

Hand Bacterial Repopulation Dynamics Following Two Methods of Surgical Hand Preparation during Elective Orthopedic Surgeries

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Abstract

Context: Antiseptic hand preparations are routine prior to surgical procedures to reduce microbial load on the operating gloved hands. Two methods of surgical hand preparations available are the antibacterial detergent hand wash and an alcohol-based hand rub. **Aim:** The aim of the study was to compare quantitatively, the efficacy of the two methods in hand bacterial reductions during elective orthopedic surgeries. **Setting and Design:** This comparative study was conducted at the orthopedic surgery department of a tertiary health facility. **Subjects and Methods:** One-hundred and sixty dominant hands of operating surgeons and nurses involved in forty elective orthopedic surgeries were studied. The subjects were randomly assigned to either the antibacterial detergent hand-washing (HW) or the alcohol-based hand-rubbing (HR) groups. Swab samples were obtained from the hands before and after hand preparations and at the end of surgeries following removal of the operating gloves. These samples were then subjected to culture. The bacterial counts on these were then obtained through an automated colony counter, and the results were expressed in logarithmic values (\log_{10}). **Statistical Analysis Used:** The analysis was done using IBM SPSS software version 20. The mean results obtained were subjected to an independent *t*-test analysis with the statistical significance level set at $P < 0.05$. **Results:** Both methods of hand antisepsis showed comparable efficacies in attaining surgical hand hygiene at 1-min postapplication ($P = 0.73$). HR group, however, showed greater sustained effects during the period of surgeries, though not statistically significant ($P = 0.18$). **Conclusion:** Scrubbing using the HR method is a viable alternative to the HW method during elective orthopedic surgery.

Keywords: Hand rubbing, hand washing, surgical hand antisepsis

INTRODUCTION

Hand preparation prior to donning of surgical gowns and gloves is routine in day-to-day surgical practice. The prime purpose is to reduce the microbial flora of the hands to the barest minimum and to maintain these reductions during the entire period of the procedure. Intraoperative glove perforations are very common, especially during orthopedic surgeries, and these perforations are a potential source of wound contamination which could lead to surgical-site infections (SSIs).¹⁻³ The human skin microflora consists of numerous bacteria, viruses, and fungi, which have been classified into the resident, transient, and infectious groups.^{4,5}

The use of plain soap and water to prepare the hands has been shown to possess no antimicrobial property and poorly reduces the microbial density of the hands, while the use of gloves

alone without proper hand preparation has also been shown to poorly protect against wound contamination.^{6,7}

The recommended methods of attaining surgical hand hygiene by the Centers for Disease Control and Prevention, the Food and Drug Administration, and the World Health Organization are the surgical hand-washing (HW) technique and the surgical hand-rubbing (HR) method.^{6,8} Orthopedic surgery frequently

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involves manipulations intraoperatively and use of various ranges of instrumentations from light to heavy unlike other general surgical procedures. This peculiarity may confer a higher rate of shedding of skin, which may be higher than other general surgical procedures and may affect the dynamics of hand bacteria.

This study seeks to quantitatively compare these two methods of surgical hand antisepsis during elective orthopedic surgeries performed at a tertiary health facility in the southwestern part of Nigeria.

SUBJECTS AND METHODS

This was a randomized comparative study carried out at the orthopedic surgery department of a tertiary health facility. Ethical approval was obtained from the institutional ethical board, and the consent of the participants was sought. This study was done in compliance with the 1964 Declaration of Helsinki and its later amendment. This study spanned forty elective orthopedic surgeries which were, in turn, randomly assigned to either the HW group or the HR group, indicating the proposed method of surgical hand preparation to be adopted by the operating team before donning their surgical apparel.

One hundred and sixty dominant hands of operating personnel who were not on any form of antibiotics were analyzed during the period of the study. A list of personnel making up the orthopedic surgery teams were identified, and all those enlisted to participate were engaged in a forum where the study and its aims were discussed along with the current standard of practice. A double-blind randomization process was adopted through a ballot system whereby an independent observer kept picking from a bag containing fifty crumpled paper slips (of which twenty were inscribed HW indicating hand washing and another 20, HR indicating hand rubbing). The remaining ten were left blank and were only intended to strengthen the randomization process. Only slips with inscriptions picked were entered into a ledger, indicating the order, in which eligible patients presenting for surgery would be serially arranged into the study groups. The operating personnel, authors, or patients had no access or knowledge of the order in the ledger except the microbiologist involved in the study.

Swab sticks with different color codes were used to avoid the risk of mixing up the samples collected: white-colored swab sticks for the baseline samples, red-colored swab sticks for immediate samples, and blue-coded swab sticks for the sustained samples. These hands were evenly comprised of lead surgeons, assistant surgeons, and scrub nurses, directly involved intraoperatively in surgeries. The inclusion criteria were routine elective clean orthopedic surgeries for patients having no comorbidities scheduled as the first procedure for the day, whereas the exclusion criteria were open wounds, patients with comorbidities, and obvious intraoperative perforations of the surgical gloves.

The HW method involved the serial use of 4% chlorhexidine gluconate (Hibiscrub) over a 5 min' time frame, whereas the HR entailed an initial 1-min hand wash using plain soap and

water before application of a 70% alcohol-based surgical hand gel (PURELL®) twice until the hands were dried. Three sets of skin swab samples were obtained from the dominant hands of the operating personnel. A swab sample was taken from the first dorsal digital web space, while another was obtained from the subungual region of the ring finger. The first was before the hand preparation, the second at 1-min post hand prepping, and the third was obtained at the end of surgery following the removal of the surgical gloves.

These samples were smeared immediately on Petri dishes containing tryptic soy broth by the microbiologist in the operating room environment and transported to the laboratory within 2–3 h of collection where they were incubated at 36 + 1° C for 48 h at the microbiology laboratory. The three sets were designated baseline bacterial count (BBC), immediate bacterial count (IBC), and sustained bacterial count (SBC). The bacterial reduction factors were extrapolated by the following formulas:

- $BBC - IBC =$ Immediate reduction factor (IRF)
- $BBC - SBC =$ Sustained reduction factor (SRF).

The bacterial repopulation rates were determined following subtraction of the SRF from the corresponding IRF.

The bacterial colony counts observed were counted using an automated colony counter and expressed in logarithmic values (\log_{10}). The mean values were analyzed and subjected to an independent *t*-test analysis using IBM SPSS version 20 (IBM SPSS Inc., Chicago, IL). The level of statistical significance was set at $P < 0.05$.

RESULTS

Out of the 160 dominant hands studied, 132 (82.5%) were right handed, whereas 28 (17.5%) were left handed. Analysis of the bacterial count following culturing was $4.87 + 1.12$ (colony-forming unit/mL) with a range of 1.0–6.0.

The mean BBCs of the individual personnel are shown in Table 1.

A tabular analysis of the bacterial reduction factors following the employment of the hand antisepsis methods in the HW and HR groups is shown in Table 2.

The elective orthopedic surgical cases performed during the period of the study had a mean duration of 152.6 and

Table 1: Analysis of inter-personnel baseline bacterial count

Personnel	Mean BBC (CFU/mL)		P
	HW	HR	
Lead surgeon	5.19±0.73	4.98±0.90	0.61
1 st assistant surgeon	5.23±0.67	4.89±1.07	0.42
2 nd assistant surgeon	4.44±1.61	4.85±0.94	0.52
Scrub nurse	5.26±0.68	4.12±1.71	0.08

HW – Hand-washing group; HR – Hand-rubbing group; BBC – Baseline bacterial count; CFU – Colony-forming unit

Table 2: Analysis of the immediate and sustained effects of two methods

	HW	HR	P
Mean IRF	0.81±1.27	0.73±0.79	0.72
Mean SRF	0.63±1.67	1.10±1.21	0.18
Repopulation factor (SRF – IRF)	0.10±1.44	0.40±1.16	0.34

IRF – Immediate reduction factor; SRF – Sustained reduction factor;
HW – Hand-washing group; HR – Hand-rubbing group

145.9 min in the HW and HR group, respectively ($P = 1.0$). Locked intramedullary nailing (55%) was the most frequent surgery performed, while plate osteosynthesis accounted for 27% of the population studied. Other procedures done were hemiarthroplasty (12.5%) and implant takedown accounting for 5.5%.

DISCUSSION

The act of hand preparation prior to surgeries is probably one of the most important steps when scrubbing.

In this study, the hand microbial loads were quantified before and after hand preparation in the two groups (HR and HW) and at the end of surgery. The BBCs were observed to be similar in both groups and upon the inter-personnel comparison ($P > 0.05$). This shows that the two groups are similar and comparable. The high bacterial count is probably attributable to the cases included in the study, being the first cases of the day, and participants may not have had any contact with any hand antiseptic agents.

In the immediate postapplication phase of the study, which precisely was at the 1-min mark, the HW group displayed a slightly better but not statistically significant hand bacterial reductions when compared to the HR group ($P = 0.72$). Hence, both methods showed equal efficacy in the immediate antibacterial effect on the hands at 1 min. Kac *et al.* and Tavolacci *et al.* had similar results in terms of the immediate effects of the two methods on the hands as both works showed no statistical differences between the two methods.^{9,10} Abhishek *et al.* in their study found that hand scrubbing for >2 min and 30 s significantly reduced the transmission of infective pathogens in orthopedic surgery.¹¹ This further underscores the effectiveness of chlorhexidine gluconate as a reliable agent for surgical hand preparation. We, however, used 5 min as the yardstick for the HW group in this study. In another study by Rotter *et al.*, the HR method using different alcohol-based agents with or without supplements with antibacterial activities showed much higher antibacterial effects in the immediate period after application than what was obtained in this study.¹² Even after 3 h of glove use, the bacterial counts were still below the baseline values. However, the hands were exposed prior to gloving for 3 min instead of the 1-min time frame used for this study.

The reverse was the case when the residual antibacterial effects of the two methods were studied. The HR method displayed

marginally higher sustained antimicrobial action on the hands. The bacterial repopulation factor was higher in the HR group, which connoted higher ongoing hand bacterial reductions during the period of surgeries, but this observation was not statistically significant. The findings regarding the sustained effects in this study are in tandem with the results observed by Tavolacci *et al.*, who also found HR using alcohol-based hand gels to have a long-lasting effect than the HW method using chlorhexidine.¹⁰ Carro *et al.* also observed better sustained antimicrobial actions following the HR method than in the HW method during cardiothoracic surgeries.¹³ Their method of obtaining culture was by the glove juice technique as against the swab stick method used for this study.

SSIs are as a result of multiple risk factors related to the patient, surgeon, and environmental condition of the health-care institution. Despite the use of gloves, surgical hand preparation is essential to reduce the organisms on the operating hands in case of inadvertent puncture which in many instances may go unnoticed.^{14,15}

A limitation of this study is the fact that the rate of bacterial shedding between the various team members was not studied. Further studies will be encouraged in this direction. In conclusion, no significant difference was obtained between the two methods of hand preparation. Both methods are effective and can be used in orthopedic implant surgery.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Adesukanmi AK, Badmus TA, Ogunlusi JO. Accidental injuries and cutaneous contaminations during surgical operations in a Nigerian teaching hospital. *East Afr Med J* 2003;80:227-34.
- Yinusa W, Li YH, Chow W, Ho WY, Leong JC. Glove punctures in orthopaedic surgery. *Int Orthop* 2004;28:36-9.
- Magill SS, Hellinger W, Cohen J, Kay R, Bailey C, Boland B, *et al.* Prevalence of healthcare-associated infections in acute care facilities. *Infect Control Hosp Epidemiol* 2012;33:283-91.
- Price PB. The bacteriology of normal skin: A new quantitative test applied to a study of bacterial flora and the disinfectant action of mechanical cleansing. *J Infect Dis* 1938;63:301-8.
- Aly R, Maibach HI. Factors controlling skin bacterial flora. *Skin microbiology; Relevance to clinical infection*. New York: Springer-Verlag; 1981. p. 29-39.
- Kampf G, Kramer A. Epidemiologic background of hand hygiene and evaluation of the most important agents for scrubs and rubs. *Microbiol Rev* 2004;17:863-93.
- Widmer AF. Replace hand washing with the use of waterless alcohol rub. *Clin Infect Disease* 2000;31:136-43.
- Girard R, Amazion K, Fabry J. Better compliance and better tolerance in relation to a well-conducted introduction to rub-in hand disinfection. *J Hosp Infect* 2001;47:131-7.
- Kac G, Masmejean E, Gueneret M, Rodi A, Peyrard S, Podglajen I. Bactericidal efficacy of a 1.5-minute surgical hand-rubbing protocol under in-use condition. *J Hosp Infect* 2009;72:135-9.
- Tavolacci MP, Pitrou I, Merle V, Haghghat S, Thillard D, Czernichow P. Surgical hand rubbing compared with surgical hand scrubbing: Comparison of efficacy and cost. *J Hosp Infect* 2006;63:55-9.

11. Abhishek SB, Ronald JM, D'souza T, Jacob I. Duration of surgical hand scrub in orthopaedic surgeries. *Int J Orthod Sci* 2017;3:34-6.
12. Rotter ML, Kampf G, Suchomel M, Kundi M. Population kinetics of the skin flora on gloved hands following surgical hand disinfection with 3 propanol-based hand rubs: A prospective, randomized, double-blind trial. *Infection Control and Hospital Epidemiology* 2007;28:346-50.
13. Carro C, Camilleri L, Traore O, Badrikian L, Legault B, Azarnoush K, *et al.* An in-use microbiological comparison of two surgical hand disinfection techniques in cardiothoracic surgery: Hand rubbing versus hand scrubbing. *J Hosp Infect* 2007;67:62-6.
14. Beltrami EM, Williams IT, Shapiro CN, Chamberland ME. Risk and management of blood-borne infections in health care workers. *Clin Microbiol Rev* 2000;13:385-407.
15. Kampf G, Goroncy-Bermes P, Fraise A, Rotter M. Terminology in surgical hand disinfection-a new tower of babel in infection control. *J Hosp Infect* 2005;59:269-71.