Assessment of potential risk factors of Middle East respiratory syndrome coronavirus (MERS-CoV) infection among health care personnel in a health care setting

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PROTOCOL SUMMARY

Comprehensive investigations of health care personnel (HCP) who may have been exposed to patients infected with Middle East respiratory syndrome coronavirus (MERS-CoV), diagnosed either prospectively or retrospectively, are essential to understand the extent of human-to-human transmission within health care facilities. The risk factors of infection identified from such investigations may provide insights into the potential modes of transmission to inform guidance and policy in infection control in health care facilities, and in directing national and international public health response.

The epidemiological methods to guide data collection for the comprehensive assessment of risk factors of infection among HCP are set out in this document. This protocol outlines methods of an analytical epidemiological, virological and serological study involving staff working at a health care facility(ies) where an index patient infected with MERS-CoV virus is currently being or has been treated.

Other protocols currently available or under development include (all available on WHO website): http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-surveillance/en/

- Cross-sectional seroprevalence study of MERS-CoV infection in presumed high risk populations
- Case-control study to assess potential risk factors related to human illness caused by MERS-CoV
- Seroepidemiological investigation of contacts of MERS-CoV patients

Using a standardized protocol such as the protocol described below, epidemiological exposure data and biological samples can be systematically collected and shared rapidly in a format that can be easily aggregated, tabulated and analyzed across many different settings globally. This is particularly important in the context of a novel respiratory pathogen.

Comments for the user's consideration are provided in purple text throughout the document as the user may need to modify methods slightly because of the local context in which this study will be carried out.

In the event of an outbreak of a novel respiratory pathogen, this protocol could be adapted to assess risk factors for infection of the novel respiratory pathogen among HCP. In this context, the biological specimens, exposure questions and laboratory methods would need to be adapted to reflect the characteristics of the novel respiratory pathogen.

DEVELOPMENT OF PROTOCOL

The World Health Organization (WHO), together with technical partners (see Acknowledgements at the end for individual reviewers), developed this document, which was adapted from a protocol developed by the Consortium for the Standardization for Influenza Seroepidemiology (CONSISE) - a global partnership that aims to develop influenza investigation protocols and standardize seroepidemiology to inform public health policy for pandemic, zoonotic and seasonal influenza. This global partnership was created out of a need, identified during the 2009 H1N1 pandemic, for standardized seroepidemiological data to estimate infection attack rates and severity of epidemic and pandemic viruses and to inform policy decisions. More information on the CONSISE network can be found on the website: www.CONSISE.tghn.org.

The initial draft of the protocol was released in 2013. This current update takes into account recent advances in knowledge of animal-to-human and human-to-human transmission of MERS-CoV, laboratory methods and infection prevention and control measures to prevent MERS-CoV infection.

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CONTENTS

1.0 SCIENTIFIC BACKGROUND & RATIONALE FOR STUDY

As of July 2018, more than 2220 laboratory-confirmed cases of human infection with Middle East respiratory syndrome coronavirus (MERS-CoV) have been reported to WHO [1]. Infections have largely been reported from countries across the Arabian Peninsula, with occasional importations and associated clusters in other regions of the world.

MERS-CoV is zoonotic in origin and dromedary camels are the main animal reservoir and the only known source of transmission from animals to humans, although the exact route(s) of transmission remains unclear. The clinical spectrum of MERS-CoV infection ranges from asymptomatic infection to severe pneumonia with acute respiratory distress syndrome (ARDS) and other life-threatening complications. Mild symptoms are non-specific and can include headache, tiredness, fever, mild cough, sore throat, and runny nose. Some patients may present with gastrointestinal symptoms such as mild diarrhea [1].

While MERS-CoV appears to be inefficient at transmitting between humans in the general community, approximately half of the reported MERS-CoV infections have occurred in health care settings when infection, prevention and control measures have been inadequate. Health care associated human-to-human transmission of MERS-CoV, France, Jordan, the Republic of Health Saudi Arabia, United Arab Emirates, the Republic of Korea and the United Kingdom which has on occasion resulted in significantly large outbreaks [2-6]. Secondary human-to-human transmission has occurred during unprotected contact between patients, from patients to health care workers, and from patients to visitors of the hospital [1-6].

MERS-CoV surveillance initially focused on patients with severe disease, and, as such, the full spectrum of the disease, including the extent of mild or asymptomatic forms of infection is not clear. Since 2015, WHO has updated its guidance for contact tracing, and, as a result, more asymptomatic or mild forms of the disease have been reported [7,10]. Further, several studies conducted during hospital outbreaks of MERS have evaluated the extent of infection among HCP following contact with confirmed MERS patients [9,11-13].

Factors associated with amplified human-to-human transmission in health care facilities have also been conducted. One study conducted in the United Arab Emirates during a large nosocomial outbreak indicated overcrowding in tertiary care, excessive movement of patients within the health care facility and poor infection prevention and control compliance by health care personnel as risk factors for human-to-human transmission [10]. Studies of other respiratory pathogens including MERS-CoV conducted in the Middle East and the Republic of Korea illustrate that aerosol generating procedures and non-invasive ventilation, combined with inadequate infection prevention and control compliance, have had an important role in facilitating human-to-human transmission in health care settings [4,15-19]. The role of environmental contamination has been evaluated in a number of hospitals following the 2015 MERS outbreak in the Republic of Korea and collaborative, experimental studies are being conducted to evaluate MERS-CoV viability and persistence on surfaces and in the air [20-22]. The role of mild or asymptomatic cases in transmission also remains unclear [23-27].

Recurrent secondary transmission of MERS-CoV to humans, particularly in health care facilities, call for further investigations to understand secondary transmission to and among HCP. The protocol outlined below aims to evaluate the extent of MERS-CoV infection among health care workers, high risk contacts who care for MERS patients, often before MERS is diagnosed. The study also aims to identify factors that facilitate

transmission in health care facilities and can inform measures to be taken to interrupt secondary transmission.

Specifically, this study aims to collect data to evaluate risk factors for human-to-human MERS-CoV transmission in health care facilities by comparing exposures of HCP infected with MERS-CoV (based on virological or serological confirmation) with HCP not infected with MERS-CoV (seronegative study participants) during a recent or ongoing MERS-CoV outbreak(s).

Current information on the MERS-CoV and interim guidance on infection prevention and control can be found on the WHO website: http://www.who.int/emergencies/mers-cov/en/

COMMENT: Before submission to a local/national Institutional Review Board (IRB) or ethical review committee, the background and rationale described above will need to be updated with the most recent research findings and further description of the epidemiology of the outbreak in the country in which this study is being conducted.

1.1 OBJECTIVES

The data collected from this study will be used to further characterize the key epidemiological secondary transmission features of MERS-CoV virus to and among health care personnel and to inform strategies for prevention and control of MERS-CoV transmission in health care settings.

COMMENT: This protocol addresses risk factors for transmission specifically among health care personnel. Other protocols available or under development include (all available on WHO website): http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-surveillance/en/

- Cross-sectional seroprevalence study of MERS-CoV infection in presumed high risk populations
- Case-control study to assess potential risk factors related to human illness caused by MERS-CoV
- Seroepidemiological investigation of contacts of MERS-CoV patients

1.1.1 PRIMARY OBJECTIVES

The primary objectives of this study are to:

- Estimate the extent of MERS-CoV human-to-human transmission among health care professionals working in health care settings where MERS cases are treated
- Determine the risk factors for MERS CoV infection in health care workers

1.1.2 SECONDARY OBJECTIVES

Seroepidemiologic investigations, such as the one described below, can provide rich data to assess secondary objectives, including, but not limited to:

- Description of the spectrum of illness and clinical course of disease with MERS-CoV infection
- Quantification of the proportion of asymptomatic and sub-clinical MERS-CoV infections
- Quantification of the proportion of individuals in whom seroconversion occurs in areas in which outbreaks of MERS-CoV have not previously been reported
- Assessment of the effectiveness of infection control measures

COMMENT: There is currently a lack of generalizable information on antibody kinetics of MERS-CoV in human patients. One study conducted on 42 MERS-CoV infected from the outbreak in the Republic of Korea and found that although all surviving patients were seroconverted, none had antibodies 10 months after infection [28]. This study employs the use of molecular testing of high risk health care worker contacts as well as serology, in an attempt to capture acute sub-clinical infection or asymptomatic as well as seroconversion. Another study conducted in the Republic of Korea found that antibody responses may wane beyond 12 months [29]. Extensive contact tracing policies recommended by WHO and implemented in KSA have identified a substantial number of asymptomatic secondary HCW infections [4,30,31], however very few of these individuals seroconvert (personal communication). These considerations should be accounted for when assessing the ability of the study to capture evidence of seroconversion as a secondary objective of this study.

2.0 STUDY PROCEDURES

This study uses epidemiological, virological and serological methods to assess the risk factors for human-to-human transmission of MERS-CoV among HCP exposed to a patient infected with MERS-CoV. The exposures of laboratory-confirmed (by RT-PCR or serology) MERS-CoV infected HCP will be compared to those of MERS-CoV negative HCP in order to determine risk factors associated with MERS-CoV infection.

COMMENT: The study population is restricted to HCP in a health care facility with a known MERS-CoV infected patient. It does not extend to contacts of the patient such as visitors. A protocol to investigate high-risk contacts of a known MERS-CoV patient can be found here:

http://www.who.int/csr/disease/coronavirus_infections/WHO_Contact_Protocol_MERSCoV_19_November_2013.pdf?ua=1

2.1 IDENTIFICATION OF HEALTH CARE PERSONNEL

Visiting the health care facility prior to the start of the study is critical in order to understand the management, infrastructure, personnel and policies of infection prevention and control and the possible exposures HCP may have had to MERS-CoV. A data collection tool to help in formulating hypotheses about exposures and to identify all potential participants for this study is provided in Appendix A. It is recommended that the investigation begins with a general interview of HCP, including supervisors and colleagues, to have a better understanding of the potential exposures and existing infection prevention and control practices. If, for example, HCP are unable to participate in the interview process as a result of critical illness or death, a direct supervisor or colleague may be used as a proxy. The interview should be used in conjunction with a data collection form to identify all potential study subjects (Appendix B).

Based on the results of preliminary interviews describes above, a detailed questionnaire can then be developed. A sample questionnaire has been provided in Appendix C as a starting point.

COMMENT: The timing of this study is critical. Ideally, this study should be conducted as soon a patient with MERS-CoV (the potential index case) is identified at a health care facility. This protocol is based on the assumption that the patient with MERS-CoV infection was identified while still in the hospital.

2.2 SELECTION OF HEALTH CARE PERSONNEL

Every effort will be made to include all HCP who may have come in contact with the MERS-CoV confirmed patient(s). Identification of HCP should include consultation of duty rosters, interviewing personnel and tracing contacts from the time of the first contact with a MERS-CoV infected patient (or patient's materials) to 14 days after the last contact.

COMMENT: For the purposes of this protocol specifically designed for MERS-CoV, we recommend that the definition of a contact should not be too restrictive so that a large number of potentially exposed HCP are included in the study. Contacts should include, for example, cleaners, clerks, and others who may not

have provided direct care to the patient (e.g., touched the patient), but who may have been in relatively close proximity to the patient or with the patient's materials.

COMMENT: If the patient with MERS-CoV infection consulted or received treatment at any other health care facility for this illness, these health care facilities need to be contacted and the HCP from these facilities recruited into the study.

HCP in contact with MERS-CoV infected patient should be identified initially by hospital infection prevention and control staff. These will include all staff involved in provision of care for a MERS-CoV infected patient, including those who may have been present in the same area as the infected patient for other purposes and those who may have had contact with patient body fluids, potentially contaminated items or environmental surfaces. The study population should therefore comprise all staff working in all health care facilities involved in provision of care to the infected patient during all or part of the time of potential exposure, including reception area/admission facilities, specialized and supporting services. All categories of potentially exposed staff should be selected, including health care workers, allied health professionals, auxiliary health workers (e.g. cleaning and laundry personnel, x-ray physicians and technicians, clerks, phlebotomists, respiratory therapists, nutritionists, social workers, physical therapists, lab personnel, cleaners, clerks, patient transporters, catering staff, etc.).

2.2.1 ELIGIBILTY CRITERIA

Inclusion criteria: All HCP with potential exposure to a MERS-CoV infected patient hospitalized or previously hospitalized in the health care facility or to the patient's materials.

Exclusion criteria: Any HCP who is unable to give informed consent.

COMMENT: This protocol is designed to assess risk factors for infection among HCP with potential exposure to MERS-CoV. It does not include visitors to the health care facility who may have contact with a MERS-CoV infected patient or the patient's material. A protocol that looks specifically at non-HCP contacts of a MERS-CoV infected patient is available on the WHO website:

http://www.who.int/csr/disease/coronavirus_infections/WHO_Contact_Protocol_MERSCoV_19_November_2013.pdf?ua=1

COMMENT: The concept of "protected exposure" should be avoided when selecting the study participants. In particular, wearing personal protective equipment (PPE) should not be considered an exclusion criterion, as one of the risk factors to be studied is the effectiveness of PPE.

COMMENT: Recommendations are provided for the definition of a HCP contact in terms of space and duration. Any variation in the definition of HCP contacts between studies will result in reduced comparability, so definition of a contact in terms of space and time in the reporting of the results of this study will be critical for interpretation of the results and comparability of the results to other studies. This also applies if the protocol is used for viruses other than MERS-CoV.

2.3 FOLLOW UP AND SPECIMEN COLLECTION

After potential participants have been identified and listed, informed consent from all participants will be obtained (see 2.5.1 below). Details of the HCP contacts will be kept in a line list by the investigation team (see Appendix B). At the time of recruitment, biological sampling will be conducted (see Table below) and a questionnaire will be administered (Appendix C).

Specimen collection	**Timing of collection**	**References for methods**
Nasopharyngeal and oropharyngeal swabs	At the time of recruitment. Sample collection should be done as soon as possible and within 14 days from last point of exposure	MERS-CoV RT-PCR assay on RNA [32]
Single serum sample	Sample collection >14-21 days from last contact with MERS-CoV patient / point of exposure	Laboratory confirmation methods [32-37]
Paired serum (from same individual)	Sample collection: • First sample: as soon as possible after contact with MERS-CoV patient / point of exposure • Second sample: ≥21 days after first sample	Paired serum guidance [38] Antibody kinetics [28,29]
Questionnaire	Administer questionnaire at the point of data collection. If paired sample collection, two questionnaires should be administered	See Appendix C

Specimen collection, shipment and laboratory testing for MERS-CoV is provided here: http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-laboratory/en/.

All participants will be monitored daily for symptoms for 14 consecutive days after the last contact with a MERS-CoV patient or with the patient's materials.

If symptoms are reported by the HCP contact during the follow up period, molecular testing will be carried out immediately. Additional specimens to be collected from HCP who report symptoms during the 14-day follow up period include combined nasopharyngeal and oropharyngeal swabs for molecular testing, and, ideally, specimens from the lower respiratory tract (e.g., induced sputum, aspirate, lavage, as appropriate), if possible. The clinical management of any HCP who report symptoms will be guided by the standards of care at the site at which the investigation is being conducted.

Any contact who shows molecular or serologic evidence of MERS-CoV infection as defined by WHO [37] will be re-classified as a confirmed case of MERS-CoV infection and reported as such to WHO under the International Health Regulations (2005). Each newly confirmed case of MERS-CoV infection will initiate a new contact investigation as outlined above.

2.3.1 SPECIMEN COLLECTION, TRANSPORTATION

All those involved in collection and transporting specimens should be trained in safe handling practices and spill decontamination procedures. Guidance documents on infection control are available at http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-infection/en/.

When collecting nasopharyngeal and oropharyngeal specimens, swabs specifically designed for collecting specimens for virology must be used. These swab kits should contain virus transport medium. The nasopharyngeal and oropharyngeal swabs should be placed in the same tube to increase the viral load.

For each biological sample collected, the time of collection, the conditions for transportation and the time of arrival at the study laboratory will be recorded. Specimens should reach the laboratory as soon as possible after collection. If the specimen is not likely to reach the laboratory within 72 hours, specimens should be frozen, preferably at -80°C, and shipped on dry ice. It is, however, important to avoid repeated freezing and thawing of specimens. The storage of respiratory and serum specimens in domestic frost-free freezers should be avoided, owing to their wide temperature fluctuations. Serum should be separated from whole blood and can be stored and shipped at 4°C or frozen to -20°C or lower and shipped on dry ice.

Transport of specimens within national borders should comply with applicable national regulations. International transport of MERS-CoV specimens should follow applicable international regulations as described in the WHO Guidance on Regulations for the Transport of Infectious Substances 2013- 2014 available at: http://www.who.int/ihr/publications/who_hse_ihr_20100801/en/index.html.

COMMENT: You may consider that specimens will be aliquotted so that specimens remain in country and only aliquots are sent to a reference lab. Some serologic assays may become available to be done in country.

WHO laboratory guidance on specimen collection and transportation in full can be found at: http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-laboratory/en/.

Whenever specimens are collected from cases under investigation, appropriate infection control guidelines must be followed. Guidance documents on infection control are available at http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-infection/en/.

Key points to remember are:

- All health-care workers who collect specimens from patients suspected or confirmed to be infected with MERS-CoV must wear appropriate personal protective equipment (PPE); and

- All those involved in collection and transporting specimens should be trained in safe handling practices and spill decontamination procedures.

2.4 DEMOGRAPHIC AND EXPOSURE DATA COLLECTION

At the time of recruitment, a brief questionnaire will be administered to those HCP who have provided written, informed consent. A sample questionnaire has been provided in Appendix C. However, this will need to be adapted based on the local setting, health care facility and outbreak characteristics. It will also need to be pilot tested in a small group of participants and revised before being administered to all participants.

This questionnaire will collect information on demographics, professional duties in the health care facility, symptoms of respiratory disease, use of PPE, compliance to infection prevention and control measures (triage processes, hand hygiene, environmental cleaning etc.) and specific exposures to the MERS-CoV infected patient or patient's materials. Additional exposure (including exposures to confirmed or suspected human cases in the community and to other potential sources such as animals) questions will be included for all study subjects in the questionnaire.

A template of the study questionnaire for the use of all cases and contacts is provided in Appendix C.

2.5 ETHICAL CONSIDERATIONS

Ethical approval must be sought in accordance with local, regional and national authorities prior to the implementation of this protocol.

COMMENT: It is recommended that ethical approval be obtained from relevant ethical or institutional review boards in advance using a generic protocol such as this one before an outbreak occurs. If an outbreak occurs, the study design, questionnaires, sampling and consent forms can be modified rapidly to reflect the current outbreak situation. This will likely have to be resubmitted for ethical approval, but if the generic protocol has already been approved, the process is possible that second review may be more rapid, minimizing delays to the start of investigations.

2.5.1 INFORMED CONSENT

The purpose of the investigation will be explained to all HCP with potential exposure to a MERS infected patient hospitalized or previously hospitalized in the health care facility or the patient's materials. Informed consent will be obtained from all HCP willing to participate in the investigation before any procedure is performed as part of the investigation by a trained member of the investigation team. Each participant must be informed that participation in the investigation is voluntary and that s/he is free to withdraw, without justification, from the investigation at any time without consequences and without affecting professional responsibilities.

Informed consent will seek approval to collect blood, combined nasopharyngeal and oropharyngeal swabs and possibly lower respiratory tract specimens for the intended purpose of this investigation, that samples may be shipped outside of the home country for additional testing and that samples may be used for future research purposes. Informed consent will also indicate that any suspected or confirmed MERS-CoV infection may be notified to the national health authorities under the requirements of the International Health Regulations (IHR).

2.5.2 RISKS AND BENEFITS FOR SUBJECTS

This investigation poses minimal risk to participants, involving collection of a small amount of blood and upper (and lower) respiratory tract specimens. The direct benefit to the participant is the possibility for early detection of MERS-CoV infection which would allow for appropriate monitoring and treatment. The primary benefit of the study is indirect in that data collected will help improve and guide efforts to understand transmission of MERS-CoV and prevent further spread of MERS-CoV in health care facilities, particularly among HCP.

2.5.3 CONFIDENTIALITY

Participant confidentiality will be maintained throughout the investigation. All subjects who participate in the investigation will be assigned a study identification number by hospital staff for the labeling of study questionnaires and clinical specimens. The link of this identification number to individuals will be maintained by the health care facility and the Ministry of Health (or equivalent) and will not be disclosed to any other research personnel.

COMMENT: If the data is shared by the implementing organization to WHO or any agency or institution providing support for data analysis, data shared will include only the study identification number and not any personably identifiable information.

2.5.4 PREVENTION OF MERS-COV TRANSMISSION IN STUDY PERSONNEL

Before the start of the investigation, all HCP in the health care facility and study personnel, will be provided training in infection prevention and control procedures (standard contact, droplet or airborne precautions, as determined by national or local guidelines). These procedures but should include proper hand hygiene and the correct use of surgical or respiratory face masks, if necessary, not only to minimize their own risk of infection when in close contact with MERS-CoV infected patients in a health care setting, during home visits and elsewhere, but also to minimize the risk of spread among other HCP and household members.

WHO technical guidance on infection prevention and control specific to MERS-CoV can be found here: http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-infection/en/.

2.6 LABORATORY EVALUATIONS

As of January 2018, a MERS-CoV case may be laboratory confirmed by detection of viral nucleic acid or by serology. WHO MERS laboratory guidance can be found here: http://www.who.int/csr/disease/coronavirus_infections/technical-guidance-laboratory/en/.

COMMENT: The following laboratory recommendations are subject to further updates as diagnostic tests and approaches become available.

2.6.1 MOLECULAR TESTING

The presence of viral nucleic acid can be confirmed by either positive results for nucleic acid amplification assays, such as reverse transcription polymerase chain reaction (RT-PCR), for at least two specific genomic targets, or a single positive target with sequencing of a second target.

A positive PCR assay for a single specific target without further testing is considered *presumptive* evidence of MERS-CoV infection. Final classification of cases will depend on clinical and epidemiological information combined with laboratory data. Member States are requested to immediately notify WHO of any positive results.

2.6.2 SEROLOGICAL TESTING

When investigations of outbreaks or contacts of confirmed MERS patients are being conducted, serology is often useful. It is advised that serum samples are collected from contacts as early as possible after the date of contact with a MERS patient and that a second serum sample is collected 3-4 weeks after the last contact. Sera may be tested by a screening serological test (ELISA or IFA) and positive screening results need confirmation with neutralization tests. In the event that a participant reports symptoms, appropriate respiratory specimens should also be collected for nucleic acid amplification test (NAAT) testing (see section 2.3)

A number of different technical approaches for confirming MERS-CoV infection using serology have been developed. Details of two immunofluorescence assays to detect antibodies to MERS-CoV have been published [32], and these assays, along with a serum neutralization test, were used in a 2 to 3 stage procedure to screen contacts of a case in Germany and determine population seroprevalence in Saudi Arabia [32,33].

An assay for detection of MERS-CoV antibodies using protein microarray technology has also been developed and the details published [34,35] suggest it is highly specific. Another two-stage approach with a screening test using a recombinant nucleocapsid (N) and spike (S) protein-based indirect enzyme-linked immunosorbent (ELISA), followed by a confirmatory microneutralization, has recently been described [36]. Details of a neutralization test based on retroviral pseudoparticles which demonstrates high levels of specificity to MERS-CoV have been published [37].

COMMENT: A limited number of laboratories have the facilities for MERS-CoV serological testing and therefore collaboration between countries without current capacity and designated reference laboratories is possible. Collaboration is up to the discretion of Member States carrying out the

investigation, but WHO strongly supports such collaborations and is prepared to facilitate this collaboration and possible shipment for testing, if required.

3.0 STUDY ENDPOINTS & STATISTICAL ANALYSES

The following section discusses sample size considerations, study endpoints – that is, what can be measured and calculated using the data collected in this study – and the statistical analyses that should be performed to answer the study questions.

3.1 SAMPLE SIZE CONSIDERATIONS

The study-specific sample size will be determined by the number of HCP in contact with the confirmed MERS-CoV patient(s) and by assumptions related to secondary MERS-CoV transmission. Every effort should be made to include all HCP who have been or are in contact with confirmed MERS-CoV patients to maximize the statistical power of the investigation.

3.2 STUDY OUTCOME MEASURES

3.2.1 PRIMARY ENDPOINTS

The primary objective of this study is to assess the frequency of infection (virological and serological) among exposed HCP. The primary endpoints will therefore be:

- Virological infection = % of all HCP included in study who are RT-PCR positive for MERS-CoV according to WHO definitions

- Immunological infection = % of all HCP included in study who are seropositive (see section 2.6.2 for seropositivity definition)

COMMENT: Depending on the study sample size, these proportions may be reported as overall infection rates or by subgroup (e.g. by occupational group or job duty, by age, gender, etc.).

3.2.2 RISK FACTORS FOR INFECTION

The exposures (e.g. characteristics, behaviors, practices) of HCP with positive molecular or serologic results (combining the two into a "infected" group) should be compared to HCP with negative molecular and serologic results.

These comparisons should be done using appropriate statistical tests. For example, bivariate associations between risk factors for infection should be determined by chi-square statistics or 2-sided Fisher's exact test and expressed as odds ratios with 95% confidence intervals. Multivariate logistic regression should be used to further analyze the associations if the sample size permits.

COMMENT: Univariate statistical analysis by logistic regression could be used to test the significance of each predictor on the outcome of infection. Multivariate logistic regression can be used to identify

independent risk factors (after adjusting for known or potential confounders) or a combination of risk factors associated with the odds of infection.

COMMENT: Alternatively, Mantel-Haenszel matched-pair analysis (McNemar test) can be used to estimate the strength and statistical significance of associations between exposures and infection.

4.0 REPORTING OF FINDINGS

Reports of the results of this study should include the number of HCP recruited and the number of confirmed MERS-CoV infections among HCP, or the number of HCP with serological evidence of MERS-CoV infection.

It is also important to fully document the study design, including recruitment methods, eligibility criteria, techniques for determining MERS-CoV infection and the outcome measurements, in order to assist the interpretation of the findings.

COMMENT: The timely dissemination of the results of this study are critical in understanding transmission of the MERS-CoV virus to inform guidance for policy to direct national and international public health response.

REFERENCES

1. Zaki AM, van Boheemen S, Bestebroer TM, Osterhaus AD, Fouchier RA (2012) Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. *N Engl J Med* 367: 1814-1820.

2. Park, H. Y., Lee, E. J., Ryu, Y. A., Kim, Y., Kim, H., Lee, H., & Yi, S. J. (2015). Epidemiological investigation of MERS-CoV spread in a single hospital in South Korea, May to June 2015. *Euro Surveill*, 20: 1-6.

3. Fagbo, S. F., Skakni, L., Chu, D. K. W., Garbati, M. A., Joseph, M., Peiris, M., & Hakawi, A. M. (2015). Molecular Epidemiology of Hospital Outbreak of Middle East Respiratory Syndrome, Riyadh, Saudi Arabia, 2014. *Emerg Infect Dis* 2: 1981–1988.

4. Assiri A, McGeer A, Perl TM, Price CS, Al Rabeeah AA, et al. (2013) Hospital Outbreak of Middle East Respiratory Syndrome Coronavirus. *N Engl J Med* 369: 407-416.

5. Guery B, Poissy J, el Mansouf L, Séjourné C, Ettahar N, Lemaire X et al. (2013) Clinical features and viral diagnosis of two cases of infection with Middle East Respiratory Syndrome coronavirus: a report of nosocomial transmission. *Lancet* 381: 2265-72.

6. Hijawi B, Abdallat M, Sayaydeh A, Alqasrawi S, Haddadin A, et al. (2013) Novel coronavirus infections in Jordan, April 2012: epidemiological findings from a retrospective investigation. *East Mediterr Health J* 19: S12-S18.

7. Elkholy AA, Grant R, Assiri A, Elhakim M, Malik MMD, Van Kerkhove MD. MERS-CoV infection among health care 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* 2018 (ahead of publication)

8. Alraddadi B, Bawareth N, Omar H, et al. Patient characteristics infected with Middle East respiratory syndrome coronavirus infection in a tertiary hospital. *Ann Thorac Med* 2016; **11**(2): 128-31.

9. Oboho IK, Tomczyk SM, Al-Asmari AM, et al. 2014 MERS-CoV Outbreak in Jeddah - A Link to Health Care Facilities. *New Engl J Med* 2015; **372**(9): 846-54.

10. Balkhy HH, Alenazi TH, Alshamrani MM. Notes from the Field: Nosocomial Outbreak of Middle East Respiratory Syndrome in a Large Tertiary Care Hospital — Riyadh, Saudi Arabia, 2015 *MMWR Morb Mortal Wkly Rep*. 2016 Feb 19;65(6):163-4.

11 Memish ZA, Zumla AI, Assiri A. Middle East Respiratory Syndrome Coronavirus Infections in Health Care Workers. *New Engl J Med* 2013; **369**(9): 884-6.

12. Alfaraj SH, Al-Tawfiq JA, Altuwaijri TA, Alanazi M, Alzahrani N, Memish ZA. Middle East respiratory syndrome coronavirus transmission among health care workers: Implication for infection control. *Am J Infect Control* 2018; 46(2): 165-168.

13. Song YJ, Yang JS, Yoon HJ. Asymptomatic Middle East Respiratory Syndrome coronavirus infection using a serologic survey in Korea. *Epidemiol Health* 2018 40: e2018014.

14. The WHO MERS-CoV Research Group (2013). State of Knowledge and Data Gaps of Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in Humans. *PLOS Currents Outbreaks*. 2013 Nov 12. Edition 1.

15. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J (2012) Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One* 7: e35797.

16. Yu IT, Xie ZH, Tsoi KK CY, Lok SW, Tang XP, Hui DS, et al. (2007) Why did outbreaks of severe acute respiratory syndrome occur in some hospital wards but not in others? *Clin Infect Dis* 44: 1017-25.

17. Tran K, Cimon K, Severn M, Pessoa-Silva CL, Conly J. (2012) Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One* 7: e35797.

18. Thompson K-A, Pappachan JV, Bennett AM, et al. (2013) Influenza Aerosols in UK Hospitals during the H1N1 (2009) Pandemic – The Risk of Aerosol Generation during Medical Procedures. *PLoS One* 8: e56278.

19. Balkhy HH, Alenazi TH, Alshamrani MM, et al. (2016) Description of a Hospital Outbreak of Middle East Respiratory Syndrome in a Large Tertiary Care Hospital in Saudi Arabia. *Infect Control Hosp Epidemiol* 37:1147-55.

20. Bin SY, Heo JY, Song M-S, et al. (2016) Environmental Contamination and Viral Shedding in MERS Patients During MERS-CoV Outbreak in South Korea. *Clin Infect Dis* 62: 755-60.

21. Kim S-H, Chang SY, Sung M, et al. Extensive viable Middle East respiratory syndrome (MERS) coronavirus contamination in air and surrounding environment in MERS outbreak units. *Clin Infect Dis* 63(3):363-9.

22. van Doremalen N, Bushmaker T, Munster VJ. (2013) Stability of Middle East Respiratory Syndrome Coronavirus (MERS-CoV) under different environmental conditions. *Euro Surveill* 2013;18:pii=20590.

23. Omrani AS, Matin MA, Haddad Q, Al-Nakhli D, Memish ZA, Albarrak AM (2013). A family cluster of Middle East Respiratory Syndrome Coronavirus infections related to a likely unrecognized asymptomatic or mild case. *Int J Infect Dis* 17: e668-e72.

24. Memish ZA, Assiri AM, Al-Tawfiq JA. (2014) Middle East respiratory syndrome coronavirus (MERS-CoV) viral shedding in the respiratory tract: an observational analysis with infection control implications. *Int J Infect Dis* 29:307-8.

25. Al-Gethamy M, Corman VM, Hussain R, Al-Tawfiq JA, Drosten C, Memish ZA. (2015) A case of long-term excretion and subclinical infection with Middle East respiratory syndrome coronavirus in a healthcare worker. *Clin Infect Dis* 60: 973-4.

26. Moon SY, Son JS. (2017) Infectivity of an Asymptomatic Patient With Middle East Respiratory Syndrome Coronavirus Infection. *Clin Infect Dis* 64:1457-8.

27. Bin Saeed AA, Abedi GR, Alzahrani AG, Salameh I, Abdirizak F, Alhakeem R. et al (2017). Surveillance and Testing for Middle East Respiratory Syndrome Coronavirus, Saudi Arabia, April 2015–February 2016. *Emerg Infect Dis.* 23: 682–685.

28. Ko JH, Müller MA, Seok H, Park GE, Lee JY, Cho SY et al. (2017) Serologic responses of 42 MERS-coronavirus-infected patients according to the disease severity. *Diagn Microbiol Infect Dis* 89:106-111.

29. Choe PG, Perera RAPM, Park WB et al. (2017). MERS-CoV Antibody Responses 1 Year after Symptom Onset, South Korea, 2015. *Emerg Infect Dis* 23(7): 1079-1084

30. Drosten C, Meyer B, Müller MA, et al. Transmission of MERS-coronavirus in household contacts. *N Engl J Med* 2014; 371: 828–35.

31. Arwady MA, Alraddadi B, Basler C, et al. Middle East respiratory syndrome coronavirus transmission in extended family, Saudi Arabia, 2014. *Emerg Infect Dis* 2016; 22: 1395–402.

32. Corman VM, Müller MA, Costabel U, Timm J, Binger T, et al. (2012) Assays for laboratory confirmation of novel human coronavirus (hCoV-EMC) infections. *Euro Surveill* 17(49): pii=20334.

33. Buchholz U, Müller MA, Nitsche A, Sanewski A, Wevering N, et al. (2013) Contact investigation of a case of human novel coronavirus infection treated in a German hospital, October-November 2012. *Euro Surveill* 18(8): pii=20334.

34. Bin Saeed AA, Abedi GR, Alzahrani AG, Salameh I, Abdirizak F, Alhakeem R et al. (2017). Surveillance and Testing for Middle East Respiratory Syndrome Coronavirus, Saudi Arabia, April 2015–February 2016. *Emerg Infect Dis* 23: 682–685.

35. Reusken C, H Mou, G J Godeke, et al. (2013). Specific serology for emerging human coronaviruses by protein microarray. *Euro Surveill* 18: 20441

36. Trivedi S, Miao C, Al-Abdallat MM, et al. (2018). Inclusion of MERS-spike protein ELISA in algorithm to determine serologic evidence of MERS-CoV infection. *J Med Virol* 90(2): 367-71

37. Perera, R. A., Wang, P., Gomaa, M. R., El-Shesheny, R., Kandeil, A., Bagato, O., ... & Li, M. (2013). Seroepidemiology for MERS coronavirus using microneutralisation and pseudoparticle virus neutralisation assays reveal a high prevalence of antibody in dromedary camels in Egypt, June 2013. *Euro Surveill* 18(36): 20574.

38. World Health Organization (2018). Laboratory Testing for Middle East Respiratory Syndrome Coronavirus: Interim guidance (revised) January 2018. http://www.who.int/csr/disease/coronavirus_infections/mers-laboratory-testing/en/

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APPENDIX A: QUESTIONNAIRE FOR IDENTIFYING POSSIBLE EXPOSURES TO MERS-COV IN HEALTH CARE FACILITY

This questionnaire has been designed to have a better understanding of the potential exposures to MERS-CoV and existing infection prevention and control practices in a health care facility as soon a patient with MERS-CoV (the index case) is identified at a health care facility, assuming that the patient with MERS-CoV infection was identified while still in the hospital.

These questions, while not part of the final analysis, will both help to formulate hypotheses about exposures which will inform the questionnaire administered to all HCP eligible for participation in the study (Appendix C) and provide an evaluation of the health care facility's preparedness for managing cases of MERS-CoV.

This questionnaire should be completed by members of the healthcare facility's administration and infection prevention and control team before the full study is implemented.

1.1 Date of MERS-CoV infection confirmation in patient receiving treatment in health care facility	___/___/ _____ (DD/MM/YYYY)
1.2 Date of completion of questionnaire	___/___/ _____ (DD/MM/YYYY)
1.3 Role in health care facility of personnel completing questionnaire	

	Yes	No	Unknown
2.1 Is there an infection prevention and control (IPC) program in the health care facility?			
2.2 Does your health care facility have dedicated IPC professionals?			
2.3 Is there a policy in the health care facility to prevent transmission of respiratory infection?			
2.4 Is there a triage system in place to detect cases of respiratory pathogens early and isolate them?			
2.5 Are there negative-pressure airborne infection isolation rooms or well ventilated isolation rooms that are functioning correctly and appropriately monitored for airflow and exhaust handling?			

2.6 Are PPE and other infection control supplies (e.g. hand hygiene supplies) available in sufficient quantities? 2.7 Are there procedures for laboratory submission of specimens for MERS-CoV testing? 2.8 Are there procedures for cleaning of a patient's room with confirmed MERS-CoV infection? 2.9 Are there policies and procedures for screening and work restrictions for exposed or ill HCP? 2.10 Is IPC education and training provided to HCP? 2.10A If yes, does training include respiratory pathogen exposure? 2.10B If yes, how often is training for respiratory pathogen required for HCP? (tick all that apply) - On employment - Every year - As needed 2.11 Have any HCP been infected with MERS-CoV in your health care facility? 2.12 Was IPC information on this specific MERS-CoV infection provided to HCP?			

APPENDIX B: IDENTIFICATION OF POTENTIALLY EXPOSED HEALTH CARE PERSONNEL

The following table should be completed to identify all personnel working in the health care facility who has been potentially exposed to a MERS-CoV infected patient during all or part of the hospitalization of the patient or to the materials of the patient: biological samples, soiled garments or potentially contaminated areas of the health care facility. Identification of personnel should involve consultation of duty rosters, interviewing personnel and tracing contacts within the health care facility from the time of the first contact with a MERS-CoV infected patient (or patient's materials) to 14 days after the last contact.

All personnel identified in the table below should be invited to participate in the study.

Contact ID	Initials	Age	Sex M/F	Role in health care facility	Ward in hospital of potential MERS-CoV exposure	Type of contact with MERS-CoV patient	Date of first questionnaire administration	Date of first specimen collection	Symptoms at first specimen collection	Date of second questionnaire administration	Date of second specimen collection	Symptoms at second specimen collection
Doctors, nurses, dietitians, physical therapists, social workers, nursing assistants, medical orderly, hospital attendants												
Technicians, lab personnel, research staff, administrative clerks (in ER, ICU etc.)												
Hospital cleaning staff, laundry staff, catering staff, security staff												

COMMENT: Modify/Add more lines as needed

APPENDIX C: FREQUENCY AND PATTERN OF EXPOSURE OF HEALTH CARE PERSONNEL TO MERS-COV INFECTED PATIENT

This draft questionnaire is designed to gather information about the frequency and patterns of contact of health care personnel who have been potentially exposed to a MERS-CoV infected patient during all or part of the hospitalization of the patient or to the materials of the patient: biological samples, soiled garments or potentially contaminated areas of the health care facility.

This is not intended as an investigation form, but rather a questionnaire that will allow health authorities and public health researchers to better understand potential exposures that may lead to infection to and among health care personnel and to develop hypotheses to test in subsequent studies.

It should be completed by all health care personnel who have been potentially exposed to a MERS-CoV infected patient, either through direct care to the patient (e.g., touched the patient), and or those who have been in relatively close proximity to the patient or with the patient's materials.

The administration of this questionnaire should be repeated each time biological specimens are collected as part of this investigation.

If you have any questions, please contact:

Name of study investigator: _____

Telephone: _____

COMMENT: Once the questionnaire has been finalized, skip patterns should be added.

Section A: General demographic questions
The following section is a series of general demographic questions.

A.1. Participant Name (Family Name/First Name) _____

A.2. Study Identification number _____

A.3. Name of interviewer: _____

A.4. Date of interview (DD/MM/YYYY): ___/____/_____

A.5. Place of interview: _____

A.6. Sex

☐ Male ☐ Female

A.7. Age: _____years

A.8. Role in health care facility

☐	Doctor	☐	Laboratory personnel
☐	Nurse	☐	Research staff
☐	Therapist	☐	Administrative clerk
☐	Dietitian/Nutritionist	☐	Hospital cleaning staff
☐	Social worker	☐	Laundry staff
☐	Nursing assistant	☐	Catering staff
☐	Medical orderly/ hospital attendant	☐	Security staff
☐	Technician	☐	Other, please specify _____

A.9. Current marital status:

☐	Single	☐	Married
☐	Divorced	☐	Widowed

Section B: Exposures to MERS-CoV in health care facility (to be filled in by study personnel)

This section should be adapted to the health care facility and include questions addressing the following:

- Contact with MERS-CoV patient and infection prevention and control measures
- Contact with biological samples
- Contact with soiled garments
- Contact with potentially contaminated areas of the health care facility
- Use of PPE

Section C: IPC training and procedures for respiratory pathogens

This section should be adapted to the health care facility and include standard infection prevention and control measures as well as enhanced precautions for respiratory pathogens, including when caring for a suspect MERS patient.

Section D: Respiratory symptoms or illness

The following series of questions are focused whether you have had any signs and symptoms of respiratory illness during the last 14 days and if so, details about the medical care you received.

D1. Are you sick today with fever and/or cough?
☐ Yes ☐ No

D2. Have you experienced any respiratory symptoms or signs of illness during the last 14 days?

☐ Yes ☐ No ☐ Unknown

D3. If you answered yes to either B1 or B2, please indicate which symptoms:

	Today			Last 14 days		
	Yes	No	Unknown	Yes	No	Unknown
D3.1 Dry cough	☐	☐	☐	☐	☐	☐
D3.2 Productive cough	☐	☐	☐	☐	☐	☐
D3.3 Phlegm	☐	☐	☐	☐	☐	☐
D3.4 Runny nose	☐	☐	☐	☐	☐	☐
D3.5 Sore throat	☐	☐	☐	☐	☐	☐
D3.6 Fever	☐	☐	☐	☐	☐	☐
D3.7 Shortness of breath	☐	☐	☐	☐	☐	☐
D3.8 Muscle pain	☐	☐	☐	☐	☐	☐
D3.9 Diarrhea	☐	☐	☐	☐	☐	☐
D3.10 Chest Pain	☐	☐	☐	☐	☐	☐
D3.11 Vomiting	☐	☐	☐	☐	☐	☐
D3.12 Rashes	☐	☐	☐	☐	☐	☐

D4. Have you sought/did you seek medical consultation?

☐ Yes ☐ No ☐ Unknown

D4.1 If yes, where did you seek medical care (Name and address of medical facility/outpatient center)?
_____

D5. Have you been hospitalized during the course of your illness?

☐ Yes ☐ No ☐ Unknown

D5.1 If yes, when were you hospitalized (DD/MM/YYYY): ____/___/_____

D5.2 If yes, which hospital did you receive treatment(s)? (Name and address of medical facility)
_____

Section E: Medical history

The following series of questions are focused on your health status and current or previous medical conditions.

E1. Do you currently smoke tobacco (ex. cigarettes, cigars, shisha)?
☐ Daily ☐ A few days a week ☐ Not at all ☐ Unknown

E2. Do you share your tobacco (e.g., shisha)?
☐ Yes ☐ No ☐ Unknown

E3. Have you smoked tobacco daily in the past?

☐ Yes ☐ No ☐ Unknown

E4. Is there any hereditary disease running in your family?

☐ Yes ☐ No ☐ Unknown

E4.1 If yes, please specify the disease(s):

_____

E5. Do you currently have any chronic illness (e.g. asthma, cancer, diabetes)?

☐ Yes ☐ No ☐ Unknown

C5.1. If yes, please specify the disease(s):

_____

E6. Have you taken medications regularly in the last six months?

☐ Yes ☐ No ☐ Unknown

C6.1 If yes, what medications do you regularly take?

List all: _____

E7. Have you taken any traditional medications in the last six months?

☐ Yes ☐ No ☐ Unknown

E7.1 If yes, which traditional medications?

List all: _____

E8. Have you seen a traditional healer in the last six months?

☐ Yes ☐ No ☐ Unknown

E9. If female, were you pregnant in the last six months?

☐ Yes ☐ No ☐ Unknown

Section F: Recent travel history

The following series of questions are focused places you have travelled within the 14 days before the onset of illness (case) or within the last 14 days after last contact with a MERS-CoV patient (contact) and the contact with animals you may have had during these travels.

F1. During the last 14 days have you travelled outside (insert country where investigation is being conducted)?

☐ Yes ☐ No

F1.1 If yes, what countries/regions have you visited?

Country	Region/City	Approximate dates

F2. Have you attended any mass gatherings (e.g., weddings, festivals or religious pilgrimages) where there were large numbers of people together within the 14 days before the onset of illness (case) or within the last 14 days after last contact with a MERS-CoV patient (contact)?
☐ Yes ☐ No ☐ Unknown

F2.1 If yes, specify event(s) and location:
_____

F3. When you travelled, did you do any of the following?

Tick all that apply:		**Location of the farm (town, country)**	**Animals present at venue**	**Did you have direct contact with any of these animals?**	**Did you have any direct contact with any animal carcasses, body fluids, secretions, urine or excrement while at this venue?**
Visit a farm with animals	☐		☐ Camel ☐ Goat ☐ Sheep ☐ Horse ☐ Cattle	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown
Visit an animal market	☐		☐ Camel ☐ Goat ☐ Sheep ☐ Horse ☐ Cattle	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown
Visit a slaughter house	☐		☐ Camel ☐ Goat ☐ Sheep ☐ Horse ☐ Cattle	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown
Visit a camel race track	☐		☐ Camel ☐ Goat ☐ Sheep ☐ Horse ☐ Cattle	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown

Section G: Dromedary camel exposures in/around the home where you live
The following series of questions are focused on exposures to dromedary camels in and around the home or place of residence.

G1. Have you had any dromedary camels in or around your home in the last six months?
☐ Yes ☐ No ☐ Unknown

G1.1 Indicate the number of dromedary camels and what they are used for

Number of camels	**What are they used for?**	**Did you have direct contact (i.e., touch) with these camels?**	**Any illness affecting camels in the last six months?**
☐ None ☐ < 10 animals	☐ income ☐ food	☐ Yes	☐ Yes

☐ ≥ 10 animals	☐ work ☐ racing ☐ pets	☐ No ☐ Unknown	☐ No ☐ Unknown

G2. In the last six months, did you have any contact with any carcasses, body fluids, secretions, urine or excrement of camels in or around your home?

☐ Yes ☐ No ☐ Unknown

G3. In the last six months, did you have any contact with any camel bedding, stray of feed in or around your home?

☐ Yes ☐ No ☐ Unknown

G4. At your home, in the last six months did you do any of the following activities:

	Yes	No	Unknown
G4.1 Feed camels	☐	☐	☐
G4.2 Clean camel housing	☐	☐	☐
G4.3 Slaughter camels	☐	☐	☐
G4.4 Assist with the birth of camels	☐	☐	☐
G4.5 Milk camels	☐	☐	☐
G4.6 Kiss/hug camels	☐	☐	☐
G4.7 Other tasks related to camels Specify:	☐	☐	☐

G5. Do others living in your household (e.g., domestic help or relative) frequently visit or work on a farm or market where camels are kept or sold?

☐ Yes ☐ No ☐ Unknown

G5.1 Have others living in your household (e.g. domestic help or relative) visited or worked at a farm or market where camels are kept or sold within the 14 days before the onset of illness (case) or within the last 14 days after last contact with a MERS-CoV patient (contact)?

☐ Yes ☐ No ☐ Unknown

G5.2 Have others living in your household (e.g. domestic help or relative) had direct contact with camels within the 14 days before the onset of illness (case) or within the last 14 days after last contact with a MERS-CoV patient (contact)?

☐ Yes ☐ No ☐ Unknown

Section H: Food medicinal exposures

The following series of questions are focused on regular food exposures and consumption of camel or camel products for medicinal or therapeutic reasons.

H1. Do you regularly eat camel meat or consume other camel products (e.g., milk, urine)?

☐ Yes ☐ No

	Yes	**No**
H1.1 Do you regularly drink raw camel milk?	☐	☐

H1.2 Do you regularly drink boiled camel milk?	☐	☐
H1.3 Do you regularly drink camel urine?	☐	☐
H1.4 Do you regularly eat raw camel meat?	☐	☐
H1.5 Do you regularly eat cooked camel meat?	☐	☐

H2. Do you believe that camels or camel products have medicinal or therapeutic properties?
☐ Yes ☐ No ☐ Not sure

H3. Do you use camel products for medicinal purposes?
☐ Yes ☐ No

	Yes	**No**
H3.1 Do you drink camel milk for medicinal or therapeutic purposes?	☐	☐
H3.2 Do you drink camel urine for medicinal purposes?	☐	☐
H3.3 Do you receive or use any traditional medications that contain camel products?	☐	☐

H4. What illnesses or medical conditions are you treating with camel or camel related products?

_____

I: Contact

I1. May we contact you again with follow up questions or clarifications?
☐ Yes ☐ No ☐ Unknown

I1.1 If yes, telephone number of participant:

_____

Thank you very much for participating in this study.

The information you have provided will help to assess the risk of MERS-CoV infection among health care personnel. It will also help to understand the full extent of infection and transmission of MERS-CoV, which in turn can assist efforts to reduce the further spread of MERS-CoV.