

## ORIGINAL RESEARCH

# The Incidence and Nature of Fingernail Flora after Routine Pre-operative Hand Scrubbing

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## ABSTRACT

**Background:** Nail folds and subungual are areas where bacteria can remain even after effective washing. The presence of the pathogenic bacteria will cause contamination through the fingernails. Infected hand of the health-care personnel is the main cause of spread of these infections. These can be passed from the hospital employees to the patients resulting in nosocomial infections. Gram-positive and some Gram-negative bacteria are found which remain stable.

**Aim and Objectives:** The study was to investigate the incidence and nature of fingernail flora after routine pre-operative hand scrubbing.

**Materials and Methods:** Fifteen consecutive patients were studied. After scrubbing with betadine/soap solution for 10 min, the patients' nails of all digits were trimmed. Gram staining of the isolates was performed. Fungal cultures were done by plating the suspension onto Sabouraud's agar slants and incubating at 30°C for up to 4 weeks with weekly observations.

**Results:** Fingernail isolates from the 15 patients varied. Some patients had more than one type of microorganism (i.e. bacterial, mold, and yeast) and others had several different species of the same type. Microscopic observations revealed the presence of fungi: *Mucor* sp., *Aspergillus* sp., *Penicillium* sp., and yeast *Candida*.

**Conclusions:** The study has shown the presence of bacteria in high frequency in and around fingernail. In spite of adequate pre-operative hand scrubbing, the fingernails were heavily contaminated.

**Keywords:** Contamination, Fingernail flora, Hand hygiene, Health-care personnel, Pre-operative hand scrubbing.

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## INTRODUCTION

The human body surface is constantly in contact with environmental microorganisms and becomes readily colonized by certain microbial species, Gram-negative and Gram-positive pathogens in clinical specimens.<sup>[1-4]</sup> It can cause a variety of community- or hospital-acquired infections, including those of the urinary tract, respiratory tract, wounds and burns, bacteremia, neonatal meningococcal meningitis, empyema, and osteomyelitis.<sup>[5]</sup> The hand serves as a major vehicle of transmission of various microbes, including the enteric species. About 5% of all patients admitted to hospitals develop a nosocomial infection. Contaminated hands of health-care personnel are reported as a major route for the spread of nosocomial infections.<sup>[6]</sup> Nevertheless, little importance has been given to relevant factors which control the survival of microorganisms on the hands. The degree of hydration of the epidermis is one of the most significant factors in the control of bacterial flora on the skin.<sup>[7-10]</sup> Gram-negative bacteria such as *Pseudomonas* spp. or Enterobacteriaceae are more sensitive to drying than Gram-positive *Streptococcus pyogenes* or *Staphylococcus aureus*.<sup>[11]</sup> There are few reports on the survival of these organisms when artificially applied to hands.<sup>[12]</sup> The objective of the present study was to investigate the incidence and nature of fingernail flora after routine pre-operative hand scrubbing of the patients.

## MATERIALS AND METHODS

Fifteen consecutive patients were studied. There were 10 females and 5 males. Their ages ranged from 19 to 22 years. The doctors who scrubbed the patients' hands were not aware of the study and did not specifically instruct them to trim and cleanse the nails. After scrubbing with betadine/soap solution for 10 min, the patients' nails of all digits were trimmed. The nails were placed on a sterile moist gauze pad in a plastic container and delivered to the microbiology laboratory for culture within 30 min after collection.

In the laboratory, the nails were observed macroscopically for dirt and other materials. Then, they were placed in a sterile 13 mm × 100 mm glass, screw-cap test

tube that contained 1.0 ml of sterile deionized water. The nails and water were vortexed for 30 s to loosen and suspend debris. Bacterial cultures were quantitated as follows: Serial dilutions of the suspension were prepared and 0.1 ml sample of each dilution was plated on nutrient agar plate. The plates were then incubated at 37°C and observed daily for growth. Microorganisms were identified by conventional methods, and colony counts were taken (range 30–300 colony-forming unit /ml) as cultures became positive [Table 1]. The colonies were streaked on nutrient agar medium for isolation. [Figures 1 and 2]. Gram staining of the isolates was performed [Table 2]. Fungal cultures were done by plating the suspension onto Sabouraud's agar slants and incubating at 30°C for up to 4 weeks with weekly observations.

## RESULTS

Fingernail isolates from the 15 patients varied. There were 10 females and 5 males. Their ages ranged from 19 to 22 years. Some patients had more than one type of microorganism (i.e. bacterial, mold, yeast) and others had several different species of the same type. Microscopic

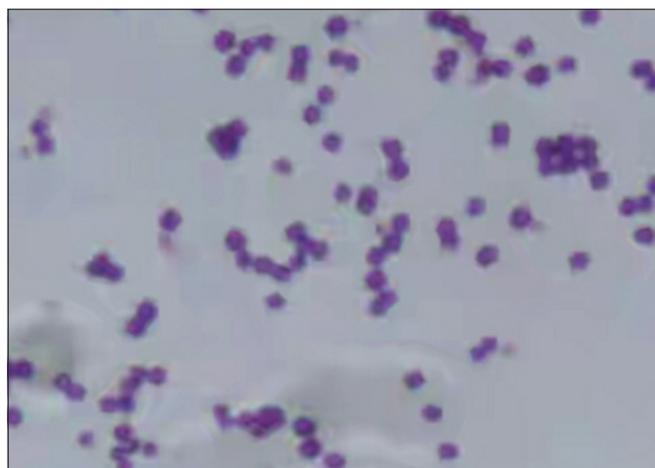


Figure 1: Gram staining of isolate 1

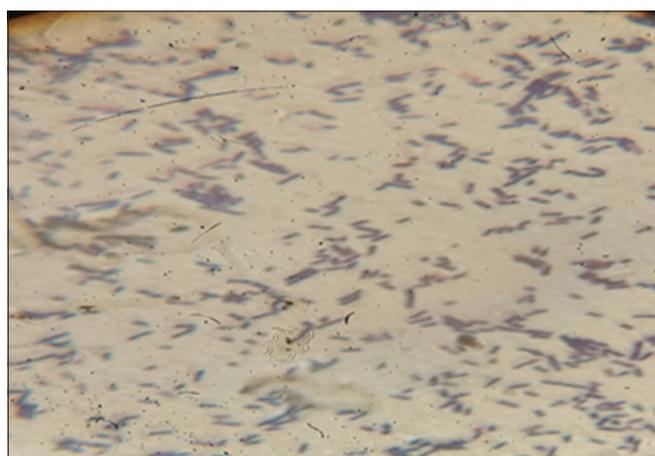


Figure 2: Gram staining of isolate 2

observations revealed the presence of fungi: *Mucor* sp., *Aspergillus* sp., *Penicillium* sp., and yeast *Candida*.

## DISCUSSION

Transient and resident bacterial flora can be passed from hospital employees to patients, resulting in nosocomial infections. Contaminated hands of health-care personnel are major vehicles for the spread of nosocomial infection.<sup>[13]</sup> Some Gram-positive microorganisms (e.g., *Staphylococcus*) are resistant to drying and can survive a long time on the hands of hospital personnel. Attempts have been made by some to reduce the number of bacteria residing on the hands, but the Gram-positive flora remains stable, regardless of changes in the external and physiologic environment.<sup>[14,15]</sup>

Rayan and Flournoy had reported heavy bacterial growth under fingernails that were more than 1 mm in length and showed that students with short fingernails (properly cut) had 64% bacterial contamination (bacterial count) and students with long fingernails showed more (67%) contamination of bacterial count on their hands.<sup>[16]</sup>

Lau *et al.* reported that long fingernail tends to harbor more microorganisms than short nails. Visibly clean nails were observed merely by the appearance of fingernails of students, showed the presence of 62% bacterial contamination on their hands.<sup>[17]</sup> Ray *et al.* observed a decrease in colony count following hand washing with soap in 60% of the samples.<sup>[18]</sup>

Tambekar *et al.* also observed that highest bacterial contamination (70%) was observed on the hands of the KG

Table 1: Microorganism colony count

Sample No.	10 <sup>-2</sup>	10 <sup>-4</sup>	10 <sup>-6</sup>	10 <sup>-8</sup>	CFU/ml
A	UC	UC	83	9	83×10 <sup>7</sup>
B	UC	UC	240	11	240×10 <sup>7</sup>
C	UC	UC	258	10	258×10 <sup>7</sup>
D	UC	UC	32	12	32×10 <sup>7</sup>
E	UC	8	7	5	-
F	UC	UC	43	27	43×10 <sup>7</sup>
G	UC	UC	233	33	233×10 <sup>7</sup>
H	UC	212	39	13	39×10 <sup>7</sup>
I	UC	UC	256	16	256×10 <sup>7</sup>
J	UC	22	13	7	-
K	UC	UC	234	43	234×10 <sup>7</sup>
L	UC	UC	157	39	157×10 <sup>7</sup>
M	UC	UC	47	21	47×10 <sup>7</sup>
N	UC	267	163	32	163×10 <sup>7</sup>
O	UC	UC	247	25	247×10 <sup>7</sup>

UC: Uncountable, CFU: Colony-forming unit

Table 2: Gram staining of isolates

Organism	Gram nature	Motility
<i>Staphylococcus</i> sps.	Gram-positive cocci	Non-motile
<i>Bacillus</i> sps.	Gram-positive bacilli	Motile

students followed by 67% on hands of primary students, 66% on secondary students, 64% on PG students, and least (57%) on the hands of undergraduate students.<sup>[19]</sup>

Ray *et al.* found that hand swab samples of 61% children harbor potential pathogens before taking food and also reported the presence of pathogenic microbes on the hands of the students which included *S. aureus*, *Escherichia coli*, *Enterococcus faecalis*, and *Klebsiella* spp.<sup>[20]</sup> Tambekar and Shirsat reported the presence of *E. coli*, *Pseudomonas* spp., *Proteus* spp., *Citrobacter* spp., *Klebsiella* spp., *Salmonella* spp., *Enterobacter* spp., and *S. aureus* from the hand swabs of students.<sup>[21]</sup> Chinakwe *et al.* also isolated *E. coli*, *S. aureus*, *Enterobacter* spp., *Klebsiella* spp., *Enterococcus* spp., *Pseudomonas* spp., *Shigella* spp., and *Corynebacterium* spp. from the handwash water samples.<sup>[22]</sup> Oniya *et al.* isolated microorganisms transmissible through handshake and also reported that the prevalence of microorganisms was higher in primary and secondary school students than in the undergraduate students.<sup>[23]</sup> The reduction in the number of pathogens after handwashing was also reported by Tambekar *et al.*<sup>[19]</sup>

Isolation of microorganisms from the fingernails of all the patients in our study indicates that fingernails can be a source of contamination and emphasizes the importance of nail hygiene in health care personnel to prevent nosocomial infections. The predominant bacteria residing on the fingernails were *Staphylococcus* and *Bacillus*; several molds and yeasts were also present.

These and other normally saprophytic organisms may become pathogens in the right environment (i.e., immunocompromised patients) and therefore should not be considered merely contaminants. In our study, *Staphylococcus* and *Bacillus* species appeared to be major inhabitants of the fingernails. Our report suggests that the patient's own nail flora might be responsible for some infections.

## CONCLUSIONS

The study has shown the presence of bacteria in high frequency in and around fingernail. In spite of adequate pre-operative hand scrubbing, the fingernails were heavily contaminated. Such organisms may become pathogens and should not always be considered contaminants. This study also confirmed the importance of pre-operative fingernail trimming and cleaning.

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