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CASE REPORT

The First Case of *Candida auris* Detection and Infection Control in a Pediatric Bone Marrow Transplant Child Patient in Guangxi, China

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Abstract: *Candida auris* is an emerging yeast species and an opportunistic pathogen. Due to its multi-drug resistance and ability to colonize and transmit, it poses a significant risk for outbreaks in medical institutions. In this study, we report the first case of *C. auris* detected in a pediatric bone marrow transplant child patient in Guangxi, China. *C. auris* was isolated from urine and identified using matrix-assisted laser desorption ionization–time of flight (MALDI-TOF) mass spectrometry, and the isolate belonged to clade I using sequencing. We have implemented stringent infection control measures including personal protective equipment and treatment in a single room, and conducted regular surveillance screening of patients' body surfaces, as well as those of related medical and logistics personnel, medical equipment, and surrounding environmental surfaces. These measures aim to effectively control the colonization of *C. auris* in patients, prevent its spread within hospitals, and ensure the quality of diagnosis and treatment for patients.

Keywords: *Candida auris*, colonization, MALDI-TOF, infection control, surveillance screening

Introduction

Candida auris is a globally emerging fungal pathogen characterized by virulence and pathogenicity, which was first isolated in 2009 in Japan from the external ear canal secretions of a 70-year-old female hospitalized patient.[1] *C. auris* is difficult to identify because it is phenotypically similar to other yeasts and is often misidentified by commercially available tests, leading to outbreaks of *C. auris*. Currently, accurate identification of *C. auris* requires mass spectrometry or molecular-based systems. *C. auris* has significant geographical features and can be divided into five clades based on its genome sequence.[2]

The ability of *C. auris* to robustly colonize various living and abiotic substrates is central to its emergence as a new global public health threat. *C. auris* is frequently reported to be associated with hospital outbreaks, which are characterized by persistent colonization of the patient skin and abiotic surfaces that can remain positive for extended periods, serving as a source of contamination transmission.[3] Additionally, *C. auris* colonizes indwelling medical devices, posing a risk factor for the development of invasive diseases.[4,5] Currently, it is challenging to de-colonize patients who have been colonized with *C. auris*, and colonization may persist even after the resolution of active infection.[6]

Here we report the first case of *C. auris* in Guangxi, China. Furthermore, the stringent infection control measures and regular surveillance screening of the case were implemented carefully.

Case Report

A 14-year-old child with a history of acute myeloid leukemia M2 had received comprehensive anti-infective treatment following hematopoietic stem cell transplantation. Upon reexamination, the patient continued to exhibit symptoms of

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recurrent high fever, cough, and sputum production, along with skin breakdown in the sacrococcygeal region and other areas. Therefore, the patient was transferred to our hospital on January 20, 2024, where multiple skin pressure ulcers were identified, particularly in the sacrococcygeal area and on the heels. Laboratory tests conducted upon admission, including nine respiratory pathogen antibodies, influenza A and B virus antigens, blood culture, sputum culture, and urine culture (with an indwelling urinary catheter), returned negative results. On March 19, 2024, due to the appearance of floc in the patient's urine, a urine culture was promptly performed. The EXS3000 matrix-assisted laser desorption ionization–time of flight mass spectrometry (MALDI-TOF MS) system (Zybio, China) identification revealed the presence of Enterococcus faecium and *C. auris* in urine (Figure 1), and the serum 1,3-β-D glucan level was 101 pg/mL, the procalcitonin (PCT) level was 0.22 ng/mL. Based on sequencing results from the ITS and D1/D2 regions, we found the isolate belonged to clade I (Figure 2). In vitro susceptibility of *C. auris* strains to ten antifungal drugs was determined using the Sensititre CMC1JHY panel (Thermo Fisher Scientific, USA) and the AMB microbroth dilution kit (BIO-KONT®, Wenzhou, China) based on manufacturer's instructions. The antifungal resistance of *C. auris* was analyzed based on the tentative minimum inhibitory concentrations (MICs) breakpoints published by the Centers for Disease Control and Prevention (CDC) (https://www.cdc.gov/fungal/candida-auris/c-auris-antifungal.html). The isolate was resistant to fluconazole with an MIC of 128 μg/mL, and sensitive to echinocandins (anidulafungin, 0.12 μg/mL; caspofungin, 0.25 μg/mL; micafungin, 0.06 μg/mL). And the isolate with clade I were sensitive to amphotericin B with an MIC of 1 μg/mL. For other triazoles, posaconazole and isavuconazole (MIC = 0.06 μg/mL) presented lower MICs than voriconazole (MIC = 0.5 μg/mL) and itraconazole (MIC = 0.25 μg/mL). In addition, the MIC of *C. auris* to 5-flucytosine was 0.12 μg/mL (Table 1).

The patient was treated with a combination of antifungal and antibacterial therapies. For antifungal treatment, bladder irrigation with a mixture of amphotericin B 50 mg and normal saline 1000 mL was administered for treatment of possible urinary tract fungal infection. Debridement was performed until cultures of *C. auris* from the wound returned negative. For bacterial treatment, vancomycin was prescribed for two weeks. Six weeks after the cessation of vancomycin, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* were detected in the urine, leading to a five-day treatment course with ceftazidime. Throughout the treatment period, the patient received internal Chinese medicine, external applications, and acupuncture to enhance immunity. On April 16, 2024, the levels of 1,3-β-D-glucan and procalcitonin decreased to 51.3 pg/mL and 0.16 ng/mL, respectively. And the load of *C. auris* colonized by the urinary tract decreased from 10^4 to 10^2 CFU/mL. Furthermore, on May 27, 2024, *C. auris* was not isolated from the urine culture.

Considering the strong colonization ability and rapid spread of *C. auris*, we have implemented stringent infection control measures to prevent nosocomial outbreaks. These measures include the isolation of patients in single rooms within nursing units, the allocation of dedicated medical equipment for individual use, and if sharing is necessary, strict disinfection protocols after each use. We have increased the frequency of disinfection and wiping of patients' body

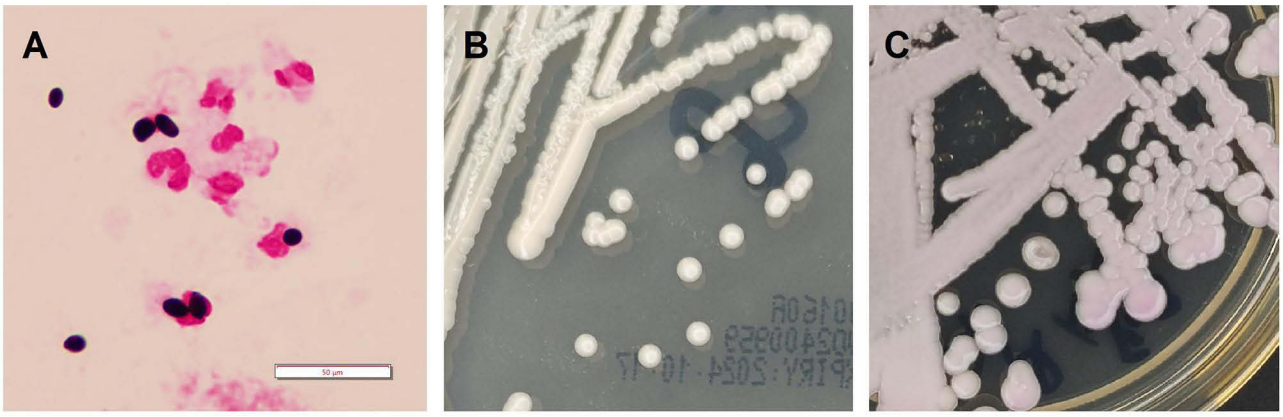

Figure 1 (**A**) Microscopy of *C. auris* at ×1000 magnification by an optical microscope with urine centrifugal specimen. (**B** and **C**) Phenotypic characterization of *C. auris* colonies on Sabouraud dextrose agar and Chromagar *Candida* at 35 °C for 3 days.

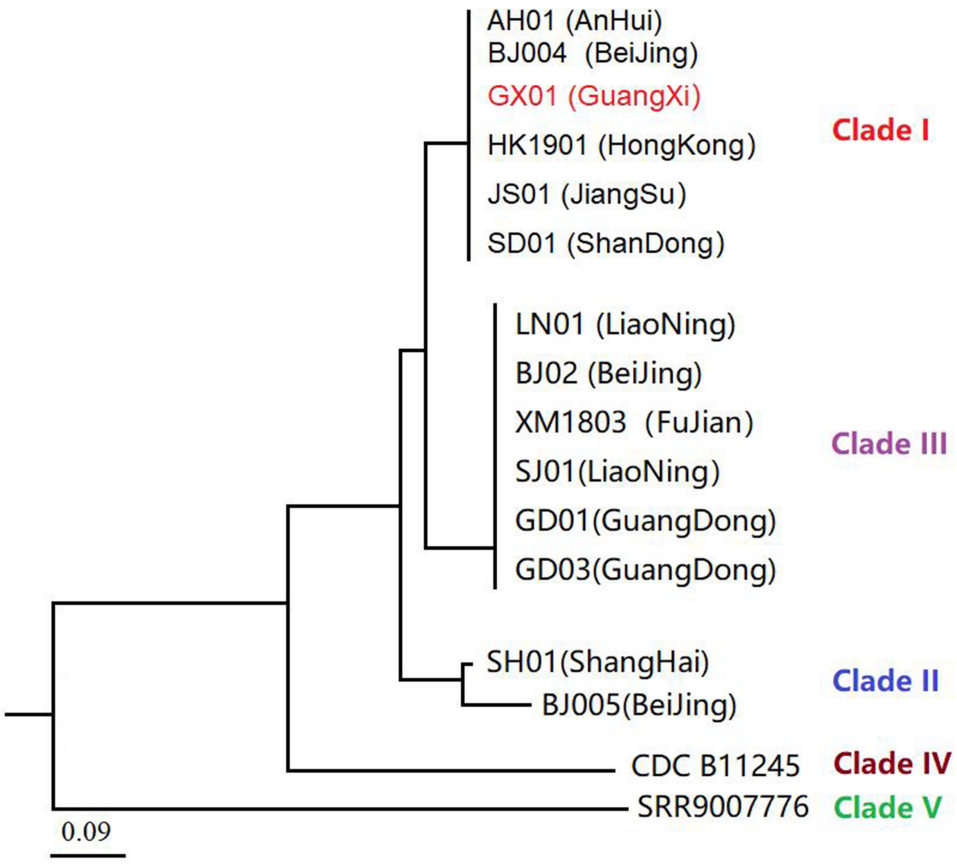

Figure 2 Maximum-likelihood phylogeny analysis of representative *C. auris* strains. Phylogenetic tree of 14 *C. auris* strains based on sequences from China. Data of *C. auris* clade IV and clade V strains were retrieved from the NCBI SRA database. Strains of clade I, II, and III are indicated in red, blue, and purple, respectively.

surfaces to 3–4 times per day using 2% chlorhexidine. For relevant medical and logistics personnel, we mandate the use of disposable medical protective equipment, ensuring one use per person and one replacement. Strict hand hygiene and disinfection practices are also enforced. Regarding medical devices and environmental surfaces, when performing invasive procedures, it is imperative to strictly disinfect the body surface and adhere to aseptic techniques. Urinary

Table 1 Antifungal susceptibility testing of *Candida auris* GX01

Antifungals	MIC (μg/mL)	Antifungal susceptibility
Fluconazole	128	R
Itraconazole	0.25	–
Posaconazole	0.06	–
Voriconazole	0.5	–
Isavuconazole	0.06	–
Amphotericin B	1	S
5-flucytosine	0.12	-
Anidulafungin	0.12	S
Caspofungin	0.25	S
Micafungin	0.06	S

Abbreviations: MIC, minimal inhibitory concentration; R, resistance; S, sensitive; -, no MIC breakpoints.

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catheters should be replaced regularly, every 15 days, and catheter measuring cups must be cleaned immediately after use, followed by soaking and disinfection with a chlorine-containing disinfectant at a concentration of 1000 mg/L. Environmental surfaces should be wiped down with a chlorine-containing disinfectant (1000 mg/L), compound quaternary ammonium salt disinfectant wipes, and 75% alcohol, three times per day. Terminal disinfection of the room environment in the nursing unit should be conducted once a week, and medical waste must be double-packed, clearly marked, and transported after thorough disinfection. Additionally, we conduct regular sampling and monitoring of body surfaces of patients, as well as on related medical and logistics personnel, the medical equipment they utilize during diagnosis and treatment, and the surrounding environmental surfaces. The collected swabs were inoculated onto Sabouraud dextrose agar culture medium (Thermo Fisher Scientific, USA) and Chromagar Candida (Shanghai Yihua Biotechnology Co., Ltd, China) to improve the detection rate of *C. auris*.

The number of *C. auris* detected on body and object surfaces gradually decreases following the strict implementation of infection control measures. As shown in Table 2, a total of 10 samples were cultured positive for *C. auris* on

Table 2 The culture detection of *C. Auris* on body surface and object surface

Samples	Area	Sample description	3.25	4.1	4.8	4.16	4.22	4.29	5.6	5.13	5.21
Body surface	Patient	Groin	√	√	√	√	√	√	√	√	√
		Underarm	√	√	√	√	√	√	√	√	√
		Mouth cavity									
		Nasal cavity	√			√	√				
		Anus	√	√	√	√	√	√	√		√
	Patient's family	Hand		√						√	
		Underarm							√		
		Nasal cavity									
	Doctor	Hand									
		Underarm									
		Nasal cavity									
	Nurse	Hand									
		Underarm									
		Nasal cavity									
	cleaner	Hand									
		Underarm									
		Nasal cavity									
	care worker	Hand									
		Underarm									
		Nasal cavity									
Object surface	sickroom	Lamp switch		√							
		Door handle	√								
		Bathroom door handle									
		Night table	√		√		√				
		Bed rail	√	√	√		√				
		Infusion stand			√						
		Blood Pressure Monitor				√					
		Escort bed	√								
		Treatment cart	√		√						
		Aspirator/device tape									
		Stethoscope			√		√				
		Red light lamp	√								
		TDP lighting				√		√			
		Bed station						√	√		
		Electro-acupuncture apparatus				√					

(*Continued*)

Table 2 (Continued).

Samples	Area	Sample description	3.25	4.1	4.8	4.16	4.22	4.29	5.6	5.13	5.21
	Ward corridor	Mop rod Straight drink machine Handrail in the corridor beside the ward									
	Tea room	Microwave oven Table									
	Nurse station	Computer keyboard Medical record cart and medical record holder Storage cabinet									
	Treatment cart	Treatment cart									
	Dumper	Dumper									
	Mobile nurse station	Computer keyboard and mouse									
No. of positive detections			10	6	8	7	7	5	5	3	3

March 21, and only three samples were cultured positive for *C. auris* on May 13 and May 21. And we performed simultaneous culture and polymerase chain reaction (PCR) tests (*Candida auris* PCR assay kit, Dyna Biotechnology Co., Ltd., China) on 119 samples, the PCR positive rate was 21.85% (26/119), while the culture positive rate was 17.65% (21/119).

Discussion

C. auris is an emerging pathogen that has rapidly become a global concern since its discovery in Japan in 2009. *C. auris* is persistent in nature, functioning both as an environmental pathogen and an infectious agent.[7] Its remarkable ability to adhere to surfaces is largely attributed to the formation of biofilms, which enhances the adhesion of *C. auris* to surfaces such as medical devices. Santana et al found that the *C. auris*–specific adhesin Scf1, an uncharacterized adhesin, and the conserved adhesin Iff4109 are important for infection and long-term colonization of both biological and abiotic surfaces.[8] Reports indicate that the pathogen can survive on medical devices for up to several weeks.[9] This environmental persistence facilitates significant spread among high-risk patients within healthcare institutions. Even after adequate treatment, persistent infection or colonization can hinder effective control, leading to invasive infections and the development of drug resistance. Notably, the prolonged hospitalization of this patient may serve as a risk factor for colonization or infection by *C. auris*.

C. auris does not pose a significant threat to the general population; however, hospitalized patients with critical illnesses and invasive catheters, such as central venous catheters and enteral feeding tubes, are at substantial risk of morbidity and mortality if infected with *C. auris*. Similar to other Candida species, the presence of *C. auris* in the urethra does not necessarily indicate a urinary tract infection and may instead represent colonization. But there are no specific criteria to differentiate between colonization and infection.[10] We found that the serum 1,3-β-D glucan level was at or below the threshold, which may indicate the patient was in a *C. auris* colonized state, and the patient did not develop a bloodstream disseminated infection through the effective infection control strategy. In line with high resistance rates of *C. auris* to fluconazole,[5] the isolate we reported here was resistant to fluconazole with an MIC of 128 μg/mL. The triazoles, posaconazole and isavuconazole showed good activity against *C. auris*. The majority of *C. auris* isolates in China presented low MICs for amphotericin B,[11] and our data showed similar results.

Due to the potential for colonization of the skin by *C. auris* prior to infection, implementing effective infection control measures is critical for managing this pathogen. The correct use of personal protective equipment is essential to prevent transmission between healthcare workers and patients. The patient was treated in a single room equipped with

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designated medical supplies to mitigate the risk of widespread transmission. Furthermore, close healthcare contacts of patients with *C. auris* infection or colonization, including hospital roommates, should undergo screening. Due to the ability of *C. auris* to persist on surfaces within healthcare settings, environmental disinfection is vital for preventing its spread. Effective cleaning methods are crucial for controlling *C. auris* infections. Since commonly used disinfectants may not be guaranteed to be effective against *C. auris*, we use chlorine disinfectant (1000 mg/L), compound quaternary ammonium salt wipes and 75% alcohol for environmental surface cleaning (three times/day). *C. auris* has been detected on high-touch surfaces such as the bed rail, bedside table and infusion stand, as well as on shared medical equipment such as blood pressure monitors and stethoscopes. It is imperative that shared equipment be cleaned and disinfected after each use. Upon patient discharge, deep cleaning and disinfection should be conducted, potentially utilizing enhanced techniques such as ultraviolet light or hydrogen peroxide vapor, especially considering the possibility of *C. auris* developing resistance to approved disinfectants.[12]

Surveillance screening regularly is also essential for preventing the spread of *C. auris* and should be implemented when a patient is identified as colonized or infected. Since *C. auris* has been first isolated from the patient's urine, we conducted surveillance and screening of the patient's contacts weekly, including relevant medical and support staff, as well as family members, to identify potential subsequent infections. Additionally, screening of the healthcare environment weekly, encompassing medical devices and environmental surfaces, is crucial for preventing, identifying, and managing the potential for outbreaks within the institution. And the collected swabs were inoculated onto Sabouraud dextrose agar culture medium and Chromagar Candida to improve the detection rate.

Conclusion

The emergence of *C. auris* poses a challenge to the isolation and containment of pathogens in today's globally interconnected landscape. We implemented stringent infection control measures and conducted regular surveillance screening to combat the emerging organism. These measures aim to effectively control the colonization of *C. auris*, prevent its spread within hospitals, and ensure the quality of diagnosis and treatment.

Ethics Approval

The study was approved by the Ethics Committee of Guangxi International Zhuang Medicine Hospital (No. 2024-119-02) and conducted in accordance with the CARE guidelines.

Consent Statement

Informed consent was obtained from the patient for the publication of any potentially identifiable images or data included in this case report prior to inclusion.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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