Masri et al. Saudi J Er Med. 2021;2(2):186-192
https://doi.org/10.24911/SJEMed/72-1606296807

ORIGINAL ARTICLE

Functional exercise to test the response measures of the emergency medicine department to the COVID-19 pandemic in a tertiary center in Jeddah, Saudi Arabia

Ghada A. Merdad[1*], Abdulrahman A. Sindi[1], Wejdan R. Alsaiari[2], Taha M. Masri[1]

ABSTRACT

Background: In response to the coronavirus disease 19 (COVID-19) pandemic, a new set of rapid measures for containment was necessary to deal with the medical emergency, and emergency services are a vital part of this response. However, if poorly handled, it can facilitate transmission to patients and healthcare workers. Yet, the practice-based exercises required to evaluate the preparedness of healthcare facilities in face of the current pandemic are lacking. We aim to assess the applicability of emergency procedures for respiratory pathogens for tertiary medical center in Saudi Arabia.

Methods: Suitability and rapidity of the response were measured by conducting the "Homeland Security Exercise and Evaluation Program" simulation in which six medical evaluators observe the admission procedures of four mock victims of COVID-19 to the Emergency Department in King Abdulaziz University Hospital, Jeddah.

Results: A total of 27 healthcare workers participated in the exercise during March 2020. The simulation drills gave the hospital the tool to test the preparedness to the COVID-19 pandemic. It uncovered the strengths and mostly the area of development in the clinical protocols and proficiency in personal protective equipment use.

Conclusion: Simulation exercises can be beneficial in examining the readiness of the hospitals, including infrastructures, protocols, surge capacity, and staff competencies to deal with real-time health emergencies and to find solutions to fill the gaps. This study provided valuable feedback and opportunities for healthcare staff to practice before the peak of the COVID-19 pandemic was reached in Saudi Arabia. Establishing an out emergency department respiratory illness facility for initial screening of potential COVID-19 patients is recommended for proper containment while still providing the standard assessment, triage, and management practices.

Keywords: SARS-CoV-2, hospital disaster preparedness, disaster planning, surge capacity, isolation, simulation exercise, infection control.

Introduction

In December 2019, the coronavirus severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was identified as the cause of an outbreak of an emerging respiratory illness (pneumonia) of unknown origin, in Wuhan, China [1,2]. As named coronavirus disease 19 (COVID-19), it comprises the seventh member of the coronaviruses family that can infect humans [3]. Although most human coronavirus infections are mild, two β-coronaviruses [SARS-CoV in 2002 and Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012] were responsible for large-scale epidemics with well over 10,000 fatalities [4,5].

On the 31st of January 2020, the World Health Organization (WHO) announced COVID-19 as the sixth public health emergency of international concern

Correspondence to: Ghada A. Merdad
*Department of Emergency Medicine, College of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia.
Email: ghada.merdad@gmail.com
Full list of author information is available at the end of the article.
Received: 25 November 2020 | **Accepted:** 21 March 2021

since the H1N1 in 2009 [6]. Later, on 11th March, the WHO raised the COVID-19 status to a global pandemic [7]. At the present moment, COVID-19 is confirmed in 216 countries and/or territories, with over 105 million confirmed cases and 2.3 million deaths [8].

In Saudi Arabia, the first reported case of COVID-19 was on 2nd March 2020 [9]; to date, there have been 370,634 confirmed cases and 6,406 deaths [8].

The COVID-19 pandemic represented - and still is - a critical challenge for health services in all countries for a variety of reasons, not least of which is the sometimes indistinguishable symptoms to a number of other respiratory conditions, making it a challenge to detect, diagnose, and isolate. As a result, in the first few months of the pandemic, clinicians have had to aid diagnosis by indirect means, such as history of travel abroad, patient working conditions, or physical contact with confirmed COVID-19 case, that could account for exposure [10,11]. With the rapid spread of the infection and the absence of definitive treatment or vaccines, COVID-19 infection was a major healthcare crisis.

During public health emergencies, adequate procedures and emergency department (ED) facilities are vital in the initial response and containment, especially for respiratory infectious diseases. Crowded waiting areas, management rooms, and limited ability for ensuring isolation have been shown to facilitate the transmission of infections to patients, visitors, and healthcare workers, leading to the infectious spread within hospitals and surrounding communities [12-14]. With this in mind, it is readily apparent that ED teams should not only be skilled in screening and treatment procedures, but also in prevention and control.

There has been an ever-increasing pressure on healthcare workers to provide a reliable method to deal with public health emergencies. Practice-based exercises have been used as a significant method to aid in EDs' rapid-response ability, namely real-time disaster simulation exercises. These drills are designed to examine the response to mass casualty emergencies by recreating a disaster situation using mock victims, theoretical scenarios, or computer simulations [15-17]. By evaluating healthcare facilities' ability for recognizing and isolating communicable diseases and the effectiveness of observed emergency protocols, it has become possible to assess a medical center's preparedness to potential outbreaks, and to establish a national baseline regarding infectious disease control and prevention. Practice-based exercises are necessary to identify potential gaps and weaknesses and implement corrective actionable measures of healthcare facilities designated to provide care during the pandemic. However, there is still no consensus in the literature as to the best methods by which to assess these parameters.

Several tools are available, and more are being designed to assist hospital disaster planners and managers [18-22]; previous reports have emphasized the use of drills for assessing a center's preparedness to properly react to viral outbreaks (Ebola, Avian Influenza, MERS-CoV, Smallpox, etc.) and other sudden emergencies such as mass shootings and terrorism [13,16,23-27].

Nevertheless, the success of functional exercises to evaluate the response of the healthcare settings to an initial influx of the number of COVID-19 cases has not been investigated in the face of the COVID-19 potential disaster. Accordingly, our aim is to assess the preparedness of local EDs and to suggest methods for improvement for medical centers and staff in response to COVID-19.

Methodology

A functional exercise was developed and executed in conjunction with the simulation center at King Abdulaziz University Hospital (KAUH).

Setting

This exercise was conducted at the ED of KAUH, Jeddah, Saudi Arabia, during March 2020. KAUH is a tertiary academic hospital with 845 hospital beds, including 71 ED beds, and receives around 70,000 visits annually [28].

Drill planning and goals

The initial drill working team was a multidisciplinary team that included members from the disaster medicine and management section, ED, and infection control. They formulated a list of objectives (Table 1).

After the development of these objectives, in conjunction with the KAUH simulation center, the scenarios of four different patients were outlined. The exercise used the "Homeland Security Exercise and Evaluation Program" as a basis for its design [29].

The exercises were conducted in real-time with the clinical team in the ED. The ED team involved in the exercise was informed hours earlier about the exercise and instructed on how to remain safe during the entire process. The exercise utilized the influx of multiple suspected COVID-19 scenarios without disrupting ongoing patient care and allowed a unique opportunity to evaluate ED triaging, screening, isolation, assessment, sampling, transportation measures, and identifying common challenges encountered. Approval from hospital administration was obtained for the exercise.

Scenarios

During the exercise, four high-fidelity simulated patient mannequins (modeled on real-life patient standardized models) were brought to the ED; two critically ill patients simulated the clinical profile of COVID-19 that would usually result in admission to hospital (two adult patients with respiratory symptoms, CURB-65 (pneumonia severity index) 65 score = 3, one with a recent travel to a country with ongoing community transmission of COVID-19, and the other went recently to a facility with confirmed cases of COVID-19), while the remaining two patients had a profile that would normally result in being discharged home with proper follow-up and home isolation instructions (two stable patients with no co-morbidities, one was an adult who had a close family member with a recent history of COVID-19, and the other one was a pediatric patient who travelled recently to a country with ongoing community transmission of COVID-19).

Table 1. *The overall objectives of the drill.*

1. Evaluate the hospital ED plan and procedure in handling the sudden influx of patients with febrile respiratory illness in the form of the COVID-19 pandemic.
2. Evaluate the method of screening, according to the approved cases definition, of every visitor to the ED based on their travel history and symptomatology.
3. Evaluate the proper use of personal protective equipment (PPE) among hospital staff, especially the first responders.
4. Evaluate the practice of respiratory sampling, managing, disposition, and transporting suspected COVID-19 patients from the ED.

Table 2. *Example of a master sequence of events list.*

Inject	Participant	Expected actions
Suspected patient came to ED	Visual triage personnel	-Recognize patients with symptoms. -Establish a point of contact.
Establish Triage	Triage and registration teams	-Patient arrival and sorting. -Establish points of contact (masks -tissue - hand hygiene) - Patient registration process - Proper waiting area to limit the transmission of infection
Patient care and treatment	Doctors, nurses, and porters.	-Patient's care area. -Infection control measures. -Patients monitoring and equipment. -Procedures performing. -Limit patient movement. -Visitor's policy.
Patient's placement	ED team	- Built-in isolation rooms -Regular single room with HEPA (high-efficiency particulate absorbing) filter and infection control measures.

ED = emergency department; ICP = infection control personnel.

COVID-19 case definitions

The WHO guidelines and the Saudi Centre for Disease Prevention and Control COVID-19 surveillance case definitions and disposition were followed [10,30]:

Outcome measurements

The expectation of the exercise was to identify, isolate, triage, and register patients; to handle the influx of suspected cases to ED; taking respiratory samples, treating suspected cases of COVID-19, following the hospital infection control and environmental health unit policy, and liaising with other departments with regard to the patient's disposition and transportation (Table 2). Evaluators were given a handbook that included the scenario, discussion questions, and additional resources.

Evaluation

The performance was assessed by evaluators at each tested site using checklists that measure how well an activity was carried out and can be measured in terms of accuracy and quality. A group of six evaluators who were physicians and experts in disaster medicine was assigned for the evaluation process. Feedback was provided from evaluators, observers, and video records during the debriefing session. The planning and exercise materials, including evaluation guides, participant handouts, and after-action reports, and improvement plans, were reviewed.

Results

A total of 27 healthcare workers participated in the exercise, including two triage team members, five doctors, ten nurses, two registration employees, two security personnel, two porters, two cleaners, and two ICP.

Strengths were observed in the triaging and isolation of suspected cases of COVID-19 commonly, and lesser in PPE use. However, gaps between the expected and the observed actions were seen in all observed parameters (Table 3).

As shown in the table, the best adherence practice seen was in the procedures of triaging and isolation of the COVID-19 patients: from implementing screening stations, to addressing critically ill patients, and seen finally in placing them in the proper isolation area in a timely manner. Most of the first-line healthcare providers attended well-constructed PPE preparation courses, despite the deficiency identified in some of the PPEs when there is increased demand. The rated strengths and weakness of disposition and transporting of the suspected patients from the ED were approximately close. The least adherence practice seen was in handling the sudden and continuous influx of suspected patients. The ED capacity was not well-coordinated for managing the continuously increasing number of cases.

Discussion

COVID-19 has had a significant effect on healthcare systems worldwide [31]. With more than 34 million residents, Saudi Arabia provides free health services to the general public [32]. With all precautionary measures taken to prevent and slow down the spread of COVID-19, adequately preparing and appropriately responding to emerging respiratory pathogens is a fundamental requirement to enhance healthcare settings in Saudi Arabia.

Table 3. *Major strengths and weakness observed in relation to the study's goal.*

Triaging, isolation, and management	
Strengths	• A well-organized pathway for acute respiratory illness (ARI) and non-ARI patient. • Structured epidemiological and symptom screening tool and bilingual speakers. • On-site patient registration without direct patient contact. • Nurses asked the patients/relatives all of the required questions according to the latest guideline and scoring system. • Efficient communication between nurses and physicians with multiple channels • Well-ventilated designated rooms for the respiratory symptoms' patients separated from other kinds of patients. • A well-prepared infection isolation rooms with a proper instrument and HEPA filter. • Addressing critically ill patients immediately to their specific areas and use treatment plans according to the latest guideline. • Obtain sufficient specimen collection in a suitable packaging system and adequate processing and transportation. • Adequate communication with the infection control team in proper time.
Challenges	• Lack of staff familiarity with the disease • No standardized protocol was established for pediatric patients with suspected COVID-19 infection. • Need for more restriction of the movement of patients and their relatives in ED (security and E-access door(• Not all designated resuscitation area was equipped with HEPA filter and infection control measures to handle respiratory isolation. • Prolonged waiting time for the stable respiratory illness suspected cases to be seen and other non-respiratory illness patients coming to ED
Handling the sudden influx of patients with COVID-19 suspected patients	
Challenges	• Lapses on the security in controlling the crowd and restricting the movement of the incoming patients and their relatives. • Scarcity of the medical staff surge to respond properly to the sudden increase in symptomatic patients. • The need for the more designated waiting area for patients to be seated in with more physical separation (1.5 m space in between (• ED capacity to accommodate the increase in the number of stable patients coming with respiratory symptoms.
Personal Protective Equipment (PPE)	
Strengths	• Appropriate use of PPE among ED healthcare providers. • Proper donning and doffing among ED personnel • Coordinated PPE supply chain
Challenges	• Improper use of PPE by some of the healthcare providers and other ED staff, which was not based on risk exposure or transmission dynamic. • All staff did not test theN95 mask fitness, which could lead to the risk of getting COVID-19 infection using an unfitted size or type. • Some ED non-healthcare providers exhibited no proficient competency when donning and doffing their PPE. • No designated doffing and donning sites in the newly designated respiratory illness naturally ventilated areas.
Disposition and transporting suspected patients from the ED	
Strengths	• The proper and timely fashion of patient's disposition among the critically ill patients. • Proper transportation of suspected patients' inter- and intra-departmental using appropriate infection and arousal control measures. • Maintain good communication with other departments for referral and patient disposition.
Challenges	• Patients' contacts were not taken properly in some cases, some language barriers. • Delay in decision-making the pediatric case came with suspected respiratory illness.

Recent outbreaks of infectious diseases have exposed the vulnerability of the healthcare system to increase the transmission of diseases among healthcare workers and patients [12-14]. Those previous outbreaks highlighted the importance of rapid screening and isolation of patients, access to PPE, education of donning and doffing appropriately, and adhering to infection control measures.

Earlier research into infectious and non-infectious disaster drills has shown effectiveness in improving healthcare settings [13,16,23-27]. Practiced-based drills which are conducted within the patient care environment, aid in improving clinical team performance, detecting latent safety threats to patients and healthcare workers, and updating clinical protocols and infrastructure [15-17].

Accordingly, this functional exercise was designed to test the response measures of the ED to COVID-19 pandemic infection in order to discover and remove any possible gaps and weaknesses of the disaster management in our hospital. In the present study, participants were expected to identify COVID-19 cases besides handling suspected patients, symptomatic, and close contact. Moreover, the exercise is formulated to practice and maintain the current skills of PPE among the hospital staff, especially the first responders, in addition to examining placement and transferring of the suspected patients to isolation areas.

From the data collected by the drill evaluators, the best adherence practice of this exercise identified was in the procedures of triaging and isolation of the COVID-19 pandemic. However, latent safety threats were seen in all four concerned areas in the current study.

As revealed in our study, there was a significant success in developing and implementing screening stations (visual triage) that was established at the entrance to ED to identify suspected and close contact cases of COVID-19, addressing critically ill patients and placing patients in the proper isolation area in an appropriate time. The registration process carried out insight without interacting with the patient directly by the administrative staff or other patients. Nevertheless, due to the evolving new information and the vague presentation of the disease, there was a lack of disease familiarity among the medical staff. Standardized protocols of screening and triaging were not clear for patients' relatives and for pediatric patients. A protocolized treatment criteria and management plan were established to increase the efficacy of dealing with such a group of patients. Sometimes there was a language barrier between healthcare providers and some patients who speak with languages other than Arabic and English. The drill emphasized the need to minimize the unnecessary movement of patients or their relatives in the ED and control the crowed by security staff in order to decrease the mode of transmission of such virulent disease.

Regarding the proper use of PPE, the ED staff showed a good adherent and awareness with the procedure, in terms

of how to put on, remove, and dispose of it. Most of the first-line healthcare providers attended well-constructed PPE preparation courses. The PPE appropriately used included medical masks, gowns, gloves, eye protection (goggles or face shields). Although there was a deficiency in some of the PPEs with increasing demand, a proper and expanded supply chain plan was placed. Other measures that were suggested to minimize the need for PPE while protecting healthcare providers and other people from exposure to the infection is restricting the number of attending healthcare workers to respiratory treatment zone if they are not involved in patient's direct care, restricting the number of visitors and acquaintances, and adopting the extended use protocol when caring for multiple respiratory illness patients.

Finally, our results showed a huge concern in handling the sudden influx of suspected patients. ED capacity was not well-matched for accommodating, isolating, and managing the continuously increasing number of patients. The abrupt increase of ambulatory patient's coming to ED with respiratory symptoms will alleviate crowding the limit waiting areas, which might lead to an increase in the rate of transmission of nosocomial infection. Adding more space to the waiting areas by utilizing classrooms and meeting rooms is one of the earliest strategies developed to overcome this issue. The limitations of space and shortage of medical staffing were critical issues as the influx of patients with the progress of the pandemic expected to rise and might exceed capacity. Establishing treatment areas for stable patients in unconventional locations, making more room for the higher risk patients that need intensive care, expanding the staff by recruiting support from allied healthcare and trainees, and establishing alternative care site are all strategies and methods to expand the surge capacity.

Overall, the current functional exercise designed was able to estimate the potential readiness of our ED to the COVID-19 pandemic. At the same time of our study, *in situ* simulation was conducted as a part of a study to test the preparedness of operating room response measures taken in a tertiary hospital, Singapore. Their result is in accordance with our study. They showed that the simulation was valuable in evaluating the feasibility of set-ups or workflow of the operating room to identify the unexpected problems in unfamiliar situation. However, they did not individually assess each procedure taken [33].

In June 2020, a Canadian team in two EDs, Toronto, tested the preparedness for COVID-19 using rapid cycle *in situ* simulation [34]. Their study was designed to assess PPE, personal, supply and environment, and finally the communication. The *in situ* simulation was helpful to implement new based on feedback they received, which allowed for incremental improvements in their practice, especially in personal safety.

As a result of our study, an out ED respiratory illness alternative care site was recommended to be established in our hospital in order to control the abrupt increase in hospital and ED registers during a pandemic period, decrease the susceptibility of infection transmission among patients and healthcare workers, decrease the crowdedness in waiting areas, and decrease waiting time. The development of an organized team within a well-designed infrastructure clinic will assess suspect pandemic COVID cases that are not in need of high-level ED care and will be beneficial for the healthcare facility during the pandemic season.

Limitations

There were only four mock victims in our exercise. Including more mock cases can give more comprehensive and reliable results showing additional strengths and weaknesses. One other limitation is that this exercise type does not allow adequate evaluation regarding communication, coordination, process, and structure of the hospital incident command system. A table-top exercise or large-scale exercise may provide a better chance to evaluate and assess these aspects.

Conclusion

COVID-19 infection is a critical challenge for healthcare services. EDs are vulnerable points in pandemic disasters. Simulation exercises can be beneficial in examining the readiness of the hospitals, including infrastructures, protocols, surge capacity, and staff competencies to deal with real-time healthcare emergencies and to find solutions to fill the gaps. This study provided valuable feedback and opportunities for healthcare staff to practice before the peak of the pandemic COVID-19 was reached in Saudi Arabia. The development of an alternative care respiratory illness facility as dedicated space is recommended for the proper standardized management of patients and to decrease the opportunity of infection transmission.

Conflict of interest
The authors declare that there is no conflict of interest regarding the publication of this article.

Funding
None.

Consent to participate
Written consent was obtained from all the participants.

Ethical approval
Ethical approval was granted by The Unit of Ethics and Research Committee via reference number No 460-20 dated: September 7, 2020.

Author details
Ghada A. Merdad[1], Abdulrahman A. Sindi[1], Wejdan R. Alsaiari[2], Taha M. Masri[1]
1. Department of Emergency Medicine, College of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia
2. College of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

References

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497–506. https://doi.10.1016/S0140-6736(20)30183-5
2. Lu H, Stratton CW, Tang YW. Outbreak of pneumonia of unknown etiology in Wuhan, China: the mystery and

the miracle. J Med Virol. 2020;92(4):401–2. https://doi.10.1002/jmv.25678

3. Chan JFW, Kok KH, Zhu Z, Chu H, To KKW, Yuan S, et al. Genomic characterization of the 2019 novel human-pathogenic coronavirus isolated from a patient with atypical pneumonia after visiting Wuhan. Emerg Microbes Infect. 2020;9(1):221–36. https://doi.10.1080/22221751.2020.1719902
4. Chan JF, Lau SK, To KK, Cheng VC, Woo PC, Yuen KY. Middle east respiratory syndrome coronavirus: another zoonotic betacoronavirus causing SARS-like disease. Clin Microbiol Rev. 2015;28(2):465–522. https://doi.10.1128/cmr.00102-14
5. Cheng VCC, Lau SKP, Woo PCY, Yuen KY. Severe acute respiratory syndrome coronavirus as an agent of emerging and reemerging infection. Clin Microbiol Rev. 2007;20(4):660–94. https://doi.10.1128/CMR.00023-07
6. World Health Organization. Rolling updates on coronavirus disease (COVID-19) 2020 Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen.
7. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation report – 52 2020 Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200312-sitrep-52-covid-19.pdf?sfvrsn=e2bfc9c0_4.
8. World Health Organization. Weekly epidemiological update. [cited 2021 Feb 9] Available from: https://www.who.int/publications/m/item/weekly-epidemiological-update---9-february-2021
9. Ministry of Health. MOH reports first case of coronavirus infection 2020 [cited 2020 Mar 2]. Available from: https://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2020-03-02-002.aspx
10. Saudi Center for Disease Prevention and control. Quick interim guide to COVID-19 surveillance case definitions and disposition 2020 [cited 2020 April 2]. Available from: https://covid19.cdc.gov.sa/wp-content/uploads/2020/04/AREN_Quick-Guide-to-COVID-19-Surveillance-Case-Definitions-and-Disposition-v2.pdf
11. European Centre for Disease Prevention and Control. Case definition for coronavirus disease 2019 (COVID-19) 2020 [cited 2020 May 29]. Available from: https://www.ecdc.europa.eu/en/covid-19/surveillance/case-definition.
12. Liang SY, Riethman M, Fox J. Infection prevention for the emergency department: out of reach or standard of care? Emerg Med Clin North Am. 2018;36(4):873–87. https://doi.10.1016/j.emc.2018.06.013
13. Maltezou HC, Wicker S. Measles in healthcare settings. Am J Infect Control. 2013;41(7):661–3. https://doi.10.1016/j.ajic.2012.09.017
14. McDonald LC, Simor AE, Su IJ, Maloney S, Ofner M, Chen KT, et al. SARS in healthcare facilities, Toronto and Taiwan. Emerg Infect Dis. 2004;10(5):777–81. https://doi.10.3201/eid1005.030791
15. Dausey DJ, Buehler JW, Lurie N. Designing and conducting tabletop exercises to assess public health preparedness for manmade and naturally occurring biological threats. BMC Public Health. 2007;7(1):92. https://doi.10.1186/1471-2458-7-92
16. Foote M, Daver R, Quinn C. Using "Mystery Patient" drills to assess hospital ebola preparedness in New York City, 2014-2015. Health Secur. 2017;15(5):500–8. https://doi.10.1089/hs.2016.0130
17. Petrosoniak A, Auerbach M, Wong AH, Hicks CM. In situ simulation in emergency medicine: moving beyond the simulation lab. Emerg Med Australas. 2017;29(1):83–8. https://doi.10.1111/1742-6723.12705
18. Adini B, Laor D, Hornik-Lurie T, Schwartz D, Aharonson-Daniel L. Improving hospital mass casualty preparedness through ongoing readiness evaluation. Am J Med Qual. 2012;27(5):426–33. https://doi.10.1177/1062860611432303
19. Adini B, Verbeek L, Trapp S, Schilling S, Sasse J, Pientka K, et al. Continued vigilance - development of an online evaluation tool for assessing preparedness of medical facilities for biological events. Front Public Health. 2014;2:35. https://doi.10.3389/fpubh.2014.00035
20. Djalali A, Carenzo L, Ragazzoni L, Azzaretto M, Petrino R, Della Corte F, et al. Does hospital disaster preparedness predict response performance during a full-scale exercise? A pilot study. Prehosp Disaster Med. 2014;29(5):441–7. https://doi.10.1017/s1049023x1400082x
21. Marcozzi DE, Lurie N. Measuring healthcare preparedness: an all-hazards approach. Isr J Health Policy Res. 2012;1(1):42. https://doi.10.1186/2045-4015-1-42
22. Vasa A, Madad S, Larson L, Kraft CS, Vanairsdale S, Grein JD, et al. A novel approach to infectious disease preparedness: incorporating investigational therapeutics and research objectives into full-scale exercises. Health Secur. 2019;17(1):54–61. https://doi.10.1089/hs.2018.0100
23. Cardeñosa N, Domínguez A, Carratalà J, Ricarte JI, Jansà JM, Arnau J, et al. Usefulness of simulated cases for assessing pandemic influenza preparedness plans. Clin Microbiol Infect. 2010;16(9):1364–7. https://doi.10.1111/j.1469-0691.2009.03144.x
24. Foote MMK, Styles TS, Quinn CL. Assessment of hospital emergency department response to potentially infectious diseases using unannounced mystery patient drills - New York City, 2016. MMWR Morb Mortal Wkly Rep. 2017;66(36):945–9. https://doi.10.15585/mmwr.mm6636a2
25. Klein KR, Atas JG, Collins J. Testing emergency medical personnel response to patients with suspected infectious disease. Prehosp Disaster Med. 2004;19(3):256–65. https://doi.10.1017/s1049023x00001850
26. Leiba A, Goldberg A, Hourvitz A, Amsalem Y, Aran A, Weiss G, et al. Lessons learned from clinical anthrax drills: evaluation of knowledge and preparedness for a bioterrorist threat in Israeli emergency departments. Ann Emerg Med. 2006;48(2):194–9, 9.e1–2. https://doi.10.1016/j.annemergmed.2005.12.006
27. Wexler B, Flamm A. Lessons learned from an active shooter full-scale functional exercise in a newly constructed emergency department. Disaster Med Public Health Prep. 2017;11(5):522–5. https://doi.10.1017/dmp.2016.181
28. Abualenain J. Characteristics of emergency department visits at King Abdulaziz University Hospital: a one year analysis. J King Abdulaziz Univ. 2018;25(1):7. https://doi.10.4197/med.25(1)
29. FEMA. Homeland security exercise and evaluation program 2020 [cited 2020 Jan]. Available from: https://www.fema.gov/media-library-data/1582669862650-94efb02c8373e28cadf57413ef293ac6/Homeland-Security-Exercise-and-Evaluation-Program-Doctrine-2020-Revision-2-2-25.pdf

30. World wide Organization. Coronavirus disease 2019 (COVID-19). Situation Report – 61 2020 [cited 2020 Mar 20]. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200321-sitrep-61-covid-19.pdf?sfvrsn=ce5ca11c_2

31. Mensah D, Asampong R, Amuna P, Ayanore MA. COVID-19 effects on national health system response to a local epidemic: the case of cerebrospinal meningitis outbreak in Ghana. Pan Afr Med J. 2020;35(Suppl 2):14. https://doi.10.11604/pamj.2020.35.2.23138

32. General authority of statistics Kingdom of Saudi Arabia. Available from: https://www.stats.gov.sa/en/indicators/1

33. Wong J, Goh QY, Tan Z, Lie SA, Tay YC, Ng SY, et al. Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore. Can J Anesth. 2020;67:732–45. https://doi.10.1007/s12630-020-01620-9

34. Dharamsi A, Hayman K, Yi S, Chow R, Yee C, Gaylord E, et al. Enhancing departmental preparedness for COVID-19 using rapid cycle in situ simulation. J Hosp Infect. 2020;105(4):604–7. https://doi.10.1016/j.jhin.2020.06.020