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Effectiveness of Alcohol-based Solution for Hand Hygiene.

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ABSTRACT

Healthcare workers can transmit microbial flora between patients during clinical examination. Some important members of bacterial flora causing hospital-acquired infections include *Staphylococcus aureus (S.aureus),* Coagulase-negative *Staphylococci* (CoNS) and *Pseudomonas* species. In healthcare settings, the most common way of hand hygiene is washing hands with soap and water. Alcohol-based Hand Rubs (ABHRs) are an alternative way of hand hygiene without compromising the quality of care. These hand rubs primarily contain either isopropyl alcohol, ethanol, or a combination of both, in concentrations between 65% and 95%. According to the World Health Organization (WHO), the efficacy of ABHRs can be assessed by estimating the bacterial loads before and after hand hygiene practices. Observations typically show significant reduction in bacterial count following ABHR use. Therefore, this study aims to study the impact of ABHR on bacterial loads in accordance with WHO's hand hygiene guidelines. A total of 50 participants of different places of work and different role in hospital (Doctor, nurse, lab technician) were enrolled after informed consent. Pre and post Alcohol based hand rub hand hygiene, fingerprints were taken on blood agar plates and sent immediately within an hour for incubation for 24 - 48hours. Following overnight incubation, the plates were analyzed for bacterial growth types and colony counts in terms of colony forming units (CFUs). Standard bacteriological methods, including Gram staining, biochemical testing, and antibiotic susceptibility testing according to CLSI guidelines 2023 were used to identify the microorganisms. All data were entered into Microsoft Excel and were analyzed using JMP® version 16.0.0 software. Prior to use of ABHR for hand hygiene, the median colony count for fingerprints from the left and right hands were 23.5 CFUs (IQR= 8.75 - 54.5) and 13.5 CFUs (IQR= 5 - 43.75), with a maximum of 150 CFUs and 100 CFUs, respectively. Following the use of ABHR, 70% (35 out of 50) of left-hand fingerprint cultures and 74% (37 out of 50) of right-hand fingerprint cultures showed no bacterial growth. The comparison of CFU counts before and after ABHR use showed a statistically significant decrease in CFU counts for both hands, both individually and in total (p-value <0.001). Strict use of alcohol-based hand rubs significantly reduced the bacterial burden on the hands of healthcare workers. It is crucial for healthcare workers to diligently adhere to the hand hygiene steps as recommended by the WHO, as each step of hand hygiene is vital in the thorough reduction of bacterial load on the hands of the healthcare worker as evident in the study.

Keywords: Hand hygiene, Colony forming unit, Finger-pad method, Healthcare worker

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INTRODUCTION

Hospital Acquired Infections (HAIs), as defined by the Centers for Disease Control and Prevention (CDC), are infections acquired by a patient after two days of hospital admission. These infections can occur during various healthcare services, including preventive, diagnostic and treatment services [1]. According to the latest World Health Organization (WHO) data, out of every 100 patients admitted, HAI accounts for around seven patients in high-income and 15 in middle- to low-income countries [2]. Among the multiple factors that contribute to occurrence of HAI include hospital environment, length of stay, invasive devices and healthcare workers not following proper infection control practices [3]. HAIs can be prevented by following standard and transmission-based precautions. Hand hygiene is one of the most common methods of preventing HAI [4, 5]. The importance of hand hygiene first came to light after a renowned Hungarian physician and scientist, Dr Ignaz Semmelweis, established a relationship between improper hand hygiene during childbirth and the outbreak of puerperal fever [6]. Subsequently, as a result of growing concern regarding hand hygiene practices, various organizations, including the WHO, the Centers for Disease Control and Prevention (CDC), the Association for Professionals in Infection Control and Epidemiology (APIC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC), have developed and published comprehensive guidelines to address and enhance hand hygiene practices.[5] Among all the available guidelines, the "WHO Guidelines 2009" is a globally recognized standard for hand hygiene.

Healthcare workers can transmit microbial flora between patients during clinical examination. Some important members of bacterial flora causing hospital-acquired infections include *Staphylococcus aureus (S. aureus),* Coagulase-negative *Staphylococci* (CoNS) and *Pseudomonas* species [8]. Therefore, to counter this, HCWs are advised to adhere to the five moments of hand hygiene as recommended by the WHO [7]. However, the adherence to hand hygiene practices is relatively low, averaging around 40%, and widely varies from 5% to 81% [9, 10]. This inconsistency can be attributed to several factors, including inadequate water supply, limited handwashing facilities, skin reactions to soaps and alcohol rubs, understaffing, heavy workloads, high patient turnover, lack of resources and insufficient educational programs and awareness [11-14].

In healthcare settings, the most common way of hand hygiene is washing hands with soap and water.[1] Alcohol-based Hand Rubs (ABHRs) are an alternative way of hand hygiene without compromising the quality of care. These hand rubs primarily contain either isopropyl alcohol, ethanol or a combination of both, in concentrations between 65% and 95% [15]. They act on the cell membrane of microorganisms, including bacteria, viruses, and fungi, leading to denaturation of proteins and cell lysis [16]. The use of ABHRs has increased tremendously during the COVID-19 pandemic, possibly due to increased patient-to-HCW ratio, their easy availability at the point of care, ease of use, and improved awareness of hand hygiene among HCWs and the general population [17]. According to the WHO, the efficacy of ABHRs can be assessed by estimating the bacterial loads before and after hand hygiene practices [18]. Observations typically show significant reduction in bacterial count following ABHR use. Therefore, this study aims to study the impact of ABHR on bacterial loads in accordance with WHO's HH guidelines.

MATERIAL AND METHODS

Study Design and Location

A descriptive cross-sectional study was conducted at the Department of Microbiology, BJ Government Medical College (BJGMC), Pune, between 23rd February 2024 and 28th February 2024. The study was approved by the institutional ethics committee. Using a convenient sampling method, participants, including nurses and doctors, from various wards and intensive care units (ICUs) were included in the study.

Sample Collection

After an informed consent, the fingerprints of participants were taken on blood agar plates, as described by WHO.[17] Following this, participants were asked to perform hand hygiene using ABHR (Zuvagard16 Hand Rub, Zuverlässe Hygiene India Pvt. Ltd., India). Each participant was dispensed approximately 5ml of the product to perform hand hygiene. The participants performed the hand hygiene steps recommended by WHO [6], with the process being closely monitored by the investigator to ensure

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proper execution. Upon completion and after confirming the hands were fully dry, a second set of fingerprints were taken on blood agar plates in the same manner as stated earlier. The blood agar plates were immediately transported to the bacteriology section and incubated aerobically at 37°C overnight.

Microbiological Analysis

Following overnight incubation, the plates were analyzed for bacterial growth types and colony counts in terms of colony forming units (CFUs). Standard bacteriological methods, including Gram staining, biochemical testing, and antibiotic susceptibility testing according to CLSI guidelines 2023[19] were used to identify the microorganisms. All data were entered into Microsoft Excel and were analyzed using JMP® version 16.0.0 software.

RESULTS

A total of 50 participants were included in the study. Fifty fingerprint samples, each pre and post hand hygiene, were collected and processed. The mean age of the study population was 34.6 years (SD ±1= 9.52) and showed a significant female predominance (74%) (**Figure 1 and 2**).

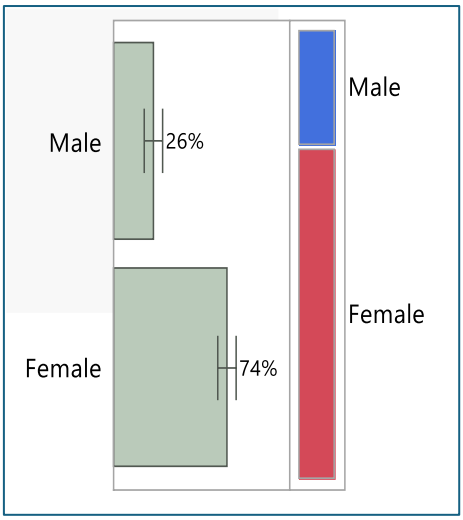

Figure 1: Gender distribution of the study participants

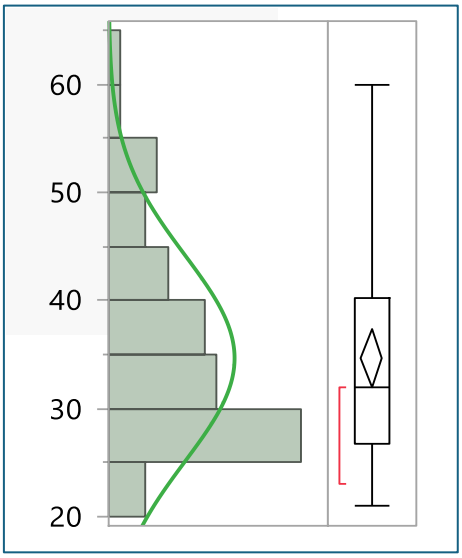

Figure 2: Age distribution of the study participants

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Among the participants, doctors were in the majority (50%) followed by nurses and technicians (**Figure 3**). Moreover, most participants were from the wards (44%), followed by those working in laboratories and ICUs (**Figure 4**).

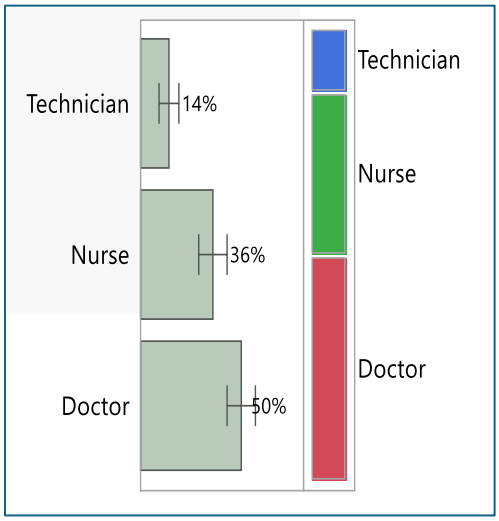

Figure 3: Distribution of study participants-based on their role in the healthcare facility

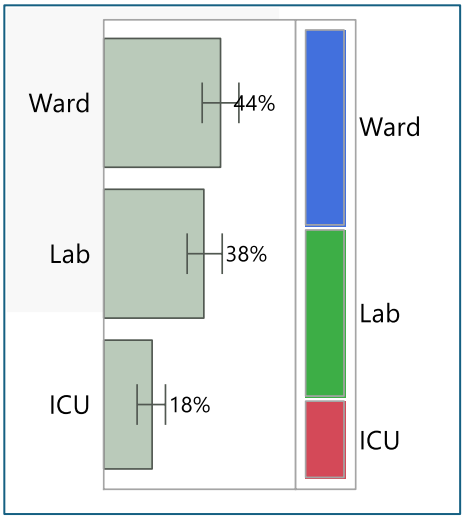

Figure 4: Distribution of workplace of the study participants

Prior to use of ABHR for hand hygiene, the median colony count for fingerprints from the left and right hands were 23.5 CFUs (IQR= 8.75 - 54.5) and 13.5 CFUs (IQR= 5 - 43.75), with a maximum of 150 CFUs and 100 CFUs, respectively. Following the use of ABHR, 70% (35 out of 50) of left-hand fingerprint cultures and 74% (37 out of 50) of right-hand fingerprint cultures with (median= 0 CFU) showed no organism growth. The comparison of CFU counts before and after ABHR use showed a statistically significant decrease in CFU counts for both hands, both individually and in total (p-value <0.001) (**Figure 5**).

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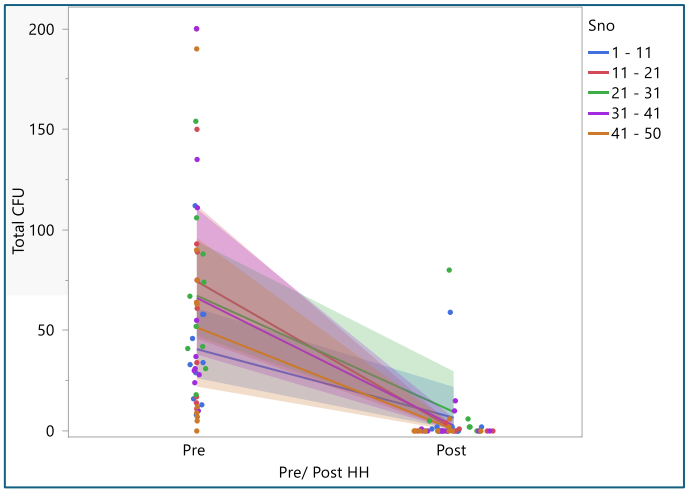

Figure 5: Graph showing decrease in CFU count pre- and post-ABHR use

The most common bacteria isolated in pre-hand hygiene fingerprint cultures were CoNS (96%), Gram-positive bacilli (GPB) (92%) and *Micrococci* (2%). However, no significant growth correlation was found between the presence of CoNS and GPB and the role of participants or workplace (*p*-values: CoNS- 0.2667, 0.2651 and 0.1848, GPB- 0.789, 0.3056, respectively). Similarly, in the case of post-hand hygiene cultures, 65% (32 out of 50 for each hand) of cultures showed no growth, while in remaining cultures, 8% of CoNS and 32% of GPB were identified on either of the hands. There were no statistically significant differences in the prevalence of CoNS and GPB post-hand hygiene, in relation to the role of HCW or workplace (*p*-values: CoNS- 0.405 and 0.713, GPB- 0.360, 0.783, respectively). The CoNS isolated was further subjected to identify methicillin resistance by cefoxitin disk method and one isolate in pre HH culture plate was identified as MR-CoNS.

In the post-hand hygiene cultures, the relation of growth and the fingers involved were also studied. Regardless of the hand orientation, out of 14 culture positive plates, thumb was the most affected finger 85% (12 plates), followed by little finger 57% (8 plates), middle finger 50% (7 plates), index finger 35.7% (5 plates), and ring finger 28.5% (4 plates).

DISCUSSION

The present study evaluates the effectiveness of ABHR in reducing the bacterial burden on the hands of healthcare workers. The bacterial counts on fingertips before hygiene measures ranged from 0 to 150 CFUs, consistent with the findings of D Pittet et al., who reported CFUs ranging between 0 to 300 [20]. Consistent with the outcomes of similar studies conducted in hospital settings worldwide, a significant reduction in microbial load was observed following ABHR use [21-24]. Also, another study by Todd et al. demonstrated that compared to traditional hand washing, there was a significant decrease in bacterial counts after ABHR use [25].

The most common bacteria identified were CoNS an85%d GPB, and this distribution was similar to the findings of Mukena Nawa et al. However, unlike their study, the present study did not identify organisms like *S. aureus*, *E. coli*, or *Enterobacter* species [26]. A high prevalence of CoNS can be attributed to its role as a resident flora on the stratum corneum of the skin, while the presence of GPB can be explained by the ubiquitous nature of this bacteria. Though traditionally considered non-pathogenic, recent studies have demonstrated the pathogenic potential of CoNS, especially in immunocompromised individuals, where they can lead to invasive infections [26]. Unlike other studies, this study did not observe an increased occurrence of methicillin-resistant CoNS. Also, this study did not observe any Gram-negative bacteria, unlike other studies [21-24]. Following ABHR use, there was a significant reduction in the CFU counts; however, the post-ABHR cultures showed a relatively higher percentage of GPB (32%) than CoNS (8%). This can be explained as GPB being resistant to alcohol, an observation supported by a study conducted in Japan, where they showed that contamination of hands with spores and decrease in CFU post hand washing [27]. Despite its resistance to alcohol, there was a statistically significant

reduction in CFU counts post-hand hygiene, indicating the effectiveness of ABHR in hand hygiene practices.

Interestingly, post-hand hygiene cultures showed the highest colony counts on the thumbprints (24%), followed by little fingers (16%). This observation is consistent with the findings from the Gniadek A et al. study, where the thumb, followed by the little finger, was most frequently missed during hand hygiene [28]. Though this distribution was not statistically significant, it could be attributed to the natural hand-rubbing motions during hand hygiene, which primarily concentrate on the palms, back of the hands, and between the fingers. This often leads to the thumbs being overlooked during the hand hygiene process. Therefore, it is essential to meticulously follow each step outlined in the WHO hand hygiene guidelines.

The study suffers from limitations. First, it was carried out with limited participants; thus, the findings cannot be generalized. Secondly, the study did not investigate the presence of anaerobic bacteria, fungi, and viruses, which are potential causes of HAIs. Further, the study did not specifically identify the species of coagulase-negative *Staphylococci*.

CONCLUSION

To conclude, our findings showed that using alcohol-based hand rubs significantly reduced the bacterial burden on the hands of healthcare workers. It is crucial for healthcare workers to diligently adhere to the hand hygiene steps as recommended by the WHO, as each step is vital in the thorough reduction of transient bacterial load, as evident in the study. It enhances the efficacy of alcohol-based hand rubs and reinforces the overall effectiveness of infection control protocols, ensuring a safer environment for both healthcare providers and patients.

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