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Abbreviations:
AR, Augmented Reality; COVID-19, Coronavirus Disease; GC, Geiger Counter; HUREMPT, HU Radiation Emergency Medical Preparedness Training; REMP, Radiation Emergency Medical Preparedness; VR, Virtual Reality

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Are Online Simulations for Radiation Emergency Medical Preparedness Less Effective in Teaching Than Face-to-Face Simulations?

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Abstract

Objective: The study clarified differences in understanding and satisfaction between face-to-face and online training on radiation emergency medical preparedness (REMP) training.
Methods: The training was held at Hirosaki University between 2018 and 2022, with 46 face-to-face participants and 25 online participants.
Results: Face-to-face training was significantly more understandable than online for the use of the Geiger counter ($P < 0.05$), but the educational effect of virtual reality (VR) was not significantly different from the actual practice. For the team exercise of taking care of the victims, online resulted in a significantly higher understanding ($P < 0.05$).
Conclusions: Interactive exercises can be done online with equipment sent to learners, and VR is also as effective. The use of videos was more effective for first-timers to learn the practical process from a bird's-eye view, especially for team-based medical procedures.

A non-contact environment between people is required by the coronavirus disease (COVID-19) pandemic. Online education and an e-learning system have covered face-to-face education, while workshop required interactive communication and learning practical skills utilized online meeting systems like Zoom during the pandemic.[1,2] In terms of education, there are pros and cons of educational effects on utilizing an online education system. Although our experience has shown us that some educational objectives are difficult to achieve without face-to-face instruction, we have also found that much of the content can be taught online by incorporating simulations.[3] We also conducted a training session in a hybrid format during the COVID-19 pandemic, and while there was generally no significant difference in educational effects from the face-to-face training, the discussion between face-to-face and online participants did not go smoothly, and the air and timing gap between participants became an issue.[4] Online education, which has spread rapidly and is both time- and cost-friendly for learners, is in high demand and it is useful to continue it even after the downgrade of COVID-19 to a "common infectious disease," if the educational benefits are high.

The purpose of this study is to verify whether there is any difference in the level of understanding and satisfaction when the face-to-face training sessions on radiation emergency medical preparedness (REMP) are replaced by online training sessions.

Methods

Subjects were nurses and radiology technicians who participated in the training courses on radiation disaster preparedness held at Hirosaki University Graduate School of Health Sciences from 2018 to 2022. There were 46 participants in face-to-face training, 17 nurses, and 28 radiology technicians. There were 25 online participants, 13 nurses, 12 radiology technicians, and 1 other researcher. In terms of previous radiation disaster preparedness training, 36 participants were first-time attendees in face-to-face, and 10 had attended at least once. In the online training, 12 were first-time attendees and 13 had attended at least once.

Training Detail

This 2-day training course is designed to provide participants with the opportunity to practice medical treatment and radiation control for contaminated casualties in the event of a nuclear disaster, as well as to learn the principles of lifesaving priority, prevention of contamination spread, and radiation protection. There are 3 lectures: Psychological Care in Nuclear Disaster, Previous Nuclear Disasters and Radiation Accidents, and The Road to Reconstruction after the Fukushima Nuclear Accident and the Current Situation. There are 5 exercises: individual practical sessions such as "how to use the Geiger counter," "decontamination," "Putting on and taking off protective gear," and group work and exercises on "zoning and team building" and "practices for taking care of injured contaminated victims." All necessary items were sent to the online participant's home. During the face-to-face session, the actual Geiger counter (GC) was prepared, step-by-step instructions were given on how to use it, and the participants surveyed to find radioactive sources hidden in the model. Meanwhile, we sent virtual reality (VR) content to those who wanted to learn how to use the GC online training, and participants experienced it supported by a facilitator through Zoom. The content is called *Nap:RI Survey*, developed by the authors and others, and is practiced on the Oculus 2. When the user puts on the goggles, a GC image of lying and standing victims appears.[5] Participants who did not want VR saw the exercise mirrored in VR and its explanation. As for group work, each group also added 2 facilitators to each group in the Zoom breakout room for discussion. One group discussion focused on team building and zoning. Another targeted taking care of radioactive contaminated injured victims. The participants watched previous training videos of the care of injured radioactive contaminated victims in action to confirm the process and the roles of each team member in each zone. They also checked for any missing actions regarding the prevention of contamination spread and radiation protection.

Evaluation

The level of understanding was evaluated on a 4-point scale, from "very well understood" to "not at all understood," and the level of satisfaction with the whole training was also evaluated on a 4-point scale, from "very satisfied" to "not at all satisfied."

Statistical Analysis

The values of understanding and satisfaction with the learning content face-to-face and online were analyzed in IBM SPSS 28.0 (IBM Corp, Armonk, NY) using the Mann-Whitney U test. The significant level was set at less than 5%.

Ethical Considerations

For the questionnaire after this training, we did not take personal information such as names and affiliations and used only data that we confirmed in writing and obtained consent from the participants that we would verify the effectiveness of the training and that we would evaluate the data for the purpose of improving the training.

Results

Thirty-eight face-to-face training participants (82.6% response rate) responded to the questionnaire: 15 nurses and 23 radiology technicians. There were 25 online participants (100% response rate): 13 nurses, 11 radiology technicians, and 1 researcher. There were 10 online VR practitioners and 15 non-VR practitioners; 3 VR practitioners had motion sickness.

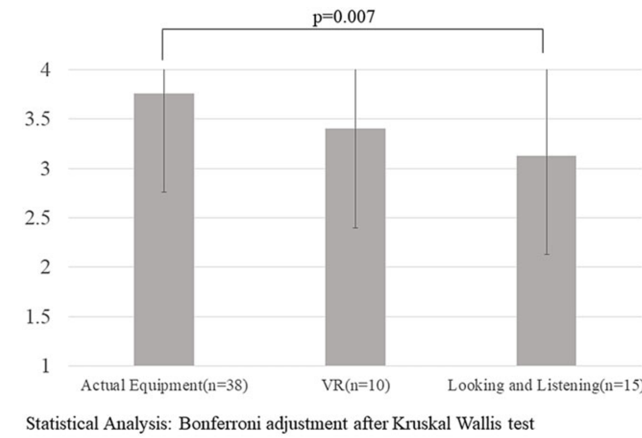

Figure 1. Comparison of Understanding level among educational devices.

There were no significant differences in understanding of the 3 lectures, "Psychological Care in Nuclear Disaster," "Previous Nuclear Disaster and Radiation Accident," and "The Road to Reconstruction after the Fukushima Nuclear Accident and Current Situation," among face-to-face and online participants (Table 1). For the practices, face-to-face was predominantly higher (mean = 3.76, SD = 0.43) than online (mean = 3.24, SD = 0.93) for the use of the GC ($P < 0.05$). However, there was a significant difference between the real device's group and the group that only viewed the operation screen and measurements: mean = 3.1, SD = 0.9, $P = 0.007$ (Figure 1). There was no difference in comprehension between the real devices group (n = 38) and VR: mean = 3.4, SD = 0.97, $P = 0.38$.

Moreover, there were no significant differences in "Putting on and Taking off protective gear," "decontamination," and "zoning and team building," but the online group had a significantly better understanding of the "practices for taking care of injured contaminated victims": mean = 3.0 (SD = 0.7) for face-to-face and mean = 3.6 (SD = 0.65) for online ($P < 0.05$). There was no significant difference in satisfaction, although the standard deviation was larger for face-to-face at mean = 3.53 (SD = 1.96) than online at mean = 3.6 (SD = 0.5).

Discussion

This study focused on the differences in educational effectiveness between online and face-to-face training and compared the understanding of each session and overall satisfaction. The results showed that the face-to-face exercise to learn about contamination detection using a GC was significantly more understandable than the online exercise, which included VR. However, there was no difference in comprehension between the real devices group and VR. The results showed that, although it is easier to understand the distance and weight of the actual instruments by using them, there is no difference in the educational effect of the VR practice and that of the real ones. In addition, it is possible that the learners were not able to learn the GC well enough because it takes time to get used to VR without experience using the head-mounted display and operating the controller, but it was suggested that some learning effect could be obtained without VR sickness.

In addition, the exercises such as medical treatment and decontamination for injured contaminated victims were

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Table 1. Comparisons of Understanding levels between face-to-face and Online

		Face to face (n = 37)	Online (n = 25)	Mann Whitney Utest *P*-value
Lecture 1	Psychological care in nuclear disaster	3.5 ± 0.59	3.6 ± 0.6	*P* = 0.81
Lecture 2	Previous nuclear disasters and radiation accidents	3.8 ± 0.5	3.7 ± 0.5	*P* = 0.7
Lecture 3	The road to reconstruction after the Fukushima Nuclear accident and the current situation	4.0 ± 0.16	3.6 ± 0.6	*P* = 0.016
Exercise 1	How to use the Geiger counter	3.8 ± 0.4	3.2 ± 0.9	*P* = 0.84
Exercise 2	Decontamination	3.7 ± 0.5	3.8 ± 0.4	*P* = 0.2
Exercise 3	Putting on and taking off protective gear	3.6 ± 0.5	3.8 ± 0.4	*P* = 0.001
Exercise 4	Zoning and team building	3.3 ± 1.5	3.5 ± 0.7	*P* = 0.019
Exercise 5	Taking care of radioactive contaminated injured victims	3.1 ± 0.7	3.6 ± 0.6	*P* = 0.001
Satisfaction of whole training program		3.6 ± 1.9	3.6 ± 0.5	*P* = 0.42

significantly better understood in the group work sessions in which participants watched video materials and learned about the roles and actions of personnel in hot and cold zones, compared to the face-to-face simulations. Most of the participants were novices in medical treatment for radiation disaster preparedness, and it is thought that group work in which they watched videos and learned what to do step by step and what to watch out for increased their understanding, as they were able to see things from a bird's-eye view rather than being there and experiencing them on site. Online training is more effective than face-to-face training because it is a session in which debriefing is combined and a wide-angle, bird's-eye view is provided to grasp the the entire picture. Some previous studies have reported better online results for disaster nursing, and it is possible that a combination of education and timing could be even more effective.[6] However, since "understanding" and "being able to actually work" are entirely different, it indeed suggests that face-to-face training after the online session would be more effective than "being able to actually work." Depending on the learner's readiness and educational goals, it is of utmost importance that the educator selects an appropriate educational method.

Limitations

It is undeniable that the educational effects in this study are partial because the method is based on subjective feedback and not a direct comparison of skills or a test of knowledge levels. In the future, more valid educational effects can be found by evaluating more variables. In addition, the incidence of motion sickness was approximately 30%. Although it depends on age and individual differences, it is difficult to eliminate motion sickness if VR is used. Future development using augmented reality (AR) is expected to reduce the induction of motion sickness to project the computer graphic onto the correct image of reality.

Conclusions

This study compared face-to-face and online REMP training. Most lecture exercises showed similar educational effects. There are no notable disparities in GC handling between VR and actual devices. For team training, step-by-step zoning discussion and video-based learning improved understanding for new students.

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Competing interests. The authors have no conflicts of interest to declare.

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