

Protocol  
Date 1 May 2023

**The effectiveness of a multicomponent education program of hand hygiene  
in nursing students: a randomized controlled trial**

**NCT05872581**

**Date: 1 May 2023**

## Background

The ongoing COVID-19 pandemic has posed serious threats to public health worldwide. Although children have mild symptoms, they have been found to more likely transmit the virus within the household than the other age groups. The importance of hand hygiene cannot be underestimated in both healthcare and community settings (Allegranzi et al., 2011; Mathur, 2011). The promotion of hand hygiene is the best practices in preventing health care-associated infection (WHO, 2009). It has been estimated that hand hygiene could reduce over 500 000 attributable deaths per year. It was found that the annual economic impact of health care-associated infection in the US was approximately US\$6.5 billion in 2004 (WHO, 2009) and every US\$1 spent on hand hygiene promotion could result in a US\$23.7 benefit (Chen et al., 2011). Education plays a key role in setting a good practice base in hand hygiene.

The traditional training methods for nursing students include in-class lecture and practical, but students seldom receive individualized instructions and feedbacks due to limited manpower and facilities. Hence, there is an urgent need of designing an automated and individualized education program. This study aims to design and test a multicomponent education program of hand hygiene in nursing students. Specifically, this program has two components: 1) training videos according to the WHO guidelines on hand hygiene in health care (<https://polyu.ap.panopto.com/Panopto/Pages/Viewer.aspx?id=f3973cee-bcfb-48fd-a306-b6893dacaabd>); 2) a hand scanner used for students to immediately visualize the missing spots of hand hygiene.

This study has the following specific objectives:

- 1) conduct a randomized controlled trial (RCT) to test the effectiveness of this program on knowledge and practice of hand hygiene in nursing students;
- 2) evaluate the effects of each component and collect feedbacks from participants.

If demonstrated effective, this program can be integrated into the curriculum of nursing students as an e-learning approach. In future, this system can also be used at point-of-care for real-time monitoring and audit of healthcare workers in other healthcare settings.

## Methods

### *Study design*

This is a four-arm RCT.

### *Subject recruitment*

We will recruit all year one nursing students from the Bachelor of Nursing and Bachelor of Mental Health Nursing program in School of Nursing (total number is approximately 280) during June to July 2023. The participants will subscribe a timeslot of training sessions (each session has 3 participants). All participants who attend the same session will be assigned to the same group by cluster randomization. A statistician will assign the groups in advance by a random number generator. The participants will not be informed about their group before arriving the study site (the Squina International Centre for Infection Control in PolyU).

## Protocol

Date 1 May 2023

### *Pre-intervention assessment*

During the site visit, the participants will sign a consent form first and be asked to fill in a questionnaire on knowledge and practice of hand hygiene (attached in Appendix).

Participants will need to put fluorescent powder on both of their hands, and hold hands under ultraviolet (UV) light (wavelength: 365nm) to take digital image of hands. Participants will then perform hand washing using liquid soap without any instructions (1<sup>st</sup> HW attempt). The camera installed above the hand-wash basins will take videos of both hands (no face nor other parts of the body) during this procedure. After washing hands, participants will hold hands under UV light again to take digital image of hands, and will need to scan fluorescent powder remained on their hands in a hand scanner (The Semmelweis Scanner<sup>TM</sup>). The digital images of hands and the recorded hand washing videos will be used to train the AI algorithms for automatic image processing and assessments. Two IPC experts will judge the quality of hand hygiene in these images/videos, which will be adopted as ground truth in image processing. The percentage of fluorescent gel residual on hands shown in the hand scanner will be used as an objective assessment for efficacy of hand washing in individual participants.

### *Intervention and control groups*

#### Group A (Hand scanner instant feedback)

Participants will be informed about their hand scanner results of the first HW attempt to get individualized feedback about their hand wash performance. But no training video is provided.

#### Group B (Video training)

Participants will watch a training video about the 7 steps of hand washing after the first HW attempt, but they will not be informed about their hand scanner results.

#### Group C (Hand scanner + Video training)

Participants will be informed about their hand scanner results during the first HW attempt. They will also watch a training video about the 7 steps of hand washing.

#### Group D (Control group without intervention)

Participants will not be informed about the hand scanner results in the first HW attempt and no training videos will be provided.

### *Post-intervention assessment*

The participants will take the second HW attempt by putting fluorescent powder on both of their hands again and then perform hand wash with videos recorded. Digital images of hands will again be taken under UV light before and after hand wash. After washing hands, participants will scan fluorescent residual remained on their hands again in a hand scanner.

Participants will also be asked to fill in a questionnaire on knowledge and practice of hand hygiene as part of post-intervention assessment.

For the training purpose, after the completion of post-intervention measurements, the participants of the control group (Group D) will watch the training video and repeated hand washing and scanning for the third time if they agree. But the results of their third HW attempt will not be included into data analysis in this

Protocol  
Date 1 May 2023

study.

### **Randomization, allocation concealment, and blinding**

Participants will be randomly assigned to the intervention groups or control group through a process of randomization performed by a statistician who will not be involved in subject recruitment. The participants will be blinded. The RAs involved in subject recruitment and the IPC experts who judge the quality of hand hygiene will be blinded to the groupings. The RAs and student assistants involved in hand hygiene video recording at the study site will not be blinded because they will be giving instructions to the participants.

### **Ethical consideration**

The effect of exposure to UV-A light is similar to outdoor exposure to sunlight. It is anticipated that the study will not pose any physical or psychological harm to the participants. The contact details of either the ethical or the research in-charge personnel are clearly written in the information sheet.

Explanation of the study will be given to participants who are interested in participating in the study. Participants will also be given the opportunity to ask our project personnel questions. Furthermore, the information sheet including the purpose of the study, confidentiality of the data, and rights of the participants, will also be provided to the participants. The contact details of either the ethical or the research in-charge personnel are clearly written in the information sheet. If they agree to participate in the study, they are required to sign the consent form. Their participation is on a voluntary basis, they have the right to withdraw from the study at any time if they want to without consequence.

All the collected data will be kept confidentially, and only the research personnel can access and handle the data. No personal information of the participants will be collected except the student ID number.

### **Confidentiality and Security**

Data collection will be anonymous, only analysed for specified purposes and on the basis of the consent or other legitimate basis laid down by law. No personal information will be linked to image/video data. All the image/video data will be deleted one year after the project is completed. The Project will not involve any activities or results raising security issues.

### **References**

Al-Shatri, H., Müller, S., & Klein, A. (2016, 22-27 May 2016). Distributed algorithm for energy efficient multi-hop computation offloading. 2016 IEEE International Conference on Communications (ICC),

Allegranzi, B., Bagheri Nejad, S., Combescure, C., Graafmans, W., Attar, H., Donaldson, L., & Pittet, D. (2011). Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet*, 377(9761), 228-241. [https://doi.org/10.1016/S0140-6736\(10\)61458-4](https://doi.org/10.1016/S0140-6736(10)61458-4)

Protocol

Date 1 May 2023

Chen, Y. C., Sheng, W. H., Wang, J. T., Chang, S. C., Lin, H. C., Tien, K. L., Hsu, L. Y., & Tsai, K. S. (2011). Effectiveness and limitations of hand hygiene promotion on decreasing healthcare-associated infections. *PLoS One*, 6(11), e27163. <https://doi.org/10.1371/journal.pone.0027163>

Gasteiger, N., Dowding, D., Ali, S. M., Scott, A. J. S., Wilson, P., & van der Veer, S. N. (2021). Sticky apps, not sticky hands: A systematic review and content synthesis of hand hygiene mobile apps. *J Am Med Inform Assoc*, 28(9), 2027-2038. <https://doi.org/10.1093/jamia/ocab094>

Mathur, P. (2011). Hand hygiene: back to the basics of infection control. *Indian J Med Res*, 134(5), 611-620. <https://doi.org/10.4103/0971-5916.90985>

Mueller, F., Bernard, F., Sotnychenko, O., Mehta, D., Sridhar, S., Casas, D., & Theobalt, C. (2018). GANerated Hands for Real-time 3D Hand Tracking from Monocular RGB. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 49-59.

WHO. (2009). In *WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge Clean Care Is Safer Care*. <https://www.ncbi.nlm.nih.gov/pubmed/23805438>

Yang, L., Lu, Y., Cao, J., Huang, J., & Zhang, M. (2020). E-Tree Learning: A Novel Decentralized Model Learning Framework for Edge AI. *IEEE Internet of Things Journal*.

Appendix

**Survey on knowledge and practice of Hand Hygiene in Nursing Students**

**Part I: Demographic**

1. Student ID: \_\_\_\_\_
2. Age: \_\_\_\_\_ yrs
3. Gender:      Female      Male
4. Programme:      BSN      Mental Health Nursing

**Part II: Hand hygiene**

5. Have you ever received formal training in hand hygiene?

Yes      No

If your answer is yes; when did you receive the training (give the latest year)?

Answer: \_\_\_\_\_ (yyyy)

6. How many steps are required for healthcare workers to perform hand hygiene (please give a number) ?

Answer: \_\_\_\_\_

7. How many types of hand hygiene are there (please give a number)?

Answer: \_\_\_\_\_

8. How long is the minimal duration of hand washing?

Answer: \_\_\_\_\_ seconds

- 9: Which of the following sequence is correct for hand hygiene? (MC Question)

A	Ans: B	C
Finger webs	Finger webs	Thumbs
Finger tips	Back of fingers	Finger tips
Back of fingers	Thumbs	Finger webs

Protocol

Date 1 May 2023

Thumbs	Finger tips	Back of fingers
--------	-------------	-----------------

10. Which of the following is one of hand hygiene steps EXCEPT?

- Rub palms
- Rub fingernails
- Rub wrists
- Fingers interlocked

11. Do you agree or disagree with the following statement:

Hand hygiene is part of infection prevention and control in healthcare settings.

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

**Additional questions for post evaluation**

12. What are the 7-steps of hand washing? (MC Questions)

	A	B	C	Answers
Step 1	Finger tips	Palms	Between fingers	Palms
Step 2	Back of hands	Back of fingers	Palms	Back of hands
Step 3	Thumbs	Finger tips	Between fingers	Between fingers
Step 4	Palms	Between fingers	Back of hands	Back of fingers
Step 5	Finger tips	Thumbs	Back of fingers	Thumbs
Step 6	Back of fingers	Finger tips	Wrists	Finger tips
Step 7	Wrists	Thumbs	Back of hands	Wrists

13. What is the sequence for hand hygiene?

Steps		Drag Answer Here:
Finger tips	Step 1	
Back of hands	Step 2	
Thumbs	Step 3	
Palms	Step 4	

Protocol

Date 1 May 2023

Finger tips	Step 5	
Back of fingers	Step 6	
Wrists	Step 7	