Infection Control & Hospital Epidemiology (2026), 1–4
doi:10.1017/ice.2026.10509

SHEA

Original Article

Evaluation of the impact of a novel surgical handwashing method on reformation of microbial flora on surgeons' hands

Abbas Tokyay MD[1], Şehmuz Kaya MD[2], Sezai Özkan MD[2], Necip Güven MD[2], Tülin Türközü MD[2], Cihan Adanaş MD[2], Mehmet Parlak MD[3], Kübra Nur Doğan MD[3], Mehmet Ata Gökalp MD[2] and Gülsüm Kaya PhD[4]

[1]Department of Orthopedics and Traumatology, Yalova University Faculty of Medicine, Yalova, Türkiye; [2]Department of Orthopedics and Traumatology, Van Yüzüncü Yıl University Faculty of Medicine, Van, Türkiye; [3]Department of Clinical Microbiology, Van Yüzüncü Yıl University Faculty of Medicine, Van, Türkiye and [4]Department of Medical Microbiology, Yalova University Faculty of Medicine, Yalova, Türkiye

Abstract

Objective: The purpose of surgical hand antisepsis before surgical or invasive procedures is to suppress microbial flora on the hands. This study aimed to evaluate the effect of a modified surgical hand antisepsis technique on recolonization of microbial flora on surgeons' hands over time.

Methods: Participating surgeons were randomly assigned to one of two study groups. In both groups, surgical hand antisepsis was performed using 10% povidone-iodine followed by rinsing of the hands and forearms. In Group 1, surgeons dried their hands after rinsing according to the conventional method. In Group 2, surgeons applied an additional layer of 10% povidone-iodine to the still-wet hands and forearms after rinsing and then allowed the solution to dry without further rinsing. Hand cultures were obtained immediately after antisepsis (0 hour) and at 1 and 2 hours thereafter. Colony-forming units (CFUs) were counted and compared between groups and sampling periods.

Results: Fourteen surgeons participated in the study, with seven surgeons allocated to each group. No significant difference in bacterial growth was observed between the groups at 0 hour (Group 1: mean CFU 41.59 ± 72.53 vs Group 2: 18.63 ± 24.27, $P = .27$). At 1 hour, bacterial growth was significantly lower in Group 2 compared with Group 1 (8.43 ± 20.65 vs 25.44 ± 53.62 CFU, $P = .001$). Similarly, at 2 hours, Group 2 demonstrated significantly lower bacterial growth than Group 1 (16.37 ± 34.25 vs 32.88 ± 52.55 CFU, $P = .022$).

Conclusion: Compared with the conventional surgical handwashing technique, reapplication of povidone-iodine without a final rinse resulted in significantly reduced bacterial recolonization on surgeons' hands at 1 and 2 hours after hand antisepsis. These findings suggest that this modified technique may provide prolonged antimicrobial activity during surgical procedures. Further large-scale studies are warranted to confirm its clinical utility.

(Received 16 March 2025 UTC; accepted 18 June 2026 UTC)

Introduction

Surgical hand antisepsis refers to the use of antiseptic solutions to remove temporary skin flora and reduce the permanent flora of the hands. Surgical hand antisepsis may involve use of a waterless, alcohol-based hand rub or an antiseptic handwash solution, typically chlorhexidine gluconate or povidone-iodine, with or without the use of a brush. When antiseptic handwash solutions are used, the hands are rinsed and then dried with a sterile towel.[1]

The rationale for surgical hand antisepsis is to reduce the risk of transmission of microorganisms from surgeons' hands to the surgical field through micropunctures that may occur in the sterile gloves worn during surgical procedures.[2] We sought to determine if rubbing the hands with an antiseptic solution and drying them without rinsing after completing a traditional surgical handwashing protocol could delay regrowth of flora on surgeons' hands compared to use of a traditional surgical hand washing protocol.

Methods

Study design

This study was approved by the Yüzüncü Yıl University Faculty of Medicine Clinical Research Ethics Committee (Decision no: 03, date: 25.11.2020). In this prospective study, only the first surgical procedures of the day performed in the orthopedics and traumatology operating room were included. Since some surgeons participated in more than one procedure during the study period, a total of 14 individual surgeons were included in the final analysis. The study included operations lasting at least 2 hours and excluded trauma surgeries. Surgical procedures performed for active infections were also excluded. There were 14 surgeons in total in our clinic, and at least two surgeons participated in each operation.

Corresponding author: Abbas Tokyay; Email: dr.abbas_tokyay@hotmail.com
Cite this article: Tokyay A, Kaya Ş, Özkan S, *et al*. Evaluation of the impact of a novel surgical handwashing method on reformation of microbial flora on surgeons' hands. *Infect Control Hosp Epidemiol* 2026. doi: 10.1017/ice.2026.10509

© The Author(s), 2026. Published by Cambridge University Press on behalf of The Society for Healthcare Epidemiology of America. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted re-use, distribution and reproduction, provided the original article is properly cited.

Check for updates

Surgical hand washing protocols

Surgeons were randomly divided into two groups by tossing a coin in the operating room. All jewelry on the hands and arms of participating surgeons was removed. The hands and arms were examined for disruptions in skin integrity by one of the study investigators before surgical hand antisepsis. Those with suspicious findings were excluded from the study. The surgeons in both groups used 10% povidone-iodine solution (Pharma Nobis LLC, Tbilisi, Georgia) as the antiseptic solution. The amount of solution (5 ml) recommended by the manufacturer was placed into the palm, and surgical hand antisepsis was performed by rubbing the fingertips, interdigital areas, hands, and forearms up to approximately four fingerbreadths above the elbow.[1] No brush was used for scrubbing. Washing and rinsing was done starting from the fingertips up to the elbows. The hands were rubbed and rinsed three times with antiseptic solution and rinsed after 3–5 minutes of washing.[2,14] Surgeons in Group 1 (the traditional surgical handwash group) dried their hands with a sterile towel after rinsing. In Group 2, surgeons applied an additional 5 ml of povidone-iodine solution to the still-wet hands and forearms immediately after rinsing and then dried their hands without further rinsing. Representative photographs of the surgical handwashing protocols used in Groups 1 and 2 are presented in Supplementary Figures S1 and S2. Participants were monitored for local adverse skin reactions, including dermatitis, skin irritation, and allergic reactions, throughout the study period.

Culture samples

Samples for culture were collected by swabbing the interdigital areas, palms, and fingertips using sterile cotton-tipped swabs with plastic or wooden shafts (Medpoint, Turkey) that had been moistened once with physiological saline solution. No neutralization agent was used. No hand cultures were obtained before surgical hand antisepsis because superficial flora was expected to be removed during surgical handwashing and therefore was not considered likely to affect the study results. Representative images of the culture sampling procedure are presented in Supplementary Figure S3. In both groups, culture samples were obtained immediately after completion of the assigned surgical handwashing antisepsis protocol and prior to donning sterile gloves (t0). Additional samples were collected at 1 hour (t1) and 2 hours (t2) after completion of surgical hand antisepsis. Surgeons' gloves were removed aseptically before sample collection, and the operation continued after a new pair of sterile gloves had been donned.

Processing of culture samples

After the swab samples were taken, they were inoculated into 5% sheep blood agar and Eosin Methylene Blue agar media in the operating room and immediately delivered to the microbiology laboratory (Supplementary Figure S4). Cultures were incubated at 37°C and assessed within 24–48 hours according to the routine microbiology laboratory protocol. All culture samples were processed under standardized incubation conditions in order to minimize potential bias related to incubation duration. When no growth was detected, the colony count was recorded as 0. Colonies were identified by conventional microbiologic methods.

Statistical analysis

Statistical analyses were conducted on the number of CFUs counted on the agar plates. Descriptive statistics were expressed as median, mean, standard deviation, minimum and maximum value. The Wilcoxon signed-rank test was used to compare bacterial growth between different sampling time points within each group. The Mann–Whitney *U* test was used to compare bacterial growth between the two groups at each sampling time point. Also, Spearman correlation coefficient was calculated separately for the groups in order to determine the association between microbial growth at 0, 1, and 2 hours after hand antisepsis. Statistical significance level was considered as $P < .05$. Analyses were conducted using SPSS version 21 statistical software (IBM Corp., Armonk, NY, USA). Because this was an exploratory prospective pilot study, a formal sample size calculation was not performed. The sample size was determined by the number of eligible surgical procedures meeting the predefined inclusion and exclusion criteria during the study period.

Results

Three surgical procedures were excluded because the operative duration was less than 2 hours. Additionally, six surgeons were excluded because intraoperative breaches in sterile technique that could have resulted in hand contamination were observed. After applying the inclusion and exclusion criteria, 32 surgical procedures were included in the study, with 16 procedures assigned to each group. Samples were obtained from 14 surgeons (7 in each group). Colony counts ranged from 0 to >300 CFU per plate. In Group 1 (traditional surgical handwashing), no bacterial growth was detected in 5/16 samples (31.3%) at 0 hours and in 3/16 samples (18.8%) at 1 and 2 hours after surgical handwashing. In Group 2, no bacterial growth was detected in 7/16 samples (43.8%) at 0 hours, 15/16 samples (93.8%) at 1 hour, and 12/16 samples (75.0%) at 2 hours after surgical handwashing. The most commonly identified bacteria in both groups were coagulase-negative staphylococci, followed by gram-positive bacilli, *Streptococcus* spp., and *Staphylococcus aureus*.

Comparison of bacterial growth between groups at each period is shown in Table 1 and Figure 1. There was no difference between groups at 0 hours. Bacterial growth was significantly higher in group 1 than group 2 at hours 1 and 2. Within groups, there were no significant differences in bacterial growth at the three time points.

Discussion

SSIs remain an important cause of postoperative morbidity and healthcare burden. One potential source of contamination is the transfer of microorganisms from surgeons' hand flora to the surgical field through glove micropunctures occurring during surgery. Previous studies have demonstrated an association between glove perforation and bacterial contamination during surgical procedures.[2,3,12,15,16]

In the present study, reapplication of povidone-iodine without rinsing following conventional surgical hand antisepsis significantly reduced bacterial regrowth on surgeons' hands at 1 and 2 hours after handwashing compared with the traditional protocol alone. Prolonged contact of povidone-iodine with the skin surface may contribute to delayed recolonization of microbial flora. Previous studies have reported variable residual antimicrobial activity of iodophors after hand antisepsis.[24–26]

https://doi.org/10.1017/ice.2026.10509 Published online by Cambridge University Press

Table 1. Bacterial growth expressed as colony-forming unit counts according to study group and results of between-group and within-group comparisons

	Group 1 (standard surgical hand washing)			Group 2 (surgical hand washing with povidone iodine)			
Hours	Min–Max	Mean	Std. dev.	Min–Max	Mean	Std. dev.	*P*
Hour 0	0–312	41.59	72.53	0–80	18.63	24.27	.27
1st hour	0–300	25.44	53.62	0–95	8.43	20.65	.001
2nd hour	0–200	32.88	52.55	0–126	16.37	34.25	.022
Within-group comparisons between sampling time points		$P_{(0-1)}$: 0.187 $P_{(0-2)}$: 0.877 $P_{(1-2)}$: 0.354			$P_{(0-1)}$: 0.087 $P_{(0-2)}$: 0.306 $P_{(1-2)}$: 0.067		

Min: minimum, Max: maximum, Std. dev: Standard deviation.

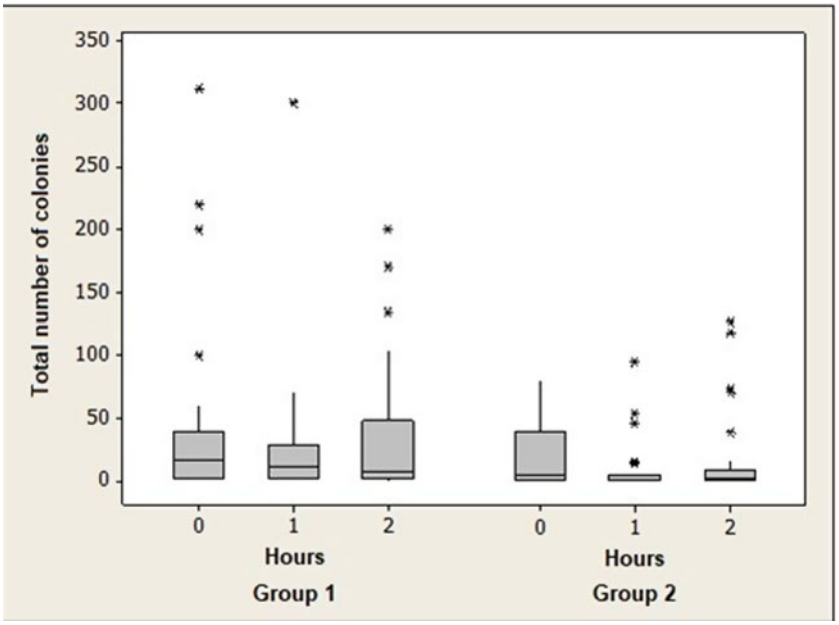


Figure 1. Comparison of the groups in terms of bacterial growth count.

This study has several limitations. The sample size was relatively small, and only orthopedic surgical procedures were included. In addition, the study evaluated microbiological outcomes rather than clinical outcomes such as surgical site infection rates. Although significant reductions in bacterial growth were observed, the clinical relevance of these findings remains uncertain. Another limitation is that cultures were evaluated within 24–48 hours according to routine laboratory protocols, which may have introduced potential bias despite standardized incubation conditions.

In conclusion, reapplication of povidone-iodine without a final rinse after conventional surgical hand antisepsis reduced bacterial recolonization on surgeons' hands during surgery. Larger prospective studies evaluating both microbiological and clinical outcomes are needed to determine the potential role of this modified protocol in reducing surgical site infections.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/ice.2026.10509.

Acknowledgements. We would like to thank the healthcare professionals working in the operating room for their support during the sample collection process.

Financial support. None.

Competing interests. The authors declare no conflict of interest related to this article.

Ethical standard. The ethics committee approval of the study was obtained from the Clinical Research Ethics Committee of Yüzüncü Yıl University Faculty of Medicine (Dated 25.11.2020 and number 03).

References

1. World Health Organization. WHO guidelines on hand hygiene in health care: first global patient safety challenge clean care is safer care. Geneva: World Health Organization; 2009. https://www.who.int/publications/i/item/9789241597906 . Accessed May 19, 2026.
2. Tanner J, Dumville JC, Norman G, *et al.* Surgical hand antisepsis to reduce surgical site infection. *Cochrane Database Syst Rev* 2016;(1).
3. 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 Recomm Rep* 2002;51(RR-16):1–45.

4. Bryce EA, Spence D, Roberts FJ. An in-use evaluation of an alcohol-based pre-surgical hand disinfectant. *Infect Control Hosp Epidemiol* 2001;22:635–639.
5. Cheng SM, Garcia M, Espin S, *et al.* Literature review and survey comparing surgical scrub techniques. *AORN J.* 2001;74:218, 221–224.
6. Rotter ML, Kampf G, Suchomel M, *et al.* 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. *Infect Control Hosp Epidemiol* 2007;28:346–350.
7. Howard JD, Jowett C, Faoagali J, *et al.* New method for assessing hand disinfection shows that pre-operative alcohol/chlorhexidine rub is as effective as a traditional surgical scrub. *J Hosp Infect* 2014;88:78–83.
8. Santacatalina Mas R, Peix Sagues MT, Miranda Salmerón J, *et al.* Lavado quirúrgico de manos: Fricción alcohólica o frotado jabonoso [surgical hand washing: handscrubbing or handrubbing]. *Rev Enferm* 2016;39:8–16.
9. Jones RD, Jampani H, Mulberry G, *et al.* Moisturizing alcohol hand gels for surgical hand preparation. *AORN J* 2000;71:584–587, 589–590, 592.
10. Kampf G, Ostermeyer C, Heeg P. Surgical hand disinfection with a propanol-based hand rub: equivalence of shorter application times. *J Hosp Infect* 2005;59:304–310.
11. Larson EL, Aiello AE, Heilman JM, *et al.* Comparison of different regimens for surgical hand preparation. *AORN J* 2001;73:412–414, 417–418, 420.
12. Parienti JJ, Thibon P, Heller R, *et al.* Antisepsie Chirurgicale des mains Study Group. 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 288:722–727.
13. Labadie JC, Kampf G, Lejeune B, *et al.* Recommendations for surgical hand disinfection – requirements, implementation and need for research. A proposal by representatives of the SFHH, DGHM and DGKH for a European discussion. *J Hosp Infect* 2002;51:312–315.
14. Pittet D, Allegranzi B, Boyce J, World Health Organization World Alliance for Patient Safety First Global Patient Safety Challenge Core Group of Experts. The World Health Organization Guidelines on Hand Hygiene in Health Care and their consensus recommendations. *Infect Control Hosp Epidemiol* 2009;30:611–622.
15. Hagen GØ, Arntzen H. Risiko for perforasjon av operasjonshansker [The risk of surgical glove perforations]. *Tidsskr Nor Laegeforen* 2007;127:856–858.
16. Kralj N, Beie M, Hofmann F. Chirurgische Handschuhe–wie gut schützen sie vor Infektionen? [Surgical gloves–how well do the protect against infections?]. *Gesundheitswesen* 1999;61:398–403.
17. Khan A, McLaren SG, Nelson CL. Surgical hand scrub practices in orthopaedic surgery. *Clin Orthop Relat Res* 2003;414:65–68.
18. Furukawa K, Ogawa R, Norose Y, *et al.* A new surgical handwashing and hand antisepsis from scrubbing to rubbing. *J Nippon Med Sch* 2004;71:190–197.
19. Rotter ML. Arguments for alcoholic hand disinfection. *J Hosp Infect* 2001;48(Suppl A): S4–S8.
20. Allen, G. Evidence appraisal of Liu LQ, Mehigan S. The effects of surgical hand scrubbing protocols on skin integrity and surgical site infection rates: a systematic review: AORN J. 2016;103(5):468–482. *AORN J* 2016;104:468–482.
21. Feng W, Lin S, Huang D, *et al.* Surgical hand rubbing versus surgical hand scrubbing: systematic review and meta-analysis of efficacy. *Injury* 2020;51:1250–1257.
22. Hosseini P, Mundis GM Jr, Eastlack R, *et al.* Do longer surgical procedures result in greater contamination of surgeons' hands? *Clin Orthop Relat Res* 2016;474:1707–1713.
23. Trampuz A, Widmer AF. Hand hygiene: a frequently missed lifesaving opportunity during patient care. *Mayo Clin Proc* 2004;79:109–116.
24. Paulson DS. Comparative evaluation of five surgical hand scrub preparations. *AORN J* 1994;60:246, 249–256.
25. Ayliffe GA, Babb JR, Davies JG, *et al.* Hand disinfection: a comparison of various agents in laboratory and ward studies. *J Hosp Infect* 1988;11: 226–243.
26. Wade JJ, Casewell MW. The evaluation of residual antimicrobial activity on hands and its clinical relevance. 1991;18:23–28.
27. Anderson RL. Iodophor antiseptics: intrinsic microbial contamination with resistant bacteria. *Infect Control Hosp Epidemiol* 1989;10:443–446.

https://doi.org/10.1017/ice.2026.10509 Published online by Cambridge University Press