



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



ELSEVIER

EDITORIAL


<http://www.elsevier.com/locate/jiph>

Taming the beast: Hospital management of a nosocomial middle east respiratory syndrome outbreak



Humans have been battling pathogens for ages, long before they realized it and well before the germ theory was discovered in the sixteenth century [1]. Emerging infectious disease outbreaks have always been a significant cause of morbidity and mortality in humans and continue to be to this day. A number of these outbreaks have reached catastrophic proportions. A prime example is the 1918 Spanish flu that infected one third of the world's population at the time and claimed the lives of an estimated 50 million people [2]. After the establishment of the foundations of modern epidemiology in the 1850s, the unequal battle took a different turn. Many achievements have been accomplished through advances in bio-surveillance systems, infection control and prevention practices, improved diagnostics, vaccine manufacturing and pharmaceutical interventions [3]. However, the recent Severe Acute Respiratory Syndrome (SARS) pandemic and the deadly West African Ebola outbreak should serve as a reminder that this battle is far from over, and further research is still needed to enhance the detection and response to emerging infectious disease outbreaks [4].

The most recent chapter in this battle started when a novel coronavirus was discovered in November 2012 [4]. The virus was later named The Middle East Respiratory Syndrome Coronavirus (MERS-CoV), and it has been demonstrated to be one of the most fatal emerging pathogens in the 21st century. MERS-CoV is believed to be of zoonotic origin and has been recently linked to camels in the Arabian Peninsula [5]. Sporadic cases, travel-related clusters and nosocomial outbreaks of MERS-CoV infections have been reported

in 26 countries worldwide. According to the World Health Organization (WHO) reports, a total of 1644 laboratory-confirmed cases and 590 MERS-CoV-related deaths were recorded as of the 5th of March 2016 [6]. The majority of reported cases originated from Saudi Arabia, and hospitals in different regions of the country had experienced nosocomial clusters of variable sizes over the past three years [7,8]. The MERS outbreak at King Abdulaziz Medical City-Riyadh (KAMC-R) during August and September 2015 in particular caught media attention and raised global concerns regarding the vulnerability of healthcare facilities to MERS and the response capabilities of public health agencies and healthcare facilities to emerging infectious disease outbreaks [9].

The conceptual framework for hospital management of infectious disease outbreaks should ideally follow the four phases of the disaster management cycle that has been described for disasters in general [10]. The first phase is known as *the mitigation phase* and starts once the threat has been identified through a structured Hazard Vulnerability Analysis (HVA). Mitigation encompasses all actions taken to prevent or minimize the effect of a particular threat. This is usually followed by *the preparedness phase*, which includes the creation of response plans, training activities and exercises. When the disaster strikes, *the response phase* starts in order to address the effects of the disaster and reduce its impact on people, property and the surrounding environment. The final phase is *the recovery phase*, and it should begin as soon as possible after the disaster event with the aim of returning to pre-disaster conditions. This article will highlight

<http://dx.doi.org/10.1016/j.jiph.2016.03.002>

1876-0341/© 2016 King Saud Bin Abdulaziz University for Health Sciences. Published by Elsevier Limited. All rights reserved.

the preparedness and response activities that took place at KAMC-R during the MERS outbreak.

KAMC-R administration was quick to realize the unique threat of MERS and the need for special preparedness and planning. By early 2013, a special committee was appointed to update existing plans and improve infectious disease response capabilities. The committee representatives include all involved hospital departments, specialists in infectious diseases, and the director of the infection prevention and control department. After 9 months of weekly meetings and a number of drafts, the committee finally prepared a three-phase Infectious Disease Epidemic Plan (IDEP). The activation of phases was based on the number of confirmed cases of MERS in the hospital, and each phase specified a number of action items to ensure a well-coordinated hospital-wide response. Emphasis was placed on leadership, isolation unit allocation, specimen handling, laboratory procedures, communication, security, health care workers' safety and continuity of operations. This planning was followed by a tabletop exercise to test the plan and correct defects.

On the 21st of June 2015, a 67-year-old patient with multiple comorbidities presented to the Emergency Department (ED) with a fever and cough for more than 10 days and eventually tested positive for MERS-CoV via real-time Polymerase Chain Reaction (rPCR). Although direct links to secondary cases were not established, his hospital stay before death overlapped with subsequent cases. On the 15th of July, (approximately two weeks after the admission of the first patient), another middle-aged patient with multiple comorbidities, who had a strong history of camel exposure, presented to the ED with a fever, cough and shortness of breath and tested positive for MERS-CoV via rPCR. At least three of the early identified positive cases had been clearly linked to this case. Next, several cases of MERS were identified among inpatients and health care workers (HCWs). As part of the IDEP, contacts of confirmed/probable cases were screened for MERS-CoV, and additional cases were identified. By the beginning of August, positive cases were detected at multiple locations in the hospital, and most of them were linked to the exposure at the ED. Eventually, the number of confirmed cases in the hospital reached the activation threshold for Phase II of the IDEP, and it was activated on the 5th of August, signaling the beginning of the KAMC-R MERS-CoV outbreak response operation. The incident command center was immediately activated, and the hospital medical director assumed the role of the incident commander. A series of actions followed the activation as dictated by the IDEP. These actions

included ensuring that all suspected/confirmed cases were placed under proper isolation, cohorting suspected/confirmed cases in dedicated units, training HCWs in high-risk clinical areas for the use of personal protective equipment (PPE), performing fit-testing for the N-95 respirators, and escalating the monitoring process for the compliance to infection control and prevention practices.

On the 18th of August, the number of confirmed cases met the threshold for activation of phase III of the IDEP. The incident command team met twice daily and was responsible for the overall management of the hospital during the outbreak. The objectives identified during this response phase were as follows: closing non-critical services, cohorting suspected and confirmed cases in separate units, training and N-95 fit-testing for all HCWs, screening HCWs in high-risk clinical areas for MERS-CoV, restricting visitations and implementing tighter security control over all hospital entrances. The incident command center released daily reports and frequent staff debriefings to update hospital staff about the situation. As a result, outpatient clinics, dental services, elective surgical operations, physiotherapy services, the emergency department and all ancillary services were closed. Mutual aid agreements with partner health care providers were enacted to evacuate non-MERS cases to other health care facilities. Only critical services continued to operate during phase III, including hemodialysis, chemotherapy, prosthetic valve clinics, labor and delivery, and care of critically ill patients. A mobile hospital was placed outside the ED to triage patients away to other healthcare facilities and identify critically ill patients who required admission to the ED. Community engagement was also a vital part of the response, and it was accomplished through identifying spokesmen, joint press conferences and regular updates posted on social media outlets.

In this instance, the measures taken in phase III of the IDEP, in addition to partnership with local and international public health agencies, succeeded in stopping cross transmission and controlling the outbreak. The last recorded date of onset of symptoms of a MERS-confirmed case was on the 28th of August. However, the command center took a conservative approach regarding the decision to deactivate the IDEP and decided to extend the activation for twice the incubation period of a MERS-CoV infection. Finally, on the 18th of October, the IDEP was officially deactivated, marking the end of the outbreak.

Nosocomial infectious disease outbreaks are serious threats that can impose great stress on any given healthcare facility if not managed properly.

This experience resulted in a deeper understanding of nosocomial MERS outbreaks and highlighted significant room for improvement. The lessons learned at KAMC-R have initiated a transformation process that will support the ongoing task of eliminating shortcomings and mitigating future outbreaks.

References

- [1] Karamanou M, Panayiotakopoulos G, Tsoucalas G, Kousoulis AA, Androutsos G. From miasmas to germs: a historical approach to theories of infectious disease transmission [Le infezioni in medicina: rivista periodica di eziologia, epidemiologia, diagnostica, clinica e terapia delle patologie infettive]. *Infez Med* 2012;20:58–62.
- [2] Chandra S, Kassens-Noor E. The evolution of pandemic influenza: evidence from India, 1918–19. *BMC Infect Dis* 2014;14:510.
- [3] Cerda LJ, Valdivia CG. John Snow, the cholera epidemic and the foundation of modern epidemiology. *Revista Chilena de Infectologia: Organo Oficial de la Sociedad Chilena de Infectologia* 2007;24:331–4.
- [4] Ammon A. From SARS to Ebola – 10 years of disease prevention and control at ECDC. *Eur Commun Dis Bull* 2015;20.
- [5] Drosten C, Kellam P, Memish ZA. Evidence for camel-to-human transmission of MERS coronavirus. *New Engl J Med* 2014;371:1359–60.
- [6] <http://www.who.int/emergencies/mers-cov/en/> [accessed 05.03.16].
- [7] Drosten C, Muth D, Corman VM, Hussain R, Al Masri M, HajOmar W, et al. An observational, laboratory-based study of outbreaks of middle East respiratory syndrome coronavirus in Jeddah and Riyadh, kingdom of Saudi Arabia, 2014. *Clinical Infect Dis: Off Publ Infect Dis Soc Am* 2015;60:369–77.
- [8] <http://www.moh.gov.sa/en/CCC/PressReleases/Pages/default.aspx> [accessed 5.03.15].
- [9] Baffoe-Bonnie H, Al-Abdely HM, El-Saed A, Al Arbash HA, Al Mayahi ZK, Assiri AM, Bin Saeed A. Notes from the field: nosocomial outbreak of middle east respiratory syndrome in a Large Tertiary Care Hospital – Riyadh, Saudi Arabia, 2015. *MMWR Morb Mortal Wkly Rep* 2016;65(Feb (6)): 163–4.
- [10] James JJ. Education and training: integrating the disaster cycle. *Disaster Med Public Health Prep* 2014;8:279.

Sami A. Yousif (MD, SBEM)*

Emergency Medicine Department, King Saud bin Abdulaziz University for Health Sciences and King Abdullah International Medical Research Center, PO Box 22490, Riyadh 11426, Saudi Arabia

Thamer H. Alenazi (MD, SBIM, ArBIM, FRCP(Edin))
Medicine Department, Infection Control and Prevention Department, King Saud bin Abdulaziz University for Health Sciences and King Abdullah International Medical Research Center, Riyadh, Saudi Arabia

Yaseen Arabi (MD, FCCP, FCCM)
Intensive Care Department, King Saud bin Abdulaziz University for Health Sciences and King Abdullah International Medical Research Center, Riyadh, Saudi Arabia

* Corresponding author.

E-mail addresses: Dr_sami911@yahoo.com (S.A. Yousif), EnaziTH@ngha.med.sa (T.H. Alenazi), arabi@ngha.med.sa (Y. Arabi).

Available online at www.sciencedirect.com

ScienceDirect