2018

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APA Citation

Abualenain, J., & Al-Alawi, M. (2018). Simulation-based training in Ebola Personal Protective Equipment for healthcare workers: Experience from King Abdulaziz University Hospital in Saudi Arabia. *Journal of Infection and Public Health,* (). http://dx.doi.org/10.1016/j.jiph.2018.05.002

Journal of Infection and Public Health xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Infection and Public Health

journal homepage: http://www.elsevier.com/locate/jiph

Simulation-based training in Ebola Personal Protective Equipment for healthcare workers: Experience from King Abdulaziz University Hospital in Saudi Arabia

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ARTICLE INFO

Article history:
Received 14 January 2018
Received in revised form 10 April 2018
Accepted 2 May 2018

Keywords:
Simulation
Personal Protective Equipment
Training
Ebola

ABSTRACT

Background: Millions of Muslims from across the world gather annually to perform pilgrimage. This can import unusual communicable diseases such as Ebola. Communicable diseases with a high risk of mortality necessitate special training to master the required competency to avert transmission of infections. The efficacy of simulation-based training (SBT) has been shown in such circumstances.
Objective: We sought to develop an SBT program in Ebola Personal Protective Equipment (PPE) for all healthcare workers (HCWs).
Methods: We conducted a quasi-experimental study at the clinical skills and simulation center at the King Abdulaziz University. An interdisciplinary committee was formed to develop this program in three stages. Pre-intervention: Needs assessment "Diagnostic drill"; we conducted in-situ simulation in the emergency department (ED). High-fidelity simulator (HFS) was used as a suspected Ebola case to assess HCWs' competency of PPE. We used a checklist that was developed in accordance with the national and international guidelines. We then conducted "Train the Trainer in Ebola PPE" course to develop potential instructors. Intervention: PPE competency SBT courses. This involved focusing on trainees to be skilled in Ebola PPE and becoming trained observers using skill stations and Ebola scenario with HFS, followed by debriefing. All courses gathered participants' evaluations, pre, and post-tests. Post-intervention: In-situ simulation in the ED two months later that was similar to the diagnostic drill.
Results: Pre-intervention: 7 HCWs were involved in the drill, the average score was 37% of the checklist items. For train the trainer, 19 potential PPE instructors attended the program; of them, 65% were female and 35% male, and 6 were physicians and 13 nurses. Average pre and post-tests scores were 72% and 86%, respectively. Intervention: 10 PPE courses that were attended by 179 HCWs; of them, 67% were female and 33% male, and 52 were physicians, 112 nurses, and 15 others. Pre and posttests were 67% (57–75%) and 85% (81–91%), respectively, with a p-value < 0.01. Post-intervention: Post Program drill's average score was 86% of the checklist items (37% in diagnostic drill).
Conclusions: Using SBT could be an effective method of developing competent HCWs in Ebola PPE.

Introduction

Background and importance

In numerous circumstances, the geographic location of the city or the hospital places healthcare workers (HCWs) at risk of acquiring infections, through dealing with highly contagious cases, if they are not prepared or equipped to lever such risk without adequate training. This can affect the security of any country, alerting leaders

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https://doi.org/10.1016/j.jiph.2018.05.002

to assertively assess and mitigate such risk. In Saudi Arabia, approximately 3 million Muslims from across the world gather annually to perform pilgrimage and Umrah. This major influx of hajjis to Saudi can effortlessly import unusual communicable diseases such as Ebola virus disease (EVD).

Rare communicable diseases that are not frequently encountered by HCWs necessitate special training to master the required competency to avert transmission to staff and other patients, in order to maintain a safety culture within the healthcare system [1]. EVD is one of the infections that mandate special training, especially after the largest Ebola outbreak that West Africa suffered from 2014 till 2016 when the Health Organization (WHO) declared the outbreak to be over. The latest report states that there were about 27 thousand confirmed, probable, and suspected cases of Ebola, with around 11 thousand reported deaths. Moreover, a total of 869 confirmed HCW infections, with 507 reported deaths [2,3].

Simulation-based training (SBT) has been used in many medical specialties to establish competencies in skills essentials to the medical practice. Simulation can mimic various clinical scenarios that are designed to address specific objectives and can integrate knowledge to practice, allowing trainees to assess their performance in virtual sitting where they can identify the areas that need improvement and build up self-confidence when dealing with similar real-life cases. One of the invaluable advantages of simulation is the ability to replicate rare and highly infectious disease cases in a safe, yet challenging, environment without jeopardizing anyone's safety [4–6]. Furthermore, high-fidelity simulator (HFS) can assess the progress of the learners (from novice to expert level) in accordance with Miller's pyramid for clinical competency, which is an essential pillar for training and assessment [7].

Study objective

In this study, we sought to develop an SBT program in Ebola Personal Protective Equipment (PPE) for all HCWs in King Abdulaziz University Hospital (KAUH) as a continuous effort for preparedness, patient's safety, and crisis management. Utilization of HFS and scenarios mimicking real case encounters would create a high level of realism. This will ensure that we simulate the real challenges that the HCWs face when caring for Ebola cases and will aid in assessing whether HCWs would maintain PPE during case encounter.

Materials and methods

Design and settings

This is a quasi-experimental study that was conducted from March to October 2016 in the clinical skills and simulation center (CSSC) at KAUH. Leaders in KAUH, along with the leaders of CSSC, recognized the urgent needs to be prepared for Ebola. Part of the organization's risk mitigation strategy is to establish simulation-based infectious diseases training program to ensure the safety of the staff, students and patients. KAUH is a 1002 tertiary academic care center located in Jeddah, Saudi Arabia (50 miles from Mecca). CSSC is a well-recognized SBT center both nationally and in the Middle East. It was recently internationally accredited by the two most prestigious bodies in the field of simulation: The Royal College of Physicians and Surgeons of Canada and The Society for Simulation in Healthcare. In addition, CSSC was awarded the ASPIRE trophy for "Excellence in Simulation" at the Association for Medical Education in Europe's (AMEE) 2017 International Conference on Medical Education in Finland.

Initially, an interdisciplinary committee was formed (15 members; 8 physicians and 7 nurses. Two members are from Infectious Diseases Unit) to develop the PPE program under the guidance of KAUH and CSSC leadership. The committee met a couple of times until they developed the structure of the program and the implementation plan. This work was reviewed and approved by KAU's research ethics committee. Like any other activity that takes place in CSSC, all participants in the program signed a confidentiality agreement and consented to participation as per the CSSC's policy and procedures. The PPE program consisted of three stages: pre-intervention, intervention, and post intervention.

In the pre-intervention stage, we started by needs assessment, i.e., "Diagnostic drill," using the concept of in-situ simulation in which the simulation is conducted at the workplace instead of the regular training center [8]. Seven members from the CSSC brought portable audiovisual equipment and HFS with its vital signs monitor to the triage area of the emergency department (ED) as a suspected Ebola case with the following scenario: "a 45-year-old Saudi male referred from a private clinic by Red Crescent accompanied by his brother and a paramedic technician; the patient endorsed as a suspected Ebola case. He recently arrived from a trip to Sierra Leone, complaining of fever, epistaxis and frank bleeding from the nose for three days, and general fatigue (moulage for epistaxis applied to manikin)." The aim was to assess the HCWs competency of Ebola PPE (donning and doffing) and maintain its integrity during triaging the patient, transferring to an ED room, management, and the admission/consultation process. A checklist for Ebola PPE was developed internally in accordance with national and international guidelines to evaluate the event. (Appendix A) It was used by two raters (instructors) independently, who observed the drill live on video.

After the needs assessment, we proceeded to the development of potential instructors through "Train the trainer in Ebola PPE" course. This was a one-time course that took place at the CSSC to develop PPE course instructors. The participants of this course were personally selected by CSSC leaders from different specialties. The selection was based on prior knowledge of the candidates' skills in teaching and experience with simulation training. The course focused on essential skills of SBT, basic debriefing, and Ebola PPE principles. Candidates initially went through Ebola PPE "donning and doffing" competency checklist station to become trained observers. Afterward, the candidates were divided into two groups to go through two HFS PPE sessions. The scenarios were for a suspected Ebola case; stable vital signs, in ED settings which later deteriorates, requiring aggressive interventions (airway protection, central venous access, or cardiopulmonary resuscitation). Additionally, there was a family member who is exposed to the suspected case and also being disruptive to the medical team. Each session was followed by group debriefing. We used recorded videos of candidates' performance to facilitate the discussion and to point out the errors encountered during the session. Trainees reflected on how they thought on self-performance, things that went well, and things that need to be improved in the future, by reviewing and reflecting on the videos. Written pretest and posttest were conducted (Appendix B).

In the intervention stage, we conducted PPE simulation-based competency training courses for HCWs. Here, the emphasis was on trainees to be skilled in Ebola PPE, as well as becoming trained observers, using skill stations (instructors with checklist and video). Participants went through two HFS PPE scenarios, followed by group debriefing. The focus was placed on maintaining PPE integrity during HFS case contact. The scenarios were similar to the ones conducted for "Train the trainer for Ebola PPE." At the end of each session, a debriefing session was conducted where the trainees reflected on their performance (as described above). Written pretest and posttest were conducted for each course. In this stage, invitations were sent to all clinical departments' heads, including nursing department, in the hospital. The invitations listed the dates for the PPE courses and encouraged each department to

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send their HCWs to attend the PPE course at any of the assigned dates. CSSC was responsible for balancing the participants' list such that there are enough physicians to be able to run the scenarios in a realistic way that mimics real patients' encounters. The courses were directed and instructed by CSSC leaders who are simulation experts and leaders from the Infectious Disease Unit. Additionally, six co-instructors who attended "Train the Trainer for PPE" course participated in the course's instructions.

In the post-intervention stage, we conducted post-program evaluation. The program's organizing committee decided to evaluate the impact of the courses on the ground. Around two months from the last course, an Ebola drill took place in the ED using in-situ simulation (similar to the diagnostic drill). The same checklist was used by two raters (instructors) independently to assess HCWs' competency of Ebola PPE (donning and doffing) and maintain its integrity during the whole encounter.

Statistical analysis

Data coding was carried out manually and analyzed using Stata Version 13.0 (Stata Corp, College Station, Texas, USA). The descriptive analysis of the quantitative data for categorical variables was presented by using frequencies and percentages. Paired t-test was used to assess the difference between pretest and posttest among participants. The significance level was set at $P \leq 0.05$.

Results

Pre-intervention: The diagnostic drill was conducted by nine CSSC members: two instructors, two nurses, and five simulation-IT technicians. Seven HCWs participated during the Ebola diagnostic drill; four were from the ED, and three were from the intensive care unit (ICU). Using the checklist, the average score for the involved HCWs was 37% of the "donning and doffing" checklist items. For the potential PPE instructor's course, 19 candidates completed "Train the Trainer in PPE" course. The group included 65% female and 35% male participants, and six physicians and 13 nurses. They were from the following departments: six were from ED, five ICU, one infection control, and eight nursing. Average pre and post-tests scores were72% and 86%, respectively. Six instructors became regularly involved in PPE courses.

Intervention: A total of 10 courses were conducted during the study period. The total number of participants was 179 HCWs; of them, 67% female and 33% male. Of the total participants, 112 were nurses, 52 were physicians who attended from different specialties, and 15 were in the "others" category. The detailed characteristics of HCWs who attended these 10 courses are shown in Table 1. Pre-test and post-test cumulative scores for the participants in the 10 courses improved significantly (p-value < 0.01) and were 67% (57–75%) and 85% (81–91%), respectively. (Fig. 1) Of note, even though all 179 HCWs completed the Ebola PPE checklist, about half compromised (different levels of compromising) the PPE protocol at some point during HFS Ebola encounters in order to care for the case. Post-intervention: Score of the Ebola post-program drill was 86% of the checklist items. (Fig. 2)

Table 1
Characteristics of healthcare workers who participated in Phase 3.

	N = 179 (%)
Female	120 (67%)
Male	59 (33%)
Physicians	<52 (29%)
Emergency medicine	28 (54%)
Anesthesia	15 (29%)
Pediatrics	2 (4%)
Intensive care unit	4 (8%)
Internal medicine	3 (6%)
Nurses	113 (63%)
Ward, clinics, and non-critical	64 (57%)
Critical care	35 (31%)
Emergency department	14 (12%)
Technicians	14 (8%)
Paramedics	10 (71%)
Anesthesia tech.	1 (7%)
Others	3 (22%)

The staff has acknowledged the following during the course's evaluations: the essential need to provide, on a regular basis, infectious-disease SBT, as SBT courses helped them feel more confident, prepared, and met their educational needs.

Discussion

In response to the rising worldwide anxiety in view of the Ebola epidemic in West Africa, the leaders in KAUH and CSSC called for urgent SBT for all frontline HCWs. A multidisciplinary team conducted the program over 3 stages (pre-intervention, intervention, and post-intervention). The needs assessment reflected our gaps and HCWs' vulnerability, as the average score using our check-

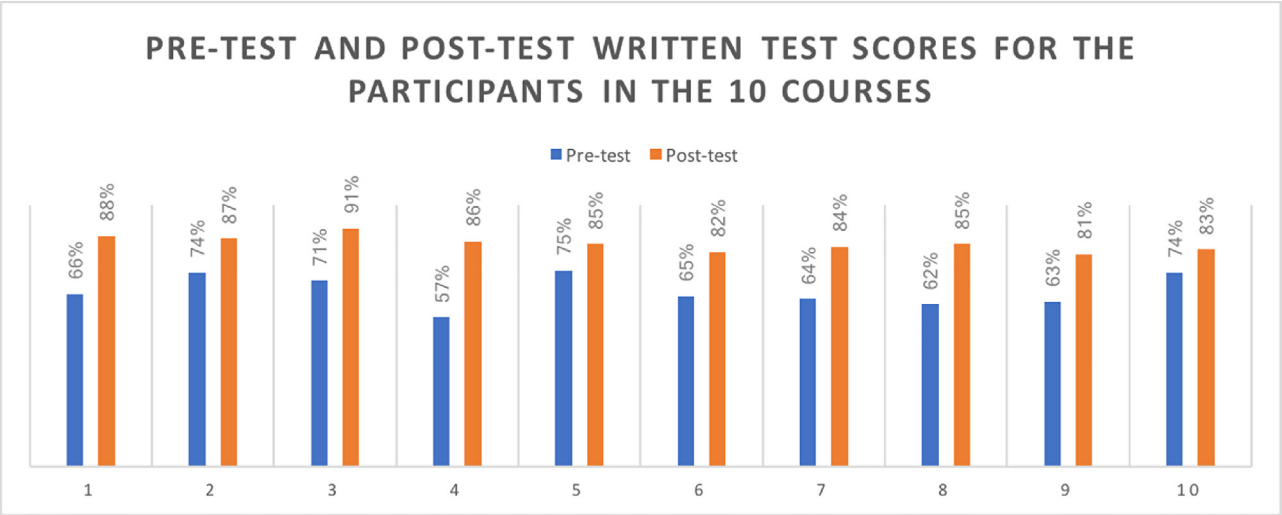

Fig. 1. Pre-test and post-test written test scores for the participants in the 10 courses.

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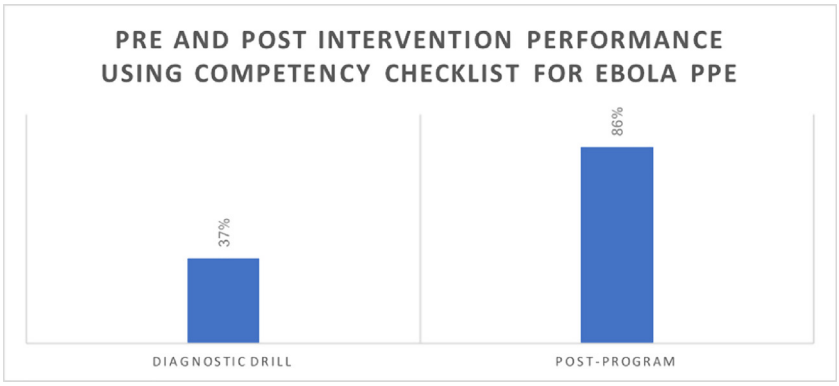

Fig. 2. Pre and post-intervention performance using competency checklist for Ebola PPE.

list upon encounter suspected case of Ebola was 37%, which was improved significantly after 10 courses (intervention stage). These courses were successfully conducted by the CSSC team and six co-instructors who received training for PPE course and were certified as instructors. Investment on our HCWs and supporting them to become instructors/educators were one of the invaluable outcomes of this program. Upon conducting the post-program Ebola drill (post-intervention), a couple of outcomes were achieved: HCWs scored 86%, being able to identify suspected Ebola case promptly, allocate the required PPE, and having the confidence to deal with EVD.

Donning and doffing are skills that can be mastered through competency-based training. However, maintaining these skills during critical situations is not guaranteed. This was one of our observations during the courses. Many candidates failed to maintain their PPE during the HFS encounters during the SBT sessions, even though all of them successfully completed the skill station and became trained observers. This is the value of SBT and the experiential learning, where learners are given a chance to practice skills they learned in situations mimicking real patient encounters. All learners participated in the debriefing sessions to reflect on their performance using videos to discuss things that went well, things to improve, and take-home messages.

SBT is one of the strategies that governments implement to ensure the country's preparedness for a wide range of infections, including Ebola. For instance, the British government crisis response committee contacted the Hillingdon Hospital to conduct Ebola SBT for Hillingdon staff due to its adjoining location to Heathrow airport, where many travelers are arriving from Ebola-known countries. Nurse Farrell, who headed the simulation, highlighted that the exercise assesses the organization needs, and more importantly, the hospital established a time limit of 30 min for wearing the protective equipment, as the staff felt warm when the suit was worn more than 30 min. Such discovery could not be achieved without simulation [8]. O'Keeff et al. aimed from their Ebola training to master skills that can be used to manage all different infectious cases by SBT with clear objectives and well-designed scenarios [9].

Simultaneously, the Children's hospital in Ohio, USA responded in 12 h with SBT and assessment to the declaration of the HCW who acquired EVD from an infected traveler. The hospital preparedness was assessed, and the gaps were recognized at different patient encounters from the ED, transport team, and pediatric ICU. For any other interdepartmental transfers, timely identification and communication of these potential safety concerns led to huge improvement in the processes. Biddell et al. concluded in their paper that the rapid organization of the simulation was not possible without an investment in simulation educators, technologists, and a robust simulation infrastructure. They stated that these aspects are the most vital requirement to ensure readiness or competency of staff as the infrastructure for training must be set [10].

Limitations

Limitations of this work include the generalizability of our program and findings to other institutions where simulation or infectious-disease expertise are lacking or not supported by the administration. As in most of the simulation literature, the results cannot be translated to actual change in outcomes despite the fact that it improves performance and knowledge. Moreover, the sustainability of such a program is challenging and requires multiple resources. Another limitation was not training all our HCWs on the risk for exposure in the institution since we conducted 10 courses to cover 179 HCWs only for this program.

Conclusion

Ebola is a real threat to Saudi Arabia during the Hajj (pilgrimage) and Umra seasons. Ensuring that HCWs are competent in Ebola PPE is crucial as a part of preparedness for crisis and disasters. Developing an SBT program requires a joint effort from the organization leaders, administration, simulation experts, and department leaders. Using the HFS program for Ebola PPE training could be an effective and practical method of developing competent HCWs in Ebola PPE. HCWs felt that SBT courses helped them feel more confident, prepared, and met their educational needs.

Funding

This work was supported by King Abdulaziz University Hospital. The authors did not receive any type of commercial support for this study. The author has no financial interest in any of the products or devices, mentioned in this article.

Competing interests

None declared.

Ethical approval

Obtained from Unit of Biomedical Ethics at King Abdulaziz University, Faculty of Medicine.

Acknowledgements

The authors extend their appreciation to Professor Abdulaziz Boker, Dr Abeer Arab, & Mr Jamal Alshorman from the Clinical Skills

& Simulation Center at King Abdulaziz University for their support and assistance. We are grateful to Dr Amro Ahibshi, Dr Shadi Alkhayyat, Mrs Laila Altabsh, & Ms Marites Macapagal from King Abdulaziz University Hospital for their support and assistance. We want to acknowledge Ms. Rawiah Sami Bahlas for her support with the statistical section.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jiph.2018.05.002.

References

[1] Kent A, Sepkowitz MD. Occupationally acquired infections in health care workers: part II. Ann Intern Med 1996;125(11):917–28.
[2] Gomes MF, y Piontti AP, Rossi L, Chao D, Longini I, Halloran ME, Vespignani A. Assessing the international spreading risk associated with the West African outbreak. PLoS Curr 2014;(September).
[3] https://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/index.html.
[4] Lateef Fatimah. Simulation-based learning: just like the real thing. J Emerg Trauma Shock 2010;3(October–December (4)):348–52.
[5] Jones Felipe. Simulation in medical education: brief history and methodology. Princ Prac Clin Res 2015;2(July–August (1)):56–63.
[6] Munshi F, Lababidi H, Alyousef S. Low-versus high-fidelity simulations in teaching and assessing clinical skills. J Taibah University Med Sci 2015;10(1):12–5.
[7] Lopreiato JO, editors. Downing D, Gammon W, Lioce L, Sittner B, Slot V, Spain AE. (Associate editors), and the Terminology & Concepts Working Group. Healthcare Simulation Dictionary; 2016. Retrieved from http://www.ssih.org/dictionary.
[8] Nurses close to Heathrow take part in Ebola simulation exercise. Nurs Stand 2014;29(9):13.
[9] Ann O'Keeffe Dara. Ebola emergency preparedness: simulation training for, frontline health care professionals. MedEdPORTAL 2016;12:10433.
[10] Elizabeth A. Biddell MD. Use of simulation to gauge preparedness for Ebola at a free-standing children's hospital. Soc Simul Healthcare 2016;11(April (2)).

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