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Research Article

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Incidence, management and outcome of MERS CoV outbreak in a hospital, Eastern Province, Saudi Arabia

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Abstract

Background: *In August 2014, there was a striking rise in positive cases of MERS-CoV was reported at a Hospital in the Eastern Province of Saudi Arabia (KSA) after unprotected exposure to a MERS-CoV patient. This study aims to report the outbreak of MERS-CoV in the hospital and the response implemented.*

Methods: *Rapid response team was activated and mobilized to the hospital. Epidemic investigation was conducted. Epidemiological data of patients and health care workers in relation to unprotected exposure was collected. Based on risk stratification, expanded surveillance among health care workers was conducted. A plan was initiated and implemented by the rapid response team in collaboration with the hospital's stakeholders and designated staff. The plan consisted of many aspects, including case finding and management, strict adherence to infection prevention and control measures, health care education, and their implementation. This was continued for 14 days after the last laboratory confirmed results.*

Results: *During the surveillance period, 8 HCWs (2 physicians, 6 nurses), and two patients in addition to the index case were positive to MERS CoV. One physician, a nurse and 2 patients had no direct contact with the index case. No additional cases were identified after gap identification and strict implementation of infection prevention and control measures at the hospital.*

Conclusions: *This outbreak of MERS-CoV was contained after implementing appropriate infection prevention and control measures. Early case identification and risk stratification might have played a major role in containing the cluster. This study highlights the importance of health care workers awareness, especially those on the front lines, and their response to case definition of MERS-CoV in KSA.*

Keywords: MERS CoV, Incidence, Management, Outbreak, Saudi Arabia

Introduction

At midnight of 21st of August 2014, a 69 year old male, known case of coronary artery disease, type 2 diabetes mellitus, hypertension, congestive heart failure and chronic renal failure, was admitted to the Intensive Care Unit (ICU) through the Emergency Department (ER) of Hospital "A", Eastern Province, KSA.

The patient was complaining of chest tightness, vomiting, shivering and epigastric pain, and was diagnosed as a case of coronary artery disease. In the ICU, he was started on Ceftriaxone and was stabilized. The following day (22 August) at 16:30, he was transported to the male medical ward where he was in good stable condition and mobilizing. His condition suddenly deteriorated and the patient was transported back to the ICU at 22:00 on the same day. He was complaining of fever (38.9°C) and dyspnea. He was desaturated and pulmonary infiltrates was found in chest X-ray. Diagnosis of pulmonary edema superadded chest infection was documented in his medical record. He was started on non-invasive positive pressure ventilation due to further deterioration in his respiratory status. On 23rd of August 2014, he was transferred to

hospital "B" where he was admitted in the ICU, open cubic bed. Chest X-ray revealed massive lung infiltration. Deterioration in renal function was additionally reported. On 24th of August, MERS-CoV was suggested as a differential diagnosis. Nasopharyngeal (NP) and oropharyngeal (OP) swabs were taken and the patient was shifted to a negative pressure room and intubated. Results of the swabs came positive for MERS-CoV. On inquiry from the patient's relatives, they admitted his recent contact with camels.

The patient died on 27th of August, 2014 of multiorgan failure. The Preventive medicine department in hospital "B" informed the referring hospital "A" of the result and proceeded to tracing contacts among the community.

After hospital "A" was informed of the positive result of the index case, the hospital noted the rise in further laboratory confirmed positive cases.

Description of the MERS-CoV Cluster in hospital A

After confirmation of the positivity of the index case, efforts were made towards contact tracing. Those who had unprotected exposure to the index case were traced and instructed to report any respiratory symptoms or fever. On 27th of August, four health care workers (HCWs) were found to complain of flu-like symptoms. Nasopharyngeal and oropharyngeal swabs were consequently taken. Swabs from a male nurse who transported the index case from the medical ward to ICU came positive for MERS-CoV, while the results of the rest came negative.

On 30th of August, five additional confirmed MERS-CoV cases were reported. Cases were an eighty year old female patient admitted in the female medical ward, and 4 nurses working in the ICU. Two of nurses had been working in the night shift. One of them had been assigned to the index case and the other was helping her when the patient had vomited. The following day, another positive result was reported from a nurse working in the male medical ward where the index case had been admitted, and had contact with the patient on his admission.

On the 1st of September, the eighth confirmed MERS-CoV case was reported. This was a patient admitted in the female medical ward, and her room was adjacent to the previously reported MERS-CoV patient. On the 2nd of September, a pediatrician, who was caring for pediatric ICU patients, developed respiratory symptoms and fever. NP and OP swabs were taken and results were negative for MERS-CoV. However, his symptoms worsened and swabs repeated on the 7th of September came positive. His condition deteriorated with time and he was intubated.

On 30th of August, as a part of active surveillance, NP and OP swabs were taken from an ICU physician and results were negative. Nevertheless, swabs were repeated on 10th of September, since he had accompanied the pediatric physician during his transfer to the corona referral center, confirmed positivity for MERS CoV. Therefore, by 10 September, there were 10 laboratory confirmed MERS-CoV cases, in addition to the index case.

The aim of this report is to describe the outbreak management including investigation, finding, response, in addition to, infection prevention and control procedures implemented to prevent further transmission of MERS-CoV within the hospital.

Clinical characteristics of laboratory confirmed MERS-CoV in Hospital A will be elaborated in details in further report. Laboratory and environmental results are out of the scope of this study.

The measures had been taken can be applied in era of COVID 19, or similar respiratory infection outbreak.

Hospital A is a 216 bed general hospital in the Eastern Province, KSA. The ICU is a close unit contains 10-beds, 2 are open cubic and the rest are closed rooms. Two of them have installed portable negative pressure tent. ICU has both adult and pediatric patients in the same zone, where entrance of two beds pediatric open room located in a corridor with other adults room. It is located approximately 7 meters away from the adult room previously occupied by the index case.

The hospital capacity was cut down to 140 beds due to expansion and renovation plan taking place at the time of the event. Each unit of care has separated common air duct and same design applied to all ward for all levels.

Methods

On confirmation of unprotected exposure of HCWs at Hospital A to the index case, the General Directorate of Health Affairs in EP activated its MERS-CoV outbreak management team. Additionally, the MOH Command and Control Center (CCC) issued situation update once a day to relevant government stakeholders during the outbreak.

The MERS-CoV management team is composed of the Emergency Preparedness Team in the region and members of the Infection Control Rapid Response Team. The management team was subdivided into four main groups: The first was for outbreak investigation, the second was responsible for listing contacts among household members and dormitory of nurses and health care workers in the facility, the third was the infection control group whose job was observation of infection control practices, identification of gaps, analysis, prioritization of needs and auditing, and the fourth group was responsible for studying the quality of available infection prevention and control supplies, identification of missing ones and arranging with the supply and purchasing department to provide the required supplies and facilitate communication with trustable companies. All four groups worked in collaboration with Hospital A staff, including personnel from managerial office, infection control department, laboratory, nursing office, respiratory therapists, and environmental department. Daily meetings with stakeholders at the hospital were conducted. The purposes of meeting were initially to put a plan, agree on it, discuss methods of implementation and ensure its clarity for involved persons. Later on, meetings were held to communicate, discuss obstacles and suggest solutions. The ultimate goal was to control the spread of the virus and prevent secondary transmission.

Active surveillance was initiated at the hospital immediately af-

ter receiving the notification of the confirmed results of the index patient who was transferred to hospital B. The plan was to reduce the risk of exposure to undiagnosed MERS-CoV HCWs; therefore they were stratified into two groups: symptomatic and asymptomatic. Management of each category will be elaborated in the next section.

Clinical response to the outbreak

Upon identification of the first cluster of MERS-CoV, a bundle of actions was taken at the hospital, starting with the emergency department (ER), the busiest area and the entrance for most admitted cases. A modified triage system was established at the ER, with a clear pathway to identify those with fever and respiratory symptoms. All patients had been triaged, and those with respiratory symptoms instructed to wear facemask and sit at least 1.5 m away from others. A rapid track was established for suspected cases in order for them not to remain in the ER for a long time. Those were rapidly diverted by a triage nurse to a separate designated area to minimize transmission to others. After that they are directed to the respiratory clinic, where clinical examination and the required investigations are conducted. After that, a decision was made based on the patient's situation and home condition, whether to admit him/her to an isolation room, until the result of MERS-CoV is confirmed, or send him/her home with isolation instructions. Staff involved in the triage process were supervised for hand hygiene, donning of face mask and eye protection. They were instructed to wash hands before and after contact with any patient after activities likely to cause contamination and after removing gloves, in addition to the five moments of hand hygiene. In addition to standard precaution, all individuals who log into rooms or inhabitants of positive cases were required to adhere to appropriate isolation precaution and to use personal protective equipment (PPE) consisting of gowns, gloves, eye goggles and N95 mask if close contact was predicted.

Infection prevention and control measures gaps were identified. Accordingly, an assigned group started educational sessions and extensive training to HCWs on different aspects of infection prevention and control measures, including hand hygiene, PPE, risk factors, MERS-CoV case definition, management, and control measures [2-5]. Designated HCWs were trained to observe and calculate hand hygiene compliance rate according to WHO forms [1]. Champions were promoted. Clinical staff were provided with training on appropriate diagnosis and case management. The management plan included rapid identification of suspected cases and quick discharge of patients who do not require inpatient medical care. Training was provided to paramedics and drivers assigned to ambulances on how to handle cases during their transfer. Meticulous cleaning, proper disinfection and fumigation were performed for ambulances used for transportation of positive cases to the Corona center in Dammam. Infection prevention and control knowledge and practice were assessed before and after training.

Nominated staff were trained on performance of respiratory fit test. Respiratory fit testing were initiated and done for all HCWs in ICU and ER and the rest were scheduled. HCWs who practiced proper standard and isolation precautions and were fit to one of available N95 were dedicated to provide care to suspected and confirmed cases.

Regarding HCWs and symptomatic contacts were prohibited from work, investigated and instructed to stay at home for 2 weeks from the last exposure if the results were negative. NP and OP swabs were repeated weekly for those positive cases isolated at home. If results came negative and the HCW was asymptomatic, he/she will be allowed back to work.

Laboratory methods

Oropharyngeal (OP) and Nasopharyngeal (NO) samples were taken using synthetic fiber swabs with plastic shafts. They were immediately placed into sterile tubes containing 2-3 ml of viral transport media, then refrigerated at 2-8°C up to 72 hours; if exceeding 72 hours, they were frozen at -70°C. All specimens were shipped on dry ice to the regional lab in Dammam [6]. Laboratory confirmed results of MERS-CoV meant that reverse transcriptase chain reaction (RT-PCR) from naso- and oropharyngeal swabs in two genomes were positive.

Asymptomatic contacts were further stratified into:

High risk group

Those who had unprotected exposure to blood or body fluid of a confirmed case or were present in the case's room during Aerosol Generating Procedure (AGP). Those HCWs were allowed to stay home for 2 weeks from the last exposure. However, if they received the test and result came back negative, they were instructed to resume work.

Intermediate risk group

Those who had unprotected exposure to a confirmed case but were neither exposed to any body fluid, nor were they present during aerosol generating procedures. These individuals were allowed to work in low risk areas until the result of their swabs came back negative. If still asymptomatic, they were directed back to their original place of work.

Low risk group

Those with protected exposure, i.e. with adherence to isolation precaution, and not present during AGP. These individuals were allowed to continue their work. All contacts were instructed to report any fever and/or respiratory symptoms even if they had a previous negative result during the outbreak time.

Nevertheless, this plan was changed after occurrence of the cluster of positive MERS-CoV cases among contacts of the index case, particularly since most of them were asymptomatic. An agreed strict action was undertaken in collaboration with the hospital management to expand surveillance by screening all contacts of the index case, whether symptomatic or not. The rationale was that since the index case was undiagnosed at first, all individuals who had contact with him may have had unprotected exposure to MERS-CoV.

Later on, the surveillance was expanded to include all individuals working in the ICU and male medical ward where the index case was admitted. NP and OP swabs were taken whether the HCW was symptomatic or not, or whether he/she had documented contact

with the index case or not since, apparently, some of the new detected cases had had no contact with the positive cases.

The homes of those isolated at home and dormitories were inspected to ensure their proper fulfillment of quarantine requirements whenever a case was fit for home isolation.

Stratification of patients based on risk of exposure was also performed. The first category was composed of positive confirmed cases who were isolated at home if stable and home suitable. Otherwise, the patient was transported to a negative pressure isolation room till arrangements were made for transfer to Corona center in Dammam Medical complex. Designated staff and equipment were cohorted for isolated patients.

The second category was composed of suspected cases who were planned to be transported to a pre-designated ward, where strict adherence to infection prevention and control measures is applied by skillful trained staff, until the patient gets one negative result, after which they are transferred to a regular ward. If the result is positive, the patient is transferred to the isolation ward.

The third category was composed of low risk patients in whom no risk of exposure could be identified.
For any new confirmed case, household contact tracing was established. A list of all patients who had been admitted and discharged, and those who were followed up as outpatient's clinic with physician who turned to be positive between August 21st and September 10th was prepared. Those patients were contacted by the preventive medicine department, questioned regarding appearance of any fever or respiratory symptoms and requested to report those symptoms immediately if they experience them within 14 days from their discharge or appointment.

Head nurses of the ICU and Male Medical Wards, in addition to the treating physicians and assigned nurses were interviewed, and duty schedules of HCWs were reviewed. Furthermore, pulled out and pulled in list of nurses working in departments where positive cases had been admitted or had worked were reviewed to identify the contacts among them.

HCWs who had positive results were interviewed and questioned regarding epidemiological risks and potential exposures to other patients. Their exposure to other positive HCWs or patients was confirmed by their working schedules. The epidemic curve of number of positive laboratory cases by reported date of illness onset was constructed. (Figure 1)

In order to be able to manage the situation, understand the trend, control the epidemic and potential risk of infection transmission, in additional to overcoming the shortage of staff, admission into the hospital was restricted to emergency conditions. Furthermore, coordination was established with a neighboring hospital to admit and manage some cases. Elective surgical operations and admissions were postponed. They were resumed gradually after the situation settled down, 1 week from the last reported positive case.
Visitors were initially prohibited from entering the ICU. Later on, they were allowed but in limited numbers and instructed to register in a log book indicating entry and exit times and the room visited. In addition, they were instructed to practice hand hygiene and proper PPE.

Alcohol gel dispensers for hand hygiene, soap, tissue, paper towels, as well as PPE supplies were distributed and made available and easily accessible to staff, patients and visitors. Signs and posters of hand hygiene and cough etiquette were distributed. Moreover, posters containing educational materials about MERS-CoV were provided to the hospital and distributed in front line locations.

A Logbook for each suspected or confirmed case to record contacts was introduced. HCWs were instructed to initiate a log book in each department to register their temperature at the beginning of each shift, and every 4 hours thereafter, in addition to documenting any respiratory symptoms.

Negative pressure rooms had previously been without monitoring, so the required negative pressure actually was virtually non-existent. Hence, monitoring was established. Some portable negative pressure tents were not fixed properly, so the responsible company was contacted and they were fixed.
Environmental investigation included obtaining samples from air, ducts was done. Heat ventilation air condition (HVAC) was studied.

All surfaces were wiped with approved disinfectants twice daily and as required by cleaning crews. Terminal cleaning of each patient's room was conducted after his/her discharge, including discarding unused disposable items.

Furthermore, fumigation of ICU by hydrogen peroxide was done after scheduling and mobilizing of the occupied bed accordingly. The Adenosine triphosphate (ATP) detection (which measure the amount of organic materials to verify the cleanliness of hospital surfaces) was done by independent third party and it was zero in all spots measured in ICU, ducts and surfaces despite taking countless points.

Health promotion campaigns for hand hygiene and environmental sanitation were conducted. These were continued for approximately 2 weeks after the last reported case.

Results

By 10th of September, there were 10 laboratory confirmed MERS-CoV cases by regional lab out of 116 contacts identified, swabbed and followed during the response. Identified cases represent a wide spectrum of case presentation ranging from asymptomatic cases, cases with mild symptoms, cases with critical condition that required ICU admission, intubation and extracorporeal membrane oxygenation (ECMO), and the extreme picture of disease presentation that ended in death.

The index case, whose family denied any exposure to camels, in spite of this fact being confirmed at first by some of his relatives who admitted that he owned a farm in Sarar region where camels were being shepherded.

A summary of demographic characteristics of confirmed MERS-CoV cases, number of their contacts and their outcome is demonstrated in table (1). Time line is illustrated in figure (1).

Table 1: Line list of MERS-CoV confirmed cases in Hospital A, during the period from 24 August to 25 September 2014

No.	Age	Sex	Co morbid conditions	Meet Case Definition	Admission ward	nationality	Occupation	Date of positive result	Contact No.	CONTACT	Out come
Index case	69	M	DM, HTN, Dislipidemia, CKD, Hypothyroidism, IHD Post bypass grafting, AF	Yes	ER, ICU, 5B	Saudi	Retired	24/8/2014	39	direct contact with case 1,4,7,5,6, 10	Died
Case 1	35	M	No	Yes	N/A	Filipino	5B Nurse	28/8/2014	25	direct contact with index case, case 10	negative on 19/09/2014
Case 2	80	F	HTN	No	4B, 4A	Saudi	housewife	30/08/14	31	? indirect contact case 7 who contact the index case	Died
Case 3	39	F	No	No	N/A	Filipino	Nurse	30/08/14	29	contact with case 5 who contact index case and case 10	negative on 07/09/2014
Case 4	51	F	No	No	N/A	Indian	ICU Nurse	30/08/14	27	contact with index case , 10, 9, 3,5	negative on 07/09/2015
Case 5	26	F	No	No	N/A	Filipino	ICU Nurse	30/08/14	27	contact with index case ,3, 9	negative on 07/09/2016
Case 6	23	F	No	No	N/A	Filipino	ICU Nurse	30/8/2014	27	contact with index, case 4	Negative result on 15/9/2014
Case 7	32	F	No	No	N/A	Filipino	5B Nurse	31/8/2014	25	contact with index case, case2	Negative result on 23/9/2014
Case 8	72	F	DM,HTN, IHD, fracture L1 (osteoprosis)	No	4B	Saudi	housewife	01/09/14	35	? indirect contact case 7 who contact the index case	Negative result on 03/09/2014
Case 9	60	M	No	Yes	5B, ICU	Jordanian	physician	07/09/14	68	contact with case 5 who contact index case	Negative result on 8/9/2014
Case 10	51	M	No	No	N/A	Sudanese	ICU physician	10/09/14	44	contact with index, case 1, 3, 4	Negative result on 23/9/2014

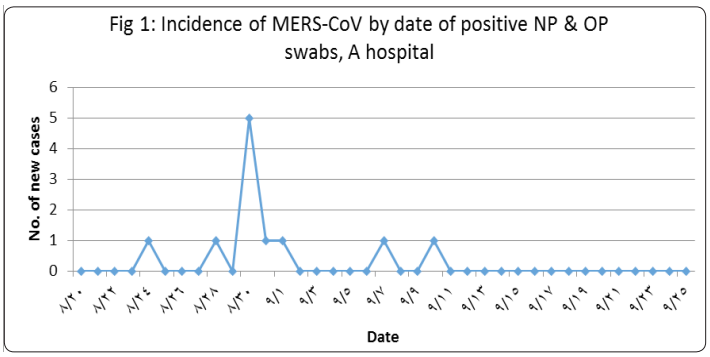

Figure 1: Incidence of MERS-CoV by date of positive NP&OP swabs, A Hospital

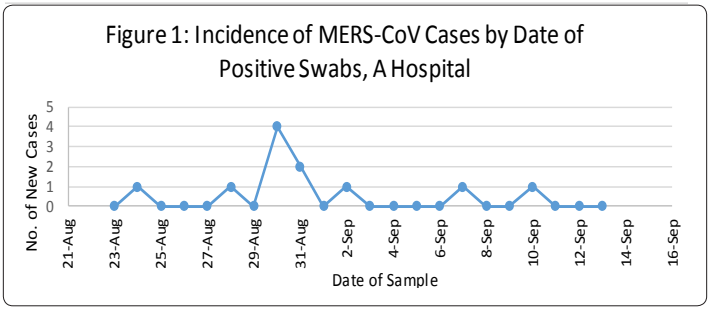

Figure 1: Incidence of MERS-CoV Cases by Date of Positive Swabs, A Hospital

Out of 10 confirmed MERS-CoV cases, eight were HCWS; 6 nurses and 2 doctors. One of them had had no direct contact with the index case, although direct exposure to an asymptomatic positive nurse was revealed. The other two were female patients whose rooms were adjacent to each other. Both had never been exposed to the index case. However, they may have had indirect contact on the 28th of August with an asymptomatic positive nurse pulled in from the male medical ward, where the index case had been admitted (See Figure (2) hypothetical transmission nodal graph). Moreover, those two patients did not meet the case definition; contact of positive case of MERS CoV, plus respiratory symptoms. One of them had chronic disease, was bedridden and had been complaining of fever for approximately 20 days prior to diagnosis. The other one was admitted on 12th of August with chronic disease and complaining of dyspnea and mild fever. However, there was no noticeable change in chest X-ray upon MERS diagnosis in a previously infiltrated chest.

No further cases related to the hospital were identified in the 10 days following implementation of management measures, and no ill household contact was identified, which suggested that the MERS-CoV cluster in hospital "A" might have been contained.

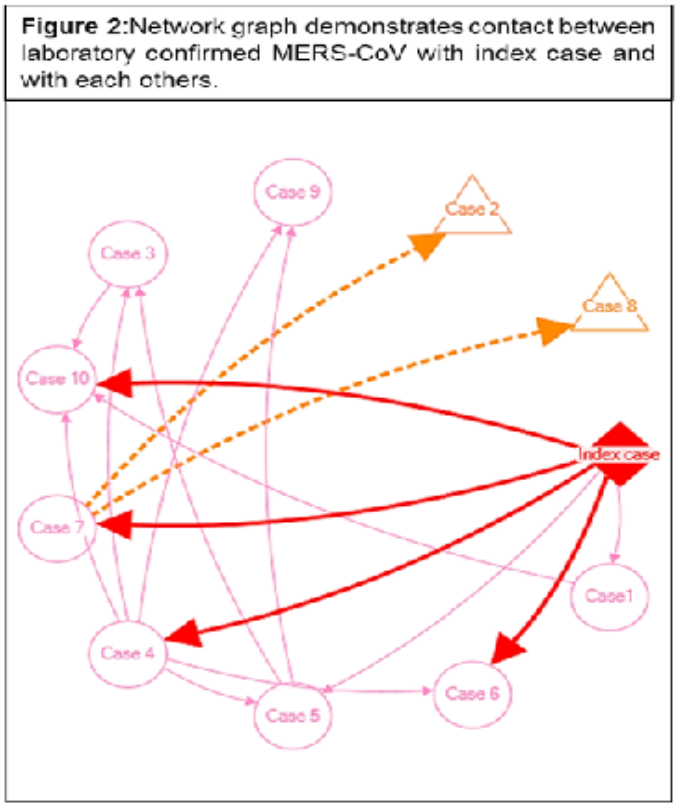

Figure 2: Network graph demonstrates contact between laboratory confirmed MERS-CoV with index case and with each others.

Discussion

MERS-CoV has become a public health issue in KSA since 2012. Since the diagnosis of the first MERS-CoV case, this disease raised significant anxiety among scientific institutes and communities due to high mortality rate among cases and the obscure mode of transmission to primary cases [7]. The MOH has invested effort and resources to respond to the recommended preparedness plan for dealing with such cases.

The index case was harboring MERS-CoV infection during his admission period in hospital "A" since he was undiagnosed, many health care workers (HCWs) had unprotected exposure to him that might explain the source of infection for some cases. However, presence of confirmed cases who did not have obvious contact with the index case, short period of exposure of others and indefinite information about the mode of transmission at that time and the chain of infection for MERS-CoV, led to suggestion of multiple hypothesis which were discussed and need further studies.

This outbreak highlights the importance of being vigilant at all times of the year in KSA as an outbreak of this disease may occur at any time. It demonstrated the importance of having an assertive plan of dealing with any lower respiratory case admitted to the hospital, and to take the required precautions to prevent its transmission to health care workers. Our knowledge about the natural history and mode of transmission of the virus is still growing. The fact of camel transmission as a possible mode of transmission is a

challenge waiting to be proven [8, 9]. This is related to the natural culture of part of population in the Arabian Peninsula, where camels are considered as sources of life and pride. It is therefore expected that positive cases or their relatives will deny any contact or dealing with camels. They are afraid of being forced to implement infection protection measures, such as getting rid of their camels.

This cluster was one of the largest MERS-CoV clusters faced in the Eastern Province, KSA in 2014. The vast majority of positive cases had direct contact with the index case. However, at least 3 of them had direct contact with an asymptomatic laboratory confirmed positive case of MERS-CoV. During epidemic investigation, a question was raised, if HCWs were not exposed to the index case, then how was the pathogen transmitted? It became clear that the nurses in the ICU had been assisting each other during patient care.

It was also noticed that almost half the laboratory confirmed MERS-CoV cases in the ICU had been working at night. Unfortunately, there is usually lack of supervision and adherence to infection control measures during night shifts [10]. Accordingly, directed training and supervision during night shifts are essential in order to control secondary transmission of infections.

It was detected that one of the laboratory confirmed positive cases who had been in contact with the index case at the male medical ward, was pulled in to the female medical ward where another laboratory positive MERS-CoV were confirmed. This may have been the source of transmission of the pathogen, either by direct or indirect contact or through fellow HCWs, who were taking care of patients. If we accept this hypothesis, it means that the incubation period might have been less than 48 hours, and may even be reduced to 36 hours.

This possibility of mode of transmission could be supported by the fact that the pediatrician got infected without any evidence of direct contact with the index case or the other symptomatic cases, apart from the asymptomatic laboratory confirmed nurse in ICU who was assisting her colleagues, besides her assigned job in the pediatric ICU.

The fact that the physician who transported the pediatrician, became positive to the virus in spite of being on protective respiratory barrier, might be explained by the fact that he had unprotected contact with the index case and his initial negative result was because either the virus was within the incubation period, the swab was not taken appropriately, or the negative predictive value of the test needs to be assessed in further studies. Otherwise, the PPE as tool of protection need to be re-assessed if the physician had got infected during transportation, unless he was not wearing them appropriately. In either case, this scenario raises the importance of following up exposed individuals until the end of the incubation period, counted from the date of the last exposure to the positive case during outbreak management.

The rationale for screening of symptomatic and asymptomatic contacts was the belief that to contain the transmission of virus, the status of contact should be clear. In this case, unprotected exposure to undetected index case with consequent non specific isolation precaution, evolving of positive cases with unidentified contact, patients with subclinical or very mild disease may not have been identified by case definition. Besides, uncertainty about the natural history of this disease may have played a role.

It is believed that transmission of MERS-CoV by such patients would have been prevented by appropriate implementation of infection control precautions. Therefore, comprehensive infection control measures were implemented rigorously to control the MERS-CoV cluster. It appears that the method of response to this cluster was effective.

However, there might have been other unidentified factors responsible for the decline in the number of cases. It might not have been needed to adhere to an aggressive expanded measure of investigation and screening of both symptomatic and asymptomatic contacts if only one case of community acquired MERS-CoV had been reported. The situation is different in this particular outbreak, since there was unprotected case with expanded level of contacts, in addition to social gathering during the exposure, which expanded the circle of laboratory confirmed cases, with at least 2 cases deteriorating to a critical point, which led to one of them dying.

Since the vigorous intervention was implemented, no further cases were detected among HCWs. Although modest improvement of hand hygiene was achieved, more studies are needed to evaluate the effectiveness of training program and its sustainability [11].

Conclusion

The early detection of this outbreak highlighted its importance, so early warning was activated to help contain the transmission of the virus. Formulation of a case definition and awareness of this definition is a corner stone in management of any outbreak as this will result in early detection of cases and appropriate management.

The extensive infection control precautions that were described in this report are critical to be implemented to avoid any new cases of MERS-CoV in a health facility, especially if infection is transmitted to health care workers, or other patients.

This study, illustrates the importance of health care workers awareness especially those on the front lines and their response to case definition of MERS-CoV in KSA.

Drastic measures for screening of the whole contacts are justified. Further studies of the utility of mass screening measures in the management of MERS outbreak will highlights its effectiveness.

Recommendations

- An existing active surveillance with a response plan in place will make containment of any hospital outbreak easier.
- Investment in sustained training is a first step to control the spread of infections at health care settings. In addition, continued vigilance among health care workers is vital.
- Presence of nominated, trained team to lead the containment process of any emergent outbreak is important.
- A virtual case scenario could help in preparedness of any health care facility to deal with similar situation.

- Encouragement of effective communication between relevant commander and relevant response managers, which plays a critical role for achieving optimum results regarding supplies, preparedness, sharing experiences, action plan,..etc....,
- More studies are needed to assess the validity and predictive value of PCR in diagnosis of MERS-CoV.

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