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RESEARCH ARTICLE

Fungal carriage on healthcare workers' hands, clothing, stethoscopes and electronic devices during routine patient care: a study from a tertiary care center

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Keywords

Fungal surveillance • Heath care workers • *Candida auris* • Hands • Electronic devices

Summary

Background. *Invasive fungal infections are a constant threat to immunocompromised and critically ill patients. Healthcare workers caring for such patients act as conduits of transmission through their contaminated hands and belongings causing nosocomial infections. Although bacterial contamination of healthcare workers is known, our knowledge about fungal carriage is sparse. Among the fungi, candida species colonization of hands of healthcare workers is known however it would be interesting to know the type of fungal carriage on their inanimate belongings.*

Aim. *To study the prevalence and type of fungal carriage on healthcare workers hands, aprons/hospital scrubs, electronic devices, and stethoscopes.*

Methods. *Healthcare workers working in Medicine ward and ICU during November and December 2019 were sampled. Hand washes were collected in Brain Heart Infusion (BHI) broth with gentamycin. Direct impression smears on blood agar were taken from aprons/hospital scrubs. Electronic devices and stethoscopes were sampled using moist cotton swabs. Subculture and plating was done on Sabarouds Dextrose Agar (SDA). Yeasts were identified using Matrix Assisted Laser Desorption Ionisation Time of Flight (MALDI TOF) and moulds were identified using microscopy.*

Findings. *Out of 60 health care workers, 20 (33.3%) had fungal carriage. Aprons/hospital scrubs and hands were contaminated in 17 (28.3%) and 3 (5%) respectively. Aprons/hospital scrubs mainly constituted moulds belonging to species of Aspergillus. Hands were contaminated with Candida tropicalis, Candida parapsilosis and Candida auris. Electronic devices and stethoscopes had no fungal contamination.*

Conclusions. *Active fungal surveillance provides prevalent carriage rates and serve as a feedback to improve our disinfection and hand hygiene practices. It also aids in identification of potential source of hospital outbreaks.*

Introduction

Fungal nosocomial infections continue to be a serious problem among hospitalized patients causing increasing morbidity, mortality and healthcare costs [1]. A study done at a tertiary care center in India reported 15% invasive fungal infections in ICU, including invasive aspergillosis, invasive candidiasis and mucormycosis [2]. Most of the fungal nosocomial infections are due to exogenous acquisition of the fungus which shows a marked tendency to colonize hospital environments. These fungal pathogens flourish on their surfaces and form biofilms causing plethora of hospital acquired infections. The presence of biofilms proves to be therapeutic challenge and thus complicates the clinical scenario [3, 4]. The major implicated agent involved in spread of fungal infections are the hands of healthcare workers (HCWs) which are vulnerable to colonization and infection by fungal pathogens, especially with *Candida species* [5, 6]. Recent studies have observed, *Candida parapsilosis* represents the most frequently isolated fungus from the hands of healthy people and healthcare workers thus highlighting the importance of hand washing to prevent the horizontal transmission of this pathogen [7, 8]. The other modes of transmission of nosocomial infections are less studied in fungal pathogens, hence this study was undertaken to assess the frequency and type of carriage of fungal pathogens on health care workers hands, apron/hospital scrubs, electronic devices and stethoscopes and their role as conduits of transmission.

Methods

A cross sectional study was conducted over a period of two months (November and December 2019) among health care workers working in wards and ICU of medicine department AIIMS, New Delhi after receiving ethical approval from institute ethics committee. The health care workers included were doctors, nursing officers and other support staff (OT technicians, hospital attendants and sanitary attendants)

Samples from hands were taken using Brain Heart Infusion (BHI) broth with gentamycin, in which the hands were washed, and samples were collected as hand washes. The hand wash broths were further incubated

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at 38 degree Celsius for 48 hours and later was sub-cultured on Sabarouds Dextrose Agar (SDA).
Samples from apron/hospital scrubs sleeves and side pockets were taken as direct impression smears on blood agar plates. Stethoscopes and electronic devices were swabbed using moist cotton swabs and were further cultured on SDA and incubated.
SDA and blood agar plates were incubated at 38 degree Celsius for a maximum of five days to look for any growth. The growth was identified using gram stain and Matrix Assisted Laser Desorption Ionisation Time of Flight (MALDI TOF) for yeast like colonies. Moulds were identified by microscopy based on morphology on Lactophenol Cotton Blue (LPCB) mount.
This pilot study was carried out on healthcare workers working in medicine wards and ICU. A total of 60 healthcare workers were sampled based on convenience and available resources. A descriptive statistical analysis was performed in the form of frequency and percentages to assess the nature of fungal carriage on healthcare workers hands, aprons/hospital scrubs, stethoscopes, and devices.

Results

Sixty healthcare workers in medicine wards and ICU were sampled during the study period. It included 43 males and 17 females. They were further stratified based on their designation, 36.7, 26.7, 25, 10 and 1.7% were Junior Residents, Nursing staff, Senior Residents, Support staff and interns, respectively. 75 and 25% of the healthcare workers included were working in medicine wards and ICU respectively (Tab. I). A total of 41 stethoscopes, 66 devices (Mobile phones, tablets, pulse oximeters), everyone's hands and aprons were sampled, totalling up to 227 samples. Fifty-four (90%) had a single device while 6 (10%) had two devices.
Twenty (33.3%) out of the 60 healthcare workers had one or the other fungi isolated. None of the stethoscopes or the devices swabbed had any fungal growth while growth was seen mainly in the aprons and hands. Out of the 20 fungi isolated, 17 were from aprons, 3 were from hands (Tab. II). Amongst the fungi isolated from apron, 15 were *Aspergillus* species, one *Rhizopus oryzae* and one *Lichthemia corymbifera*. Only *Candida* species was isolated from hands which included one each of *Candida tropicalis, Candida parapsilosis* and *Candida auris* (Tab. III). Electronic devices and stethoscopes had no fungal contamination. Eight out of 15 (53.3%) and 12 out of 45 (26.7%) of healthcare workers working in wards and ICU respectively were contaminated with fungi (Tab. IV).

Tab. I. Demographic profile.

Demographic characteristic		Number (%), N = 60
Male		43 (71.7%)
Designation	Senior resident	15 (25%)
	Junior resident	22 (36.7%)
	Intern	1 (1.7%)
	Nursing staff	16 (26.7%)
	Support staff	6 (10%)
Unit of surveillance	Ward	45 (75%)
	ICU	15 (25%)

Tab. II. Fungal isolates from different samples.

Sample (N)	Number of fungal isolates (n = 20) (%)
Stethoscope (41)	0
Devices (66)	0
Aprons (60)	17 (28.3%)
Hands (60)	3 (5%)

Tab. III. Species of fungi isolated from various samples.

Sample	Fungal isolate	Number (n = 20) (%)
Aprons/ hospital scrubs	*Aspergillus fumigatus*	10 (50%)
	Aspergillus flavus	2 (1%)
	Aspergillus terreus	1 (0.5%)
	Aspergillus nidulans	1 (0.5%)
	Aspergillus sydowii	1(0.5%)
	Rhizopus oryzae	1 (0.5%)
	Lichthemia corymbifera	1 (0.5%)
Hand	*Candida auris*	1 (0.5%)
	Candida tropicalis	1 (0.5%)
	Candida parapsilosis	1 (0.5%)

Tab. IV. Fungal isolates in different surveillance units.

Surveillance unit (N)	Number of fungal isolates (n = 20) (%)	
Ward [45]	12 (26.7%)	Apron - 11
		Hands - 1
ICU [15]	8 (53.3%)	Apron - 6
		Hands - 2

Discussion

Our study was conducted to analyse the fungal carriage among healthcare workers by active surveillance. Wide spectrum of healthcare workers were sampled including senior residents, junior residents, interns, nursing staff and support staff working in wards and ICU. All potential sites of contamination including hands, aprons/ hospital scrubs, devices and stethoscope of healthcare workers were sampled. The total fungal carriage among healthcare workers was 33.3% in our study, which accounts for one third of the healthcare workers sampled. Single studies which have comprehensively investigated all possible sites for fungal carriage in a healthcare worker are sparse. Most of the studies have focussed on bacterial carriage, however the present study has shown a significant proportion of fungal carriage.
Aprons/hospital scrubs and hands were the major sources of contamination accounting for 28.3% and 5% respectively. Varying levels of fungal isolation have been reported from hands. A surveillance study on yeast carriage on hands reported a prevalence of 61% from healthcare workers out of which 57% were candida species [5]. While another study revealed a prevalence

of 16.6% Candida species [9]. Our rates of carriage were much lower, the probable reason could be good adherence to hand hygiene practices. However, among the three *Candida* species isolated one of them was *Candida auris*. It is known to cause hospital outbreaks. Its multidrug resistant nature and persistent colonization makes it difficult to treat in critically ill patients. Health care workers can have transient colonization and can act as conduits of transmission as reported in a study which had a *Candida auris* carriage rate of 2.8% [10]. With the isolation of *Candida auris*, ICU staff were alerted, and strict hand hygiene measures were employed. Repeat testing after 2 weeks did not show any growth. Emphasizing the need for handwashing.

Aprons/hospital scrubs were the major source of fungal contamination, accounting up to 28.3% in our study which mainly included various species of Aspergillus. Fungal isolation was seen 1.9% in a study, which included Mucorales [11]. Swabbing was their method of surveillance which markedly differed from ours wherein blood agar plates were directly inoculated from the scrubs. Fungal spores are ubiquitous in the environment and can readily contaminate the scrubs and thus can act as potential sources of transmission. In the absence of HEPA filters, fungal spores can cause invasive infections in immunocompromised patients.

Bacterial contamination of cell phones has been documented however moulds and yeasts have been infrequently isolated from electronic devices used by healthcare workers [12-14]. Similarly, we were also not able to isolate any fungal growth from both stethoscope and electronic devices which mainly included mobile phones. That does not mean that they cannot be a source of contamination and it probably requires better method of surveillance.

This study emphasizes the need for active fungal microbiological surveillance among healthcare workers. Neutropenic and critically ill patients are at an increased risk of invasive fungal infections. Most of the surveillance currently focuses on isolation of bacteria, however fungal surveillance can help in recognizing healthcare workers as a source of transmission and thus prevent an outbreak as evidenced in this study by isolation of *Candida auris* and a potential outbreak could be averted. This study also provides insight into novel surveillance methods which can be tried in contrast to the usual swabbing technique. A significant fungal carriage was reported in this study, but does this carriage translate into transmission and disease in patients requires additional studies.

Conclusions

Fungal carriage among healthcare workers is significant. They can serve as a potential source of transmission. Active surveillance, adequate disinfection of hospital scrubs and compliance to hand hygiene can go a long way in reducing invasive fungal infections.

Abbreviations

ICU: Intensive Care Unit
BHI: Brain Heart Infusion
SDA: Sabarouds Dextrose Agar. Yeasts were identified using
MALDI TOF: Matrix Assisted Laser Desorption Ionisation Time of Flight
LPCB: Lactophenol Cotton Blue

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Conflicts of interest statement

The authors declare no conflict of interest.

Authors' contributions

VCK, AK and GS conceived the study. VCK, NR and MS were involved in collection of samples and processing under the guidance of GS. VCK wrote the manuscript and was guided by AK. MAK was involved in statistical analysis and script editing. NW and IX were involved in script editing and script critical review. All authors read and approved the final version of the manuscript.

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