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ORIGINAL ARTICLE

Can daily bathing with 4% chlorhexidine + daily chlorhexidine wipe for 1 week be effective in decolonizing *Candida auris* colonization?

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Abstract

Background Herein, it is aimed to present the decolonizing rates of *Candida auris* colonized cases after daily bathing with 4% chlorhexidine plus daily cleaning with 4% chlorhexidine wipe for 1 week (will be mentioned as DCHX).

Methods The study period was from October, 2021, to November, 2022. Inclusion criteria were (i) age > 18, (ii) receiving DCHX, (iii) proven *C. auris* carrier on auricular, or axillar or inguinal swab surveillance cultures up to 5-day period before DCHX. Cases with three consecutive negative surveillance cultures 3 days apart were considered to be decolonized.

Results A total of 38 cases [14 female, aged 61.8 ± 15.5 years] fulfilled the inclusion criteria. Six (15.8%), 23 (60.1%), and 22 cases (57.8%) were postauricular, inguinal, and axillary culture positive, respectively. Only three cases (7.9%) were triple culture positive. Nine cases (23.7%) had three consequent negative surveillance cultures after DCHX and were considered to be decolonized. There was no significant difference in decolonization rates of concomitant only antibiotic receiving cohort vs. concomitant antifungal + antibiotic receiving cohort (5/16 vs. 2/8, $p = 1$) were decolonized similarly. Of the nine *C. auris* decolonized cases, two developed *C. auris* infection in 30 days follow-up after decolonization. However, 10 (34.5%) of 29 non-decolonized cases developed *C. auris* infection (p: 0.450) within 30 days after surveillance culture positivity. Over all cohorts, day 30 mortality was 23.7% (9/38).

Conclusion In conclusion, based on our observational and relatively small uncontrolled series, it appears that DCHX is not very effective in decolonizing *C. auris* carriers (especially in cases who are *C. auris* colonized in > 1 areas), although it is not completely ineffective.

Keywords *Candida auris* · Colonization · Decolonization · Chlorhexidine

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Introduction

Candida auris is a relatively new fungus that was first discovered in the ear canal of a Japanese patient in 2009 [1]. Since then, *C. auris* has been found in various parts of the body in patients from different countries [2]. The fact that *C. auris* is multidrug resistant (MDR) and has high mortality rates makes it a particularly challenging pathogen. Additionally, its ability to easily spread among patients is a cause for serious concern. Consequently, *C. auris* is now a widely distributed and significant pathogen associated with significant illness and death [3].

C. auris colonization of body sites and urinary tract commonly occurs in hospitalized patients in the ICUs and general wards. Colonization may generally increase the patient's susceptibility to infection by the pathogen and may also serve as a source for spreading it to other patients [4]. Moreover, discharged cases may continue to spread the pathogen in the community.

During the contact isolation procedures for the epidemiologically important pathogens, contact isolation is discontinued when patients have been decolonized for a specific period of time [4]. This is crucial for proper patient care, efficient hospital bed management, and cost-effectiveness. However, there is limited data available on decolonization of *C. auris* [5]. In this study, we aimed to determine the decolonization rates of *C. auris* in colonized cases after daily bathing with 4% chlorhexidine and daily cleaning with 4% chlorhexidine wipes for 1 week (will be mentioned as DCHX).

Methods

Setting

This single center, retrospective cohort study was performed in a 164-bed tertiary-care educational hemato-oncology hospital in a 1.5 million populated country. The study period was between October, 2021, and November, 2022.

Candida auris screening procedure

Screening patients were performed via swabs that were collected from axillary, groin, and postauricular areas (collected from postauricular area rather than inside the ear).

Afterward, swab specimens were submitted to Microbiology Laboratory. In Microbiology Laboratory, swabs were cultured on Sabouraud dextrose agar with chloramphenicol (MEDYSINAL, Dubai, UAE) and incubated for 24–48 h. Any yeast colony identified on the Sabouraud dextrose agar and identified as *C. auris* by MALDI-TOF (matrix-assisted laser desorption/ionization–time of flight) was reported through the hospital electronic patient record system.

Decolonization procedure

- Daily bathing with 4% chlorhexidine (Hydrex, 4% chlorhexidine gluconate including skin cleanser, Ecolab, MN, USA): 25–30 mL 4% CHG solution was used for bathing the cases.
- Daily cleaning with 4% chlorhexidine wipe: 10 mL 4% CHG solutions (Hydrex, 4% chlorhexidine gluconate including skin cleanser, Ecolab, MN, USA) was poured on a non-woven j-cloth disposable wipe (Medstar, Leading Trading Est, Bahrain) washcloth directly and the patient was wiped with that washcloth.

The same 4% CHG solution product was used for daily bath and daily cleaning. Manufacturer's instructions were followed during the procedure. All procedures including daily bath and daily wipe were performed by the assigned nurses. Our hospital policy instructions were provided to the assigned nurses for clear guidance of product application and adherence to the protocol. For auricular de-colonization, CHG bath and wiping were applied to postauricular area, not into the ear.

Data collection

Initially, all *C. auris* screening culture-positive results were extracted from the hospital electronic medical records (Hope system). All clinical and microbiological data (demographic data, underlying diseases, colonization or infection, decolonization, outcome, etc.) were retrieved from the hospital electronic database.

Inclusion criteria

(i) Age > 18; (ii) receiving daily bathing with 4% chlorhexidine for 1 week + daily cleaning with 4% chlorhexidine wipe (DCHX) for 1 week; (iii) proven *C. auris* carrier on one of auricular, axillar, or inguinal swab surveillance cultures up to 5 days before DCHX.

Justifying decolonization

The first repeated surveillance cultures were performed 3–5 days after the end of DCHX. Cases with three consecutive negative surveillance cultures 3 days apart were considered to be decolonized.

Ethics

Local institutional review board approved the study [Ref #22–564].

Statistical analysis

The number and percentage of patients were determined for categorical variables (gender, decolonization, etc.) and the median (interquartile range) was used for continuous variables. Rates of infection and decolonization and related factors were analyzed by Fisher's exact test by using SPSS 25.0.

Results

A total of 38 cases [14 female, mean age 61.8 ± 15.5 (min. 23–max. 95)] fulfilled the inclusion criteria with 51 swab culture positivity.

Six (15.8%), 23 (60.1%), and 22 cases (57.8%) were postauricular, inguinal (groin), and axillary culture positive, respectively. Only three cases (7.9%) were triple-area culture positive. The numbers of single area, double area, and triple area colonization rates were 28 (73.7%), 7 (18.4%), and 3 (7.9%), respectively. Single-area colonized cases included groin ($n = 14$), axillary ($n = 13$), and postauricular ($n = 1$) colonization.

Decolonization analysis

Nine cases (23.7%) who were all single-area colonized cases, had three consequent negative surveillance cultures after DCHX, and were considered to be decolonized. However, one of these nine cases recolonized after decolonization (8 days) during 30-days follow-up. Gender did not affect decolonization rate after DCHX (3/14–23.7% vs. 6/24–25%, $p = 1$).

Antimicrobial use and decolonization

Fifteen (39.5%) cases had a history of antifungal usage in the previous month and two (13%) of them were decolonized after DCHX. Seven cases were receiving concomitant antifungal during DCHX and two (29%) of them were decolonized. Two of the 13 cases (15.4%), who were receiving concomitant antibiotic and antifungal during DCHX, were decolonized. Only five of 16 cases (31.2%), who were receiving concomitant antibiotic during DCHX, were decolonized. Finally, only two of eight cases (25%) who received no concomitant antibiotic/antifungal during DCHX were decolonized. In terms of decolonization, there was no significant difference between concomitant only antibiotic vs. antifungal + antibiotic receiving cohort (5/16 vs. 2/8, $p = 1$).

Decolonization according to the colonized sites

Only groin area–colonized cases were decolonized non-significantly higher than only axillary area colonized cases (6/14–42.9% vs. 3/13–23.1%, $p = 0.419$). None of the postauricular area cases (0/6) were decolonized after DCHX.

Single-area colonized cases were decolonized non-significantly higher than double or triple-area colonized cases (9/28–32.1% vs. 0/10–0%, $p = 0.078$).

Development of C. auris infection among the colonizers

Of the nine *C. auris* decolonized cases, two developed *C. auris* infection within 30 days after decolonization (one case developed UTI 8 days after decolonization and another case developed UTI 21 days after decolonization). However, 10 (34.5%) of 29 non-decolonized cases developed *C. auris* infection (five urinary tract infections and three bloodstream infections, one ascitic fluid infection, and one infected bedsore p: 0.450) within 30 days after the first surveillance culture positivity. Over all cohorts, day 30 mortality was 23.7% (9/38).

Demographics and decolonization/colonization rates are summarized in Table 1.

None of the cases developed severe adverse effect that caused withholding the decolonization process.

Discussion

C. auris, a multi-drug-resistant fungal pathogen, is globally emerging and has the potential to cause widespread outbreaks in healthcare settings [6]. In the hospital setting, in addition to the inanimate surfaces, the patients may be colonized with *C. auris* particularly at axilla, groin, nostrils, ears, and rectum [7]. In our cohort, the most frequently colonized area was the inguinal area, accounting for over half of the cases. This is consistent with the findings of Proctor et al., who reported that the groin, along with the nares, palms, fingertips, and toe webs, were the most commonly colonized areas (with 42.9% of residents testing positive at the nares, 40.4% at the palms and/or fingertips, and 35.7% at the toe webs) [8, 9].

Eliminating skin colonization is of utmost importance in order to decrease the probability of invasive infections and outbreaks. There is currently no well-established recommendation regarding the best disinfectant to use for *C. auris* decolonization in the available literature. The mostly studied disinfectant against *C. auris* is chlorhexidine gluconate (CHG). It has been shown that *C. auris* is successfully inhibited by CHG in in vitro studies. *C. auris* growth was inhibited by 0.02% chlorhexidine after 24-h incubation in broth microdilution [10]. In addition, CHG solution

Table 1 Demographics and decolonization/colonization rate

	Patient number, $N=38$* (%)
Age	61.8 ± 15.5
Gender	
Female	14 36.8%)
• Decolonized	3/14
Receiving concomitant antibiotic and antifungal during DCHX	13 34.2%)
• Decolonized	2/13
Receiving concomitant antibiotic during DCHX	16 (42.1%)
• Decolonized	5/16
Received no concomitant antibiotic/antifungal during DCHX	8 (21%)
• Decolonized	2/8
Only groin colonized cases	
• Decolonized	6/14
Only axilla colonized cases	
• Decolonized	3/13
Only postauricular colonized cases	
• Decolonized	0/6

*One case received only antifungal during the decolonization period

effectively inhibited *C. auris*, at a concentration range of 0.125 and 1.5% at 3-min exposure with increased efficacy at 3 and 30 h [11]. Efficacy of combination approach has also been evaluated. CHG combined with isopropyl alcohol was shown to be more effective in suppressing *C. auris* growth within a 2-min contact time when compared with only 2% chlorhexidine-based disinfectant [12]. Iodophors, such as povidone-iodine, have also been evaluated for *C. auris* activity. Two in vitro studies showed that 1.25% and 10% povidone-iodine were successful in suppressing *C. auris* growth [11, 12]. Besides, tea tree (*Melaleuca alternifolia*) oil and lemongrass (*Cymbopogon flexuosus*) oil had a synergistic effect with chlorhexidine/isopropanol to enhance decolonization activity [13]. However, there are no clinical studies to support these findings in terms of *C. auris* decolonization. In our center, we started CHG-based decolonization according to the above-mentioned in vitro findings [9].

Although the inhibition of *C. auris* with CHG-based compounds in in vitro studies was promising, these results did not always reflect positive results in the clinical practice. In our study, decolonization was not achieved in 76.3% of our cohort, even with daily bathing using 4% chlorhexidine and daily chlorhexidine wipes for 1 week. Additionally, no patient with double- or triple-area colonization was successfully decolonized, while approximately 32% of cases with single-area colonization were decolonized ($p=0.078$). Another study reported that daily washing of colonized patients with 2% chlorhexidine did not consistently eliminate the pathogen [11]. However, decolonization of *C. auris* with CHG was not evaluated systemically in this study [11]. Furthermore, despite the strong in vitro activity of CHG, the burden of *C. auris* on porcine skin was only modestly reduced by CHG. This lack of effectiveness has been attributed to the limited skin penetration of chlorhexidine, including hair follicles, and the compound's inability to penetrate deeper layers of the skin [14]. It is possible that the relatively low decolonization rate in our cohort may be associated with these factors.

There are several limitations to our study. Firstly, it was not a randomized controlled trial and only included the intervention arm without a control group. Additionally, the number of cases was relatively low. We did not perform a quantitative evaluation on the mycological culture, so the reduction in the microorganism load was not assessed. However, to the best of our knowledge, this is the first interventional study aimed at analyzing the effect of decolonization with CHG in *C. auris* decolonization.

In conclusion, based on our observational and relatively small series, it appears that DCHX is not very effective in decolonizing *C. auris* carriers (especially in cases who are *C. auris* colonized in > 1 areas), although it is not completely ineffective. However, these findings need to be confirmed in larger cohorts, preferably through randomized-controlled trials. Further studies should investigate alternative skin disinfectants, concentrations, frequencies, and longer contact time to more efficiently eliminate *C. auris* from the skin.

Author contribution Conceptualization and methodology: FD and ORS; data curation: CSDR, JP, and CV; writing—original draft: UE;

writing—review and editing: ORS, HE, and EF; formal analysis: AK, SH, and SPS; investigation: OK and SSR; supervision: ORS. All authors have seen and approved the final manuscript.

Data availability The datasets used and analyzed in this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval Local institutional review board approved the study [Ref #22–564].

Consent to participate Not applicable.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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