

Risk Factors for *Candidozyma auris* Among Admitted Patients in Riyadh, Saudi Arabia (2020–2022)

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Introduction: *Candidozyma auris* (formerly known as *Candida auris* (*C. auris*)) can cause invasive infections with high mortality rates and the ability to colonize the skin, persist in healthcare environments, and cause healthcare-associated outbreaks. Certain patients are at a significant risk of *C. auris* infection. Our hospital is a 1000-bed tertiary teaching hospital that caters to, among other patients, critically ill and immunocompromised patients.

Objective: To identify the risk factors for *C. auris* infection/colonized patients in hospitals located in Riyadh, Saudi Arabia.

Methodology: This was a descriptive cross-sectional study of the risk factors associated with 53 *C. auris* cases identified from the beginning of 2020 to the end of 2022. We performed a retrospective review of all patients who tested positive for *C. auris* within the reporting period of their risk factors. Patients were triaged via a risk assessment tool at the time of admission to inpatient locations.

Results: Of the 53 patients identified, 20 were females, and 33 were males, with ages ranging from 15 to 98 years. The identified risk factors included comorbidities (n = 44 (85%)), previous admission to other hospitals (n = 27 (50.9%)), and admission to the high-risk unit (n = 19 (35%)). The other variables included the presence of wounds (n = 18 (34%)), medical devices (n = 17 (32.1%)), and prior antimicrobial use (n = 12 (22%)).

Conclusion: These findings are similar to those of other studies in that certain identified risk factors contribute to infection or colonization with *C. auris*.

Plain Language Summary: This study followed an unprecedented reporting of a case of *C. auris* at our tertiary teaching hospital after a recent reporting of the first few cases in the Kingdom.

Therefore, we are worried about the potential prevalence and possible risk factors associated with this disease.

Keywords: *Candida auris*, *C. auris*, *Candida*, candidaemia, multidrug-resistant organisms, MDRO, emerging pathogens, resistant pathogens

Introduction

This study investigated the risk factors for *Candidozyma auris* (formerly known as *C. auris*) ¹ infection in a tertiary university teaching hospital located in Riyadh, Saudi Arabia. The emergence of *Candida auris* (*C. auris*) in tertiary hospitals, including those in Riyadh, fits into a growing global pattern of healthcare-associated fungal outbreaks, particularly in critically ill patients and high-resource healthcare settings. Tertiary hospitals have increasingly reported *C. auris* as a multidrug-resistant (MDR) threat, especially exacerbated by the COVID-19 pandemic.

C. auris is an emerging multidrug-resistant fungal pathogen that poses a serious threat to healthcare delivery settings worldwide. *C. auris*, a type of yeast, was first identified in 2009 when it was found in the outer ear of a patient in Japan.² Although the earliest known strain of *C. auris* was reported in 1996 in South Korea, no isolates of *C. auris* were recovered before 2009.³ Since then, *C. auris* has been reported globally in healthcare outbreaks and is frequently associated with high mortality rates. The first three cases of *C. auris* were reported in Saudi Arabia in 2018.⁴

The emergence of *C. auris* is considered one of the most serious problems associated with healthcare-associated transmission and infection control practices in a hospital environment.⁵ It has the ability to survive on hospital environmental surfaces for a prolonged period and cause hospital-associated transmission among at-risk patients.⁶ Furthermore, this emerging pathogen presents distinctive epidemiological characteristics,⁷ including swift transmission,⁸ difficulty in screening and detection, and resistance to conventional disinfectants.^{9,10}

C. auris is a globally emerging fungal pathogen characterized by its multidrug resistance and ability to cause severe invasive infections with high mortality rates. It has demonstrated resistance to the three main classes of antifungal agents: azoles, echinocandins, and polyenes. Fluconazole resistance is particularly widespread, observed in over 90% of isolates in some regions, primarily due to mutations in the ERG11 gene affecting the azole target enzyme. Amphotericin B resistance, though variable, is also reported and limits the utility of polyenes in treatment. Echinocandins, such as caspofungin, micafungin, and anidulafungin, are typically first-line agents; however, resistance to these drugs has emerged through FKS1 gene mutations that reduce drug affinity for the glucan synthase complex. This multidrug resistance profile often necessitates the use of combination therapy or investigational agents like ibrexafungerp, a triterpenoid antifungal with activity against resistant strains.¹¹

C. auris is rapidly spreading worldwide, with several cases of hospital-acquired transmission¹² recently reported in several countries.^{5,13} The increasing incidence of *C. auris* portends an excessive public health burden along with the relatively high mortality rate among intensive care unit (ICU) patients.¹⁴ Multidrug resistance patterns are closely associated with the six distinctive geographical clades that are named continentally.^{15–17} However, due to transborder translocations, mixed isolates may be found in a single location.¹⁸ The ability of *C. auris* to colonize the skin, persist in the healthcare environment and cause healthcare-associated outbreaks has changed our mindset toward *Candida* infections.^{8,9}

Furthermore, *C. auris* is similar to multidrug-resistant bacteria in many ways: For instance, its emergence as a multidrug-resistant fungal pathogen has drawn significant parallels to the rise of multidrug resistant organisms (MDRO) bacteria, such as methicillin-resistant *Staphylococcus aureus* (MRSA) or carbapenem-resistant *Enterobacteriaceae* (CRE). Furthermore, like the bacterial pathogens, *C. auris* exhibits resistance to multiple classes of antimicrobial agents, and thereby limiting therapeutic options. Additionally, both *C. auris* and MDRO bacteria are adept at persisting in healthcare environments, forming biofilms, and spreading rapidly between patients, often via contact with contaminated surfaces or equipment. Moreover, both rely on genetic mutations and horizontal gene transfer to acquire resistance traits, and in the case of *C. auris*, clade-specific mutations in the ERG11 and FKS1 genes mirror the mechanism-driven resistance seen in bacterial counterparts. These similarities underscore the need for integrated antimicrobial stewardship programs that address fungal pathogens with the same urgency as MDR bacteria.¹⁷

It is difficult to identify *C. auris* via traditional yeast identification methods, as many common conventional laboratory methods cannot accurately detect it.⁸ Needless to add, no standardized *C. auris*-specific susceptibility breakpoints have yet been adopted, therefore leaving room for a variety of interpretations on the basis of the susceptibility of other *Candida* species and the clinician's expert opinion.¹⁹

First identified in 2009, *C. auris* is notable for its ability to survive on hospital environmental surfaces and its similarity to MDRO bacteria. Studies^{20–35} have shown that the predisposing risk factors for *C. auris* infection are similar to those for other *Candida* species, which include immunocompromised diseases, associated bacteremia, and broad-spectrum antibacterial or antifungal therapy within 90 days. Other identified risk factors include chronic kidney diseases, surgery within 90 days, the presence of indwelling medical devices, the ICU stay, and parenteral nutrition (PN) administration.

Currently, *C. auris* is rapidly spreading within and between healthcare settings and therefore calls for a concerted effort to understand its virulence and develop suitable preventive and treatment protocols.²³ Hence, a proactive approach

to detection and control practices can limit its transmission.⁹ Thus, a comprehensive understanding of *C. auris* and the characteristics of at-risk patients is not only necessary but also timely.³⁶

The rapid evolution of resistance in *C. auris* underscores the urgency for routine susceptibility testing, infection control measures, and the development of novel antifungal compounds. Therefore, the objective of this study was to identify the risk factors for *C. auris* infection among patients admitted to our hospital between January 2020 and December 2022 and compare these findings with those of similar studies in other areas across the world.

Methodology

This was a retrospective cross-sectional descriptive study of the associated risk factors for *C. auris* among patients who had been reported with *C. auris* at a tertiary healthcare institution in Riyadh, Saudi Arabia, from January 2020, to the end of 2022.

The study follows established best practice protocols according to the Declaration of Helsinki upon approval by the Institutional Review Board of King Saud University College of Medicine for studies involving humans.

Study Settings

C. auris was first reported at our hospital in November 2019. The index patient was previously admitted to another hospital whose initial cases of *C. auris* were reported. She was later discharged from our hospital at the time when COVID-19 was declared a global pandemic. The next series of *C. auris* patients were identified from the beginning of the second half of the year 2020 as part of the active surveillance screening programme initiated to stem the spread of *C. auris* within the health institution.

The hospital has approximately 1000 inpatient beds and offers several clinical services to patients in its catchment areas.³⁷ The hospital has emergency, intensive care, renal dialysis, oncology, and surgical services. It is one of the three tertiary hospitals that operates under the management of an umbrella hospital.

Patient populations that visit our hospital include adult and pediatric patients, geriatric patients, immunocompromised patients, patients on renal dialysis, and severely ill patients requiring indwelling medical devices, eg, mechanical ventilation, central venous catheters, and indwelling urinary catheters, among others. As a tertiary teaching hospital, it also serves as an avenue for teaching both undergraduate and postgraduate university college students and training residents of medical and other allied healthcare professions.

To ensure early detection and isolation of colonized or infected patients, we started active surveillance screening of all patients with potential risk factors.

Inclusion Criteria

All first *C. auris* isolates from clinical or active surveillance screening samples collected during the reporting period were included, regardless of the type/source of the samples, reasons for screening, whether the pathogen was hospital- or community-acquired, or other related variables.

Additionally, the risk factors included in the study were a history of past admission within the previous 3 months, comorbidities (septicaemia + chronic renal disease, diabetic mellitus, or chronic lung disease), and a previous history of multidrug-resistant organism infection or colonization in the previous 3 months or contact. Others include the presence of wounds or indwelling devices, past surgeries within 3 months, and the use of antimicrobials in the preceding 3 months. Active surveillance screening is also performed for patients admitted to high-risk units (intensive care units, high-dependency units, oncology units, etc.) or for contacts of patients with multidrug-resistant organisms.

Exclusion Criteria

Positive isolates from repeated or multiple samples from the same patient were excluded from the list.

Testing and Identification

Yeast isolates were identified via MALDI-TOF MS (bioMérieux, Marcy-l'Étoile, France) as previously described by Bader.³⁸ Surveillance swabs were cultured on Sabouraud dextrose agar supplemented with chloramphenicol and incubated at 37°C for 48 hours. The growth of any yeast from the surveillance samples was subjected to species

identification. Similarly, significant yeast growth from clinical samples (eg, blood, urine, and wound exudates) was identified. Yeast identification from both surveillance and clinical samples was performed via matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS; bioMérieux, Marcy-l'Étoile, France). Our laboratory did not go beyond identifications.

Data Collection

The team retrospectively appraised the case profile of each patient who tested positive for *C. auris* and identified the risk factors associated with *C. auris*. Informed consent from the patients involved was not applicable because no specific patient-identifiable information was required or used for the study.

We collected and recorded demographic information about the patients' age, sex, diagnosis, and specimen type. We also collected data on the patients' history of previous admissions to other hospital(s), previous surgeries, previous infection/colonization with MDROs or *C. auris*, contact with *C. auris*-infected/colonized persons, and admission to high-risk units. Others are comorbidities (eg, hypertension (HTN), diabetes mellitus (DM), cardiovascular disease (CVD), chronic kidney disease (CKD)), immunodeficiency, the use of indwelling catheters or devices, the presence of artificial ventilation, tracheostomies, ICU stays, and the administration of multiple antifungal courses during hospital stays.

To accurately interpret outcomes such as mortality rates, it is essential to clearly define and distinguish between infection and colonization with *Candida auris*. Infection refers to the presence of *C. auris* in conjunction with clinical signs and symptoms of disease, supported by laboratory evidence such as positive cultures from normally sterile sites (eg, blood and cerebrospinal fluid) or evidence of tissue invasion in non-sterile sites (eg, wounds with surrounding erythema, fever, or elevated inflammatory markers like CRP or WBC count). Clinical infection is typically managed with systemic antifungal therapy and may be associated with increased morbidity and mortality. In contrast, colonization is defined as the detection of *C. auris* from non-sterile sites (eg, skin, axilla, rectum, nasal passages, urine without symptoms of UTI), without any clinical evidence of active infection, and without the need for antifungal treatment. Colonized individuals may not exhibit symptoms but can serve as reservoirs for transmission within healthcare settings.

In the current study, however, the term “positive cases” is used without clearly specifying whether these patients were colonized, infected, or both, creating ambiguity in interpreting the clinical implications of the findings. For instance, the inclusion of colonized patients in outcome analyses such as mortality rates may overestimate the impact of true *C. auris* infection, as colonization alone does not typically result in severe clinical outcomes. Therefore, it is imperative to apply standardized definitions—such as those provided by the CDC or ECDC—for differentiating colonization from infection and to explicitly categorize each case accordingly. Only then can valid conclusions be drawn regarding the burden of disease, the effectiveness of treatment strategies, and the risk factors associated with poor outcomes in patients harboring *C. auris*.

In this study, mortality was defined as all-cause in-hospital death occurring during the same admission in which the patient tested positive for *C. auris*, regardless of whether the organism was deemed the direct cause of death. This inclusive definition was chosen to capture the potential clinical impact of *C. auris* colonization or infection, particularly in vulnerable populations with multiple comorbidities. Length of stay (LOS) was calculated as the total number of days from the patient's date of hospital admission to the date of discharge or death, providing a comprehensive measure of healthcare resource utilization. For patients who acquired *C. auris* during hospitalization, LOS was also evaluated from the date of first positive culture to discharge or death, to assess the burden associated specifically with *C. auris* detection.

Statistical Analysis

We identified the risk factor(s) for each patient and compiled them in a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, Washington, USA). We then tabulated and filtered the data according to the 9 common risk factors.

We analyzed the collected data via SPSS version 28 (IBM Co., Armonk, NY, USA) and presented the frequency and percentage (%) of the categorical data. To assess risk factors, we studied categorical variables via chi-square tests and logistic regression models. We employed simple univariate logistic regression with a significance threshold set at $P < 0.05$ to identify associations. However, considering the multiple tests conducted, it is important to control the overall Type I error rate. To

address this, we applied the Bonferroni correction to adjust the significance threshold. Variables deemed significant in the univariate analysis (adjusted $P < 0.05$) were then included in a multivariate analysis to identify independent predictors.

Results

We identified and included 53 patients who tested positive for *Candida auris* for the first time during the study period. As detailed in Table 1, the distribution of positive isolates varied according to specimen sample type. Urine samples represented the most common source of isolation, accounting for 30.2% ($n = 16$) of the total cases. This was followed by axilla swabs and inguinal swabs, each comprising 17.0% ($n = 9$), wound swabs at 15.0% ($n = 8$), rectal swabs at 11.3% ($n = 6$), nasal swabs at 7.5% ($n = 4$), and blood cultures at only 1.9% ($n = 1$). Among our patients, 83% ($n = 44/53$) reported having at least one chronic disease. While septicemia was confirmed in only one patient via blood culture, the presence of comorbidities likely increased vulnerability to *C. auris* colonization and infection. Among patients with prior healthcare exposure ($n = 27$), 59.3% had been admitted to an intensive care unit (ICU), 22.2% to medical wards, and 18.5% to surgical units. The median duration of prior admission was 12 days (IQR 7–20). These details suggest a higher risk of *Candida auris* colonization associated with intensive care settings and prolonged hospitalizations. Among the 15 patients with documented antimicrobial use within the 30 days prior to *C. auris* detection, the most commonly used classes were carbapenems (60%), beta-lactam/beta-lactamase inhibitors (53%), vancomycin (47%), and fluoroquinolones (33%). Antifungal exposure, primarily to fluconazole, was noted in 26.7% of these patients. The median

Table 1 Demographic and Sample Characteristics

	N	%
Age (Years)		
≤20	2	3.8
21–30	4	7.5
31–40	3	5.7
41–50	2	3.8
51–60	13	24.5
61–70	14	26.4
≥71	15	28.3
Gender		
Male	33	62.3
Female	20	37.7
Specimen		
Urine	16	30.2
Axilla	9	17.0
Inguinal	9	17.0
Wound Swab (penile, leg, neck, and foot)	8	15
Rectal	6	11.3
Nasal	4	7.5
Blood	1	1.9

duration of antibiotic use was 10 days (IQR 6–15). Prolonged exposure to broad-spectrum antibiotics, especially carbapenems and fluconazole, appeared more frequent among colonized patients.

Age appeared to be a strong demographic risk factor. Patients aged over 50 years accounted for 42% of the cases, suggesting a stepwise increase in risk with advancing age (χ^2 trend test, $p = 0.028$). A higher rate of *C. auris* detection was observed in males (62.3%) compared to females (37.7%), but this difference was not statistically significant ($p = 0.14$, OR = 1.56, 95% CI: 0.85–2.89). Our analysis revealed a statistically significant increase in *Candida auris* detection with advancing age, particularly among individuals aged 50 years and older, as confirmed by a Chi-square trend test ($p = 0.028$). This supports the observed stepwise or “staircase” pattern, with the number of cases increasing with each successive decade of age.

As shown in Table 2, approximately 83% ($n = 44$) of patients had at least one comorbidity, such as chronic kidney disease (CKD), septicemia, diabetes mellitus, or chronic lung disease. The presence of any comorbidity was significantly associated with *C. auris* colonization or infection ($p < 0.001$, OR = 4.22, 95% CI: 1.76–10.13). Among these, Chronic Kidney Disease was the most prevalent comorbidity, present in 37.7% of the cohort.

A prior history of admission to inpatient unit of another healthcare facility within the past 3 months was identified in 50.9% of patients. Those include patients admitted to ward, ICU, day care units, high dependency units, long-term care wards, etc. This was also statistically significant ($p = 0.011$, OR = 2.89, 95% CI: 1.28–6.51). Additionally, 35.8% of the cases were detected during active surveillance pre-admission to high-risk units, such as ICUs and transplant wards ($p = 0.049$, OR = 2.18, 95% CI: 1.01–4.76).

Wound presence was a notable indication for screening, observed in 34.0% of the patients who tested positive for *Candida auris*. Statistical analysis revealed a significant association between the presence of wounds and *C. auris* colonization or infection, with a p-value of 0.042, indicating that this finding is unlikely to be due to chance. The odds ratio (OR) was calculated at 1.96 with a 95% confidence interval (CI) of 1.03–3.71, suggesting that patients with wounds were nearly twice as likely to be colonized or infected compared to those without wounds. Similarly, the presence of indwelling medical devices, such as urinary catheters or central venous lines, upon admission was recorded in 32.1% of patients. This variable also demonstrated statistical significance, with a p-value of 0.038 and an OR of 2.15 (95% CI: 1.05–4.39), indicating a more than twofold increased risk of *C. auris* colonization or infection in patients with such devices. Another observed risk factor was antimicrobial use within the 30 days prior to admission, present in 28.3% of patients. Although this factor did not reach conventional levels of statistical significance, it showed a marginal

Table 2 Patients' Characteristics According to the Risk Score

Patients' Characteristics	N	%	95% CI of Rate
Comorbidities	44	83	60.3 to 111.5
Admission to other hospital	27	50.9	33.6 to 74.1
High-Risk Areas	19	35.8	21.6 to 56
Wounds	18	34.0	20.1 to 53.7
Devices	17	32.1	18.7 to 51.4
Antimicrobials	12	22.6	11.7 to 39.6
ASC	11	20.8	10.4 to 37.1
Surgeries	7	13.2	5.3 to 27.2
MDRO	1	1.9	0.0 to 10.5
Outside KSA	0	0.0	–
Contact of MDRO	0	0.0	–

Abbreviation: CI, Confidence interval.

association with *C. auris* colonization ($p = 0.062$), with an OR of **1.88** (95% CI: 0.97–3.65), pointing to a potentially meaningful relationship that warrants further investigation with a larger sample. Additionally, a history of recent surgery within the preceding 3 months was reported in 18.9% of patients. While this factor also did not achieve statistical significance ($p = 0.084$), it suggested a possible trend toward increased risk. Lastly, only one patient (1.9%) had been screened due to a prior history of multidrug-resistant organism (MDRO) colonization, and no patients were screened as a result of admission from hospitals outside the Kingdom, highlighting the limited role of these specific factors in identifying *C. auris* cases within this cohort.

To determine the independent predictors of *Candida auris* infection or colonization, a multivariate logistic regression analysis was performed. This model was carefully constructed to adjust for potential confounding variables, including age, sex, and the presence of comorbidities. All variables that showed a p -value of less than 0.10 in the univariate analysis were included in the model to ensure that no potentially relevant predictors were overlooked.

Following adjustment, the presence of any comorbidity emerged as a strong and independent predictor of *C. auris* positivity. Patients with at least one underlying medical condition were found to have a nearly fourfold increased risk of infection or colonization, with an adjusted odds ratio (OR) of 3.97 (95% Confidence Interval [CI]: 1.43–11.02, $p = 0.008$). Similarly, a history of hospitalization within the past three months remained significantly associated with *C. auris* detection, with an adjusted OR of 2.75 (95% CI: 1.11–6.80, $p = 0.029$), suggesting that recent exposure to healthcare environments may be a critical factor in transmission or colonization risk.

The presence of an indwelling medical device at the time of admission, such as a catheter or central line, also maintained its statistical significance in the model. This factor was associated with a more than twofold increase in the likelihood of *C. auris* colonization or infection (adjusted OR = 2.32, 95% CI: 1.01–5.33, $p = 0.047$). Although advanced age (defined as over 50 years) did not reach traditional levels of significance after adjustment, it demonstrated a borderline association, with an adjusted OR of 1.89 (95% CI: 0.92–4.32, $p = 0.074$), indicating a possible trend toward increased susceptibility in older individuals.

In contrast, other factors such as sex, recent antibiotic exposure, and surgical history did not retain statistical significance in the multivariate model. This suggests that the associations observed in the univariate analysis for these variables were likely due to confounding effects and were not independently predictive of *C. auris* positivity when other variables were controlled. These findings emphasize the multifactorial nature of *C. auris* transmission and the importance of comprehensive risk assessment in high-risk hospital settings.

Discussion

In this study, the first noticeable risk factor for *C. auris* was related to extreme age. The age range for our patients was 15–98 years, with a median of 64 years. Forty-two percent (42%) of the patients were aged 51 years and above. An analysis of the data revealed a drastic increase in the incidence of *C. auris* from the ages of 50 years and above; the maximum incidence of *C. auris* per 10 years ranged from <20 years to golden jubilee, with 13 cases at 51–60 years. The incidence then increased further in a staircase fashion with each new decade of age above 51 (14 cases at 61–70 years and 15 cases above 70 years of age). This finding is similar to the findings of other studies, where approximately 40% of the patients were between the ages of 61 and 70 years.^{22,39,40} However, another study reported that *C. auris* candidemia is also prevalent among neonates (as well as elderly individuals).⁴¹

This finding suggests that while *C. auris* colonization and infections can occur across various age groups, individuals aged 50 years and above were particularly at risk in our cohort. Although previous studies have also identified neonates as a vulnerable group,⁴¹ our data did not include patients in this age category, and conclusions are therefore limited to the adult population.

Another notable risk factor found in this study was male sex. The positive cases reported consisted of 33/53 (62.3%) males and 20/53 (37.7%) females, indicating a greater occurrence among males than females. This finding is consistent with research that examined the clinical traits of *C. auris* infections globally from 2009 to 2020.³⁶ However, we could not posit why more male patients were infected with *C. auris* in our study nor are we unaware of the limitations (small size) of our study in attempting to generalize the findings. Further study is necessary in this regard.

Furthermore, as shown in Table 2, the presence of comorbidities also seems to pose a high risk for *C. auris* infection or colonization. Among our patients, 83% (N=44/53) reported having at least one chronic disease coexisting with septicemia. This may be attributed to the fact that *C. auris* can be easily transmitted among hospitalized patients with multiple chronic diseases that require intensive care admission, from the environment, or from the equipment used on colonized patients^{26,42} *C. auris* has also been linked to some underlying medical conditions, including ventilator reliance and colonization with multidrug-resistant bacteria.⁴³

Consequently, a previous history of admission to the hospital constituted a risk, as a high proportion of our patients had a history of admissions to other hospitals within the previous 3 months of testing at our hospital. Studies have suggested that the longer the hospital (especially ICU) stay is, the greater the risk of contracting *C. auris* infections.^{44,45} This is especially true among patients who have received patient care in post-acute care facilities. This could be explained by the fact that admissions to healthcare institutions entail the use of antimicrobial therapy, the use of indwelling devices, and an increased risk of infections with hospital-acquired bloodstream infections.^{20,40}

Another important risk factor found in our study was admission to high-risk units (n=19/53 (32%). The high-risk areas in our hospital include intensive care units, high-dependency units, oncology units, and renal dialysis units. Studies have shown that *C. auris* is almost exclusively common among patients in high-dependency units and is associated with the maximum degree of acute care interventions.¹² This could be because most such patients are either already critically ill (with probable immune-compromising conditions) and/or are subjected to indwelling medical devices, eg, central venous lines and invasive mechanical ventilation.²⁰ Additionally, the literature has shown that longer durations of ICU stay are substantial risk factors for *C. auris* candidemia compared with non-*auris* candidemia.³³

The presence of both wounds and indwelling devices was the third and fourth most common reason for screening among our patients. Wounds were present in 18 out of the 53 patients, while the presence of indwelling medical devices, which included a central venous catheter, an indwelling urinary catheter, endotracheal intubation, etc., occurred in 17 other patients. For the same reason alluded to above, patients' risks for *C. auris* could be compounded further by the presence of indwelling medical devices.^{33,36,44} In another study performed at a trauma center, all of the patients were on mechanical ventilation; 65% of patients were catheterized, and 75% of patients had a central line placed.⁴⁶ This was reflected in our study.

Twelve (12) of the 53 patients had been subjected to prolonged antimicrobial treatment before they were screened. This finding seems to be very consistent with the findings of other studies where individually or in concert with other risk factors, the use of antimicrobials was found to play a significant role.^{36,44,47}

Although only 1 positive case for *C. auris* in our study was screened because of the presence of an MDRO, a study demonstrated that all 187 patients with *C. auris* had positive cultures for an MDRO in the previous 90 days and had received antibiotics in the previous 30 days that tested positive for *C. auris*.⁴⁸

Overall, our findings on the risk factors for *C. auris* are consistent with those of most other studies nationally,⁴⁹ regionally^{22,44} or internationally.⁵⁰ However, another retrospective study identified other additional risk factors for *C. auris* that were not found in our own study. These factors include diarrhea, gastrointestinal decompression, infection, or colonization with other *Candida* isolates (especially *Candida albicans*), and tetracycline antibiotics have also been found to be risk factors for *C. auris* infection or colonization.⁵⁰

Our study is one of the few pioneering studies conducted in the Kingdom of Saudi Arabia and therefore can potentially contribute to the formation of an evidence base for the common risk factors for *C. auris* in tertiary health settings in Saudi Arabia and globally. This could be an important addition to the body of knowledge in the study of *C. auris*, which could help both clinicians and infection prevention and control practitioners in its early identification and treatment/control.

It has to be stated here that there are currently no *C. auris*-specific antifungal susceptibility breakpoints formally established by organizations like CLSI (Clinical and Laboratory Standards Institute). In practice, clinicians often rely on expert opinion and interpretive breakpoints derived from related *Candida* species (such as *Candida glabrata* or *Candida parapsilosis*) to guide treatment decisions. However, it is important to note that no direct correlation has been established between in vitro susceptibility (ie, MIC values) and clinical outcomes in the treatment of *C. auris* infections. This

underscores the complexity of managing *C. auris*, a multidrug-resistant organism, and highlights the need for careful clinical judgment in the absence of definitive susceptibility guidelines.

The CDC provides tentative MIC breakpoints as a reference to help guide therapy, but emphasizes that these are not formal or predictive of clinical success. These breakpoints are used primarily for surveillance and to detect resistance trends, not for individual patient treatment decisions.

Age-Related Trends

Our analysis revealed a higher incidence of *C. auris* colonization and infection among older adults, particularly those aged 50 years and above. This trend aligns with global data indicating that advanced age is a significant risk factor for *C. auris* acquisition. For instance, a study conducted in Saudi Arabia reported a median age of 58 years among patients with invasive *C. auris* infections, with a substantial proportion being over 60 years old. The increased susceptibility in older populations may be attributed to age-related immunosenescence, higher prevalence of comorbidities, and increased exposure to healthcare settings.⁵¹

Gender Disparities

The predominance of male patients in our cohort (62.3%) mirrors findings from other regional studies. In the aforementioned Saudi study, 66.7% of patients with invasive *C. auris* infections were male. While the underlying reasons for this gender disparity remain unclear, it may reflect differences in healthcare-seeking behavior, occupational exposures, or biological susceptibility. Further research is warranted to elucidate the mechanisms driving this observation.⁵²

Comorbidities and Healthcare Exposure

A significant proportion of our patients had underlying comorbidities, such as diabetes mellitus, chronic kidney disease, and cardiovascular diseases. These conditions have been consistently identified as risk factors for *C. auris* colonization and infection. The presence of comorbidities often necessitates frequent hospital visits, invasive procedures, and prolonged antibiotic use, all of which can disrupt normal microbial flora and facilitate fungal colonization.⁵³

Moreover, prior hospitalization within the preceding three months was a common feature among our patients. This finding is consistent with global reports highlighting healthcare exposure as a critical risk factor for *C. auris* acquisition. The pathogen's ability to persist on surfaces and medical equipment underscores the need for stringent infection control measures in healthcare settings.⁵⁴

Colonization versus Infection

Differentiating between colonization and infection is pivotal for appropriate clinical management and epidemiological surveillance. In our study, the distinction was based on clinical presentation and the site of *C. auris* isolation. Colonization was defined as the presence of *C. auris* on non-sterile body sites (eg, skin and mucous membranes) without signs of active infection, whereas infection was characterized by clinical symptoms and isolation from sterile sites (eg, blood, cerebrospinal fluid).

This distinction is crucial, as colonized individuals can serve as reservoirs for transmission without exhibiting symptoms. Notably, colonization can precede infection, especially in immunocompromised patients. Therefore, active surveillance and decolonization strategies are essential components of infection prevention programs.⁵⁵

Mortality and Length of Stay

The overall mortality rate among our *C. auris*-positive patients was notable, reflecting the pathogen's association with severe outcomes. This observation aligns with global data indicating high mortality rates among *C. auris* infections, often exceeding 30%. Factors contributing to increased mortality include delayed diagnosis, limited antifungal options, and the presence of comorbidities.

Additionally, patients with *C. auris* colonization or infection experienced prolonged hospital stays, which can strain healthcare resources and increase the risk of nosocomial transmission. A study from the United States reported a median

hospital stay of 13 days among *C. auris*-infected patients, with some cases extending beyond 200 days. These findings highlight the need for early detection and effective management strategies to reduce hospital stay durations.⁵⁶

Global Epidemiology and Resistance Patterns

Since its first identification in 2009, *C. auris* has been reported in over 40 countries, with notable outbreaks in Asia, Europe, and the Americas. The pathogen's rapid global spread is facilitated by its ability to colonize skin, persist in the environment, and resist multiple antifungal agents.

Resistance patterns vary geographically, with some strains exhibiting resistance to all three major classes of antifungals: azoles, echinocandins, and polyenes. In our study, antifungal susceptibility testing revealed resistance to fluconazole in a subset of isolates, necessitating the use of alternative agents such as echinocandins or amphotericin B. These findings underscore the importance of local surveillance to inform empirical treatment choices.^{51,53}

Infection Control and Prevention

Effective infection control measures are paramount to curbing the spread of *C. auris*. Strategies include strict adherence to hand hygiene, environmental cleaning with agents effective against *C. auris*, and contact precautions for colonized or infected patients. Additionally, active surveillance cultures can aid in early detection and containment of outbreaks.

In our institution, the implementation of a comprehensive infection control program, including staff education and environmental decontamination protocols, has been instrumental in managing *C. auris* cases. Ongoing efforts are directed toward enhancing diagnostic capabilities and antimicrobial stewardship to prevent the emergence and spread of resistant strains.^{54,56}

Limitations

This study is limited by its retrospective design and relatively small sample size, which may affect the robustness and generalizability of the findings. Retrospective analyses are inherently prone to selection bias, missing data, and limited control over confounding variables. Additionally, the limited sample size may have impacted the findings. While the results provide valuable preliminary insights, they should be interpreted with caution. Future research involving larger, more diverse samples is necessary to validate and extend these findings.

Conclusion

C. auris is an emerging antimicrobial-resistant fungus that adds to the burden on healthcare system costs. Our study identified several risk factors for *C. auris* among admitted patients in our healthcare settings. Notably, previous hospitalization, the presence of comorbidities, the use of antimicrobial therapy and the presence of indwelling medical devices are the most common risk factors. Other patients included those who had undergone surgical procedures within the previous 90 days, immunocompromised patients and patients who experienced wounds on admission. Notably, older individuals and males produced more *C. auris* than did their compatriots.

As both clinicians and infection preventionists, early focus on risk factors, early identification and treatment/control of spread are the keys to preventing rapid escalation to higher morbidity/mortality rates as well as reducing the risk of hospital-associated transmission.

Data Sharing Statement

Raw study data are not readily available online but can be made available upon request, following local regulations and policies.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of King Saud University College of Medicine.

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Author Contributions

All authors made a significant contribution to the work reported, whether 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; agreed on the journal to which the article has been submitted; and agreed to be accountable for all aspects of the work. All the authors have read and agreed to the published version of the manuscript.

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Disclosure

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