

Review Article

## Role of Health Simulation Training in Response to Pandemic Crises in General and COVID-19 Specifically

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### Abstract

COVID-19 pandemic current status mandates a major role of healthcare in preventing the spread of infection besides treating infected patients. Health simulation training provides a practical role to improve the response to crises. This role involves the education and preparation of healthcare workers and the community while checking health system

preparation in response to the pandemic crisis. The aim of this review is to describe the role of simulation in response to pandemic crises in general and the COVID-19 pandemic specifically. We seek to find and collect evidence that can be used to analyze what are the needs of this pandemic, describe how can simulation help in improving responses to the crisis, describe the major issues that can be faced

when integrating simulation into programs and organizations, and specify the areas that need focus when conducting simulations. We conducted a literature review of available literature from 2004 to May 2020 to summarize the last evidence related to simulation and pandemic crisis.

**Keywords:** COVID-19; Hospital disaster preparedness; Health simulation; Medical simulation; Pandemic;

**Abbreviations:** COVID-19: Coronavirus infection disease 2019; EVD: Ebola virus disease; ED: Emergency department; HCW: Healthcare workers; ISS: In situ simulation; MERS: Middle East respiratory syndrome; OR: Operating room; PEDs: Pandemic and epidemic diseases; PPE: Personal protective equipment; SARS: Severe acute respiratory syndrome; SBT: Simulation-based training; WHO: World Health Organization

## 1. Introduction

COVID-19 started in Wuhan province in China after the emergence of cases of pneumonia with unknown etiology [1]. World health Organization (WHO) declared this epidemic as a global threat by January 2020 [2]. Such a pandemic disease requires specific training in a wide set of skills for Health Care Workers (HCW) as it was associated with high mortality rate avoid healthcare-associated poor performance and avoid infection. During past epidemics, the health care system had been utilizing simulation as a medical education tool [3]. Simulation centers had helped in training medical personnel in multiple situations, including previous recent epidemic like [3]. We conducted a literature review from January 2004 to May 2020 to summarize the last evidence related to simulation and pandemic

crisis. We will discuss and summarize the importance of SBT and share different methods, which could be applied in threatened healthcare organizations. Simulation can improve the responses to crisis at three levels (1) personal (HCW education, training and preparation), (2) prehospital preparation, and (3) system (analysis, policy integration, and testing new protocols).

## 2. Discussion

### 2.1. Role of simulation at HCW level

Providing medical care to patients infected with COVID-19 mandate mastering the safe process of utilizing equipment, consumables, and skills. Lack of education, unfamiliarity with a particular disease, unfamiliar equipment, and performing new procedures are stressors to HCWs [4]. Furthermore, a lack of knowledge can be associated with great risk as there will a false sense of security. The possibility of attending highly contiguous infections cases makes HCWs vulnerable to infection [5]. Providing safe and high-quality patient care while providing a safe environment to HCWs is a challenge. Essential skills can be taught in realistic safe environment utilizing simulation modules [6]. There is no way to train personnel for every challenge. Even though common clinical scenarios are frequently used for simulations, there is also a way to prepare the medical team for unfamiliar and emerging scenarios [7,8]. A study during the severe acute respiratory syndrome (SARS) epidemic showed that HCW were experiencing high stress amounts, which their health care institutions' is in charge of protecting them from. [9]. Patient care was sne of the many aspects affected by HCW stress [10]. One strategy is to train these professionals with simulation scenarios aiming to have these scenarios as realistic as possible, where they can practice and bolide their teamwork skills

and be granted being observed by experts and get feedbacks [7]. During the Ebola crisis, Carvalho et al stated that SBT improves HCWs' perception of safety and preparedness related to treating patients under investigation of Ebola virus [11]. Despite SBT's benefits in improving HCWs' coping skills, self-confidence, willingness to undertake patient management and treatment, they reported that the anxiety among participants wasn't changed. Debriefing helped in enhancing confidence in trainees by promoting reflective learning. Additional benefit was added by including non-medical health care workers in multidisciplinary teams training that enhanced coordination between whole team members, [11].

During the COVID-19 era, Dieckmann et al explained the necessity of SBT to enhance hospital responses to COVID-19 and they provided resources to stimulate systematic analysis in different contexts [3]. Additionally, they provided useful questions for needs analysis that could be utilized for both debriefing and observing they also gave practical guides on starting, running and debriefing for [12]. Likewise, Aldekhyl et al shared their multidisciplinary simulation experience in critical care in Saudi Arabia. Simulation based training have many applications in COVID-19 including infection control precautions, safe clinical skills, resource management, and latent safety threat identification [13]. They recommended that use of PPE should be modified to respect global shortages [13]. Li et al presented the risk of face-to-face manner of providing simulation programs increases infection risks for simulationists and trainees. They summarized the steps taken to deal with the urgent need for learning driven by technology and simulation during China's COVID-19 outbreak.

Furthermore, they provided a list for SBT activities namely procedural and bedside skills, and training to adapting unfamiliar situations with the expected challenges and possible solutions could be applied [14]. Proper use of PPE was explained in a recent guidelines published by The Centers for Disease Control and Prevention [15]. They recommended PPE for the care of COVID patients, and in case of aerosol generating procedures as intubation and airway assessment, a respirator mask is mandatory [16]. Notably, during the SARS pandemic in 2003, 21% of infected people were HCWs [17]. Only clinical staff who are trained and competent in the use of PPE should be allowed to deal with COVID-19 cases. To achieve maximum safety, simulation sessions are necessary for all untrained HCWs. Simulation played a major role to illustrate the efficacy of PPE and testing different types of PPE during the Ebola Virus Disease (EVD), H1N1 and COVID-19 crises [18-21]. All medical procedures and the entire scenarios were performed while the team were wearing PPE, which gave the participants the sense of difficulty associated with working in such conditions, and assess their resistant capability with those equipment, this experience showed that participants could tolerate wearing PPE 'comfortably' for up to 90 minutes [11]. Schumacher et al published a randomized simulation based study during the COVID-19 pandemic comparing the results of standard versus powered air purifying respirators in difficult intubation scenarios. The findings of this investigation showed there were no effect on prolonging the intubation training [18]. Likewise, during EVD Abualenain et al conducted an experimental study and SBT program to train HCWs by using high-fidelity simulators and quasi-real scenarios. The evidence from this study suggests that

SBT is an effective program to develop skilled HCWs in Ebola PPE [20].

## 2.2. Role of different simulation models in preparation for pandemic

Under crisis circumstances, traditional training can be difficult to reach remote areas and accessing workers in remote regions. Virtual reality in SBT can solve this problem. Hew et al 2010 reported that immersive simulation using virtual reality can promote fundamental infection control related principles [22]. Gala et al 2016 developed a learning platform using virtual reality in Liberia. This tool improved both competence and confidence level of HCW working in the EVD outbreak region. The infection prevention control module was divided to a total of four sections that focusing on specific learning principles. (1) basic knowledge about Ebola virus, and why is using proper PPE is important. (2) PPE donning training (3) identifying hazards in the clinical environment as well as risks. (4) PPE doffing training. The content aligned with WHO and Liberia's Ministry of Health guidelines [23]. The same concepts are applicable to other disasters types to communicate key messages to the medical team. Ragazzoni et al described mannequins based training in PPE use, blood drawing by inserting peripheral intravenous line, and physical care of patients with Ebola virus in a virtual reality based environment, this approach allowed participants to be fully immersed in the training and master utilizing key equipment with low cost and less logistic concerns than the usual environment [5].

Simulation exercise that are table-top based where the participant do role playing during hypotheses emergency in a safe riskless environment, after word they will be evaluated based of pre-decide

benchmarks. This type of exercises is helpful in assessing plans, procedures and protocol, all are fundamental in pandemic training as they have to be modified based on the nature of the pandemic [24-26]. The drawback of tabletop exercise that it will not discover the communication gaps during decision making hence the decision made during it won't be tested accurately [27]. Incorporating computer-based simulation models in tabletop exercise may improve it [28, 29]. Decision making and better situational analysis giving the present tools and resources, as well as assessing plans effectiveness as improved by simulations [30, 31]. Beaton et al in 2007 showed that pandemic preparedness was improved utilizing tabletop exercise in one academic hospital; the improvement was noticed in most aspects related to managing cases and communication [28]. Simulation modules had been useful to evaluate the decision by policy makers; its role in support decision makers in public health sector was tested also [30, 32].

## 2.3. Role of simulation at the system

This section discusses the implementation, evaluation, integration, and improvement of preparedness strategies during pandemic crises. Pandemics management (pharmacological and non pharmacological) is aimed to decrease spread, minimize effect of the community and lower mortality rate. During the A/H1N1 influenza outbreak in 2009, simulations were used in universities and schools to test pandemic preparedness strategies before evaluation. Educational communities are unique in that they function within the larger community and university students often travel internationally. The sections for university preparation are: creating an inclusive planning document, initiating an alternative measures to continuity of functions, construct infection control

policy and emerging communication procedures. The simulation was used to evaluate university preparation strategies. The tabletop simulation module was used to involve participants in the discussion, enhance public health and help in deliver advice to participants in formulating real-time decisions [33]. Bill Gates found out that simulation is playing an important role in strengthening the health system in developing countries [34]. Simulation plays a big role in testing preplanned hospital disaster plans, and to ensure the effectiveness of preparedness policies and plans. This assessment is not easy and no clear methods can be used due to the lack of prospective studies (majority of the related literature are retrospective studies) [35]. Though studies still show that simulation modalities are generally effective in testing hospital disaster preparedness, they also demonstrate that reported surge capacity was more accurate during tabletop exercises than obtaining the information via phone [36]. Furthermore, simulation plays another role in allocating new unknown defects and confusion areas that emerge with new pandemics and epidemics. This was obvious during the Ebola outbreak. A study conducted in Spain showed that the implementation of simulation uncovered some defects in teamwork dynamics while treating a simulated Ebola case and revealed that some guidelines were confusing and had to be re-written and clarified [37]. Similarly, a Canadian study showed benefits from simulation sessions for managing Ebola patients, it also helped in quickly detecting and addressing safety threats, so hospital administration could take corrective action [38]. Also, McGaghie stated that simulation helped in team preparation for taking care of EVD, while maintaining patient safety along with HCW and staff safety [39].

Policy changes and infrastructure evaluation can be facilitated and tested utilizing simulation [8]. SBT helps as well in detecting gaps and strong parts of both protocols and guide lines, identifying areas of improvement will also help in designing training exercises [40]. An instructional design at Valdecilla Hospital had four phases-knowledge acquisition, review, simulations, and debriefing [40]. There is high evidence that simulation is very valuable in validating the protocols before implantation in hospital care [40]. Arriaga et al demonstrated that high-fidelity simulation using checklist was associated with improvement in the operating room (OR) crisis management [41]. Simulation plays a critical role in system integration in cases of new policy as result of pandemic crises. During the era of EVD, simulation programs played a central role in integration the critical strategies in the health system and developing a preparation plan. The plan involved development of a preparation program for first responses. The program composed of online materials and simulation training sessions to educate and train the first responders and the institute to patients with Ebola [42]. In response to H1N1, Ozgus and Colleagues established a simulation model to facilitate the decision makers in developing the strategic policy for pandemic crisis. The model they developed captured disease dynamics with social dynamics that could be controlled by numerous social distancing policies in the university's pandemic influenza plan. The simulation model gave the decision-makers an opportunity to quantify and visualize the consequences of their decisions. In addition, it helped them in making the decision-makers forced to discuss with other responsible individuals. Majority of participants stated that the sessions improved their readiness for a pandemic [32].

## **2.4. Role of simulation in disaster preparedness at undergraduate level**

Some of Disaster training healthcare competencies are based on the ability to recognize events, start the appropriate management principles of these events, understanding and applying hospital emergency management by doing the appropriate preassigned role for each member and practicing proper communication [43]. Disaster simulation has been implemented in undergraduate as well postgraduate teaching/training of HCWs in many institutions around the world. A variety of skills and knowledge were improved following disaster simulations sessions. In nursing student's education, disaster simulation sessions were well received. It helped the students increase their knowledge, teamwork skills and confidence, and ability to handle disasters [44]. Disaster-related inter-professional education using simulation improved collaboration between different healthcare sector students but was not as effective in care planning of simulated patients and families [45]. Other interdisciplinary educational and simulation programs had improved self-confidence, performance, as well as objective testing of participants in regard to terrorism response [46]. Another study conducted on medical students showed improvement in both triage time and command and control markers were better in the group who had computer-based simulation compared to the control group when dealing with simulated mass casualty incidents [47]. The same effects were noticed on public health students, wherein simulation-based pandemic education had improved their knowledge [48]. In Japan, in response to pandemic outbreaks due to H5N1 influenza and swine flu, a simulation-based education drill was introduced to prepare Japanese medical students. This drill more aware of the

importance of team based approach in pandemic management [49].

## **2.5. Role of prehospital professionals**

Prehospital professionals are often the first line and at increased risk during their lifesaving work [50]. Training of emergency medical services regarding pandemic and epidemic diseases are essential and can improve their understanding of guidelines, enhance awareness and preparedness. In 2012, the first case of Middle East Respiratory Syndrome (MERS) was reported in Saudi Arabia [51]. In 2015, 18% of the total (1106) reported confirmed MERS-CoV to WHO cases were HCW [52]. Elcin et al conducted a prehospital professional based training program using the MERS epidemic, They used standardized patients scenarios to assess the level of awareness as well as preparedness of the tested team (paramedic students and emergency medical services providers) [53]. The training program subdivided into three sessions that started with a baseline evaluation which included two clinical scenarios to evaluate awareness and preparedness, followed by educational session about MERS followed by debriefing and finally a post-training evaluation. Two evaluators evaluated one participant; they compared post-training data to baseline data. Result showed 84% realized that the case was at risk of being infected with MERS-CoV. PPE donning and doffing breaches were detected in all participants, this was improved in the post training evaluation, the research group recommended regular training activities for the prehospital team pandemic and epidemic diseases [53].

## **2.6. Role of simulation in hospital department preparation**

### **2.6.1 On-site clinical response team training**



Phrampus et al, during the Ebola era, developed on-site training sessions after online modules. This training was based on hands-on activities [41]. Additionally, they used a simulation in the assessment aspects of HCWs' roles. The simulation included steps from triaging patients through some resuscitative procedures and ending by handling human remains [42]. Moreover, several outcomes (environmental and human were realized), as an example the suspected tolerated time of HCW functionality wearing PPE was proven to be 2 hours instead of presumed 4 hours, the logistic of patient care and dealing with infectious wastes proven to be more difficult than assumed, They concluded that simulation programs can help in building rapid response to potential threats [42]. Likewise, to mimic the complexity of dealing with actual people as patients, two research teams from University of Pittsburgh included the patients as part of the simulation. Finally, assigning clear roles and goals for the team member was a crucial thing [54, 55].

### 2.6.2. Intensive care unit

Simulation was of great benefit in training HCWs in dealing with SARS cases, especially procedures requiring special skills like cardiac arrest management. An In Situ Simulation (ISS) training session conducted for dealing with SARS-positive cardiac arrest cases showed multiple infection control and advanced cardiac life support errors that were not counted before [56]. As we are now dealing the COVID-19 pandemic with all related uncertainty and uniqueness, simulation-based disaster training helped in highlighting issues with the mindfulness of the surrounding situation, communication (because of PPE limitations), and weak understanding of the current patient's plan and situation. In the UK, Fregene et al developed simulation updated

intubations checklist, prone positioning checklist, and assembly of COVID-19-specific intubation trolley [57].

### 2.6.3. Operating Room

Surgical activities are the heart of any healthcare system. Hence, the OR is a potential health risk because of the presence multidisciplinary team and necessity of performing procedures associated with high transmission risks. The application of ISS involves multidisciplinary team training through different scenarios, which recreate events encountered in healthcare systems, especially those associated with high risk to HCWs. potential cross-infection in the hospital can be reduced by the use of ISS for COVID-19 patients in the OR. Muret-Wagstaff et al initiated a 10 days ISS During the COVID-19 pandemic, aiming at surgical teams organization and replicating tasks and tools that are based on simulation to enhance HCW safety [58]. Initially, a multidisciplinary team of simulation educators and clinical leaders from many departments (surgical, anesthesia, and nursing) in addition to infection control officer and administrators, they were given an intensive interdisciplinary simulation sessions over a half day. They disseminated this ISS to an additional five hospitals on the eighth day of the simulation. Additionally, they focused on enhancing patient safety by using checklists, digital, and closed-loop communication technique to avoid misunderstanding and cockpit resource management techniques [58]. Likewise, Tong et al created and applied high-fidelity ISS to understand how to decrease movement through the OR with positive pressure in order to minimize aerosol contamination. They reported an improvement in the OR workflow and processes, and they recommended including different surgical

specialties in ISS training before management of COVID-19 patients [59].

#### 2.6.4. Emergency department

ED considered the gate of hospital, staffs' personnel on the frontline of any outbreak. Therefore, rigorous training is mandatory. Simulation was described as an effective tool to prepare nurses for bioterrorism threats. Morrison et al described their experience using simulation to train senior nursing students. A high-fidelity simulation exercise was conducted over three days to simulate infectious disease outbreak. Students indicated the value of the experiment on their level understanding and skills acquisition [60]. The simulation was also used to measure ED preparedness for bioterrorism attacks and the study evaluated resource use and waiting times as parameters for performance [61]. An experiment to train for infection disease outbreak, specifically Ebola, was conducted by Abualenain et al in Saudi Arabia and involved multiple stages of planning and execution of SBT. The main objection of this activity was to train frontline HCWs on Ebola PPE. The experiment showed significant improvement of HCWs' scores on PPE competency [62].

### 3. Conclusion

Simulation training proves to be a fundamental element for preparation to outbreak disasters. It allows stakeholders the to gather information regarding the complex and challenging situations in caring for an infected patient, test crisis resource management, assess communication adequacy, and ensure proper allocation of critical resources. Furthermore, SBT improves the preparation of HCW at all levels.

### Declaration

Ethical approval: approved by Princess Nourah University institutionalized review board.

The authors contributed equally to this work.

### Disclosure

There are no financial conflicts of interest to disclose.

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