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ORIGINAL RESEARCH

The Prevalence and Risk Factors of Trichosporonosis at King Abdulaziz University Hospital

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Background: Fungal infections, especially those caused have emerged as a significant medical concern over the past three decades, particularly among immunocompromised patients. However, recent studies have highlighted the increasing prevalence of fungal infections resembling yeast other than *Candida*, such as trichosporonosis, especially among immunosuppressed individuals worldwide. *Trichosporon* has been identified as a significant contributor to superficial and invasive infections. Invasive trichosporonosis, primarily affecting immunocompromised patients, poses a significant threat with high mortality rates.

Purpose: The current study aimed to explore the clinical epidemiology of *Trichosporon* spp at King Abdulaziz University Hospital (KAUH) in Saudi Arabia.

Methods: This retrospective study aimed to assess the clinical epidemiology of *Trichosporon* spp. infections in microbiology cultures obtained from KAUH in Saudi Arabia. The study analyzed data from patients over a five-year period, focusing on demographic, clinical, and microbiological characteristics.

Results: This study encompassed 21 participants, categorized into four distinct age groups. Moreover, this study indicated *T. asahii* as the predominant species isolated, accounting for 90.5% of infections, followed by *T. mucoides* (9.5%). ICU hospitalization, diabetes mellitus, taking immunosuppressive drugs, and antifungal drugs, and the use of invasive medical equipment were identified as prominent risk factors for trichosporonosis. Urinary tract infections were the most common clinical presentation, particularly among male and elderly patients. Mortality rates were high, especially among older individuals.

Conclusion: This study contributes valuable epidemiological insights into trichosporonosis, highlighting the need for enhanced surveillance and preventive strategies in healthcare settings. Further research is warranted to optimize treatment approaches and infection control measures, ultimately reducing the burden of *Trichosporon* infections on patient outcomes.

Keywords: fungal infection, trichosporonosis, *Trichosporon* spp, *Trichosporon asahii*, invasive, risk factors

Introduction

In the past three decades, fungal infections have been found to cause severe medical manifestations in patients with cancer, organ transplant recipients, deep burns victims, immunosuppressive therapy users, and patients with immunodeficiency diseases.[1] Indeed, fungal infections have become a major contributor to mortality among these populations. Aspergillosis and candidiasis are clinically recognized as common isolated fungi.[1] However, several studies have noted the rise of fungal

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infections resembling yeast other than *Candida* such as trichosporonosis in immunosuppressed patients worldwide.[2,3] The prevalence of these fungi has been found to differ from country to country, although related infections are always linked to a substantial fatality rate among immunosuppressed and immunodeficiency patients.[1,3,4] *Trichosporon* is a basidiomycete with a yeast-like appearance that is widespread in the environment Additionally, it is part of the natural flora of the human body. However, under specific circumstances, it can transition to a pathogenic state in humans. The Trichosporon genus is clinically linked to superficial infections such as white Piedra, allergic pneumonitis, and many other invasive infections.[5] Invasive trichosporonosis is an opportunistic and life-threatening condition caused by *Trichosporon*. It is mainly identified in immunocompromised patients and has a mortality rate that ranges between 42% and 90%.[6] In 1865, Hermann Beigel became the first to describe the genus *Trichosporon* and conclude that it is capable of causing a hair infection. The nomenclature concerning *Trichosporon* has undergone several modifications throughout the years. Initially, all *Trichosporon* species were categorized under *T. beigelii*. (now known as *T. asahii*) and thought to mainly cause infection in the superficial hair, meaning that they were considered to lead to deep-seated infection only rarely.[1]

Recent studies have reported the common risk factors for *Trichosporon* infection to include intensive care unit (ICU) admission or hospitalization, diabetes mellitus (DM), advanced renal failure, human immunodeficiency virus (HIV), neutropenia, persistent fever, use of immunosuppressive drugs and the utilization of medical equipment that penetrates the body.[1,3] The misdiagnosis of trichosporonosis as other fungal infections is common, with Skin and hair infections on the surface and hypersensitivity pneumonitis of the summer type (SHP) being the most frequent alternative diagnoses.[7] However, meningitis, chronic pneumonia, endocarditis, urinary tract infections, disseminated infections, and fungemia are also commonly reported in immunocompromised patients with trichosporonosis.[1]

Over the last two decades, doctors have been recommending the antifungal drug amphotericin B for the treatment of trichosporonosis infections, despite its limited efficacy in this aspect.[8] Thankfully, enhanced comprehension of the azole group among clinical institutions has led to voriconazole being designated as the preferred medication for treating trichosporonosis, which has enhanced the efficacy of treatment when compared with the utilization of amphotericin B.[9] The susceptibility of *Trichosporon* to antifungal drugs is an important consideration, considering the condition of patients with compromised immune systems and those admitted to hospitals with other underlying diseases who receive antifungals, especially caspofungin, which is less effective than voriconazole against *Trichosporon*, can be neglected to the extent that their condition worsens or develops into trichosporonosis.[10] By 1992, only twenty species of *Trichosporon* had been identified, including only six pathogens: *T. ovoides, T. asteroids, T. asahii, T. mucoides, T. cutaneum* and *T. inkin*.[11] Following that, in 1994 and 1995, researchers identified 17 different *Trichosporon* species along with five varieties.[1] As of 2002, the count of recognized *Trichosporon* species had risen to twenty-five, with eight posing a threat to humans, introducing two novel species, *T. domesticum* and *T. montevideense*.[12] Currently, fifty species of *Trichosporon* have been identified, with sixteen of them being known to cause infections in humans.[13]

Over the last three decades, studies concerning trichosporonosis, including the present investigation, have indicated *T. asahii* to be the predominant clinical pathogen of the genus *Trichosporon* as well as the species that causes more than half of all *Trichosporon* infections.[5,14,15] Despite such findings, the improvement of the diagnosis, treatment and prognosis of patients infected with *Trichosporon* requires accurate epidemiological studies that establish the prevalence of this microorganism in countries worldwide.[16] As a consequence, epidemiological studies concerning *Trichosporon* have been conducted across the globe in recent decades, providing good data for the management of *Trichosporon* infections due to the similarities and differences in the reported outcomes among the involved patients.[1,6,17,18]

The current study sought to assess the clinical epidemiology of *Trichosporon* spp. in microbiology cultures obtained from King Abdulaziz University Hospital (KAUH) in Saudi Arabia. In doing so, the intention was to identify the factors contributing to the risk, outcomes, and isolated species of *Trichosporon* in order to better support the proper management of the infections caused by these fungi. *Trichosporon* infection represents an emerging and still underestimated type of fungal infection that can lead to severe medical manifestations. Moreover, *Trichosporon* infection has been found to be associated with a high mortality rate worldwide, especially among immunocompromised patients.[19] Despite this, local epidemiological data concerning *Trichosporon* remains insufficient.[20] Further epidemiological studies should aid in the assessment of the prevalence and risk factors for trichosporonosis. Thus, such studies are key to ensuring the provision of appropriate medical care to trichosporonosis patients.

Material and Methods

Methodology

Study Design

This single-center study employed a retrospective record review design to analyze data from the microbiology database of KAUH. More specifically, the data analysis in this study took place in three stages. The first stage involved the collection of samples. The fungal strains were obtained from the microbiology cultures of samples from patients collected within the last five years (1st May 2017 to 1st May 2022). The parameters of interest included the epidemiological and clinical traits of every patient experiencing an infection attributed to *Trichosporon* species without any restriction as to age. Here, *Trichosporon* infection was defined as fungal growth on the microbiology cultures accompanied by signs and symptoms of infection. All of the underlying diseases and comorbid conditions of each patient were also included in the analysis. The research adhered to the ethical approval standards provided by the Local Research Ethics Committee at KAUH (approval number HA-02-J-008). We would like to clarify that the Local Research Ethics Committee at KAUH has waived the requirement for patient consent to review their medical records for this study. This waiver was granted based on the nature of the study, which involves retrospective analysis of anonymized data, and the minimal risk posed to patients' privacy and confidentiality. We are dedicated to safeguarding patient confidentiality and adhering to the ethical principles set forth in the Declaration of Helsinki. Our commitment underscores our unwavering dedication to maintaining the utmost ethical standards throughout the conduct and reporting of our research.

The second stage concerned the microbial identification of the fungal isolates. All of the specimens were cultured according to the clinical microbiology laboratory policies and procedures of KAUH. The specimens were cultured on and MacConkey agar, Chocolate agar, 5% Sheep Blood agar (produced by Saudi Prepared Media Laboratories, Riyadh, Kingdom of Saudi Arabia), and then incubated at 37°C for a period of 24–48 hours. The blood culture bottles were incubated for five days starting from the date of collection in aerobic or anaerobic bottles utilizing the BacT/Alert Virtuo microbial detection system (BioMérieux, Durham, NC, USA). The VITEK MS mass spectrometry system (BioMérieux, Durham, NC, USA) was used for microbial identification. VITEK 2 yeast identification (ID) cards (BioMérieux, Marcy-L'Étoile, France) were utilized for the accurate detection of the fungal isolates.[21]

The third stage involved the analysis of the gathered data. Following the extraction of data, a thorough review, coding, and input into Statistical Package for the Social Sciences (SPSS) version 22 software (IBM, Chicago, IL, USA) was undertaken. All statistical analyses were conducted using two-tailed tests, and a significance threshold of $P < 0.05$ was applied. A descriptive analysis was performed, considering frequency and percentage distributions was also performed regarding the patients' demographic, clinical, isolated organism, and outcome data. The isolated *Trichosporon* spp. and the clinical outcomes were graphed. Cross-tabulation was performed to evaluate the factors related to the type of isolated *Trichosporon* species and the factors related to death among the infected patients. It was also used to test the associations among the different types of isolated fungi. Due to the small frequency distributions, The precise probability test was employed to assess significance.[22]

Microbial Identification of the Fungal Isolates

All patient samples underwent culturing on 5% sheep blood agar, chocolate agar, and MacConkey agar from Saudi Prepared Media Laboratories in Riyadh, Saudi Arabia. Specifically, MacConkey agar plates were incubated at 35–37°C for 18–24 hours in a standard incubator. Blood agar and chocolate agar plates were incubated at 35–37°C in 5–10% CO2 for 18–24 hours. Fungal subcultures on Sabouraud agar from Saudi Prepared Media Laboratories in Riyadh, Saudi Arabia, underwent incubation at 30°C for 24–72 hours. All of the aerobic or anaerobic blood culture bottles were incubated at the Clinical and Molecular Microbiology Laboratory at KAUH employing the BacT/Alert Virtuo microbial detection system (BioMérieux, Durham, NC, USA), a fully automated system providing real-time results, blood culture bottles were incubated until a signal-positive alarm or a maximum of five days, whichever occurred first. Positive blood culture bottle samples underwent processing through Gram staining and methylene blue staining. The outcomes were recorded in the system, and the pertinent department received verbal notification.[23]

After incubation, the fungal colonies were detected utilizing the VITEK 2 and VITEK MS systems (BioMérieux, Marcy-L'Étoile, France) in accordance with the guidelines provided by the manufacturer. The VITEK 2 automated

system employs a turbidimetric method in conjunction with fungal/yeast ID cards to precisely identify fungal pathogens. The VITEK MS system is a mass spectrometry system for microbial identification. Utilizing matrix-assisted laser desorption ionization time-of-flight (MALDI-TOF) technology, the system can rapidly ascertain the species, genus, or group level within minutes using pure colonies obtained from cultural media.[24]

Data Analysis

The data collected in this study underwent analysis using SPSS version 22 statistical software. Here, the numerical data are presented as the mean ± standard deviation, while categorical data are presented utilizing percentages and frequencies, the Chi-square test was employed to explore associations between the study variables and the type of pathogen.

Results

Patients' Demographic Data

This study encompassed 21 participants, whose ages spanned from one month to 85 years, and they had an average of 42.8 ± 29.2 years. The group of patients aged 18–65 years represented the largest population of infected patients (47.6%), and 28.6% were aged over 65 years. The pediatric population in this study ranged from one month to ten years old, accounting for 23.8% of all patients. Some 60% of the pediatric patients had a postoperative status, while 40% of them suffered from cancer. A total of 13 (61.9%) patients were male and eight (38.1%) were female. Moreover, a total of nine (42.9%) patients were in the ICU, five (23.8%) were in the pediatrics department, four (19%) were in the surgical department, two (9.5%) were in the dialysis department and one (4.8%) was in the ER. A total of ten (47.6%) patients were diabetic, eight (38.1%) had hypertension, seven (33.3%) complained of chronic heart disease (CHD), six (28.6%) had a post-surgical infection and three (14.3%) had COVID19 (Table 1).

Table 1 Patients' Demographic Data. No (Number)

Demographic Data	No.	Percent %
Age in Years		
<10	5	23.8
10–65	10	47.6
>65	6	28.6
Gender		
Male	13	61.9
Female	8	38.1
Department		
ICU	9	42.9
Pediatrics	5	23.8
Surgical	4	19.0
Dialysis	2	9.5
ER	1	4.8

(*Continued*)

Table 1 (Continued).

Demographic Data	No.	Percent %
Underlying diseases		
DM	10	47.6
HTN	8	38.1
CHD	7	33.3
Post-surgery	6	28.6
Cancer	5	23.8
COVID-19	3	14.2

Abbreviations: ICU, intensive care unit; DM, diabetes mellitus; HTN, hypertension; CHD, chronic heart disease.

Patients' Clinical Data

A total of ten (47.6%) urine cultures, four (19%) bodily fluid cultures, three (14.3%) tracheal aspiration cultures, two (9.5%) blood cultures, one (4.8%) ear swab culture and one (4.8%) tissue culture were assessed in this study. There were 17 (81%) HAIs and four (19%) CAIs. A total of 14 (66.7%) patients had a catheter, while four (19%) had an intravenous (IV) line. The most frequently reported clinical presentation was fever (28.6%), followed by malignancy (23.8%), shortness of breath (SOB) (23.8%), gangrene (19%), lower back pain (14.3%) and then heart disease, surgical complications, and loss of consciousness (9.5% for each). A total of 15 (71.4%) patients had a high neutrophil level. In terms of the utilized drugs, five (23.8%) patients were taking immunosuppressive drugs, three (14.3%) were taking antifungal drugs (caspofungin and posaconazole) and eight (38.1%) were taking both types (Table 2).

Table 2 Patients' Clinical Data. No (Number)

Clinical Data	No.	Percent (%)
Culture type		
Urine	10	47.6
Body fluids	4	19.0
Tracheal aspiration	3	14.3
Blood culture	2	9.5
Ear swab	1	4.8
Tissue	1	4.8
Hospital/community		
CAI	4	19.0
HAI	17	81.0
Line/catheter		
Catheter	14	66.7
IV line	4	19.0
N/A	3	14.3

(*Continued*)

Table 2 (Continued).

Clinical Data	No.	Percent (%)
Clinical presentation		
Fever	6	28.6
Malignancy	5	23.8
SOB	5	23.8
Gangrene	4	19.0
Lower back pain	3	14.3
Loss of consciousness	2	9.5
Surgical complications	2	9.5
Heart disease	2	9.5
Neutrophil		
Normal	5	23.8
High	15	71.4
Low	1	4.8
Drugs		
None	5	23.8
Antifungal	3	14.3
Immunosuppressive	5	23.8

Abbreviations: CAI, community-acquired infection; HAI, healthcare-associated infection; IV, intravenous; N/A, not applicable; SOB, shortness of breath.

Isolated Trichosporon Spp

The most isolated species of *Trichosporon* was *T. asahii* (90.5%), followed by *T. mucoides* (9.5%). Figure 1 presents the *Trichosporon* species that were isolated from the samples of the patients enrolled in this study (Table 3).

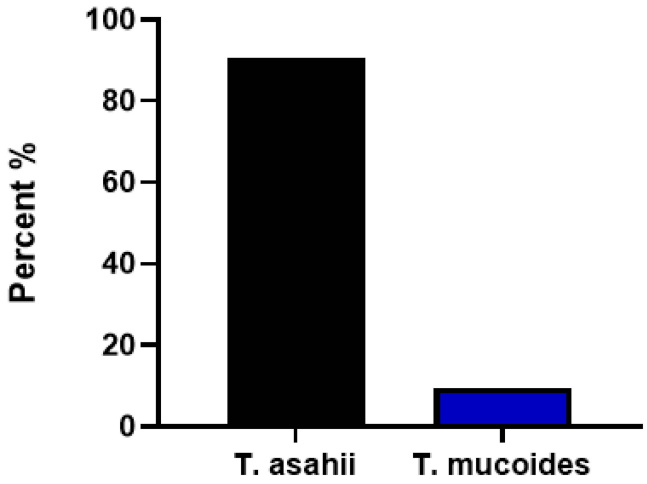

Figure 1 Shows *Trichosporon* species isolated from patient samples. *T. asahii* accounted for 90.5% of infections, followed by *T. mucoides* at 9.5%.

Table 3 Factors Associated with Isolated Species of *Trichosporon*. No (Number)

Factors	Organism				
	T. mucoides		*T. asahii*		P-value
	No.	Percent %	No.	Percent %	
Age in years					
<10	0	0.0	5	100.0	0.643
10–65	1	10.0	9	90.0	
>65	1	16.7	5	83.3	
Gender					0.716
Male	1	7.7	12	92.3	
Female	1	12.5	7	87.5	
Department					
Dialysis	1	50.0	1	50.0	0. 165
ER	0	0.0	1	100.0	
ICU	0	0.0	9	100.0	
Pediatrics	0	0.0	5	100.0	
Surgical	1	25.0	3	75.0	
Hospital/community					
CAI	2	50.0	2	50.0	0.002*
HAI	0	0.0	17	100.0	
Neutrophil					
Normal	1	20.0	4	80.0	0.643
High	1	6.7	14	93.3	
Low	0	0.0	1	100.0	
Line/catheter					
Catheter	2	14.3	12	85.7	0.575
IV line	0	0.0	4	100.0	
N/A	0	0.0	3	100.0	

Notes: P: exact probability test P < 0.05 (significant). *Denotes a statistically significant distinction between the groups.

Abbreviations: ER, emergency room; ICU, intensive care unit; HAI, healthcare-associated infection; CAI, community-acquired infection; IV, intravenous; N/A, not applicable.

Clinical Outcomes

Among the patients with *Trichosporon* infections participating in this study, a total of 11 (52.4%) patients died, while 10 (47.6%) were discharged. Figure 2 illustrates the clinical outcomes of the patients included in this study.

Factors Associated with the Isolated Species of Trichosporon

Among the patients infected with *T. asahii*, nine (42.8%) were in the ICU, while five (24%) were in the pediatrics department, one patient (4.7%) was in the dialysis department, one patient (4.7%) was in the ER and three patients

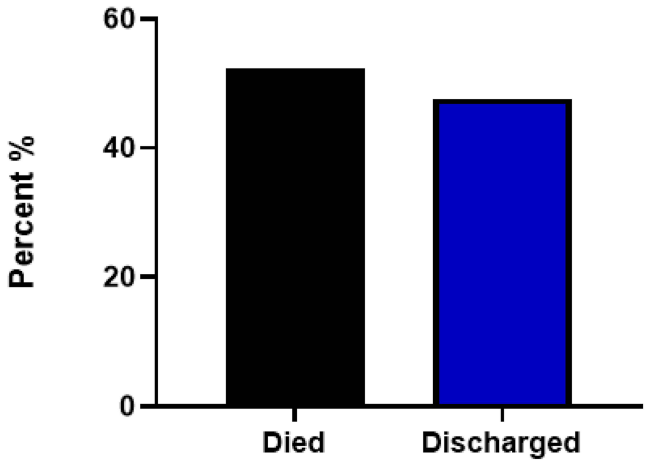

Figure 2 Displays the clinical outcomes of patients with Trichosporon infections in the study. Of the total patients, 52.4% (11) died, while 47.6% (10) were discharged.

(14.2%) were in the surgical department. Only the source of the infection was significantly associated with the type of isolated fungi. That is, 50% of CAIs were due to *T. asahii* when compared with 49.1% of HAIs, while the other 50% of CAIs were due to *T.*

Association Between Isolated Species of Trichosporon and Patients' Clinical Presentations and Outcomes

The most reported clinical presentations among the patients infected with *T. asahii* were fever (33.3%), SOB (27.8%) and gangrene (22.2%). One (50%) patient infected with *T. mucoides* presented with lower back pain, while one (50%) presented with surgical site infections. Moreover, all the patients with *T. asahii* (n = 1) cases were presented with surgical complications, albeit with no statistical significance (P = 0.121). In terms of the clinical outcomes, 55.6% of the patients with *T. asahii* infection died when compared with 50% of the patients with *T. mucoides* infection (Table 4).

Factors Associated with Mortality Among Patients with Trichosporon Infections

A total of five (83.3%) patients aged >65 years died when compared with one patient (20%) age assessed factors, including the patient's gender, type of infection and underlying diseases, were insignificantly associated with mortality. Table 5 details the findings concerning the factors related to mortality among the patients with *Trichosporon* infections.

Table 4 Association Between Isolated Species of *Trichosporon* and Patients' Clinical Presentations and Outcomes. No (Number)

Factors	*T. mucoides*	Percent %	*T. asahii*	Percent%	P-value
	No.		No.		
Clinical presentation					
Fever	0	0.0	6	31.6	
Lower back pain	1	50.0	2	10.5	
Loss of consciousness	0	0.0	2	10.5%	0.283
SOB	0	0.0	7	36.8%	
Surgical infections	1	50.0	1	5.3%	

(*Continued*)

Table 4 (Continued).

Factors	*T. mucoides*	Percent %	*T. asahii*	Percent%	P-value
	No.		No.		
Gangrene	0	0.0	4	21.1%	
Heart disease	0	0.0	0	0.0%	
Outcome					
Died	1	50.0	10	52.6%	0.943
Discharged	1	50.0	9	47.4%	

Table 5 Factors Associated with Mortality Among Patients with *Trichosporon* Infections. No (Number)

Factors	Outcome				p-value
	Died		Discharged		
	No.	Percent %	No.	Percent %	
Age in years					0.049*
<10	1	20.0	4	80.0	
10–65	5	50.0	5	50.0	
>65	5	83.3	1	16.7	
Gender					0.864
Male	7	53.8	6	46.2	
Female	4	50.0	4	50.0	
Hospital/community					0.223
CAI	1	25.0	3	75.0	
HAI	10	58.8	7	41.2	
Underlying diseases					0.144
DM	6	60.0	4	40.0	
HTN	6	75.0	2	25.0	
CHD	5	71.4	2	28.6	
Post-surgery	3	50.0	3	50.0	
Malignancy	1	20.0	4	80.0	
COVID-19	3	100.0	0	0.0	
Renal disease	2	66.7	1	33.3	

Notes: P: exact probability test. *Indicates a statistically significant distinction among the groups.

Abbreviations: CAI, community-acquired infection; HAI, healthcare-associated infection; DM, diabetes mellitus; HTN, hypertension; CHD, chronic heart disease.

Risk Factors

Patients' Age

This study comprised 21 participants, categorized into four different age groups. The group of patients aged 18–65 years represented the largest population of infected patients (47.6%), followed by the group aged over 65 years (28.6%) and the group aged less than one year (9.5%). Among the pediatric population, 14.3% of patients were aged from one year to ten years old. The average age of the patients was 42.8 ± 29.2 years.

Patients' Gender

Among the patients enrolled in this study, 61.9% were male and 38.1% were female, a distribution like that found in certain prior studies.[15] Similar to the findings of earlier studies concerning trichosporonosis.[1,17,25] ICU hospitalization, antibiotic usage and the use of invasive medical equipment (urinary catheters, central venous catheters, endotracheal tubes, and intravenous catheters) were identified as prevalent risk factors associated with trichosporonosis in the present study. In addition, it was determined that DM and the use of immunosuppressive drugs were also common risk factors for trichosporonosis at KAUH. Some 42.9% of the *Trichosporon*-infected patients were in the ICU department, followed by 23.8% in the pediatrics department. Moreover, 23.8% of patients were using immunosuppressive drugs, 14.3% were using antifungal drugs and 38.1% were using both types of drugs. In terms of the underlying diseases, 47.6% of patients had DM, while 28.6% had post-surgical infections. Furthermore, 85.7% of *Trichosporon*-infected patients required the use of invasive medical equipment.

Underlying Diseases

As mentioned above, 47.6% of *Trichosporon*-infected patients had DM, which was the most common underlying disease in this study, while 28.6% had post-surgical infections, 23.8% had malignancy and 14.2% had COVID-19. 3.8.5 Type and site of infection at KAUH, 47.6% of *Trichosporon* infections were urinary infections, followed by 19% being body fluid (synovial fluid and aspiration pleural effusion) infections and 14.3% being respiratory infections. Only 9.5% of infections were fungaemia infections, while ear and tissue infections accounted for only one case each.

Community and Nosocomial Trichosporonosis

Considering the definition of an NI provided by the CDC, 90.5% of patients in this study had HAIs, while only 9.5% had CAIs. Interestingly, all the CAIs were caused by *T mucoides*. Trichosporonosis was found to be more likely to be associated with a negative outcome than a positive outcome in this study. Indeed, 52.4% of patients experienced a negative outcome (eg, mortality) when compared with 47.6% who experienced a positive outcome. More specifically, 83.3% of patients >65 years of age population died and 50% of the 10–65 years population died when compared with 20% of patients appears linked to an increased risk of a negative outcome among cases of trichosporonosis.

Discussion

The emerging nature and clinical significance of *Trichosporon* infections underscore the importance of understanding its epidemiology, risk factors, and outcomes. *Trichosporon* infection is an emerging and still underestimated superficial fungal infection that is associated with invasive and opportunistic behaviors and can have severe medical consequences.[2,26] Various species belonging to the *Trichosporon* genus have been recognized in studies made about *Trichosporon* infections and were involved in different invasive infections, including *T. asahii* (previously identified as *T. beigelii*), which is the most common isolated species worldwide, *T. mucoides, T. dermatis, T. faecalis* and others.[7] In accordance with these earlier findings, the current study found *T. asahii* to be the predominant species isolated from the patient specimens, accounting for 90.5% of the total isolated *Trichosporon* species, followed by *T. mucoides* (9.5%).[27] The findings of this study, therefore, corroborate the findings of certain prior studies.[26,28] These studies have stated that 68–84% of invasive *Trichosporon* isolated species are *T. asahii*. However,[17] found *T. asahii* to account for only 35.3% of the total cases. Our study findings are in line with previous research, indicating *T. asahii* as the predominant species isolated from patient specimens, consistent with its global prevalence. In a retrospective investigation conducted from 1991 to 2000 to identify the yeasts responsible for fungemia in a Saudi Arabian university hospital, only a small fraction

(3.2%) of the 189 recorded episodes were linked to *Trichosporon beigelii*. Our findings contrast with this study, as we observed *T. asahii* (formerly known as *Trichosporon beigelii)* to be the predominant species isolated.[29] The scarcity of *Trichosporon* in the studies emphasizes the critical need for sustained surveillance and expanded research endeavors to achieve a more comprehensive comprehension of the epidemiological and clinical ramifications of *Trichosporon* infections within the region.

Colombo et al (2011)[14] stated that 'Patients with probable invasive trichosporonosis present all of the following criteria: the presence of at least one host factor (therapy with an immunosuppressive drug [s], neutropenia, or persisting fever despite therapy with appropriate broad-spectrum antibiotics. Regarding these criteria, 71.4% of the infected patients at KAUH had a high neutrophil level, 23.8% used immunosuppressive drugs, 14.3% used antifungal drugs, 38.1% used both types of drugs, 33.3% had a persistent fever and 85.7% required the use of invasive medical equipment. The percentage of antibiotic users in this study was like the percentage reported in the work by,[1] who found that 46.4% of infected patients were antibiotic users, although they found only 44.3% of patients to be invasive medical equipment users. Liao et al (2015)[15] mentioned that most patients in their study had a background of neutropenia (60.49%), undergone chemotherapy (58.44%), or received antimicrobial treatment (84.05%) which suggests that there is a high association between immunosuppressive drug use, antibiotic use, persistent fever, and invasive medical equipment use and *Trichosporon* infections. According to,[18] "Studying epidemiological features of these fungi is essential to identify their association with disease severity and determining the risk factors and species distribution to provide better health care services since this infection prevalence is different from one country to another". Under certain circumstances, hospitalized patients can be vulnerable to different NI by opportunistic microorganisms. The association between trichosporonosis and host factors such as neutropenia, immunosuppressive therapy, and persistent fever is well-documented, highlighting the vulnerability of immunocompromised patients to invasive fungal infections.

This study found that 42.9% of *Trichosporon*-infected patients were in the ICU department, followed by 23.8% in the pediatrics department. In their 23-year epidemiological analysis of *T. asahii* infections,[1] observed that most of the *Trichosporon*-infected patients were ICU patients, and they considered ICU hospitalization to be among the most common risk factors for invasive *Trichosporon* infection. Moreover, the high prevalence of trichosporonosis among hospitalized patients, particularly those in the ICU, underscores the importance of infection control measures in healthcare settings.

They also found DM to be the second most common underlying disease following hematologic diseases, with 13.6% of infected patients having DM. At KAUH, some 47.6% of patients had DM, making it the most common underlying disease among *Trichosporon*-infected patients, while 28.6% had post-surgical infections, which represented the second most common underlying condition. This finding is like the finding of,[3] who reported that 34% of patients had a post-operative status. The association between trichosporonosis and underlying conditions like diabetes mellitus (DM) and post-surgical infections further emphasizes the need for tailored management strategies for high-risk patient populations.

One common risk factor for microbial infections is the use of invasive medical equipment.[30] The findings from this study suggested that 85.7% of *Trichosporon*-infected patients had required invasive equipment to be applied to them. Li et al[1] discovered that the utilization of invasive medical equipment was a second major risk factor for *Trichosporon* infection, with 44.3% of patients having used such equipment, which corroborates the finding of this study that the application of invasive medical equipment represents a major risk factor for *Trichosporon* infection among hospitalized patients at KAUH. The significant use of invasive medical equipment among *Trichosporon*-infected patients highlights the role of nosocomial transmission and underscores the importance of implementing stringent infection control measures in healthcare facilities.

The amassed dataset indicates that several discernible risk factors predispose patients at King Abdulaziz University Hospital (KAUH) to trichosporonosis, a fungal infection of notable concern within healthcare settings. Among these factors, diabetes mellitus (DM), intensive care unit (ICU) hospitalization, and the utilization of invasive medical equipment emerge as prominent contributors to the heightened susceptibility observed within this patient cohort. Similarly, the heightened vulnerability conferred by ICU hospitalization underscores the intricate nexus between critical illness and nosocomial pathogen exposure.[31] Moreover, the utilization of invasive medical equipment, encompassing indwelling catheters, mechanical ventilation devices, and vascular access devices, represents a salient risk factor for trichosporonosis acquisition among patients within the healthcare milieu.[32] The introduction of foreign materials into the

body, coupled with the attendant breaches in mucocutaneous barriers, not only facilitates fungal ingress but also provides a nidus for biofilm formation,[33] thereby perpetuating a cycle of persistent colonization and infection.[34]

Furthermore, at KAUH, 47.6% of *Trichosporon*-infected patients had urinary infections, while only 9.5% had fungemia infections. These findings contrast with those of,[28] in Guo et al 2019 study they isolated 78.8% of *Trichosporon* spp from the blood cultures of infected patients, although they corroborate those of,[1] who found that 25% of patients had urinary infections, which was considered the leading type of *Trichosporon* infection. Li et al[1] further found that 59.3% of infected patients in their study were male, while only 33.6% were female. Similarly, this study found that 61.9% of infected patients were male and only 38.1% were female. Liao et al[15] also found that most infected patients were male (66.12%). These data indicate that the prevalence of *Trichosporon* infection at KAUH was higher among male patients than female patients over at least the last five years. Additionally, the predominance of urinary tract infections among *Trichosporon*-infected patients at our institution, along with the higher prevalence among male patients, provides valuable epidemiological insights that can inform targeted prevention and treatment strategies.

The effects of aging on the human body render it more susceptible to infection for a number of reasons, including (1) the decline in the efficiency of the immune response, especially cell-mediated immunity, with advancing age; (2) Age-related alterations in the structure and function of certain organs, such as the lungs; (3) Infections in older individuals may be triggered by concurrent conditions, including degenerative diseases, catheterization, malnutrition, or other infections.[35] Yet, the age of onset of trichosporonosis ranges from one month to 85 years old, with the mean age of onset being 42.8 years. Liao et al.[15] Discovered that the average age of individuals affected by the infection is 47 years, with a variation spanning from 0 to 84 years.; however, in the present study, the group of patients aged 18–65 years represented the largest population of infected patients (47.6%), followed by the group aged over 65 years (28.6%) and the group aged zero to one-year-old (9.5%). The pediatric population ranged from one month to ten years old, representing 14.3% of all infected patients. Some 60% of the pediatric patients had a post-operative status, while 40% had malignancy. Interestingly, the largest population of infected patients in this study (47.6% of patients aged 18–65 years) contrasted with the largest population in the study by,[1] who found the largest infected population to be the group of individuals above 65 years old (34.3%). Trichosporonosis was found to have a negative outcome than a positive outcome more commonly in this study, with the mortality rate being 52.4% when compared with the discharge rate of 47.6%. A total of 83.3% of patients aged >65 years died when compared with 20% of patients aged <10 years. These data corroborate the findings of,[15] who stated that 58.92% of Patients encountered adverse results, including death or deterioration, with 41.08% exhibiting favorable outcomes such as recovery or improvement. Thus, trichosporonosis-infected patients aged over 65 years face a higher risk of a negative outcome.

Furthermore, our study highlights the age-related vulnerability to trichosporonosis, with older patients facing a higher risk of adverse outcomes, including mortality. This underscores the importance of early detection, prompt management, and close monitoring in elderly patients with *Trichosporon* infections. Our study contributes to the growing body of literature on trichosporonosis, providing valuable insights into its epidemiology, risk factors, and outcomes. Future research efforts should continue to explore preventive strategies, optimal treatment approaches, and infection control measures to mitigate the burden of *Trichosporon* infections in healthcare settings.

Limitations

It must be acknowledged that the current study had some limitations. First, the study was based on a retrospective analysis. Second, the study was based on data concerning patients from only a single healthcare center. Third, this study did not assess the anti-fungal susceptibility profile that could be helpful in the development of therapeutic strategies.

Conclusion

In conclusion, trichosporonosis is a significant fungal infection with invasive potential, particularly prevalent in hospital settings. *T. asahii* is the predominant species implicated, often affecting patients with immunosuppression, neutropenia, and persistent fever. Critical illness, ICU stays, diabetes, and invasive medical procedures increase susceptibility. Urinary infections are common, especially among males and the elderly. Heightened awareness and surveillance are crucial for better management and prevention in healthcare settings.

Abbreviations

T. beigelii, Trichosporon beigelii, DM, Diabetes mellitus, ICU, Intensive care unit, HIV, Human immunodeficiency virus, SHB, Summer-type hypersensitivity pneumonitis, *T. asahii Trichosporon. asahii, T. asteroides, Trichosporon asteroides T. cutaneum, Trichosporon cutaneum, T. inkin, Trichosporon inkin T. mucoides Trichosporon mucoides T. ovoides Trichosporon ovoides.*

Disclosure

The authors declare no competing interests in this study.

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