

COVID-19: Repeated video-watching vs. combined video-watching and live demonstration as training to health care providers for donning and doffing personal protective equipment

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Abstract

Background

During the COVID-19 pandemic, not only was there a lack of personal protective equipment (PPE) for health care workers but a dearth in training in respect of its donning and doffing. This study compared two training methods for donning and doffing PPE in order to teach health care workers how to do so more effectively and quickly.

Method

A total of 48 health care workers were recruited and randomly divided into two groups. Group A watched a 10-minute demonstration (demo) video repeated four times, while Group B watched the same demo video twice followed by a 10-minute live demo twice. The learning time of both groups was the same, and an examination was performed immediately after the completion of training. The examination scores of Group A and Group B were recorded according to the checklist (Appendix 1). The time taken for the participants to don and doff PPE, their satisfaction with the training, and the confidence to don and doff PPE were analyzed.

Results

The average score of Group B was better than that of Group A, with a mean (SD) of 94.92 (1.72) vs. 86.63 (6.34), respectively ($P < 0.001$). The average time spent by Group B to do the examination was shorter than that of Group A, with a mean (SD) of 17.67 (1.01) vs. 21.75 (1.82), respectively ($P < 0.001$). The satisfaction and confidence of Group B were higher than those of group A ($P < 0.001$).

Conclusions

Compared with repeated video-watching learning, the video-watching plus a live demonstration teaching method is more suitable for health care workers to learn how to put on and remove personal protective equipment.

Introduction

With the global outbreak of coronavirus disease 2019 (COVID-19) and the explosive growth in the number of patients, global health care systems are facing daunting challenges. According to the World Health Organization(1) as of May 14, more than 4,218,212 people worldwide had been infected with COVID-19 of whom 290,242 have died. Due to the shortage of PPE, a large number of health care workers have also been infected by COVID-19 with at least 193,825 cases of COVID-infected medical staff from 52 countries being reported by April 8, 2020.(2)

In the early days of the COVID-19 epidemic, more than 3,000 health care workers in China were infected with COVID-19.(3) For Hubei, the most serious area of the epidemic, a total of 42,000 health care workers were sent to the province, however, until now, none have been infected with COVID-19. According to the study, training in donning and doffing PPE is equally as important as its provision.(4–7) Meanwhile, according to a survey of orthopedic surgeons in Wuhan, participating in real-time training is a key factor in preventing COVID-19 infection.(8) COVID-19 is a pandemic and we lack training in this field. If PPE is not properly donned, we will not only fail to protect ourselves but also waste protective materials, worsening the effects on an already strained medical system.

Therefore, in order to study how to train health care workers to don and doff PPE more quickly and effectively, a study was designed to compare two training methods. A total of 48 health care workers were recruited and randomly divided into two groups. Group A watched a 10-minute demo video repeatedly four times, while Group B watched the 10-minute demo video twice followed by a 10-minute live demo twice. The learning time of the two groups was the same. The examination was performed immediately after the completion of the training. The hypothesis was that combined video-watching and live demonstration is better than video-watching alone. The primary outcome was to compare the average score of the two groups, and the secondary outcome was to compare the times spent by each group.

Methods

The study was approved by the Ethics Committee of the First Affiliated Hospital of Guangzhou University of Chinese Medicine (NO. ZYYEC-ERK[2020]029), and all participants provided informed consent. In this study, doctors and nurses who are active in the clinical front line of the Department of Anesthesiology were recruited, none of whom had participated in relevant training prior to this. The study was conducted by the Department of Anesthesiology, at the First Affiliated Hospital of Guangzhou University of Chinese Medicine. Medical staff in frontline clinical work were included, but we excluded those older than 60 years or who either had a serious disease or had recently experienced coughing or fever. A total of 48 medical staff in the anesthesiology department were recruited.

The training video was provided by Guangdong Province Emergency Hospital and is available for use by all medical institutions. The video was divided into two parts: donning and doffing, each for five minutes, for a total of 10 minutes. The physician responsible for the live demonstration and training was a doctor who had received both professional and advanced training prior to the demonstration. To ensure that the live demonstration group had the same video training steps and scores, the checklist was created according to the video content and available PPE in our department(Appendix 1). The physicians in charge of the assessment were another two doctors who had also been professionally trained, but they did not know the grouping at the time of the assessment. During the exam, the two physicians graded the participants from different angles and then summarized them. (See Fig. 1 for participants' process of donning PPE).

The order of the exams was determined by a random sequence of numbers generated by computer. Each participant was allocated their own unique number and the grouping was placed in an opaque envelope, so participants were not aware of their grouping until they opened their own envelope. In order to ensure the efficiency of learning, on the day before the experiment a checklist containing the steps and scores of donning and doffing PPE was received by all participants. The method of donning and doffing PPE was demonstrated by professionally trained doctors. Group A watched the video for 40 minutes (the ten-minute video repeated four times); while Group B watched the 10-minute video twice and then the 10-minute live demo twice, after which the participants were allowed to ask any questions. The study time of the two groups was the same; both 40 minutes. The exam began immediately after the demonstration was completed (Fig. 2). The whole exam consists of 29 steps, with 1 to 6 points for each step, for a total of 100 points (Appendix 1). The donning and doffing time were recorded for subsequent analysis. The participants' satisfaction with the training was recorded, and categorized into five levels using a 5-point Likert scale: 1 = very dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, and 5 = very satisfied. Likewise, to record how easily they were able to don and doff the PPE, the difficulty levels were categorized into five levels: 1 = very difficult, 2 = difficult, 3 = neutral, 4 = easy, and 5 = very easy.

Based on our pilot study of 10 participants, the average scores of the two groups (A and B) were 85.6 and 94.6, respectively, with 6.67 as the standard deviation (SD). With 90% power and a significance level of 0.05, we calculated that each group would require 23 participants. Thus, assuming potential drop-outs, we recruited 48 participants.

Statistical analysis was performed using SPSS 23.0 (Statistical Product and Service Solutions, IBM) and $P < 0.05$ was considered statistically significant. The measurement data first tested the homogeneity of variance, and if the variance was uniform, a t-test was used to compare the differences between the two groups, the mean was used to describe the concentrated trend of the sample, and the standard deviation was used to describe the discrete trend of the sample. If the variance differed, the Wilcoxon signed-rank test was used to compare the differences between the two groups. The data of satisfaction and ease of use were compared with the Wilcoxon signed-rank test. The median was used to describe the concentrated trend, while the maximum and minimum values were used to describe the discrete trend (Table 1). Fisher's exact test was used to compare the deduction steps between groups A and B (Fig. 3).

Results

There were 48 participants in the study, consisting of 24 participants in each group. None of the participants had attended training of this nature before, and the characteristics of the participants are described in detail in Table 1.

The average score of Group B was better than that of Group A, with a mean (SD) of 94.92 (1.72) vs. 86.63 (6.34), respectively ($P < 0.001$). The average time spent by group B was shorter than that of group A, with a mean (SD) of 17.67 (1.01) vs. 21.75 (1.82), respectively ($P < 0.001$). The median satisfaction of Group A was 4 vs. 4.5, compared with Group B ($P < 0.001$). A comparison of the median ease of participants in

Group A with Group B, showed 3 vs. 4.2, respectively ($P < 0.001$) (Table 1). In the full process of donning and doffing, the five steps in which mistakes were most likely to be made were as follows: Step 10. Wear a powered air-purifying respirator (PAPR) and belt (27.1%) (Fig. 1: B–C); Step 3. Check the air tightness of the N95 respirator (22.9%); Step 11. Turn on the power supply and ensure that the battery power is sufficient (20.8%) (Fig. 1:B); Step 21. Perform hand hygiene, enter the second shift strip room, remove the hood carefully (by yourself or with the help of your assistant, and be careful not to touch the contaminated part of the hood (20.8%); Step 27. Perform hand hygiene, then remove the disposable hat and inner gloves (22.9%), respectively (Fig. 3).

Discussion

Our results show that the average score of Group B watching video plus a live demonstration was higher than that of Group A, and the time used was also shorter. At the same time, Group B had higher satisfaction with training and confidence in donning and doffing PPE. Therefore, our study shows that the training method of Group B is faster and better and suitable for recommendation to health care workers.

There were significant differences in scores between our two groups, and we believe that video plus a live demonstration is more effective. However, a study by Liva and colleagues(9) indicated no difference between video and live presentations. Compared with their research, we did not set up a separate live demonstration only group. In comparison with the study of Liva et al., we believe that with today's highly developed network and electronic equipment, separate solely on-site training is no longer appropriate for the actual situation. With a sample size twice that of Liva et al., we believe our study has more authority to identify differences. Considering our pre-experiment and sample size calculation, we argue that it reasonably proves that video plus a live demonstration is more effective for training to don and doff PPE.

In addition to the test scores, the time spent donning and doffing PPE is equally important because in clinical work, time donning and doffing PPE would be better used treating patients. Therefore, the average saving of four minutes per staff member in Group B's training method is meaningful, especially when rescuing patients. Nevertheless, there is still room for improvement in Group B, whose average time was 17 minutes compared to 11.61 minutes reported by Kang(10) (don = 7.55 minutes and doff = 4.06 minutes). The possible reasons for our longer time are as follows: (1) Our steps are more detailed and safer. (2) This was the first time any of the participants had actually worn PPE, thus we believe that time will be significantly reduced after a few sessions of training and practice. (3) Our training time is shorter because the participants who were selected are all frontline clinical personnel, and this approach is more in line with the clinical situation and is a better comparison of the differences between the two methods.

The PPE used in our study may differ from that of other countries. Our protective clothing consists of a cover-all with a hood inside and waterproof gowns on the outside (Fig. 1). The hood in our protective cover-all does not have a thumb loop as do cover gowns as reported by Thriveen, (11) but we used a two-glove technique that would be effective in reducing contamination during PPE removal.(12, 13) Wearing waterproof boot covers and PAPR make it possible to ensure that the whole body is protected (Fig. 1). In

China, since the standards of PPE are almost the same according to the Chinese national standards list of epidemic prevention products,(14) the steps of donning and doffing PPE are the same in all hospitals, although there only videos with no guidelines. Both PPE and the steps taken to don and doff it may differ in other countries, hence the steps should be followed according to the Instructions of PPE or expert guidelines. In China, since there has been sufficient PPE and training, there have been no reports of infections among medical staff on the front line.

Among all the steps that were error-prone, Step 10 had the highest importance and difficulty. Thirteen (27.1%) participants made mistakes as they were all medical staff in the anesthesiology department who were receiving training for the first time, as they (we) had no similar experience before the COVID-19 epidemic. Even after a short training period, it is still impossible to quickly master PAPR usage skills without seeing it beforehand. Therefore, the importance of training, especially a suitable training method, should be emphasized.

In Step 21, 10 (20.8%) participants made mistakes. It is crucial to not touch the contaminated part of the hood because doing so results in failure. When removing the hood, the neck is often contaminated due to improper operation. This can also be attributed to a lack of PAPR training. It is well known that doffing PPE has a very high risk of contamination(12) (Steps 17–29). According to reports, the self-contamination rate ranges from 46–90% while doffing PPE.(13, 15) Therefore, in our clinical practice, when entering or leaving the contaminated area, each member of medical staff must be accompanied by another to watch for any possible contamination when removing the PPE. In Step 27, there were 11 (22.9%) participants who could potentially be contaminated when removing their gloves. Our results are consistent with those of Tomas et al., who reported that the contamination rate for removing gloves is as high as 52.9%, (13) which is higher than that for removing gowns,(15) thus this should not be ignored. The other steps will not be discussed as they either do not differ much from our usual work or the risk of infection is small. In short, to prevent cross-contamination we should pay more attention to doffing PPE than donning it.(16)

Among all of our participants, 98 was the highest score. We believe that the main reasons are the complex procedures of donning and doffing PPE, the short training time, and the tension of on-the-spot examination, which can lead to mistakes, making it difficult to reach 100 points. Our main purpose was to distinguish which of the two training methods is faster and more applicable. However, in clinical practice, in order to ensure safety, all medical staff who may be exposed to COVID-19 must practice repeatedly in accordance with better training methods until they score 100 points in the examination for three consecutive times and, when entering a contaminated area, two people go in to help and watch each other.

In recent years, with the rapid development of network and electronic equipment, network courses and training have become increasingly popular.(17, 18) Due to its convenience and not limited by time and space, web-based courses are preferred by many people and are, therefore, often used as one of the teaching or training methods. However, Daniel J, Klass(19) believes that electronic courses cannot be

separated from practice. In practice, web-based courses are often not as impressive as on-site courses, which have unique advantages such as immersion and interaction. Therefore, in our research, a simple video course is not as beneficial as a video course supplemented by on-the-spot teaching, although the learning time is the same. In addition, regarding participants' satisfaction levels, Group B was also higher than Group A, indicating that in terms of PPE training, more people still prefer on-site teaching, which concurs with the findings of a study by Thomas Brockfeld.(20)

COVID-19 is highly contagious,(21) and health care providers, including those working in the operating theater where surgical trauma may potentially activate the otherwise latent COVID-19 infection,(22) are at highest risk. In particular, in the face of the rapid escalation in COVID-19 worldwide, a vaccine has yet to be developed, so donning and doffing PPE with protective measures cannot be overemphasized.(4, 6) How to don and doff PPE is as important as its supply, not only to better protect oneself but also to avoid the waste of valuable resources caused by irregular donning and doffing of PPE. Therefore, in order to study how medical staff learn to don and doff PPE faster and better, we compared the two training methods and found that the video plus a live demonstration method is more effective, which provides theoretical support for medical staff training.

Limitations

Our study has several limitations. First, we did not set up the live presentation group as a separate group, so we may have missed the opportunity to compare the live presentation group with the video group. However, considering the actual clinical situation and other similar studies that have been performed,(9) we believe that it was reasonable not to set up a separate live demonstration group because in clinical practice, in order to ensure accuracy and security, everyone must first watch a standard video regardless of the length of time. Therefore, the differences between the two training methods can be better compared according to clinical practice. Second, the participants we recruited were mainly doctors in the Department of Anesthesiology, which may potentially limit the applicability of this study for doctors in ICU or other departments. The members of staff who voluntarily participated in this study may be those who are more interested in PPE and thus may have selective bias and be more careful when they realize that they are being monitored while removing the PPE. In addition, we did not set up video recordings and fluorescent markers because our standard videos have been verified by a large number of frontline health care workers and, as our main purpose was to compare the differences between the two training methods not to test the safety of PPE, we did not believe they were necessary. If we were to test the safety of donning and doffing PPE in COVID-19, we would need fluorescent markers and clinical trials. However, according to the data of the 42,000 medical staff we support in Wuhan, there is currently no infection once the steps for donning and doffing PPE are strictly followed.

Conclusion

The outbreak of COVID-19 has made the task of donning and doffing PPE crucial to personal safety and preventing the spread of the virus. Prior to the outbreak there was little experience of this kind of training.

When comparing the simple video-watching method with the video-watching plus on-the-spot teaching method, our results show that the latter is more suitable for medical staff to learn how to don and doff PPE.

Declarations

Ethical Approval and Consent to participate

The study was approved by the Ethics Committee of the First Affiliated Hospital of Guangzhou University of Chinese Medicine (NO. ZYYEC-ERK[2020]029), and all participants provided informed consent.

Consent for publication

All participants had consent for publication.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no conflict of interest.

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The data collection or material support: YHL, MZ, XQG

The data analysis and supervision: CNW, HHL, YXL

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Authors' information

Not applicable

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Tables

Table 1 The comparison results between group A and group B, and the characteristics of the number of participants

	Group A	Group B	Statistical significance
The average score of the exam			
Mean(SD)	86.63(6.34)	94.92±1.72	P<0.001
Time consuming(Minute)			
Mean(SD)	21.75(1.82)	17.67(1.01)	P<0.001
Participants' satisfaction			
Median (Min, Max)	4(3,5)	4.5(3,5)	P<0.001
Ease degree			
Median (Min, Max)	3(2,4)	4(3,5)	P<0.001
Role			
Nurse: doctor			7∓41
Gender			
Male: female			21∓27
Working age(years)			
1-5years			20
5-10years			16
>10years			12

Figures

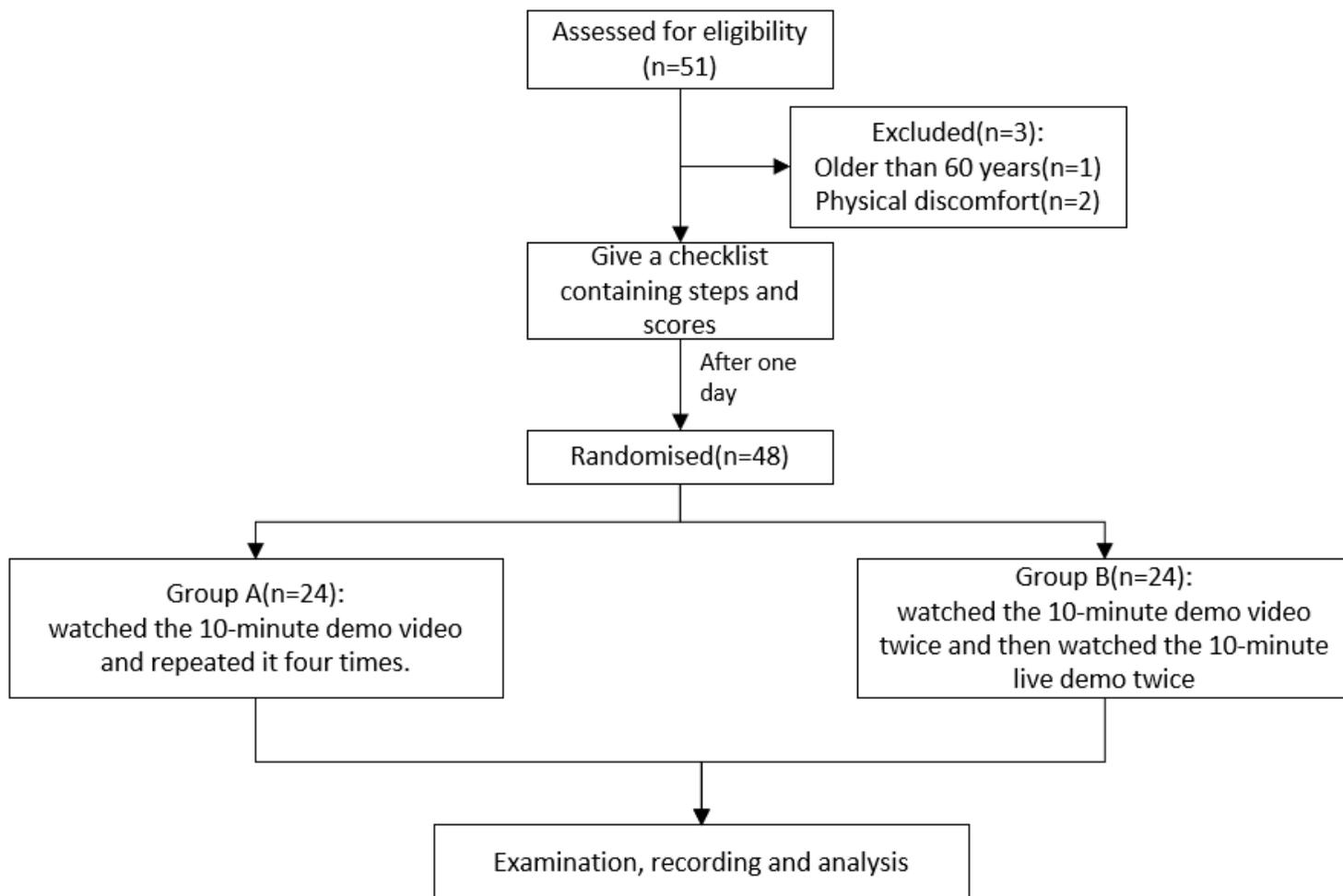


Figure 1

CONSORT diagram of recruitment.



Figure 2

Participant's process of donning PPE.(A: the protective cover-all with hood, B-C: Wear an powered air purifying respirator (PAPR),D:Finished donning PPE.)

Figure 3

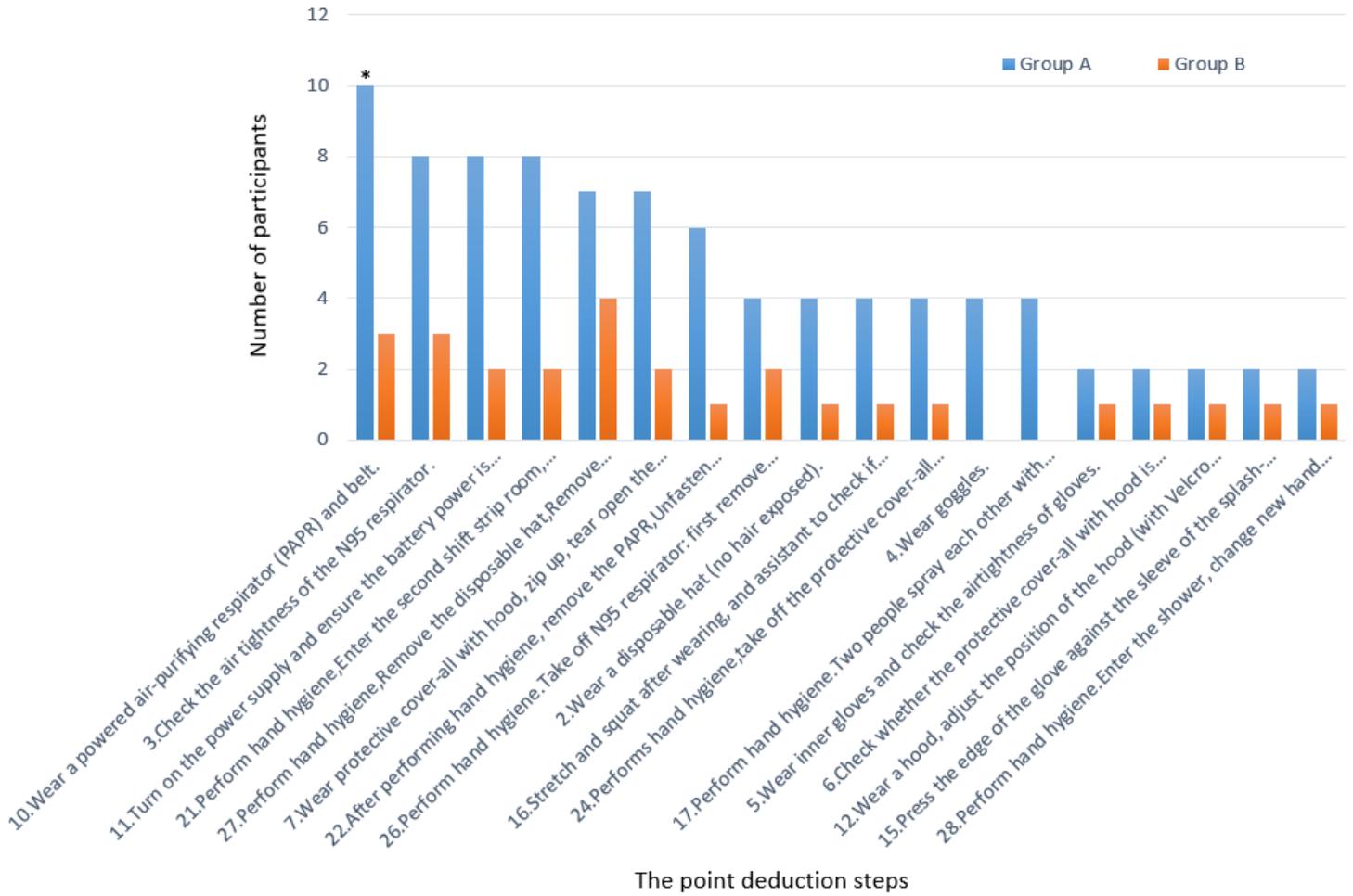


Figure 3

These steps are the most easy to make mistakes*: Group A compared with group B, $p < 0.05$

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Appendix1.docx](#)