

## Evaluation of the effectiveness of handwashing training given to paramedic students remotely

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### Abstract

**Background and objectives:** The COVID-19 pandemic has affected face to face medical education and training activities around the world. The aim of this study was to provide remote practical handwashing training to health sciences students and to measure the effectiveness of the training provided and to create a feedback model.

**Methods:** Students of the Paramedic department were included in the study. Two virtual classrooms were created via Zoom Video Communication system. An 11-step handwashing algorithm was developed. Two hours of remote handwashing training was given. Participants were asked to apply the handwashing application they learned at their own location and to record videos. Application videos were evaluated and scored.

**Results:** A total of 135 Term-1 and Term 2 students of the Paramedic department participated in the study. The duration of the evaluated videos was on average  $57.67 \pm 12.69$  (34-95) seconds. Fifty five (40.7%) of the participants successfully completed all the steps and their average success score was  $10.3 \pm 0.67$  (8-11). The most failure (33.3%) in the process steps was the 9th step in which the wrists are rubbed with soap.

**Conclusion:** Suitable teaching and feedback methods are required for medical and health science students who receive education and practical training remotely from home.

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### Introduction

The COVID-19 pandemic has deeply affected education and training activities around the world. In Turkey, education and internship program have been stopped within the scope of health measures and all kinds of patient contact are prohibited. However, some countries have graduated their medical students early to meet the increasing need for service [1,2]. This new situation has created the risk of inadequate education in the field of health

sciences where applied education is compulsory. University administrations had to make new decisions regarding the education of health sciences students [3]. Models such as virtual classroom creation, online learning and hybrid education models have been rapidly implemented. However, this situation has created new problems for applied trainings. The most important of these problems is the measurement of the effectiveness of the training provided.

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Hand hygiene is an important element in combating infectious diseases and hospital infection. Hand hygiene education is an element that increases the theoretical knowledge of students, predicts their practice and contributes to the fight against pandemic. One of the main recommendations published by the World Health Organization (WHO) for the public is to wash hands frequently and correctly to prevent SARS-CoV-2 infection [4]. During this period when the importance of hand hygiene education and distance education models are discussed, the fact that it is difficult to manage practical trainings remotely [5]. The aim of this study was to provide handwashing training to health sciences students whose practical training was interrupted, to measure the effectiveness of the training provided, and to create a feedback model for remote practical training.

### Materials and methods

The study was approved by the institutional ethics committee. The study was conducted with first and second year paramedic students. No pre-test was applied as none of the participants had received handwashing training before.

### Workflow

**First step:** Training content and plan were determined. The training plan included:

- a. *learning the indications of handwashing*
- b. *correct handwashing application* - Using the hand hygiene guide recommended by WHO [6] and the handwashing algorithm recommended by the Turkish Republic (TR) Ministry of Health [7], an 11-step handwashing algorithm of Hasan Kalyoncu University was created (Image-1), and
- c. *Wrong applications during handwashing*

**Second Step:** Learning resources were determined and training materials were produced. At this stage, Power Point presentation, visual and written resources were prepared in accordance with the learning objectives and training content. Learning

materials were created based on videos and brochures prepared by WHO and Turkish Ministry of Health. Using these guides, a 60-second implementation video was shot. The video and the prepared algorithm were sent to the groups in which the participants were included via the WhatsApp Messenger application.

**Third step:** Two virtual classrooms consisting of first and second year students of the paramedic department were established over the Zoom Video Communications system. During the study, two hours of remote handwashing training was given to both groups separately by the coordinators of the study. In these presentations, handwashing skill was explained to the participants in practice. Participants were able to present instant questions and contribute during the presentation.

**Fourth step:** It was aimed to provide feedback of the participants. Participants were asked to apply the handwashing application they learned at their own location and to record videos during the application. Participants were notified beforehand that recordings were limited to <100 seconds. The recorded images were sent to the study directors via e-mail within a period of 15 days.

**Fifth step:** Application videos were evaluated. First of all, video quality was evaluated with the Global Quality Score (Table-1). Videos with a Global Quality Score of 4 and 5 were evaluated in terms of content.

The application stages were scored separately according to the Hasan Kalyoncu University handwashing algorithm (Image-1). While evaluating the videos, "1 point" was given for each correct step of the participant and "0 point" for incorrect step. Each participant received a minimum of "0" and a maximum of "11" points from the applications. The participant who secured full 11 points from one application was deemed successful; the participant with less than 11 points was termed as failed. The videos were scored individually by two independent observers (two emergency medicine specialists with at least 5 years of experience) using a rubric.



**Figure-1:** Hasan Kalyoncu University handwashing algorithm

Participants who did not want to participate in the study, who wanted to leave the study, who did not submit their video recording on time, who had a Global video quality score of <4 and a video duration of <15 seconds were excluded from the study.

**Table-1:** Global Quality Score

Score	Description
1	Poor quality, poor flow of the site, most information missing, not at all useful for patients
2	Generally poor quality and poor flow, some information listed but many important topics missing, of very limited use to patients
3	Moderate quality, suboptimal flow, some important information is adequately discussed but others poorly discussed, somewhat useful for patients
4	Good quality and generally good flow. Most of the relevant information is listed, but some topics not covered, useful for patients
5	Excellent quality and flow, very useful for patients

**Statistical Method:** The normality distribution of the data was evaluated using the Shapiro Wilk test. Student's t test was used to compare two independent groups with normal distribution, and the Mann Whitney U test was used to compare two independent groups that were not normally distributed. Relationships between categorical variables were analyzed using Pearson's and exact chi-square tests. Pearson Correlation test was used to determine rater reliability, which shows consistency between raters. For descriptive statistics, mean  $\pm$  standard deviation for numerical variables, numbers and percentages for categorical variables were used. Statistical analysis was performed using the SPSS Windows 24.0 package program and a  $p < 0.05$  level was considered statistically significant.

## Results

Pearson Correlation test was used to show consistency between raters and to determine rater reliability. Analysis of results showed a high correlation between raters ( $r = 0.90$ ,  $p < 0.05$ ). A total of 135 participants who met the criteria were included in the study. Out of 135, 41 (30.4%) and

94 (69.6%) participants were male and female respectively while, 66 (48.9%) were Term-1 and 69 (51.1%) were Term-2 students of the Paramedic department. The duration of the evaluated videos was on average  $57.67 \pm 12.69$  (range: 34-95) seconds (Table-2). Fifty five (40.7%) of the participants successfully completed all the steps and their average success score was  $10.3 \pm 0.67$  (range: 8-11). The most failure rates were in the 9<sup>th</sup> (33.3%) and 6<sup>th</sup> (16.3%) process steps (Image-1) where the wrists and volar surface of the fingers were rubbed with soap (Table-3).

**Table-2:** Descriptive data of the study participants (N=135)

Parameter	Values
<b>Gender, n (%)</b>	
Male	41 (30.4)
Female	94 (69.6)
<b>Class, n (%)</b>	
Term-1	66 (48.9)
Term-2	69 (51.1)
<b>Video duration in second, <math>\bar{x} \pm SD</math>, (Range)</b>	
General	$57.67 \pm 12.69$ (34-95)
Term-1	$55.39 \pm 11.61$ (34-88)
Term-2	$59.85 \pm 13.36$ (37-95)

Participants were compared within themselves (Table-4). Average achievement score of female students was found to be higher [ $10.37 \pm 0.56$ , (9-11) points] and they showed more success [39 (41.5%)], but were not statistically different from male students ( $p=0.789$ ). The average achievement score of Term-1 students was found to be higher [ $10.32 \pm 0.71$ , (8-11) points] and they were more successful (28, 42.4%) but were not significantly ( $p=0.697$ ) different from the score of Term-2 students (39.1%).

**Table-3:** Success status of each process step of the study participants (N=135)

Process step	Successful n (%)	Unsuccessful n (%)
Step 1	134 (99.3)	1 (0.7)
Step 2	135 (100)	0 (0.0)
Step 3	126 (93.3)	9 (6.7)
Step 4	135 (100)	0 (0.0)
Step 5	135 (100)	0 (0.0)
Step 6	113 (83.7)	22 (16.3)
Step 7	135 (100.0)	0 (0.0)
Step 8	134 (99.3)	1 (0.7)
Step 9	90 (66.7)	45 (33.3)
Step 10	135 (100)	0 (0.0)
Step 11	124 (91.9)	11 (8.1)
<b>Total success</b>	<b>55 (40.7)</b>	<b>80 (59.3)</b>
<b>Success points (Total), Mean <math>\pm</math> SD (min-max)</b>	<b><math>10.3 \pm 0.67</math> (8-11)</b>	

**Table-4:** Comparative performance data of the study participants (N=135)

	Success points Mean $\pm$ sd (min-max)	Successful Number (%)	Unsuccessful Number (%)
<b>Gender</b>			
Male (n=41)	$10.2 \pm 0.81$ (8-11)	16 (39.0)	25 (61.0)
Female (n=94)	$10.37 \pm 0.56$ (9-11)	39 (41.5)	55 (58.5)
p value	0.388*		0.789**
<b>Class</b>			
Term-1 (n=66)	$10.32 \pm 0.71$ (8-11)	28/66 (42.4)	38/66 (57.6)
Term-2 (n=69)	$10.30 \pm 0.63$ (9-11)	27 (39.1)	42 (60.9)
p value	0.660*		0.697**

\*p value was obtained from Mann Whitney U test;

\*\*p value was obtained from Pearson Chi Square test

## Discussion

Hand hygiene, correct handwashing education and habits are not standardized by health professionals and health science students [8]. On the other hand, it is known that hand hygiene is an important factor that improves patient safety and especially prevents in-hospital infections [9]. Studies have shown that only 5.3% to 9.5% of health science students and health professionals have completely clean hands after washing their hands [8]. In the study conducted by Yoo et al., it was observed that less than half of the paramedic students (45%) washed their hands 5-8 times a day and the average washing time was 24.34 seconds [10]. Ho et al in an observational study found that paramedics sanitize their hands nine times during patients contact compared to only three times before touching the patient [11]. Studies conducted in our country have shown that the vast majority of health science students have a habit of washing their hands before and after the procedure. They wash their hands > 10 times a day for more than 60 seconds, but again, their level of knowledge about hand hygiene is low [8,12,13]. According to the available data, it is a necessity for health sciences students who frequently touch patients in pre-hospital health and emergency services after graduation to receive handwashing training and gain this habit. However due to the pandemic, suitable methods are required for such practical training and feedback of education for students receiving education from home. In our study, this difficulty was tried to be overcome with video feedback.

Hand hygiene is a habit that is frequently needed in all areas of life rather than being a part of a professional line of business. Studies show that almost all (95%) people leave at least some part of their hands dirty after handwashing [8,14]. The most common areas are the nails, thumb (especially of the non-dominant hand), fingers and wrist [14-16]. It has been reported that hands of people wearing watches and bracelets on their wrists tend to remain dirty even after washing their hands [14,15]. In some visual algorithms of global

health organizations such as the World Health Organization, there is no step of rubbing the wrist with soap [6]. We believe that updating such visual algorithms by emphasizing the rubbing of the wrist with soap will contribute to improve the hand hygiene. In addition, it has been shown that the fingertips are not rubbed on the palm during washing and the fingertips and nail bed remain dirty [8,17]. It is known that long and dirty nails are associated with in-hospital serious infections [18,19]. Therefore, many handwashing algorithms emphasize the cleaning of these areas more [6,7]. In our study, 40.7% of our participants correctly applied all handwashing steps. The 5th step where the fingers were cleaned, the 7th step where the thumbs were cleaned and the 8th step where the nails were cleaned were successfully performed by the majority of the participants (> 99%). However, the 6th step in which the volar surface of the fingers were washed a significant portion of the participants (16.3%) made mistake in the second application. Although none of the participants used any wrist jewelry during the handwashing procedure, the most common misapplication (33.3%; Table-3) was observed during the washing of the wrists. As a result of this application, it is possible to say that the volar aspect of the wrists and the fingers, the most frequently used area, remain dirty. It is seen that personal differences, habits and accessories used have an effect on handwashing habits. For this reason, correct handwashing technique trainings should be supported not only with written and illustrated brochures but also with visual applications and should be repeated frequently to make the process into a habit. Many studies on hand hygiene are based on detecting the dirty parts of the hand by using the reflection of ultraviolet light [8,14,15]. In the present study, it was not possible to use ultraviolet light for us to see which part of hands remained dirty in a usual act of handwashing.

Differences between societies (such as hygiene, belief, geographical differences, water resource limitations) make it difficult to standardize handwashing practices [8,16]. In our study, 8.1% of

the participants turned off the tap with their hands after washing their hands. Some of these people stated in their video recordings that they did this practice in order not to waste water while taking the paper towel and drying their hands. In a similar study, the most common wrong application was found at this step and the participants stated that they performed this application in order to prevent water waste [16]. Only 15% of the usable fresh water resources in our country and in the world are used for domestic and drinking purposes while most of the water resources are used for agricultural irrigation and industrial areas and therefore wasted in those areas [20,21]. It is difficult to compare the wastage of water during handwashing and the financial loss caused by infections due to incomplete hand hygiene. However, hand hygiene is known to be an important practice that affects public health positively, and also prevents in-hospital infections and reduces morbidity and mortality [18,19,22]. Therefore, the main purpose of hand hygiene is to reduce contamination and this should be started from the taps where hygiene begins.

Distance education is a learning-teaching method that has gradually increased its place and effectiveness in education in recent years. Face-to-face trainings have advantages such as visual contact between student and teacher, agreement with body language, ability to instantly ask and clarify issues that the students do not understand, and contribute [23,24]. Online or offline presentations, digital materials and distance education with long texts often fail to address the above issues. This makes it difficult to understand the feedback and effectiveness of distance education. Students who receive distance education have stated that this is a necessity to decrease their anxiety during the pandemic process and increases their responsibilities in the learning process [25]. However, one of the biggest problems is the evaluation of the effectiveness of the education given [23]. In this study, hand hygiene training was provided remotely and enriched with visual contents. Since it is a practical training, the participants were asked to apply what

they learned. Thus, we think that the participant could gain the correct handwashing technique and habit by showing the correct and incorrect practices according to the standardized application steps and by repeating these practices regularly.

### Limitations

Due to the pandemic, ultraviolet light could not be used to confirm the accuracy of hand washing as a requirement of distance education. No pre-test application video was taken, as the participants had not previously received handwashing training. The wrong applications of the participants as a result of the video analysis were reported to them, but they were not asked for a re-application video.

### Conclusion

Despite the training given in our study, 59.3% of our participants could not perform the correct handwashing practice. The most common mistake was made in the washing steps of the wrist and finger volar surfaces. The reason could be selective emphasis for washing of nail and fingertips. Therefore, we recommend hand hygiene training should emphasize cleaning the hand as a whole. It is necessary to update the global handwashing algorithms to emphasize the rubbing of the areas such as wrist appropriately with soap. About 8.1% of the participants re-contaminated their hands they washed with the idea of saving water. So, during water saving campaigns we should emphasize that hygiene (especially hand hygiene) is as important as saving water. In addition, widespread use of sensor faucets would contribute to the solution of the problem. Practical skills of health sciences students can be taught through distance education using appropriate teaching-learning module. Video applications on smartphone can be used to evaluate the skills.

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### Conflict of Interest

All Authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest.

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