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Preparing for emerging respiratory pathogens such as SARS-CoV, MERS-CoV, and SARS-CoV-2

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SUMMARY

Preparing for emerging respiratory pathogens is a fundamental requirement for enhancements of the safeguard in healthcare settings. We are facing an increasing pressure to be prepared more than before. Healthcare organizations should be ready to deal with such emerging infectious disease. Here, we share some points that are essential to be considered while we

prepare our institutions to prevent the transmission of emerging respiratory pathogens such as MERS-CoV and the recently emerging pandemic of SARS-CoV-2, the causative agent of COVID-19.

Keywords: Preparedness; emerging respiratory infections; MERS-CoV; COVID-19; SARS-CoV-2.

INTRODUCTION

Preparing for emerging respiratory pathogens is a fundamental requirement for enhancements of the safeguard in healthcare settings. For a long-time, we had feared the emergence of a novel pathogen that would result in a pandemic. The question is not if it will happen or not, but when it is going to happen. In 2002, we had witnessed the emergence of Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) in Guangdong Province, China [1,2]. Then cases were described in multiple countries including Vietnam, Hong Kong, Canada, United States, Ireland, Vietnam, and Singapore [1, 3-10]. All the mentioned cases were linked to a patient who stayed in hotel M in Hong Kong [11]. In 2012, we

had seen the emergence of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) [12-14]. MERS-CoV was associated with multiple healthcare associated outbreaks and this became a hallmark of MERS-CoV [15-17]. In December 2019, the 2019-novel coronavirus (nCoV), later termed COVID-19, emerged in Wuhan city, China, and this virus is called SARS-CoV-2. There are multiple factors for the emergence and amplification of infectious diseases as outlined by the World Health Organization [18, 19]. Thus, we are facing an increasing pressure to be prepared more than before. Here, we share some points that are essential to be considered while we prepare our institutions to prevent the transmission of emerging respiratory pathogens such as the 2019 nCoV (SARS-CoV-2), the etiologic agent of COVID-19.

Administrative support

Infection Prevention and Control (IPC) encompasses the administrative level as well as the healthcare workers. Involving the top hospitals'

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management staff such as the chief executive officer, the chief medical, nursing and operating officers to ensure appropriate and timely support for all IPC preventive measures and plans. These administrators are expected to allocate adequate resources and personnel to the infection control department.

Communication plans

It is imperative to have an excellent communication plan that covers multiple aspects of the preparedness. In a study of pandemic influenza preparedness, the preparation and risk communication scored 48% [20]. Health risk communication in the event of emerging infectious diseases is important to mitigate negative consequences and requires a coordinated efforts [21]. Effective communication should ensure active internal reporting system between the hospital departments and infection prevention and control staff. This communication should also include an active reporting system within the overall health system in a country in relation to suspected or confirmed cases. Emerging infectious disease epidemics and pandemics similar to other crises necessitate unique forms of communication [22]. In addition, it is important to have consultation with the public and key stakeholder in the development of planning strategies for communication [23]. This activity is further enhanced by the rapidly growing social media and these media could be used to disseminate information quickly and widely [24].

Personal Protective Equipment (PPE)

Personal protective equipment is a part of standard precautions and includes the use of gowns, gloves, and protective mask or goggles. The availability of all required IPC supplies with easy access to all staff should be ensured at all the times. Healthcare organizations may need to develop a stringent plan of communications to ensure achieving of personal protection.

“Zero tolerance” policy regarding IPC measures violation

It is important to implement and strictly observe a “zero tolerance” policy regarding the non-adherence to IPC measures and that they should not tolerate violation among staff. Additionally, adopting a zero-tolerance approach to IPC measures violation is an achievable and an imperative

goal in the setting of increasing health-care associated transmissions of multiple organisms and the occurrence of outbreaks [25]. This approach had recently received criticism as the occurrence of one infection after a period of zero infection had resulted in blaming the infection control program for such occurrence. Thus, the initial concept was associated with positive outcomes, it later got more negative connection necessitating the need to express the message in a more positive way [26].

The emergence of MERS-CoV was linked to the multiple healthcare associated outbreaks and this is a hallmark of MERS [15]. Many of these outbreaks were brought under control with the basics of infection control measures. So, it is very important to deliver a positive message for adherence to infection control standards at all time and avoid the blame game and such program had been implemented to target zero tolerance to hand hygiene non-compliance [27].

Visual or Numerical Triage Scoring System

For effective and immediate isolation of patients suspected to have infectious diseases, healthcare workers (HCWs) should have a high index of suspicion. Such suspicion is improved by specific triage policies and procedures such as the utilization of visual alertness to prompt HCWs to further screen suspected patients for fever, respiratory symptoms, and epidemiologic links for early detection and isolation. Visual or numerical triage scoring system utilizes a scoring system based on the case definition and assign a relative score for each epidemiologic link, clinical link and signs or symptoms. Such a triage system was used by the Saudi Ministry of Health MERS-CoV as shown in table 1 and 2 [28]. Visual triage or otherwise known as respiratory triage should be efficient and utilized as visual clues to alert HCWs on the case definitions and can be used in emergency room (ER), hemodialysis unit, and urgent care units. Such visual triage was used in the case of MERS-CoV in Saudi Arabia [29, 30]. The main purpose of such visual triage is the identification of possible cases meeting the case definition through the application of evidence from objective observation of the patient's characteristics to prioritize emergency treatment. One study found that visual triage scoring system to have sensitivity and specificity of this cutoff score

Table 1 - Visual triage showing clinical symptoms and signs in one section and the second section showing epidemiologic link to MERS-CoV.

A. Clinical/ symptoms/sign		Points	Score
1	Fever ($\geq 38^{\circ}\text{C}$)	2	
2	Cough (New or worsening)	2	
3	Shortness of breath (New or worsening)	2	
4	Nausea, vomiting, diarrhea	1	
5	Sore throat and/or runny nose	1	
6	DM. Chronic renal failure. CAD/heart failure	1	
B. Risk of exposure to MERS			
7	Exposure to a confirmed MERS case in last two weeks	3	
8	Exposure to camel or products (Direct or indirect*) in the last two weeks	2	
9	Visit to health care facility that has MERS case in last two weeks	1	
Total Score			

*Patient or household.

DM = Diabetes Mellitus.

CAD = Coronary Artery Disease.

MERS = Middle East Respiratory Syndrome Coronavirus infection.

of 74.1% and 18.6%, respectively for MERS-CoV infection [30].

Emerging Infectious Disease Drill

In a study evaluating infectious disease drills for MERS, measles and Ebola cases, 40% of hospitals failed at least one drill [31]. In addition, the drill identified lapses in infection control such as: hand hygiene (36%), PPE use (74%), and posting of isolation signage (70%) [31]. These drills utilized unannounced mystery patient drills to test preparedness for MERS and measles and other drills utilized patients imitating smallpox infection or anthrax exposure [31-33]. Recently, the Central Board of Accreditation of Healthcare Institutions (CBAHI) in Saudi Arabia had launched such a program to test the preparedness of hospitals to recognize and manage patients suspected to have COVID-19. Such unannounced inspections are thought to strengthen hospitals' infection control measures and reduce risk of infectious disease transmission [34]. In a previous study of unannounced mystery patient simulating avian influenza attending emergency departments and public health centers showed that 89% did not respond correctly [34]. It is important to realize

Table 2 - Respiratory Triage Checklist for MERS-CoV and COVID-19 from the Saudi Ministry of Health.

Risks for Acute Respiratory Illnesses	Score	
A. Exposure Risks	Any Patient (Adult or Pediatric)	
A history of travel abroad during the 14 days prior to symptom onset. OR Visiting or being a resident of a high-risk area for COVID-19 in the kingdom during the 14 days prior to symptom onset*. OR A close physical contact with a confirmed case of COVID-19 or MERS-CoV in the past 14 days. OR An exposure to camel or camel's products (direct or indirect**) in the past 14 days.	3	
B. Clinical Signs and Symptoms and Medical History	Pediatric	Adult
1. Fever or recent history of fever.	1	2
2. Cough (new or worsening).	1	2
3. Shortness of breath (new or worsening).	1	2
4. Nausea, vomiting, and/or diarrhea.	–	1
5. Chronic renal failure, CAD/heart failure, Immunocompromised patient.	–	1
Total Score		

*As determined and announced by the Ministry of Interior or Ministry of Health.

**Patient or household.

A score ≥ 4 , ask the patient to perform hand hygiene, wear a surgical mask, direct the patient through the respiratory pathway and inform MD for assessment. MERS-CoV OR COVID-19 testing should be only done according to case definitions.

geographic/cultural variations in holding such drills. In addition, drills are valuable to identify those failures so that specific corrective action can be taken and thus doing drills actually leads to improved outcomes.

Staff accommodation for isolation or quarantine

Quarantine is the separation or restriction of movement of exposed well persons for the duration of the incubation period. The origin of the word quarantine comes from the Latin *quadragesima* or the Italian *quaranta*, meaning 40, as sailors were observed 40 days before disembarkation of ship during the bubonic and pneumonic plague [35]. This procedure could be accomplished at home or in a designated quarantine location. These spaces should be available and ready to be used at any time with availability of all required supply. During emerging respiratory illnesses, there will be a need to isolate and quarantine staff. During SARS, there were government quarantine facilities, and those needing quarantine were positioned in individual rooms and meals were delivered [35]. For healthcare workers who had unprotected exposure to MERS-CoV, for example, it is required to quarantine themselves and SARS exposed staff were quarantined after exposure [36, 37]. In Hong Kong, 131,132 persons (50,319 close contacts and 80,813 travelers) were placed in quarantine [35].

Routine Audits and Rounds by the Infection Prevention and Control Staff

Infection control risk assessment through routine audits and rounds is essential to monitor and protect healthcare facilities. These activities are very important to monitor compliance with infection control practices but also important as IPC staff would utilize these rounds for education and training on the case definitions. Thus, more routine and more frequent rounds/visits by IPC staff to all hospitals areas/departments especially for high risk areas such as critical care, emergency rooms, hemodialysis, and burn units are recommended. It is important to ensure the best utilization of the IPC link nurses/staff to support the staff with this regards mainly after working hours. Hospitals had long been doing audit and feedback on fundamental concepts in infection control such as hand hygiene with the development of an improvement plan to increase com-

pliance [38-40]. Thus, it is also very important to maximize these audits to include case definitions and understanding of emerging infectious diseases. Audit is based on five steps: choosing a topic, stipulating suitable practice standards, testing actual practice by collecting data, correcting practice, and then to show improvement in practice (closing the loop) [41, 42].

Immediate Recognitions and Isolation of Suspected Patients

It is essential that HCWs are well trained on the case definitions for any emerging infectious disease to allow prompt identification and isolation of such patients. Case definitions usually rely on the presence of symptoms and epidemiologic link. It is important to ensure proper implementation of isolation with minimum exposure to the patients. One strategy could use the Identify-Isolate-Inform tool. This tool was developed for Ebola virus disease containment and was adopted for other communicable diseases such as measles [43, 44].

Airborne Infection Isolation (AII) Rooms

Airborne Infection Isolation (AII) rooms, otherwise known as negative pressure isolation rooms, are structurally engineered spaces that contain airborne particles within it. Ensuring appropriate functioning of negative pressure isolation rooms is important in airborne infections. In a study in the USA, negative-pressure isolation rooms of surveyed hospitals with airborne precautions were available in 77% [45]. In another study in 2009 in USA, it is reported that 15% of hospitals does not have sufficient numbers of negative-pressure rooms to accommodate current isolation needs [46]. Although, hospitals might not have sufficient Airborne Infection Isolation rooms, healthcare organizations should have plans for interim AII rooms surge capacity allowing to convert rooms or areas to safely accommodate patients requiring AII on an emergent base pending the availability of a longer term AII rooms. Such surge capacity was indicated by 71% of organization in one survey [46]. SARS-CoV-2 is considered to be transmitted through contact and droplet as the mode of transmission, however, it is still strongly recommended to perform any aerosol generating procedures under negative pressure environment [47].

N-95 and Respirator Training and Availability

N-95 respirators are important parts of the personal protective equipment during the care of patients requiring airborne infection isolation (AII) precautions. The 'N' class indicates protection against non-oil-based aerosols and '95' represents that the respirator is at least 95% efficient at filtering particles with a median diameter $>0.3 \mu\text{m}$ [48]. The use of powered air-purifying respirator (PAPR) is needed for those who could not be fit tested. PAPR draws air through a filter and delivers a filtered air under positive pressure to a hood that is worn by the healthcare worker [49]. PAPR is much more expensive than N-95 respirators [50]. The use of PAPR was common during the SARS outbreak and in one study 84% preferred PAPR over N-95 respirator [50]. It is imperative to make sure that healthcare workers receive N-95 respirator fit testing or PAPR training. The purpose of fit-testing is to make sure that the healthcare worker has an N-95 respirator with the correct brand, model, and size designed that appropriately seals the face [51]. In addition, the training will focus on adequate training of donning and doffing of personal protective equipment and the practice of seal-check with each use of N-95 respirator [52]. It was found that N-95 fit testing reduced geometric mean exposures to airborne particles from 25% to 4% of ambient levels before and after quantitative fit-testing, respectively [53]. On the other hand, PAPR have high-efficiency particulate air (HEPA) filters which filter $>99.97\%$ of oil proof particles $0.3 \mu\text{m}$ in diameter [54]. Thus, it is important to have adequate supply and training on N-95. One study showed the availability of N-95 mask in 95% of Emergency departments [45]. Another study showed that there was no difference in video presentation, small group demonstration, and self-directed slide show just-in-time training modalities for N-95 fit testing [55].

CONCLUSION

The emergence of the COVID-19 pandemic had illustrated to all healthcare organizations, the need to be prepared for such occurrence. It might had been a theoretical risk but the COVID-19 had showed the reality. This review had shed some light on few areas of concern for healthcare organizations and further studies are needed to optimize preparedness.

Conflicts of interest

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REFERENCES

- [1] Lee N, Hui D, Wu A, et al. A major outbreak of severe acute respiratory syndrome in Hong Kong. *N Engl J Med.* 2003; 348, 1986-94.
- [2] Shaw K. The 2003 SARS outbreak and its impact on infection control practices. *Public Health.* 2006; 120, 8-14.
- [3] Leung GM, Hedley AJ, Ho L-M, et al. The epidemiology of severe acute respiratory syndrome in the 2003 Hong Kong epidemic: an analysis of all 1755 patients. *Ann Intern Med.* 2004; 141, 662-73.
- [4] Tsang KW, Ho PL, Ooi GC, et al. A cluster of cases of severe acute respiratory syndrome in Hong Kong. *N Engl J Med.* 2003; 348, 1977-85.
- [5] Poutanen SM, Low DE, Henry B, et al. Identification of Severe Acute Respiratory Syndrome in Canada. *N Engl J Med.* 2003; 348, 1995-2005.
- [6] Centers for Disease Control and Prevention (CDC). Outbreak of severe acute respiratory syndrome--worldwide, 2003. *MMWR Morb Mortal Wkly Rep.* 2003; 52, 226-8.
- [7] Centers for Disease Control and Prevention (CDC). Preliminary clinical description of severe acute respiratory syndrome. *MMWR Morb Mortal Wkly Rep.* 2003; 52, 255-6.
- [8] Centers for Disease Control and Prevention (CDC). Update: severe acute respiratory syndrome--United States, June 4, 2003. *MMWR Morb Mortal Wkly Rep.* 2003; 52, 525-6.
- [9] Centers for Disease Control and Prevention (CDC). Severe acute respiratory syndrome (SARS) and coronavirus testing--United States, 2003. *MMWR Morb Mortal Wkly Rep.* 2003; 52, 297-302.
- [10] Centers for Disease Control and Prevention (CDC). Severe acute respiratory syndrome--Singapore, 2003. *MMWR Morb Mortal Wkly Rep.* 2003; 52, 405-11.
- [11] Parashar UD, Anderson LJ. Severe acute respiratory syndrome: review and lessons of the 2003 outbreak. *Int J Epidemiol.* 2004; 33, 628-34.
- [12] de Groot RJ, Baker SC, Baric RS, et al. Middle East Respiratory Syndrome Coronavirus (MERS-CoV): Announcement of the Coronavirus Study Group. *J Virol.* 2013; 87 (14), 7790-2.
- [13] Zaki AM, van Boheemen S, Bestebroer TM, Osterhaus ADME, Fouchier RA. Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. *N Engl J Med.* 2012; 367, 1814-20.
- [14] Corman VM, Eckerle I, Bleicker T, et al. Detection of a novel human coronavirus by real-time reverse-transcription PCR.

- scription polymerase chain reaction. *Euro Surveill.* 2012; 17 (39), 20285.
- [15] Al-Tawfiq JA, Auwaerter PG. Healthcare-associated infections: the hallmark of Middle East respiratory syndrome coronavirus with review of the literature. *J Hosp Infect.* 2019; 101, 20-9.
- [16] Hastings DL, Tokars JI, Abdel Aziz IZAM, et al. Outbreak of Middle East Respiratory Syndrome at Tertiary Care Hospital, Jeddah, Saudi Arabia, 2014. *Emerg Infect Dis.* 2016; 22, 794-801.
- [17] Garout MA, Jokhdar HAA, Aljahdali IA, Zein AR, Goweda RA, Hassan-Hussein A. Mortality rate of ICU patients with the middle east respiratory syndrome - Coronavirus infection at king Fahad hospital, Jeddah, Saudi Arabia. *Cent Eur J Public Health.* 2018; 26, 87-91.
- [18] Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. *Lancet.* 2020. doi: 10.1016/S0140-6736(20)30185-9.
- [19] World Health Organization. Anticipating Emerging Infectious Disease Epidemics 2016. www.who.int (accessed February 15, 2020).
- [20] Sambala EZ, Kanyenda T, Iwu CJ, Iwu CD, Jaca A, Wiysonge CS. Pandemic influenza preparedness in the WHO African region: are we ready yet? *BMC Infect Dis.* 2018; 18, 567.
- [21] Institute of Medicine (US) Forum on Emerging Infections. Emerging Infectious Diseases from the Global to the Local Perspective. National Academies Press; 2001. doi:10.17226/10084.
- [22] Covello VT, Peters RG, Wojtecki JG, Hyde RC. Risk communication, the West Nile virus epidemic, and bioterrorism: responding to the communication challenges posed by the intentional or unintentional release of a pathogen in an urban setting. *J Urban Health.* 2001; 78, 382-91.
- [23] Tam T, Sciberras J, Mullington B, King A. Fortune favours the prepared mind: a national perspective on pandemic preparedness. *Can J Public Health.* 2005; 96, 406-8.
- [24] Arguin PM, Navin AW, Steele SF, Weld LH, Kozarsky PE. Health communication during SARS. *Emerg Infect Dis.* 2004; 10, 377-80.
- [25] Warye KL, Murphy DM. Targeting zero health care-associated infections. *Am J Infect Control.* 2008; 36, 683-4.
- [26] Don't shoot the messenger: Downside of "zero-tolerance" approach to infections. *Hosp Infect Control* 2008; 35, 61-4. <https://www.reliasmedia.com/articles/12413-don-t-shoot-the-messenger-downside-of-zero-tolerance-approach-to-infections> (accessed February 22, 2020).
- [27] NHS. Title Zero Tolerance Hand Hygiene Policy Document Type Policy Document Number ICT001/07. 2014. <http://www.nhs.uk/media/271676/zero-tolerance-hand-hygiene-policy-nhs-borders-v2.pdf> (Accessed February 22, 2020).
- [28] Saudi Center for Disease Control and Prevention. Quick Interim Guide to COVID-19 Surveillance Case Definitions and Disposition 2020. <https://covid19.cdc.gov.sa/> (accessed May 1, 2020).
- [29] Al Marshed A, Nienaa M, Shadaid R, et al. Visual triage contributes toward early detection and management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV). *EC Microbiol.* 2017; 9.3, 121-30.
- [30] Alfaraj SH, Al-Tawfiq JA, Gautret P, Alenazi MG, Asiri AY, Memish ZA. Evaluation of visual triage for screening of Middle East respiratory syndrome coronavirus patients. *New Microbes New Infect.* 2018; 26, 49-52.
- [31] 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, 945-9.
- [32] 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.
- [33] Leiba A, Goldberg A, Hourvitz A, 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.
- [34] Cardenosa N, Domínguez A, Carratalà J, et al. Usefulness of Simulated Cases for Assessing Pandemic Influenza Preparedness Plans. *Clin Microbiol Infect.* 2009; 16, 1364-7.
- [35] Centers for Disease Control and Prevention (CDC). Use of quarantine to prevent transmission of severe acute respiratory syndrome -Taiwan, 2003. *Morb Mortal Wkly Rep.* 2003; 52, 680-3.
- [36] Saudi Ministry of Health. Middle East Respiratory Syndrome Coronavirus 2018 Guidelines for Healthcare Professionals 2018. https://www.moh.gov.sa/CCC/healthp/regulations/Documents/MERS-CoV_Guidelines_for_Healthcare_Professionals_-_May_2018_-_v5.1%281%29.pdf (accessed May 23, 2019).
- [37] [No authors listed]. Will your ED have staff quarantined for SARS? Brace yourself for the worst. *ED Manag.* 2003; 15 (5), 49-51, suppl 1.
- [38] Al-Tawfiq JA, Rothwell S, McGregor HA, Khouri ZA. A multi-faceted approach of a nursing led education in response to MERS-CoV infection. *J Infect Public Health.* 2018; 11 (2), 260-4.
- [39] Al-Tawfiq JA, Pittet D. Improving Hand Hygiene Compliance in Healthcare Settings Using Behavior Change Theories: Reflections. *Teach Learn Med.* 2013; 25 (4), 374-82.
- [40] Al-Tawfiq JA, Treble M, Abdrabalnabi R, Okeahialam C, Khazindar S, Myers S. Using targeted solution tools as an initiative to improve hand hygiene: challenges and lessons learned. *Epidemiol Infect.* 2017; 146 (2), 276-82.

- [41] French GL. Closing the loop: audit in infection control. *J Hosp Infect.* 1993; 24 (4), 301-8.
- [42] Hay A. Audit in infection control. *J Hosp Infect.* 2006; 62 (3), 270-7.
- [43] Koenig KL, Alassaf W, Burns MJ. Identify-Iso-late-Inform: A tool for initial detection and management of measles patients in the emergency department. *West J Emerg Med.* 2015; 16, 212-9.
- [44] Koenig KL. Identify, Isolate, Inform: A 3-pronged Approach to Management of Public Health Emergencies. *Disaster Med Public Health Prep.* 2015; 9, 86-7.
- [45] Kanwar A, Heppler S, Donskey C, Brown CK. A cross-sectional survey of measles preparedness in critical-access hospitals of Idaho. *Am J Infect Control.* 2019. doi: 10.1016/j.ajic.2019.11.015.
- [46] Rebmann T, Wilson R, La Pointe S, Russell B, Moroz D. Hospital infectious disease emergency preparedness: A 2007 survey of infection control professionals. *Am J Infect. Control* 2009; 37, 1-8.
- [47] Pegram A, Bloomfield J. Infection prevention and control. *Nurs Stand.* 2015; 29, 37-42.
- [48] Martyny J, Glazer CS, Newman LS. Respiratory protection. *N Engl J Med.* 2002; 347, 824-30.
- [49] Fennelly KP. Personal respiratory protection against *Mycobacterium tuberculosis*. *Clin Chest Med.* 1997; 18, 1-17.
- [50] Khoo K-L, Leng P-H, Ibrahim IB, Lim TK. The changing face of healthcare worker perceptions on powered air-purifying respirators during the SARS outbreak. *Respirology.* 2005; 10 (1), 107-10.
- [51] Coffey CC, Campbell DL, Myers WR. Comparison of six respirator fit-test methods with an actual measurement of exposure in a simulated health care environment: Part III--Validation. *Am Ind Hyg Assoc J.* 1999; 60, 363-6.
- [52] Yassi A, Moore D, Fitzgerald JM, et al. Research gaps in protecting healthcare workers from SARS and other respiratory pathogens: an interdisciplinary, multi-stakeholder, evidence-based approach. *J Occup Environ Med.* 2005; 47, 41-50.
- [53] Viscusi DJ, Bergman M, Sinkule E, Shaffer RE. Evaluation of the filtration performance of 21 N95 filtering face piece respirators after prolonged storage. *Am J Infect Control.* 2009; 37, 381-6.
- [54] Centers for Disease Control and Prevention (CDC). NIOSH Respirator Selection Logic 2004 2004. <https://www.cdc.gov/niosh/docs/2005-100/> (accessed March 6, 2020).
- [55] Jones, MD D, Stoler, MD G, Suyama, MD J. Effectiveness of three just-in-time training modalities for N-95 mask fit testing. *Am J Disaster Med.* 2013; 8, 283-6.