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Research paper

The educational outcomes of an online pilot workshop in CBRNe emergencies

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ABSTRACT

Background: In the past 20 years, humanity, particularly in the Middle East, has experienced three outbreaks of coronavirus disease, restricting our ordinary activities. In addition to the growing risk of chemical, biological, radiological, nuclear, and explosive incidents, discussing an alternative to the usual refresher or first-time face-to-face disaster preparedness education is necessary. This study aimed to evaluate the participants' educational outcomes following their participation in the "HazMat/CBRNe in the context of mass gatherings" online pilot workshop, which used PowerPoint® presentations, a remotely facilitated tabletop exercise, and videos.

Methods and Analysis: This was a retrospective quantitative analysis study based on the participants' pre- and post-workshop session 1 multiple choice assessment scores and their evaluation results.

Results: Although it was based on a small number of participants, the implemented workshop helped accomplish the participants' educational outcomes.

Conclusion: This study demonstrated that this online workshop helped fulfil the participants' educational needs and familiarize them with the concept of readiness and preparedness for CBRNe threats in mass gatherings; hence, it should be conducted again for other participants. The increasing worldwide use of CBRN agents in industries and bioterrorism heightens the need to ensure appropriate healthcare workers' readiness through practical, innovative continuous professional development tools in times of pandemics.

Keywords: mass gathering, online tabletop exercise, HazMat/CBRNe, preparedness, emergency training

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KEY MESSAGES

- **What is already known about this topic:** The growing risk of deliberate and unintentional chemical, biological, radiological, nuclear, and explosive events highlights the need for healthcare professional training to ensure adequate preparedness.
- **What this study adds:** Conducting online workshops using tabletop exercises and role-play represents an effective alternative to the usual refresher or first-time face-to-face disaster preparedness training format. Thus, it adds value to continuous professional development in disaster preparedness during pandemics.
- **How this study might affect research, practice, or policy:** Online tools, specifically tabletop exercises and video-based training, allow participants to express their opinions freely, discuss ideas, and achieve the training objectives with the facilitators' assistance. They are also less costly for the healthcare system to organize and deliver and ensure the participants' safety when physical distancing is needed, such as in the case of a pandemic.

INTRODUCTION

The threat of hazardous materials and chemical, biological, radiological, nuclear, and explosive (HazMat/CBRNe) incidents is growing globally. They can cause harm in different ways, including by affecting water, food, soil, and the air, spreading in public places, and potentially affecting an entire community[1]. Therefore, healthcare providers must be prepared for potential accidents or deliberate CBRNe incidents[2].

Researchers have consistently demonstrated that medical responders in the pre-hospital setting need sufficient knowledge and continuous training to manage a high-risk HazMat/CBRNe environment[2–5]. Furthermore, continuous training helps to reduce the risk of secondary contamination and increase the odds of safe and effective medical management of the related HazMat/CBRNe events[1,6]. In such incidents, mistakes can be lethal, and healthcare workers (HCWs) can rapidly become the victims instead of rescuers if deployed with poor knowledge and insufficient training. With the "fear" factor, as demonstrated in recent research[7], affecting their willingness to respond to such an event, HCWs might find themselves in a critical situation that jeopardizes patient outcomes at the disaster scene. Therefore, with Qatar's FIFA 2022 World Cup kick-off fast approaching and the growing risk of deliberate or unintentional CBRNe events, discussing an effective alternative to the usual refresher or first-time face-to-face disaster preparedness course seemed necessary.

Hamad Medical Corporation (HMC) is one of Qatar's main governmental healthcare providers. It plays a crucial role in managing major health incidents in coordination with all other governmental and non-governmental healthcare agencies and providers. Therefore, with Qatar hosting many mass gathering events, like the FIFA World Cup 2022, public and private healthcare partners must empower their medical personnel with the appropriate knowledge and skills to manage potential HazMat/CBRNe incidents.

HMC, for the past three years, has organized the Qatar Health Conference as an international multidisciplinary academic assembly open to healthcare professionals and experts from different backgrounds and countries. It has focused on aspects related to preparation for the FIFA World Cup 2022, such as mass gatherings, mass casualty incidents, trauma, sports medicine, and public health[8–10]. Due to the COVID-19 pandemic, the conference was held online in 2021 and 2022 to ensure participants' safety[9,10]. In line with the conference's topics of interest, HMCAS (Hamad Medical Corporation Ambulance Service) conducted a newly designed online workshop entitled "HazMat/CBRNe in the context of mass gatherings"[10].

This study aimed to evaluate the participants' educational outcomes following their participation in the "HazMat/CBRNe in the context of Mass gatherings" online pilot workshop, which used PowerPoint® presentations, a remotely facilitated tabletop exercise, and videos.

METHODS

Study Design

The "HazMat/CBRNe in the context of mass gatherings" pilot workshop was held for the first time on February 9, 2022, during the Qatar Health 2022 International Conference. This pilot workshop (Figure 1) was held online for over five hours (including the pre-registration and the breaks). It was accredited by the Department of Health Professions (DHP) of the Qatar Ministry of Public Health for continuing professional development (CPD) credits. It aimed to discuss the management and

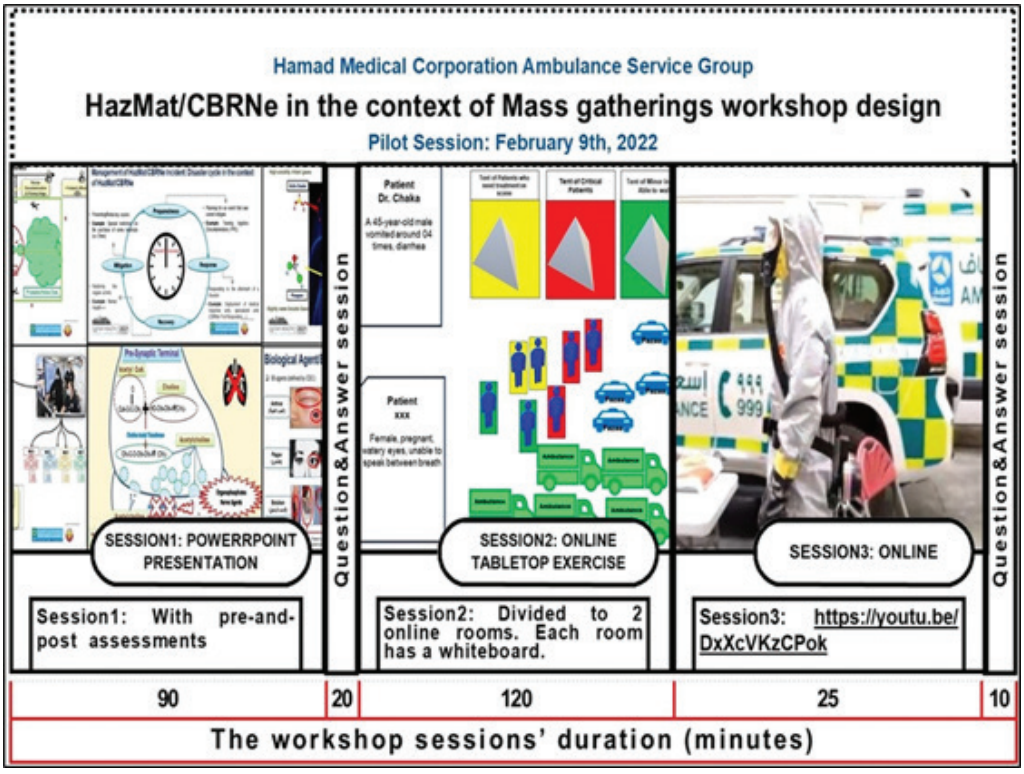

Figure 1. HazMat-CBRNe in the context of mass gatherings workshop leaflet.

response of HazMat/CBRNe incidents during mass gathering events in the pre-hospital setting and emergency departments. Only a maximum of 20 participants could register for the pilot workshop to ensure it is interactive and of high quality. The workshop included three sessions:

– *Session 1*: PowerPoint® presentation.
– *Session 2*: Online tabletop exercise.
– *Session 3*: Pre-recorded video.

Session 1: PowerPoint presentation

Fifty five slides entitled "Medical Management of CBRN Emergencies in the pre-hospital setting" were presented over 45 minutes, followed by 20 minutes of Questions and Answers session. This session aimed to describe the differences between deliberate and unintentional CBRNe events from the medical perspective. The PowerPoint® presentation helped explain the risks of secondary exposure of HCWs to CBRNe agents and the pre-hospital and emergency departments' medical response during mass gathering emergencies. Furthermore, pre- and post-*session 1* multiple choice questions (MCQ) assessments were conducted online on the same day as the training activity.

Session 2: Online tabletop exercises (https://hassans-organization.gitbook.io/online-cbrne-workshop-tabletop-sessions-scenarios/)

Participants were divided into two groups ensuring that both groups had similar numbers of physicians, paramedics, and nurses. Each group was allocated to an online room with an online whiteboard on which participants could interact with each other (Figure 2). Four scenarios were prepared for this interactive activity, and each group could select two scenarios for two hours.

An annexure to the participants' scenarios handout explained the Emergency Response Guidebook mobile application utilization. The scenarios (Supplementary materials) are explained as follows:

– *Scenario 1*: "Bioterrorism? Exposure to a biological agent?": A hospital in a small town called "HazChem" received many patients with similar infection symptoms a few hours following a rock concert in the city.

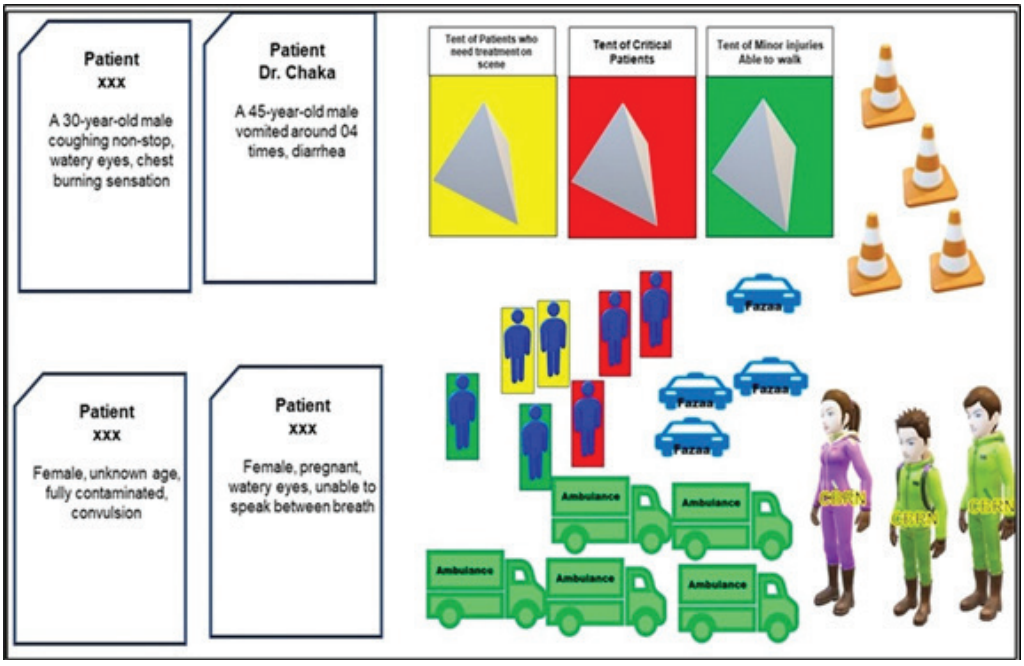

Figure 2. Examples of the workshop materials.

- *Scenario 2*: "Terrorist attack in HazChem town, Convention Centre Metro station": Many travellers started to suffer from sudden neurological and respiratory distress symptoms in the underground metro station. A suspicious unattended bag was observed. This scenario included a call-taking part (a witness called the emergency number) simulating the protocol utilized by the HMCAS call center[6]. Participants performed a role-play during this session. The metro station was designed based on Qatar's metro stations' layout.
- *Scenario 3*: "Is it a communicable disease or intoxication scene?": Many conference attendees suddenly developed symptoms of acute diarrhoea and vomiting, bloody for some, following a welcome honouring international guests, including some coming from countries with an increased number of Ebola virus disease cases. A call-taking phase to the emergency call center was also included, during which participants engaged in a role-play activity.
- *Scenario 4*: "Chemical incident leakage in a plant near a football stadium": Leakage of chlorine gas in a chemical plant on a windy day, with exposure of the workers in this industrial facility causing a burning sensation in their nose, throat, and eyes. Meanwhile, a soccer football match was ongoing downwind, a few kilometres away from this plant. The "HazChem town" hospital emergency department also received many victims with the same respiratory symptoms. Some of them came directly from the football game in a panic state. A call-taking phase was included, and participants engaged in a role-play activity.

Session 3: Online video

A 25 minutes video (https://youtu.be/DxXcVKzCPok) was prepared to introduce the Sarin subway attack in Tokyo in 1995[11] and present the types of decontamination equipment used by HMCAS as well as the donning and doffing techniques of the Level C protection HazMat.

Participants and Sampling

In this study, purposive sampling was performed. The "HazMat/CBRNe in the context of mass gatherings" workshop targeted all HCWs with experience in disaster preparedness and response. The workshop's agenda on the online registration web page explained the requirements. The participants were requested to indicate their institution, roles, and background when registering for the workshop to ensure attending it was relevant for them. In Qatar, the DHP of the Ministry of Public Health validates the participants' attendance certificates for the attended CPD activities only if the workshop or training attended was relevant to their background[12]. Furthermore, all participants who

registered and attended the online workshop were included in this study. The participants who could not attend the entire workshop were excluded from the relevant part of the analysis.

Interventions

This study is based on a retrospective quantitative analysis of the pre- and post-*session 1* MCQ assessments and participants' satisfaction survey conducted in this workshop. In addition, an analysis of the workshop's educational concepts was performed.

Pre- and post-session 1 assessments

The pre- and post-*session 1* assessments were prepared as MCQs (Pre-session 1 assessment: https://forms.office.com/r/DNYQa7kyKG and post-session 1 assessment: https://forms.office.com/r/KLvtSy20e2). They had different sets of questions; the pre-session 1 assessments' questions were about general information on the management of HazMat/CBRNe mass casualty incidents. The post-*session 1* assessment questions were about the content of the session's PowerPoint®. They aimed to measure the impact of the PowerPoint® presentation on the participants' knowledge. Each one of the MCQ assessments had 10 items. The items were judged to be of a similar difficulty level. Each question had three distractors and one correct answer. The workshop facilitator leader initially prepared them; then, each question was validated by the workshop's scientific planning committee (SPC) by verifying and judging their relevance to *session 1*'s objectives. The SPC included medical doctors, paramedics, and nurses experienced in disaster management (particularly in CBRNe) and medical education.

Participants had 15 minutes to complete each assessment individually. In the pre-*session 1* assessment, we also asked participants to provide demographic information (age, sex, profession, institution, number of years of healthcare experience, and if they received any previous training about HazMat/CBRNe). The participants were asked to use a "nickname" instead of their real names and re-utilize the same during the post-*session 1* assessment to match responses for analysis. Participants were informed that the assessment results would be utilized for evaluation purposes and were not a pass–fail assessment.

Session 2: Online tabletop exercise evaluation

For workshop *session 2* ("Online tabletop exercise"), the evaluation was based on the facilitators' observation of the participant's performance during the interactive activity. The facilitators received training about the management of CBRNe incidents and experienced working with the HMCAS CBRNe first responder team. They kept the discussion session moving and intervened only to redirect it to meet the intended objectives by clarifying or introducing elements in the scenario. Participants were encouraged to improvise, express their ideas, and share their plans, for there were multiple acceptable answers to each scenario's questions. As the grid matrix (Table 1) mentioned, the facilitators helped them restructure their ideas and validated session 2 learning objectives.

Post "HazMat/CBRNe in the context of mass gatherings" pilot workshop satisfaction survey

From February 10th until March 15th, 2022, all the participants in the "HazMat/CBRNe in the context of mass gatherings" pilot workshop were requested to respond to a satisfaction survey. This survey aimed to evaluate the participants' satisfaction with the topics discussed during this workshop.

The survey included two demographic questions, eight five-Likert scale questions about their opinions concerning each workshop's session, and one question asking their suggestions for improvement. The survey remained accessible for one month after the workshop with weekly e-mail reminders. Participants had to answer it so they could collect their CPD certificate. The same SPC panel validated the survey by judging whether the questions appropriately and relevantly covered the concept we intended to measure or not[13]. Due to COVID-19 pandemic restrictions, the panel meeting was held online.

Statistical Methods

Python® for data science software was utilized in this study.

Firstly, the normality distribution of both assessments' scores (the pre- and post-*session 1* assessments) was assessed. The Shapiro test was utilized to assess the normality distribution[14]. Then, based on the results, the confidence interval and the *p*-value of the Student's t-test for the paired groups (pre- and post-*session 1* MCQ assessments' scores) were calculated to measure the PowerPoint®

Table 1. Online tabletop (session 2) objectives evaluation grid.

Online tabletop session's objectives:		Scenario 1 ☐			Scenario 2 ☐			Scenario 3 ☐			Scenario 4 ☐		
		(V = Validated; NV = Not Validated; NA = Not Applicable)											
		V	NV	NA	V	NV	NA	V	NV	NA	V	NV	NA
1. Practising emergency call-taking: Caller–call taker role-play													
2. Initial METHANE Report	**M**ajor incident declared/standby												
	Exact location												
	Type of the incident												
	Hazards involved (name)												
	Access and egress to the location												
	Number and type of victims												
	Extra resources needed												
3. Update of the METHANE as per the changes													
4. Establishing of initial command structure													
5. Establishing of Gold/Silver/Bronze command structure													
6. Identification of HazMat-CBRN scene	Deliberate												
	Unintentional												
7. Identification of the HazMat-CBRN agent	UN number												
	Name												
	Contagious diseases												
8. The utilization of the Emergency Response Guidebook mobile application													
9. Determination of safety distance	Initial solation distance												
	Initial protection zone distance												
10. Triage	Green												
	Yellow												
	Red												
11. PPE identified													
12. Decontamination on scene													
13. Decontamination in the emergency department													
14. Antidote identified													
15. Debriefing													

presentation's impact on improving their knowledge level[6]. The pre-and post-*session 1* assessments' averages with their standard deviation were also calculated. The standard deviation was determined to measure the degree of the individual scores' dispersion around the mean. They would be considered clustered around the mean for a low standard deviation and spread out of the mean for a high standard[15].

Secondly, for the post-workshop satisfaction survey, the inter-item's internal consistency was assessed by calculating the Cronbach's alpha coefficient to measure the inter-item's reliability. The aim of assessing the survey's reliability is to determine whether the survey remains consistent over repeated trials under similar circumstances[16]. The survey would be considered poorly reliable if Cronbach's alpha < 0.6, satisfactory if $0.6 \leq$ Cronbach's alpha < 0.9, and excellent if Cronbach's alpha ≥ 0.9[16,17].

Subsequently, a descriptive data analysis was performed for the post-workshop satisfaction survey. During the analysis, the items were grouped into the following themes: educational content, professional practice, impact on performance knowledge, competence and patient safety, selection of the topics, questions and discussion, relevance to practice, and overall quality. The demographic data were also analyzed.

RESULTS

Twenty participants were registered; 19 were from different institutions in Qatar (Qatar Petroleum State, Qatar Gas Company, HMC, and private sector), and 1 was from the United Arab Emirates. There were six medical doctors, five paramedics, seven nurses (including three nurses undergoing their PhD studies), one manager in emergency preparedness, and one administrative staff, both with critical care paramedic backgrounds and currently working in disaster management. Twelve participants attended the workshop and completed the pre-and post-*session 1* assessments and hence were included in this study. It included three female and nine male participants. Four of them were from Qatar's governmental health sector (HMC), while the others were from the private sector with nursing backgrounds. Their mean age was 39 years (standard deviation = ±11.52). The average number of years of work experience in healthcare was 12.92 years (standard deviation = ±7.75). Before this workshop, only two participants had received previous training in the HazMat/CBRNe field. Eleven participants completed the workshop's satisfaction survey.

The pre- and post-*session 1* assessment scores for each participant are presented in Figure 3. The Shapiro test to assess the normality distribution was calculated. According to Figure 3 and the *p*-values of the pre- and post-*session 1* assessment scores (*p*-value = 0.02 for each), both assessments' scores were not normally distributed despite the logarithmic transformation[14]. Therefore, the paired group's non-parametric test was conducted using the Wilcoxon ranked test. It generated a *p*-value >0.05 with a 95% confidence interval (CI) between 0.52 and 0.69, indicating that the difference in median scores was independent of one another, noting that the Wilcoxon Ranked test would determine a more robust and accurate *p*-value as the sample size increases[18]. Hence, we cannot conclude that session 1 impacted the participants' level of knowledge. Thus, in Figure 3, there were no statistically significant differences between most participants' pre- and post-*session 1* assessment scores. Moreover, the pre-*session 1* assessment mean score was equal to 6.16 with a 95% CI between 4.95 and 7.37. The post-*session 1* assessment's mean score was equal to six with a 95% CI between 4.58 and 7.41.

For the tabletop session 2 online exercises (Session 2), the facilitators ensured that the objectives mentioned in the evaluation grid in Table 1 were achieved whenever applicable.

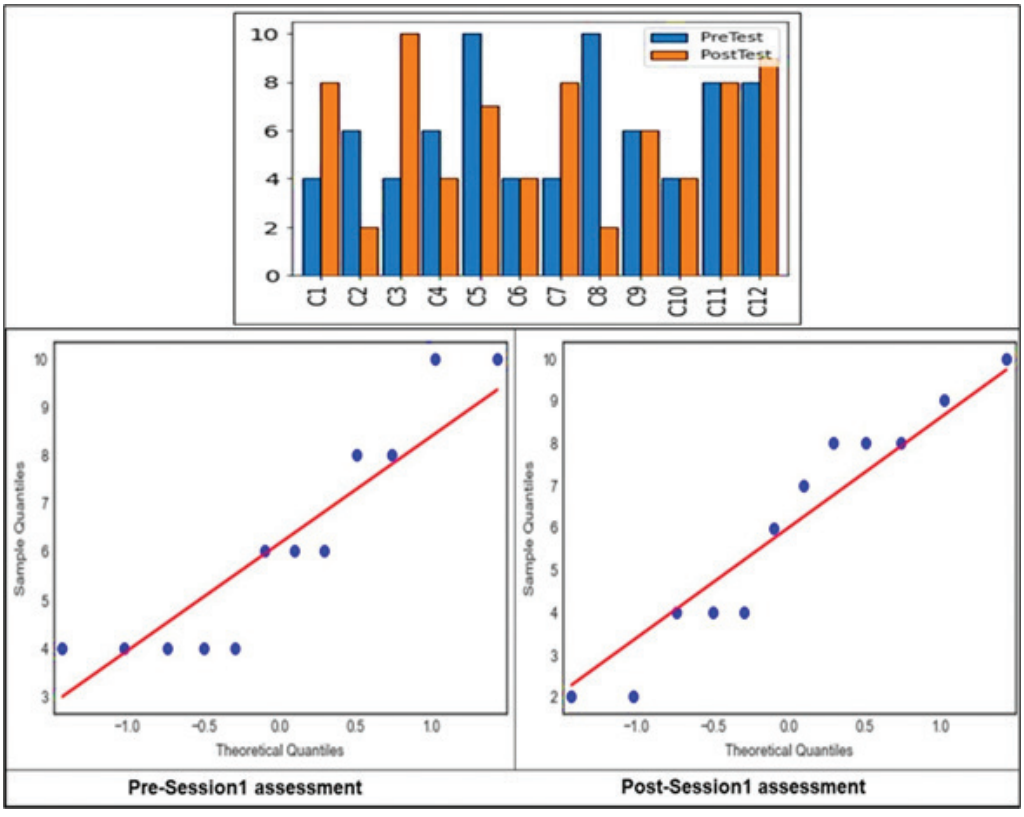

Figure 3. Pre- and post-workshop *session 1* assessment results.

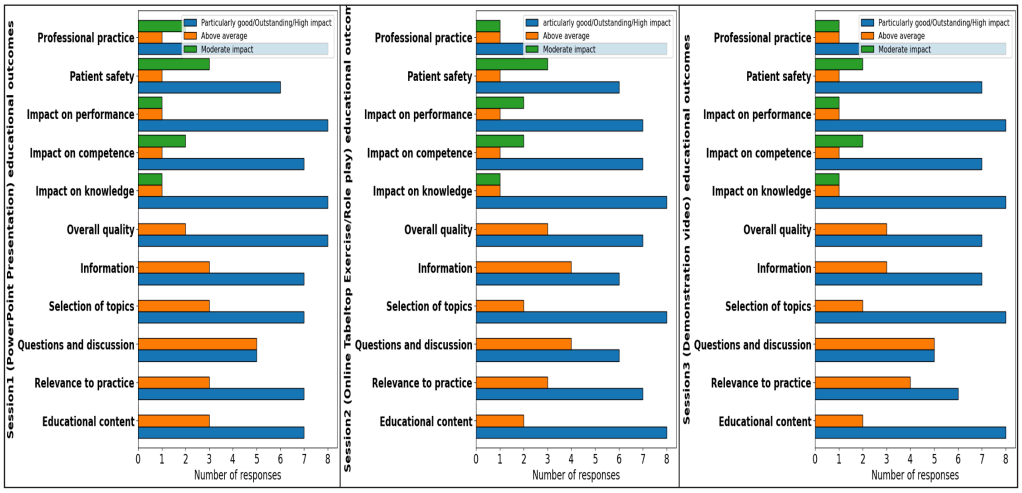

Figure 4. Evaluation of the HazMat-CBRNe in the context of mass gathering workshop by the participants.

For the post-workshop satisfaction survey, Cronbach's alpha was determined. It was equal to 0.89 with 95% CIs between 0.77 and 0.96, indicating that this survey has a good reliability. The survey's items were grouped according to the theme they were assessing. The participants' responses regarding their level of satisfaction with the various components of the workshop are shown in Figure 4. In addition, 70% of the participants considered that both facilitators were knowledgeable, organized, and effective in their presentations during the three workshop sessions.

DISCUSSION

In this study, the impact of *session 1* on the participants' level of knowledge was not conclusive, as some obtained lower scores. In addition, the evaluation grid in the *session 2* tabletop exercises helped to validate 100% of the predetermined learning objectives. Furthermore, the satisfaction responses in this *session 2* confirmed their enthusiastic participation observed by the facilitators during the activity. The videos in *session 3* were perceived positively by the participants.

Firstly, research in different fields has demonstrated that PowerPoint® presentations are the most widely utilized tool in education. Their importance seems undeniable, as they help provide visual support for the instructor. It helps establish an appropriate connection between what the instructor is trying to say and what the participants should receive[19,20]. Other research also demonstrated that colors are vital in helping learners retain information in their memory. We ensured that the slides were appropriately colorful (Figure 5)[21].

However, PowerPoint® presentations are not the best educational approach to ensure information retention[21]. The learners usually receive a lot of verbal information in a limited time, making it challenging to retain much of it. Some researchers have called the PowerPoint® presentation "lazy profs, lazy students and lazy public speakers"[21]. Eighteen participants remained seated for an extended period (45 minutes in the study workshop *session 1*), listening and trying to store the information provided in 50 slides. This would explain the lower post-workshop *session 1* assessment scores (Figure 3), considering that 70% of the participants confirmed that both facilitators were knowledgeable, organized, and effective in their performance. In addition, despite the attractive animation used in the PowerPoint® presentation, a single slide with one picture can sometimes provide much information (Figure 5). The slide design becomes too distracting, and participants might lose concentration (Figure 5), making the valuable information less meaningful. The pre- and post-*session 1* assessments reflected this idea as no gains in knowledge were noticed. The difference between assessment scores for the participants is variable, sometimes negative, and not statistically significant.

Secondly, as a novel approach due to the COVID-19 pandemic, *session 2* of the online tabletop exercise seemed well perceived by learners, particularly in the disaster preparedness and response teaching domain. Participants could participate actively, discuss their ideas, brainstorm together, and figure out the most appropriate plan for each situation. In *session 2* of the online tabletop

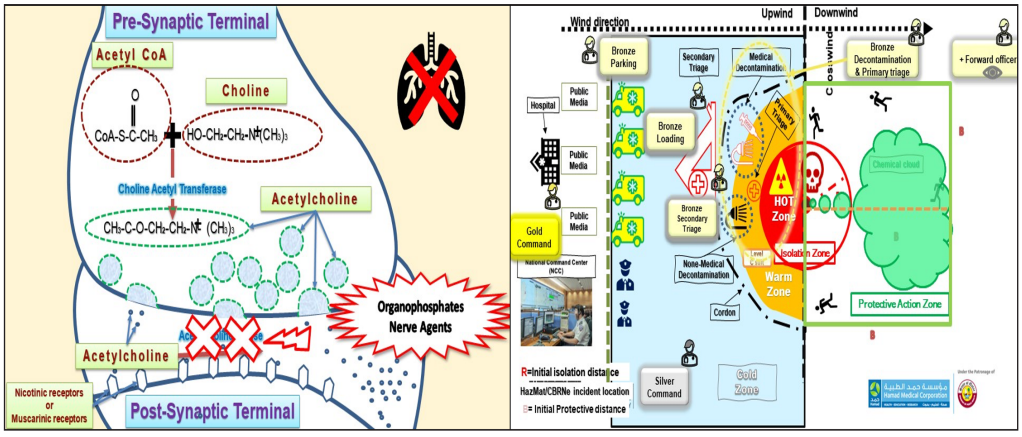

Figure 5. Example of *session 1* slides.

activity, participants could ask questions continuously and discuss the potential answers among themselves. This enabled them to strengthen their active strategic thinking abilities within the scope of the workshop's objectives[22]. It was well complemented by the evaluation grid presented in Table 1. Some studies have demonstrated that the participation of HCWs in a few tabletop exercises yearly helped them enhance their readiness for major incidents[23–25]. In addition, compared to the more traditional full-scale simulation activities, tabletop exercises are less costly, less resource-intensive, and injury-free for learners. Full-scale simulation exercises are often more time-consuming to organize and run over a more extended period of time because of the resources that have to be deployed for "real"[26,27]. This could emphasize accomplishing tasks no matter what, rather than giving enough time for the participants to think and act and step back when needed to rebuild strategies.

Furthermore, we demonstrated that space and distance no longer limit organizing such tabletop sessions. The COVID-19 pandemic helped us to explore not only telemedicine but also "tele-education" to a greater extent than before. Moreover, by utilizing more tools such as the online whiteboard, several participants from different countries in this study could be actively engaged and place the prepared shapes around the incident's scene, create new elements, and redesign their response plan as required (Figure 4) in a fashion similar to visually enhanced mental simulation[28].

Thirdly, video-based teaching has become a preferred tool compared to the traditional teaching methods in the last few years[29]. It has been demonstrated that learners can gain more knowledge from video-based education than when using more traditional educational techniques[29]. Hence, established in 2005 as a video sharing site, YouTube® has often been favored as an educational platform in the health sciences field in recent years[30–32]. With 2 billion monthly active users[33], YouTube® contributes to dissemination of medical-related information. However, these videos may also provide the users with inaccurate information and compromise the quality of education offered[34]. In this study's *session 3*, the facilitators utilized a video by CAN Insider® to introduce the sarin attack in Tokyo's metro station in 1995[11]. In addition, the facilitators created a video to demonstrate the donning and doffing technique and the decontamination equipment used locally and uploaded it online (https://youtu.be/DxXcVKzCPok). The feedback from participants showed a high level of satisfaction with the educational content of the video in *session 3* (Figure 4).

LIMITATIONS

The surge response to the COVID-19 pandemic wave at the beginning of 2022 contributed to the lower participation of the 20 registered participants in the workshop. In addition, the considerable number of users connected simultaneously on the various online workshops offered as part of the Qatar Health 2022 International Conference seemed to have caused connectivity issues for some users. As a result, some participants could not connect or remain online for the entire workshop. Overall, this impacted the number of participants and limited the analysis of *session 1* outcomes, including regression analysis. With insight, to better evaluate the educational value of each session of the workshop, it would have been interesting to get some participants to complete the post-educational intervention assessment after *sessions 2* and *3*. This would have necessitated a much higher number of participants to enable a valid statistical analysis.

CONCLUSIONS

The COVID-19 pandemic stimulated greater adoption of online platforms to deliver education and training. The "HazMat/CBRNe in the context of mass gatherings" workshop has demonstrated that conducting online tabletop exercises in disaster preparedness and response is feasible and helps achieve valuable educational outcomes, as shown by the evaluation survey responses. With the increasing worldwide threat of HazMat/CBRNe incidents and the regular occurrence of organized mass gathering events all over the world, and in particular in the Middle East and North Africa region (Hadj, FIFA World Cup 2022, sporting events, and political marches), the delivery of such training activities seems to be a must to improve the medical response to potential HazMat/CBRNe events at the national and international level. We plan to deliver the same workshop several times in the future with some minor improvements to evaluate the educational impact of each of its components properly and with sufficient numbers of participants.

ETHICAL CONSIDERATIONS

The retrospective study was reviewed by the Institutional Review Board and approved by the HMC Medical Research Center (Ref: MRC-01-22-196). It was conducted according to the guidelines of the Declaration of Helsinki.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

FUNDING

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DATA SHARING STATEMENT

The data is available with the principal author and can be provided upon special request.

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