


Simulation-based training programme and preparedness testing for COVID-19 using system integration methodology

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ABSTRACT

Background COVID-19 pandemic is presenting serious challenges to the world's healthcare systems. The high communicability of the COVID-19 necessitates robust medical preparedness and vigilance.

Objective To report on the simulation-based training and test preparedness activities to prepare healthcare workers (HCWs) for effective and safe handling of patients with COVID-19.

Methodology Two activities were conducted: simulation-based training to all HCWs and a full-scale unannounced simulation-based disaster exercise at King Fahad Medical City (KFMC). The online module was designed to enhance the knowledge on COVID-19. This module was available to all KFMC staff. The five hands-on practical part of the course was available to frontliner HCWs. The unannounced undercover simulated patients' full-scale COVID-19 simulation-based disaster exercise took place in the emergency department over 3 hours. Six scenarios were executed to test the existing plan in providing care of suspected COVID-19 cases.

Results 2620 HCWs took the online module, 17 courses were conducted and 337 frontliner HCWs were trained. 94% of learners were satisfied and recommended the activity to others. The overall compliance rate of the full-scale COVID-19 disaster drill with infection control guidelines was 90%. Post-drill debriefing sessions recommended reinforcing PPE training, ensuring availability of different sizes of PPEs and developing an algorithm to transfer patients to designated quarantine areas.

Conclusion Simulation-based training and preparedness testing activities are vital in identifying gaps to apply corrective actions immediately. In the presence of a highly hazardous contagious disease like COVID-19, such exercises are a necessity to any healthcare institution.

INTRODUCTION

The novel coronavirus pandemic has presented serious challenges to the world's healthcare systems' infrastructure.¹ The high communicability of the COVID-19 disease necessitates robust medical preparedness and vigilance.² Detailed practices and precautions need to be applied throughout the spectrum of care of patients with COVID-19.³ Routine testing of preparedness remains an integral

What is already known in this subject

- ▶ Performance evaluation in disasters is a major challenge to healthcare administrators.
- ▶ Personal protective equipment are needed for protecting healthcare workers against COVID-19.
- ▶ System integration is used to bridge gaps and improve performance.

What this study adds

- ▶ COVID-19 presented serious challenges to the world's healthcare systems.
- ▶ Our study enforces the benefits of using simulation-based training and drills to prepare healthcare workers for effective and safe handling of patients with COVID-19 patients.
- ▶ Three areas worth of testing for COVID-19 preparedness: triage system, infection control measures and flow of patients.

step in assuring effective and safe handling and treatment of patients with highly hazardous contagious disease. The Center of Research, Education and Simulation Enhanced Training (CRESENT) at King Fahad Medical City (KFMC) in Riyadh, Saudi Arabia, has been conducting simulation exercises for performance improvement and to test operational preparedness for many years. CRESENT conducted simulation training exercises for mock codes, bed sores in intensive care unit,⁴ Ebola virus disease preparedness, speaking up as well as operational preparedness of new emergency department (ED) and bronchoscopy suite.⁵

This article reports on the simulation-based training and test preparedness activities to prepare KFMC healthcare workers (HCWs) for effective and safe handling of patients with COVID-19.

METHODS

KFMC is the largest tertiary care medical centre under the Ministry of Health (MOH) in Saudi Arabia. The KFMC campus includes four hospitals with 1200-bed capacity and nine apartment



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Table 1 Characteristics of skill stations

Skill station	Category	Elements	Description
PPE donning and doffing	Orientation	Simulator	Participants were oriented to PPE: N95 masks, surgical masks, gowns
		Environment	Multipurpose room
	Instructional design	Equipment	Gloves, gowns, face shield, N95 mask, hand sanitizer, cleaning wipes
		Duration	30 min (five learners)
		Structure	Demonstration by facilitator and each learner performs donning and doffing
	Feedback	Assessment	Direct observation
		Source	Facilitator
		Duration	During demonstration
		Facilitator	Infection control nurse
		Structure	Immediate feedback
PAPR	Orientation	Simulator	Participants were oriented to PAPR and Airway Larry (Nasco)
		Environment	Skills training room
	Instructional design	Equipment	PAPRs, cleaning spray and wipes, Airway Larry (Nasco) task trainer
		Duration	30 min (five learners)
		Structure	Demonstration by facilitator and assembly on manikin by learners
	Feedback	Assessment	Direct observation
		Source	Facilitator
		Duration	During demonstration
		Facilitator	Infection control nurse
		Structure	Immediate feedback
Cleaning of medical equipment	Orientation	Simulator	Participants were oriented to the vital signs monitor and room furniture
		Environment	ER examination clinic in simulation centre
	Instructional design	Equipment	Vital signs monitor (Carescape V100), crash cart, hospital bed, wipes
		Duration	30 min (five learners)
		Structure	Participants work together to clean equipment and surfaces
	Feedback	Assessment	Direct observation
		Source	Facilitator
		Duration	During demonstration
		Facilitator	Environmental Services Instructor
		Structure	Immediate feedback
Obtaining a nasopharyngeal swab	Orientation	Simulator	Participants were oriented to nasogastric tube model (3B Scientific)
		Environment	Skills training room
	Instructional design	Equipment	Nasogastric tube simulator, universal transport medium kit, blue top viral transfer, biohazard bag, labels, requisition form
		Duration	30 min (five learners)
		Structure	Demonstration by facilitator then each learner performs task
	Feedback	Assessment	Direct observation
		Source	Facilitator
		Duration	During demonstration
		Facilitator	Nursing educator
		Structure	Immediate feedback
Speaking up group discussion	Orientation	Simulator	Participants were oriented to group discussion format
		Environment	Classroom
	Simulation scenario	Equipment	Computer, LCD screen, flip chart
		Event	Each group will watch the video: 'We stand alone together, moments in China's coronavirus battle', followed by group discussion
		Format	Group discussion
	Instructional design	Duration	30 min
		Structure	Participants divided into four groups (five learners per group). In each station, they will watch a video for 3 min and then have group discussion
		Assessment	Learner's participation
		Source	Facilitator
		Duration	PC, LCD, chairs, flip chart, markers
Feedback	Facilitator	Simulationist with expertise in debriefing	
	Structure	Advocacy inquiry debriefing	
	Timing	20–25 min	

ER, emergency room; LCD, liquid crystal display; PAPR, powered air-purifying respirator; PC, personal computer; PPE, personal protective equipment.

Table 2 Scenarios of full-scale COVID-19 simulation exercise

No	Scenario	Expected action
1	A 35-year-old HCW living in the hospital housing calls hospital dispatch centre and tells them: he has high fever and cough and came from Egypt 2 days ago. Vital signs: BP=140/90 mm Hg, temperature=38.6°C, RR=28/min, HR=100/min, O ₂ Sat=91% (room air). After a few hours, the COVID-19 result is negative.	<ul style="list-style-type: none"> ▶ EMS actions: <ol style="list-style-type: none"> 1. The hospital dispatch centre informs EMS to respond and deal with the cases on location. 2. Bring patient to ED. ▶ ED actions: <ol style="list-style-type: none"> 3. Calculate COVID score and apply precautions. 4. Triage and admit to ED respiratory zone. 5. Perform COVID-19 screening. 6. Report case to ICD. ▶ Infection control action: <ol style="list-style-type: none"> 7. Assess patient status to clear from isolation.
2	A 40-year-old HCW came from South Korea (Daegu City) asymptomatic and came to ED to check herself. Vital signs: BP=135/85 mm Hg, temperature=36.5°C, RR=18/min, HR=80/min, O ₂ Sat=96% (room air).	<ul style="list-style-type: none"> ▶ ED actions: <ol style="list-style-type: none"> 1. Calculate COVID score and apply precautions. 2. Triage and admit to ED respiratory zone. 3. Perform COVID-19 screening. 4. ED physician to order sick leave for 14 days. 5. Report case to ICD. 6. Transfer patient from ED by EMS to designated quarantine housing. 7. ICD to follow-up results and health status on daily bases. ▶ The healthcare provider is considered CLEAR if: <ol style="list-style-type: none"> 1. Asymptomatic for >48 hours and 2. One negative COVID-19 PCR result and 3. The 14 days' observation period is over.
3	A 41-year-old Lebanese HCW, asymptomatic came to ER to check himself. Vital signs: BP=130/80 mm Hg, temperature=37°C, RR=16/min, HR=75/min, O ₂ Sat=97% (room air).	<ul style="list-style-type: none"> ▶ ED actions: <ol style="list-style-type: none"> 1. Calculate COVID score and apply precautions. 2. Report case to ICD. 3. Physician to order sick leave for 14 days. 4. Home isolation where HCW is living. 5. ICD to instruct HCW on: <ol style="list-style-type: none"> a. Limit contact with others. b. Adhere to hand hygiene. c. Avoid going to public places. d. If symptoms develop, wear a mask and go to the ED respiratory zone. 6. ICD will follow up HCWs' health status daily. ▶ The healthcare provider is considered CLEAR if: <ol style="list-style-type: none"> 1. Asymptomatic for >48 hours and 2. One negative COVID-19 PCR result and 3. The 14 days' observation period is over.
4	A 35-year-old nurse arrived 5 days back from India presented to the ED with cough, fever, fatigue and runny nose. Vital signs: BP=135/75 mm Hg, temperature=39°C, RR=20/min, HR=105/min, O ₂ Sat=95% (room air). CXR and laboratories: normal.	<ul style="list-style-type: none"> ▶ ED actions: <ol style="list-style-type: none"> 1. Calculate COVID score and apply precautions. 2. Triage and admit to ED respiratory zone. 3. Report case to the ICD. 4. Perform COVID-19 screening. ▶ If patient is stable for discharge: <ol style="list-style-type: none"> 1. ED physician to order sick leave for 3 days. 2. Referral to Employee Health. 3. Home isolation where HCW is living. ▶ If COVID-19 result is positive, transfer to the designated isolation hospital. ▶ HCWs considered CLEAR if they remain: <ol style="list-style-type: none"> 1. Asymptomatic for at least 48 hours and 2. COVID-19 PCR negative.
5	A 60-year-old man with diabetes, hypertension, complaining of cough, fever and shortness of breath came from Eastern Province in Saudi Arabia to the ED and has a contact with positive COVID-19 case. After triage and admission to a room in the ED Critical Area, a SimMan 3G is placed on the stretcher instead of the patient. Vital signs: BP=110/65 mm Hg, temperature=38.5°C, RR=28/min, HR=135/min, O ₂ Sat=85% (room air).	<ol style="list-style-type: none"> 1. ED actions: 2. Identify patient as level 2. 3. Send patient to ED Adult Critical Care area. 4. ED physician to identify as COVID-19 case. 5. Apply contact and airborne precautions for intubation. 6. Perform COVID-19 screening. 7. Keep patient in ED while waiting for results. 8. If COVID-19 result is positive, then transfer patient to ICU in designated hospital.
6	A 22-year-old college student comes from Eastern Province of Saudi Arabia to ED with fever, runny nose, sore throat and fatigue. Vital signs: BP=125/80 mm Hg, temperature=38.5°C, RR=18/min, HR=100/min, O ₂ Sat=96% (room air).	<ul style="list-style-type: none"> ▶ ED actions: <ol style="list-style-type: none"> 1. Calculate COVID score and apply precautions. 2. Triage and admit to the ED respiratory zone. 3. ED physician to identify as COVID-19 case. 4. Perform COVID-19 screening. 5. Report case to ICD. 6. Instruct for strict home isolation. 7. MOH will follow-up after discharge.

BP, blood pressure; CXR, chest X-ray; ED, emergency department; EMS, Emergency Medical Services; ER, emergency room; HCW, healthcare worker; HR, heart rate; ICD, Infection Control Department; ICU, intensive care unit; MOH, Ministry of Health; O₂ Sat, oxygen saturation; RR, respiratory rate.

towers for nursing staff and more than 400 living quarters. The higher administration of KFMC approved the initiative from the Infection Control Department (ICD), Disaster Management

Department and CRESENT to train and test preparedness for COVID-19. A multidisciplinary committee composed of nurses, physicians, paramedics, simulationists and experts in

system integration, quality control and disaster management were actively involved in developing and executing the training programme. The COVID-19 preparedness committee identified a specific goal for training and testing of KFMC HCWs: to increase awareness and preparedness of KFMC HCWs as per Saudi MOH, WHO and Centers for Disease Control and Prevention guidelines regarding COVID-19.^{6,7} The committee followed system integration methodology by reviewing and analysing current policies and practices related to the subject matter, identifying the gaps, exploring opportunities and composing a simulation-based training to bridge the previously identified gaps.⁸ Three main system domains were identified: triage system, infection control measures and flow of patients. Using structured electronic questionnaire, a representative sample from targeted departments was surveyed to identify their top needed skills and attitude objectives, preferred teaching methodology, target audience and ideal duration and timing of the training programme without affecting patient care. To accomplish these needs, the committee decided on two separate initiatives: a simulation-based training to all HCWs at KFMC who may get in contact with COVID-19 cases and a full-scale unannounced simulation-based disaster exercise at KFMC. Accordingly, two task forces were formed to develop the curriculum for the simulation-based education exercises.

The COVID-19 training task force objectives were:

1. To understand definition, epidemiology, symptoms and transmission of COVID-19.
2. To demonstrate competency in donning and doffing of personal protective equipment (PPE) including N95 mask.
3. To learn proper use of powered air-purifying respirators (PAPRs).
4. To perform medical equipment cleaning after a suspected case of COVID-19.
5. To recognise the importance of speaking up regarding infection control measures.

The course followed the blended learning approach. The online self-learning module was designed to enhance the knowledge of the learners on COVID-19 definition, epidemiology, signs, symptoms and transmission as per Saudi MOH. This module was made available to all KFMC staff (around 4500 HCWs) and was followed by an online examination. An electronic certificate was generated indicating completion of the theoretical part. The practical part of the course was made available to front-line staff (around 950 HCWs). It consisted of five hands-on skill stations: donning and doffing of PPE, PAPR, equipment cleaning, nasopharyngeal swab and one group discussion session on speaking up (table 1).

On the other hand, the full-scale COVID-19 simulation-based disaster exercise objectives were the following:

1. To test Emergency Medical Services (EMS) response in a pre-hospital setting as per KFMC epidemic protocol.
2. To evaluate ED response dealing with suspected COVID-19 cases as per newly developed algorithms.
3. To assess infection control measures when dealing with COVID-19 cases.

Ancillary hospital departments at KFMC whose services were critical to the success of caring for patients with COVID-19 were involved in the unannounced exercise. These were: ED, EMS, patient affairs, security staff and Nursing Administration. The full-scale COVID-19 simulation-based disaster exercise took place in the ED over 3 hours with participation of around 70 staff from those departments. A total of six scenarios, using six standardised patients (SP) and one full body manikin, were executed to test the existing plan in providing care of the six patients with

Table 3 Characteristics of healthcare providers who participated in COVID-19 training

Characteristics	n (%)
Total	337 (100)
Females	292 (87)
Males	45 (13)
Physicians	9 (2.5)
Nurses	317 (94)
Paramedics	9 (2.5)
Allied health	2 (1)

suspected COVID-19 disease (table 2). Compliance with infection control procedures was measured by computing the rate of fulfilments of the 'expected actions' from table 2. Plus-delta debriefing methodology was used for postexercise debriefing (table 2). The cited information and/or identifiable in table 2 are not from an actual patient. Any resemblance to real person living or deceased will be coincidence. In one hybrid scenario, the SP was switched to a manikin after he asked for a urinal and the HCW left the room.

RESULTS

A total of 2620 HCWs at KFMC took the online module. Until the writing of this manuscript, a total of 17 courses were conducted with a total of 337 frontliner HCWs trained (table 3). Post-course evaluations were collected and presented in table 4. Around 94% of learners were satisfied or highly satisfied and recommended the simulation-based educational activity to the others.

A total of 14 members from Disaster Management, ICD, Nursing Administration and CRESENT, 6 evaluators and 6 SPs conducted the full-scale COVID-19 simulation-based disaster exercise on the 11 March 2020. The overall compliance rate of the HCWs with infection control guidelines was 90%. Post-drill debriefing sessions with all participating departments/administrations were conducted to empower the strength points and

Table 4 COVID-19 course evaluation

Item	Percentage
<i>Educational perspective</i>	
Content of this course related to my practice	92
Objectives of the course are clearly defined	88
Course has enough hands-on practice	66
Course duration was adequate for the content	84
Course information was up-to-date	88
<i>Course objectives</i>	
Understand the definition, epidemiology, symptoms and transmission of COVID-19	82
Recognise the WHO and MOH guidelines and policy of COVID-19 outbreak preparedness	80
Follow the proper steps and guidelines when exposed to confirmed/ suspected patient with COVID-19	88
Demonstrate competency in donning and doffing the PPE	92
Use PAPR effectively when dealing with suspected or confirmed cases	88
Recognise importance of speaking up when dealing with breaching of proper infection control guidelines	90

MOH, Ministry of Health; PAPR, powered air-purifying respirator; PPE, personal protective equipment.

Table 5 Strengths and challenges of the full-scale COVID-19 simulation-based disaster exercise

Strengths	<ol style="list-style-type: none"> 1. The drill was endorsed by Chief Executive Officer and KFMC COVID-19 taskforce. 2. Presence of all related department/administrations leaders. 3. Security presence was optimal in controlling traffic. 4. A special quarantine area for HCWs has been allocated. 5. Having a clear IC, EMS and ED algorithms and pathways. 6. Excellent social media monitoring during the drill. 7. EMS followed proper procedure in transporting patients to ED. 8. Dispatch response (activation time) was optimal. 9. Nursing staff in ER did a great job as per the IC assessment. 10. Terminal cleaning was done for ambulances.
Challenges	<ol style="list-style-type: none"> 1. Linen used by EMS was taken back to the ambulance. 2. ED nurse not wearing proper PPE. 3. No proper cleaning of the queuing machine. 4. Lack of written home isolation instructions. 5. No designated party to transfer back quarantined HCWs. 6. Training of security staff in HCWs quarantine areas on IC.

ED, emergency department; EMS, Emergency Medical Services; ER, emergency room; HCWs, healthcare workers; IC, infection control; ICD, Infection Control Department; PPE, personal protective equipment.

identify the gaps in the triage system, infection control and flow of patients (table 5).

Triage system

The Nursing Administration at KFMC developed a robust algorithm for screening and triage of all patients arriving to ED (figure 1). Two main strengths of this full-scale COVID-19 simulation-based disaster drill worth mentioning. First was the identification of all undercovered (mystery) simulated patients as possible COVID-19 cases early on at arrival to the main door and namely by the so-called ‘visual nurse’. Second, the integration of Canadian Triage and Acuity Scale⁹ and the Visual Triage Checklist for Acute Respiratory Illness (figure 2) in the screening and triage process. No challenges reported under this domain.

Infection control

All HCWs who participated in the full-scale COVID-19 simulation-based disaster drill practised strict infection control measures. Many strengths were described by the observation team. Hand hygiene was universally applied by all HCWs.

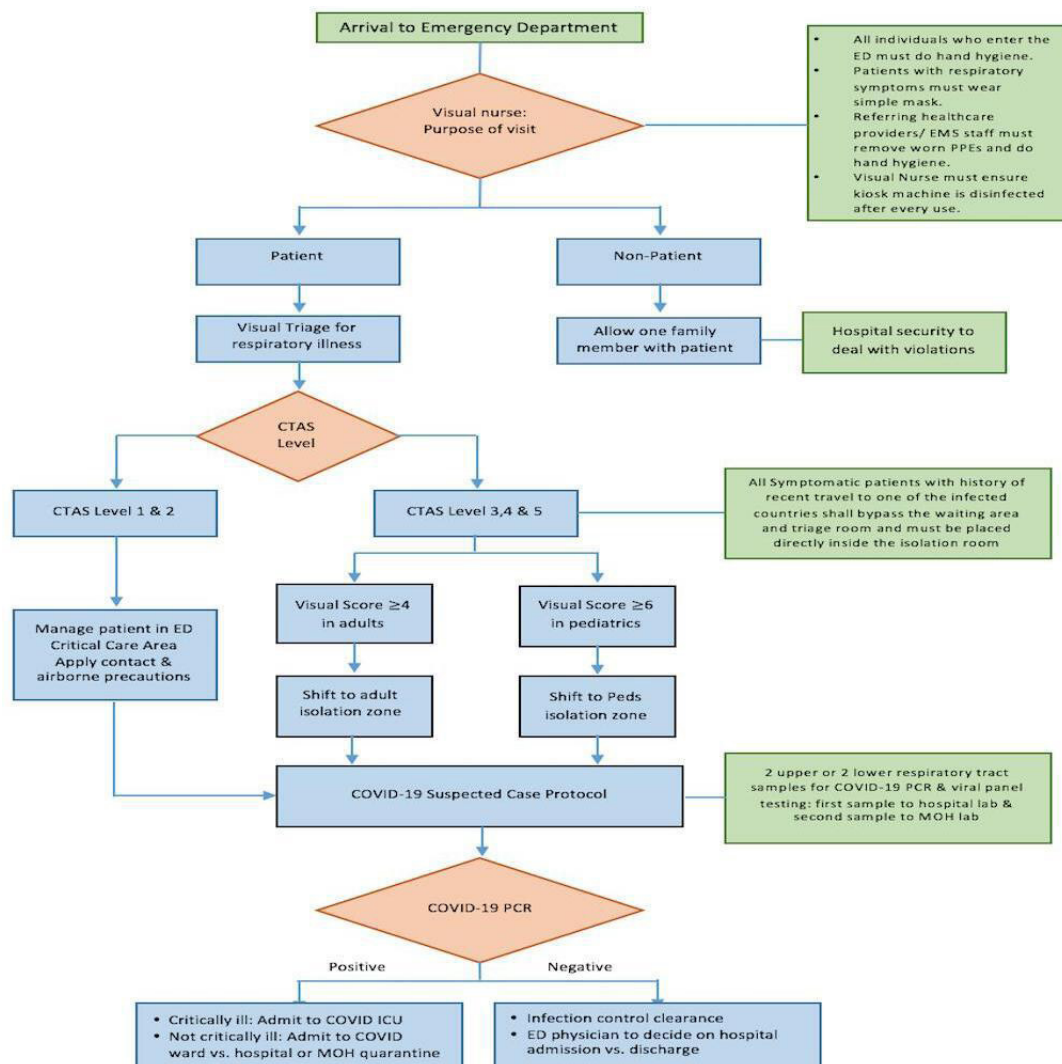


Figure 1 COVID-19 algorithm for screening and triage of patients arriving to emergency department (ED). CTAS, Canadian Triage and Acuity Scale; EMS, Emergency Medical Services; ICU, intensive care unit; MOH, Ministry of Health; PPEs, personal protective equipments.

Visual Triage Checklist
Visual Triage Checklist for Acute Respiratory Illnesses

Date: _____ Time: _____ MRN: _____
Name: _____ ID#: _____ Hospital: _____

Circle the number reflecting the patient's condition (exposure and clinical picture) and calculate the final score:

Risks for Acute Respiratory Illnesses	Score		
A. Exposure Risks	<i>Any Patient (Adult or Pediatric)</i>		
1. Had a history of travel abroad or to the identified high-risk area in the Kingdom (Qatif) QR A close physical contact in the past 14 days prior to symptoms onset with a confirmed case of COVID-19 QR Working in or attended a health care facility where patients with confirmed COVID-19 were admitted.	5		
2. Exposure to a confirmed MERS case in the last two weeks	3		
3. Exposure to camel or products (direct or indirect*) in the last two weeks	2		
4. Visit to a healthcare facility that had MERS case in the last two weeks	1		
B. Clinical Signs and Symptoms	<i>Adult Patient with Exposure Risk No. 1</i>	<i>Patient with or without Exposure Risk No. 2, 3 or 4</i>	
		<i>Pediatric</i>	<i>Adult</i>
1. Fever	1	1	2
2. Cough (new or worsening)	1	1	2
3. Shortness of breath (new or worsening)	1	1	2
4. Sore throat and/or runny nose	1	-	1
5. Nausea, vomiting and/or diarrhea	-	-	1
6. Chronic renal failure, CAD/heart failure	-	-	1
Total Score			

* Patient or household

A score ≥ 4 , place patient in an isolation room and inform MD for assessment. MERS-CoV testing should be done only according to case definition.

A score ≥ 6 , place patient in an isolation room and inform MD for assessment. COVID-19 testing should be done only according to case definition.

Staff name: _____ ID number: _____

Figure 2 Visual triage checklist for acute respiratory illness. CAD, coronary artery disease; MERS-CoV, Middle East respiratory syndrome coronavirus; MRN, medical record number.

There was limited access to the ED and hospital security played a noticeable role to achieve it. The challenges included: one nurse was not wearing the proper PPE, no proper cleaning of the queuing machine and linen used by EMS was taken back to the ambulance.

Flow of patients

The prehospital transfer of symptomatic HCWs from their living quarters to ED was adequate. The flow of patients within the ED was well controlled by hospital security and triage nurses. As for the confirmed patients with COVID-19 who require hospitalisation, they were transferred by EMS to the MOH-designated COVID-19 hospital outside KFMC as per protocol. Undercovered simulated HCWs with COVID-19 were supposed to be transferred to one of the KFMC housing towers that was designated by the ICD for home quarantine. Three challenges were identified: lack of written instructions for home isolation, no designated party to transfer back quarantined HCWs and lack of training of security staff in HCWs' quarantine areas on infection control measures.

The major recommendations that were included in the final report: reinforcing PPE training regularly and registration in the COVID-19 course, ensuring availability of different sizes of

PPEs and developing a clear algorithm to transfer patients to designated quarantine areas.

DISCUSSION

Evaluating healthcare facilities performance in disasters remains a major challenge to healthcare administrators. Advanced healthcare systems, such as Italy, Spain and China, were overwhelmed with patients with COVID-19.¹⁰⁻¹² Full-scale exercises and drills have been widely used to assess hospital readiness for effective and safe performance during highly contagious outbreaks.¹³⁻¹⁶ Violations of infection control practices by HCWs can be a major factor in facilitating the transmission of pathogens and outbreak.¹⁷ Infection control measures like hand hygiene require relentless efforts to secure a high level of awareness and compliance among HCWs.¹⁸ This study showed very high compliance of KFMC HCWs in applying written protocols when dealing with suspected cases of COVID-19. It also discovered gaps that were remediated immediately. The high compliance rate we encountered is due to the high awareness level of the KFMC HCWs as well as the unprecedented global effect of COVID-19. People around the world are exercising extreme measures like social distancing, disinfection of belongings and home quarantine to limit the spread of this highly communicable disease.

A key element in the success of any quality improvement and system integration project is the support from higher administration.¹⁹ The CRESENT System Integration Committee at KFMC, formed from leaders in high positions, has the mission to apply consistent, planned, collaborative and integrated interventions, in conjunction with systems engineering and risk management, to address KFMC healthcare system issues and needs and achieve excellent clinical care, enhanced patient safety and improved outcome metrics across the healthcare system. It represents an organised bidirectional feedback loop between CRESENT and the healthcare system at KFMC to integrate simulation programmes within the whole KFMC healthcare system.²⁰ Many accelerated precautions decisions were taken at higher levels during the period of conducting the course, like stopping all training activities which might increase the risk of disease outbreak. The COVID-19 training course was excluded and precautions were arranged with the ICD to provide safe training to attendees and instructors. These precautions included reducing the number of participants per session, spacing the skill stations and frequent hand washing.

Protecting HCWs from getting infected remains an essential weapon in defeating COVID-19. Physicians, nurses, respiratory therapists, EMS personnel, environmental services personnel are all vulnerable and need to be protected both physically²¹ and psychologically.²² By the end of February 2020, China reported more than 3000 infected HCWs in Hubei alone.²³ In a single designated hospital in Wuhan, 28 physicians and nurses contracted COVID-19.²⁴ The figures from Italy have been more alarming given the difference in population and healthcare workforce. Around 9% (2609) of the COVID-19 cases are among HCWs.²⁵ We included HCWs in four out of the six scenarios in the full-scale COVID-19 simulation-based disaster exercise with various risks to COVID-19.

The full-scale COVID-19 simulation-based disaster drill was unannounced with injected undercover simulated patients. Unannounced or no-notice drills provide added realism and produce more realistic data when compared with scheduled drills. In Ebola preparedness no-notice drills, 40% of hospitals failed to ask patients about travel history, occupation, contact history and cluster information compared with 90% compliance rate during regular inspection.²⁶ Furthermore, 49 New York City EDs were evaluated regarding their response to communicable diseases through unannounced undercover simulated patient drills.²⁷ These drills generated valuable information to the hospitals to improve on identifying and isolating patients with a potentially highly infectious disease.²⁷

During this experience, we faced a few challenges. The main challenge was related to limited time in planning and execution of training and exercise. The COVID-19 has been spreading fast all over the world and immediate training and preparedness testing is of utmost importance. Another challenge is the balance of using PPE for training and saving hospital resources like N95 masks for the real pandemic. Such decisions need to be discussed properly with the institution's supply chain and may affect course design and execution. The drills were carried out by members of Disaster Management, CRESENT and ICDs. Most of them are known by the hospital staff and this can affect performance and evaluation.

Simulation-based training and preparedness testing activities are vital in identifying gaps to apply corrective actions immediately. In the presence of a highly hazardous contagious disease like COVID-19, such exercise is a necessity to any healthcare institution. It identifies gaps and improves the HCWs' preparedness. The main three areas worth of emphasising for COVID-19

preparedness simulation training include triage system, infection control measures and flow of patients.

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