ORIGINAL ARTICLE DOI: https://doi.org/10.52206/jsmc.2024.14.4.933 OPEN ACCESS

Does Observation Improve Compliance to Standard Surgical Hand Scrubbing?

Faaiz Ali Shah, Shams Ur Rehman, Shahidullah, Yasir Imran

Lady Reading Hospital, Peshawar, KP Pakistan.

ABSTRACT

Background: Standard surgical hand scrubbing techniques are essential for the prevention of surgical site infections. Overt observation is the gold standard to assess compliance to surgical hand scrubbing techniques but is confounded by the Hawthorne effect.

Objective: To compare the compliance of surgical hand scrubbing technique in Orthopaedic operation theatres as observed overtly and covertly by trained independent observers.

Materials and Methods: We conducted this cross sectional study in Orthopaedic operation theatres of Lady Reading Hospital, Peshawar, from 15th November 2023 to 15th February 2024. All the participants fulfilling inclusion criteria were overtly and covertly observed by independent trained observers for compliance to WHO surgical hand scrubbing techniques. The difference in the rate of surgical hand scrubbing compliance between overt and covert observations served as a measure of the Hawthorne effect.

Results: The total number of participants in our study were 48 including 11 Orthopaedic consultants and 37 Orthopaedic residents. The overt observation revealed that the compliance to the various steps of WHO surgical hand scrubbing ranges from 89.58% to 100% with a weighted mean of 95.76%. The compliance rate ranged from 60.41% to 89.58% with a weighted mean of 68.43% when data was collected through covert observation. The overall increased compliance rate reported through covert observation as compared to overt observation(*P*=0.007) is attributed to the Hawthorne effect.

Conclusion: Compliance of the Orthopaedic consultants and residents to the standard surgical hand scrubbing technique in Orthopaedic operation theatre was significantly high with overt observation than with covert observation.

Keywords: Compliance, Covert observation, Hand hygiene, Hawthorne effect, Overt observation, Surgical site infection.

This article may be cited as: Shah FA, Rehman SU, Shahidullah, Imran Y. Does Observation Improve Compliance to Standard Surgical Hand Scrubbing? J Saidu Med Coll Swat. 2024;14(4):323-329. DOI: https://doi.org/10.52206/jsmc.2024.14.4.933

INTRODUCTION

Healthcare-associated infection(HCAI) is defined as any infection manifested in a hospitalized patient 48 hours or more after admission or within 30-days after receiving treatment in a hospital provided the acquired infection is not present or incubated at the time of admission to the hospital.[1] The prevalence of HCAI in hospitalized patients is 10% in developed countries and 25% in developing countries.[2] It can cause respiratory tract infections, urinary tract infections, gastrointestinal infections, bloodstream infections and surgical site infections(SSI) resulting in serious consequences ranging from prolonged hospital stay, additional hospital expenses, increased antibiotic resistance, disability and mortality.[3] It has been reported that approximately 20% to 40% of HCAIs are caused by transmission of microbes from contaminated hands of healthcare workers(HCWs).[4] This is a preventable cause and HH is therefore declared as the single most important initial step to minimize the incidence of HCAI.[2] SSI is one of the most common HCAI with a global incidence of 2.5% and the highest incidence of around 7.2% in African countries.[5] Studies have reported that proper surgical hands scrubbing technique can reduce SSI rate from 45% to 15%[6] by reducing antimicrobial colonization and direct transmission of bacteria from health care worker(HCW) to the patient and thus is an essential preventative measure to control HCAIs.[3] The global compliance of HCW to standard hand hygiene guidelines is variable but poor and is around 40% in high income countries and below 20% in low income countries.[7,8] Monitoring of the HH compliance is of paramount importance as it tends to improve the performance of HCWs, ensuring feedback, implementation of standard protocols and interventions with ultimate improvement of patient care.[9] World Health Organization(WHO) recommend direct human observation of HH practices to monitor compliance to standard HH guidelines.[10] The accuracy of direct human observation is however challenged by Hawthorne effect which is defined as any change in the behavior of HCW because of awareness of being observed and which tends to overestimate HH compliance rate.[11] To overcome the Hawthorne effect and to determine the actual HH compliance rate covert observation of HH has been suggested by many studies.[12] Very few studies however detected surgical hands scrubbing compliance in Orthopaedic operation theatres using overt or covert observations.[13]

The objective of our study was to compare the compliance of surgical hand scrubbing technique in Orthopaedic operation theatres using covert and overt observation. We believe that covert observation will provide a baseline while covert observation will reveal the uninfluenced behavior of Orthopaedic surgeons and residents regarding surgical hand scrubbing technique. To the best of our knowledge this will be the first study in our hospital. The results of our study will be used to formulate local surgical hand scrubbing guidelines and advise measures to increase compliance to these guidelines in order to minimize SSI.

Correspondence: Dr. Shams Ur Rehman
Associate Professor Orthopaedics,
Lady Reading Hospital, Peshawar, KP Pakistan.
Email: drshamswazir_80@yahoo.com

Received: March 24th, 2024 - 1st Revision: April 09th 2024
2nd Revision: August 03rd 2024 - 3rd Revision: August 18th 2024
Accepted: August 26th, 2024

MATERIALS AND METHODS

This descriptive cross sectional study was conducted in Orthopaedic operation theatres of Lady Reading Hospital, Peshawar, from 15th November 2023 to 15th February 2024. Our study received Ethical approval from Institutional Review Board (IRB) of Lady Reading Hospital, Peshawar, [Ref No.1008/LRH/MTI, dated 8th November 2023]. Before data collection informed written consent was taken from all participants of this study. All Orthopaedic consultants and FCPS-II Orthopaedic residents of our hospital were included in this study. Residents on elective rotations in Orthopaedics, anaesthetic doctors, technicians, paramedics and nursing staff working in Orthopaedic operation theatres were excluded. All the participants were told that they will be monitored physically for adherence to standard WHO hand scrubbing technique in operation theatre twice, once direct observation (overt) and the other unannounced covert observation.

Our preliminary pre study survey revealed that our hospital has no uniform standard surgical hand scrubbing policy. Therefore before the actual data collection for this study, we initiated the WHO Multimodal Hand Hygiene Improvement Strategy.[10] This included provision of summary of the WHO Guidelines and Information Sheets regarding standard Surgical Hand Scrubbing Technique to all study participants followed by slide presentation and practical training sessions about hand rubbing, handwashing techniques, video watching, and group discussion. As a reminder posters of WHO Surgical Hand Scrubbing Technique are displayed in the scrubbing areas in Orthopaedic operation theaters.

Two groups each including one senior Orthopaedic consultant and one senior Orthopaedic resident were trained and designated as overt observers and covert observers for assessing compliance to standard Surgical Hand Scrubbing Technique in Orthopaedic theatres. Both covert and overt observers received identical training and instructions. The course included lectures, videos and practical demonstration of WHO surgical hand scrubbing guidelines. In addition the covert observers were also taught the techniques of covert observation. The WHO surgical hand scrubbing technique via video watching was served as the means to reach inter-observer agreement (=80%) between the two observers. All the observers were issued certificate after passing written examination.

All the observation were done in the morning session and covered major Orthopaedic surgeries (surgeries done under spinal anaesthesia or general anaesthesia with patient intubated and surgeries lasting for 1 to 2 hours) scheduled on elective Orthopaedic operation list. To minimize observer bias both the overt and covert observers were trained not to interpret the covert or overt observation in their own way but to strictly follow WHO checklist. To minimize selection bias the observers were instructed to observe scrubbing compliance of Orthopaedic faculty and residents for major surgery in the middle of elective operation list.

The first cycle of observation was overt. Each observer noted the surgical hand scrubbing practices of Orthopaedic consultants and residence in operation theatre when they were scrubbing for major Orthopaedic surgery. After completion of all data in the overt phase next covert observation was commenced. In our hospital all the four Orthopaedic operation theatres have adjacent scrubbing areas. The covert observer kept the scrubbing area in his view to observe hand scrubbing practices of Orthopaedic consultants and residents. Covert observers did not inform the Orthopaedic consultants and residents about observing their surgical hand scrubbing compliance. They present themselves as “Secret Observers” and carried other reading material in their hands with WHO checklist hiding in it. Each overt/covert observer had a stop watch and the WHO checklist for marking each steps of as Inappropriate, Somewhat appropriate and Appropriate. (table I) Surgical hand scrubbing compliance was defined as performing each step labelled as Appropriate. Covert observers were trained to observe for short period (5 minutes) to reduce the chances of being exposed.

To remember covert observation and to reduce recall bias we designed a unique coding system for steps of surgical hand scrubbing. The number 1 would represent forearm,2 for hand, R denoted right, L denoted left, V represented volume of antiseptic solution used, T represented time consumed, I stands for inappropriate, S for somewhat appropriate and A for appropriate. For example if a surgeon followed all steps for scrubbing his right forearm and hand the observer would memorize 12RVTA and would record the codes in WHO checklist as soon as possible. Both overt and covert observers compared their results every fortnightly to ensure consistency and clarity and any problems about the observations were discussed to reach a consensus.

We analyzed our data with SPSS version 29. Frequency and percentage was calculated for qualitative variables while mean and standard deviation for quantitative variables. The overt and covert observations were matched for consultants, trainees and seniority. The difference in the rate of surgical hand scrubbing compliance between overt and covert observers is a measure of the Hawthorne effect. One sample t-test and Chi-square test was applied to determine statistical significance of important quantitative and qualitative variables. P value < 0.05 was considered significant. Data was presented in table where necessary.

Table 01. WHO checklist for monitoring compliance of surgical hand scrubbing technique in Orthopaedic operation theatres.[6]

S.No	Steps of Surgical Hand Scrubbing	Inappropriate		Somewhat Appropriate		Appropriate	
		Overt	Covert	Overt	Covert	Overt	Covert
		n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
1	"Used approximately 5ml (3 doses) of antiseptic solution in the palm of left hand, using the elbow other arm to operate the dispenser."	2 (4.16%)	8 (16.66%)	3 (6.25%)	8 (16.66%)	43 (89.58%)	32 (66.66%)
2	"Dip the fingertips of right hand in the antiseptic solution to decontaminate under the nails (5 seconds)."	1 (2.08%)	7 (14.58%)	2 (4.16%)	8 (16.66%)	45 (93.75%)	33 (68.75%)
3	"Apply the antiseptic solution on the right forearm up to the elbow. by using circular movements around the forearm (10-15 seconds)."	--	8 (16.66%)	1 (2.08%)	9 (18.75%)	47 (97.91%)	31 (64.58%)
4	"Repetition of above steps for the left hand and forearm."	1 (2.08%)	6 (12.5%)	1 (2.08%)	9 (18.75%)	46 (95.83%)	33 (68.75%)
5	"Put approximately 5ml (3 doses) of antiseptic solution in the palm of left hand to rub both hands at the same time up to the wrists, (20-30 seconds)."	1 (2.08%)	10 (20.83%)	2 (4.16%)	8 (16.66%)	45 (93.75%)	30 (62.5%)
6	"Cover the whole surface of the hands up to the wrist with antiseptic solution rubbing palm against palm with a rotating movement."	--	9 (18.75%)	--	10 (20.83%)	48 (100%)	29 (60.41%)
7	"Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa."	2 (4.16%)	10 (20.83%)	1 (2.08%)	8 (16.66%)	45 (93.75%)	30 (62.5%)
8	"Rub palm against palm back and forth with fingers interlinked."	1 (2.08%)	8 (16.66%)	1 (2.08%)	9 (18.75%)	46 (95.83%)	31 (64.58%)
9	"Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement."	2 (4.16%)	9 (18.75%)	2 (4.16%)	7 (14.58%)	44 (91.66%)	32 (66.66%)
10	"Rub the thumb of the left hand by rotating it in the clasped palm of the right hand and vice versa."	--	7 (14.58%)	--	8 (16.66%)	48 (100%)	33 (68.75%)
11	"When the hands are dry, sterile surgical clothing and gloves was donned."	--	3 (6.25%)	--	2 (4.16%)	48 (100%)	43 (89.58%)

RESULTS

Our study had 48 participants including 11 Orthopaedic consultants and 37 Orthopaedic residents. Amongst the consultants two were Professors, one Associate Professor and 8 were Assistant Professors. All the participants were male. Majority (48.64%, n=18) of our residents had third year residency training followed by second year(29.72%,n=11) and first year (21.62%,n=8). The overt observation revealed that compliance to the various steps of WHO surgical hand scrubbing ranges from 89.58% to 100% with a weighted mean of 95.76% (Table 01).

Our results revealed that the highest compliance rate (100%) were noted for step 6,10 and 11 of the surgical hand scrubbing technique with overt observation (Table 01) while with covert observation it was reported that step 6,10 and 11 was appropriately performed by 60.41% (n=29), 68.75% (n=33) and 89.58% (n=43) of our study participants respectively. Step 5 and 7 of surgical hand scrubbing technique was reported to be inappropriately executed by maximum (20.83%,n=10) number of participants when documented with covert observation. Senior faculty and senior residents showed more compliance than junior consultants and residents but the difference was not statistically significant (P = 0.08). The compliance rate ranged from 60.41% to 89.58% with a weighted mean of 68.43% when data was collected through covert observation. A statistically significant difference(P=0.001) was noted as senior faculty and senior residents were more compliant than junior consultants and residents as noted by covert observers. The overall increased compliance rate reported through covert observation as compared to overt observation is attributed to the Hawthorne effect. (P=0.007) The minimum recommended time for surgical hands scrubbing was 3 minutes. The recommended volume of scrubbing was 15ml. The average scrubbing time noted in the covert observation was 220±7 seconds while in the overt observation it was 170±5 seconds(P=0.03). The volume of scrubbing solution consumed for scrubbing was 20.5±3ml and 12.1±5ml reported by overt and cover observations respectively(P=0.09). About 90%(n=10) of the consultants took appropriate time for scrubbing and 100%(n=11) utilized appropriate volume of scrub when overt observation was made. Majority (81%, n=09) took appropriate time and 90%(n=10) consumed appropriate volume with covert observation as shown in table 02. The time taken by 32(86.48%) Orthopaedic residents for surgical scrubbing was appropriate with overt observation while covert observation revealed that 29(78.37%) residents took appropriate time of scrubbing as shown in table 03.

Table 02. Compliance of Ortopaedic consultants regarding time taken and volume of surgical scrub used

Surgical Hands Scrubbing Parameter	Orthopaedic Consultants (n-11)			
	Overt Observation		Covert Observation	
	Appropriate(n , %)	Inappropriate(n , %)	Appropriate(n , %)	Inappropriate(n , %)
Time taken for surgical scrubbing	10(90.90%)	01(9.09%)	09(81.81%)	02(18.18%)
Volume of surgical scrub used	11(100%)	--	10(90.90%)	01(9.09%)

Table 03. Compliance of Ortopaedic residents regarding time taken and volume of surgical scrub used

Surgical Hands Scrubbing Parameter	Orthopaedic Resident (n-37)			
	Overt Observation		Covert Observation	
	Appropriate(n , %)	Inappropriate(n , %)	Appropriate(n , %)	Inappropriate(n , %)
Time taken for surgical scrubbing	32(86.48%)	05(13.51%)	29(78.37%)	8(21.62%)
Volume of surgical scrub used	34(91.89%)	03(8.10%)	32(86.48%)	05(13.51%)

DISCUSSION

In our study we had documented that the overall overt compliance rate to WHO scrubbing protocol was very high (weighted mean 95.76%) while the covert compliance rate was very low (weighted mean of 68.43%). Our study confirmed the existence of Hawthorne effect by documenting the overall increased compliance rate reported through covert observation as compared to overt observation. (P=0.007) Direct observation is gold standard and the recognized monitoring method supported by WHO. It is easy to perform and has low cost. The observers can not only provide direct feedback and education but can serve as role models for establishing and sustaining good surgical hand scrubbing. We believe that Hawthorne effect can be used as an effective tool for improving surgical hand scrubbing practices. The covert observation will serve to measure efficacy by minimizing the observer bias and the Hawthorne effect.

Literature revealed variable compliance rates to standard hand surgical guidelines. The probable reasons for these variable results are different methods of observations techniques employed in these studies with different criteria used and the assessed specialties and ranks were different. Wu KS et al[14] noted that

compliance to hand hygiene was statistically higher(P<0.001) with overt observation (78%) than with covert observation (55%). Knighton[15] reported that the compliance was 87.1% with overt observation and 44.9% with overt observation. (p<0.001). Kim[16] documented that compliance to hand scrubbing improved from 62.6%(covert) to 77.9% (overt) Borah and Dey[17] noted that the overall compliance measured with covert observation was 28.57%. with Ophthalmologists having the higher compliance to scrubbing (57.89%) in operation theatres followed by Orthopaedic surgeons (33.34%) In one clinical audit of 30 residence of General surgical unit of Lahore General hospital the overt compliance to standard WHO surgical hand scrubbing improved from 63% to 90.3% after intervention and training.[18] Another study found that compliance to hand hygiene practices improved by 15% when observation was done directly. This study also revealed that units with low base line hand hygiene practices showed increased improvement in compliance than others when observed covertly.[19]

We had noted that the average scrubbing time in the covert observation was 220±7 seconds while in the overt observation it was 170±5 seconds(P=0.03). The volume of scrubbing solution consumed for scrubbing was 20.5±3ml and 12.1±5ml noted in overt and covert observations respectively (P=0.09). The total scrubbing time depends upon the type of scrubbing solution used but WHO[10] recommend 3 minutes as the minimum effective time for most of the commonly used commercial hand scrubbing solutions. WHO scrubbing solution of choice is 60% to 80% alcohol based solution but 5% to 10% Povidone-Iodine is also recommended if cost and availability of alcohol solutions is an issue. Although the volume of hands scrubbing solution depends upon the size of hands and forearm, WHO recommend that the amount used should not be less 15 ml. Khan[20] conducted a study in Department of Orthopaedic surgery University of Arkansas for Medical Science, Little Rock USA. He recorded the scrubbing time of 48 Orthopaedic surgeons covertly and noted that the overall mean scrubbing time was 2.54minutes with 35% of the participants had <2 minutes (less than the recommended 5 minutes time in their institution). Riaz and Khan[21] conducted a cross sectional study involving 182 consultants and residents belonging to all surgical departments (including 46 from Orthopaedic department) of Khyber Teaching hospital Peshawar. They covertly observed the compliance to WHO surgical scrubbing protocol and noted a very low compliance rate of 1.6%. The mean scrubbing time was also very low (0.95±0.6 seconds) in their study. Baier and colleague[22] conducted a cross sectional study in a specialized Orthopaedic Hospital in Hannover Germany. They directly observed the scrubbing of 45 surgeons,33 nurses and 12 anesthesiologists. The overall compliance rate was 40.8%. Anesthesiologists had a higher compliance rate (47.9%) than surgeons (19.6%). This study however utilized WHO 5- movements of Hand hygiene model for assessing the compliance.

Compliance to standard surgical hand scrubbing techniques can be improved by conducting training workshops and displaying and distribution posters. This is demonstrated by Ben Fredj et al[23] who assessed the effectiveness of hand hygiene improvement strategies amongst health care workers and assessed the compliance rate. They noted that the initial compliance rate amongst Orthopaedic surgeon was 7% and improved significantly to 37.8%(p<0.001) post intervention. In a recent systematic review and meta-analysis conducted by Bajunaid and Saeed[24] revealed that in Eastern Mediterranean region two thirds of the health care workers are not complying to standard hand hygiene practices and WHO guidelines are more effective to improve compliance rate more than two times than other guide lines. (OR=2.26, CI 95% 2.09-2.44,p<0.001)

CONCLUSION

Compliance of the Orthopaedic consultants and residents to the standard surgical hand scrubbing technique in Orthopaedic operation theatre was significantly high with overt observation than with covert observation.

Limitations of the Study

The limitation of our study is that we were unable to enrolled any female participant in our study.

Recommendations of the Study

We recommend further studies in other surgical specialties and inclusion of female staff. Hand hygiene should be declared a priority to improve safety of patients in hospitals. Furthermore, surgical hand scrubbing techniques should be incorporated into residency training. Administrative implementation of surgical hand scrubbing protocol combined with periodic audit and effective feedback would be more effective in achieving increased compliance.

Ethical consideration

This study was approved by Institutional Review Board (IRB) Lady Reading Hospital, Peshawar, Pakistan.

Funding

There is no role of any funding agency in this study.

Conflict of Interest

Authors declared no conflict of interest.

REFERENCES

1. Erdem I, Yıldırım I, Safak B, Karaali R, Erdal B, Ardic E, et al. A 5-year surveillance of healthcare-associated infections in a university hospital: A retrospective analysis. SAGE Open Med. 2022 Apr 19;10:20503121221091789. DOI: https://doi.org/10.1177/20503121221091789.
2. Clancy C, Delungahawatta T, Dunne CP. Hand-hygiene-related clinical trials reported between 2014 and 2020: a comprehensive systematic review. J Hosp Infect. 2021 May;111:6-26. DOI: https://doi.org/10.1016/j.jhin.2021.03.007.
3. Gidey K, Gidey MT, Hailu BY, Gebreamlak ZB, Niriayo YL. Clinical and economic burden of healthcare-associated infections: A prospective cohort study. PLoS One. 2023 Feb 23;18(2): e0282141. DOI: https://doi.org/10.1371/journal.pone.0282141.
4. Weber DJ, Rutala WA, Miller MB, Huslage K, Sickbert-Bennett E. Role of hospital surfaces in the transmission of emerging health care-associated pathogens: norovirus, Clostridium difficile, and Acinetobacter species. Am J Infect Control. 2010 Jun;38(5 Suppl 1):S25-33. DOI: https://doi.org/10.1016/j.ajic.2010.04.196.
5. Mengistu DA, Alemu A, Abdukadir AA, Mohammed Husen A, Ahmed F, Mohammed B, et al. Global Incidence of Surgical Site Infection Among Patients: Systematic Review and Meta-Analysis. Inquiry. 2023 Jan-Dec;60:469580231162549. DOI: https://doi.org/10.1177/00469580231162549.
6. Allegranzi B, Bischoff P, de Jonge S, Kubilay NZ, Zayed B, Gomes SM, et al. WHO Guidelines Development Group. New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016 Dec;16(12):e276-e287. DOI: https://doi.org/10.1016/S1473-3099(16)30398-X.
7. De Kraker MEA, Tartari E, Tomczyk S, Twyman A, Francioli LC, Cassini A, et al. Implementation of hand hygiene in health-care facilities: results from the WHO Hand Hygiene Self-Assessment Framework global survey 2019. Lancet Infect Dis. 2022 Jun;22(6):835-844. DOI: https://doi.org/10.1016/S1473-3099(21)00618-6.
8. Lotfinejad N, Peters A, Tartari E, Fankhauser-Rodriguez C, Pires D, Pittet D. Hand hygiene in health care: 20 years of ongoing advances and perspectives. Lancet Infect Dis. 2021 Aug;21(8):e209-e221. Doi: 10.1016/S1473-3099(21)00383-2. Erratum in: Lancet Infect Dis. 2021 Oct;21(10):e302. doi: https://doi.org/10.1016/S1473-3099(21)00476-X.
9. Libero G, Bordino V, Garlasco J, Vicentini C, Maria Zotti C. Hand hygiene monitoring: Comparison between app and paper forms for direct observation. Public Health Nurs. 2023 Mar;40(2):313-316. DOI: https://doi.org/10.1111/phn.13160.
10. World Health Organization: World Health Organization. WHO guidelines for hand hygiene in health care. Geneva, Switzerland: World Health Organization. Available from http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf?ua=1; 2009. Accessed April 30, 2017.
11. Purssell E, Drey N, Chudleigh J, Creedon S, Gould DJ. The Hawthorne effect on adherence to hand hygiene in patient care. J Hosp Infect. 2020 Oct;106(2):311-317. DOI: https://doi.org/10.1016/j.jhin.2020.07.028.
12. Bruchez SA, Duarte GC, Sadowski RA, Custodio da Silva Filho A, Fahning WE, Belini Nishiyama SA, et al. Assessing the Hawthorne effect on hand hygiene compliance in an intensive care unit. Infect Prev Pract. 2020 Feb 27;2(2):100049. DOI: https://doi.org/10.1016/j.infpip.2020.100049.
13. Pan SC, Tien KL, Hung IC, Lin YJ, Sheng WH, Wang MJ, et al. Compliance of health care workers with hand hygiene practices: independent advantages of overt and covert observers. PLoS One. 2013;8(1):e53746. DOI: https://doi.org/10.1371/journal.pone.0053746.
14. Wu KS, Lee SS, Chen JK, Chen YS, Tsai HC, Chen YJ, et al. Identifying heterogeneity in the Hawthorne effect on hand hygiene observation: a cohort study of overtly and covertly observed results. BMC Infect Dis. 2018 Aug 6;18(1):369. DOI: https://doi.org/10.1186/s12879-018-3292-5.
15. Knighton SC, Davis J. Journal Club: Quantifying the Hawthorne effect using overt and covert observation of hand hygiene at a tertiary care hospital in Saudi Arabia. Am J Infect Control. 2018 Aug;46(8):928-929. DOI: https://doi.org/10.1016/j.ajic.2018.04.212.
16. Kim JH, Jeong JS, Kim MN, Park JY, Choi HR. The Hawthorne Effect between Covert and Overt Observations in the Monitoring of Hand Hygiene Adherence among Healthcare Personnel at Coronary Care Unit and Cardiac Surgery Intensive Care Unit. Korean J Nosocomial Infect Control 2014;19(1):20-28. DOI: http://dx.doi.org/10.14192/kjnic.2014.19.1.20
17. Borah TJ, Dey S, Yunus M, Chanu SM, Karim HMR, Bhattacharyya P. Compliance of Hand Hygiene in the Operation Theatre in a Tertiary Care Hospital: An Observational Study. Ann. Int. Med. Den. Res. 2017;3(S1):62-65. DOI: https://doi.org/10.21276/aimdr.2017.3.S1.16
18. Hussain F, Rahman MK, Qadri HM, Rabbani RA, Surgical Hand Washing A Clinical Audit of Young Surgeons at a Tertiary Care Hospital. P J M H S 2022; 16(06):05-207. DOI: https://doi.org/10.53350/pjmhs22166205.
19. Chen LF, Carriker C, Staheli R, Isaacs P, Elliott B, Miller BA, et al. Observing and improving hand hygiene compliance: implementation and refinement of an electronic-assisted direct-observer hand hygiene audit program. Infect Control Hosp Epidemiol. 2013 Feb;34(2):207-10. DOI: https://doi.org/10.1086/669084.
20. Khan A, McLaren SG, Nelson CL. Surgical hand scrub practices in Orthopaedic surgery. Clin Orthop Relat Res. 2003 Sep;(414):65-8. DOI: https://doi.org/10.1097/01.blo.0000084404.53464.17.
21. Riaz M, Khan W, Hussain F, Shahet D. Adherence of surgeons to the World Health Organization recommendations of hand scrubbing in a tertiary care hospital in Peshawar. Int J Res Med Sci. 2022 Feb;10(2):336-340.

22. Baier C, Tinne M, von Lengerke T, Gosse F, Ebadi E. Compliance with hand disinfection in the surgical area of an orthopedic university clinic: results of an observational study. Antimicrob Resist Infect Control. 2022 Jan 31;11(1):22. DOI: https://doi.org/10.1186/s13756-022-01058-2.
23. Ben Fredj S, Ben Cheikh A, Bhiri S, Ghali H, Khefacha S, Dhidah L, et al. Multimodal intervention program to improve hand hygiene compliance: effectiveness and challenges. J Egypt Public Health Assoc. 2020 Mar 23;95(1):11. DOI: https://doi.org/10.1186/s42506-020-00039-w.
24. Bajunaid RM, Saeed A, Bostaji M, Farsi NJ. Hand hygiene compliance and improvement interventions in the Eastern Mediterranean Region: a systematic review and meta-analysis. Infect Prev Pract. 2024 Mar 27;6(2):100363. DOI: https://doi.org/10.1016/j.infpip.2024.100363.

DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

AUTHORS' CONTRIBUTION

The following authors fullfill authorship criteria as per ICMJE guidelines;

Shah FA:	Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Rehman SU:	Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Shahidullah:	Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Imran Y:	Analysis and interpretation of data, critical revision,final approval, agreed to be accountable for all the work.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License, which permits unrestricted use, distribution & reproduction in any medium provided that original work is cited properly.