WHO-EM/CSR/059/E

Report on the

Technical consultative meeting on novel coronavirus

Cairo, Egypt
14–15 January 2013

World Health Organization
Regional Office for the Eastern Mediterranean

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EXECUTIVE SUMMARY

In 2012 nine cases of a novel human coronavirus (nCoV) were detected in persons from the Middle East. All of the cases were severely ill, with renal failure a common feature of the clinical spectrum, and five cases died. This novel virus is genetically distinct from common human coronaviruses responsible for mild illness and the SARS coronavirus which caused significant illness and deaths in 2003. To date it has not given rise to any sustained spread of disease. However, the event raised serious concerns among public health officials.

An urgent meeting was convened by WHO on 14–15 January 2013 at the Regional Office for the Eastern Mediterranean, Cairo, Egypt. The meeting brought together WHO, public health officials from Member States, scientists involved in the investigation of the known cases, and public health experts involved in the SARS epidemic of 2002–2003. The purpose of the meeting was to review and discuss the key issues related to the novel coronavirus. The objectives were to: collect and share information about the cases and their diagnosis; develop a gap analysis for further epidemiological and virological studies; and identify the next steps for further public health action at the national and international level.

The total number of confirmed cases detected up to the time of the meeting was 9: 5 from Saudi Arabia, 2 from Qatar and 2 from Jordan. Presentations on the epidemiology and public health response to these cases were made from each of the affected countries. In Saudi Arabia, 2 of the cases were sporadic and 3 were part of a family cluster. Three of the cases died. In Qatar, 2 unrelated sporadic cases with onset in September and October were detected when one patient transferred to England and one transferred to Germany for treatment of their undiagnosed severe respiratory illness. In Jordan, a cluster of 10 health care workers at a public hospital, 2 of their family contacts, and one patient at the same hospital developed a respiratory illness between 2 and 26 April 2012. Two of these individuals were retrospectively confirmed as having nCoV in November 2012; the remaining 11 are considered probable cases. Extensive epidemiological and microbiological investigations have been carried out among case contacts and health care workers in all three Middle East countries, England and Germany, as well as among a large group of Hajj pilgrims with respiratory infections returning to their many respective countries. All respiratory samples from contacts and Hajj pilgrims have been negative for nCoV infection as well as serological samples from close contacts in England and Germany. Sera from the contacts in the Middle East have not yet been tested.

Two samples of the novel coronavirus have been fully sequenced, one from Saudi Arabia and one from Qatar. From these data, it has been possible to develop polymerase chain reaction (PCR) primers for detection of nCoV. These PCR assays are now commercially available for worldwide use and have been provided to the countries where cases occurred. The receptor involved in the nCoV disease process has also been studied and found to be expressed in lower respiratory tract cells of the bronchus, kidney, spleen and intestinal cells but not in ciliated cells of the upper respiratory tract. Immunofluorescent antibody detection assays and confirmatory tests using neutralization methods have been developed for serological testing for nCoV but are not widely available.

Areas identified as priorities for furthering investigation on nCoV centred around defining the extent of virus transmission, detecting any increase in incidence, the case

definition, the source of infection, and mode of transmission. For defining the extent of transmission a standardized approach to retrospective testing for nCoV was recommended for identifying severely ill persons, mildly ill persons, and persons who may have been exposed to the virus but remained well. Which serological tests to use will be decided after further development and validation has taken place in reference centres, which may take several months. Next steps with support from WHO included creating a study group and framework for designing screening studies, a laboratory training programme and animal studies for defining the source of infection or route of transmission.

Activities needed to assess any increase in incidence focused on establishing hospital baselines for pneumonia; monitoring any future changes in those baselines; prospective sampling of sputa from patients with severe acute respiratory infection (SARI); and enhanced surveillance within groups such as case contacts, health care workers and clusters of patients with severe respiratory illness.

A proposal was put forth to expand the case definition beyond cases with a connection to the Middle East. More data are needed on the clinical spectrum and natural history of nCoV to inform changes to the case definition. WHO supported contacting the affected countries to request comprehensive data on the clinical features of the known cases and to pool these data using standardized epidemiological tools to aid development of a wider case definition for nCoV. Protocols from the SARS epidemic could be utilized to develop risk factor studies.

In summary, the following consolidated actions were agreed to advance knowledge of nCoV in the immediate and long term.

- Prepare an inventory of current nCoV virological research activities in European, American and other national laboratories
- Encourage cooperation in the development of virological studies
- Prepare an inventory of training opportunities for laboratory staff testing for nCoV
- Prepare an inventory of laboratories developing nCoV serological tests and list which laboratories are using which tests
- Prepare an inventory of countries willing to test SARI cases for nCoV
- Liaise with the animal research group to strengthen collaborative studies and coordinate future studies into the reservoir of infection for nCoV
- Itemize all collaborating resources and identify where capacity building is required
- Ensure risk assessment guidelines, infection control guidelines and other documents are regularly reviewed and communicated to those that need to know
- Prioritize research needs.

1. INTRODUCTION

Nine confirmed cases of a novel human coronavirus (nCoV) occurred between March and November 2012. The cases came from Saudi Arabia (5), Qatar (2) and Jordan (2). Five cases died. Two clusters were detected; one involving a family in Saudi Arabia and one a hospital in Jordan. An urgent meeting of scientific and public health experts involved in the national and international investigations of this new disease was convened by WHO to assess the current situation and state of information. The meeting was held at the Eastern Mediterranean Regional Office, Cairo from 14–15 January 2013. The purpose of the meeting was to review and discuss the key issues related to the novel coronavirus. The objectives of were to:

- obtain the most up-to-date scientific and public health understanding of novel coronavirus based on available information;
- identify critical knowledge gaps in understanding the current risk and identify additional steps needed to improve the knowledge and research gap; and
- provide an update on the situation in order to increase global awareness and reach consensus on measures to be taken for improving public health preparedness;

The meeting brought together staff of WHO, public health officials from Member States, scientists involved in the investigation of the known cases and public health experts involved in the SARS epidemic of 2002–2003. The agenda and list of participants are given in Annexes 1 and 2. A list of documents consulted by the participants is attached as Annex 3.

An introduction to the meeting was given by Dr Ala Alwan, WHO Regional Director for the Eastern Mediterranean. He thanked the participants for attending this very important meeting at such short notice and outlined its objectives and methods of work. Dr Keiji Fukuda, Assistant Director General, Communicable Diseases, chaired the two-day meeting. He began by setting the global context of the new novel coronavirus incident, emphasizing the urgent need to learn more about this new virus through collaboration and collective sharing of information.

It was stressed at the start of the meeting that openness and transparency between participants was expected. All declarations of interest were noted and all funding sources for laboratory research into the new virus reported.

2. BACKGROUND

Coronaviruses are part of the family of viruses that commonly cause a variety of illnesses including respiratory infections in humans and animals. They were first identified in the mid-1960s and are named for the crown-like projections on their surface. They fall into three main subgroups – alpha, beta and gamma coronavirus lineages – and studies suggest that bats may act as a natural reservoir (1.van Boheemen). Coronaviruses came to prominence in 2003 when a novel strain was identified as the causative agent (SARS-CoV) for the SARS epidemic that caused over 8000 human cases worldwide, approximately 10% of whom died (2. Anderson). The small number of new cases of novel coronavirus that were

detected in the Middle East in 2012 are genetically distinct from the SARS virus and to date have not given rise to any sustained spread of disease. Public health officials are concerned that this could change, however, current knowledge of the epidemiology and natural history of infection with this new agent is very limited. Further studies are required to answer questions about the source of the virus, its transmissibility, exposures that result in infection, and the clinical spectrum of disease.

On 20 September 2012 a report appeared on *ProMed* (3) of a case of fatal respiratory disease in Saudi Arabia in an otherwise healthy male aged 60 years who had been ill in June. A variety of clinical specimens were taken from the patient and a novel human coronavirus was eventually isolated (4. Zaki). The isolate was sequenced at the Erasmus Medical Centre (EMC) in Rotterdam, the Netherlands and is referred to as nCoV-EMC. A second case was discovered in September in a 49 year old male from Qatar. The otherwise healthy male developed severe pneumonia and was transferred from Qatar to a hospital in the United Kingdom for treatment of his deteriorating condition. A novel human coronavirus was isolated in the United Kingdom from the patient's samples and sequenced at the Health Protection Agency (HPA) Colindale, in London. (5. Bermingham) Comparison of the genetic sequence of the virus from the Qatari patient had a 99.5% similarity to the nCoV-EMC virus. These two results confirmed that a novel human coronavirus had caused illness in two different countries widely separated in time. This virus is the sixth coronavirus known to infect humans and the first to be identified within the betacoronavirus lineage C causing disease in humans. (1.van Boheemen)

These two cases of nCoV prompted an immediate international public health response, coordinated by WHO. It also prompted authorities in Jordan to retrospectively test stored samples from an outbreak of respiratory disease in a health care facility near Amman, the cause of which had never been determined. This testing found evidence of the virus in two cases, evidence that the outbreak was also related to nCoV. Enhanced surveillance activities have now been introduced in the affected countries according to recommendations issued by WHO, and further case finding has been carried out. Guidelines for surveillance, case definitions, laboratory recommendations, and clinical management advice can be found at the WHO novel coronavirus website: http://www.who.int/csr/disease/coronavirus_infections/en/index.html

3. OVERVIEW OF CASES 2012

The total number of laboratory confirmed cases detected in 2012 was 9: 5 from Saudi Arabia, 2 from Qatar and 2 from Jordan (Table 1). An additional 11 cases with similar clinical presentations and contact with confirmed cases have been classified as "probable" in Jordan. The cases are described below.

Table 1. Clinical spectrum for the nine confirmed cases of nCoV

Clinical history/spectrum of disease	Saudi Arabia	Qatar	Jordan	Total
Smoker or former smoker	4	1	unknown	5
Underlying disease	2	1	1	4
Mechanical ventilation	4	2	2	8
Renal failure	3	2	0	5
Renal abnormalities	5	unknown	0	5
Diarrhoea	2	unknown	0	2
Total cases	5	2	2	9

3.1 Saudi Arabia

Saudi Arabia has a population of approximately 26.2 million, 15% of whom are foreign nationals. 29% of the population is under 14 years of age, 68% are aged 15–64 years and 3% are aged 65y and over. 50% of the population live in households of six or more persons.

Around 4.5 million pilgrims took part in the Hajj in 2012. Pilgrims came from 187 countries during October, the month of pilgrimage and visited the main religious sites of Saudi Arabia in Mecca and Medina.

Dr Ziad Memish, Deputy Minister for Preventive Medicine at the Ministry of Health, Riyadh presented an update on the five cases linked to infection in Saudi Arabia (Table 2). Two were sporadic and three were part of a family cluster. The dates of onset for the two sporadic cases were 6 June and 10 October 2012. The family cluster occurred between 5 October and 3 November. Three of the cases died; the June case and two from the family cluster.

The presence of a novel coronavirus in the first case was not confirmed until September 2012, three months after the patient had died. Upon being notified of the presence of a novel virus, the Ministry of Public Health, Saudi Arabia initiated a number of public health interventions and investigations. WHO assisted with coordination of the response and worked with the Saudi medical authorities in developing a case definition for use in these investigations. The United States Centers for Disease Control and Prevention (CDC) was invited to advise and assist with the development of protocols for carrying out retrospective exposure histories for this case and for the collection of serological samples from health care workers in Jeddah and other close contacts. These serum samples are yet to be tested. Dr Ian Lipkin of Columbia University, New York assisted with the investigation of contacts at the first admitting hospital in Bisha and in environmental investigations as to the possible source of infection (see report below). Using ICD-10 codes for pneumonia, the records at the hospitals in both Bisha and Jeddah were reviewed for any change in the pattern of pneumonia-related deaths over the last two years. None were found.

Table 2. Details of cases associated with infection in Saudi Arabia

Case no.	Age/sex/ location	Date of onset and clinical background	Clinical history	Outcome	Laboratory investigations
SAU0001 Business man	M60 Bisha and Jeddah	06/06 non-smoker	10/06 Pneumonia 13/06 transferred to Jeddah hospital 14/06 ARDS-ICU 16/06 acute RF haemodialysis	Died 24/06	Jeddah - isolate nCoV EMC confirmed and sequenced as nCoV-EMC
SAU0002 Gym teacher	M45 Riyadh	10/10 smoker, IHD, hypertension diabetic, single kidney	12/10 Adm hosp Rt lower lobe pneum 13/10 ICU 16/10 acute RF haemodialysis ×3 23/10 off ventilator	Recovered-Discharged 04/11 Normal renal function	Jeddah upper respiratory swab PCR+ve HPA confirmed nCoV
SAU0003 Grandfather ex soldier	M70 Riyadh	05/10 ex-smoker IHD, hypertension CABG status, diabetic, CVA 2008	6 days ER visits 13/10 adm fever, congestive heart failure 17/10 CCU 19/10 atypical pneum – intubated 20/10 Acute RF, dialysis, multi organ failure	Died 23/10 Dr M also says death on 24 Oct	BAL +ve ? which lab HPA confirmed nCoV
SAU0004 Office worker Son of 0003	M39 Riyadh	24/10 smoker	24-25/10 ER visits with fever/cough 27/10 adm overnight only 28/10 adm - rt mid lobe pneumonia 29/10 severe bilateral pneum- Intubated 02/11 cardiac arrest	Died 02/11	Bronchoscopy not done – pt too ill Upper respiratory swab PCR+ve ?which lab HPA confirmed nCoV
SAU0005 Security guard Son of 0003	M31 Riyadh	02/11 smoker	3-5/11 ER visits with fever/cough 06/11 adm – rt lower lobe pneum 07-09/11 bilateral air space disease 10-12/11 improving 13/11 discharged	Recovered - Discharged 13/11	Upper respiratory swab PCR+ve ?which lab HPA confirmed nCoV
SAU0006 Student grandson of 0003 and son of 0005	M18 Riyadh	03/11	3/11 ER visit with fever/cough and diarrhoeal 07/11 adm bilateral pneumonia 09/11 improving 11/11 discharged	Recovered - Discharged 11/11	Upper respiratory swab PCR neg ?which lab HPA confirmed neg nCoV

The annual Hajj took place on 10–31 October 2012. The Saudi National Committee for Infectious Diseases worked with WHO at this time to prepare a case definition and protocol for detecting and testing pilgrims who developed a respiratory infection. In total, 190 nasopharyngeal and serum samples were collected from pilgrims with respiratory symptoms in Medina hospitals and 90 from patients in Mecca hospitals. All tested samples were negative for nCoV. Screening was also carried out in Europe and elsewhere for pilgrims returning to their own countries with respiratory illness. Over 300 returning pilgrims were tested by polymerase chain reaction (PCR) in a number of different countries and all were negative for nCoV infection.

An exposure history was collected from the second Saudi case and testing of close contacts and health care workers was carried out. Nasal swabs were all negative for nCoV by PCR and serum samples have been stored at -80°C for future analysis.

Investigations around a cluster of three confirmed and one probable case (case 0006) that occurred in an extended family in Riyadh were described. Four related family units occupied the home in Riyadh and comprised 28 people, nine of whom were children aged < 14 years. The grandfather, son, and grandson (cases 0003, 0004 and 0006) and their families lived on the first floor. Two families lived on the ground floor – one of which included case 0005. There was significant ongoing contact between all household members. Cases 0004 and 0005 spent 12 hour shifts caring for their father when he was severely ill in the hospital. Exposure histories from cases were collected. Serum samples from all family members and other close contacts including health care workers were taken and stored for future testing. All were negative for other respiratory pathogens.

The dates of onset of cases within the family cluster were sequential and ranged from 5 October to 3 November, consistent with human-to-human transmission. No health care workers or other family members were affected. While this chronology is consistent with human-to-human transmission, the possibility remains that exposure was from a low level common source.

An investigation of potential environmental and animal sources of the nCoV was carried out by Dr Ian Lipkin of Columbia University in the United States and his team in September 2012. Bats and dates were the main focus of investigation. Bats were targeted because of the genetic relatedness of the nCoV to coronaviruses previously found in bats elsewhere. 755 oral, rectal and serological samples from insectivorous bats in the Bisha area of Saudi Arabia were tested in the United States in October 2012. Although the shipment of samples arrived thawed, bat CoVHKU9, bovine respiratory CoV and Kenya Idoline bat viruses were detected. Sequencing of RNA extracted from the specimens was carried out using primer sets developed for the nCoV found in the first human cases. Only one short sequence (182 nucleotides) was obtained by nested PCR that showed the Saudi bat virus to be genetically indistinguishable from the nCoV identified by EMC. This sequence could not be extended on further testing, nor has it been found in other bat samples from Africa, Asia and South America. No virus was cultured from the Bisha bats.

No microbiological or environmental link was made between date farming and date consumption for this first case and no tests were carried out on camels or goats. Though the inability to culture the virus or extend the sequence makes interpretation of the results difficult, it does suggest that the virus may be present at very low frequency and concentration. A longer sequence of the genome will be necessary to confirm that the virus is the same as that found in the human case. It remains unknown whether the virus is in livestock or another intermediate and how it may have been transmitted to the human case. Bat samples have been taken in areas of Saudi Arabia where the other cases occurred and testing continues but no results are available yet.

3.2 Qatar

Qatar has a population of approximately 1.7 million. Fewer than 20% are Qataris; the remainder are foreign expatriates who mainly come from the Indian subcontinent (45%), other Arab nations (20%), South East Asia (10%) and elsewhere (5%).

Dr Hamad Al Romaihi Head of Surveillance and Outbreak Investigations, Supreme Council of Health, Doha presented an epidemiological report on the two cases with nCoV infection in Qatar. Dr Said Al Dhahry Head, Division of Virology, Department of Laboratory Medicine and Pathology, Hamad Medical Corporation, Doha presented an update on the laboratory findings related to these two cases (Table 3). Presentations were also made by Dr Richard Pebody (HPA) Dr Maria Zambon (HPA) and Dr Udo Buchholz (Robert Koch Institute) on investigations carried out in the United Kingdom and Germany related to the patients' transfers to these countries.

Table 3. Details of cases associated with infection in Qatar

Case no.	Age/sex/ location	Date of onset and clinical background	Clinical history	Outcome	Laboratory investigations
QA0001 Business man	M49	03/09 no history of smoking	08/09 admitted to hospital with 5 day history of fever and cough CXR - bilateral lower zone infiltrates 11/09 intubated and transferred to ICU 12/09 transferred to London UK. Acute renal failure (ARF) noted and haemodialysis started	Still on ECMO and remains in hospital in London	Tests for respiratory viruses all negative in Qatar on standard panel.. In HPA – bronchial lavage (BAL) +ve for nCoV
QA0002 Business man	M45	05/10 Heavy smoker, Diabetic	12/10 admitted to hospital with 7 day history of fever and cough 13/10 transferred to 2nd hospital. Developed ARDS, intubated and transferred to ICU 13/10 developed ARF 24/10 transferred to Germany on ventilation Improved and moved to rehabilitation on 21 November	Recovered	Tests for respiratory viruses all negative in Qatar on standard panel. HPA – endotracheal aspirate +ve for nCoV

Case 1 had onset of his illness on 3 September 2012. He had visited Mecca between 29 July and 18 August 2012. He had no known contact with sick people. He owns a farm with camels and sheep which he visited once on 19 August after returning from Mecca. He is

married with eight children. His illness was managed in three places in the Qatar hospital (emergency department, ward, and medical intensive care unit) from 08–12 September. The estimated number of health care workers associated with this stay was about 21. Respiratory samples taken from the patient on 11 September, including nasal swabs and BAL, were negative on a standard panel of respiratory viruses in Qatar. The patient transferred to London on 12 September, where the nCoV was identified through culture and PCR. Genetic sequencing indicated that the virus was the same as that previously found in the patient in Saudi Arabia. A contact investigation of health care workers exposed to the patient was carried out in Doha. Swabs later taken from four health care workers who became symptomatic after exposure were negative when tested at HPA for nCoV.

On 12 September, the patient was transferred by air ambulance to an intensive care unit in London. Due to further deterioration, he was then transferred to another London hospital on 20 September. The HPA became aware of the transferred case through notification to the HPA Imported Fever Service, a system established for the London Olympics, on 14 September. (7. Pebody) The ProMed report of the first Saudi case on 20 September led HPA, in consultation with local clinicians, to investigate respiratory tract samples from the patient for the presence of the novel coronavirus. A pan-coronavirus assay yielded a band of the correct size on 21 September from lower respiratory tract samples taken on 17 and 19 September but the assays for seasonal coronaviruses were negative. Sequencing of the pan-coronavirus PCR product (a 251 base pair fragment encompassing nucleotides 104–354 of the NSP12 gene) yielded a sequence that it was genetically similar to the one from the Saudi patient.

Immediate actions taken in London after the discovery of the nCoV included a rapid risk assessment, implementation of infection control procedures, enhanced surveillance through the development of case and close contact definitions, information and advice for public health management, national and international alerting mechanisms and laboratory development of new diagnostic tools to aid further case finding. United Kingdom contacts[1] of the index case were observed for 10 days from time of last close contact with the patient. A total of 64 contacts were identified (56 health care workers and 8 family and friends). Respiratory symptoms were reported by 13 of the 64 contacts during the 10-day follow-up period. Respiratory tract specimens were obtained from 10 of these 13 cases; nine of whom had a negative seasonal respiratory virus screen and one of whom was positive for rhinovirus.

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[1]Close contact definition:

From date of illness onset in index case and throughout symptomatic period.

- Health and social care workers: worker who provided direct clinical or personal care or examination of symptomatic confirmed case or within close vicinity of aerosol generating procedure
- AND not wearing full personal protective equipment (PPE) - defined as correctly fitted high filtration mask (FFP3), gown, gloves and eye protection.
- Household or close contact: any person with prolonged face-to-face contact (>15 minutes) with symptomatic confirmed case in a household or other closed setting.

Sera were requested from case and contacts at day 0 and >14 days after the baseline sera or 28 days after the exposure if no baseline sample could be obtained. 62 of the 64 contacts complied with the request, with 58 providing paired sera and 4 providing single samples. All eight of the family members, who were exposed from the start of the patient illness, provided samples; 54 health care workers provided samples. Health care workers had a variety of exposures including some during an aerosol generating procedure. Preliminary results of serological testing found no evidence of a serological response consistent with infection among close contacts of the confirmed case.

Surveillance of returning travelers from the Arabian peninsula to the United Kingdom with respiratory symptoms detected a total of 27 suspect cases who were laboratory investigated with nCoV infection. All were negative for nCoV on laboratory testing. Of these 27, 12 did not fit the clinical and epidemiological criteria, 10 ultimately had an alternative diagnosis for their illness and only 5 both fitted the clinical and epidemiological criteria and remained without a microbiological diagnosis.

Infectious period: PCR results in London were available on samples up to 40 days from onset of illness for the Qatar case. PCR results were positive for nCoV for up to 14 days in the upper respiratory tract, 24 days in the lower respiratory tract (and negative at 36 days), 29 days in a blood sample and 20 days in a faecal sample (negative at 36 days) post illness onset. No urine samples were positive at 36 days after onset

Outcome: The patient is still hospitalized in London and still requires oxygen support, and his prognosis is poor. He has suffered several nosocomial infections and a brain haemorrhage during the course of his illness. There is lung damage due both to the virus infection and ventilation air pressures. His renal function is improving and haemodialysis is no longer required.

Case 2 is a single male living at home with his mother and seven siblings. He owns a camel and goat farm but had no contact with the animals, had no history of travel and no known contact with sick people. He was managed in two hospitals in Qatar from 12–24 October. Respiratory specimens from the patient were collected on 13 and 17 October, including nasal swabs and an endotracheal tube (ETT) aspirate. They were tested for a standard panel of respiratory viruses in Qatar and all were negative on a standard panel for respiratory pathogens. No sera were collected. The ETT sample from 17 October was sent to HPA London on 13 November and was positive for nCoV by PCR. The patient was transferred to Germany on 24 October. He was recovering at the time of transfer and was nearly ready for extubation. He subsequently was discharged to a rehabilitation unit on 21 November. At least 85 health care workers and family members were estimated to have had contact with the patient while he was still in Qatar. Respiratory and serum samples were collected from 20 of these contacts who had mild symptoms after the contact; nCoV was not detected in any of the respiratory samples and serum samples have not yet been tested.

In Germany, the Robert Koch Institute (RKI) was informed by WHO on 22 November 2012 of a case of nCoV transferred from Qatar, hospitalized in Germany since 24 October. As the diagnosis of nCoV had not been made prior to transfer of the patient to Germany, no

specific infection control procedures had been implemented. The public health measures initiated by RKI included recorded interviews with the patient, further sampling and testing for nCoV and the identification, epidemiological and microbiological follow up of 123 close contacts, 85 of whom provided sera.

Respiratory symptoms were reported by 23% (13 of 56) hospital contacts. Contact started for eight of these sick workers in weeks three and four of the patient's illness (21-28 days post onset), and in week five (35 days post onset) for the other five workers. Sera were obtained from 12 of the 13 health care workers considered at high risk (first contact at weeks three or four, contact distance within 2 metres, facemask worn rarely or never), 4 of whom developed acute respiratory infection.

Of the 85 serum samples from contacts that were tested in Germany, 83 were negative for nCoV, one was weakly positive for IgM by Immunofluorescent Antibody test (IFA) and one was indeterminate for IgG but neither had evidence of nCoV-EMC specific neutralizing antibodies and both were considered not to have evidence of infection.

Infectious period: A BAL sample taken from the patient on 25 October (day 20 post onset) was positive for nCoV by PCR but negative by culture of the virus. A pharyngeal wash from the eighth week of illness was negative by PCR.

Surveillance enhancements in Qatar: In Doha, the virology laboratory of the Hamad Medical Corporation introduced the HPA PCR assay for detection and confirmation of nCoV in December 2012 with assistances from scientists from the HPA London. The laboratory is only equipped for bio-safety level 2 work and so RNA extraction is being done at the tuberculosis lab, which meets the standard for BSL-3. Commercially produced assays have subsequently been obtained for testing samples. There are approximately 350 respiratory samples in storage from SARI patients since 2010. Twenty four of these recent cases have been tested by the HPA and with commercial PCR assays; all have been negative for nCoV. In the future, any positive results from Qatar will be confirmed at HPA, London.

3.3 Jordan

Jordan has an estimated population at 6.2 million. The average household size is 5.2 persons. A large number of foreign workers live in Jordan and in recent years many hundreds of thousands of people from Iraq and the Syrian Arab Republic have taken refuge in the country. SARI surveillance was established in 2008 at three hospital sentinel sites, one in the north, one in the south, and one in central Jordan. Unusual diseases including cases of SARI were added to the immediate notification system in 2010.

The Jordan team, led by Dr Ayyob As-Sayaideh Director of Communicable Diseases, Ministry of Health Amman presented a report on investigations around a cluster of severe respiratory disease cases in a hospital near Amman. Two of 13 cases of respiratory infection were confirmed as nCoV; all cases in the cluster had onset of illness from 21 March to 26 April 2012 (Table 4).

Table 4. Details of cases associated with infection in Jordan (by date of onset)

Case No.	Age/sex/location	Date of onset and clinical background	Clinical history	Outcome	Classification and laboratory investigations
JOR0001 student	M25 Zarqa	21/03	04/04 adm hosp SOB and pneumonia and pericarditis 15/04 Transferred to Amman Hosp Intubated	Died 25/04	Confirmed: NAMRU-3 PCR +ve nCoV
JOR0002 nurse	M30 Zarqa	29/03	08/04 Adm hosp CCU with bilateral pneumonia Transferred to Islamic hosp CCU 23/04 improving	Recovered	Probable case
JOR0003 nurse	F40 Zarqa	02/04	09/04 adm ICU right side pneumonia 14/04 transferred to private hospital 18/04 intubated 19/04 DIC	Died 19/04	Confirmed: NAMRU-3 PCR+ve nCoV
JOR0004 physician	M60, Living in Amman, working in Zarqa	02/04 Zarqa	05/04 severe cough with haemoptysis 05/04 bilateral pneumonia refused hosp admission 09/04 improvement no illness in family members	Recovered	Probable case
JOR0005 nurse	M29 Zarqa	11/04		Recovered	Probable case
JOR0006 nurse	M33 Zarqa	12/04		Recovered	Probable case
JOR0007 nurse	M28 Zarqa	13/04		Recovered	Probable case
JOR0008 Road construction worker and brother of 0003	M45 Zarqa	14/04		Recovered	Probable case
JOR0009 nurse	M46 Zarqa	15/04		Recovered	Probable case
JOR00010 nurse	M25 Zarqa	15/04		Recovered	Probable case
JOR00011 physician, internist	M53 Zarqa	18/04		Recovered	Probable case
JOR00012 nurse	F28 Zarqa	19/04		Recovered	Probable case
JOR00013 Mother of 0002	F60 Zarqa	26/04 Hypertension and diabetic	30/04 Admitted Islam Hospital CCU	Recovered	Probable case

Four cases of pneumonia in health care workers at the same hospital were reported to authorities on 14 April. Retrospective and prospective case searching immediately took place and all SARI cases in Jordan were reviewed. No increase in community acquired pneumonia in the Zarqa hospital catchment area was found and no change in the reporting of cases to the

SARI sentinel surveillance was observed. Screening of hospital workers was carried out using a standardized questionnaire and case definition, and all laboratory results for blood and sputum cultures from patients admitted to the cardiac or intensive care units since 15 March were re-examined. Viral and bacterial tests to identify a common pathogen responsible for the cluster of cases were all negative although *Pseudomonas aeroginosa* was detected in samples from four patients.

In September 2012 after hearing reports of a novel coronavirus discovered in nearby countries, the Ministry of Health Jordan requested the Naval Medical Research Unit (NAMRU-3) to retest some of the stored specimens from the April pneumonia cluster. Only a few specimens remained and two were positive by PCR for nCoV. As part of the new investigations, a mission from WHO headquarters and the Regional Office visited Jordan from 28 November to 7 December to: assess the SARI surveillance; review data from the April cluster; assess Jordan's infection prevention and control programmes; and assess laboratory capacity for testing for nCoV. Further epidemiological information was sought from the cases and contacts; however, the time elapsed since the event limited the amount of detail individuals could recall.

Only two of the cases, a health care worker (0003) and a patient (0001), have been confirmed by PCR, the remaining 11 are considered probable. Ten of the cases were health care workers in the same hospital. The remaining three were a student (0001), the brother of confirmed case 0003 and the mother of probable case 0002. The epidemic curve is suggestive of person-to-person transmission but whether the case with earliest recorded onset of symptoms (0001) is the index case is unclear. Cases 0002, 0003 and 0004 were already sick when the case 0001 was admitted to the hospital on 4 April. Given the time course of subsequent cases, person-to-person transmission is a likely explanation for the nine cases with onsets between 11 and 26 April.

4. MICROBIOLOGICAL UPDATES

Presentations were made by Drs. Bart Hagmans and Ron Fouchier (EMC), Dr Christian Drosten (University of Bonn) and Dr Maria Zambon (HPA). These reference centres together with the NAMRU-3 Cairo laboratory have led the work on sequencing the virus and confirming the diagnosis in all of the cases to date.

Pathogenesis: New information was provided by the teams from Bonn and EMC about work on the cellular receptor for the virus. (9. Müller) It has been previously shown that changes in the spike protein (S1) of the coronavirus are an important means by which the virus adapts to a new host. This was clearly demonstrated in the SARS outbreak. The S1 protein as the presumed binding protein on the virus was cloned and tested for binding to target cells and was found to bind to human cells, macaque monkey cells and pig cells. A likely candidate has now been identified as a receptor to which the S1 virus protein binds in human and bat cells. Work at EMC has shown that the putative receptor is expressed in lower respiratory tract non-ciliated epithelium cells of the bronchus as well as in kidney, spleen, and intestinal cells. A small number of macaque monkeys and ferrets have also been studied as animal models.

Sequencing studies: The complete genome sequence of the nCoV-EMC/2012 virus has been published. (1.Van Boheemen) Only two viruses have been fully sequenced to date, the nCoV-EMC from Saudi Arabia and the one from Qatar sequenced by the HPA in London (England1_novel_CoV_2012). The genetic structure of the Qatari virus isolate in Germany is identical to the London Qatari virus on analysis of three sequenced genomic fragments.

Methods for detecting the nCoV by two real-time reverse-transcription polymerase chain reaction assays (real-time RT-PCR) were published in September 2012. (10. Corman 1). Two target regions were chosen for screening, confirmation and sequencing of the nCoV; the Upstream of the E gene (UpE) for screening and ORF1b for confirmation. A third assay (N-gene), from the nucleic capsid region, produced by Bonn could not be validated at the HPA. Of note, the N gene showed two amino acid deletions in the London virus from Qatar compared with the nCoV-EMC virus from Saudi Arabia, demonstrating that small genetic differences exist between these two viruses. This may mean that they belong to two lineages. It was suggested that some differences between the London virus and the EMC virus might have been due to the type of samples they each received and tested. EMC's results came from a clinical isolate whereas London's were directly from clinical material. However, the fact that genetic information from an isolate from a second passage of the clinical material in London showed no mutations in the virus and none were found in the Netherlands after a fourth passage of the virus, would indicate that the differences are real and not introduced by culture. Sequence data are needed from the other confirmed cases in order to fully verify the existence of different lineages.

A 700 nucleotide segment of the N gene of the virus from one of the cases in Jordan has now been sequenced at NAMRU-3 and had 99% homology to the EMC and London viruses.

Laboratory capacity for PCR testing: A survey of reference laboratories in the WHO European Region with capacity for screening and confirmation of nCoV was carried out in November 2012. (11. Palm) The survey found that 48% (22/46) of responding countries could detect nCoV by real-time RT-PCR using the available primer assays. A further confirmatory assay (1A) was made public in December, together with two new assays for sequencing, particularly where an insertion/deletion polymorphism might exist, as is the case between the EMC virus and the London virus. (12. Corman 2) The assays are now available commercially worldwide and have been provided to some of the Middle East countries where cases have occurred. The current WHO interim guidance on PCR testing for nCoV states that a positive PCR test should be followed by a confirmatory test with the 1A assay or by sequencing target sites within the nucleocapsid protein region of the genome. (13. WHO 21 Dec) Positive control materials developed by Bonn are available for the upE and 1A tests.

The CDC reported that they have developed two nucleocapsid assays for detection of nCoV. These assays were distributed to Saudi Arabia and Jordan and were used by NAMRU-3 to confirm the cases in Jordan. Dr Al Dhahry from the Jordan Virology laboratory (Amman) reported that he now has commercially prepared assays in his laboratory that are similar in performance to the upE assay.

Development of serological tests: Two immunofluorescent antibody (IFA) detection assays have been developed; one using conventional IFA methods and the other rapid. Confirmatory tests for positive IFA results are done through recombinant subunit assays, placque reduction neutralization tests, and western blot to rule out false positive results. (12. Corman 2) Tests for sensitivity and cross reactivity against other coronaviruses and other respiratory viruses with the nCoV-EMC found no cross reactivity using these confirmatory methods. It was noted that nonstructural proteins in coronavirus are conserved among different strains and that IFA using whole viruses would be expected to cross react broadly, however, the IFA antibody detection assay developed in Bonn was tested against a non-exposed population in Germany and no false positive results were obtained. The researchers point out that more validation studies are needed and the test is not suitable for broad population screening of asymptomatic individuals. Many serological samples are in storage from the nine nCoV cases and their contacts and could be used to further validate the IFA tests.

In London the HPA tested 124 sera from family and health care worker contacts of the Qatari London case. Sera were screened for reactivity to coronavirus NL63 (CoV gp1), OC43 (CoV gp2a), SARS (CoV gp2b) and nCoV England/1 2012 (CoV gp2c). No reactivity with the nCoV England 1 antigen was detected. When recombinant assays were tested for cross reactivity with these strains and bat CoV strains from groups 1, 2a, 2b, 2c and 2d, the group 2c bat strains were reactive to the London patient sera. Dr Zambon reported that these results were part of work in progress and further studies will be needed to interpret the data. She believes though that one might expect to see some cross reactivity, particularly in older people who have been exposed to different coronaviruses over time. Cross reactions might also occur when detecting low titres that might be due to past infection combined with a fresh infection of a different CoV. A wide range of tests are required to fully understand these issues.

Ecological studies: Ecological studies have shown that bats are natural hosts of 2b and 2c betacoronavirus subgroups. Extensive bat sampling has been carried out in Africa and Europe where a high percentage of bats were found among the Nycteris (25%) and Pipistrellus (36%) breeds to be positive with CoV of the 2c clade. The pipistrellus bats inhabit the Arabian peninsula but also migrate to Africa and other continents. The knowledge that insectivorous bats are natural hosts for betacoronaviruses, and that coronaviruses have been detected in a significant proportion of bats, does not in itself provide definitive evidence that they are the source of infection for the Middle East cases of nCoV. More studies are needed to ascertain whether the virus might be found in other species even more closely related to nCoV-EMC and whether other animals might be the source or the carrier of the novel human coronavirus. However, this study is important because it provides a comparative dataset of sequences and virus functionality and the basis upon which to build further studies.

The SARS experience: Two presentations were made, one by Dr Jeffery Cutter from the Ministry of Health of Singapore and one from Dr Theresa Tam from the Public Health Agency of Canada. The presentations were a reminder of how appearance of a new virus can quickly change from a few sporadic cases to a worldwide epidemic. It was stated that the SARS virus spread to five countries within a 24-hour period, before international public

health measures were in place to identify, control and prevent the spread of infection. The new virus severely affected the economies of several countries, especially in Hong Kong. Both speakers emphasized the importance and the challenges in the implementation of public health measures such as strict hospital infection control, case identification, and comprehensive identification and quarantine of contacts. Although its effectiveness is unproven, there was an expectation from the public that governments would do entry and exit screening at international points of entry as means for controlling the spread of SARS. While the effectiveness of border screening was unknown this was seen as an opportunity to heighten public awareness in taking appropriate actions when they felt sick post arrival. Sharing of information at the local, national and international level was also key to managing public and professional fear and anxiety. The lessons learned from the SARS outbreak in 2003 included the need to strengthen international health regulations, have national plans in place to handle similar future outbreaks, maintain public health epidemiological and microbiological capacity, and keep ahead of the curve.

nCoV communication overview: National and international public health organizations have kept the public fully apprised of the emergence and investigation of the nCoV cases on their websites through regular bulletins and updates, question and answer sheets, or through publications such as the rapid reports in Eurosurveillance. WHO has three main communication channels – the Event Information Site (EIS) a password protected rapid reporting system; the disease outbreak news (DON) which is a public system; and traditional media through its website and publications. Mr Gregory H□rtl, Coordinator, New Media at WHO headquarters, outlined the communication steps taken by WHO during the course of the incident to date, including the use of new social media such as twitter. The important lessons learned were mainly related to information dissemination. If there is another incident like the nCoV emergence Mr H□rtl stated that more frequent press briefings should be held to reassure and to provide information to the public, especially in anticipation of any surge in cases. Outbreak communication guidelines should be prepared so that all relevant communications departments are ready to make first announcements at the appropriate time.

5. GAP ANALYSIS AND IDENTIFICATION OF FUTURE PRIORITIES FOR RESEARCH AND INVESTIGATION

Professor Angus Nicoll from the European Centre for Disease Prevention and Control (ECDC) presented a document that described the important public health ‘known unknowns’ for nCoV. The document is structured around three column headings: the ‘what’; the ‘why’; and the ‘how’ in terms of information required. It listed ten areas where itemizing the known unknowns was helpful for consolidating current known and unknown information. Although the document is still in draft form and remains an informal work in progress, it nevertheless provided a useful introduction to the gap analysis discussions.

Dr Fukuda led the discussion on the gap analysis. As outlined at the start of the two day meeting, many facts about the nCoV and its epidemiology/pathology and virology were missing or incomplete. These are itemized below:

1. Source of the nCoV infection, the animal reservoir(s)

2. Extent of geographical spread
3. Route(s) of transmission
4. Transmissibility of infection and degree of infectiousness
5. Exposure patterns
6. Incubation periods
7. Pathogenesis, including age and gender determinants
8. Clinical spectrum of illness and evidence of mild infections
9. What further diagnostic tests should be developed
10. Laboratory diagnostic capabilities
11. Interpretation of test results

Five areas for guiding future efforts in furthering our understanding and knowledge of nCoV were highlighted: 1) defining the spectrum of disease severity; 2) identifying activities needed to inform whether the situation is escalating; 3) improving the case definition; 4) identifying the source of infection; and 5) specifying WHO's role for future studies.

Defining the spectrum of disease severity

We still do not know if the nine cases identified to date represent only a small portion of a larger number of undiagnosed severely ill cases in the affected or other countries. Since only very severely ill cases have been confirmed to date, it is possible that many milder cases have occurred which remain undiagnosed. It is notable that the probable cases in the Jordanian cluster had milder presentations than the confirmed cases, which suggests that milder forms of the illness can occur. No systematic screening of patients has been carried out in the region; stored specimens from these cases need to be checked retrospectively for evidence of nCoV infection. Serological tests of contacts of confirmed cases and retrospective testing of probable cases could also help to answer the question of disease spectrum.

Recommended activities: Screening

A standardized and sensitive approach to screening should be developed. This should focus on targeting the affected countries through screening of people meeting a modified case definition that incorporates detection of both severely ill and mildly ill persons. Data to be collected should be based on a standardized questionnaire for use by all the investigating sites. Groups to be prioritized for screening should be

- Patients with severe acute respiratory infection (SARI)
- Close contacts of cases who become symptomatic
- Clusters of SARI occurring in occupational groups, particularly health care workers.

The SARI surveillance system could be an important tool for persons infected with nCoV. Seven countries in the Eastern Mediterranean Region have some form of SARI surveillance. Five have been established since 2008. NAMRU-3 is the testing centre for clinical specimens from these systems and currently has 12 000–15 000 respiratory specimens in storage. To date, permission to test these for nCoV has been obtained from

Jordan, Qatar and Oman. The regional network for influenza surveillance could be utilized for coordinating these activities. In liaison with CDC, it has been agreed that specimens negative for influenza and RSV and from patients aged 12 years or more should be prioritized for this testing. Testing has already taken place on 206 respiratory specimens from Jordan during 2012 (all of which were negative). Jordan's SARI sentinel sites have been expanded and will implement prospective testing for nCoV for the next two months.

Qatar has 350 SARI respiratory specimens in its sample bank from 2010 and will test them for nCoV. However, standardized methods for collecting and handling specimens and a consensus on the optimum serological test to use, together with the choice of which laboratory to use for confirmatory testing must all be clarified before these studies are initiated.

Laboratory methods for serological screening

The laboratory approach should start with a rapid screening test (e.g. an IFA or ELISA test) with positive results confirmed by a neutralization test. The decision as to which ELISA test to use can only come about after standardization and validation has taken place and this will take several months to achieve. It was acknowledged at the meeting that few laboratories currently have the expertise to use serology for nCoV infection. The required level of biosafety to perform these tests is also not available in some laboratories of the Region. Centres of diagnostic expertise should therefore be used for this early work.

Next steps with support from WHO

- Create a study group and framework for designing appropriate studies using standardized epidemiological methods
- Identify and prioritize groups for testing
- Develop protocols for standardized serological methods
- Encourage sharing of clinical samples between countries and laboratories
- Initiate laboratory training programmes for using standard methods
- Include animal studies in framework.

Monitoring activities needed to inform whether the situation is escalating

Enhanced surveillance

The historical context must first be understood in order to ascertain whether the current situation is static or changing. Evidence could be built up through systematic checking of hospital pneumonia data from previous years in the affected countries, as Saudi Arabia has already initiated. Baselines for pneumonia cases in different hospitals should be collected to monitor any unexplained future rise that might be associated with nCoV. Other alert mechanisms in hospital activity could include as monitoring chest X-ray usage, drug dispensing, or changes in diagnostic methods. The additional collection of sputum specimens from SARI patients for prospective testing was recommended.

Activities to be included in enhanced surveillance were prioritized as follows.

- Study of household contacts of cases to determine secondary attack rates
- Prospective systematic collection of sera from future close contacts
- Prospective study of health care workers; absenteeism, illness attack rates
- Surveillance of clusters of SARI

Next steps with support from WHO

- Develop standard surveillance tools for monitoring changes in rates of pneumonic illness or detection of illness in selected population groups
- Develop a standard protocol for guidance on types of specimens to collect from selected population groups
- Ensure countries in the Region test single cases of unexplained severe respiratory illness and report positives to WHO

Refining the case definition

Case definitions should be modified to find new cases in the future not just in countries of the Region but in a wider geographical area. However, more data on the clinical presentation and natural history of the disease are needed to inform new case definitions. The illness spectrum has been shown to be wider than respiratory for many of the cases. Some of the specific complications of nCoV infection such acute renal failure or pericarditis have significant implications for clinical presentation and clinical management of cases and their frequency of occurrence needs to be clarified.

A revised case definition should consider

- Implementing a two stage case definition of initial screening followed by closer examination of cases that meet specific criteria. **All** possible complications of the disease cannot be included in the screening case definition.
- Practicality and feasibility of this system. It could result in a huge burden of work for clinicians and public health officials but emphasis should be on sensitivity rather than specificity.
- Extending the geographical regions when screening cases to exclude any risk of missing cases.
- Make recommendations for WHO to investigate before employing strict case definition.

Next steps with support from WHO

- Contact affected countries to request data to define key clinical features of known cases
- Obtain clinical information on known cases – pool all information from affected countries using a standardized extraction form
- Initiate sero-surveys of contacts and probable cases to elucidate the full clinical spectrum of the disease, mindful of cross reaction issues in serological studies
- Develop a global case definition for reporting

- Continue to monitor the effectiveness of the case definition and revise when relevant

Identifying the source of infection

Currently, almost nothing is known about the source of infection for nCoV infection, how cases are exposed and the route of transmission. Animal studies are urgently needed to inform some of these pathways. It was suggested that protocols from the studies carried out for the SARS epidemic be utilized for developing risk factor studies into nCoV infection.

WHO's role in future studies

WHO organized this meeting to bring together experts for furthering the understanding of what is known, what is not known, and to update participants on current scientific activities on nCoV. In summary the following actions were agreed for consolidating activities that will advance knowledge about this infection in the immediate and long term.

- Prepare an inventory of current nCoV virological research activities in European, American and other national laboratories
- Encourage cooperation in the development of virological studies
- Prepare an inventory of training opportunities for laboratory staff testing for nCoV
- Prepare an inventory of laboratories developing nCoV serological tests and list which laboratories are using which tests
- Prepare an inventory of countries willing to test SARI cases for nCoV
- Liaise with the animal research group to strengthen collaborative studies and coordinate future studies into the reservoir of infection for nCoV
- Itemize all collaborating resources and identify where capacity building is required
- Ensure risk assessment guidelines, infection control guidelines and other documents are regularly reviewed and communicated to those that need to know
- Prioritize research needs.

6. CONCLUSIONS

The emergence of new infectious global threats in the past four decades (e.g. AIDS, H5N1, SARS) has reshaped thinking at the national and international level on the nature and level of public health responses needed for these threats. The International Health Regulations have emphasized that all countries are at risk from new infections and therefore need to collaborate on information sharing and data exchange when they occur. In the current age of immediate and ongoing access to worldwide digital information, there are high expectations globally that everything is being done to detect and control an emerging disease problem. Uncertainties as to how a newly discovered disease is going to evolve means that preparations have to be determined at both the national and international level.

This meeting has evaluated all that is currently known about the cases of nCoV infection and has shaped priorities for future actions at the national and international level. It has also checked that the activities relevant to preparedness for any future surge in cases are in place and that where necessary resources have been identified to meet these actions.

Annex 1

PROGRAMME

Monday, 14 January 2013

08:30–09:00	Registration	
09:00–09:30	Opening session Address by Dr Ala Alwan, Regional Director, WHO/EMRO Objectives of the meeting and method of work Introduction of participants	Moderated by: Dr J. Mahjour, DCD
09:30–09:45	Novel coronavirus: Global context and issues	Dr Keiji Fukuda
09:45–10:20	Update investigations and current status in Saudi Arabia	Saudi Arabia
10:20–10:35	Ecological studies in Saudi Arabia	Dr Ian Lipkin
10:55–11:25	Update investigations and current status in Qatar	Qatar
11:25–11:40	Results of investigations in Germany	Dr Udo Buchholz
11:40–11:55	Results of investigations in the United Kingdom	Dr Richard Pebody
11:55–12:35	Update investigations and current status in Jordan	Jordan
12:35–13:30	Discussion	
14:30–15:00	Update on virological studies at Erasmus Medical College	Erasmus team
15:00–15:20	Update on virological studies at the University of Bonn	Dr Christian Drosten
15:20–15:40	Update on virological studies at the Health Protection Agency (via videoconference)	Dr Maria Zambon
16:00–17:00	Discussion	

Tuesday, 15 January 2013

09:00–09:20	Status of development of serological assay (videoconference)	Dr Maria Zambon
09:20–09:40	Status of development of PCR tests	Dr Ron Fouchier
09:40–10:10	Discussion	
10:30–10:50	Lessons learned from SARS in Singapore	Dr Jeffery Cutter
10:50–11:10	Lessons learned from SARS in Canada	Dr Theresa Tam
11:10–12:00	Discussion	
12:00–12:15	Key questions, research/investigation priorities.	Dr Angus Nicoll
12:15–13:15	Discussion	
14:15–15:15	Risk assessment: What is the potential for this virus to expand based on current knowledge?	Plenary discussion
15:30–15:50	Gap analysis on novel coronavirus risk communication: lessons learned and way forward	Dr Gregory Härtl
15:50–16:50	Preparedness: What measures should we put in place now, for the coming months? What is needed if situation escalates?	Plenary discussion
16:50–17:30	Summary of key findings Recommendations	Dr Keiji Fukuda and Dr Jaouad Mahjour
17:30	Closing session	

Annex 2

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Annex 3

DOCUMENTS CONSULTED BY THE PARTICIPANTS

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