

WHO MERS Global Summary and Assessment of Risk

July 2019

WHO/MERS/RA/19.1



Global summary

Between 2012 and 30 June 2019, 2449 laboratory-confirmed cases of Middle East respiratory syndrome-coronavirus (MERS-CoV) infection were reported to WHO, of which 84.0% were reported by the Kingdom of Saudi Arabia (Figure 1). In total, cases have been reported from 27 countries in the Middle East, North Africa, Europe, the United States of America, and Asia (Table 1). Males above the age of 60 with an underlying medical conditions, such as diabetes, hypertension and renal failure, are at a higher risk of severe disease, including death. To date, 845 individuals have died (crude CFR 34.5%).

Since the last global update published on 30 June 2018, 219 laboratory-confirmed cases of MERS-CoV from four countries were reported to WHO (204 from Saudi Arabia, 13 from Oman, 1 from the Republic of Korea, and 1 from the United Kingdom), of whom 53 (24.2%) have died. Among these cases, 79.0% were male and the median age was 52 years old (IQR 39-65; range 16-94 years old). The median age is similar to the median age of all cases reported to WHO since 2012 (52 years old, IQR 37-65).

At the time of writing, 49 of the 219 (22.4%) patients were reported as asymptomatic or having mild disease. At least one underlying condition was reported in 145 cases (66.2%) since the last update, including chronic renal failure, heart disease, diabetes mellitus, and hypertension.

Overall, the epidemiology, transmission patterns, clinical presentation of MERS patients and viral characteristics reported since the last update are consistent with past patterns described in previous WHO risk assessments: MERS-CoV is a zoonotic virus that has repeatedly entered the human population via direct or indirect contact with infected dromedary camels in the Arabian Peninsula. Limited, non-sustained human-to-human transmission mainly in health care settings continues to occur, primarily in Saudi Arabia. The risk of exported cases to areas outside of the Middle East due to travel remains significant.

While there have been significant improvements in surveillance for MERS, especially in the Middle East, and in reacting to suspect clusters, early identification in the community and in health care systems, compliance with the infection prevention and control measures and contact follow up remain major challenges for MERS outbreak prevention and control.

The continued importance of MERS-CoV in health care settings

Since the last global update of 30 June 2018, 52 of the 97 secondary cases reported to WHO were associated with transmission in a health care facility. These cases included health care workers (23 cases), patients sharing rooms/wards with MERS patients, or family visitors. The remaining 45 secondary cases were infected outside health care facilities.

Though not unexpected, these transmission events continue to be deeply concerning, given that MERS-CoV is still a relatively rare disease about which medical personnel in health care facilities have low awareness. Globally, awareness for MERS is low and, because symptoms of MERS-CoV infection are non-specific, initial cases are sometimes easily missed. With improved compliance in infection prevention and control, namely adherence to the standard precautions at all times, human-to-human transmission in health care facilities can be reduced and possibly eliminated with additional use of transmission-based precautions.

Since the last update of 30 June 2018, several MERS clusters were reported, including the following:

- In September 2019, a healthcare cluster of 3 cases was reported in Al Qassim region, Saudi Arabia. Of the 3 cases, none were health care workers and 2 died.
- January-February 2019, two clusters of MERS were reported in Oman. These clusters were not epidemiologically linked. Most of the secondary cases in each of the clusters were among household contacts. The Ministry of Health of Oman, with the support of WHO, responded by identifying and following all family, household and health care worker contacts, enhancing IPC measures within healthcare facilities, and collaborated with the Ministry of Agriculture to investigate dromedaries linked to patients in the two clusters. Isolates from infected patients were shared with US CDC in Atlanta for sequencing and characterization. A WHO-led mission took place in May 2019 to support Oman Ministry of Health to review capacities for identifying potential sources of infection of the reported cases, assess human-to-human transmission patterns within these clusters, propose further field investigations and to assess the need for further epidemiological studies to evaluate the extent of

infection around identified cases. A brief description of the two clusters is below:

- The first cluster in North Batinah governorate included 9 cases, 2 of whom died. Among the 9 cases, 1 health care worker was infected and had asymptomatic infection.
- The second cluster in South Sharqia governorate included 4 cases, of which 1 was in a health care worker. Among those infected, there were 2 fatalities.
- From 29 January to 12 March 2019, a cluster of 61 infections, including 8 deaths (CFR 13.1%), was reported in Wadi Aldwasir city, Saudi Arabia (Figure 1). The median age of case was 46 years (range 16-85 years), and 75.4% were male. Human-to-human transmission occurred between the index patient and health care workers, patients in the emergency department and intensive care unit of one hospital, and from patients to household contacts. Among the 61 infections, 14 were among health care workers, one of whom died. Six health care facilities were affected by this outbreak, however human-to-human transmission occurred in two of the six health care facilities treating patients.

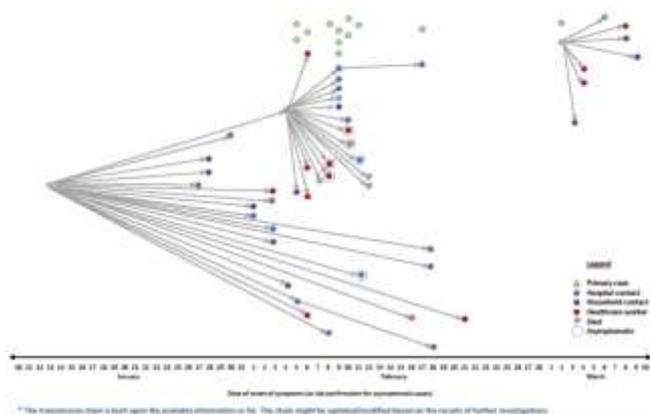
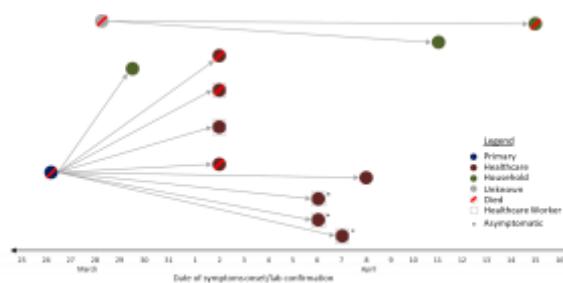


Figure 1. Transmission chain of laboratory-confirmed cases of MERS-CoV infection in the outbreak in Wadi Aldwasir city, Riyadh region, 2019 (n=61)

- In March 2019, a household cluster of 6 infections was reported in Riyadh, Saudi Arabia. The primary case, who reported contact with dromedary camels, died while all other household contacts survived.
- From 29 March to 27 April, the Ministry of Health in Saudi Arabia reported two unlinked clusters of 13 cases and 6 deaths in Al-Khafji city, Saudi Arabia. No epidemiological link was detected between the two clusters.
 - The first cluster involved 10 cases, including 1 suspected primary case who reported contact with dromedary camels, 5 health care workers, 3 hospital acquired infections, and 1 household contact.

- The second cluster involved 3 cases, including a suspected primary case and two household contacts.



** The transmission chain is built upon the available information so far. The chain might be updated/modified based on the results of further investigations.

Figure 2. Transmission chains of laboratory-confirmed cases of MERS-CoV infection in two clusters in Al-Khafji city, Riyadh region, March-April 2019 (n=13)

Since 2015, the increase in the number of asymptomatic contacts identified in health care settings is due to a policy change by the Ministry of Health of the Kingdom of Saudi Arabia, in which all high-risk contacts are tested for MERS-CoV regardless of the development of symptoms. This comprehensive contact identification, follow-up, testing and isolation of positive cases continues into 2019.

Drivers of transmission and the exact modes of transmission in health care settings still are unclear and are the focus of active collaborative scientific research in the affected countries. From observational studies, transmission in health care settings is believed to have occurred before adequate infection prevention and control procedures were applied and cases were isolated. Investigations at the time of the outbreaks indicate that aerosolizing procedures conducted in crowded emergency departments or medical wards with sub-optimal infection prevention and control measures in place resulted in human-to-human transmission and environmental contamination.

Community-acquired cases and reported links to dromedary camels

Improvement in multi-sectoral investigation of community-acquired cases is evident, including testing of dromedary animals/herds in the vicinity of community-acquired laboratory-confirmed cases and follow-up of human contacts of laboratory-confirmed cases. The Ministries of Health in affected countries notify the Ministries of Agriculture when human cases report a link with animals. Investigations in animals are carried out by officials from the Ministries of Agriculture and results, if positive for MERS-CoV, are reported [to OIE](#). Results of laboratory testing of dromedary camels in affected countries is available on the OIE website.

Exported cases identified outside the Middle East

Since the last update, two cases were reported outside of the Middle East.

The first patient was a resident of the Kingdom of Saudi Arabia who travelled to the United Kingdom of Great Britain and Northern Ireland on 16 August 2018. Laboratory

testing on samples collected returned a positive result for MERS-CoV on 21 August 2018. The patient was treated and recovered, contacts were identified and followed and no further cases were identified by authorities in the United Kingdom. The patient had no history of recent travel or contact with sick patients in Saudi Arabia, but had history of direct contact with camels before the onset of symptoms. Full genome sequencing on viral isolates was conducted and made publicly available on GenBank.

The second patient was a Korean national who visited Kuwait on business from 16 August through 6 September 2018. He returned to Korea via Dubai and a sputum sample tested positive for MERS-CoV by RT-PCR on 8 September. The patient was treated and recovered, high and low risk contacts were identified and followed and no further cases were identified by authorities in Korea. Korean officials have sequenced the virus isolated from the patient. A serologic investigation to evaluate the extent of infection among contacts of the patient while in Kuwait is ongoing, and is being conducted by officials from the Kuwait Ministry of Health, with support from WHO and an external laboratory with experience in microneutralization assays for MERS-CoV.

Summary – information available on all MERS-CoV infections reported to WHO from 2012 to 30 June 2019

To date, no sustained human-to-human transmission has occurred anywhere in the world, however limited non-sustained human-to-human transmission in health care facilities remains a prominent feature of this virus. WHO continues to work with health authorities in the affected countries to prevent and minimize health care-associated cases. WHO understands that health authorities in affected countries, especially those in the most affected countries, are aggressively investigating cases and contacts, including testing for MERS-CoV among asymptomatic contacts, and applying mitigation measures to stop human-to-human transmission in health care settings. These efforts are proving successful in mitigating the size of outbreaks.

Of all laboratory-confirmed cases reported since 2012 ($n=2449$), the median age is 52 (IQR 37-65) and 68.3% are male. More than half (51.8%) of the cases reported to WHO have had at least one of the following underlying conditions: diabetes mellitus, hypertension, heart disease, chronic renal failure or lung disease.

At the time of reporting, 20.8% of the 2449 cases were reported to have no or mild symptoms, while 46.5% had severe disease or died. Overall, 17.9% of the cases reported to date are health care workers.

Since 2012, 27 countries have reported cases of MERS-CoV infection. In the Middle East: Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, the United Arab Emirates and Yemen; in Africa: Algeria and Tunisia; in Europe: Austria, France, Germany, Greece, Italy, the Netherlands, Turkey and the United Kingdom; in Asia: China, the Republic of Korea, Malaysia, the Philippines and Thailand; and in the Americas: the United States of America (Table 1).

The majority of cases (84.0%) have been reported from Saudi Arabia (Figure 3).

Populations in close contact with dromedaries (e.g. farmers, abattoir workers, shepherds, dromedary owners) and health care workers caring for MERS-CoV patients are believed to be at higher risk of infection. Healthy adults infected with MERS-CoV tend to have mild subclinical or asymptomatic infections. To date, limited human-to-human transmission has occurred between close contacts of confirmed cases in household settings.

More efficient human-to-human transmission occurs in health care settings due to inadequate and/or incomplete compliance with the infection prevention and control measures and delay in triage or isolation of suspected MERS patients.

Health care-associated transmission has been documented in several countries between 2012-2016, including Saudi Arabia, Jordan, the United Arab Emirates, France, the United Kingdom, and the Republic of Korea with varying outbreak sizes (2-180 reported cases per outbreak).

The largest outbreak outside of the Middle East occurred in the Republic of Korea resulting in 186 cases (including one case who travelled to China) and 39 deaths. The recent exported case to the Republic of Korea in September 2018 did not result in further human-to-human transmission in the Republic of Korea. This was due to early suspicion of MERS-CoV infection, immediate isolation, clinical management of the patient upon his return from Kuwait and thorough contact tracing.

Overall, the reproduction number (R_0) of MERS-CoV is <1 with significant heterogeneity in specific contexts. Within health care settings, the reproduction number can be above 1, but outbreaks can be brought under control ($R<1$) with proper application of infection prevention and control measures and early isolation of subsequent cases. [A recent analysis of 11 health care associated outbreaks of MERS found that at the start of the outbreak, \$R_0\$ ranged from 1.0-5.7 and reduced to \$<1\$ within 2-6 weeks.](#)

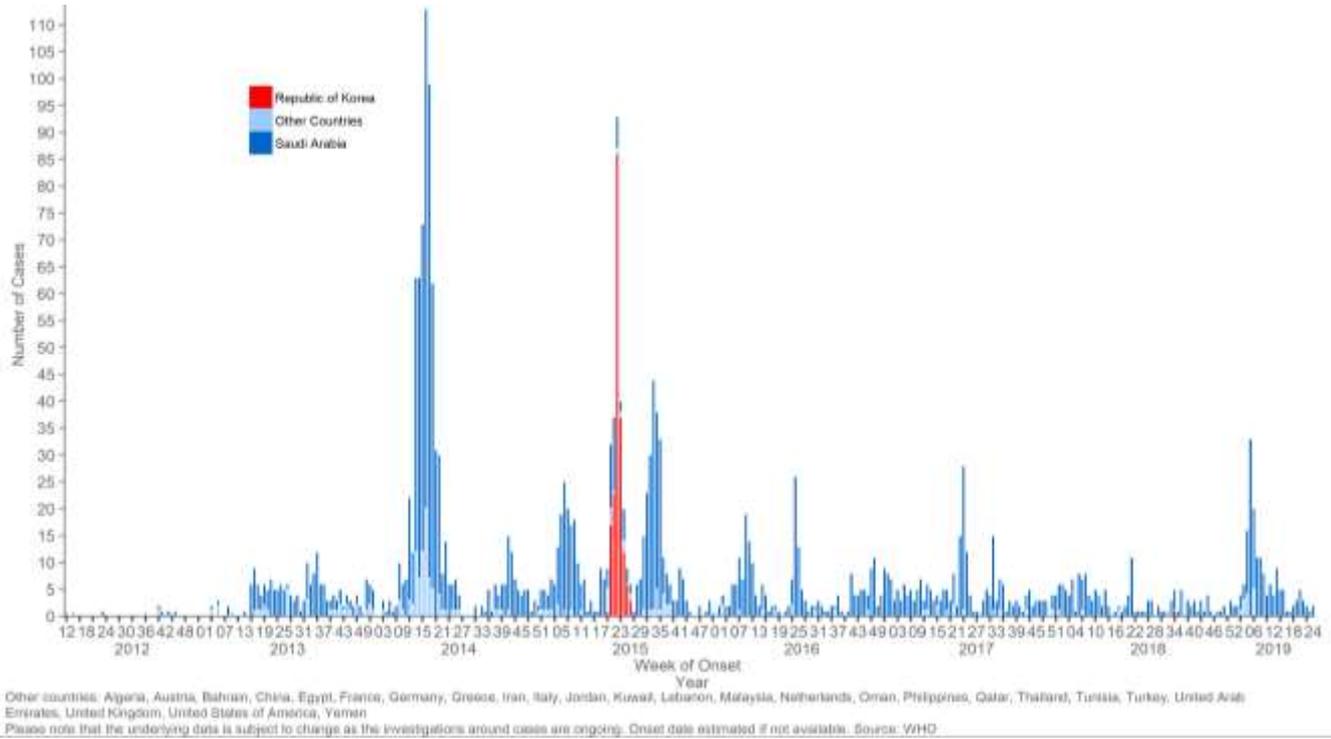


Figure 3. Epidemic curve of laboratory-confirmed MERS-CoV human infections reported to WHO* as of 30 June 2019

*Symptomatic cases are plotted by date of symptom onset; asymptomatic cases are plotted by date of notification to WHO.

**Red = Republic of Korea; blue = Kingdom of Saudi Arabia; light blue = all other countries reporting MERS-CoV cases to date including Algeria, Austria, Bahrain, China, Egypt, France, Germany, Greece, Iran, Italy, Jordan, Kuwait, Lebanon, Malaysia, the Netherlands, Oman, the Philippines, Qatar, Thailand, Tunisia, Turkey, United Arab Emirates, the United Kingdom, the United States, Yemen.

Table 1. Number of laboratory-confirmed MERS cases reported by countries, by year, since 2012*

Country reporting	Number of laboratory-confirmed MERS-CoV cases reported
Algeria	2
Austria	2
Bahrain	1
China	1
Egypt	1
France	2
Germany	3
Greece	1
Iran	6
Italy	1
Jordan	28
Kuwait	4
Lebanon	2
Malaysia	2
Netherlands	2
Oman	24
Philippines	2
Qatar	19
Republic of Korea	186
Saudi Arabia	2058
Thailand	3
Tunisia	3
Turkey	1
United Kingdom	5
United Arab Emirates	87
United States of America	2
Yemen	1
Total	2449

* Data as of 30 June 2019

WHO MERS-CoV guidance and activities

- Since July 2018, WHO updated the following information products and guidance materials:
 - [Five things you should know about Middle East Respiratory Syndrome \(MERS\)](#) Published September 2018
 - In collaboration with FIND, WHO published [An updated roadmap for MERS-CoV research and product development: Focus on diagnostics](#) in October 2018
 - [Clinical management of severe acute respiratory infection when Middle East respiratory syndrome coronavirus \(MERS-CoV\) infection is suspected](#) Updated January 2019
 - [Disease commodity package for MERS-CoV](#) Published March 2019. The Disease commodity package provides a specific datasheet that lists the critical commodities and the technical specifications for each commodity for MERS-CoV surveillance, prevention & control, and case management.
 - The WHO MERS technical team and the WHO R&D Blueprint is drafting a “Master” Phase2b/Phase 3 clinical trial protocol to evaluate MERS therapeutics. The “Master” protocol will be designed to recruit patients from multiple sites/hospitals in multiple countries and across multiple MERS-CoV outbreaks. Further discussions are underway with the R&D Blueprint methodological group, MERS clinicians and MERS-subject matter experts to determine which therapeutics should be prioritized. Once finalised, this protocol will be published on the WHO website.
 - The WHO MERS technical team and the WHO R&D Blueprint is drafting a “Master” Phase2b/Phase 3 clinical trial protocol to evaluate MERS vaccines in humans. The “Master” protocol will be designed to accommodate multiple sites/hospitals in multiple countries and across multiple MERS-CoV outbreaks. Further discussions are underway with the R&D Blueprint methodological group, MERS clinicians and MERS-subject matter experts to develop this protocol. Once finalised, this protocol will be published on the WHO website.
- WHO is in the process of updating the investigation tools aimed at assisting member states during outbreak investigations to evaluate risk factors for and extent of infection in specific human populations. The updates take into consideration recent scientific knowledge and experience from similar studies conducted by partners. An updated protocol, entitled [Assessment of potential risk factors of infection of Middle East respiratory syndrome coronavirus \(MERS-CoV\) among health care personnel in a health care setting](#) was published in January 2019. The updated protocol, entitled [Seroepidemiological Investigation of Contacts of Middle East Respiratory Syndrome Coronavirus \(MERS-CoV\) Patients](#) was also published in January 2019.
- In September 2018, WHO officials met with the Ministry of Health of Kuwait to discuss ongoing surveillance activities and infection prevention and control measures for MERS-CoV following the importation of a case in the Republic of Korea with suspected exposure in Kuwait.
- From 23-25 October 2018, WHO hosted 60 high-level public health and MERS practitioners, researchers, and experts in Abu Dhabi, United Arab Emirates to establish a pool of experts from the region that can be deployed rapidly during any future outbreaks. Despite the substantial response to MERS by national health authorities, the demand for MERS expertise continues to grow and within WHO and partner institutions in all affected and at-risk countries, the number of senior technically trained regional experts on MERS remains limited.
- In October 2018, WHO and the Food and Agriculture Organization of the United Nations (FAO) held a coordination meeting in Geneva, Switzerland to plan MERS related camel/human activities in Africa and the Middle East for 2018-2019.
- In November 2018, the WHO R&D Blueprint and WHO MERS technical team convened a group of experts to discuss methodological issues and agree a priori on principles in the design, conduct and analysis of Phase2b/Phase 3 clinical trials to evaluate MERS-CoV therapeutics and human vaccines, based on key epidemiological considerations and driven by treatment and vaccine needs from a public health perspective.
- In January 2019, WHO, FAO and the World Organisation for Animal Health (OIE) held a Tripartite Meeting in Paris, France to discuss MERS related global, regional and country-specific activities.
- In November 2018, WHO EMRO conducted a training workshop in Tunisia for rapid response teams at district level on detection and respond to MERS and other novel viruses respiratory outbreaks.
- In December 2018, WHO EMRO supported Pakistan to build the national response capacities through conduction of 5 rounds of workshops targeting the rapid response teams at province level.
- In May 2019, WHO EMRO conducted a technical mission to Oman to review the national capacities to detect and respond to MERS outbreaks and clusters.
- WHO EMRO supports the Ministry of Health of the Kingdom of Saudi Arabia to prepare and develop mitigation efforts for potential health threats related to Hajj pilgrimage and mass gathering events.
- WHO continues to support field-based epidemiological and anthropological studies at the animal-human

interface to evaluate the extent of spill over and human infection in countries outside of the Arabian Peninsula. These studies are being planned or currently being implemented in Algeria, Egypt, Ethiopia, Pakistan, Somalia and Sudan in collaboration with Ministries of Health and other technical partners.

- WHO has established an informal working group to advance the development of MERS-CoV vaccine candidates for dromedary camels and high-risk human populations. The working group includes WHO, FAO and OIE as well as research groups developing dromedary/human vaccine candidates.
- In collaboration with partners, WHO has published a number of scientific articles on MERS, including:
 - FAO-OIE-WHO MERS Technical Working Group. [MERS: Progress on the global response, remaining challenges and the way forward](#). Antiviral Res. 2018 Nov;159:35-44. doi: 10.1016/j.antiviral.2018.09.002. Epub 2018 Sep 17.
 - Donnelly CA, Malik MR, Elkholy A, Cauchemez S, Van Kerkhove MD. [Worldwide reduction in MERS cases and deaths since 2016](#). Emerg Infect Dis. 2019 Sep. <https://doi.org/10.3201/eid2509.190143>
 - Bernard-Stoeklin S, Nikolay B, Assiri A, Bin Saeed AA, Ben Embarek PK, El Bushra H, Ki M, Malik MR, Fontanet A, Cauchemez S, Van Kerkhove MD. [Comparative Analysis of Eleven Healthcare-Associated Outbreaks of Middle East Respiratory Syndrome Coronavirus \(MERS-CoV\) from 2015 to 2017](#). Sci Rep. 2019 May 14;9(1):7385. doi: 10.1038/s41598-019-43586-9.
 - Elkholy AA, Grant R, Assiri A, Elhakim M, Malik MR, Van Kerkhove MD. [MERS-CoV infection among healthcare workers and risk factors for death: Retrospective analysis of all laboratory-confirmed cases reported to WHO from 2012 to 2 June 2018](#). J Infect Public Health. 2019 May 2. pii: S1876-0341(19)30144-3. doi: 10.1016/j.jiph.2019.04.011
 - Dighe A, Jombart T, Van Kerkhove MD, Ferguson N. [A systematic review of MERS-CoV seroprevalence and RNA prevalence in dromedary camels: Implications for animal vaccination](#). Epidemics. 2019 Jun 5:100350. doi: 10.1016/j.epidem.2019.100350
 - Conzade R, Grant R, Malik MR, Elkholy A, Elhakim M, Samhoury D, Ben Embarek PK, Van Kerkhove MD. [Reported Direct and Indirect Contact with Dromedary Camels among Laboratory-Confirmed MERS-CoV Cases](#). Viruses. 2018 Aug 13;10(8).

and to develop improved measures to prevent human infections. WHO's global risk assessment of MERS remains unchanged from the last publication, from August 2018.

The continued occurrence of health care-associated outbreaks is deeply concerning and is the result of low awareness and early suspicion of MERS-CoV infections. The non-specificity of MERS symptoms complicates surveillance activities for the virus, often resulting in early missed cases, including the index case, in outbreaks and thereby providing the opportunity for human-to-human transmission in health care settings. Much more emphasis on improving standard IPC practices in all health care facilities is required.

Investigations are ongoing to evaluate transmission within health care facilities and more comprehensive scientific studies are underway to better understand the drivers of transmission, including studies of surface and air survival and persistence. Secondary cases have reported varying levels of contact with confirmed patients, ranging from direct contact (e.g., health care workers providing direct care to infected patients before diagnosis with MERS) to no clear contact (e.g., patients sharing wards with infected patients, but without sharing health care workers or rooms). At present, it is unclear which exposures result in transmission of the virus in health care settings or what the role of environmental contamination may play in such transmissions. Several studies from the Republic of Korea have identified MERS-CoV virus on surfaces inside patient rooms and on equipment during patient stays and after discharge or death. These findings highlight the importance of adequate cleaning and disinfection of patient rooms.

A recent analysis by WHO and colleagues from the University of Oxford, Imperial College London and Institut Pasteur has estimated that since 2016, 1465 cases of MERS-CoV and between 300 and 500 deaths may have been averted due to accelerated global efforts to detect infections early and reduce transmission. This is likely the result of improved infection prevention and control measures that are reducing human-to-human transmission. In addition, restriction of camel movement, stronger and more comprehensive investigations of cases and clusters at the time outbreaks are detected, and increased communication nationally and internationally have been critical in preventing international spread and sustained transmission.

WHO has updated its surveillance guidance for MERS-CoV and has specifically stated that any individuals presenting with respiratory symptoms who have recently visited the Middle East must be asked whether they have visited any health care facility there or had any direct or indirect contact with dromedary camels.

WHO continues to review and update, as necessary, all WHO information products and guidance materials. Updates are done in collaboration with our international partners and will be posted [online](#) as they become available. The latest updates are listed in the section above.

WHO stresses that it is a person's activities and exposures while in the Middle East that are relevant for MERS-CoV rather than the fact that he or she may have visited a particular country. The movement of patients between

Risk assessment

WHO continues to work with Ministries of Health in all affected and at-risk countries and with international partners to better understand transmission patterns and risk factors of MERS-CoV infection in community and health care settings

hospitals within countries and between countries for treatments and/or surgery (medical tourism) complicates the epidemiologic picture. Genetic sequencing of samples collected from confirmed patients should be a routine part of investigations into MERS-CoV clusters to better understand transmission patterns between patients and to help identify the source of the infection.

[Since July 2015, WHO recommends](#) that, in documented cases of human-to-human transmission in a health care setting, all health care contacts (e.g., health care workers and patients sharing space with a confirmed case), household contacts, and social contacts should be tested for MERS-CoV, regardless of whether they display symptoms. Among contacts who are at higher risk of infection are those who are in direct physical contact with the patient or the patient's biological fluids before MERS-CoV was diagnosed (e.g., treating physicians, health care professionals who performed intubation, cleaning staff). For these people, multiple specimens, including lower-respiratory specimens whenever possible, should be collected and tested for MERS-CoV within the 14-day incubation period. WHO encourages full genome sequencing be conducted routinely when cases are identified in dromedaries or humans and strongly advises sequencing be conducted when clusters of cases/outbreaks occur.

In 2019, the epidemiologic patterns of MERS-CoV remain the same: multiple introductions from dromedary camels in the Middle East to humans and secondary transmission in health care settings. Transmission among close family members within households remains limited for unclear reasons. What is different, however, is that the health care-associated outbreaks in the Middle East are occurring more frequently and, often, though not always, are small in size and can affect several hospitals. The large outbreaks in Jeddah/Riyadh in 2014, in the Republic of Korea in June 2015 and in Riyadh in August 2015, remind us that MERS-CoV, if not adequately controlled, can cause explosive outbreaks with substantial socio-economic consequences. The recent exported cases to the United Kingdom and the Republic of Korea in August/September 2018 show us that human-to-human transmission and large outbreaks can be prevented with early suspicion, case isolation and clinical management.

Until zoonotic transfer of the virus from infected dromedary camels into the human population is halted, the risk remains that further health care-associated outbreaks will occur. WHO advocates for the development of dromedary vaccines to prevent human infection. WHO is committed to better understand the geographic extent of MERS-CoV spillover and are funding camel/human studies in a number of countries in Africa, the Middle East and South Asia. WHO is also supporting anthropological studies to better understand cultural and occupational exposures to dromedary camels in the general population.

Following MERS technical meetings organized by WHO and partners since 2012, WHO has developed a roadmap for R&D and a broader Public Health Research Agenda for MERS. WHO is supporting a number of studies that the global community has prioritized (see below). The results of these studies are addressing key knowledge gaps and are

being used to update WHO guidance materials and information products and guide future mitigation measures.

All health care-associated cases/clusters are concerning and more work is needed to better understand the reasons behind these outbreaks and what is necessary to prevent them. Cases have been exported to a number of countries outside of the Middle East and will happen again. The combination of factors that has previously [been described](#) illustrates that low awareness and the inability to rapidly limit exposure to MERS-CoV patients can lead to large outbreaks.

The WHO missions to affected countries have provided an opportunity to fully evaluate the ongoing challenges to tackling MERS-CoV in dromedaries and humans. Control of this virus requires national leadership, coordination between animal and human sectors (and others), public trust, frequent and clear communication to all hospitals and hospital staff on measures to limit human-to-human transmission, thorough investigation of all cases and rapid dissemination of knowledge gained during outbreak investigations and research on MERS-CoV. WHO is working closely with FAO and OIE to better understand MERS-CoV in dromedary camels. WHO is pleased that affected countries have improved their responses to MERS-CoV and is also encouraged by the sharing of information on individual cases and investigations of clusters.

Have MERS-CoV transmission patterns changed?

There is no evidence of sustained human-to-human transmission in the community nor is there evidence of airborne transmission as main routes of transmission from all information available from recent MERS-CoV cases.

Therefore, the overall transmission patterns previously observed remain unchanged. WHO bases this assessment on the evidence that:

1. The clinical picture seen in recent outbreaks appears to be similar to that observed throughout previous outbreaks; secondary cases in the absence of comorbidities tend to present with milder disease than primary cases; and many of the recently reported secondary cases have been mild or were in patients whose tests were positive for MERS-CoV, but were reported to be asymptomatic;
2. The cases recently exported to countries outside of the Middle East have not resulted in sustained onward transmission to persons in close contact with these cases in the community;
3. Intensive screening of MERS-CoV contacts has revealed few instances of household transmission and no transmission has been identified thus far on airplanes or other forms of transportation;
4. There has been no increase in the size or number of observed household clusters; and
5. While there is variation of the R_0 number in different settings, the overall R_0 of MERS-CoV is < 1 . The R_0 in outbreaks in health care settings is higher, and this has been documented in health care associated outbreaks in

several countries Saudi Arabia and the Republic of Korea. With early isolation of cases and adequate infection prevention and control measures R_0 can be brought to <1 .

Can we expect additional cases of MERS-CoV infection in the Middle East? Can we expect additional cases exported to other countries?

WHO expects that additional cases of MERS-CoV infection will be reported from the Middle East and that occasional spillover will continue to occur in other countries by individuals who might acquire infection after exposure to an animal (e.g., while visiting farms or markets or consuming raw dromedary products such as milk, urine) or human source (possibly in a health care setting for planned or emergency treatment).

Until more is understood about mode of transmission and risk factors for infection, cases resulting from animal to human (zoonotic) transmission will continue to occur and will eventually lead to limited community transmission within households and possibly significant health care-associated outbreaks such as those seen in the Republic of Korea and Saudi Arabia. Consistent application of adequate infection prevention and control measures has been used to end transmission in previous clusters.

Investigation into the exported cases who reported performing Umrah in Saudi Arabia revealed that all of them had visited a health care facility, had come into contact with dromedary camels or had consumed raw camel products while in Saudi Arabia.

Recommendations

WHO has developed a [roadmap](#) for the R&D of MERS-specific diagnostics, therapeutics and vaccines in 2015, an [updated roadmap for MERS diagnostics](#) in 2018, and a [broader public health research agenda for MERS](#) in 2018.

A number of epidemiologic investigations into the transmission patterns of MERS-CoV have been conducted and published and more studies are planned or are underway. WHO hopes that these investigations can be shared with affected countries dealing with MERS-CoV and published quickly. The most urgent [research needs](#) are:

In dromedary camels:

- Conduct natural history studies and evaluate evidence of re-infection
- Conduct value chain and production system analyses
- Improve surveillance to evaluate seasonal/temporal variation, if any, in viral shedding
- Identify critical points for interventions and interruption of within species and zoonotic transmission
- Accelerate the development of vaccine candidates

At the animal-human interface

- Map virus circulation and geographic range of MERS-CoV infection in humans and dromedary camels
- Evaluate geographic extent of spillover to humans in Africa, the Middle East and South Asia
- Conduct animal/human serological and virological studies in specific locations to evaluate risk factors for human infection and exact routes of zoonotic transmission, including food/oral routes, if any
- Conduct social science and anthropological studies to describe and quantify exposures to dromedary camels and identify opportunities for risk-mitigating interventions

In human populations

- Accelerate the R&D, implementation and evaluation of medical countermeasures to reduce morbidity and mortality associated with MERS
- Identify the risk factors for infection among healthcare workers in hospital settings and role environmental controls for transmission of infection
- Understand the role of silent/asymptomatic cases in transmission of infections in humans and whether any specific behaviors may result in human infection from non-human sources
- Conduct targeted epidemiological studies in clinical settings to better understand immune response and duration of infectiousness
- Integrate testing for MERS-CoV into existing respiratory disease surveillance systems to identify extent and spectrum of mild infection in the community

Collaboration between human and animal health sectors in affected countries is essential to understanding the risk of transmission of MERS-CoV between animals and humans, whether there is any seasonal variation in the circulation of the virus in animals and the natural reservoir(s) of MERS-CoV. It is also important to work towards limiting the spread of infection in animal populations (through development of vaccines and better management of infected animals/herds) so as to reduce the opportunity for further human exposure.

WHO is supporting field-based studies at the animal/human interface to evaluate the extent of spill over in countries outside of the Arabian Peninsula. In addition, a better understanding of transmission in health care settings, especially the exposures that result in human-to-human transmission, the potential role of asymptomatic infected health care workers and the possible role of environmental contamination, is urgently needed.

Enhancing infection prevention and control awareness and implementation measures is critical to preventing the possible spread of MERS-CoV in health care facilities. It is not always possible to identify patients with MERS-CoV infection early because some have mild or non-specific symptoms. For this reason, it is important that all health care facilities establish and implement clear triage policies for rapid screening and assessment of potential MERS-CoV cases and all cases with acute respiratory symptoms. It is also important for health care workers to apply standard precautions consistently with all patients, regardless of their diagnosis, in all work practices all of the time. Droplet precautions should be added to the standard precautions

when providing care to any patient with symptoms of acute respiratory infection.

Health care facilities that provide care for patients suspected of or confirmed to be infected with MERS-CoV should take appropriate measures to decrease the risk of transmission of the virus from an infected patient to other patients, health care facility workers (medical and service personnel) and visitors. These measures involve interventions at the patient-carer interface and other general measures such as linen management, cleaning and disinfection and waste management. Contact precautions and eye protection should be added when caring for probable or confirmed cases of MERS-CoV infection and airborne precautions should be applied when performing aerosol-generating procedures. Hospital cleaning staff should also be informed of and trained to take proper precautions when cleaning rooms of MERS-CoV patients.

Until more is understood about MERS-CoV, people at high risk of developing severe disease (any person who is older, has diabetes, renal failure, chronic lung disease, or is immunocompromised), should take precautions when visiting farms or markets where dromedary camels are present (especially in the Middle East and Africa). These precautions include: avoiding contact with camels; not drinking raw camel milk or camel urine; and not eating camel meat that has not been thoroughly cooked.

Studies in Qatar, Saudi Arabia and the United Arab Emirates indicate that people handling or working with dromedary camels in these countries are at increased risk of infection with MERS-CoV compared with people who do not have contact with camels. Until more evidence is gathered, it would be prudent for camel farm workers, slaughterhouse workers, market workers, veterinarians and anyone else handling dromedary camels to practice good personal hygiene, including frequent hand hygiene. Hands should be washed with soap and water and/or alcohol gel after every contact with an animal. Workers should wear facial protection where feasible; and protective clothing, which should be removed after work (followed by hand hygiene) and washed daily.

Workers should avoid exposing family members to soiled work clothing, shoes, or other items that may have come

into contact with camel secretions and excretions. These clothes and other items should remain at the workplace for daily washing and workers should have access to and use shower facilities at their workplaces before leaving the premises.

Dromedary camels infected with MERS-CoV may not show any signs of infection. It is therefore not possible to know whether an animal on a farm, in a market, at a race track or in a slaughterhouse is excreting MERS-CoV that can potentially infect humans. However, infected animals may shed MERS-CoV through nasal and eye discharge, faeces, and potentially in their milk and urine. The virus may also be found in the raw organs and meat of infected animals. Therefore, until more is known about infection in animals, the best protection is to practice good hygiene and avoid direct contact with all of these. Obviously sick animals should never be slaughtered for consumption; dead animals should be safely buried or destroyed.

Unless protected, people should avoid contact with any animal that has been confirmed positive for MERS-CoV until subsequent tests have confirmed that the animal is free of the virus.

Health officials in countries outside of the affected regions should maintain a high level of vigilance, especially those in countries with large numbers of travellers or migrant workers returning from the Middle East. Surveillance should continue to be enhanced in these countries according to WHO guidelines, along with infection prevention and control procedures in health care facilities. WHO continues to request that Member States report all confirmed and probable cases along with information about their exposures, testing and clinical course to inform the most effective international preparedness and response.

WHO does not advise special screening at points of entry with regard to MERS-CoV nor does it currently recommend the application of any travel or trade restrictions.

WHO guidelines and tools on epidemiologic investigations can be found at http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-surveillance/en/.

WHO/MERS/RA/19.1

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