

# Steam treatment to decrease *Candida auris* environmental burden

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## Abstract

### Introduction:

*Candida auris* is associated with healthcare infections. Patients become colonized through interaction with contaminated common hospital equipment, increasing risk of infection. Current cleaning methods are slow, cumbersome, and not applicable to all equipment.

### Methods:

We tested a seat cushion, portable suction machine bag, two support straps, back rest, and arm trough used with patients in rehabilitation with varying textures, porosity and absorbance. Each piece was tested initially for *C. auris* presence, then inoculated with *C. auris* stock ( $3 \times 10^6$  colony forming units (cfu)/milliliter (ml)), swabbed and cultured (20 microliter lawn spread on CHROMagar™ *C. auris* media), and subsequently subjected to steam treatment via two steamers (Jiffy J4000; Salav) to determine *C. auris* presence. Sterile cotton tip applicators were used to inoculate equipment and BD ESwab® were used to culture each inoculated area. Plates were incubated at 37°C for 48 hours and colony counts performed.

### Results:

The *C. auris* cfu/ml range post initial inoculation for the equipment was 1,000 to >300,000 cfu/ml. Colony counts were consistent across equipment inoculums, however, one square on the arm trough resulted zero colonies. Colony counts after both steam treatments were zero for all equipment. At 48 hours post-steam, the positive control and both steam treatment areas for all equipment were zero cfu/ml.

### Conclusions:

We recovered *C. auris* approximately 20 minutes post initial inoculum but not post steam for any pieces of equipment. Persistence on the equipment may reflect a passive state where the organism is present, but not culturable. Steam cleaning may have a role in hospital cleaning.

### Public Health Significance:

Finding innovative ways of disinfecting pieces of equipment with a variety of textures, porosity and absorbance will decrease the burden of *C. auris* in the environment, allowing use for patients with *C. auris*.

## Introduction

- *Candida auris* is a significant pathogen circulating within healthcare facilities and is associated with healthcare infections<sup>1</sup>.
- This organism lives well in the environment, is hard to disinfect, facilitating easy transmission<sup>2,3</sup>.
- *Candida auris* is hard to treat due to its resistance to antifungals<sup>4,5</sup>.

We aimed to determine if commercial grade steam would reduce or eliminate the burden of *Candida auris* on selected rehabilitation equipment used at a rehabilitation facility.

## References

- <sup>1</sup>Cristina ML, et al. J Fungi 2023 Sep 8;9(9):913.
- <sup>2</sup>Ahmad S, et al. Curr Fungal Infect Rep 2023;17(1):36-48.
- <sup>3</sup>Sabino R, et al. Microorganisms 2020 Jan 28;8(2):181.
- <sup>4</sup>Kappel D, et al. NPJ Antimicrob Resist 2024;2(1):26.
- <sup>5</sup>Lockhart SR, et al. Clin Infect Dis 2017 Jan 15;64(2):134-140.

## Methodology

We were given six pieces of equipment used in patient rehabilitation with various textures, porosity and absorbance (see picture). Upon arrival to our laboratory, each piece of equipment was tested for the presence of *C. auris*, using a BD ESwab® (Becton Dickinson) as the culture medium by swabbing each piece over much of the surface area. The swab was placed back into the medium, and 20 µl was plated onto HardyCHROM™ *Candida auris*, chromogenic medium (Hardy Diagnostics) media in a lawn spread. The plates were incubated at 35-37° Celsius for 48 hours. The presence of blue colonies indicated *C. auris* presence. After the initial verification, each piece of equipment had an approximate 4 inch by 4 inch square sectioned off on three areas, one to serve as the positive control, and the other two for each steamer. Each square was inoculated with *C. auris* stock ( $3 \times 10^6$  colony forming units (cfu)/milliliter (ml)), using a sterile, cotton-tipped applicator by steaking back and forth several times. The area was left to dry for approximately 20-30 minutes and using the same culture technique as the initial testing, proceeded to culture out the inoculated area. Two inoculated areas were subjected to steam treatment via two different commercial steamers (Jiffy J4000; Salav) by moving the steaming wand back and forth for about 1-2 minutes. The area was again allowed to dry and re-cultured. All equipment was re-cultured at 48 hours post inoculation and steam treatment. The positive control did not receive any steam treatment. All plates were streaked out using a lawn pattern with 20 µl of liquid from the BD ESwab onto the *C. auris* CHROMagar media. These plates were incubated at 35-37° Celsius for 48 hours. *C. auris* colonies seen were counted and recorded.



## Results

Table 1: *Candida auris* colony-forming units per milliliter Post Culture

| EQUIPMENT PIECE              | INOCULUM              |                       | POST STEAM            |        | 48 HRS POST STEAM |              |        |                     |
|------------------------------|-----------------------|-----------------------|-----------------------|--------|-------------------|--------------|--------|---------------------|
|                              | POSITIVE CTL          | JIFFY                 | SALAV                 | JIFFY  | SALAV             | POSITIVE CTL | JIFFY  | SALAV               |
|                              | CFU/mL                | CFU/mL                | CFU/mL                | CFU/mL | CFU/mL            | CFU/mL       | CFU/mL | CFU/mL              |
| BLACK SEAT CUSHION           | 3.02x10 <sup>5</sup>  | 3.25x10 <sup>5</sup>  | 3.00x10 <sup>5</sup>  | 0      | 0                 | 0            | 0      | 0                   |
| WHITE SUPPORT STRAP          | 2.09x10 <sup>5</sup>  | 3.40x10 <sup>5</sup>  | 2.75x10 <sup>5</sup>  | 0      | 0                 | 0            | 0      | 0                   |
| ARM TROUGH                   | 1.2x10 <sup>4</sup>   | 4.3x10 <sup>4</sup>   | 0                     | 0      | 0                 | 0            | 0      | 0                   |
| BACK REST                    | 1.01x10 <sup>5</sup>  | 1.39x10 <sup>5</sup>  | 2.03x10 <sup>5</sup>  | 0      | 0                 | 0            | 0      | 0                   |
| KHAKI SUPPORT STRAP          | > 3.0x10 <sup>5</sup> | > 3.0x10 <sup>5</sup> | > 3.0x10 <sup>5</sup> | 0      | 0                 | 0            | 0      | 1.0x10 <sup>1</sup> |
| PORTABLE SUCTION MACHINE BAG | 1.3x10 <sup>4</sup>   | 1.0x10 <sup>5</sup>   | 7.0x10 <sup>5</sup>   | 0      | 0                 | 0            | 0      | 0                   |

We did not detect *C. auris* on any of the equipment entering our laboratory. After initial inoculation, the *C. auris* cfu/ml range in the marked sampling areas across all pieces of equipment ranged from 1,000 to >300,000 cfu/ml (Table 1). Consistent colony counts were observed across the three sample areas per piece of equipment, except for one sample square on the arm trough resulting in zero colonies (Table 1). Once steam treatments were applied via respective steamer, all cultures resulted in any experimental square (Table 1). At 48 hours post-steam treatment, the treated areas for all equipment were zero cfu/ml, except for the khaki support strap, which yielded a colony count of 1,000 cfu/ml. The positive control squares were re-cultured at 48 hours and resulted in colony counts of zero.

## Conclusion

We recovered *C. auris* approximately 20 minutes post initial inoculum on all pieces of equipment in all but one test square attesting to a successful inoculation on to each piece of equipment. After the steam treatment, we only recovered a small concentration (1,000 cfu/ml) on one inoculated and treated square on one of the patient straps (the khaki strap pictured to the left). Otherwise, all other cultures, at 48 hours post steam treatment, were negative, including our positive control squares.

We failed to recover any viable colonies at the 48-hour mark for the positive control squares, and most inoculated and treated squares, which may not fully exclude the presence of *C. auris*, but simply may indicate the inability to culture it out, as it may exist at that point in time in a passive state. This may also mean it is not readily transmissible.

The colonies recovered were cultured from the khaki patient support strap were from an area that was mostly Velcro. This material may support viability more readily than other materials, such as vinyl or mesh.

Steam cleaning may play a role in hospital disinfection. Future studies may include a time series to determine the viability and culturability of *C. auris* on equipment, both pre- and post-steam.