

## A comparative study of an in-house handrub solution against a commercial handrub solution

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### Abstract

Proper hand hygiene is the single most important, least expensive means of reducing infections. Alcohol based handrub have been proven to be the most effective method of hand hygiene. This study aims at testing efficacy of an in-house handrub solution and compares it with a commercial handrub solution. The sample size was 80 which included healthcare personnel. One half of the group was provided with commercial handrub and the other half with in-house handrub solution. The in-house handrub solution was prepared as per World Health Organization formula. Hand swabs were collected from participants before and after hand hygiene. The colony counts were later compared to look for the percentage of reduction in colony count. The overall reduction in the bacterial growth after using handrub solution compared to bacterial growth before using handrub solution ranged from 30.15% - 100% for commercial handrub & 33.91% - 100% for in-house handrub solution. The efficacy of in-house handrub is comparable to commercial handrub, significantly cheaper, practical and an effective alternative to commercial handrub solution.

**Key words:** Handrub, In-house, Commercial, Comparison, Hand hygiene

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### Introduction

Hand hygiene is regarded as one of the most important element of infection control activities and it can alone significantly reduce the risk of cross-transmission of infection in healthcare facilities. The growing burden of healthcare associated infections, the increasing severity of illness and complexity of treatment, superimposed by multi-drug resistant bacterial infections warrants an effective hand hygiene measure.<sup>(1)</sup> In the United States, nearly two million hospitalized patients get infections each year, which is one infection for every 20 patients.<sup>(2)</sup> There are not enough data available to estimate hospital acquired infections (HAI) in India. However in two studies done in India prevalence of HAI have shown to range from 4.4% - 33-5%.<sup>(3,4)</sup> Healthcare workers (HCW) can come in contact with microorganisms during daily routine activities like touching medical equipments, surfaces, fomites, door knobs, faucets, light switches, bed railings, etc. and microorganisms present on these surfaces can contaminate their hands. These microorganisms can be transmitted to patients or between other HCW or they can become carriers of such microorganisms. Pathogens like Methicillin resistant *Staphylococcus aureus* (MRSA), Vancomycin resistant *Enterococci* (VRE), Gram Negative bacilli

(GNB), *Candida species*, *Influenza virus*, *Clostridium difficile* etc. can be present in the hands of these HCW.<sup>(1)</sup> Proper hand hygiene is the single most important, least expensive and simplest means of reducing the prevalence of HAI and spread of antimicrobial resistance.<sup>(2,5,6)</sup> Hand hygiene can be done by washing hands with soap and water or by using an alcohol based handrub solution.<sup>(2,6)</sup> Alcohol based handrub have been proven to be the most effective method of hand hygiene in healthcare setups.<sup>(2,7)</sup> Several commercial handrub solutions are available for hand hygiene and most of them are expensive. Due to the high cost, use of commercially available handrub products deters healthcare facilities from using handrubs effectively in healthcare setup, especially in economically backward nations. In a developing country like India, effective and economical handrub solutions are the need of the day. Availability of in-house handrub solutions in all healthcare setup is not only convenient but also its increased use can help in reduction of infections. There are limited number of studies done which compares in-house handrub solution with commercial.<sup>(8)</sup> This study aims at testing efficacy of an in-house handrub solution and compares it with a commercial handrub solution. It will also evaluate if an in-house handrub solution is practical and economical to use in a healthcare facility.

### Materials and Methods

The sample size was 80. Volunteer healthcare personnel including doctors, nurses, male nursing orderly, female nursing orderly and medical students coming in contact with patients were included in the study. They were divided into two groups of 40 each. One group was provided with commercial handrub and

the other with in-house handrub solution. The commercial handrub solution used here was Sterillium (Raman & Weil Private limited, Mumbai, India). Compositions of Sterillium solution per 100gms as per the composition label on the container were 2-propanol 45 grams, 1-propanol 30 grams, Mecetronium etilsulfate 0.2 gram. Other ingredients were Glycerol 85%, 1-tetradecan, fragrances, patent blue V, purified water. The in-house handrub solution was prepared as per world health organization (WHO) formula.<sup>(6)</sup> In-house handrub solution was prepared by mixing 96% Ethanol 833.3 ml (Karnataka State Beverages corporation Limited, Mandya District, Karnataka State, India), 3% Hydrogen peroxide 41.7 ml (Merck specialities private limited, Mumbai, India), 98% Glycerol- 14.5 ml (Merck specialities private limited, Mumbai, India), sterile water 110.5ml. The total volume of the preparation was 1000ml. The final concentration of ethanol was about 80%. 3% Hydrogen peroxide was freshly prepared from 30% concentrate by diluting with sterile distilled water. First about 500ml of ethanol was poured into a large clean glass container. Hydrogen peroxide was added to this ethanol followed by Glycerol. As glycerol is very thick viscous liquid it sticks to the wall of the measuring cylinder. The remainder glycerol was rinsed off with small amount of already measured sterile water and then emptied into the glass container. Lastly the remainder of the ethanol and sterile water was added. The solution is mixed by shaking gently. Immediately it was divided and emptied into final clean containers with dispensers and they were away from sunlight and heat for 72 hours before use. The handrub solution was ready for use after 72 hours. Out of the 40 participants who were provided with in-house handrub solution, 20 participants were provided with in-house handrub solution with an additional ingredient to what mentioned above. A commercial essence used in various food preparations, Bush strawberry artificial flavouring agent (IFF international flavours & fragrances India Pvt. Ltd., Chennai, India) was added to the solution at the time of preparation in a volume of 2ml of essence to 998ml of handrub solution. The in-house handrub solution was put to sterility check before use by inoculating on nutrient agar and incubating at 37°C for 24 hours.

Hand swabs were collected from participants who have completed at least two hours of daily routine work of patient care and who have not performed any methods of hand hygiene like using handrub or soap and water, for at least two hours before collection of specimen. A total of four swabs were collected from each participant. One swab each from right and left hand before application of handrub and one swab each from right and left hand after application of handrub were collected. A sterile swab was moistened with sterile saline and rolled over the ventral aspect of hand, including all fingers and web spaces of the participants. After collection of swabs the participants were provided

the handrub solutions. For the first 40 participants, commercial handrub solution Sterillium, was provided for hand hygiene. For the remaining 40 participants, in-house handrub solution was provided for hand hygiene. About 3ml of Sterillium handrub was used by pressing the dispenser twice, as per manufacturer instructions for one hand hygiene cycle. About 2ml of in-house handrub solution was used by pressing the dispenser once for one hand hygiene cycle. The handrub solutions was spread evenly on the both palm, fingers, knuckles, dorsum of hands, web spaces and thumbs for about 20-30 seconds.<sup>(7)</sup> After application the hands were allowed to dry in air. After about five minutes the second set of hand swabs were collected in the similar method mentioned earlier. The swabs were labelled appropriately and transferred to the microbiology laboratory for testing. Each swab was inoculated individually on one nutrient agar each. The swab was rolled three times on the centre of the petri dish. With a sterile inoculating loop the agar was streaked perpendicularly to the inoculation line and spread over the entire petri dish. The nutrient agar plates were then kept for incubation at 37°C for 48 hours. The total numbers of bacterial colonies grown each of nutrient agar were counted. The bacterial colonies identified by Grams staining and standard biochemical tests.<sup>(9)</sup> Staphylococci were further tested for cefoxitin susceptibility by modified Kirby-Bauer disc diffusion method, to identify methicillin resistant Staphylococci.<sup>(10)</sup> The number of bacterial colonies grown from both hands before application of handrub were summed up and number of bacterial colonies grown from both hands after application of handrub were summed up. The colony counts were later compared to look for the percentage of reduction in colony count. Those who used commercial handrub and in-house handrub were compared separately.

## Results

Out of the 80 participants in the study 30 (37.5%) were doctors, 20 (25%) medical students, 16 (20%) nurses, 8 (10%) female nursing orderly and 6 (7.5%) male nursing orderly. The number of participants who used Sterillium were 40 (50%) and in-house handrub solution were 40 (50%). From each group hand swabs were collected before and after application of handrub solution and from right and left hands separately. Out of the 40 participants who used in-house handrub, 20 (50%) used the solution as per WHO formulation and 20 (50%) used that which had an additional strawberry essence to the WHO formulation.

Bacterial growth was observed in all 80 (100%) specimens tested before application of handrub. The various bacteria isolated in culture were methicillin sensitive Staphylococcus aureus, MRSA, Coagulase negative Staphylococci, Methicillin resistant Coagulase negative Staphylococci Micrococcus species, Acinetobacter species and Bacillus species. Either one,

two or three types of bacteria were isolated from culture of a single specimen. The specimens showing growth of one type of bacteria was 22 (27.5%), two types of bacteria 53 (66.25%) and three types of bacteria 3 (6.25%). No culture showed growth of more than three types of bacteria. The overall reduction in the bacterial growth after using handrub solution compared to bacterial growth before using handrub solution ranged from 30.15% - 100% for Sterillium & 33.91% - 100% for in-house handrub solution. The details of reduction of bacterial growth reduction in those who used Sterillium and in-house handrub solution are given in **Table 1**. Complete inhibition of bacterial growth (100%) was seen in 9 (45%) of the people who used in-house handrub solution as per WHO formulation, 5 (25%) in people who used in-house handrub solution as per WHO formulation plus added essence and 18 (45%) in those who used Sterillium. With in-house preparation as per WHO formulation the least reduction in bacterial growth was 73.6%, with in-house preparation as per WHO formulation with added essence the least reduction in bacterial growth was 33.91% and the least reduction of bacterial growth with Sterillium was 30.15%.

## Discussion

Hand carriage of resistant pathogens has repeatedly been shown to be associated with nosocomial infections. The hands may become contaminated by merely touching the patient's intact skin or during a simple activity like recording blood pressure.<sup>(2,5,6)</sup> Pathogens like MRSA, vancomycin resistant *Enterococci*, Gram Negative bacilli, *Candida species*, *Influenza virus* and *Clostridium difficile*, can be present in the hands of HCW and can survive for as long as 150 hours. Normal skin sheds approximately  $10^6$  skin epithelial cells containing viable microorganisms daily which can contaminate fomites and the patient's immediate surroundings.<sup>(1)</sup> Proper hand hygiene is the single most important, least expensive and simplest means of reducing the prevalence of HAI and spread of antimicrobial resistance.<sup>(2,5,6)</sup> Hand hygiene can be done by use of soap and water and alcohol based handrubs. Alcohol based handrubs are more effective, fast acting and have longer sustained action compared to soaps and hence it's the most suited and convenient option for hand hygiene.<sup>(2,6)</sup>

In this study 80 HCWs participated in the study. Out of 80 participants, 30 (37.5%) were doctors which was the highest number followed by 20 (25%) medical students, 16 (20%) nurses, 8 (10%) female nursing orderly and 6 (7.5%) male nursing orderly. Half of the total participants, 40 (50%) were provided with Sterillium and the remaining half in-house handrub. Among the doctors, medical students, nurses, male and female nursing orderly 50% were provided with sterillium and 50% with in-house handrub. Bacteria like

*Staphylococcus aureus*, MRSA, Coagulase negative *Staphylococci*, methicillin resistant Coagulase negative *Staphylococci*, *Micrococcus species* and *Acinetobacter species* were isolated in the culture of the samples before using handrub. From a single specimen either one, two or three types of bacteria were isolated. In 53 (66.25%) of the participants two types of organisms were isolated from the hands. The organisms isolated in this study are have been proven to colonize hands of HCWs and are responsible for HAIs worldwide.<sup>(1)</sup> Fungi, viruses and parasites were not screened from the hands of the HCWs in this study. Out of the 80 participants, 40 (50%) were provided with Sterillium and 40 (50%) with in-house handrub. Out of the 40 participants who were provided with in-house handrub solution, 20 of them were provided with the WHO formulation and the remaining 20 with same formulation handrub plus an added strawberry essence. The overall reduction of bacterial growth by in-house handrub was 33.91% - 100% and was comparable with commercial handrub, sterillium which was 30.15% - 100%. As shown in Table 1 the percentage of reduction in number of colonies was 100% in 14 (35%) of those who used in-house handrub and 18(45%) of those who used sterillium. Both handrub solutions reduced >95% of bacteria in 62-72% of the participants, thus showing their excellent efficacy. The in-house handrub solution was able to inhibit growth of bacteria like *Staphylococcus aureus* including MRSA, Coagulase negative *Staphylococci*, Methicillin resistant Coagulase negative *Staphylococci* and *Acinetobacter species* similar to sterillium.

**Table 1: Bacterial growth reduction percentage ranges after use of Sterillium and in-house handrub**

Bacterial growth reduction percentage	In-house handrub (Out of 20) No. (Percentage)	In-house handrub with added essence (Out of 20) No. (Percentage)	In-house handrub plus In-house handrub with added essence (Total out of 40) No. (Percentage)	Sterillium (Out of 40) No. (Percentage)
100%	9 (45%)	5 (25%)	14 (35%)	18 (45%)
95-99%	4 (20%)	7 (35%)	11 (27.5%)	11 (27.5%)
90-94%	3 (15%)	1 (5%)	4 (10%)	4 (10%)
80-89%	2 (10%)	2 (10%)	4 (10%)	2 (5%)
70-79%	2 (10%)	3 (15%)	5 (12.5%)	2 (5%)
60-69%	0	1 (5%)	1 (2.5%)	1 (2.5%)
50-59%	0	0	0	1 (2.5%)
30-49%	0	1 (5%)	1 (2.5%)	1 (2.5%)

The in-house handrub solution was prepared as per the WHO formulation with ingredients such as alcohol, glycerol, hydrogen peroxide and water. A food grade strawberry essence was added to this formulation and 20 participants were provided with this handrub. The reason for adding the essence was not only to test efficacy after adding additives, but also to overcome the strong alcohol odour used in the plain in-house handrub. There are not enough studies which have evaluated the efficacy of handrub formulations with added fragrances and colouring agents and hence WHO has not yet recommended addition of these additives.<sup>(6)</sup> In this study even after addition of the essence to the in-house handrub solution its efficacy was comparable and did not show decrease in efficacy. Vanilla essence was also tried in for the solution. But strawberry was more neutral and pleasant than vanilla essence when mixed with the in-house handrub and hence it was used in the study. As per the WHO formulation for handrubs clean boiled and cooled water can also be used to prepare the in-house handrub solution instead of sterile water.<sup>(6)</sup> In this study sterile distilled water was used because of availability. Sterillium was applied in a volume of approximately 3ml by dispensing twice (1.5ml twice) from the dispenser provided with the handrub container as per manufacturer's instructions. The in-house handrub solution used was approximately 2 ml by dispensing once from the dispenser. So a 500ml sterillium would be sufficient for approximately 166 applications and a 500ml in-house handrub would be sufficient for 250 applications. Hence the in-house handrub solution will last for 84 (33.6%) applications more than sterillium making it long lasting, economical and lesser intervals of refill. The efforts of preparing an in-house handrub solution would not be fruitful if there is no significant reduction in cost. The commercial handrub solution sterillium was costing Indian rupees 237 for 500ml. The in-house handrub solution cost was Indian rupees 35 for 500 ml, making it 85% cheaper than sterillium. This cost reduction can be achieved by procuring absolute alcohol at low cost in bulk from

distilleries. The low cost of this in-house handrub solution can not only reduce working costs but also can encourage to implement hand hygiene practices effectively even in small hospitals and nursing homes. However it may not be practical for standalone clinics run by a single doctor. Similar to sterillium the participants did not face any allergy or dry-hand issues with the in-house handrub solution. The in-house solution was stored for 6 months without loss of efficacy. Efficacy was not tested beyond this period.

### Conclusion

The in-house handrub solution is significantly cheaper than commercial handrub. It's efficacy is comparable to the commercial handrub solution. In-house handrub is easy to prepare and is a practical and effective alternative to commercial handrub solution.

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