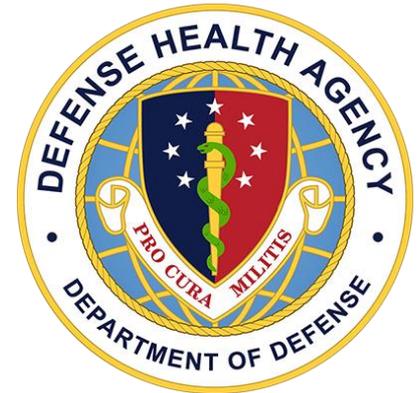


Department of Defense  
Armed Forces Health Surveillance Branch  
Global MERS-CoV Surveillance Summary  
(2 DEC 2015)



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# DEPARTMENT OF DEFENSE (AFHSB)

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### 2 DEC 2015 (next Summary 16 DEC 2015)



**CASE REPORT:** As of 2 DEC 2015, 1,701 (+2) cases of Middle East respiratory syndrome coronavirus (MERS-CoV) have been reported including 641 (+3) deaths in the Kingdom of Saudi Arabia (KSA), Jordan, Qatar, United Arab Emirates (UAE), United Kingdom (UK), France, Germany, Tunisia, Italy, Oman, Kuwait, Yemen, Malaysia, Greece, Philippines, Egypt, Lebanon, Netherlands, Iran, Algeria, Austria, Turkey, Republic of Korea (ROK), China, Thailand, and the U.S.

**ROK CASE REPORT:** On 25 NOV, the last remaining MERS-CoV patient associated with the ROK cluster died. The 35-year-old male spent 172 days in isolation, the longest recorded isolation period for this outbreak, after being initially diagnosed on 7 JUN. This case was also suffering from malignant lymphoma prior to MERS-CoV diagnosis. This new death brings the total case count to 186 cases, 4 suspected cases, and 38 (+1) deaths in ROK reported by the Ministry of Health and Welfare (MOHW). There have been no new cases in ROK since 4 JUL. While ROK officials have not announced a countdown to an official end of the outbreak, usually declared 28 days after the last MERS-CoV patient is discharged, the MOHW downgraded their "readiness level" from yellow to blue. Transmission during the ROK outbreak was attributed to delayed diagnosis and isolation of the index case, lapses in infection control, and care of patients by family members rather than HCWs. This interpretation was supported by WHO, which announced no mutations linked to transmissibility or pathogenesis were found in virus sequences obtained in ROK or China. On 25 OCT, the KCDC reported that 83% of MERS-CoV transmissions were linked to five super-spreaders (cases 1, 14, 15, 16, and 76) during the ROK outbreak. KCDC defines a super-spreader as a case that transmitted the virus to at least four other people. These five cases, all of whom had pneumonia, transmitted the virus to 153 of the 184 cases detected between 20 MAY and 13 JUL 2015 (two of the total 186 cases were excluded as their transmission routes remain unclear).

Two studies regarding the MERS-CoV outbreak in ROK were recently published in EID. One found that a longer incubation was associated with a reduced risk of death. The other sequenced full viral genomes for cases from at least four generations of transmission and found no evidence of changes in evolutionary rate of the virus. A study presented at the 2015 Infectious Disease Week (IDWeek) found that most of the "touchable environments" in MERS-CoV units in ROK were contaminated by patients and HCWs. The study also found that viable MERS-CoV virus could be shed through respiratory secretions of patients who had clinically fully recovered and were conventional-PCR negative. While it was previously known that MERS-CoV could survive on surfaces for long periods of time, the extent of persistent contamination and the period of prolonged viral shedding observed during the MERS-CoV outbreak in ROK has significant implications for hygiene and infection control practices. On 29 NOV, MOH officials from ROK, Japan, and China announced via a joint statement from the Tripartite Health Minister's Meeting in Kyoto, Japan that they will "jointly tackle future MERS-CoV outbreaks and new diseases that pose common problems for Northeast Asian countries." The three countries pledged to expand cooperation with WHO and to strengthen their health monitoring systems.

On 16 OCT, the ROK MOHW hosted a signing ceremony for a letter of intent (LOI) on collaborative research in precision medicine and MERS-CoV research between the U.S. NIH and the Korean NIH. This LOI is a follow up measure to the MOU between the HHS and ROK MOHW signed on 22 JUN detailing precision medicine and the Global Health Security Agenda as areas of bilateral collaboration.

On 13 NOV, GeneOne Life Science, Inovio Pharmaceuticals, and Walter Reed Army Institute of Research (WRAIR) announced a partnership to create a MERS-CoV vaccine. The Deputy Commander of Operations at WRAIR voiced his support for this partnership as "U.S. military personnel could be at risk in the event of a large scale MERS-CoV outbreak" and noted the clinical trials will be conducted at the WRAIR Clinical Trials Center.

**DIAGNOSTICS:** Clinical diagnostic testing is available at BAACH, NAMRU-3, LRMC, MAMC, NHRC, USAFSAM, SAMMC, TAMC, WBAMC, WRNMMC, and NIDDL (NMRC). Tripler AMC (TAMC) completed validation of clinical diagnostic testing capability on 24 NOV. Surveillance testing capability is available at NHRC, AFRIMS, NAMRU-2, NAMRU-3, NAMRU-6, USAMRU-K, and Camp Arifjan. All 50 state health laboratories and the NYC DOHMH were offered clinical testing kits. On 16 JUL, AFHSB updated [MERS-CoV testing guidelines](#) for DoD, which include lab contact information, and are aimed at capturing mild cases that may present in healthier populations such as DoD personnel.

Text updated from the previous report will be printed in red; items in (+xx) represent the change in number from the previous Summary (18 NOV 2015).

All information has been verified unless noted otherwise. Sources include USFK, ROK MOHW, KCDC, U.S. CDC, WHO, EMRO, KSA MOH, ECDC, and Vaccine News Daily.

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**BACKGROUND:** In SEP 2012, [WHO reported two cases of a novel coronavirus](#) (now known as MERS-CoV) from separate individuals - one with travel history to the KSA and Qatar and one a KSA citizen. This was the sixth strain of human coronavirus identified (including SARS). Limited human-to-human transmission has been identified in at least 35 spatial clusters predominately involving close contacts. Limited camel-to-human transmission of MERS-CoV has been proven to occur, and [studies suggest](#) camels infected with MERS-CoV may appear asymptomatic but are able to shed large quantities of the virus from the upper respiratory tract. A [study](#) published in the Annals of Saudi Medicine found that the wave of MERS-CoV cases observed from MAR-JUN 2014 in the Makkah region was likely a result of nosocomial transmission. This springtime spike in cases was previously attributed to camel breeding season. A [study funded by NIH, and published in EID, found no evidence of MERS-CoV infection in dromedary or Bactrian camel herds in Kazakhstan; these results imply dromedary camels may only maintain the virus while another animal likely serves as the natural reservoir for MERS-CoV](#). Another recent [study](#) in the International Journal of Infectious Diseases found that three waves of MERS-CoV transmission appeared to follow waves of influenza A in the Middle East during the 1 MAY 2012 to 31 MAY 2015 time period. While the connection between these two diseases is not yet clear, both present a significant health care burden and possibly share seasonality. A joint [publication](#) by the U.S. CDC, KSA MOH, and a number of affected hospitals in KSA, analyzed risk factors in contracting MERS-CoV. The study found that among 'primary' MERS-CoV cases reported in KSA from MAR-NOV 2014, direct exposure to dromedary camels during the two weeks before illness onset, as well as diabetes mellitus, heart disease, and smoking, were each independently associated with MERS-CoV illness. A case-control study [published](#) by the KSA MOH found that during the 14 days before symptom onset, cases were more likely to have had direct exposure to dromedary camels (in or around the home or recent travel to a farm with camels) than the control population.

The most recent known date of symptom onset is 24 OCT 2015; however KSA MOH has previously admitted to inconsistent reporting of asymptomatic cases. Due to these inconsistencies, it is also difficult to determine a cumulative breakdown by gender; however AFHSB is aware of at least **492 (+2)** cases in females to date. CDC reports 287 of the total cases have been identified as healthcare workers (HCWs). Of these, 178 were from KSA, 31 from UAE, 7 from Jordan, 2 from Iran, 1 from Tunisia, and 29 from ROK. Characteristics of reported cases are limited, however, CDC reports among 287 HCW cases with available information: 11 died; 55 were asymptomatic; 20 had comorbidities; and 15 presented with only mild symptoms. On 8 OCT, researchers at the University of North Carolina [announced](#) that they had successfully genetically engineered a mouse to be infected with MERS-CoV. Mice are not naturally susceptible to the MERS-CoV virus so this engineered mouse model can be used as a vehicle for animal trials of MERS-CoV drugs and vaccines. On 20 OCT, Margaret Chan, director-general of the WHO, [announced](#) that the U.S. and KSA are in discussions to prepare a vaccine for MERS-CoV ahead of the next outbreak of the disease.

**INTERAGENCY/GLOBAL ACTIONS:** WHO convened the [Tenth International Health Regulations \(IHR\) Emergency Committee](#) on 2 SEP and concluded the conditions for a Public Health Emergency of International Concern (PHEIC) have not yet been met. However, the Committee also emphasized that they have a heightened sense of concern as transmission from camels to humans continues in some countries and instances of human-to-human transmission continue to occur in health care settings. The Committee further noted that its advice has not been completely followed as asymptomatic cases that have tested positive for the virus are not always being reported as required. On 13 SEP, the WHO Regional Office for the Eastern Mediterranean (EMRO) concluded [an assessment of the outbreak in Riyadh](#). The EMRO mission identified that most of the nosocomial cases reported where the outbreak is currently ongoing involved patient-to-patient transmission. The mission also identified overcrowding as well as breaches in infection control as being causative. CDC maintains their [Travel Alert Level 2](#) for MERS-CoV in the Arabian Peninsula, which includes specific precautions for the Hajj pilgrimage. CDC is maintaining their travel notice for MERS-CoV in the ROK at a [Travel Watch Level 1](#).

The KSA MOH hosted a MERS-CoV Vaccine Development Workshop over 14-15 NOV in Riyadh, KSA. At this event, an international anti-coronavirus vaccine consortium was formed between the KSA MOH, WHO, U.S. NIH, American Institute of Health Research, and the International Vaccine Institute (IVI). Additionally, a memorandum of understanding (MOU) was signed between the KSA MOH, KSA Ministry of Agriculture (MOA), and the King Abdul Aziz City for Science and Technology (KACST) for joint cooperation that supports research related to MERS-CoV. **WHO also released updated [maps, epidemiological curves, and infographics](#) for the MERS-CoV outbreak.**

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All information has been verified unless noted otherwise. Sources include WHO, KSA MOH, UNC, Ann of Saudi Med, IJID, MD Magazine, Reuters, and CDC.

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#### MEDICAL COUNTERMEASURES IN DEVELOPMENT

RESEARCH GROUP	TYPE OF COUNTERMEASURE	STAGE OF DEVELOPMENT
ROK MOHW	Plasma Treatment	Clinical Trials Stage
Inovio Pharmaceuticals, GeneOne Life Sciences, and Walter Reed Army Institute of Research (WRAIR)	DNA-based Vaccine (GLS-5300)	Clinical Trials Stage
Novavax and University of Maryland School of Medicine	Recombinant Nanoparticle Vaccine	Preclinical Testing Phase
U.S. NIH and Fudan University	M336 Antibody Treatment	Preclinical Testing Phase
Greffex	Treatment	Not yet announced
Abviro	Treatment	Not yet announced
Shanghai Kaibao	Treatment	Not yet announced
Nanovirivide	Treatment	Not yet announced
Purdue University	Enzyme Inhibition Treatment	Not yet announced
Ludwig-Maximilians-Universitaet (LMU) in Munich	Modified Vaccinia virus Ankara (MVA) vaccine	Phase 1 Clinical Trials
Institute for Research in Biomedicine, Universita della Svizzera italiana	Antibody Therapy (LCA60)	Preclinical Testing Phase
The University of Pennsylvania, NIAID, and Inovio Pharmaceuticals	Vaccine	Preclinical Testing Phase
China MOH and China CDC	Recombinant Receptor-Binding Domain (rRBD)	Preclinical Testing Phase
Medizone International, Inc.	Hospital Disinfection System (AsepticSure®)	Purchased by Al-Hidaya International Medical Services Company in KSA
University of Southampton	Antimicrobial Copper	Not yet announced

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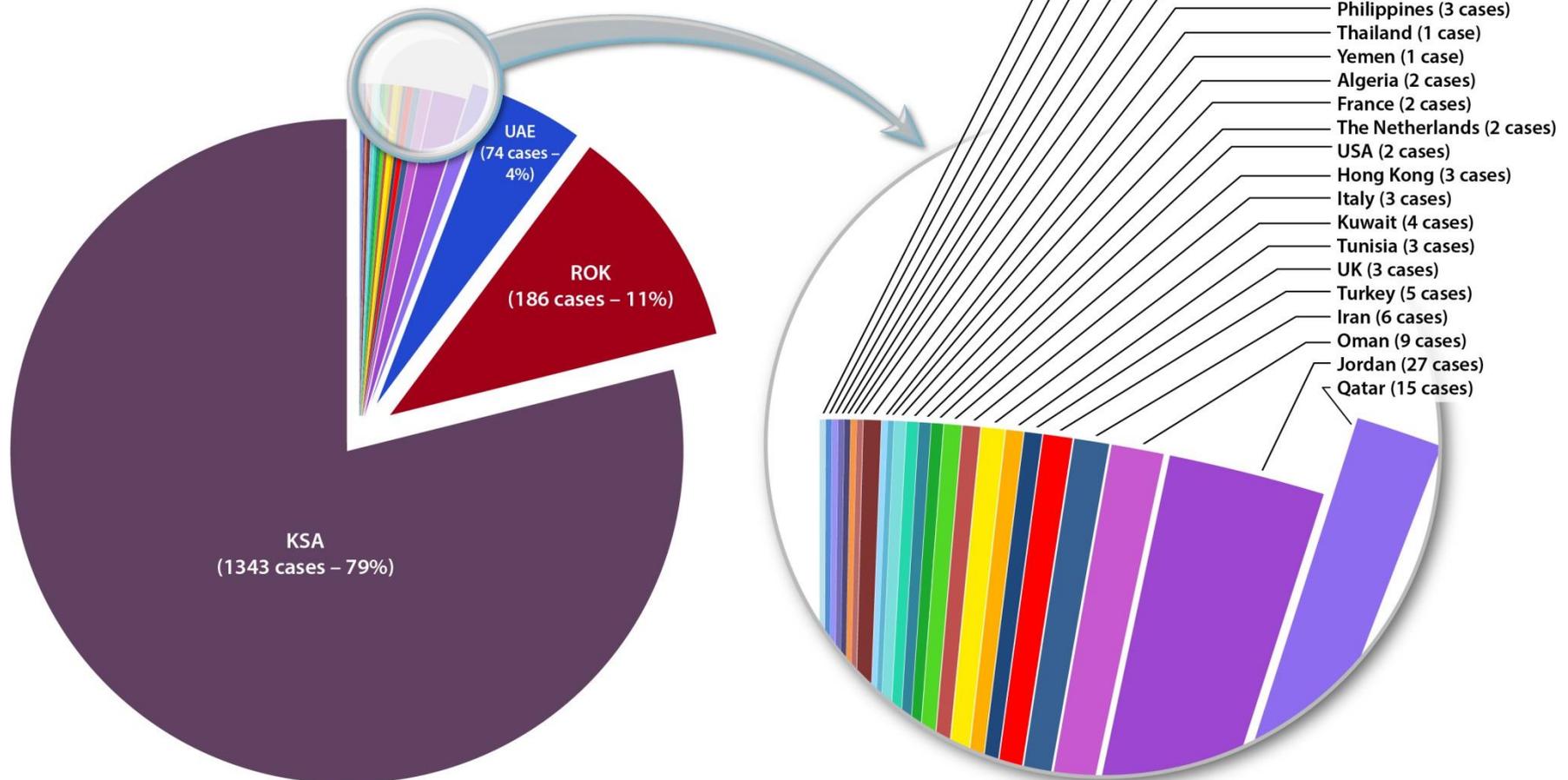
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## Global Distribution of Reported MERS-CoV Cases\* (SEP 2012 – DEC 2015)

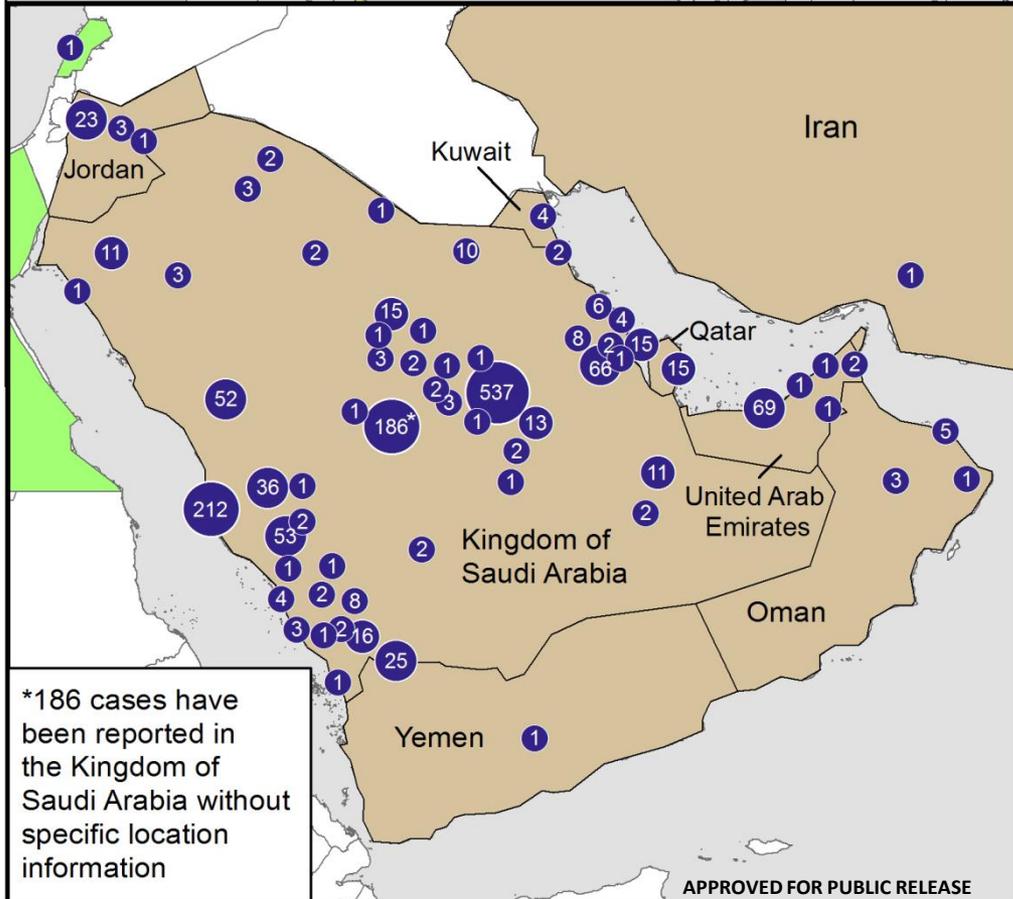
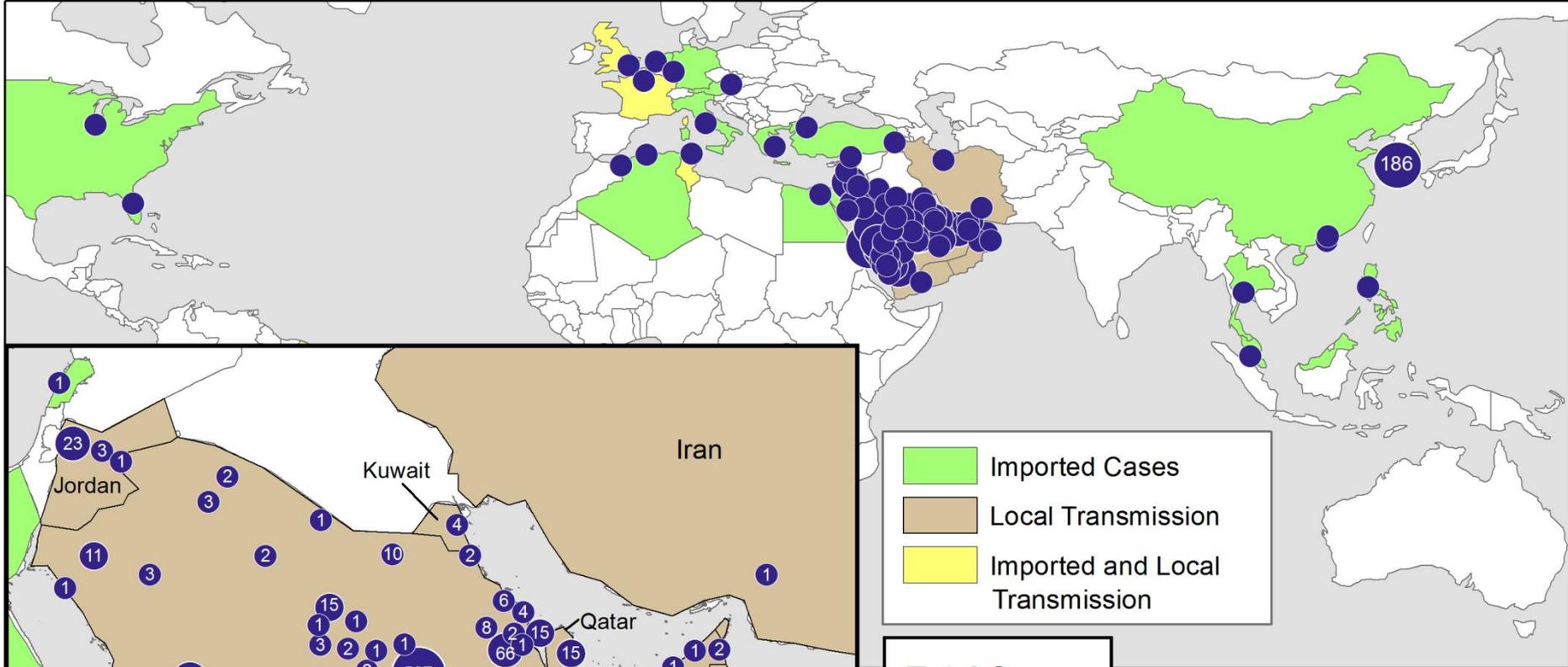


\*Data includes confirmed, suspect and probable cases reported by WHO, CDC, and various country MOHs

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Imported Cases  
 Local Transmission  
 Imported and Local Transmission

**Total Cases**  
**N = 1,701**

- 1 - 10
- 11 - 20
- 21 - 75
- 76 - 150
- 151 - 300
- >300

**Geographic Distribution of MERS-CoV Cases**  
**1 APR 2012 - 2 DEC 2015**



\*186 cases have been reported in the Kingdom of Saudi Arabia without specific location information

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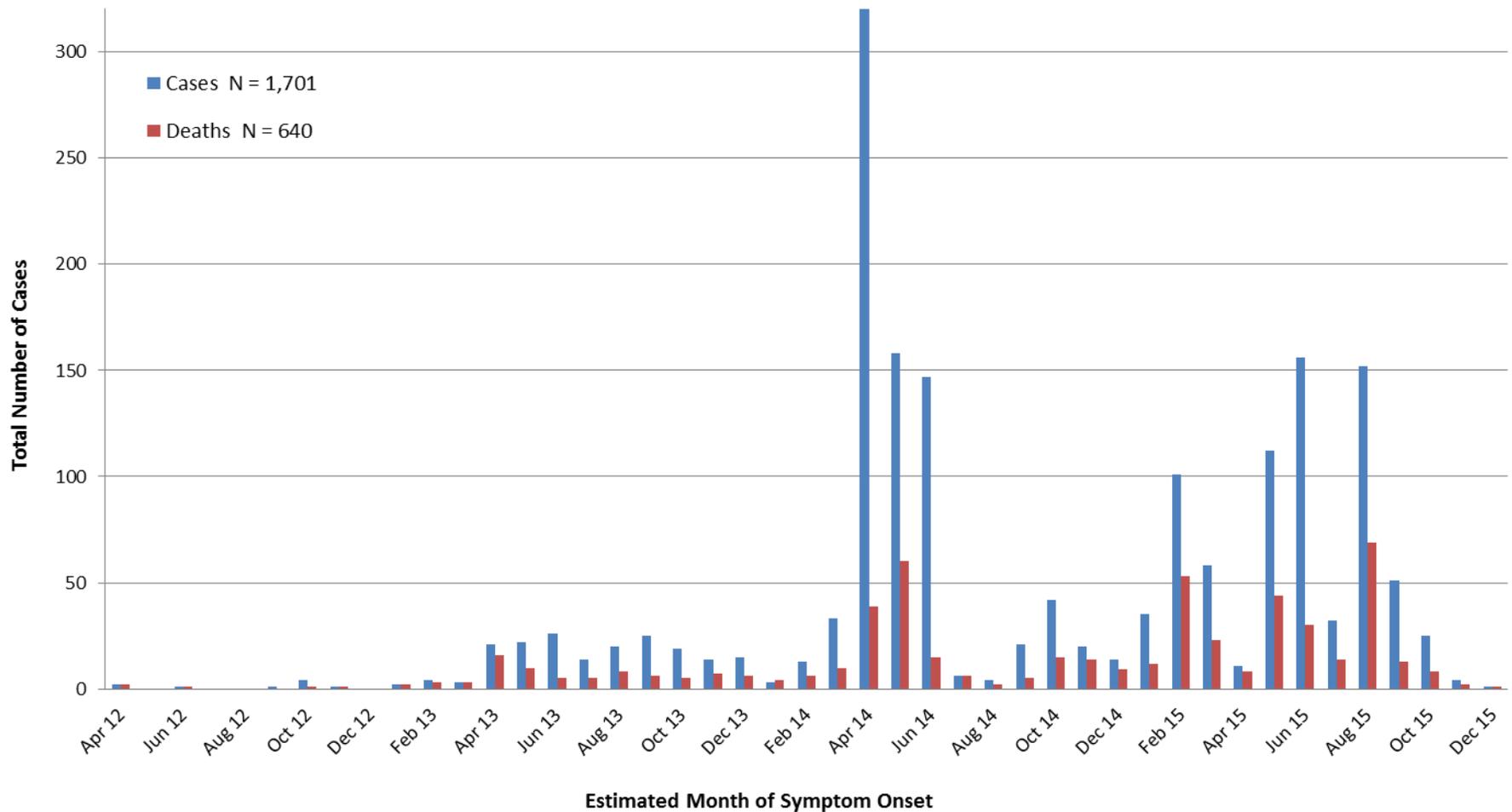
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## Global MERS-CoV Epidemiological Curve - 2 DEC 2015



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### GLOBAL MERS-CoV NUMBERS AT A GLANCE

	Total in 2012	Total in 2013	Total in 2014	Total in 2015	Cumulative Total (2012-2015)
Cases	9	171	777	744 cases (+2)	1,701 cases (+2)
Deaths*	6 deaths	72 deaths	277 deaths	286 deaths (+3)	at least 641 deaths (+3)
Case-Fatality Proportion	66%	42%	36%	38%	38%
Mean Age	45 years	51 years	49 years	55 years	52 years
Gender Breakdown*	1 female	at least 58 females	at least 175 females	258 (+2) females	at least 492 (+2) females
# of Healthcare Workers (HCWs) reported*	at least 2 HCWs	at least 31 HCWs	at least 87 HCWs	108 HCWs	at least 287 HCWs

**\*Disclaimer: Data reported on MERS-CoV cases are limited and adapted from multiple sources including various Ministries of Health, CDC, and WHO. Consequently, yearly information may not equate to the cumulative totals provided by WHO and CDC.**

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#### MERS-CoV Web Sites

- [WHO](#)
- [WHO Lab Testing Guidance](#)
- [WHO Travel Advice for Pilgrimages](#)
- [WHO 10th IHR Meeting Press Release](#)
- [CDC](#)
- [CDC Travel Advisory for the Arabian Peninsula](#)
- [CDC Travel Advisory for ROK](#)
- [CDC MMWR](#)
- [ECDC](#)
- [AFHS Detecting and Reporting Guidelines for MERS-CoV](#)

#### Information and News

- [Association between Severity of MERS-CoV Infection and Incubation Period \(CDC EIDJ, MAR 2016\)](#)
- [Absence of Middle East Respiratory Syndrome Coronavirus in Camelids, Kazakhstan, 2015 \(CDC EIDJ, MAR 2016\)](#)
- [Microevolution of Outbreak-Associated Middle East Respiratory Syndrome Coronavirus, South Korea, 2015 \(CDC EIDJ, FEB 2016\)](#)
- [S. Korea lowers MERS alert to lowest readiness level \(Yonhap News, 1 DEC\)](#)
- [S. Korea, Japanese, Chinese health ministers agree to jointly tackle MERS \(Yonhap News, 29 NOV\)](#)
- [Human Coronavirus 229E Remains Infectious on Common Touch Surface Materials \(mBio, 10 NOV\)](#)
- [Latest WHO DON on MERS-CoV in the Arabian Peninsula \(WHO, 13 NOV\)](#)
- [KSA MOH MERS CoV General Public Infographic Video \(KSA MOH, 2 JUL\)](#)
- [Multifacility Outbreak of Middle East Respiratory Syndrome in Taif, Saudi Arabia \(CDC EIDJ, JAN 2016\)](#)
- [Risk Factors for Primary Middle East Respiratory Syndrome Coronavirus Illness in Humans, Saudi Arabia, 2014 \(CDC EIDJ, JAN 2016\)](#)
- [83% of Korean MERS cases stemmed from 5 patients \(Korea Herald, 25 OCT\)](#)
- [Persistent environmental contamination and prolonged viral shedding in MERS patients during MERS-CoV outbreak in South Korea \(IDSA, 10 OCT\)](#)
- [Researchers Create a Mouse that Can Get MERS \(MD Magazine, 8 OCT\)](#)
- [Differences in the seasonality of MERS-CoV and influenza in the Middle East \(IJID, SEP 2015\)](#)
- [Association of Higher MERS-CoV Virus Load with Severe Disease and Death, Saudi Arabia, 2014 \(CDC EIDJ, SEP/NOV 2015\)](#)
- [Asymptomatic MERS-CoV Infection in Humans Possibly Linked to Infected Camels Imported from Oman to United Arab Emirates, May 2015 \(CDC EIDJ, 10 AUG\)](#)
- [MERS coronavirus: Candidate vaccine gears up for clinical \(EurekAlert, 22 JUN\)](#)
- [Presence of Middle East respiratory syndrome coronavirus antibodies in Saudi Arabia: a nationwide, cross-sectional serological study \(Lancet, 5 MAY\)](#)
- [WHO DON on first novel coronavirus infection \(WHO, 23 SEP 2012\)](#)