



## **Comparative Study of the Efficacy of Brushless Surgical Hand Preparation Techniques Using Antiseptic Soap, Alcohol and Non-medicated Soap**

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### **Authors' Contributions**

*This work was carried out in collaboration between all authors. Author JAA managed the literature searches and designed the study, author AAJF did the microbiological analysis, author MAB wrote the manuscript and performed the statistical analysis, Student group (AS, AA, AB, Abdulrahman Alsabban, AJ and Ahmad Alzomity) did the practical part of the study. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Background & Objectives:** Preoperative hand preparation with a brush-less method is almost a common practice. The aim of this study was to compare the efficacy of brush-less preoperative hand preparation using alcohol to antiseptic soap, and non-medicated soap in eliminating germs by standard proper pre-operative hand preparation.

**Methods:** Twenty volunteers tried three different ways of surgical hand preparation with antiseptic soap, alcohol, and non-medicated soap-based preoperative hand preparation.

**Results:** There was no positive bacterial growth sample in the alcohol-based scrubbing

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group while it was 2% with positive bacterial growth in the antimicrobial soap and 55% with positive bacterial growth in the non-medicated soap group.

**Conclusion:** The alcohol-based pre-operative hand preparation was significantly more efficient than both the antimicrobial soap and the non-medicated soap.

*Keywords:* Brush-less surgical hand preparation; Antiseptic soap; Alcohol; Non-medicated soap.

## 1. INTRODUCTION

The new development of modern preoperative hand preparation techniques belongs to Joseph Lister, a British surgeon who published a groundbreaking paper in 1889 called "Antiseptic Principle of Practice of Surgery". He suggested the use of carbolic acid (phenol) as a way of ensuring the complete elimination of germs [1]. The Association of Operating Room Nurses (AORN) did not recommend a specific hand preparation duration [2]. However, WHO is continuously updating its guidelines concerning preoperative hand preparation.

There is a strong evidence that hand antisepsis; has a great impact in reducing the surgery-related infections, despite a paucity of appropriate randomized controlled trials. Recently several studies suggested shorter hand preparation duration with hand disinfected is as efficient as hand preparation for longer duration [3,4,5].

Nowadays, the preoperative hand preparation with a brush-less method is almost a common practice. Alcohol was suggested to be more suitable replacement [6,7,8]. Hand washing has been recommended before alcohol hand preparation [7,9]. Antiseptic agents that contain alcohol, chlorhexidine, iodophors, parachlorometaxyleneol or triclosan are widely used in hand preparation [8,10].

According to the CDC guidelines on hand hygiene and preparation, the alcohols are more efficient and superior to many other active agents such as chlorhexidine gluconate or povidone iodine [11]. Yet, surgical hand preparation is still done with antiseptic soap or povidone iodine in many countries except in parts of Europe and USA where Alcohol-based hand preparation is a common practice [12,13].

Many studies showed that alcohol preparation was more efficient [14,15], gave better-results [16,17], more cost effective [18], convenient and time saving [19,20,21] than the other methods of hand preparation. Some other studies showed no significant difference among alcohol based hand preparation and other methods [22,23,24,25]. On the other hand, other studies showed that alcohol based hand preparations were even inferior to the other methods [26,27,28,29,30].

The aim of this study was to compare the efficacy of the classic brush-less preoperative surgical preparation using alcohol, antiseptic soap, and non-medicated soap in eliminating germs by standard proper pre-operative hand preparation in a tertiary university teaching hospital where the standard pre-operative hand preparation technique is still using the brush method.

## **2. METHODS**

This was a cross sectional experimental prospective study where healthy medical students and trainees volunteers of comparable age and gender were recruited to the study. Each recruited participant was taught the classic preoperative 5-minute surgical hand preparation technique by an experienced scrub nurse or an experienced doctor in the hand preparation area outside an operating room theatre. All the included volunteers tried the three different methods of surgical hand preparation which included scrubbing full arm, elbow and hand with antiseptic soap, alcohol-based, and non-medicated soap hand preparation.

### **2.1 Inclusion Criteria**

The study included self-motivated motivated volunteers (senior medical student & interns in the King Abdulaziz University Hospital; KAUH) that were subjected to a training course given by an expert doctor or scrub nurse about gown and scrub process and passed training as per judgment of observer or nurse. All included persons had the pre-washing information and agreed for being observed during the preparation process and to receive help when needed.

### **2.2 Exclusion Criteria**

Volunteers with chronic disease, hand cut wounds, ulcers, abrasion, or ring that cannot be removed and those with hand infection that may interfere with the technique or the result were excluded. Also, those who showed lack of adherence to aseptic technique principles during hand preparation, gowning or gloving or those who had any hand preparation during the last 2 days were excluded.

### **2.3 Technique of Hand Preparation**

After good training period for the included volunteers, the recruited persons did the surgical hand preparation under observation by an experienced nurse or doctor. Brush-less hand preparation was done at least after 2 days of the last training on surgical hand preparation. Each followed the following steps during hand preparation:

Before starting hand preparation; any rings, watches, and bracelets were removed and the hands up to the elbows were washed first with water. Then the recommended amount of soap (antiseptic soap [Chlorhexidine Gluconate 4% Solution, BioMed Systems, Inc, USA], or non-medicated soap [Becton, Dickinson and Company; USA]) was applied to hands. The hands were rubbed together vigorously for at least 15 seconds, covering all surfaces of the hands and fingers (the out sides of each finger were rubbed for 45 seconds, with paying special attention to inter digital areas then the back of the hand and palm from the base of the fingers to the wrist for 45 seconds), then the forearm, the elbows up to the arms. Then the hands were rinsed with water and dried thoroughly with a sterile disposable towel. A towel was used to turn off the faucet. If the sterillium [alcohol-based hand rubs, BODE Chemie, Hamburg-Stellingen site in Germany] was used, the water part was skipped. The volunteers did brush-less water-less hand preparation using the sterillium; then drying the hand by leaving the hand on the air for 20-35 seconds until the hands completely dry; then taking the sample by wet swab technique. It is to be noted that at least an interval of 2 days had to be passed before each hand preparation.

## 2.4 Sample Collection and Culture

A pilot experiment was conducted before the study to determine whether the contamination was similar before conducting decontamination. The samples were taken from all volunteers for all the 3 methods by wet swabs where a wet NaCl-soaked charcoal swab was wiped across the fingers. The sample collectors were blinded of groups characteristic when they took microbiology samples to avoid bias. One Sample was taken from the center of the palm of the right hand just before starting hand preparation as reference sample for one time only. Then; samples were taken within 3-5 min after each hand preparation. Eight swabs were taken from the single right hand from specific sites for each volunteer as shown in Fig. 1. The samples were brought immediately to the Clinical Microbiology Laboratory at KAUH and cultured immediately by the same technologist on sheep blood agar plates which were incubated at 37°C for 48 hours. The results were classified as either having bacterial growth or no bacterial growth. A culture was considered positive if the colonies on the blood agar ranged between 11 up to >100 colonies while it was considered negative if there was no growth [14].

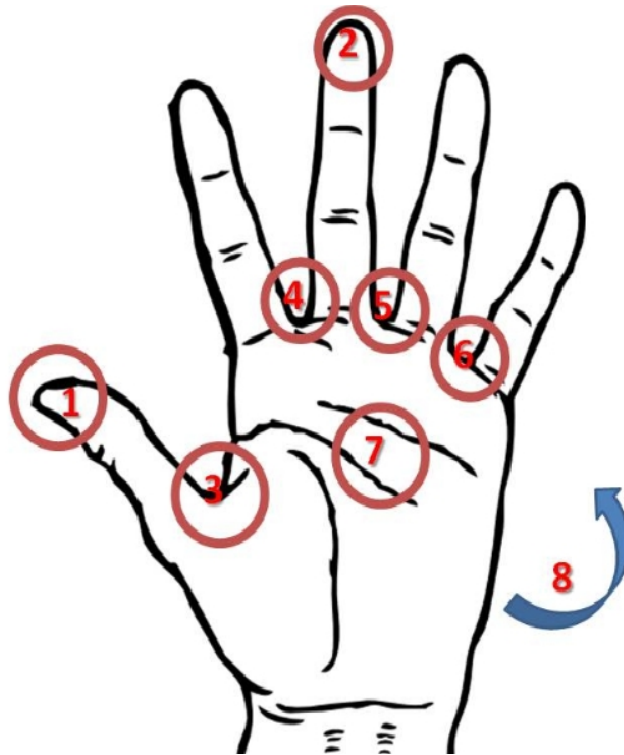


Fig. 1. showed the specific sampling sites of each volunteer. 1- Tip of thumb 2- Tip of middle finger. 3- Between thumb and index fingers 4- Between index and middle fingers 5- Between middle and ring fingers 6- Between ring and little fingers 7- The palm 8- The dorsum.

## 2.5 Statistic

We assigned number 1 for positive culture and 0 for negative culture. We used the paired value and looked at the mean of the results of each hand preparation methods. For all analysis; a statistical significance of p value < 0.05 was used. The statistical analysis was done using TexaSoft, WINKS SDA Software, Sixth Edition, Cedar Hill, Texas, 2007.

## 3. RESULTS

The study included 20 volunteer students each of the students has one swab sample before starting the hand preparation and 8 samples for every method of hand preparation with a total 25 sample for every student and 500 samples for all the study. All the 20 samples taken before hand preparation were positive and used as standard test. The remaining 480 samples results were shown in Table 1. There were 3 positive samples out of 160 samples (2%) in the antimicrobial soap group while there were 88 positive samples out of 160 (55%) in the Non-medicated soap group. The Alcohol-based hand preparation group showed no positive samples. The commonest sites for positive results were shown in Table 2. The tip of middle finger was the commonest site of positive samples (20 out of 91 [22%]) followed by the tip of thumb (19 out of 91 [21%]); while the dorsum of the hand was the least site (7 out of 91 [7.7%]).

**Table 1. Summary of the culture positive results of the study**

| Sample                         | Antimicrobial soap (160 samples) | Non-medicated soap (160 samples) | Alcohol-based (160 samples) |
|--------------------------------|----------------------------------|----------------------------------|-----------------------------|
| Tip of thumb                   | 1                                | 18                               | 0                           |
| Tip of middle finger           | 2                                | 18                               | 0                           |
| Between thumb & index finger   | 0                                | 9                                | 0                           |
| Between index & middle finger  | 0                                | 10                               | 0                           |
| Between middle and ring finger | 0                                | 9                                | 0                           |
| Between ring and little finger | 0                                | 9                                | 0                           |
| The palm                       | 0                                | 8                                | 0                           |
| The dorsum                     | 0                                | 7                                | 0                           |
| Total                          | 3 (1.87%)                        | 88 (55%)                         | 0                           |
| P 1 < 0.001                    |                                  |                                  |                             |
| P2 < 0.001                     |                                  |                                  |                             |
| P3 < 0.05                      |                                  |                                  |                             |

*P1 comparison between Antimicrobial soap and Alcohol-based  
P2 comparison between Non-medicated soap and Alcohol-based  
P3 comparison between Antimicrobial soap and Non-medicated soap*

**Table 2. The commonest sites of positive culture results.**

| Site                            | Number of Positive Cultures | Percentage |
|---------------------------------|-----------------------------|------------|
| The tip of middle finger        | 20                          | 22%        |
| Tip of thumb                    | 19                          | 21%        |
| Between index and middle finger | 10                          | 11%        |
| Between thumb and index finger  | 9                           | 9.8%       |
| Between middle and ring finger  | 9                           | 9.8%       |
| Between ring and little finger  | 9                           | 9.8%       |
| The palm                        | 8                           | 8.7        |
| The dorsum                      | 7                           | 7.7%       |
| Total                           | 91                          |            |

#### 4. DISCUSSION

The mounting frequency of multi-drug resistant bacteria and viruses increases the need for improving hand and arm preparation to fight infection. The efficiency of pre-operative hand preparation in healthcare workers depends on different factors; the efficacy of the surgical hand preparation method, the compliance of the healthcare workers, the side effects of the hand preparation methods and the diurnal variation of antimicrobial effects [31].

In the current study, we compared the efficacy of alcohol, antiseptic soap, and non-medicated soap in microbial elimination using the standard pre-operative hand preparation practice. The antimicrobial soap was far more efficient than the non-medicated soap and alcohol was the most efficient compared to both. This agrees with the work of Guilhermetti et al. [14], Girou et al. [15], Cimiotti et al. [18], Kampf & Ostermeyer [32], Kac et al. [16], Abaza et al. [21], and Turner et al 2010 [17]. Nthumba et al. showed no statistically or clinically significant difference in surgical site infection rates between non-medicated soap and water hand rub and alcohol-based hand rub. They assumed that their results were related to the probable presence of other more important factors contributing to surgical site infection development [25].

On the other hand, Oughton et al. [27] and Jabbar et al. [30] showed that water with non-medicated soap was more efficient than alcohol-based hand rub in removing *Clostridium difficile* bacteria. These two studies investigated the effect of hand washing on *C. difficile* and they claimed that the alcohol-based rub is not effective against the *C. difficile* spores and potentially leaves viable spores on the hands that can spread from patient to patient. Hand washing using soap and water (which physically rinses off the spores) is a more efficient mean of decontamination, but it may leave residual spores [27,30]. This is why manufacturers of hydroalcoholic rub solutions shall advise to wash hands with non-medicated soaps when hands are visibly soiled. Many studies showed that the alcohol hand-preparation was easier to use [5], with more compliance and more cost effective when compared to the other traditional surgical hand preparation [18,19,20,26,33].

In our study we looked at the bacterial growth on 8 points of each hand post-hand preparation and we did not study the antiviral effects of the different types of hand rubbing. We also did not study the diurnal variation of antimicrobial effects, types of the isolated microorganisms, the compliance with the different types of hand washing regimens and their side effects.

## **5. CONCLUSION**

The alcohol-based hand preparation was significantly more efficient than both the antimicrobial soap and the non-medicated soap and hence we recommend the use of brushless technique in surgical hand preparation using alcohol based solutions.

## **CONSENT**

Verbal and written information were given to all the participants with full explanation of the trial. A written informed consent was signed by all the participants before conducting the study.

## **ETHICAL APPROVAL**

The local Institutional Research Ethics Committee (IRB/ EC) approved the study protocol.

## **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

## **REFERENCES**

1. Lister J. An address on a new antiseptic dressing. *Br Med J.* 1889;2(1506):1025-9.
2. AORN Recommended Practices Committee.. Recommended practices for maintaining a sterile field. *AORN J.* 2006;83(2):402-4,407-10,413-6.
3. Babb JR, Davies JG, Ayliffe GA. A test procedure for evaluating surgical hand disinfection. *J Hosp Infect.* 1991;18 Suppl B:41-9.
4. Hingst V, Juditzki I, Heeg P, Sonntag HG. Evaluation of the efficacy of surgical hand disinfection following a reduced application time of 3 instead of 5 min. *J Hosp Infect.* 1992;20(2):79-86.
5. Pereira LJ, Lee GM, Wade KJ. An evaluation of five protocols for surgical handwashing in relation to skin condition and microbial counts. *J Hosp Infect.* 1997;36(1):49-65.
6. Grabsch EA, Mitchell DJ, Hooper J, Turnidge JD. In-use efficacy of a chlorhexidine in alcohol surgical rub: a comparative study. *ANZ J Surg.* 2004;74(9):769-72.
7. Hobson DW, Woller W, Anderson L, Guthery E. Development Sep and evaluation of a new alcohol-based surgical hand scrub formulation with persistent antimicrobial characteristics and brushless application. *Am J Infect Control.* 1998;26(5):507-12.
8. Gruendemann BJ, Bjerke NB. Is it time for brushless scrubbing with an alcohol-based agent? *AORN J.* Dec 2001;74(6):859-73.
9. Larson EL, Butz AM, Gullette DL, Laughon BA. Alcohol for surgical scrubbing? *Infect Control Hosp epidemiol.* Mar. 1990;11(3):139-43.
10. Hsieh HF, Chiu HH, Lee FP. Surgical hand scrubs in relation to microbial counts: systematic literature review. *J Adv Nurs.* 2006;55(1):68-78.

11. Boyce JM, Pittet D; Healthcare Infection Control Practices Advisory Committee; HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for Hand Hygiene in Health-Care Settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Society for Healthcare Epidemiology of America/Association for Professionals in Infection Control/Infectious Diseases Society of America. *MMWR recomb Rep.* 25;2002;51(RR-16):1-45.
12. Rotter ML. Arguments for the alcoholic hand disinfection. *J Hosp Infect.* Aug. 2001;48 Suppl A:S4-8..
13. Shiraishi T, Nakagawa Y, Matsubara H, Takada Y, Arai Y, Okada S, et al,. A survey of the appropriate use of antiseptic agents in the operating room of several key health care facilities. A comparison between surveys in 2000 and 2004. *Dermatology.* 2006;212 Suppl 1:15-20.
14. Guilhermetti M, Hernandez SE, Fukushigue Y, Garcia LB, Cardoso CL. Effectiveness of hand-cleansing agents for removing methicillin-resistant *Staphylococcus aureus* from contaminated hands. *Infect Control Hosp Epidemiol.* 2001;22(2):105-8.
15. Girou E, Loyeau S, Legrand P, Oppein F, Brun-Boisson C. Efficacy of handrubbing with alcohol based solution versus standard handwashing with antiseptic soap: randomised clinical trial. *BMJ.* 2002;325(7360):362.
16. Kac G, Podglajen I, Gueneret M, Vaupré S, Bissery A, Meyer G. Microbiological evaluation of two hand hygiene procedures achieved by healthcare workers during routine patient care: a randomized study. *J Hosp Infect.* 2005;60(1):32-9.
17. Turner RB, Fuls JL, Rodgers ND. Effectiveness of Hand Sanitizers with and without Organic Acids for Removal of Rhinovirus from Hands. *Antimicrob Agents Chemother.* 2010;54(3):1363-4.
18. Cimiotti JP, Stone PW, Larson EL. A cost comparison of hand hygiene regimens. *Nurs Econ.* 2004;22(4):196-9:204,175.
19. Bischoff WE, Reynolds TM, Sessler CN, Edmond MB, Wenzel RP. Handwashing compliance by health care workers: The impact of introducing an accessible, alcohol-based hand antiseptic. *Arch Intern Med.* 2000;160(7):1017-21.
20. Parienti JJ, Thibon P, Heller R, Le Roux Y, von Theobald P, Bensadoun H, et al. Hand-rubbing with an aqueous alcoholic solution vs traditional surgical hand-scrubbing and 30-day surgical site infection rates: a randomized equivalence study. *JAMA.* 2002;288(6):722-7.
21. Abaza AF, Amine AE, Hazzah WA. Comparative study on efficacy of different alcohol hand rubs and routine hand wash in a health-care setting, Alexandria, Egypt. *J Egypt Public Health Assoc.* 2010;85(5-6):273-83.
22. Larson E, Silberger M, Jakob K, Whittier S, Lai L, Della Latta P, Saiman L. Assessment of alternative hand hygiene regimens to improve skin health among neonatal intensive care unit nurses. *Heart Lung.* 2000;29(2):36-42.
23. Larson EL, Aiello AE, Bastyr J, Lyle C, Stahl J, Cronquist A, Lai L, Della-Latta P. Assessment of two hand hygiene regimens for intensive care unit personnel. *Crit Care Med.* 2001;29(5):944-51.
24. Davis MA, Sheng H, Newman J, Hancock DD, Hovde CJ. Comparison of a waterless hand-hygiene preparation and soap-and-water hand washing to reduce coli forms on hands in animal exhibit settings. *Epidemiol Infect.* 2006;134(5):1024-8.
25. Nthumba PM, Stepita-Poenaru E, Poenaru D, Bird P, Allegranzi B, Pittet D, et al,. Cluster-randomized, crossover trial of the efficacy of plain soap and water versus alcohol-based rub for surgical hand preparation in a rural hospital in Kenya. *Br J Surg.* 2010;97(11):1621-8.



26. Doebbeling BN, Stanley GL, Sheetz CT, Pfaller MA, Houston AK, Annis L, et al.,. Comparative efficacy of alternative hand-washing agents in reducing nosocomial infections in intensive care units. *N Engl J Med.* 1992;9;327(2):88-93.
27. Oughton MT, Loo VG, Dendukuri N, Fenn S, Libman MD. Hand hygiene with soap and water is superior to alcohol rub and antiseptic wipes for removal of *Clostridium difficile*. *Infect Control Hosp Epidemiol.* 2009;30(10):939-44.
28. Adjoussou S, Konan Blé R, Séni K, Fanny M, Toure-Ecra A, Koffi A, Koné M. Value of hand disinfection by rubbing with alcohol prior to surgery in a tropical setting. *Med Trop (Mars).* 2009;69(5):463-6.
29. Grayson ML, Melvani S, Druce J, Barr IG, Ballard SA, Johnson PD, Mastorakos T, Birch C. Efficacy of soap and water and alcohol-based hand-rub preparations against live H1N1 influenza virus on the hands of human volunteers. *Clin Infect Dis.* 2009;1;48(3):285-91.doi:10.1086/595845.
30. Jabbar U, Leischner J, Kasper D, Gerber R, Sambol SP, Parada JP, et al.,. Effectiveness of alcohol-based hand rubs for removal of *Clostridium difficile* spores from hands. *Infect Control Hosp Epidemiol.* 2010;31(6):565-70.
31. Reuelto M. Chronopharmacology and antimicrobial therapeutics. *Curr Clin Pharmacol.* 2006;1(3):265-75.
32. Kampf G, Ostermeyer C. Efficacy of two distinct ethanol-based hand rubs for surgical hand disinfection -- a controlled trial according to prEN 12791. *BMC Infect Dis.* 2005;22;5:17.
33. Tavolacci MP, Pitrou I, Merle V, Haghghat S, Thillard D, Czernichow P. Surgical hand-rubbing compared with surgical hand scrubbing: comparison of efficacy and costs. *J Hosp Infect.* 2006;63(1):55-9.

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