Clinical and Experimental Health Sciences

Evaluation of Candidemia Cases Developed in the Intensive Care Unit: A Ten-Year Analysis

Ömer Uğur[1], Barış Balaşar[2], Selvinaz Demirel[3], Huzeyfe Feyyaz Demirel[1], Mustafa Tomruk[1], Esma Eroğlu[2]

[1] Konya Meram State Hospital, Department of Anesthesiology and Reanimation, Meram/Konya Türkiye.
[2] Konya Meram State Hospital, Department of Infectious Diseases and Clinical Microbiology , Meram/Konya Türkiye.
[3] Konya Numune Hospital, Department of Anesthesiology and Reanimation, Konya Türkiye.

Correspondence Author: Esma Eroğlu
E-mail: esmagulesen@hotmail.com
Received: 22.02.2023 **Accepted:** 02.08.2024

ABSTRACT

Objective: Fungal infections have been a major health problem for many years. They constitute a major cause of increased mortality and morbidity, especially in immunocompromised patients and intensive care unit (ICU) patients. In this study, we aimed to evaluate the epidemiologic characteristics, mortality and causative agent distribution of cases of healthcare-associated candidemia (HCA) in intensive care units of our hospital and to contribute to the literature.

Methods: Our study included patients diagnosed with healthcare-associated candidemia who were hospitalized in 3rd level ICUs with various complaints between November 2011 and August 2021 in Meram State Hospital.

Results: In our study, the mean age of patients who developed candida infection during intensive care unit hospitalization was 67.2±20.5 years. Of these patients, 59.5% (n:103) were men and 40.5% (n:70) women. Mean duration of hospitalization in the intensive care unit was 38.2±29.5 (min:1, max:231) days. Grouping of candida related HCAIs developed in patients according to Centers for Disease Control and Prevention (CDC) criteria shows that the most common candida related healthcare-associated infection (HCAI) was central line-associated bloodstream infection (CLABSI) at 52% and the second most common was laboratory-confirmed bloodstream infection (LCBI) at 31.2%. Cumulatively, candidemia are significantly higher to other candida related HCAIs.

Conclusion: To prevent and empirically treat candidemia, which has a very high mortality rate, the causative agent distribution of the center should be well understood. Large-scale, high-quality studies using various biomarkers in addition to clinical findings for the correct antifungal selection and to reduce mortality due to invasive candidiasis in line with these selections are warranted.

Keywords: Candidemia, mortality, healthcare-associated infection, HCAI

1. INTRODUCTION

Fungal infections have been a major health problem for many years. They constitute a major cause of increased mortality and morbidity, especially in immunocompromised patients and intensive care unit (ICU) patients (1). Candida species account for a large proportion of healthcare-associated fungal infections (HCFAIs). According to the Centers for Disease Control and Prevention (CDC), *Candida albicans* is the 7th most common nosocomial agent (2,3).

In humans, Candida is a normal flora element of the gastrointestinal and genitourinary systems. However, under appropriate conditions, it may exhibit a wide range of pathogenicity from regional mucosal infection to septicemia with multiple organ failure. The immune response of the host plays a decisive role in the development of Candida infection or determination of the type of infection (4).

In ICU patients, the risk of developing fungal infections has increased due to reasons such as sepsis-related disruption in the mucosal and/or skin barrier, advanced age, impaired production or function of neutrophils, metabolic dysfunction, prolonged surgery, prolonged exposure to broad-spectrum antibiotics, intravenous nutrition, mechanical ventilation, and use of multipath catheters (5). While the number of ICU beds constitutes approximately 5% of the total number of hospital beds, the development of more than 20% of health

DOI: 10.33808/clinexphealthsci.1254373

care-associated infections in ICU patients emphasizes the importance of the situation (6). In addition to the increasing number of invasive candidiasis cases worldwide, a prospective study reports an increase in non-albicans candida infections, which are highly virulent and frequently associated with treatment failure (7).

Early diagnosis and treatment of healthcare-associated candida infections that will develop in these patients becomes more important due to factors such as high morbidity and mortality in ICU patients, prolonged hospitalization and increased health care costs. However, the diagnosis of invasive candida infections is usually based on suspicion. Most of the time, the patient's clinic cannot be differentiated from a bacterial infection (8). However, there are no main criteria for empirical antifungal use in ICU patients. Meanwhile, early antifungal treatment is not recommended due to reasons such as antifungal resistance, drug toxicity and increased treatment cost (9). Antifungal treatment is frequently initiated in ICU patients after failure to respond to antibacterial treatment (7).

In our study, we aimed to examine the epidemiologic characteristics, mortality, and causative agent distribution of healthcare-associated candida infections that developed in the intensive care units of our hospital for a period of 10 years in order to evaluate the situation and contribute to the literature.

2. METHODS

The study approval was obtained from Karatay University Faculty of Medicine, Non-interventional Clinical Trials Ethics Committee (approval date/number: 21.09.2022/2022/020). Following the ethics committee approval we included patients who were hospitalized in the 3rd level ICUs (Emergency critical ICU, Neurosurgery ICU, Internal Medicine ICU, General surgery ICU, General ICU, Chest diseases and Thoracic surgery ICU, Coronary and Cardiovascular surgery ICU, Nephrology ICU, Neurology ICU, Reanimation ICU) with various complaints between November 2011 and August 2021 in Konya Meram State Hospital, who had candida growth in the samples taken, and who were diagnosed with infection with clinical or laboratory findings of these growths and who were older than 18 years of age. Surveillance data of these patients prospectively recorded by the infection control committee operating within the hospital were retrospectively analyzed. Patients who developed HCAIs but in whom no candida species grew were excluded from the study. The number of patients enrolled in the study was 173.

Microbiologic evaluation

Various samples (blood, catheter, urine, tracheal aspirate, throat, bronchoalveolar lavage culture) were collected from the patients based on clinical and physical examination results. Cultures were repeated at appropriate intervals for patients whose fever persisted above 38°C. Sterile samples were incubated in BACTEC 9240 (Becton Dickson, Diagnostic Instrument System, Spark, USA) and necessary inoculation and candida related identification procedures were performed by microbiology specialists working in our hospital. HCAIs were diagnosed and identified according to the generally accepted CDC criteria (10).

Statistical analysis

For statistical analysis, mean, standard deviation, minimum, maximum and ratio were used as descriptive statistics of the data. The t-test was used for intergroup comparisons, Mann-Whitney U test was used in the presence of data not conforming to normal distribution, and Chi-square test and Fisher's Exact test were used to analyze categorical data. For statistical significance, $p<.05$ was accepted. IBM SPSS® 23.0 program was used in the analyses.

3. RESULTS

In our study, the mean age of patients who had candida infection during intensive care unit hospitalization was 67.2±20.5 years (min: 18, max: 96). Of these patients, 59.5% (n:103) were men and 40.5% (n:70) women. The mean duration of hospitalization in intensive care unit was 38.2±29.5 (min:1, max:231) days.

Our study enrolled patients who developed candida infection in all 3rd level ICUs operating within the hospital during the determined date intervals. The distribution of patients with candida infection by the ICUs is given in Table 1.

Table 1. *The distribution of patients with candida infection by the ICUs.*

Inpatient Ward	Number of Patients (n)	Percentage (%)
Reanimation ICU	30	17.3
Neurology ICU	28	16.2
Nephrology ICU	26	15
Emergency Critical ICU	25	14.5
Chest Diseases ICU	22	12.7
Cardiovascular Surgery ICU	12	6.9
Internal Medicine ICU	10	5.8
General Surgery ICU	7	4
General ICU	6	3.5
Neurosurgery ICU	5	2.9
Thoracic Surgery ICU	2	1.2

Since we did not focus on a single ICU patient in our study, the diagnosis of patients for hospitalization also varied. The diagnoses of the patients admitted to the ICU are detailed in Table 2.

Our analysis revealed that 75.1% (n:130) of the patients who were followed up and treated in different ICUs for various reasons did not have any comorbid condition at the time of hospitalization, while 24.9% (n:43) had one or more

comorbidities. The distribution of comorbid events recorded is given in Table 3.

Table 2. *Diagnoses for ICU Admission.*

Diagnosis at Admission	Number of patients (n)	Percentage (%)
General state disorder (GSD)	27	15.6
Cerebrovascular accident (CVA)	24	13.9
Renal failure (Acute/Chronic)	19	11
Trauma	18	10.4
Pneumonia	14	8.1
Asthma/COPD exacerbation	13	7.5
Malignancy	10	5.8
Other respiratory events	9	5.2
Ischemic heart disease	8	4.6
Other	7	4
Congestive heart failure (CHF)	6	3.5
Other neurological diseases	4	2.3
Ileus and its complications	3	1.7
Postoperative follow-up	3	1.7
Pulmonary embolism	3	1.7
GI bleeding	2	1.2
Septicemia	2	1.2
COVID-19	1	0.6

Table 3. *Comorbidity status at admission*

Comorbid	Alive (n)	Dead (n)	p Value
	20	23	0.475
Comorbidity	**Number of patients (n)**		**Percentage (%)**
Chronic renal failure	13		30.2
Hypertension	9		20.9
Malignancy	8		18.6
CVA	6		14
CHF	5		11.6
Diabetes Mellitus (DM)	4		9.3
Asthma/COPD	4		9.3
Other	2		4.7
Coronary artery disease	1		2.3

CVA: Cerebrovascular accident, CHF: Congestive heart failure, COPD: Chronic obstructive pulmonary disease

Grouping of candida related HCAIs developed in patients according to CDC criteria shows that the most common candida related HCAI was central line-associated bloodstream infection (CLABSI) at 52% and the second most common was laboratory-confirmed bloodstream infection (LCBI) at 31.2%. Cumulatively, candidemia are significantly higher to other candida related HCAIs. The distribution of all candida related HCAIs is shown in table 4.

When patients with candida related HCAI were evaluated for the development of secondary candida related infection, only 9 patients (5.2%) developed secondary infection in addition to the existing candida related HCAI.

It is undeniable that ICU patients are exposed to various invasive interventions due to their treatment needs and severe clinical pictures. These invasive procedures constitute a risk factor for the development of infection in general. Thus, we analyzed the parameters that may be risk factors for the development of HCAI in our patients (Table 5). Seven (4%) of our patients did not have any risk factor, whereas 166 (96%) patients had one or more risk factors. The most common risk factor in our patients was the use of urinary catheter at a rate of 95.8%. This was followed by central venous catheter use at 88% and mechanical ventilation at 69.3%.

Table 4. *Distribution of Candida related HCAIs*

Type of HCAI (%)	Alive (n)	Dead (n)	p Value
CLABSI (52)	34	56	.639
LCBI (31.2)	20	34	
Catheter-associated urinary tract infection (CAUTI) (8.1)	8	6	
Other infections of the respiratory system (3.5)	2	4	
Primary deep incisional candida infection (2.3)	4	0	
Health care-associated pneumonia (HCAP)	1	2	
Symptomatic UTI (0.6)	1	0	
Intracranial infections (0.6)	1	0	

CLABSI:Catheter line-associated infection LCBI: Laboratory-confirmed bloodstream infection

Table 5. *Risk factors.*

Risk Factor(%)	Alive (n)	Dead (n)	p Value*
Use of urinary catheter (95.8)	62	97	.065
Use of central venous catheter (88)	55	91	*.036**
Mechanical ventilation (69.3)	39	76	*.005**
Total parenteral nutrition (61.4)	43	59	.720
Use of H_2 receptor antagonists (36.1)	30	30	.104
Blood transfusion (35.5)	24	35	.944
Use of peripheral arterial catheter (35.5)	28	31	.255
Enteral nutrition (32.5)	26	28	.243
Hemodialysis (28.3)	16	31	.299
Surgical drain (5.4)	8	1	*.003**
Chest tube/thoracentesis (2.4)	3	1	.307
Colostomy (1.8)	1	2	.784
Nephrostomy (1.8)	2	1	.569
Lumbar puncture (1.2)	1	1	1.000

**p≤.05*

Candida species that cause HCAI were also analyzed by screening the culture results of our patients. According to surveillance data, the most common causative agent was *Candida parapsilosis* (37.6%) and the second most common causative agent was *C. albicans* (24.3%) (Table 6).

Table 6. *Distribution of Candida species.*

Candida Species (%)	Alive (n)	Dead (n)	p Value
C. parapsilosis (37.6)	25	40	.294
C. albicans (24.3)	19	23	
C. tropicalis (6.9)	4	8	
C. glabrata (2.9)	1	4	
C. lusitaniae (1.7)	1	2	
C. famata (1.2)	1	1	
C. kefyr (0.6)	0	1	
C. dubliniensis (0.6)	0	1	
Candida spp. (24.3)	20	22	

In our study, we observed that the mortality in patients with candida related HCAI was 59%. In addition, we also evaluated whether age, gender, comorbidity, and development of secondary infection had an effect on mortality among the patients included in the study.

No statistically significant difference was found between gender and mortality in our patients with Candida related HCAI (p>.05). However, there was a statistically significant difference between the age of the patients and mortality (p>.05).

Patients were divided into two groups of ≤ 14 days and ≥ 15 days according to the length of hospitalization and the effect on mortality was evaluated. However, no statistically significant difference was found between the days in the ICU and mortality (p>.05).

We also evaluated the relationship between the type of infection and the development of secondary infection with mortality. No statistically significant correlation was found between the mortality of the patients and either the type of infection or the development of secondary candida related HCAI (p values .639 – .110, respectively).

We also performed an analysis to evaluate the effect of comorbidities on the mortality of candida related HCAI and found no statistically significant difference between mortality in the groups with and without comorbidities (p>.05). In addition, we also found that 7 patients had multiple comorbidities. We compared these 7 patients with patients who had only one comorbidity in terms of mortality. However, we did not find a statistically significant difference in mortality between the group of patients with one comorbidity and the group of patients with multiple comorbidity (p>.05).

Analysis of the effect of risk factors for HCAI on mortality revealed that the use of MV (p>.01), the surgical drain (p>.01) and the use of CVC (p>.05) increased mortality statistically significantly, while there was no statistically significant difference between the other factors and mortality.

Finally, the difference between the genus of the pathogen causing candida related HCAI and mortality was examined and no statistically significant difference was found between candida species and mortality (p>.05). Since the number of HCAIs caused by Candida species such as *C. famata, C. dubliniensis, C. kefyr* was very low, they were grouped under two groups as albicans and non-albicans and re-evaluated. However, no statistically significant difference was found between the albicans and non-albicans groups in terms of mortality (p>.05).

4. DISCUSSION

Critically ill patients who are treated in intensive care units are facing healthcare-associated invasive candidiasis due to the necessity of various invasive interventions, the use of broad-spectrum and multiple antibiotics, or the use of immunosuppressant drugs such as corticosteroids. Generally, cases of HCAI invasive candidiasis developing in this patient group cause high mortality and morbidity (11).

According to a review of invasive candidiasis cases worldwide, the causative agent is mostly identified as C. *albicans*. However, there has been a significant increase in the detection of non-albicans candida species in the last decades and they have been the cause of almost 50% of the cases (7, 12).

In our study, unlike most of the studies in the literature (13-15), we found that C. *parapsilosis* was the most common causative agent of candida related HCAI. C. *albicans* was the second most common causative agents with the same rates. In a study from our country, C. *parapsilosis* was the most frequent agent and C. *albicans* was the second most frequent agent isolated from blood culture (16).

C. *glabrat*a was detected as the most common non-albicans candida species throughout the world except Latin America. Similar to our study, the most common non-albicans species in Latin America was C. *parapsilosis* (15). Growth of C. *kefyr* was detected in only one of the patients in our study. Candidemia of C. *kefyr* is generally observed in patients with intensive use of corticosteroids or other immunosuppressant agents or in patients with severe malignancy causing immunodeficiency (17). We have also determined that our patient was a patient with malignancy-related immunodeficiency in parallel with the data in the literature. As these studies*, C. parapsilosis* in candidemia is posing a major threat for immunocompromised patients. The study highlights the urgent need to evaluate the possibility of development of *C. parapsilosis* candidemia in immunocompromised patients exposed to these risk factors effective should be implemented.

Classification of the candida related HCAIs that developed in our patients according to CDC criteria revealed that the most common infection was CLABSI at a rate of 52%. In a study the most common candida related HCAI was CAUTI (73.1%; n: 30) (18). This difference is speculated to be due to the time period during which the patients included in the study were hospitalized in intensive care unit. Because according to the CDC criteria published in 2016, candida growth alone in the urine sample does not diagnose UTI. Patients hospitalized between 2014 and 2016. Whereas, since the patient population in our study was from 2011 to 2021, we observed

a dramatic decrease in the number of CAUTIs since 2016 in the same study.

Rates vary depending on various factors, but HCAI invasive candidiasis infections have a high mortality rate with an attributable rate of approximately 49%. Moreover, this rate may increase up to 98% in septic shock cases in which antifungal treatment is delayed (19). In our study, we found a mortality rate of 59% in cases of HCAI invasive candidiasis developing in the ICU. Similar to our study, it was reported a 30-day post-infection mortality of 57.1% (16).

The intensive care unit patient group generally consists of patients with additional comorbidities. Previous studies have reported that DM predisposes to invasive candidiasis due to microvascular perfusion disorders, immunocompromisation, neutrophil function defects and hyperglycemia (20,21). In our study, no significant relationship was found between any comorbid condition, including DM, and mortality. It is thought that this may be related to our sample. Because only 43 of our 173 patients had comorbid conditions and only 4 of them had DM.

A meta-analysis reported that renal replacement therapy, mechanical ventilation, blood transfusion and DM were important risk factors in addition to well-known risk factors for invasive candidiasis infections (TPN use, colonization with candida, abdominal surgery, broad-spectrum antibiotic use, sepsis) (22).

Since there were no candida-negative cases in the patient group included in our study, we evaluated the effect of these risk factors on mortality. In the light of the data we obtained, we noted that the use of MV, CVC and surgical drains made a statistically significant difference in mortality. Similar to our results, it was found the relationship between MV and mortality to be significant, whereas the relationship between the use of CVC was found to be insignificant in their study (18). It was also found a significant association between MV and mortality in their study on HCAI candida infections in ICU patients (23). In a similar study, it was found no significant association between MV and the development of invasive candidiasis but found a significant association with tracheostomy (14).

Although candida species have the ability to grow even in parenteral nutrition fluids where bacteria cannot grow, in our study, no significant relationship was found between the use of TPN and mortality (24). In our study, no significant relationship was seen between gender and mortality, whereas a significant relationship was observed between age and mortality. However, in another study, no significant relationship between neither age nor gender and mortality (18).

Prolonged hospitalization in the ICU is a risk factor for invasive candidiasis due to severe disease status and invasive therapies. In addition, one-way regression analyses showed a high odds ratio (OR) for length of ICU stay (22). Patients were divided into 3 groups according to length of stay as less than 7 days, 7-14 days and more than 14 days and evaluated the relationship with the development of invasive candidiasis and found that the development of invasive candidiasis was significantly higher in the groups of less than 7 days and more than 14 days (14). In our study, since there were no candida-negative cases, we divided the patients into two groups as ≤14 days and ≥15 days and examined whether there was a difference in terms of mortality. We noted no statistically significant difference in mortality between the two groups.

Invasive infection severity, treatment strategies, virulence, infection prognosis and even clinical diagnosis of various candida species may be different (25). We therefore compared the mortality of all candida species (*Candida spp., C. albicans, C. parapsilosis, C. tropicalis, C. glabrata, C. famata, C. kefyr, C. dubliniensis, C. lusitiane*) isolated from our patients. Our analysis showed that there was no significant difference between candida species in terms of mortality. Since we had a limited number of patients with some rare species, we divided the patients into two groups as albicans and non-albicans and made another comparison. Again, no significant difference was found in terms of mortality. In a study no mortality difference was found between candida species (18). However, in a study on patients hospitalized in chest diseases ICU, mortality was higher in patients with non-albicans growth than in patients with albicans growth (26). In addition, patients were devided into 3 groups (A: *C. albicans*, B: *C. parapsilosis*, *C. tropicalis*, C: *C. glabrata*, *C. krusei*) and investigated their effects on mortality. At the end of the study, they found no significant difference of mortality between group A and B but reported that group C had significantly less mortality than group A (27).

Our study has various limitations. While most of the studies in the literature involved single ICU patients and several-year episodes, our study included all 3rd level ICU patients except the pediatric ICU operating within our hospital and a 10-year period was scanned. Our study was not multicenter, which prevents the generalization of our results. In addition, our study has a retrospective design, therefore not all of the data required for the calculation of the "Candida Score" for invasive candidiasis could be obtained and the relationship between high score and mortality could not be examined (28). Another point is that the antifungal resistance pattern could not be studied for patients in every period in our hospital. Since the cases hospitalized with candidemia were analyzed retrospectively, the number of echoes that could be reached was very low (due to the recording of the echo results on a different system), and echo records were not stated respectively, because hospitalized cases with candida were analyzed.

5. CONCLUSION

Candida species are among the flora elements of our body but can cause invasive candidiasis infections of varying severity in immunocompromised patient populations such as critically ill patients in the ICU. Many factors affect the severity of infection to a greater or lesser extent. Our study suggests that the use of MV, age, use of CVC, and surgical

drains increase the mortality rate. To prevent and empirically treat candidemia, which has a very high mortality rate, the causative agent distribution of the center should be well understood. Large-scale, high-quality studies using various biomarkers in addition to clinical findings for the correct antifungal selection and to reduce mortality due to invasive candidiasis in line with these selections are warranted.

Acknowledgement: *We would like to thank the nurses for their participation*

Funding: *The author(s) received no financial support for the research.*

Conflicts of interest: *The authors declare that they have no conflict of interest.*

Ethics Committee Approval: *This study was approved by Karatay University Faculty of Medicine Ethics Committee (21.09.2022 and numbered 2022/020)*

Peer-review: *Externally peer-reviewed.*

Author Contributions:

Research idea: EE

Design of the study: ÖU

Acquisition of data for the study: HFD, MT

Analysis of data for the study: ÖU, SD

Interpretation of data for the study: ÖU, EÇK

Drafting the manuscript: ÖU, BB

Revising it critically for important intellectual content: MT

Final approval of the version to be published: EE

REFERENCES

[1] Pfaller MA, Diekema DJ. Epidemiology of invasive candidiasis: A persistent public health problem. Clin Microbiol Rev. 2007;20(1):133-63. DOI:10.1128/CMR.00029-06.

[2] Martin-Loeches I, Antonelli M, Cuenca-Estrella M, Dimopoulos G, Einav S, De Waele JJ, Garnacho-Montero J, Kanj SS, Machado FR, Montravers P, Sakr Y, Sanguinetti M, Timsit JF, Bassetti M. ESICM/ESCMID task force on practical management of invasive candidiasis in critically ill patients. Intensive Care Med. 2019;45(6):789-805. DOI: 10.1007/s00134.019.05599-w.

[3] Sydnor ER, Perl TM. Hospital epidemiology and infection control in acute-care settings. Clin Microbiol Rev. 2011; 24(1): 141–173. DOI: 10.1128/CMR.00027-10

[4] Pappas PG, Kauffman CA, Andes DR, Clancy CJ, Marr KA, Ostrosky-Zeichner L, Reboli AC, Schuster MG, Vazquez JA, Walsh TJ, Zaoutis TE, Sobel JD. Clinical practice guideline for the management of candidiasis: 2016 update by the Infectious Diseases Society of America. Clin Infect Dis. 2016;62(4):e1-50. DOI: 10.1093/cid/civ933.

[5] Poissy J, Damonti L, Bignon A, Khanna N, Von Kietzell M, Boggian K, Neofytos D, Vuotto F, Coiteux V, Artru F, Zimmerli S, Pagani JL, Calandra T, Sendid B, Poulain D, van Delden C, Lamoth F, Marchetti O, Bochud PY. Risk factors for candidemia: A prospective matched case-control study. Crit Care 2020;24(1):109. DOI: 10.1186/s13054.020.2766-1.

[6] Zaragoza R, Ramírez P, López-Pueyo MJ. Nosocomial infections in intensive care units. Enferm Infecc. Microbiol Clin. 2014; 32(5):320-7. DOI: 10.1016/j.eimc.2014.02.006.

[7] Ahmad S, Kumar S, Rajpal K, Sinha R, Kumar R, Muni S, Kumari N. Candidemia among ICU patients: Species characterisation, resistance pattern and association with candida score: A prospective study. Cureus 2022;14(4):e24612. DOI: 10.7759/cureus.24612.

[8] Luzzati R, Merelli M, Ansaldi F, Rosin C, Azzini A, Cavinato S, Brugnaro P, Vedovelli C, Cattelan A, Marina B, Gatti G, Concia E, Bassetti M. Nosocomial candidemia in patients admitted to medicine wards compared to other wards: A multicentre study. Infection 2016;44(6):747-755. DOI: 10.1007/s15010.016.0924-9.

[9] Ostrosky-Zeichner L. Prophylaxis or preemptive therapy of invasive candidiasis in the intensive care unit? Crit Care Med. 2004;32(12):2552-3. DOI: 10.1097/01.ccm.000.014.8226.95597.7e.

[10] Horan TC, Andrus M, Dudeck MA. CDC/NHSN Surveillance definition of health care-associated infection and criteria for types of infections in the acute care settings. Am. J. Infect. Control. 2008; 36(5):309-332. DOI: 10.1016/j.ajic.2008.03.002.

[11] Logan C, Martin-Loeches I, Bicanic T. Invasive candidiasis in critical care: Challenges and future directions. Intensive Care Med. 2020;46(11):2001-2014. DOI: 10.1007/s00134.020.06240-x.

[12] Arendrup MC. Epidemiology of invasive candidiasis. Curr Opin Crit Care 2010; 16(5):445-52. DOI: 10.1097/MCC.0b013e32833e84d2.

[13] Ioannou P, Vouidaski A, Spernovasilis N, Alexopoulou C, Papazachariou A, Paraschou E, Achyropoulou A, Maraki S, Samonis G, Kofteridis DP. Candida spp. isolation from critically ill patients' respiratory tract. Does antifungal treatment affect survival? Germs 2021:29;11(4):536-543. DOI: 10.18683/germs.2021.1288

[14] Wang B, He X, Lu F, Li Y, Wang Y, Zhang M, Huang Y, Xia J. Candida isolates from blood and other normally sterile foci from icu patients: Determination of epidemiology, antifungal susceptibility profile and evaluation of associated risk factors. Front Public Health 2021;11:9:779590. DOI: 10.3389/fpubh.2021.779590.

[15] Pfaller MA, Diekema DJ, Turnidge JD, Castanheira M, Jones RN. Twenty years of the SENTRY antifungal surveillance program: Results for Candida species from 1997–2016. Open Forum Infectious Diseases 2019; 6(1):79-94. DOI: 10.1093/ofid/ofy358.

[16] Kerget F, Karaşahin Ö, Çelik N, Kerget B, Yılmaz Sİ. Evaluation of candida species and candidemia risk factors isolated from patient samples in intensive care unit. Bozok Med J. 2020;10(4):55-61. DOI: 10.16919/bozoktip.636282

[17] Spiliopoulou A, Kolonitsiou F, Vrioni G, Tsoupra S, Lekkou A, Paliogianni F. Invasive Candida kefyr infection presenting as pyelonephritis in an ICU hospitalized COVID-19 patient: Case report and review of the literature. J Mycol Med. 2022; 32(2):101236. DOI: 10.1016/j.mycmed.2021.101236

[18] Çetin Ş, Sav H, Çelik İ, Bolat E, Afsar-Çagır F, Bulut T, Şengül G, Baslarlı S, Kaya Hassu Ö. Evaluation of health-care associated Candida infections in an intensive care unit Turk Hij Den Biyol Derg, 2019;76(2):169-176. DOI:10.5505/TurkHijyen.2018.78785

[19] Kollef M, Micek S, Hampton N, Doherty JA, Kumar A. Septic shock attributed to Candida infection: Importance of empiric therapy and source control. Clin Infect Dis. 2012;54(12):1739-1746. DOI: 10.1093/cid/cis305

[20] Michalopoulos A, Kriaras J, Geroulanos S. Systemic Candidiasis in Cardiac Surgery Patients. Eur J Cardiothorac Surg. 1997;11:728–31. DOI: 10.1016/s1010-7940(96)01071-8.

[21] Muskett H, Shahin J, Eyres G, Harvey S, Rowan K, Harrison D. Risk factors for invasive fungal disease in critically ill adult

patients: A systematic review. Crit Care 2011;15(6):R287. DOI: 10.1186/cc10574.

[22] Thomas-Rüddel DO, Schlattmann P, Pletz M, Kurzai O, Bloos F. Risk factors for invasive candida infection in critically ill patients: A systematic review and meta-analysis. Chest 2022;161(2):345-355. DOI: 10.1016/j.chest.2021.08.081.

[23] Yang SP, Chen YY, Hsu HS, Wang FD, Chen LY, Fung CP. A risk factors analysis of healthcare-associated fungal infections in an intensive care unit: A retrospective cohort study. BMC Infect Dis. 2013;13:1-10. DOI: 10.1186/1471-2334-13-10.

[24] Kuwahara T, Shimono K, Kaneda S, Tamura T, Ichihara M, Nakashima Y. Growth of microorganisms in total parenteral nutrition solutions containing lipid. Int J Med Sci. 2010;7(3):101-109. DOI: 10.7150/ijms.7.101

[25] Perlin DS, Rautemaa-Richardson R, Alastruey-Izquierdo A. The global problem of antifungal resistance: Prevalence, mechanisms, and management. Lancet Infect Dis. 2017; 17(12):e383-e392. DOI: 10.1016/S1473-3099(17)30316-X.

[26] Adigüzel N, Karakurt Z, Güngör G, Yazicioğlu Moçin O, Acartürk E, Soğukpinar O, Baran R. Mortality rates and risk factors associated with nosocomial Candida infection in a respiratory intensive care unit. Tuberk Toraks 2010;58(1):35-43. PMID: 20517727.

[27] Jung IY, Jeong SJ, Kim YK, Kim HY, Song YG, Kim JM, Choi JY. A multicenter retrospective analysis of the antifungal susceptibility patterns of Candida species and the predictive factors of mortality in South Korean patients with candidemia. Medicine (Baltimore) 2020; 99(11):e19494. DOI: 10.1097/MD.000.000.0000019494.

[28] León C, Ruiz-Santana S, Saavedra P, Galván B, Blanco A, Castro C, Balasini C, Utande-Vázquez A, González de Molina FJ, Blasco-Navalproto MA, López MJ, Charles PE, Martín E, Hernández-Viera MA; Cava Study Group. Usefulness of the "Candida score" for discriminating between Candida colonization and invasive candidiasis in non-neutropenic critically ill patients: A prospective multicenter study. Crit Care Med. 2009;37(5):1624-33. DOI: 10.1097/CCM.0b013e31819daa14.

How to cite this article: Uğur Ö, Balasar B, Demirel S, Demirel HF, Tomruk M, Eroğlu E. Evaluation of Candidemia Cases Developed in the Intensive Care Unit: A Ten-Year Analysis. Clin Exp Health Sci 2024; 14: 636-642. DOI: 10.33808/clinexphealthsci.1254373