infection	−0.408	0.526	0.603	0.665	0.237~1.863	0.437
Hematological malignancy	−0.542	0.814	0.443	0.582	0.118~2.867	0.506
Neutrophil count	−1.012	0.468	4.666	0.364	0.145~0.910	0.031*
Hemoglobin	−0.332	0.442	0.564	0.717	0.302~1.706	0.452
APACHE II score	−0.165	0.037	20.045	0.848	0.789~0.911	<0.001*

Note: *Significant statistical difference (*P*<0.05).
Abbreviations: BSI, bloodstream infection; ICU, intensive care unit; β, regression coefficient; SE, standard deviation; OR, odds ratio; CI, confidence interval; *P*, significance.

albicans candidemia had a longer hospital stay and higher ICU admission rate than those with *Candida albicans* candidemia. In addition, it has a greater proportion of malignant tumors, pulmonary infections, other fungi, hemodialysis, invasive procedures (urinary catheter, stomach tube, body cavity drainage tube, arteriovenous catheter and mechanical ventilation) and elevated neutrophil count. Therefore, for clinically high-risk patients, the use of invasive procedures should be minimized, and patients with already invasive procedures should be removed early. In addition, the extensive use of immunosuppressants can lead to immunodeficiency or impaired immune function, which may increase the risk of *Candida* infection in patients. Therefore, the dose of drugs for such patients should be moderate in clinical practice. Clinicians should pay attention to patients at high risk of *Candida* BSI, and also pay attention to the evaluation of *Candida* species that may be infected.

The insidious onset of Candida infection and lack of characteristic clinical manifestations lead to difficult early diagnosis and poor prognosis in patients with candidemia. It has been reported in the literature[24,25] that approximately 1.5 million people die from fungal infections each year, and *Candida* BSI accounts for half of these deaths, with mortality rates that can reach 40% or higher. Therefore, it is necessary to control risk factors to reduce the mortality of hospitalized patients. Studies have shown that patients with underlying diseases such as diabetes mellitus, cardiovascular disease, tumor, history of broad-spectrum antibiotic use, APACHE II score ≥20, history of invasive operations (central venous catheterization, mechanical ventilation, etc.), length of ICU stay, surgery, and parenteral nutrition are associated with the death of patients with *Candida* BSI.[26,27] The results of univariate analysis between the death group and the survival group in this study showed that ICU admission, hemodialysis, invasive operation (urinary catheter, arteriovenous catheter, stomach tube, body cavity drainage tube, mechanical ventilation), hematological malignancy, elevated neutrophil count, decreased hemoglobin and APACHE II score were related to the prognosis of patients with candidemia, and there were statistically significant differences between the two groups ($P < 0.05$). Multivariate logistic regression analysis showed that hemodialysis, arteriovenous catheterization, increased neutrophil count and APACHE II score were independent risk factors for death in patients with *Candida* BSI. It is suggested that timely and appropriate treatment and nursing measures should be taken to improve the survival rate of these patients. In various studies, the prognosis of different *Candida* species is different, which may be related to the differences in virulence of different strains. The analysis of this study found that there was a statistically significant difference in the prognosis of patients with *Candida albicans* and *Candida* non-*albicans* in our hospital ($P < 0.05$). Patients with *Candida* non-*albicans* bacteremia had a higher mortality rate, and the mortality rate of *Candida glabrata, Candida tropicalis* and *Candida krusei* BSI was higher, which was consistent with recent reports.[28,29]

Candida showed high sensitivity to most antifungal drugs, and only one of the 163 *Candida* strains in this study showed that amphotericin B was non-wild type. *Candida albicans* has a small number of strains resistant to triazole

antifungal agents. It is noteworthy that the resistance of *Candida* non-*albicans* to triazole antifungal drugs has increased significantly, among which more than 15% of strains of *Candida tropicalis* are resistant to drug, which is significantly higher than that of other *Candida*, and similar to literature reports.[30,31] This may be due to the low adverse reactions, reasonable price and wide penetration into tissues of triazole drugs, fluconazole has become the first choice of clinicians for preventive or empirical medication of *Candida* patients, and the extensive clinical use of this type of antifungal drug has induced drug resistance.[27] Therefore, clinicians need to consider the factors of *Candida* non-*albicans* infection and formulate a more reasonable treatment plan when conducting empirical antifungal therapy for patients.

This study was based on the clinical data of 163 patients with *Candida* BSI admitted to the First Affiliated Hospital of Bengbu Medical College in the past 10 years. The study has limitations in some respects. Firstly, we used time-of-flight mass spectrometry to identify clinical isolates of *Candida*. Due to the limitations of the bacterial bank, there may be a bias in the identification of strains. Secondly, with the increase of resistance to azole antifungal drugs, more antifungal drugs have attracted clinical attention. Echinocandins antifungal drugs interfere with the synthesis of β-1, 3-glucose in the fungal cell wall, leading to changes in the permeability of the fungal cell wall and cell lysis and death. Because of its high susceptibility to *Candida* and low toxicity to humans, it has been recommended as the first-line treatment for candidemia by the Infectious Diseases Society of America and the European Society of Clinical Microbiology and Infectious Diseases guidelines. However, sensitivity to echinocandins was not tested in this study due to the limitations of drug susceptibility testing kits. Finally, this study is only a single-center retrospective study in our hospital, which may affect the control factors of the variables and lead to bias in the results. It will be better to verify the results of this study through the analysis of a large number of multi-center data in the region, so as to reflect the relevant situation of *Candida* BSI in the region.

Conclusion

Our study found that the bloodstream infection rate of *Candida* non-*albicans* is increasing, and the high rate of drug resistance and mortality is more worthy of attention. For people with risk factors, laboratory tests should be performed in time to make an early diagnosis. More attention should be paid to middle-aged and elderly patients with multiple underlying diseases and critically ill patients admitted to ICU, and the risk factors of death should be eliminated as early as possible to reduce the risk of death of patients.

Ethical Approval

In this study, strains isolated from patient samples were used for research without adverse reactions and risks to the subjects, and the research data should be kept confidential for the information of the subjects, including cases and biological samples. The study was approved by the Medical Ethics Committee of the First Affiliated Hospital of Bengbu Medical College. This study was conducted in accordance with the Declaration of Helsinki.

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Disclosure

The authors declare that there is no conflict of interest in this work.

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