MERS-COV: Implications for Healthcare Facilities
Prof. Sotirios Tsiodras, University of Athens, Greece
A Webber Training Teleclass

Sotirios Tsiodras, MD, MSc, PhD
Associate Professor of Medicine & Infectious Diseases
Medical School, National & Kapodistrian University of Athens

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paul@webbertraining.com

New Coronavirus - MERS-CoV

The NEW ENGLAND JOURNAL of MEDICINE

BRIEF REPORT

Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia

Ali Moh Zaki, M.D., Ph.D., Sander van Boheemen, M.Sc., Theo M. Bestebroer, B.Sc.,
Albert D.M.E. Osterhaus, D.V.M., Ph.D., and Ron A.M. Fouchier, Ph.D.

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MERS-CoV
EPIDEMIOLOGY

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CONFIRMED GLOBAL CASES OF MERS-COV 2012 - 2016

MERS 2012-2016, Epicurve

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Middle East respiratory syndrome coronavirus (MERS-CoV)

Thailand confirms MERS-CoV in traveler. WHO cautions against continued risk of importation of MERS-CoV on 24 January 2016. - Thailand today confirmed Middle East respiratory syndrome coronavirus (MERS-CoV) disease in a traveler, the second such case in the country in the last 7 months, as WHO cautioned other member states in its South-East Asia Region against the continuing risk and the need to remain vigilant.

Read the press release

Case fatality 35.8 %

1,638
WHO has been notified of 1,638 laboratory-confirmed cases of infection with MERS-CoV (globally).

587
WHO has been notified of 587 deaths related to MERS-CoV since September 2012.

26
Since September 2012, 26 countries have reported cases of MERS-CoV.

MERS-CoV cases by region of likely acquisition

Ian Mackay, www.virologydownunder.blogspot.com.au

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MERS 2012-2016, Epicurve

Confirmed global cases of MERS-CoV
Reported to WHO as of 12 Feb 2016 (n=1636)

MERS – Global epi curve n /week

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MERS – Global epi curve detections by age & gender

![Graph showing MERS-CoV detections by sex and age](image1)

Ian Mackay, www.virologydownunder.blogspot.com.au

MERS – Global epi curve median age /week

![Graph showing median age of reported cases and cases during Jeddah-2014 outbreak](image2)

Ian Mackay, www.virologydownunder.blogspot.com.au
MERS by country of reporting
Middle East: Mar 2012 - Oct 2015

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Number of cases</th>
<th>Number of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle East</td>
<td>Saudi Arabia</td>
<td>1,255</td>
<td>539</td>
</tr>
<tr>
<td></td>
<td>United Arab Emirates</td>
<td>81</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Jordan</td>
<td>35</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Qatar</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Oman</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Iran</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Kuwait</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Egypt</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Lebanon</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Yemen</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

77% of cases from S Arabia

MERS – KSA 2015

Figure 4. Distribution of MERS cases by reporting city, Saudi Arabia, 1 January – 13 October 2015

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MERS - KSA 2015
Confirmed MERS by source of infection

MERS-CoV, Korea & China
May - July 2015

16 Healthcare facilities
186 cases, 36 deaths

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MERS-CoV, Korea & China 2015

MERS-CoV, Comorbidities

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MERS - Philippines 2015

- 13 Feb 2015 → WHO notified
- 31 yr female HCW in Riyadh, S Arabia
- Onset on 26 Jan 2015 while working in hospital
- Feb 1st 2015 travel to Philippines w family member
- Feb 2nd 2015 admission to local hospital
- Isolated in special hospital February 10th 2015
- All contacts (-) to date
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Bats & ... dromedary camels!!!

EMERGING INFECTIOUS DISEASES

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• Teams for KSA-USA
• isolated MERS-CoV from nasal swabs of dromedary camels in Saudi Arabia
• whole-genome sequences of humans and camels are indistinguishable.
• camels simultaneously infected w >1 MERS-CoV
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Nasal swab specimen from camel in Egypt. Full genome sequence - viruses genetically very similar to human MERS-CoV

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Chantal B.E.M. Reusken et al. EID 2014


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Human–Dromedary Camel Interactions and the Risk of Acquiring Zoonotic MERS-CoV Infection

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Evidence for Camel-to-Human Transmission of MERS Coronavirus

Esmail Azhar, Ph.D., Sherif El-Kafrawy, Ph.D., Suha A. Faraj, M.Sc.,
Ahmed M. Hassan, M.Sc., Muneera S. Al-Saeed, B.Sc.,
Anwar M. Hashem, Ph.D., and Tariq A. Madani, M.D.

SUMMARY

We describe the isolation and sequencing of Middle East respiratory syndrome coronavirus (MERS-CoV) obtained from a dromedary camel and from a patient who died of laboratory-confirmed MERS-CoV infection after close contact with camels that had rhinorrhoea. Nasal swabs collected from the patient and from one of his

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Volume 20, Number 4—April 2014
Research
Antibodies against MERS Coronavirus in Dromedary Camels, United Arab Emirates, 2003 and 2013

Benjamin Meyer, Marcel A. Müller, Victor H. Correas,
Christian D. K. Haukka, Carolin Zitz, Mert Gümüş, Erik
Lethbridge, Stephen Kellner, Arvind Parekh, Thomas van den Beek,
Jan F. Bruch, Darren Hunt, Bernd-Jon Busch, Wolfgang
Warnerey, Harro H.G. Koppelman, Renate Warnerey, and
Christine Verheugen

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MERS-CoV Antibodies in camels – UAE, 2003-2013, 97.1% (+)
= No easy Tx from animals to humans

Volume 21, Number 4—April 2015
Dispatch
Lack of Middle East Respiratory Syndrome Coronavirus Transmission from Infected Camels
Maged G. Hemida1, Abdalrahman Al-Naeem1, Ranawaka A.P.M. Perera1, Alex W.H. Chin, Leo L.M. Poon, and Malik Peiris3
Author affiliations: Kafrelsheikh University, Egypt (M.G. Hemida); King Faisal University, Hofuf, Saudi Arabia (M.G. Hemida, A. Al-Naeem); The University of Hong Kong, Hong Kong, China (R.P. Perera, A.W.H. Chin, L.L.M. Poon, M. Peiris)

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MERS-CoV, Contact w animals

Ian Mackay, www.virologydownunder.blogspot.com.au

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Ingestion
Consumptio

Droplet/Contact
Droplet and aerosol/contacts

Pothica
Birb / VvWnly

Collecting / drinking milk

Drinking / handling raw milk

Eating raw meat


EMERGING INFECTIOUS DISEASES

Volume 20, Number 7—July 2014
Letter
Stability of Middle East Respiratory Syndrome Coronavirus in Milk

Suggested citation for this article

To the Editor: Middle East respiratory syndrome coronavirus (MERS-CoV) was first diagnosed in humans in 2012. Human-to-human transmission of MERS-CoV has been limited, and the transmission route is still uncertain. On the basis of epidemiologic studies, involvement of an animal host has been suggested (1). Dennis et al. have identified a possible intermediate host on the basis of MERS-CoV antibodies and detection of MERS-CoV viral RNA in respiratory swab samples (1-2). Furthermore, MERS-CoV genome sequences obtained

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CAMEL MILK

• MERS-CoV could survive for prolonged periods in milk
• Viable virus was not detectable after pasteurization

van Doremalen N, et al, EID 2014
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OTHER DISEASES ASSOCIATED WITH CAMELS

- MERS-CoV
- Tuberculosis
- Rift valley fever
- Brucellosis
- Adenovirus - Common Respiratory viruses
- Trypanosomiasis
- Equine Herpes virus, camelpox

- GAPS in data - NEED for further studies!!!

Evolution of MERS-CoV in camels
Recent SCIENCE study

- 5 lineages in camels
- Co-circulation of multiple lineages
- At least 6 recombination events – common in RNA viruses --> ?? Increased pathogenicity
- Lineage 5, i.e. Riyadh & S. Korea/China outbreaks of recombinant origin
- Occurred between 12/2013 & 6/2014

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Evolution of MERS-CoV in camels
Recent SCIENCE study

Figure 1. Four Possible Routes for MERS-CoV Transmission. The well accepted human-to-human, human-to-camel, and camel-to-camel are labeled in solid arrows. The possible and ignored human-to-camel transmission is labeled in a dashed arrow. The camel and human images courtesy of Steven Traver and T. Michael Keesey.

Sabir, I.S. et al. (2016) Science 351, 81–84
Lin Du, GZ Han. Trends in Microbiology, February 2016, Vol. 24, No. 2

Rapid Communications
Stability of Middle East respiratory syndrome coronavirus (MERS-CoV) under different environmental conditions


The stability of Middle East respiratory syndrome coronavirus (MERS-CoV) was determined at 20°C – 40% relative humidity (RH); 30°C – 30% RH and 30°C – 80% RH. MERS-CoV was more stable at low temperature/low humidity conditions and could still be recovered after 48 hours. During aerosolisation of MERS-CoV, no decrease in stability was observed at 20°C – 40% RH. These data suggest the potential of MERS-CoV to be transmitted via contact or fomite transmission due to prolonged environmental presence.

Environmental stability
MERS-CoV (isolate HCoV-EMC/2012) and A/Mexico/04/09 (H1N1) virus were propagated and titrated by end-point titration on VeroE6 cells (for MERS-CoV) and Madin-Darby canine kidney (MDCK) cells (for A/Mexico/04/09 (H1N1) virus) as previously described (9,10). To determine the environmental stability of the two viruses, 500 µl of 10^4 tissue culture infective dose 50 (TCID50) of MERS-CoV or A/Mexico/404/2009 (H1N1) virus was spotted in droplets of 5 µl on the surface of steel or plastic washers.

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MERS-CoV
Human - Human transmission

N van Doremalen et al Euro Surveill. 2013;18(38)
Human to human – MERS CoV

- $R_0$ is <1 unless NO Infection Control!!
- Case clusters
  - UK, Tunisia, Italy, S Arabia, France
  - 2ry cases milder, asymptomatic
- > 50% of lab confirmed cases in HC settings
- 2ry transmission in households
  - 26 index → 280 contacts → 12 probable cases


Obono I et al. NEJM  Feb 26th, 2015
Drosten C et al CID 2015:60

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Source in Jeddah outbreak 2014

- Admission to health unit 34%
- Visit in outpatient offices 62%
- Patient visit 17%
- NO contact with healthcare 22%
- ≥ 1 sources / exposures !!!

Obono I et al. NEJM; 2015
MERS-CoV, HCWs / all cases

Ian Mackay, www.virologydownunder.blogspot.com.au

MERS-CoV
Clinical Picture - Diagnosis - Rx

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Clinical picture

- Analysis 144 lab. confirmed & 17 probable
  - 63.4% -> severe respiratory disease, ARDS, MOF
  - 76% w ≥ 1 underlying condition, p<0.001
    • Renal failure, Diabetes Melitus, Heart Diseases
  - 18 asymptomatic

MERS-CoV DIAGNOSIS

- Collaboration w Reference laboratories

- rRT-PCR testing of lower respiratory specimens
MERS-CoV DIAGNOSIS

Table 1. Specimens to be collected from symptomatic patients and asymptomatic contacts

<table>
<thead>
<tr>
<th>Patient</th>
<th>Test</th>
<th>Type of sample</th>
<th>Timing</th>
<th>Storage and transportation</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptomatic</td>
<td>RT-PCR</td>
<td>Lower respiratory tract</td>
<td>Collect on presentation.</td>
<td>If the specimen will reach the laboratory in less than 72 hours, store and ship at 4°C.</td>
<td>Follow international regulations and triple package system for transportation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- sputum</td>
<td>To confirm clearance of the virus.</td>
<td>If the specimen will reach the laboratory in more than 72 hours, store at -80°C and ship on dry ice or liquid nitrogen.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- aspirate</td>
<td>sample collection to be repeated until the results are negative on 2 sequential samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- lavage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upper respiratory tract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- nasopharyngeal and oropharyngeal swabs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- nasopharyngeal wash/nasopharyngeal aspirate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Serum</td>
<td>for virus detection (particularly if lower respiratory tract specimens are not available.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For monitoring the distribution of virus in the body: other sample types, stool, urine</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MERS-CoV DIAGNOSIS

<table>
<thead>
<tr>
<th>Symptomatic</th>
<th>Serology</th>
<th>Serum for serological testing</th>
<th>Paired samples are necessary for confirmation with the initial sample collected in the first week of illness and the second ideally collected 2-3 weeks later. If only a single serum sample can be collected, this should occur at least 14 days after onset of symptoms for determination of a probable case.</th>
<th>As above.</th>
<th>As above.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic Contact (particularly in health-care centre associated outbreaks or other situations of high-intensity contact)</td>
<td>PCR</td>
<td>Nasopharyngeal and oropharyngeal swabs; sputum if possible.</td>
<td>Within 14 days of last documented contact.</td>
<td>As above.</td>
<td>As above.</td>
</tr>
<tr>
<td></td>
<td>Serology</td>
<td>Serum</td>
<td>Base line serum taken within 14 days of last documented contact and convalescent serum taken 2-3 weeks later. If only a single sample is possible, collect at least 14 days after last documented contact</td>
<td>As above.</td>
<td>As above.</td>
</tr>
</tbody>
</table>
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Diagnosis - typing MERS-CoV 2015-16

Reliable typing of MERS-CoV variants with a small genome fragment

Saskia L. Smits 1,2, V. Stalin Raj 1, Suzan D. Pax 1, Chantal B.E.M. Reusken 1, Khaled Mohran 1,2, Elmouhasher A.B.A. Farag 1, Hamad E. Al-Romaihi 1, Mohd M. AlHajri 1, Bart L. Haagmans 1, Marion P. Koopmans 1,2,4

1 Department of Viroscience, Erasmus Medical Center, PO Box 2040, 3000 CA Rotterdam, Netherlands
2 Viruses and Viral Infections, Erasmus MC, Rotterdam, Netherlands
3 Ministry of the Environment, Doha, Qatar
4 Biotechnology Research Department, Animal Health Research Institute, Agricultural Research Center, Egypt
5 Veterinary Council of Health, Doha, Qatar
6 Virology Division, Center for Disease Control Research, Diagnostics and Screening, National Institute of Public Health and the Environment, Bilthoven 3700 BL, Netherlands

Viral shedding & 2ⁿ case in Greece!


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Viral shedding & 2ⁿ case in Greece!

Over 75% of MERS cases shed viral RNA in LRT tracheal aspirates & sputum for at least 30 days

Number of days to negativity

International Journal of Infectious Diseases 29 (2014) 302-308

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Rx - MERS-CoV 2016

INTERIM GUIDANCE DOCUMENT

Clinical management of severe acute respiratory infections when novel coronavirus is suspected: What to do and what not to do

11 February 2013

Rx - MERS-CoV 2016

Treatment of MERS-CoV: Information for Clinicians
Clinical decision-making support for treatment of MERS-CoV patients

5 September 2015
v3.0

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Rx - MERS-CoV 2016
ISARIC & WHO

- Benefit likely to exceed risk
  - Convalescent serum
  - Interferons esp b
  - Lopinavir
  - Monoclonal & polyclonal Abs
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Development of human neutralizing monoclonal antibodies for prevention and therapy of MERS-CoV infections
Tianlei Ying 1*, Haoyang Li 2, Lu Lu 1, Dimitar D. Dimitrov 3, Shibao Jiang 1

1 Key Laboratory of Medical Molecular Virology of MOE/RegenMed, Beijing Medical College, Peking University, 100 Ding Ao Rd., Shunyi, 100037, China
2 Nanotechnology Research Institute, Biotechnology, Institute of the National Research Council, Ottawa, Ontario, K1A 0R6, Canada
3 The Institute for Human Virology, University of Maryland School of Medicine, Baltimore, MD 21201, USA

Virology 490 (2010) 49–58

3B11-N, a monoclonal antibody against MERS-CoV, reduces lung pathology in rhesus monkeys following intratracheal inoculation of MERS-CoV Jordan-n3/2012
Reed F. Johnson 1*, Ulas Bagci 1, Lauren Keith 1, Xianchun Tang 2, Daniel J. Mollura 3, Larry Zeitlin 3, Jing Qin 4, Louis Huzella 5, Christopher J. Bartos 3, Natasha Bohorova 6, Ognian Bohorov 7, Charles Goodman 1, Do H. Kim 1, Michael H. Pautley 3, Jesus Velasco 8, Kevin J. Whaley 9, Joshua C. Johnson 1, James Pettitt 1, Britini L. Ork 6, Jeffrey Solomon 1, Nicholas Oberlander 1, Quan Zhu 10, Jusong Sun 10, Michael R. Holbrook 1, Gene G. Olinger 10, Ralph S. Baric 10, Lisa E. Hensley 1, Peter B. Jahrling 11, Wayne A. Marasco 1
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Middle East respiratory syndrome coronavirus (MERS-CoV) entry inhibitors targeting spike protein
Shuai Xia1, Qi Liu1, Qian Wang1, Zhiliu Sun2, Shan Su1, Lanying Du2, Tianlei Ying1, La Lu1, ShiBo Jiang2

1 Key Lab of Medical Molecular Virology of MERS-CoV, Shanghai Medical College, Fudan University, 130 Dong an Road, Xuhui District, Shanghai 200433
2 Institute for Virology Research, New York Blood Center, New York, NY 10019, USA

A

B

A screen of the NIH Clinical Collection small molecule library identifies potential anti-coronavirus drugs
Jianzhong Cao, J. Craig Forrest, Xuming Zhang

Department of Microbiology and Immunology, University of Arkansas for Medical Sciences, Little Rock, AR 72205, United States

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MERS – CoV
Infection control

Middle East respiratory syndrome coronavirus: Implications for health care facilities
Helena C. Maltezou MD, PhD a, b, Sotirios Tsiodras MD, PhD b
a Department for Interventions in Health Care Facilities, Healthy Center for Disease Control and Prevention, Athens, Greece
b Fourth Department of Internal Medicine, University of Athens Medical School, Athens University Hospital, Athens, Greece

Middle East respiratory syndrome coronavirus
Case definition for reporting to WHO
Interim case definition
14 July 2015

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MERS-CoV / Case definition
Confirmed

A person with laboratory confirmation of MERS-CoV infection\(^1\), irrespective of clinical signs and symptoms.

MERS-CoV / Case definition
Probable

Definition 1

- A febrile acute respiratory illness with clinical, radiological, or histopathological evidence of pulmonary parenchymal disease (e.g. pneumonia or Acute Respiratory Distress Syndrome); and
- Direct epidemiologic link\(^2\) with a confirmed MERS-CoV case; and
- Testing for MERS-CoV is unavailable, negative on a single inadequate specimen\(^3\) or inconclusive.\(^4\)
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MERS-CoV / Case definition
Probable

**Definition 2**
- A febrile acute respiratory illness with clinical, radiological, or histopathological evidence of pulmonary parenchymal disease (e.g. pneumonia or Acute Respiratory Distress Syndrome); **and**
- The person resides or travelled in the Middle East, or in countries where MERS-CoV is known to be circulating in dromedary camels or where human infections have recently occurred; **and**
- Testing for MERS-CoV is inconclusive.4

---

MERS-CoV / Case definition
Probable

**Definition 3**
- An acute febrile respiratory illness of any severity; **and**
- Direct epidemiologic link2 with a confirmed MERS-CoV case; **and**
- Testing for MERS-CoV is inconclusive.4
MERS – CoV
Infection control

• Multiple events of health-care associated transmission
  – Pts w comorbidities --> severe dz
  – HCW frequently affected --> milder dz

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- Recent KSA mission - 23 August 2015
- Hospital based outbreak
  - Virus transmission in the ER of the most heavily affected hospital !!!
    - Despite established triage !!!
    - overcrowded situations, movement of pts before dx,
      breakdowns in application of IPC measures

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MERS-CoV / IPC

Infection prevention and control during health care for probable or confirmed cases of Middle East respiratory syndrome coronavirus (MERS-CoV) infection
Interim guidance
Updated 4 June 2015
WHO/EPH/IPC15.1

Background
WHO has updated the interim guidance that was published on 6 May 2013 to meet the urgent need for up-to-date information and evidence-based recommendations for the safe care of patients with probable or confirmed Middle East respiratory syndrome coronavirus (MERS-CoV) infection. The interim recommendations are informed by evidence-based guidelines WHO has published, including the Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care. WHO Guidelines' and review of current evidence on MERS-CoV infection. The recommendations have been reviewed by experts in infection prevention and control (IPC) and other technical areas (see Acknowledgements for names and

transmission. Health-care institutions are advised to consider reinforcing a service for the oversight of HCWs’ health to ensure a safe environment for patients and HCWs. It is

crucial that HCWs are provided with the best locally available protection for caring for MERS-CoV-infected patients and are followed up if exposure has occurred.

This guidance summarizes:
• Principles of IPC strategies associated with health care
• IPC precautions:
  - for providing care to all patients
  - for providing care to ARI patients
  - for providing care to patients with confirmed MERS-CoV infection

MERS - CoV / Infection control 2016

• Infection prevention & Control critical to prevent Transmission in HC facilities!!!
• Not possible to identify pts early
  – Early symptoms non specific

• HCW should apply standard precautions w all
• Droplet precautions w all URI
• Contact & eye protection w any care of cases of probable or confirmed infection
• Airborne w aerosol generating procedures

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MERS-CoV / WHO 2016, HCW

Use a medical mask if you are close to a patient with acute respiratory symptoms

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MERS-CoV: Implications for Healthcare Facilities
Prof. Sotirios Tsiodras, University of Athens, Greece
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MERS-CoV / WHO 2016, HCW

**Wear your full PPE**
when performing a special procedure, such as intubating
- long sleeved gown,
- gloves
- eye protection
- N95 mask

World Health Organization

MERS-CoV / WHO 2016, HCW

**Wash your hands**
before and after wearing any PPE
(personal protective equipment)

World Health Organization

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MERS-CoV / 2016 donning/doffing, S Korea

Viral Shedding and Environmental Cleaning in Middle East Respiratory Syndrome Coronavirus Infection

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Viral shedding lasted 11 and 19 days from symptom onset in two patients with acute respiratory syndrome coronavirus (MERS-CoV) pneumonia, respectively. Environmental real-time RT-PCR was weakly positive for bedguard and monitors. Even after cleaning the monitors with 70% alcohol-based disinfectant, RT-PCR was still weakly positive, and converted to negative only after wiping with diluted sodium chloride. Further studies are required to clarify the appropriate methods to clean environments during and after treatment of patients with MERS-CoV infection.

Key Words: Virus shedding; Middle East Respiratory Syndrome; Coronavirus
MERS-CoV/Infection prevention 2016

- People with underlying disease are high risk
  - DM, Renal failure, chronic lung dz, immunocompromised
  - Avoid contact with animals particularly camels
    - In areas with potential virus circulation
- General hygiene measures
  - Regular hand washing, avoid contact with sick animals
- Food hygiene practices
  - Avoid --> raw camel milk/urine, not properly cooked meat

MERS-CoV WHO 2016, lay people

Consult a health worker if you have fever (38 °C or higher), cough or difficulty breathing. Inform them of your recent travel history.

Avoid close contact with people if you are sick.

Cover your mouth and nose with a tissue or your sleeve when coughing or sneezing.

Wash your hands regularly with soap and water and maintain good personal hygiene.
MERS-CoV WHO 2016 close contacts, S Korea

Table 5. Risk assessment and recommendations for asymptomatic MERS contacts

<table>
<thead>
<tr>
<th>Risk classification</th>
<th>Disease status of the infection source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>High-risk close contact</td>
<td>Quarantine</td>
</tr>
<tr>
<td>Intermediate-risk close contact</td>
<td>Contact surveillance</td>
</tr>
<tr>
<td>Casual contact</td>
<td>No intervention</td>
</tr>
</tbody>
</table>

High-risk close contact: contact during an aerosol-generating procedure (e.g., nebulizer, intubation, endotracheal suction, bronchoscopy, etc.). Intermediate-risk close contact: contact within 2 m distance of a laboratory-confirmed MERS patient or a stay of the same ward/room of a hospital exposed to laboratory-confirmed MERS patients. Casual contact: brief contact with >2 m distance from a laboratory-confirmed MERS patient.

MERS, Middle East Respiratory Syndrome.

Table 6. Control of visitors to Middle East countries or healthcare facilities affected by MERS outbreak depending on symptom manifestations

<table>
<thead>
<tr>
<th>Fever</th>
<th>Respiratory symptoms</th>
<th>Assessment</th>
<th>Intervention plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>MERS-suspected</td>
<td>PCR test, hospitalization</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td>Medical surveillance</td>
<td>PCR test, discharge and self-quarantine for 14 days from the last exposure$^a$</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td>Medical surveillance</td>
<td>PCR test, discharge and self-quarantine for 14 days from the last exposure$^a$</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>No abnormalities</td>
<td>No interventions</td>
</tr>
</tbody>
</table>

MERS, Middle East Respiratory Syndrome; PCR, polymerase chain reaction.

$^a$A healthcare facility with two or more cases of laboratory-confirmed MERS-CoV infection is regarded as being affected by MERS outbreak.

$^b$In the presence of pneumonia, the patient is classified as a patient with suspected MERS-CoV infection and placed under repatriation quarantine care.

Infect Chemother 2015;47(4):278-302

Prevalence of MERS-CoV Nasal Carriage and Compliance With the Saudi Health Recommendations Among Pilgrims Attending the 2013 Hajj

Journal of Infectious Diseases Advance Access published April 15, 2014

MAJOR ARTICLE

Prevalence of MERS-CoV Nasal Carriage and Compliance With the Saudi Health Recommendations Among Pilgrims Attending the 2013 Hajj

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Emerging Infectious Diseases
Volume 20, Number 4—April 2014
Lack of MERS Coronavirus but Prevalence of Influenza Virus in French Pilgrims after 2013 Hajj

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MERS - CoV / Travellers

Rapid Communications
A case of imported Middle East Respiratory Syndrome coronavirus infection and public health response, Greece, April 2014


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FIGURE
Timeline of possible exposure and clinical course of Middle East Respiratory Syndrome coronavirus infection case, Greece March-April 2014

MERS-CoV in other countries
Since 2012, 26 countries have been affected. The majority of cases (approximately 75%) have been reported from Saudi Arabia.

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MERS-CoV in other countries
the Jordan example

251,280 entries, 255,271 exits
In 6 months 95,128 to EU/EEA countries
N of border crossings from Arab countries 1,400,000
1,250,000 Jordanian passports

2nd case in Thailand in 7 months

Thailand confirms MERS CoV in traveler, WHO cautions against continued risk of importation

SEAR/PR/1618

New Delhi, 24 January 2016: Thailand today confirmed Middle East respiratory syndrome coronavirus (MERS CoV) disease in a traveler, the second such case in the country in the last seven months, as WHO cautioned other member states in its South-East Asia Region against the continuing risks and the need to remain vigilant.

*The new case of MERS CoV is a reminder of the continued risk of importation of the disease from countries where it still persists. All countries need to further enhance surveillance for severe acute respiratory infections, focus on
MERS - CoV / Vaccine?

Experimental vaccine for MERS developed

NOVAVAX

Contact: John Herrmann
Vice President, General Counsel
Novavax, Inc.
240-268-2000

Novavax Produces MERS-CoV Vaccine Candidate

Purified coronavirus spike protein nanoparticles induce coronavirus neutralizing antibodies in mice

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MERS - CoV Transgenic mouse

- constitutive global expression of hCD26/DPP4
  - functional receptor
- lung and brain prime sites for viral replication

MERS – CoV / Stress in HCW

Khalid et al. 2016

Table 4. Factors that helped in reducing stress during MERS-CoV outbreak (Total n=117, Maximum Score 3)

<table>
<thead>
<tr>
<th>Number</th>
<th>Factors that helped to reduce stress</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Positive attitude from colleagues in your department</td>
<td>2.34 (0.74)</td>
</tr>
<tr>
<td>2</td>
<td>None of the staff getting MERS after starting strict protective measures</td>
<td>2.34 (0.82)</td>
</tr>
<tr>
<td>3</td>
<td>Improvement in patient’s condition</td>
<td>2.30 (0.91)</td>
</tr>
<tr>
<td>4</td>
<td>Your colleagues who were infected getting better</td>
<td>2.28 (0.78)</td>
</tr>
<tr>
<td>5</td>
<td>Protective equipment provided to you by Hospital</td>
<td>2.10 (0.86)</td>
</tr>
<tr>
<td>6</td>
<td>Clear guidelines from Hospital for infection prevention</td>
<td>2.07 (1.01)</td>
</tr>
<tr>
<td>7</td>
<td>Your family members or friends outside hospital did not get MERS-CoV</td>
<td>1.97 (1.15)</td>
</tr>
<tr>
<td>8</td>
<td>Decrease in MERS-CoV cases reported in news</td>
<td>1.94 (0.99)</td>
</tr>
<tr>
<td>9</td>
<td>Likelihood that you would get extra compensation for your exposure to MERS-CoV</td>
<td>1.90 (1.18)</td>
</tr>
<tr>
<td>10</td>
<td>All healthcare professionals working together on front line</td>
<td>1.60 (1.05)</td>
</tr>
<tr>
<td>11</td>
<td>Confidence in the hospital staff in case you got sick from MERS-CoV</td>
<td>1.58 (1.12)</td>
</tr>
<tr>
<td>12</td>
<td>Not to do overtime</td>
<td>1.52 (1.08)</td>
</tr>
<tr>
<td>13</td>
<td>Sharing jokes or humor among colleagues</td>
<td>1.43 (1.04)</td>
</tr>
<tr>
<td>14</td>
<td>Getting free meals from the hospital in your unit</td>
<td>1.19 (1.16)</td>
</tr>
</tbody>
</table>

0= Not At All effective; 1= Mildly Effective; 2= Moderately Effective; 3= Extremely Effective in Reducing Stress
MERS – CoV / Stress in HCW

Table 6. Motivational factors to encourage continuation of work in future outbreaks (Total n=117, Maximum Score=3)

<table>
<thead>
<tr>
<th>Number</th>
<th>Motivational factors for future outbreaks</th>
<th>Importance factor Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Similar adequate personal protective equipment supply by the Hospital</td>
<td>2.88 (0.41)</td>
</tr>
<tr>
<td>2</td>
<td>Available cure or vaccine for the disease</td>
<td>2.85 (0.35)</td>
</tr>
<tr>
<td>3</td>
<td>Family support</td>
<td>2.71 (0.64)</td>
</tr>
<tr>
<td>4</td>
<td>Compensation to family if disease related death at work</td>
<td>2.74 (0.71)</td>
</tr>
<tr>
<td>5</td>
<td>Financial recognition of efforts</td>
<td>2.68 (0.76)</td>
</tr>
<tr>
<td>6</td>
<td>Disability benefits if disabled from the disease</td>
<td>2.64 (0.75)</td>
</tr>
<tr>
<td>7</td>
<td>Recognition from management and supervisors for the extra efforts</td>
<td>2.55 (0.77)</td>
</tr>
<tr>
<td>8</td>
<td>Psychiatric help and therapy made available in work place to help reduce stress and anxiety</td>
<td>2.27 (0.99)</td>
</tr>
<tr>
<td>9</td>
<td>Not forced to do overtime</td>
<td>1.72 (1.16)</td>
</tr>
<tr>
<td>10</td>
<td>Reduced working hours during outbreaks</td>
<td>1.67 (1.22)</td>
</tr>
</tbody>
</table>

0=Not important at all; 3=Most important

Khalid et al. 2016

MERS - CoV
Risk assessment

Severe respiratory disease associated with Middle East respiratory syndrome coronavirus (MERS-CoV)
21st update, 21 October 2015

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MERS - CoV Risk assessment

- Majority of cases still from Middle East

- The source of the virus remains unknown, but the pattern of transmission and virological studies point towards dromedary camels in the Middle East as being a reservoir from which humans sporadically become infected through zoonotic transmission.

- Human-to-human transmission is amplified among household contacts and in healthcare settings.

MERS - CoV Risk assessment

- Transmission in hospital settings is still one of the main sources of infection

- Sporadic importation can be expected

- Risk of nosocomial spread in other countries!!!
MERS - CoV
Risk assessment

• Efforts to contain the nosocomial clusters in the affected countries are vital to prevent wider transmission.

• However, with appropriate IPC
  — sustained human-to-human community transmission is unlikely

MERS - CoV
Risk assessment

• Need ↑↑ awareness among HCW and appropriate IPC activities
• No travel restrictions
• Advice for travelers especially high risk ones & HCWs !!!
• Risk of wide spread transmission remains low
HOSPITAL LOCKDOWN!!!

MOH Closes a Private Hospital for non-Compliance with Infection Control Guidelines

23 February 2015

The Ministry of Health (MOH), represented by the Command and Control Center (CCC) of Riyadh Health Affairs General Directorate, closed a private hospital in Riyadh after failing to comply with infection control guidelines issued by the CCC to prevent the spread of infectious diseases.

The Director General of Riyadh Health Affairs, Dr. Adnan Al-Abdulrahim, said, “This nonstop step comes under direct supervision of His Excellency the Minister of Health Mr. Ahmad bin Abdulrahman, and in coordination with the MOH’s Command and Control Center, in efforts to ensure public health and safety of residents and visitors.”

MERS CoV: A trigger for healthcare transformation

The most recent, significant, and urgent case of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), known as MERS-CoV, has highlighted the need for healthcare facilities to be prepared for future pandemics. This virus, first identified in 2012, has led to significant outbreaks, particularly in the Middle East, and has highlighted gaps in healthcare preparedness and response strategies.

As the world continues to grapple with the COVID-19 pandemic, the lessons learned from MERS-CoV can be applied to enhance healthcare systems in the future. This includes improving infection control measures, enhancing healthcare worker training, and strengthening public health surveillance and response capacities.

THANK YOU!!!

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Eltony Mugomere Mtech, National University of Lesotho

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THE GLOBAL MYCOBACTERIUM CHIMAERA OUTBREAK IN CARDIAC SURGERY
Dr. Hugo Sax, University of Zurich Hospitals
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CANADA QMENTUM PROGRAM
Chingiz Amirov, Canadian Journal of Infection Control
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