**From:** Gabrielle Lynn Williams
**Sent:** Wed, 19 Feb 2020 04:57:32 +0000
**To:** [redacted] (b) (6) [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6);Glass, Roger (NIH/FIC) [E]; [redacted] (b) (6); [redacted] (b) (6);Fauci, Anthony (NIH/NIAID) [E];Lane, Cliff (NIH/NIAID) [E];Higgs, Elizabeth (NIH/NIAID) [E]; [redacted] (b) (6);Dan Peters [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6);Fernandez, Jose (OS/OGA); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6);Michael Kent Ranson; [redacted] (b) (6);Andreas Seiter;Alexandru Valeriu Cebotari;Daniel Dulitzky;Dirk Reinermann;Ernest E. Massiah;Magnus Lindelow;Michael S. Bennett;Trina S. Haque;Muhammad Ali Pate;Feng Zhao;Ira Marina;Lydia Ndebele;Mukesh Chawla;Rocio Schmunis;Adrienne Kate Mcmanus
**Subject:** Consultation on Financing Coronavirus Disease (COVID-19) Vaccine Development | Thursday, February 20 from 9:30am to 1:30pm
**Attachments:** image002.png, image003.png, Consultation on Financing COVID-19 Vaccine Development_February 20, 2020_Logistics Note.pdf

Dear All,

On behalf of the World Bank health team, in coordination with the Coalition for Epidemic Preparedness Innovations (CEPI), it is our pleasure to host you for a half-day consultation on ***Financing Coronavirus Disease 2019 (COVID-19) Vaccine Development***. The meeting is set to take place on **Thursday, February 20, 2020** from **9:30am to 1:30pm** at the **World Bank Offices in Washington DC** (located at 1818 H St NW) on **floor C2, conference room MC C2-125.**

As you know, the novel Coronavirus outbreak, which started in Wuhan, China, is evolving rapidly. As of today, the number of confirmed cases has increased significantly to over 60,000 and the virus has reached 25 countries. The outbreak, a Public Health Emergency of International Concern (PHEIC), poses a threat to countries worldwide, especially those with weak health systems and low levels of pandemic preparedness.

It is of urgent importance that we move quickly to finance the development of the appropriate countermeasures for a disease that risks becoming endemic across the globe. Two critical issues are necessary to address: i) immediate financing for the development and scale-up of a diversified portfolio of vaccines, and ii) financing the manufacturing and procurement of vaccine for global distribution.

We will also circulate a draft background paper as well as an agenda, shortly.

In this context, we take this opportunity to share with you pertinent information regarding some logistics for the meeting; please see below for further details. We note that logistical information is also provided in the attached document for your convenience.

Finally, we thank all participants who have so far RSVP'd to the meeting. For those who have not yet RSVP'd, kindly confirm your participation to Ms. Gabrielle Williams, Health, Nutrition and Population Global Practice, World Bank (wbhealthevents@worldbank.org).

Please do not hesitate to reach out with any questions.

Many thanks,
Gabrielle
WBG Health Team

## LOGISTICS NOTE

It is our distinct pleasure to host you on the occasion of **Thursday, February 20, 2020 from 9:30am – 1:30pm** at the **World Bank Headquarters in Washington, DC**. Please find in the below pertinent information regarding logistics (including instructions for connecting remotely as needed):

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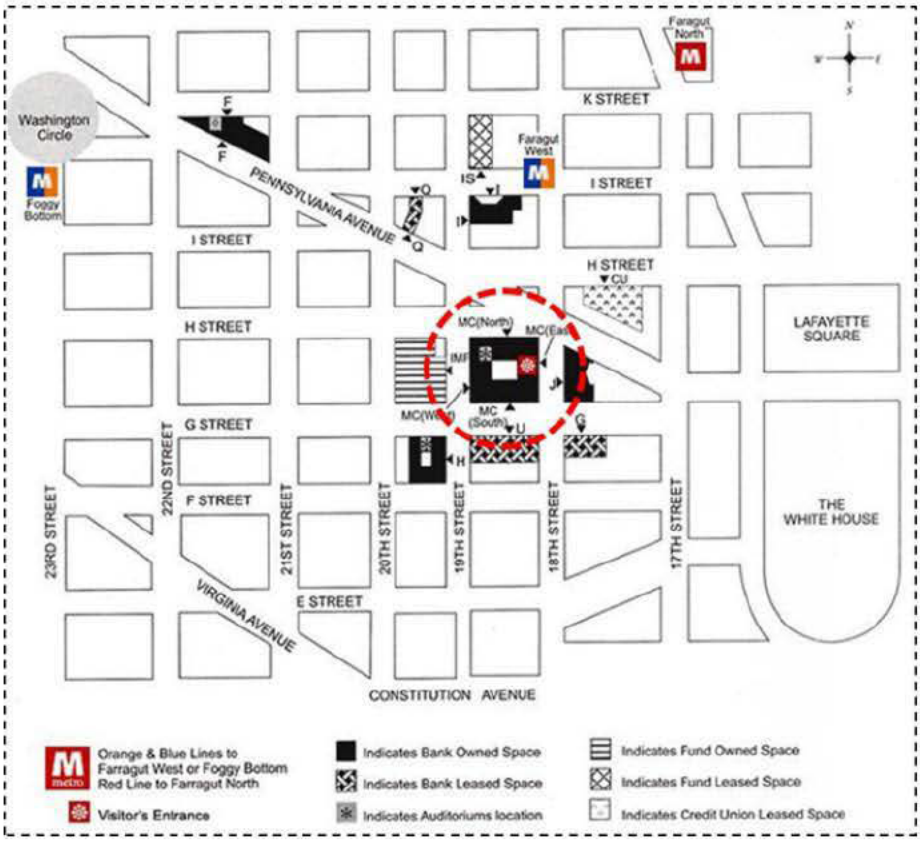


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- **To the airport**: Taxis are readily available from the World Bank Headquarters or from your hotel, whichever is most conducive to your travel arrangements.
- **For more information on public transportation**: please visit WMATA – Metro/Bus/Train andService Near Me

## Coffee & Lunch

- Coffee and tea will be available upon arrival
- Lunch will be provided; vegetarian options will be available

## Connecting Remotely

For those who will be connecting remotely, please find instructions on how to connect via Webex in the below:

**To join via computer or electronic device**:

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- Meeting number (access code): (b) (6)
- Meeting password: (b) (6)

Join meeting

**To join via phone, please use the following dial-in and access code**:

- Dial in: 1-650-479-3207 (Call-in toll number (US/Canada)) or click here for Global call-in numbers
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## Enquires or questions

If you have any further questions or enquiries regarding the meeting, please do not hesitate to contact the World Bank Health Team directly at Wbhealthevents@worldbank.org.


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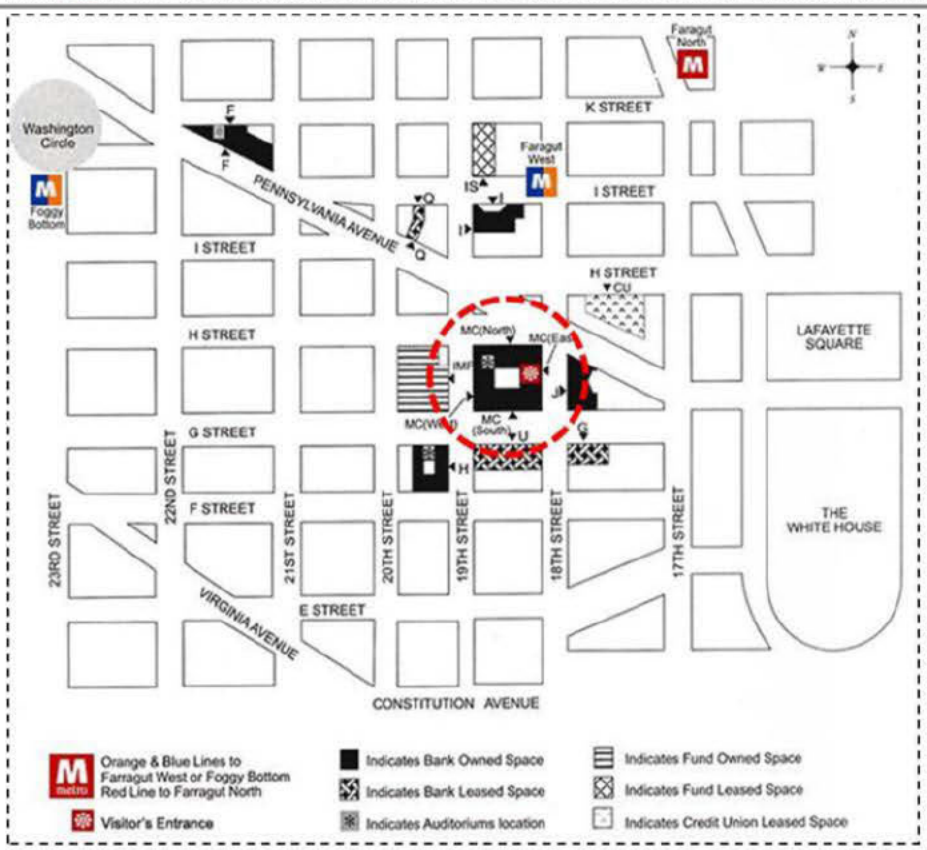
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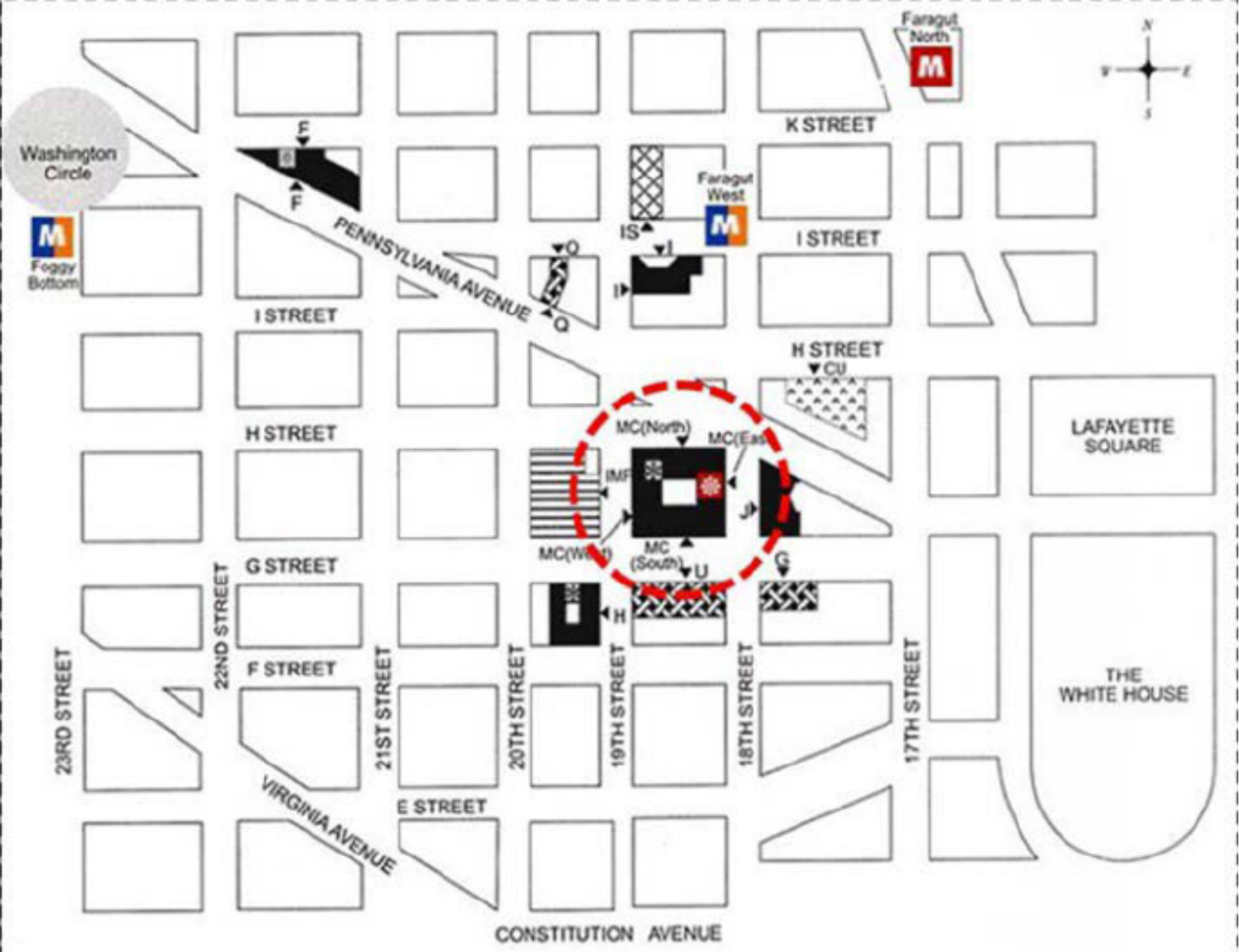
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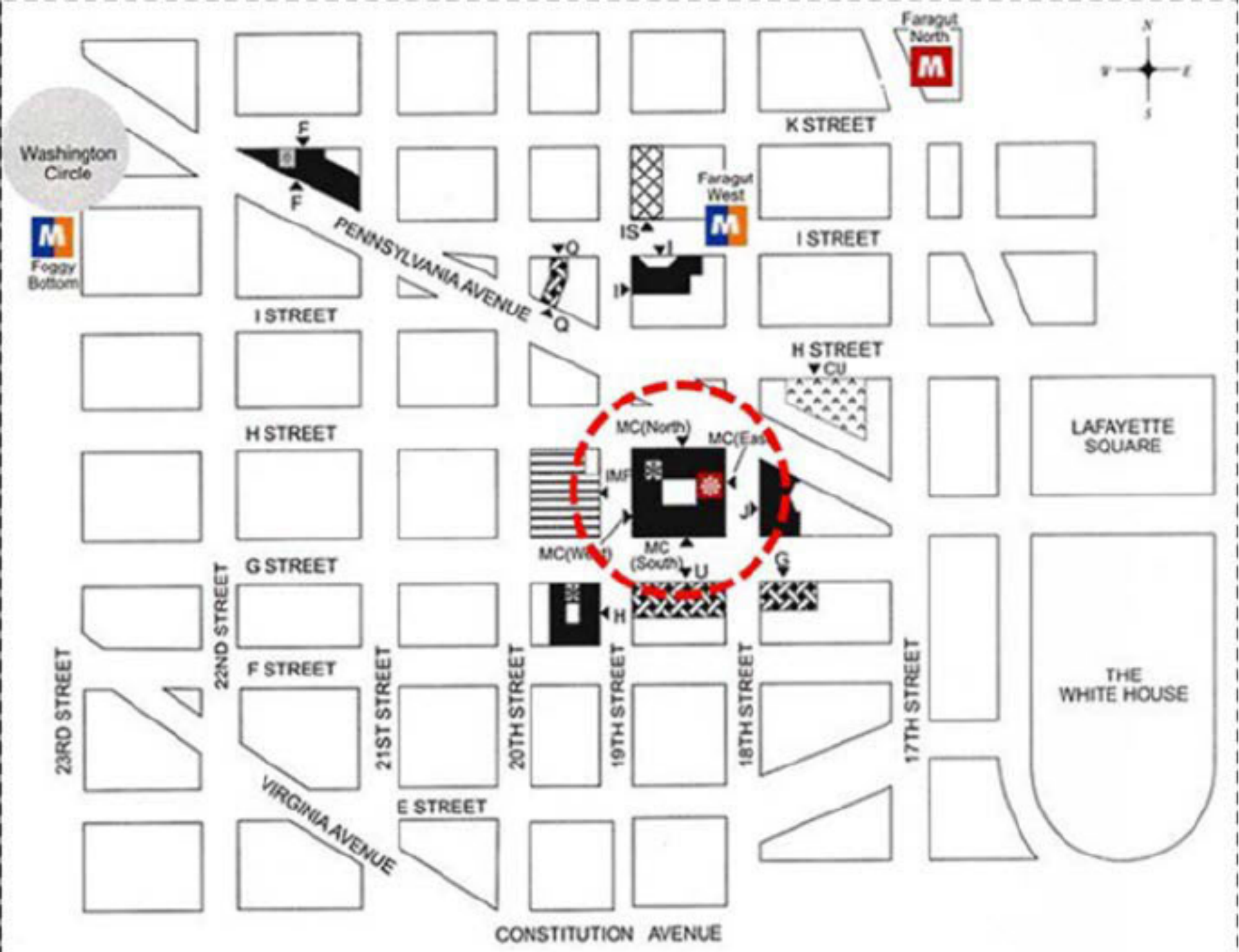
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# *Consultation on Financing Coronavirus Disease (COVID-19) Vaccine Development*

***Thursday, February 20, 2020 | 9:30am – 1:30pm***

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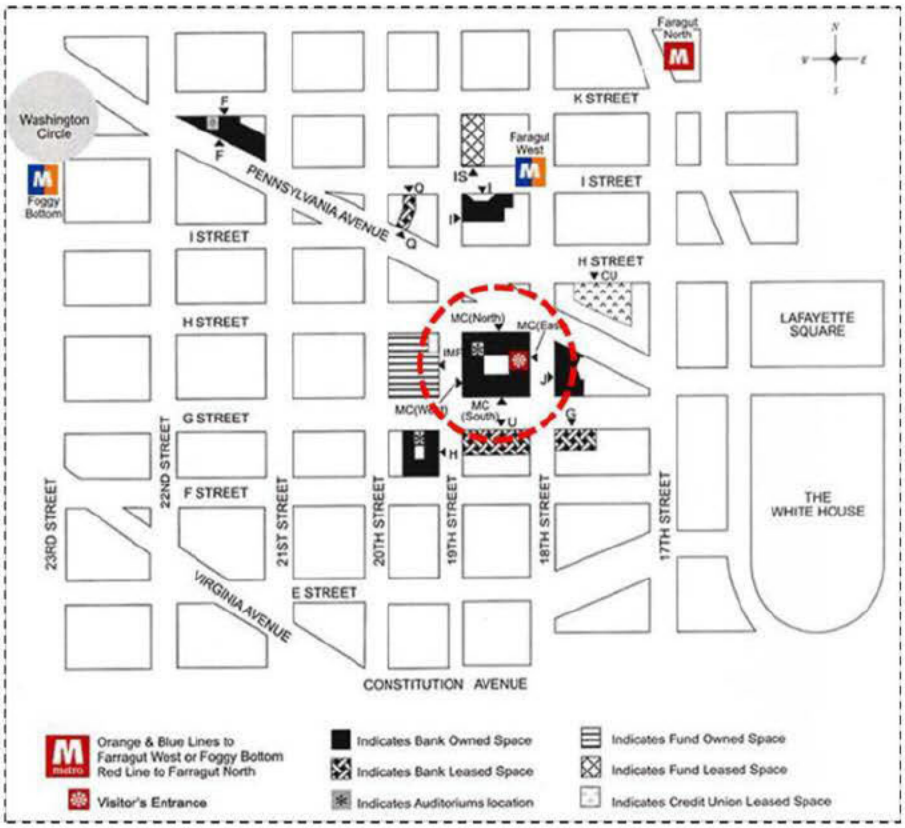


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**From:** Feng Zhao
**Sent:** Fri, 14 Feb 2020 22:07:31 +0000
**To:** Lane, Cliff (NIH/NIAID) [E]
**Cc:** (b) (6);Mukesh Chawla;Rocio Schmunis;Adrienne Kate Mcmanus;Gabrielle Lynn Williams;WB Health Events;Muhammad Ali Pate
**Subject:** Invitation to the Consultation on Financing Coronavirus Disease 2019 (COVID-19) Vaccine Development | Thursday, February 20, 2020 | 9:30am to 1:30pm | World Bank Headquarters, Washington DC

Dear Dr. Lane,

On behalf of the World Bank health team, in coordination with the Coalition for Epidemic Preparedness Innovations (CEPI), it is our pleasure to invite you to a half-day consultation on ***Financing Coronavirus Disease 2019 (COVID-19) Vaccine Development***. The meeting is set to take place on **Thursday, February 20, 2020** from **9:30am to 1:30pm** at the **World Bank Offices in Washington DC** (located at 1818 H St NW) on **floor C2, conference room MC C2-125.**

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To enhance our discussions we are working on a background paper which we will share along with an agenda at the earliest. Recognizing the short notice, we will provide remote connection details for those unable to travel for the meeting. A working lunch will also be provided.

We hope that you will be able to participate in this important meeting. Kindly confirm your participation to Ms. Gabrielle Williams, Health, Nutrition and Population Global Practice, World Bank (wbhealthevents@worldbank.org). Please do not hesitate to reach out with any questions.

Looking forward to your positive response.

Best regards,
Feng Zhao

World Health Organization

# 2019 novel Coronavirus

## Global research and innovation forum: towards a research roadmap

# DRAFT AGENDA

**11-12 February 2020**

**WHO Headquarters, Geneva, Switzerland**

**Executive Board room**

**Version 2.0 Jan 30, 2020**

## Background

The WHO R&D Blueprint is a global strategy and preparedness plan that allows the rapid activation of R&D activities during epidemics. Its aim is to fast-track the availability of effective tests, vaccines and medicines that can be used to save lives and avert large scale crisis.

The global imperative for research is to maintain a high-level discussion platform which enables consensus on strategic directions, nurtures scientific collaborations and, supports optimal and rapid research to address crucial gaps, without duplication of efforts.

Understanding the disease, its reservoirs, its transmission, its clinical severity and developing effective counter measures is critical for the control of the outbreak, the reduction of related mortality and minimization of economic impact.

**Purpose**
To enable identification of key knowledge gaps, and research priorities and thereby accelerate the generation of critical scientific information and the most needed medical products to contribute to the control the 2019-nCoV emergency.

**Expected outcome**

A research roadmap with clearly defined priorities and governance framework addressing each of several thematic areas will be considered at the meeting, namely: virus, diagnostics; natural history and transmission; clinical; therapeutics; vaccines; ethics; regulatory science; animal health; data/samples analysis and sharing and; social sciences (https://www.who.int/blueprint/en/).
.

**Attendees**
The participants will include diverse multi-disciplinary teams:

- representatives from the scientific community
- public health agencies
- regulatory authorities
- member state representatives from affected countries, from Ministries of Health
- research funders
- bioethicists with expertise in emergencies
- medical journal editors

WHO is delighted to welcome you to this 2.0 day in person meeting, which is organized in collaboration with GLOPID-R.

## Provisional Agenda

**Day 1**

| Time | Sessions | Proposed Speaker/Moderators |
|---|---|---|
| | **SESSION 1: SETTING THE SCENE** | |
| 8:30 | Registration | |
| 09:00 | Opening Remarks | |
| 09:15 | Objectives of the meeting | |
| 09:30 | Overview of the outbreak situation and control measures being implemented | WHO |
| 09:45 | Brief Countries interventions (5 min each) | Representatives from affected countries |
| 11:00 | **COFFEE and TEA** | |
| 11:30 | Overview of ongoing research activities by thematic area<br>o Virus Diagnostic/Lab/PCR/Serology – natural history and transmission<br>o Animal Health<br>o Clinical/Disease severity<br>o Candidate Therapeutics<br>o Candidate Vaccine<br>o Ethics<br>o Regulatory science<br>o Data/Sample/Sequence analysis and sharing<br>o Social Sciences | Invited experts per thematic area |
| **13:30** | **LUNCH** | |
| | **SESSION 2: DEFINING RESEARCH GAPS AND A GOVERNANCE FRAMEWORK** | |
| 13:30 | What are the research gaps and the priorities for this outbreak?<br>How can the research stakeholders effectively coordinate their activities to ensure that all gaps are addressed and overlaps are avoided (what governance framework could contribute to this?) | Parallel sessions by thematic area<br><br>(Participants will be assigned to various thematic areas) |
| **15:30** | **COFFEE AND TEA** | |
| 15:30 | (Continuation) | Parallel sessions by thematic area |
| 18:00 | Adjourn | |
| 18:30 | COCKTAIL - RECEPTION | |

**Day 2**

| Time | Sessions | Proposed Speaker/Moderator |
|---|---|---|
| **SESSION 3: DEFINING KEY PRIORITIES AND OVERAL OBJECTIVES OF THE GLOBAL RESEARCH AGENDA** | | |
| 08:30 | Feedback on the deliberations by thematic area | Leaders of each thematic group |
| **10:30** | **COFFEE AND TEA** | |
| 11:00 | Structured discussion – challenging the way forward<br>1. What should be the overall objectives of a global research plan as a response to the current outbreak and in preparation for the future?<br>2. What are the most important actions to ensure successful evaluation and use (if appropriate) for any of the investigational interventions?<br>3. What cross cutting research priorities have merged from the deliberations? | Plenary debate on the outcomes of the thematic groups and the proposed governance framework |
| **12:30** | **LUNCH** | |
| | | |
| 13:30 | 3. What governance model could contribute to the successful implementation of the research agenda during this outbreak? (As we move forward, how can the thematic areas and the overall research efforts be best coordinated?) | Panel discussion (panel members TBD) |
| 14:30 | 4. What kind of support is required to ensure successful implementation of proposed research priorities? | Panel discussion (panel members TBD) |
| **15:30** | **COFEE AND TEA** | |
| **SESSION 4: CROSS-CUTTING RESEARCH ACTIVITIES** | | |
| 16:00 | Taking stock of deliberations so far<br>- Main research gaps and priorities<br>- Model(s) governance<br>- Support required for success | Chairperson |
| 16: 30 | Next steps | Plenary discussion |
| 17:00 | Report outcome to Dr Tedros and counterparts | Chairperson |
| 17:30 | **END OF THE MEETING** | |

| | |
|---|---|
| **From:** | Lane, Cliff (NIH/NIAID) [E] </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2D7E368A3137473BBCE161547A82F2DE-CLANE> |
| **To:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6); Grady, Christine (NIH/CC/BEP) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dab06d3e2a004adcabc9f73d2d382fc7-cgrady (b) (6) |
| **Subject:** | WHO-China Joint Mission on COVID-19 |
| **Date:** | 2020/03/20 19:50:41 |
| **Priority:** | Normal |
| **Type:** | Note |

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| **Sender:** | Lane, Cliff (NIH/NIAID) [E] </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2D7E368A3137473BBCE161547A82F2DE-CLANE> |
| **Recipient:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6); Grady, Christine (NIH/CC/BEP) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dab06d3e2a004adcabc9f73d2d382fc7-cgrady (b) (6) |
| **Sent Date:** | 2020/03/20 19:50:40 |
| **Delivered Date:** | 2020/03/20 19:50:41 |

# Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)

16-24 February 2020

# Table of Contents

# I. The Mission

## Goal and Objectives

The overall goal of the Joint Mission was to rapidly inform national (China) and international planning on next steps in the response to the ongoing outbreak of the novel coronavirus disease (COVID-19[1]) and on next steps in readiness and preparedness for geographic areas not yet affected.

The major objectives of the Joint Mission were as follows:

- To enhance understanding of the evolving COVID-19 outbreak in China and the nature and impact of ongoing containment measures;
- To share knowledge on COVID-19 response and preparedness measures being implemented in countries affected by or at risk of importations of COVID-19;
- To generate recommendations for adjusting COVID-19 containment and response measures in China and internationally; and
- To establish priorities for a collaborative programme of work, research and development to address critical gaps in knowledge and response and readiness tools and activities.

## Members & Method of Work

The Joint Mission consisted of 25 national and international experts from China, Germany, Japan, Korea, Nigeria, Russia, Singapore, the United States of America and the World Health Organization (WHO). The Joint Mission was headed by Dr Bruce Aylward of WHO and Dr Wannian Liang of the People's Republic of China. The full list of members and their affiliations is available in Annex A. The Joint Mission was implemented over a 9-day period from 16-24 February 2020. The schedule of work is available in Annex B.

The Joint Mission began with a detailed workshop with representatives of all of the principal ministries that are leading and/or contributing to the response in China through the National Prevention and Control Task Force. A series of in-depth meetings were then conducted with national level institutions responsible for the management, implementation and evaluation of the response, particularly the National Health Commission and the China Centers for Disease Control and Prevention (China CDC). To gain first-hand knowledge on the field level implementation and impact of the national and local response strategy, under a range of epidemiologic and provincial contexts, visits were conducted to Beijing Municipality and the provinces of Sichuan (Chengdu), Guangdong (Guangzhou, Shenzhen) and Hubei (Wuhan). The field visits included community centers and health clinics, country/district hospitals, COVID-19 designated hospitals, transportations hubs (air, rail, road), a wet market, pharmaceutical and personal protective equipment (PPE) stocks warehouses, research institutions, provincial health commissions, and local Centers for

[1] In the Chinese version of this report, COVID-19 is referred to throughout as novel coronavirus pneumonia or NCP, the term by which COVID-19 is most widely known in the People's Republic of China.

Disease Control (provincial and prefecture). During these visits, the team had detailed discussion and consultations with Provincial Governors, municipal Mayors, their emergency operations teams, senior scientists, frontline clinical, public health and community workers, and community neighbourhood administrators. The Joint Mission concluded with working sessions to consolidate findings, generate conclusions and propose suggested actions.

To achieve its goal, the Joint Mission gave particular focus to addressing key questions related to the natural history and severity of COVID-19, the transmission dynamics of the COVID-19 virus in different settings, and the impact of ongoing response measures in areas of high (community level), moderate (clusters) and low (sporadic cases or no cases) transmission.

The findings in this report are based on the Joint Mission's review of national and local governmental reports, discussions on control and prevention measures with national and local experts and response teams, and observations made and insights gained during site visits. The figures have been produced using information and data collected during site visits and with the agreement of the relevant groups. References are available for any information in this report that has already been published in journals.

The final report of the Joint Mission was submitted on 28 February and updated 11 March.

# II. Major findings

The major findings are described in six sections: the virus, the outbreak, transmission dynamics, disease progression and severity, the China response and knowledge gaps. More detailed descriptions of technical findings are provided in Annex C.

## The virus

On 30 December 2019, three bronchoalveolar lavage samples were collected from a patient with pneumonia of unknown etiology – a surveillance definition established following the SARS outbreak of 2002-2003 – in Wuhan Jinyintan Hospital. Real-time PCR (RT-PCR) assays on these samples were positive for pan-Betacoronavirus. Using Illumina and nanopore sequencing, the whole genome sequences of the virus were acquired. Bioinformatic analyses indicated that the virus had features typical of the coronavirus family and belonged to the Betacoronavirus 2B lineage. Alignment of the full-length genome sequence of the COVID-19 virus and other available genomes of Betacoronavirus showed the closest relationship was with the bat SARS-like coronavirus strain BatCov RaTG13, identity 96%.

Virus isolation was conducted with various cell lines, such as human airway epithelial cells, Vero E6, and Huh-7. Cytopathic effects (CPE) were observed 96 hours after inoculation. Typical crown-like particles were observed under transmission electron microscope (TEM) with negative staining. The cellular infectivity of the isolated viruses could be completely neutralized by the sera collected from convalescent patients. Transgenic human ACE2 mice and Rhesus monkey intranasally challenged by this virus isolate induced multifocal pneumonia with interstitial hyperplasia. The COVID-19 virus was subsequently detected and isolated in the lung and intestinal tissues of the challenged animals.

Whole genome sequencing analysis of 104 strains of the COVID-19 virus isolated from patients in different localities with symptom onset between the end of December 2019 and mid-February 2020 showed 99.9% homology, without significant mutation (Figure 1).

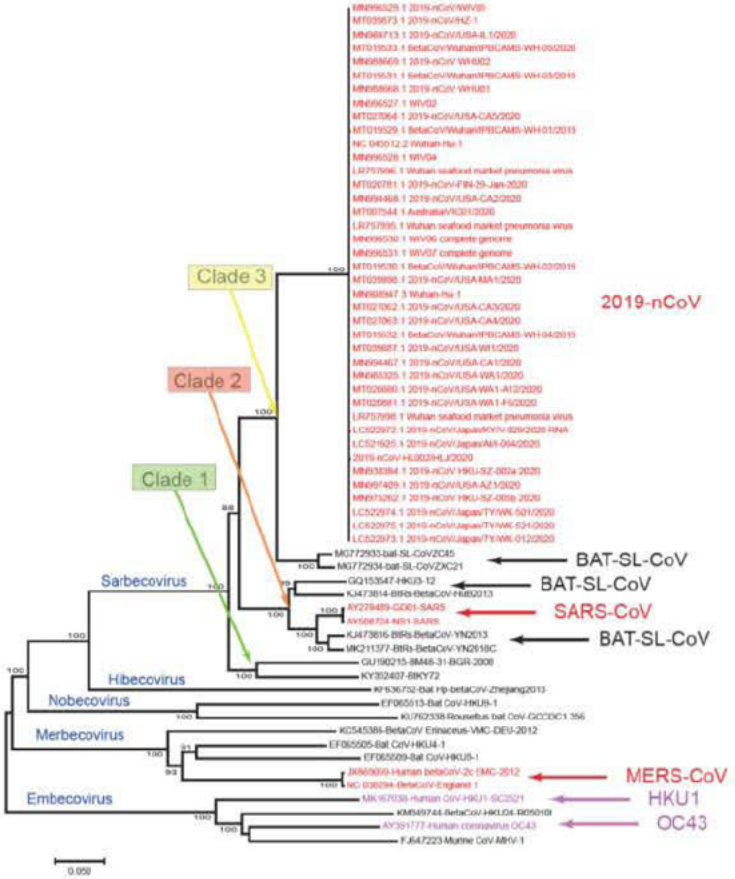


**Figure 1. Phylogenetic analysis of the COVID-19 virus and its closely related reference genomes**

Note: COVID-19 virus is referred to as 2019-nCoV in the figure, the interim virus name WHO announced early in the outbreak.

Post-mortem samples from a 50-year old male patient from Wuhan were taken from the lung, liver, and heart. Histological examination showed bilateral diffuse alveolar damage with cellular fibromyxoid exudates. The lung showed evident desquamation of pneumocytes and hyaline membrane formation, indicating acute respiratory distress syndrome (ARDS). Lung tissue also displayed cellular and fibromyxoid exudation, desquamation of pneumocytes and pulmonary oedema. Interstitial mononuclear inflammatory infiltrates, dominated by lymphocytes, were seen in both lungs. Multinucleated syncytial cells with atypical enlarged pneumocytes characterized by large nuclei, amphophilic granular cytoplasm, and prominent nucleoli were identified in the intra-alveolar spaces, showing viral cytopathic-like changes. No obvious intranuclear or intracytoplasmic viral inclusions were identified.

## The outbreak

As of 20 February 2020, a cumulative total of 75,465 COVID-19 cases were reported in China. Reported cases are based on the National Reporting System (NRS) between the

National and Provincial Health Commissions. The NRS issues daily reports of newly recorded confirmed cases, deaths, suspected cases, and contacts. A daily report is provided by each province at 0300hr in which they report cases from the previous day.

The epidemic curves presented in Figures 2 and 3 are generated using China's National Infectious Disease Information System (IDIS), which requires each COVID-19 case to be reported electronically by the responsible doctor as soon as a case has been diagnosed. It includes cases that are reported as asymptomatic and data are updated in real time. Individual case reporting forms are downloaded after 2400hr daily. Epidemiologic curves for Wuhan, Hubei (outside of Wuhan), China (outside Hubei) and China by symptom onset are provided in Figure 2.

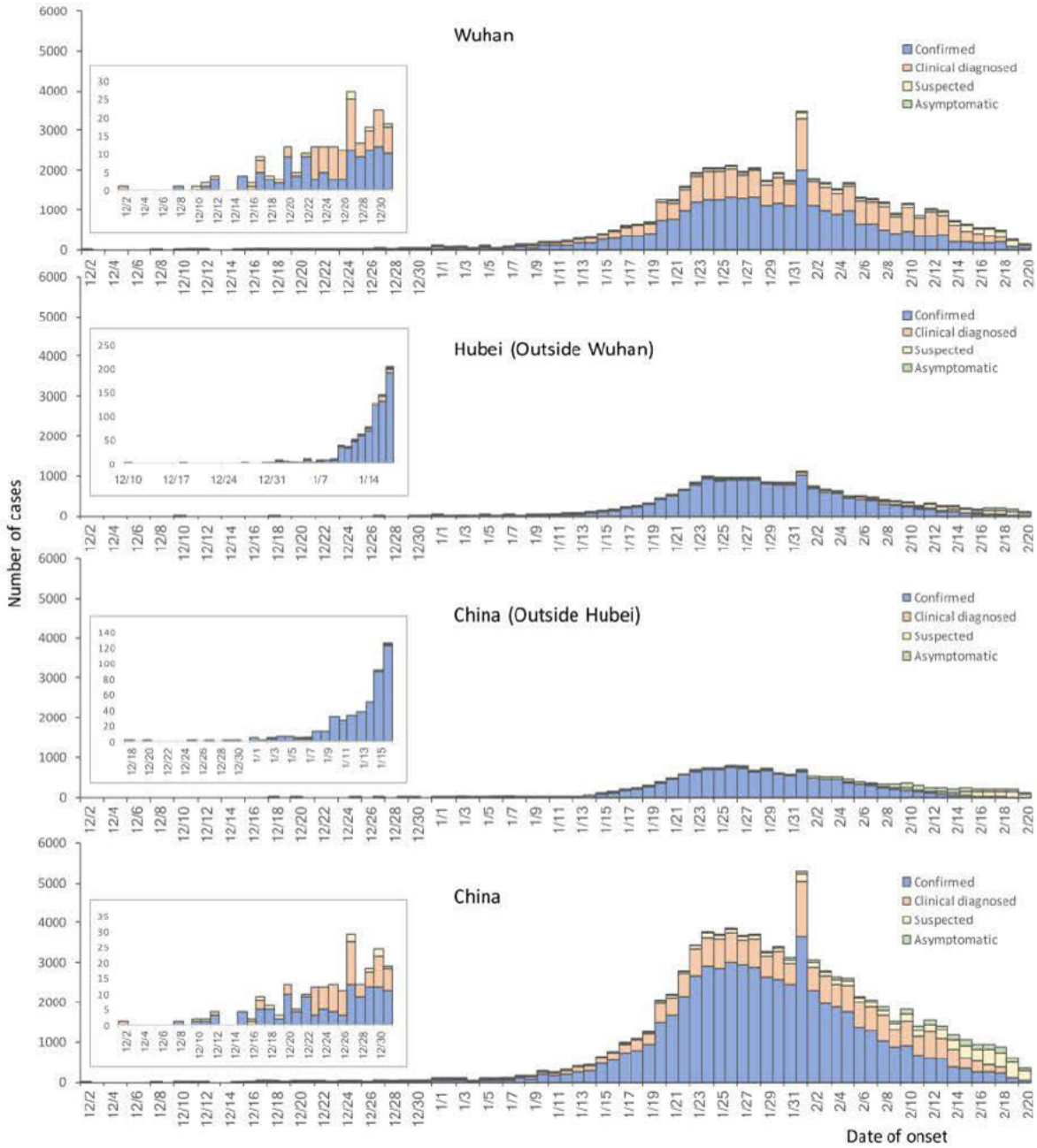


**Figure 2 Epidemiologic curve of COVID-19 laboratory confirmed cases, by date of onset of illness, reported in China, as of 20 February 2020**

Figure 3 presents epidemic curves of laboratory-confirmed cases, by symptom onset and separately by date of report, at 5, 12, and 20 February 2020. Figures 2 and 3 illustrate that the epidemic rapidly grew from 10-22 January, reported cases peaked and plateaued between 23 January and 27 January, and have been steadily declining since then, apart from the spike that was reported on 1 February (note: at a major hospital in Wuhan, fever clinic patients fell from a peak of 500/day in late January to average 50/day since mid-February).

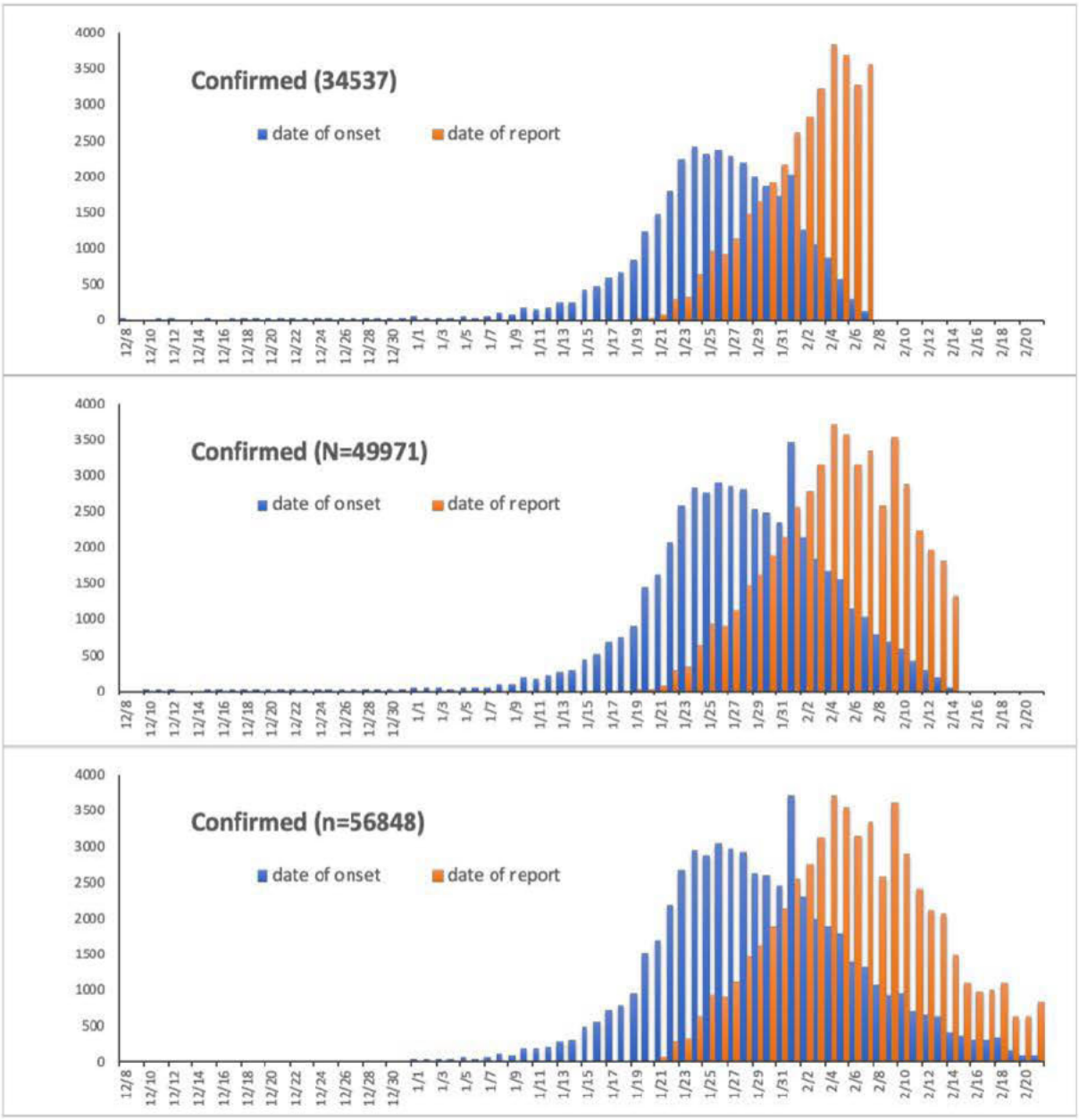


**Figure 3. Epidemic curves by symptom onset and date of report as of 5 February (top panel), 12 February (middle panel) and 20 February 2020 (lower panel) for laboratory confirmed COVID-19 cases for all of China**

Based on these epidemic curves, the published literature, and our on-site visits in Wuhan (Hubei), Guangdong (Shenzhen and Guangzhou), Sichuan (Chengdu), and Beijing, the Joint Mission team has made the following epidemiological observations:

### *Demographic characteristics*

Among 55,924 laboratory confirmed cases reported as of 20 February 2020, the median age is 51 years (range 2 days-100 years old; IQR 39-63 years old) with the majority of cases (77.8%) aged between 30–69 years. Among reported cases, 51.1% are male, 77.0% are from Hubei and 21.6% are farmers or laborers by occupation.

### *Zoonotic origins*

COVID-19 is a zoonotic virus. From phylogenetics analyses undertaken with available full genome sequences, bats appear to be the reservoir of COVID-19 virus, but the intermediate host(s) has not yet been identified. However, three important areas of work are already underway in China to inform our understanding of the zoonotic origin of this outbreak. These include early investigations of cases with symptom onset in Wuhan throughout December 2019, environmental sampling from the Huanan Wholesale Seafood Market and other area markets, and the collection of detailed records on the source and type of wildlife species sold at the Huanan market and the destination of those animals after the market was closed.

### *Routes of transmission*

COVID-19 is transmitted via droplets and fomites during close unprotected contact between an infector and infectee. Airborne spread has not been reported for COVID-19 and it is not believed to be a major driver of transmission based on available evidence; however, it can be envisaged if certain aerosol-generating procedures are conducted in health care facilities. Fecal shedding has been demonstrated from some patients, and viable virus has been identified in a limited number of case reports. However, the fecal-oral route does not appear to be a driver of COVID-19 transmission; its role and significance for COVID-19 remains to be determined. Viral shedding is discussed in the Technical Findings (Annex C).

### *Household transmission*

In China, human-to-human transmission of the COVID-19 virus is largely occurring in families. The Joint Mission received detailed information from the investigation of clusters and some household transmission studies, which are ongoing in a number of Provinces. Among 344 clusters involving 1308 cases (out of a total 1836 cases reported) in Guangdong Province and Sichuan Province, most clusters (78%-85%) have occurred in families. Household transmission studies are currently underway, but preliminary studies ongoing in Guangdong estimate the secondary attack rate in households ranges from 3-10%.

### *Contact Tracing*

China has a policy of meticulous case and contact identification for COVID-19. For example, in Wuhan more than 1800 teams of epidemiologists, with a minimum of 5 people/team, are tracing tens of thousands of contacts a day. Contact follow up is painstaking, with a high percentage of identified close contacts completing medical observation. Between 1% and 5% of contacts were subsequently laboratory confirmed cases of COVID-19, depending on location. For example:

- As of 17 February, in Shenzhen City, among 2842 identified close contacts, 2842 (100%) were traced and 2240 (79%) have completed medical observation. Among the close contacts, 88 (3.1%) were found to be infected with COVID-19.

- As of 17 February, in Sichuan Province, among 25493 identified close contacts, 25347 (99%) were traced and 23178 (91%) have completed medical observation. Among the close contacts, 0.9% were found to be infected with COVID-19.
- As of 20 February, in Guangdong Province, among 9939 identified close contacts, 9939 (100%) were traced and 7765 (78%) have completed medical observation. Among the close contacts, 479 (4.8%) were found to be infected with COVID-19.

### *Testing at fever clinics and from routine ILI/SARI surveillance*

The Joint Mission systematically enquired about testing for COVID-19 from routine respiratory disease surveillance systems to explore if COVID-19 is circulating more broadly and undetected in the community in China. These systems could include RT-PCR testing of COVID-19 virus in influenza-like-illness (ILI) and severe acute respiratory infection (SARI) surveillance systems, as well as testing of results among all visitors to fever clinics.

In Wuhan, COVID-19 testing of ILI samples (20 per week) in November and December 2019 and in the first two weeks of January 2020 found no positive results in the 2019 samples, 1 adult positive in the first week of January, and 3 adults positive in the second week of January; all children tested were negative for COVID-19 although a number were positive for influenza. In Guangdong, from 1-14 January, only 1 of more than 15000 ILI/SARI samples tested positive for the COVID-19 virus. In one hospital in Beijing, there were no COVID-19 positive samples among 1910 collected from 28 January 2019 to 13 February 2020. In a hospital in Shenzhen, 0/40 ILI samples were positive for COVID-19.

Within the fever clinics in Guangdong, the percentage of samples that tested positive for the COVID-19 virus has decreased over time from a peak of 0.47% positive on 30 January to 0.02% on 16 February. Overall in Guangdong, 0.14% of approximately 320,000 fever clinic screenings were positive for COVID-19.

### *Susceptibility*

As COVID-19 is a newly identified pathogen, there is no known pre-existing immunity in humans. Based on the epidemiologic characteristics observed so far in China, everyone is assumed to be susceptible, although there may be risk factors increasing susceptibility to infection. This requires further study, as well as to know whether there is neutralising immunity after infection.

## The transmission dynamics

Inferring from Figures 2 and 3, and based on our observations at the national and provincial/municipal levels during the Joint Mission, we summarize and interpret the transmission dynamics of COVID-19 thus far. It is important to note that transmission dynamics of any outbreak are inherently contextual. For COVID-19, we observe four major types of transmission dynamics during the epidemic growth phase and in the post-control period, and highlight what is known about transmission in children, as follows:

### *Transmission in Wuhan*

Early cases identified in Wuhan are believed to be have acquired infection from a zoonotic source as many reported visiting or working in the Huanan Wholesale Seafood Market. As of 25 February, an animal source has not yet been identified.

At some point early in the outbreak, some cases generated human-to-human transmission chains that seeded the subsequent community outbreak prior to the implementation of the comprehensive control measures that were rolled out in Wuhan. The dynamics likely approximated mass action and radiated from Wuhan to other parts of Hubei province and China, which explains a relatively high $R_0$ of 2-2.5.

The *cordon sanitaire* around Wuhan and neighboring municipalities imposed since 23 January 2020 has effectively prevented further exportation of infected individuals to the rest of the country.

### *Transmission in Hubei, other than Wuhan*

In the prefectures immediately adjoining Wuhan (Xiaogan, Huanggang, Jingzhou and Ezhou), transmission is less intense. For other prefectures, due to fewer transport links and human mobility flows with Wuhan, the dynamics are more closely aligned with those observed in the other areas of the country. Within Hubei, the implementation of control measures (including social distancing) has reduced the community force of infection, resulting in the progressively lower incident reported case counts.

### *Transmission in China outside of Hubei*

Given Wuhan's transport hub status and population movement during the Chinese New Year (chunyun), infected individuals quickly spread throughout the country, and were particularly concentrated in cities with the highest volume of traffic with Wuhan. Some of these imported seeds generated limited human-to-human transmission chains at their destination.

Given the Wuhan/Hubei experience, a comprehensive set of interventions, including aggressive case and contact identification, isolation and management and extreme social distancing, have been implemented to interrupt the chains of transmission nationwide. To date, most of the recorded cases were imported from or had direct links to Wuhan/Hubei. Community transmission has been very limited. Most locally generated cases have been clustered, the majority of which have occurred in households, as summarized above.

Of note, the highly clustered nature of local transmission may explain a relatively high $R_0$ (2-2.5) in the absence of interventions and low confirmed case counts with intense quarantine and social distancing measures.

### *Special settings*

We note that instances of transmission have occurred within health care settings prisons and other closed settings. At the present time, it is not clear what role these settings and groups play in transmission. However, they do not appear to be major drivers of the overall epidemic dynamics. Specifically, we note:

(a) **Transmission in health care settings and among health care workers (HCW)** – The Joint Mission discussed nosocomial infection in all locations visited during the Mission. As of 20 February 2020, there were 2,055 COVID-19 laboratory-confirmed cases reported among HCW from 476 hospitals across China. The majority of HCW cases (88%) were reported from Hubei.

Remarkably, more than 40,000 HCW have been deployed from other areas of China to support the response in Wuhan. Notwithstanding discrete and limited instances of nosocomial outbreaks (e.g. a nosocomial outbreak involving 15 HCW in Wuhan), transmission within health care settings and amongst health care workers does not appear to be a major transmission feature of COVID-19 in China. The Joint Mission learned that, among the HCW infections, most were identified early in the outbreak in Wuhan when supplies and experience with the new disease was lower. Additionally, investigations among HCW suggest that many may have been infected within the household rather than in a health care setting. Outside of Hubei, health care worker infections have been less frequent (i.e. 246 of the total 2055 HCW cases). When exposure was investigated in these limited cases, the exposure for most was reported to have been traced back to a confirmed case in a household.

The Joint Team noted that attention to the prevention of infection in health care workers is of paramount importance in China. Surveillance among health care workers identified factors early in the outbreak that placed HCW at higher risk of infection, and this information has been used to modify policies to improve protection of HCW.

(b) **Transmission in closed settings** – There have been reports of COVID-19 transmission in prisons (Hubei, Shandong, and Zhejiang, China), hospitals (as above) and in a long-term living facility. The close proximity and contact among people in these settings and the potential for environmental contamination are important factors, which could amplify transmission. Transmission in these settings warrants further study.

### *Children*

Data on individuals aged 18 years old and under suggest that there is a relatively low attack rate in this age group (2.4% of all reported cases). Within Wuhan, among testing of ILI samples, no children were positive in November and December of 2019 and in the first two weeks of January 2020. From available data, and in the absence of results from serologic studies, it is not possible to determine the extent of infection among children, what role children play in transmission, whether children are less susceptible or if they present differently clinically (i.e. generally milder presentations). The Joint Mission learned that infected children have largely been identified through contact tracing in households of adults. Of note, people interviewed by the Joint Mission Team could not recall episodes in which transmission occurred from a child to an adult.

## The signs, symptoms, disease progression and severity

Symptoms of COVID-19 are non-specific and the disease presentation can range from no symptoms (asymptomatic) to severe pneumonia and death. As of 20 February 2020 and

based on 55924 laboratory confirmed cases, typical **signs and symptoms** include: fever (87.9%), dry cough (67.7%), fatigue (38.1%), sputum production (33.4%), shortness of breath (18.6%), sore throat (13.9%), headache (13.6%), myalgia or arthralgia (14.8%), chills (11.4%), nausea or vomiting (5.0%), nasal congestion (4.8%), diarrhea (3.7%), and hemoptysis (0.9%), and conjunctival congestion (0.8%).

People with COVID-19 generally develop signs and symptoms, including mild respiratory symptoms and fever, on an average of 5-6 days after infection (mean incubation period 5-6 days, range 1-14 days).

Most people infected with COVID-19 virus have mild disease and recover. Approximately 80% of laboratory confirmed patients have had **mild to moderate disease**, which includes non-pneumonia and pneumonia cases, 13.8% have **severe disease** (dyspnea, respiratory frequency ≥30/minute, blood oxygen saturation ≤93%, PaO2/FiO2 ratio <300, and/or lung infiltrates >50% of the lung field within 24-48 hours) and 6.1% are **critical** (respiratory failure, septic shock, and/or multiple organ dysfunction/failure). **Asymptomatic infection** has been reported, but the majority of the relatively rare cases who are asymptomatic on the date of identification/report went on to develop disease. The proportion of truly asymptomatic infections is unclear but appears to be relatively rare and does not appear to be a major driver of transmission.

Individuals at **highest risk** for severe disease and death include people aged over 60 years and those with underlying conditions such as hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer. Disease in **children** appears to be relatively rare and mild with approximately 2.4% of the total reported cases reported amongst individuals aged under 19 years. A very small proportion of those aged under 19 years have developed severe (2.5%) or critical disease (0.2%).

As of 20 February, 2114 of the 55,924 laboratory confirmed cases have died (**crude fatality ratio** [CFR[2]] 3.8%) (note: at least some of whom were identified using a case definition that included pulmonary disease). The overall CFR varies by location and intensity of transmission (i.e. 5.8% in Wuhan vs. 0.7% in other areas in China). In China, the overall CFR was higher in the early stages of the outbreak (17.3% for cases with symptom onset from 1-10 January) and has reduced over time to 0.7% for patients with symptom onset after 1 February (Figure 4). The Joint Mission noted that the standard of care has evolved over the course of the outbreak.

Mortality increases with age, with the highest mortality among people over 80 years of age (CFR 21.9%). The CFR is higher among males compared to females (4.7% vs. 2.8%). By occupation, patients who reported being retirees had the highest CFR at 8.9%. While patients who reported no comorbid conditions had a CFR of 1.4%, patients with comorbid conditions had much higher rates: 13.2% for those with cardiovascular disease, 9.2% for diabetes, 8.4% for hypertension, 8.0% for chronic respiratory disease, and 7.6% for cancer.

[2] The Joint Mission acknowledges the known challenges and biases of reporting crude CFR early in an epidemic.

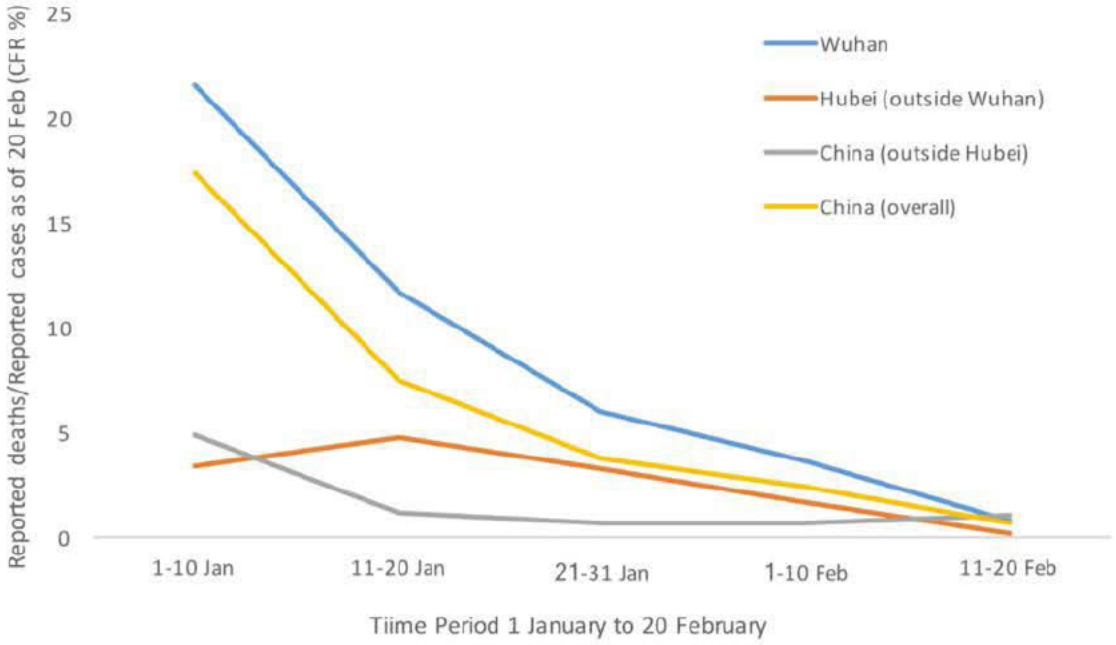


**Figure 4 Case fatality ratio (reported deaths among total cases) for COVID-19 in China over time and by location, as of 20 February 2020**

Data on the **progression of disease** is available from a limited number of reported hospitalized cases (Figure 5). Based on available information, the median time from symptom onset to laboratory confirmation nationally decreased from 12 days (range 8-18 days) in early January to 3 days (1-7) by early February 2020, and in Wuhan from 15 days (10-21) to 5 days (3-9), respectively. This has allowed for earlier case and contact identification, isolation and treatment.

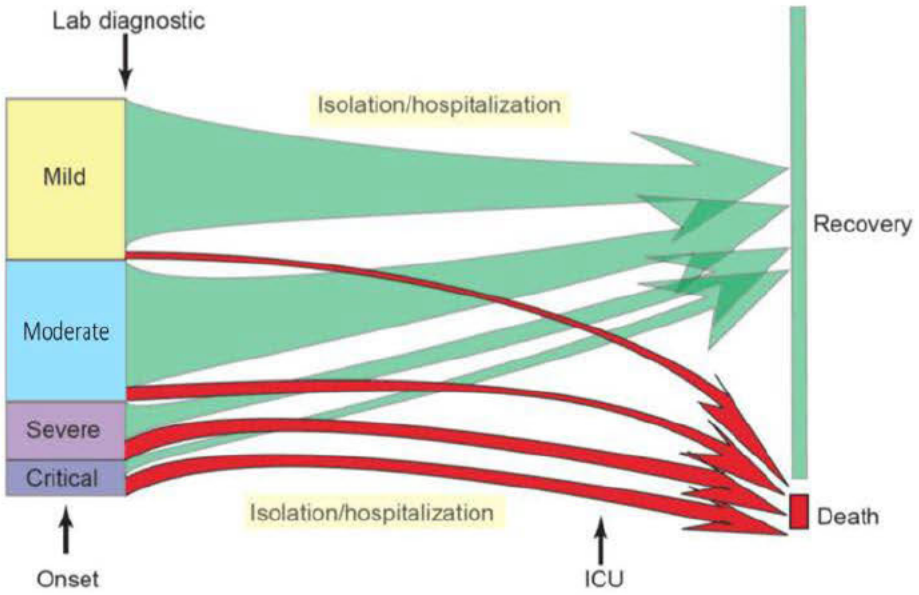


**Figure 5. Pattern of disease progression for COVID-19 in China**

Note: the relative size of the boxes for disease severity and outcome reflect the proportion of cases reported as of 20 February 2020. The size of the arrows indicates the proportion of cases who recovered or died. Disease definitions are described above. Moderate cases have a mild form of pneumonia.

Using available preliminary data, the median time from onset to clinical recovery for mild cases is approximately 2 weeks and is 3-6 weeks for patients with severe or critical disease. Preliminary data suggests that the time period from onset to the development of severe disease, including hypoxia, is 1 week. Among patients who have died, the time from symptom onset to outcome ranges from 2-8 weeks.

An increasing number of patients have **recovered**; as of 20 February, 18264 (24%) reported cases have recovered. Encouragingly, a report on 20 February from the Guangdong CDC suggests that of 125 severe cases identified in Guangdong, 33 (26.4%) have recovered and been released from hospital, and 58 (46.4%) had improved and were reclassified as having mild/moderate disease (i.e. + milder pneumonia). Among severe cases reported to date, 13.4% have died. Early identification of cases and contacts allows for earlier treatment.

## The China response

Upon the detection of a cluster of pneumonia cases of unknown etiology in Wuhan, the CPC Central Committee and the State Council launched the national emergency response. A **Central Leadership Group for Epidemic Response** and the **Joint Prevention and Control Mechanism** of the State Council were established. General Secretary Xi Jinping personally directed and deployed the prevention and control work and requested that the prevention and control of the COVID-19 outbreak be the top priority of government at all levels. Prime Minister Li Keqiang headed the Central Leading Group for Epidemic Response and went to Wuhan to inspect and coordinate the prevention and control work of relevant departments and provinces (autonomous regions and municipalities) across the country. Vice Premier Sun Chunlan, who has been working on the frontlines in Wuhan, has led and coordinated the frontline prevention and control of the outbreak.

The prevention and control measures have been implemented rapidly, from the early stages in Wuhan and other key areas of Hubei, to the current overall national epidemic. It has been undertaken in **three main phases**, with two important events defining those phases. First, COVID-19 was included in the statutory report of Class B infectious diseases and border health quarantine infectious diseases on 20 January 2020, which marked the transition from the initial partial control approach to the comprehensive adoption of various control measures in accordance with the law. The second event was the State Council's issuing, on 8 February 2020, of The Notice on Orderly Resuming Production and Resuming Production in Enterprises, which indicated that China's national epidemic control work had entered a stage of overall epidemic prevention and control together with the restoration of normal social and economic operations.

### *The first stage*

During the early stage of the outbreak, the main strategy focused on preventing the exportation of cases from Wuhan and other priority areas of Hubei Province, and preventing the importation of cases by other provinces; the overall aim was to control the source of infection, block transmission and prevent further spread. The response mechanism was initiated with multi-sectoral involvement in joint prevention and control measures. Wet markets were closed, and efforts were made to identify the zoonotic source. Information on the epidemic was notified to WHO on 3 January, and whole genome sequences of the COVID-19 virus were shared with WHO on 10 January. Protocols for COVID-19 diagnosis and

treatment, surveillance, epidemiological investigation, management of close contacts, and laboratory testing were formulated, and relevant surveillance activities and epidemiological investigations conducted. Diagnostic testing kits were developed, and wildlife and live poultry markets were placed under strict supervision and control measures.

### *The second stage*

During the second stage of the outbreak, the main strategy was to reduce the intensity of the epidemic and to slow down the increase in cases. In Wuhan and other priority areas of Hubei Province, the focus was on actively treating patients, reducing deaths, and preventing exportations. In other provinces, the focus was on preventing importations, curbing the spread of the disease and implementing joint prevention and control measures. Nationally, wildlife markets were closed and wildlife captive-breeding facilities were cordoned off. On 20 January, COVID-19 was included in the notifiable report of Class B infectious diseases and border health quarantine infectious diseases, with temperature checks, health care declarations, and quarantine against COVID-19 instituted at transportation depots in accordance with the law. On 23 January, Wuhan implemented strict traffic restrictions. The protocols for diagnosis, treatment and epidemic prevention and control were improved; case isolation and treatment were strengthened.

Measures were taken to ensure that all cases were treated, and close contacts were isolated and put under medical observation. Other measures implemented included the extension of the Spring Festival holiday, traffic controls, and the control of transportation capacity to reduce the movement of people; mass gathering activities were also cancelled. Information about the epidemic and prevention and control measures was regularly released. Public risk communications and health education were strengthened; allocation of medical supplies was coordinated, new hospitals were built, reserve beds were used and relevant premises were repurposed to ensure that all cases could be treated; efforts were made to maintain a stable supply of commodities and their prices to ensure the smooth operation of society.

### *The third stage*

The third stage of the outbreak focused on reducing clusters of cases, thoroughly controlling the epidemic, and striking a balance between epidemic prevention and control, sustainable economic and social development, the unified command, standardized guidance, and scientific evidence-based policy implementation. For Wuhan and other priority areas of Hubei Province, the focus was on patient treatment and the interruption of transmission, with an emphasis on concrete steps to fully implement relevant measures for the testing, admitting and treating of all patients. A risk-based prevention and control approach was adopted with differentiated prevention and control measures for different regions of the country and provinces. Relevant measures were strengthened in the areas of epidemiological investigation, case management and epidemic prevention in high-risk public places.

New technologies were applied such as the use of big data and artificial intelligence (AI) to strengthen contact tracing and the management of priority populations. Relevant health insurance policies were promulgated on "health insurance payment, off-site settlement, and financial compensation". All provinces provided support to Wuhan and priority areas in Hubei Province in an effort to quickly curb the spread of the disease and provide timely clinical treatment. Pre-school preparation was improved, and work resumed in phases and

batches. Health and welfare services were provided to returning workers in a targeted and 'one-stop' manner. Normal social operations are being restored in a stepwise fashion; knowledge about disease prevention is being popularized to improve public health literacy and skills; and a comprehensive program of emergency scientific research is being carried out to develop diagnostics, therapeutics and vaccines, delineate the spectrum of the disease, and identify the source of the virus.

### Knowledge gaps

Since the start of the COVID-19 outbreak, there have been extensive attempts to better understand the virus and the disease in China. It is remarkable how much knowledge about a new virus has been gained in such a short time. However, as with all new diseases, and only 7 weeks after this outbreak began, key knowledge gaps remain. Annex D summarizes the key unknowns in a number of areas including the source of infection, pathogenesis and virulence of the virus, transmissibility, risk factors for infection and disease progression, surveillance, diagnostics, clinical management of severe and critically ill patients, and the effectiveness of prevention and control measures. The timely filling of these knowledge gaps is imperative to enhance control strategies.

## III. Assessment

The Joint Mission drew four major conclusions from its work in China and four major conclusions from its knowledge of the broader global response to COVID-19. Recommendations are offered in five major areas to inform the ongoing response globally and in China.

### The China Response & Next Steps

1. **In the face of a previously unknown virus, China has rolled out perhaps the most ambitious, agile and aggressive disease containment effort in history. The strategy that underpinned this containment effort was initially a national approach that promoted universal temperature monitoring, masking, and hand washing. However, as the outbreak evolved, and knowledge was gained, a science and risk-based approach was taken to tailor implementation. Specific containment measures were adjusted to the provincial, county and even community context, the capacity of the setting, and the nature of novel coronavirus transmission there.**

   While the fundamental principles of this strategy have been consistent since its launch, there has been constant refinement of specific aspects to incorporate new knowledge on the novel coronavirus, the COVID-19 disease, and COVID-19 containment, as rapidly as that knowledge has emerged. The remarkable speed with which Chinese scientists and public health experts isolated the causative virus, established diagnostic tools, and determined key transmission parameters, such as the route of spread and incubation period, provided the vital evidence base for China's strategy, gaining invaluable time for the response.

As striking, has been the uncompromising rigor of strategy application that proved to be a hallmark in every setting and context where it was examined. There has also been a relentless focus on improving key performance indicators, for example constantly enhancing the speed of case detection, isolation and early treatment. The implementation of these containment measures has been supported and enabled by the innovative and aggressive use of cutting edge technologies, from shifting to online medical platforms for routine care and schooling, to the use of 5G platforms to support rural response operations.

2. **Achieving China's exceptional coverage with and adherence to these containment measures has only been possible due to the deep commitment of the Chinese people to collective action in the face of this common threat. At a community level this is reflected in the remarkable solidarity of provinces and cities in support of the most vulnerable populations and communities. Despite ongoing outbreaks in their own areas, Governors and Mayors have continued to send thousands of health care workers and tons of vital PPE supplies into Hubei province and Wuhan city.**

   At the individual level, the Chinese people have reacted to this outbreak with courage and conviction. They have accepted and adhered to the starkest of containment measures – whether the suspension of public gatherings, the month-long 'stay at home' advisories or prohibitions on travel. Throughout an intensive 9-days of site visits across China, in frank discussions from the level of local community mobilizers and frontline health care providers to top scientists, Governors and Mayors, the Joint Mission was struck by the sincerity and dedication that each brings to this COVID-19 response.

3. **China's bold approach to contain the rapid spread of this new respiratory pathogen has changed the course of a rapidly escalating and deadly epidemic. A particularly compelling statistic is that on the first day of the advance team's work there were 2478 newly confirmed cases of COVID-19 reported in China. Two weeks later, on the final day of this Mission, China reported 409 newly confirmed cases. This decline in COVID-19 cases across China is real.**

   Several sources of data support this conclusion, including the steep decline in fever clinic visits, the opening up of treatment beds as cured patients are discharged, and the challenges to recruiting new patients for clinical trials. Based on a comparison of crude attack rates across provinces, the Joint Mission estimates that this truly all-of-Government and all-of-society approach that has been taken in China has averted or at least delayed hundreds of thousands of COVID-19 cases in the country. By extension, the reduction that has been achieved in the force of COVID-19 infection in China has also played a significant role in protecting the global community and creating a stronger first line of defense against international spread. Containing this outbreak, however, has come at great cost and sacrifice by China and its people, in both human and material terms.

   While the scale and impact of China's COVID-19 operation has been remarkable, it has also highlighted areas for improvement in public health emergency response capacity.

These include overcoming any obstacles to act immediately on early alerts, to massively scale-up capacity for isolation and care, to optimize the protection of frontline health care workers in all settings, to enhance collaborative action on priority gaps in knowledge and tools, and to more clearly communicate key data and developments internationally.

4. **China is already, and rightfully, working to bolster its economy, reopen its schools and return to a more normal semblance of its society, even as it works to contain the remaining chains of COVID-19 transmission. Appropriately, a science-based, risk-informed and phased approach is being taken, with a clear recognition and readiness of the need to immediately react to any new COVID-19 cases or clusters as key elements of the containment strategy are lifted.**

   Despite the declining case numbers, across China every province, city and community visited is urgently escalating their investments in acute care beds and public health capacity. It is crucial that this continues. Fifty thousand infected COVID-19 patient are still under treatment, across the country. However, the Joint Mission has come to understand the substantial knowledge, experience and capacities that China has rapidly built during this crisis. Consequently, it endorses China's working assumption that in most provinces and municipalities it should soon be possible to manage a resurgence in COVID-19 cases, using even more tailored and sustainable approaches that are anchored in very rapid case detection, instant activation of key containment activities, direct oversight by top leadership, and broad community engagement.

   As China works to resume a more normal level of societal and economic activity, it is essential that the world recognizes and reacts positively to the rapidly changing, and decreasing, risk of COVID-19 in the country. China's rapid return to full connectivity with the world, and to full productivity and economic output, is vital to China and to the world. The world urgently needs access to China's experience in responding to COVID-19, as well as the material goods it brings to the global response. It is even more urgent now, with escalating COVID-19 outbreaks outside of China, to constantly reassess any restrictions on travel and/or trade to China that go beyond the recommendations of the IHR Emergency Committee on COVID-19.

## The Global Response & Next Steps

1. **The COVID-19 virus is a new pathogen that is highly contagious, can spread quickly, and must be considered capable of causing enormous health, economic and societal impacts in any setting. It is not SARS and it is not influenza. Building scenarios and strategies only on the basis of well-known pathogens risks failing to exploit all possible measures to slow transmission of the COVID-19 virus, reduce disease and save lives.**

   COVID-19 is not SARS and it is not influenza. It is a new virus with its own characteristics. For example, COVID-19 transmission in children appears to be limited compared with influenza, while the clinical picture differs from SARS. Such differences, while based on limited data, may be playing a role in the apparent efficacy of rigorously

applied non-pharmaceutical, public health measures to interrupt chains of human-to-human transmission in a range of settings in China. The COVID-19 virus is unique among human coronaviruses in its combination of high transmissibility, substantial fatal outcomes in some high-risk groups, and ability to cause huge societal and economic disruption. For planning purposes, it must be assumed that the global population is susceptible to this virus. As the animal origin of the COVID-19 virus is unknown at present, the risk of reintroduction into previously infected areas must be constantly considered.

The novel nature, and our continuously evolving understanding, of this coronavirus demands a tremendous agility in our capacity to rapidly adapt and change our readiness and response planning as has been done continually in China. This is an extraordinary feat for a country of 1.4 billion people.

2. **China's uncompromising and rigorous use of non-pharmaceutical measures to contain transmission of the COVID-19 virus in multiple settings provides vital lessons for the global response. This rather unique and unprecedented public health response in China reversed the escalating cases in both Hubei, where there has been widespread community transmission, and in the importation provinces, where family clusters appear to have driven the outbreak.**

   Although the timing of the outbreak in China has been relatively similar across the country, transmission chains were established in a wide diversity of settings, from mega-cities in the north and south of the country, to remote communities. However, the rapid adaptation and tailoring of China's strategy demonstrated that containment can be adapted and successfully operationalized in a wide range of settings.

   China's experience strongly supports the efficacy and effectiveness of anchoring COVID-19 readiness and rapid response plans in a thorough assessment of local risks and of utilizing a differentiated risk-based containment strategy to manage the outbreak in areas with no cases vs. sporadic cases vs. clusters of cases vs. community-level transmission. Such a strategy is essential for ensuring a sustainable approach while minimizing the socio-economic impact.

3. **Much of the global community is not yet ready, in mindset and materially, to implement the measures that have been employed to contain COVID-19 in China. These are the only measures that are currently proven to interrupt or minimize transmission chains in humans. Fundamental to these measures is extremely proactive surveillance to immediately detect cases, very rapid diagnosis and immediate case isolation, rigorous tracking and quarantine of close contacts, and an exceptionally high degree of population understanding and acceptance of these measures.**

   Achieving the high quality of implementation needed to be successful with such measures requires an unusual and unprecedented speed of decision-making by top leaders, operational thoroughness by public health systems, and engagement of society.

Given the damage that can be caused by uncontrolled, community-level transmission of this virus, such an approach is warranted to save lives and to gain the weeks and months needed for the testing of therapeutics and vaccine development. Furthermore, as the majority of new cases outside of China are currently occurring in high and middle-income countries, a rigorous commitment to slowing transmission in such settings with non-pharmaceutical measures is vital to achieving a second line of defense to protect low income countries that have weaker health systems and coping capacities.

The time that can be gained through the full application of these measures – even if just days or weeks – can be invaluable in ultimately reducing COVID-19 illness and deaths. This is apparent in the huge increase in knowledge, approaches and even tools that has taken place in just the 7 weeks since this virus was discovered through the rapid scientific work that has been done in China.

4. **The time gained by rigorously applying COVID-19 containment measures must be used more effectively to urgently enhance global readiness and rapidly develop the specific tools that are needed to ultimately stop this virus.**

   COVID-19 is spreading with astonishing speed; COVID-19 outbreaks in any setting have very serious consequences; and there is now strong evidence that non-pharmaceutical interventions can reduce and even interrupt transmission. Concerningly, global and national preparedness planning is often ambivalent about such interventions. However, to reduce COVID-19 illness and death, near-term readiness planning must embrace the large-scale implementation of high-quality, non-pharmaceutical public health measures. These measures must fully incorporate immediate case detection and isolation, rigorous close contact tracing and monitoring/quarantine, and direct population/community engagement.

   A huge array of COVID-19 studies, scientific research projects and product R&D efforts are ongoing in China and globally. This is essential and to be encouraged and supported. However, such a large number of projects and products needs to be prioritized. Without prioritizing, this risks compromising the concentration of attention and resources and collaboration required to cut timelines by precious weeks and months. While progress has been made, the urgency of the COVID-19 situation supports an even more ruthless prioritization of research in the areas of diagnostics, therapeutics and vaccines.

   Similarly, there is a long list of proposed studies on the origins of COVID-19, the natural history of the disease, and the virus's transmission dynamics. However, the urgency of responding to cases and saving lives makes it difficult for policy makers to consider and act on such comprehensive lists. This can be addressed by balancing studies with the immediate public health and clinical needs of the response. Studies can be prioritized in terms of the largest knowledge gaps that can be most rapidly addressed to have greatest immediate impact on response operations and patient management. This suggests prioritizing studies to identify risk factors for transmission in households, institutions and the community; convenience sampling for this virus in the population using existing surveillance systems; age-stratified sero-epidemiologic surveys; the analysis of clinical case series; and cluster investigations.

# IV. Major Recommendations

## For China

1. Maintain an appropriate level of emergency management protocols, depending on the assessed risk in each area and recognizing the real risk of new cases and clusters of COVID-19 as economic activity resumes, movement restrictions are lifted, and schools reopen;

2. Carefully monitor the phased lifting of the current restrictions on movement and public gatherings, beginning with the return of workers and migrant labor, followed by the eventual reopening of schools and lifting other measures;

3. Further strengthen the readiness of emergency management mechanisms, public health institutions (e.g. CDCs), medical facilities, and community engagement mechanisms to ensure sustained capacity to immediately launch containment activities in response to any resurgence in cases;

4. Prioritize research that rapidly informs response and risk management decisions, particularly household and health care facility studies, age-stratified sero-epidemiologic surveys and rigorous investigation of the animal-human interface; establish a centralized research program to fast-track the most promising rapid diagnostics and serologic assays, the testing of potential antivirals and vaccine candidates, and Chinese engagement in selected multi-country trials; and

5. As the country with the greatest knowledge on COVID-19, further enhance the systematic and real-time sharing of epidemiologic data, clinical results and experience to inform the global response.

## For countries with imported cases and/or outbreaks of COVID-19

1. Immediately activate the highest level of national Response Management protocols to ensure the all-of-government and all-of-society approach needed to contain COVID-19 with non-pharmaceutical public health measures;

2. Prioritize active, exhaustive case finding and immediate testing and isolation, painstaking contact tracing and rigorous quarantine of close contacts;

3. Fully educate the general public on the seriousness of COVID-19 and their role in preventing its spread;

4. Immediately expand surveillance to detect COVID-19 transmission chains, by testing all patients with atypical pneumonias, conducting screening in some patients with upper respiratory illnesses and/or recent COVID-19 exposure, and adding testing for the COVID-19 virus to existing surveillance systems (e.g. systems for influenza-like-illness and SARI); and

5. Conduct multi-sector scenario planning and simulations for the deployment of even more stringent measures to interrupt transmission chains as needed (e.g. the suspension of large-scale gatherings and the closure of schools and workplaces).

## For uninfected countries

1. Prepare to immediately activate the highest level of emergency response mechanisms to trigger the all-of-government and all-of society approach that is essential for early containment of a COVID-19 outbreak;

2. Rapidly test national preparedness plans in light of new knowledge on the effectiveness of non-pharmaceutical measures against COVID-19; incorporate rapid detection, largescale case isolation and respiratory support capacities, and rigorous contact tracing and management in national COVID-19 readiness and response plans and capacities;

3. Immediately enhance surveillance for COVID-19 as rapid detection is crucial to containing spread; consider testing all patients with atypical pneumonia for the COVID-19 virus, and adding testing for the virus to existing influenza surveillance systems;

4. Begin now to enforce rigorous application of infection prevention and control measures in all healthcare facilities, especially in emergency departments and outpatient clinics, as this is where COVID-19 will enter the health system; and

5. Rapidly assess the general population's understanding of COVID-19, adjust national health promotion materials and activities accordingly, and engage clinical champions to communicate with the media.

## For the public

1. Recognize that COVID-19 is a new and concerning disease, but that outbreaks can managed with the right response and that the vast majority of infected people will recover;

2. Begin now to adopt and rigorously practice the most important preventive measures for COVID-19 by frequent hand washing and always covering your mouth and nose when sneezing or coughing;

3. Continually update yourself on COVID-19 and its signs and symptoms (i.e. fever and dry cough), because the strategies and response activities will constantly improve as new information on this disease is accumulating every day; and

4. Be prepared to actively support a response to COVID-19 in a variety of ways, including the adoption of more stringent 'social distancing' practices and helping the high-risk elderly population.

## For the international community

1. Recognize that true solidarity and collaboration is essential between nations to tackle the common threat that COVID-19 represents and operationalize this principle;

2. Rapidly share information as required under the International Health Regulations (IHR) including detailed information about imported cases to facilitate contact tracing and inform containment measures that span countries;

3. Recognize the rapidly changing risk profile of COVID-19 affected countries and continually monitor outbreak trends and control capacities to reassess any 'additional health measures' that significantly interfere with international travel and trade.

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# Annexes

## A. WHO-China Joint Mission Members

| | |
|---|---|
| **Bruce AYLWARD** | Team Lead WHO-China Joint Mission on COVID-19, Senior Advisor to the Director-General, World Health Organization, Geneva, Switzerland |
| **Wannian LIANG** | Team Lead WHO-China Joint Mission on COVID-19, Head of Expert Panel, National Health Commission |
| **Xiaoping DONG** | Director and Researcher, Center for Global Public Health, Chinese Center for Disease Control and Prevention |
| **Tim ECKMANNS** | Head of Unit, Healthcare-associated Infections, Surveillance of Antibiotic Resistance and Consumption, Robert Koch Institute, Berlin, Germany |
| **Dale FISHER** | Professor of Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore |
| **Chikwe IHEKWEAZU** | Director General, Nigeria Centre for Disease Control, Nigeria Centre for Disease Control, Abuja, Nigeria |
| **Clifford LANE** | Clinical Director, National Institute of Allergy and Infectious Diseases, US National Institutes of Health, Bethesda, United States |
| **Jong-Koo LEE** | Professor of Family Medicine, Seoul National University College of Medicine, Seoul, Republic of Korea |
| **Gabriel LEUNG** | Dean of Medicine, Helen and Francis Zimmern Professor in Population Health, The University of Hong Kong, Hong Kong SAR, China |
| **Jiangtao LIN** | Director and Professor, Department of Pulmonary and Critical Care Medicine, China-Japan Friendship Hospital, National Clinical Research Center for Respiratory Diseases, Beijing |
| **Haiying LIU** | Deputy Director and Researcher, Institute of Pathogen Biology, Chinese Academy of Medical Sciences, Beijing China |
| **Natalia PSHENICHNAYA** | Head of International Department and Consultant, Center of Infectious Diseases, National Medical Research Center of Phthisiopulmonology and Infectious Diseases, Moscow, Russia |
| **Aleksandr SEMENOV** | Deputy Director, Saint Petersburg Pasteur Institute, Saint Petersburg, Russia |
| **Hitoshi TAKAHASHI** | Senior Research Scientist, Influenza Virus Research Center, National Institute of Infectious Diseases, Tokyo, Japan |
| **Maria VAN KERKHOVE** | Head of Unit, Emerging Diseases & Zoonoses, Global Infectious Hazard Preparedness, World Health Organization, Geneva, Switzerland |
| **Bin WANG** | Deputy Team Leader, Deputy Director General, Disease Prevention and Control Bureau, National Health Commission |
| **Guangfa WANG** | Director, Department of Respiratory and Critical Care Medicine, Peking University First Hospital |
| **Fan WU** | Vice Dean, Shanghai Medical College, Fudan University |
| **Zhongze WU** | Director, Compliance and Enforcement Division, Department of Wildlife Conservation, National Forestry and Grassland Administration |
| **Zunyou WU** | Chief Epidemiologist, Chinese Center for Disease Control and Prevention |
| **Jun XING** | Head of Unit, Country Capacity for International Health Regulations, Health Security Preparedness, World Health Organization, Geneva, Switzerland |
| **Kwok-Yung YUEN** | Chair Professor and Co-Director of State Key Laboratory of Emerging Infectious Diseases, Department of Microbiology, The University of Hong Kong |
| **Weigong ZHOU** | Medical Officer, Influenza Division, National Center for Immunization and Respiratory Diseases, US Centers for Disease Control and Prevention, Atlanta, United States |
| **Yong ZHANG** | Assistant Director and Researcher, National Institute for Viral Disease Control and prevention, Chinese Center for Disease Control and Prevention. |
| **Lei ZHOU** | Chief and Researcher, Branch for Emerging Infectious Disease, Public Health Emergency Center, Chinese Center for Disease Control and Prevention |

## B. Summary Agenda of the Mission

| Dates | Location | Activities |
|---|---|---|
| **10-15 February 2020 (Advance Team)** | Beijing | Advance Team and WHO Country team meetings with national counterparts and institutions |
| **16 February 2020** | Beijing | Meeting with the full international team for briefing at the WHO Country office |
| | Beijing | Workshop at the National Health Commission (NHC) with relevant departments of the Joint Prevention and Control Mechanism of the State Council |
| **17 February 2020** | Beijing | Site visit to Beijing Ditan Hospital |
| | Beijing | Site visit to Anhuali community and health service station, Anzhen street, Chaoyang District, Beijing |
| | Beijing | Workshop with Chinese Center for Disease Control and Prevention |
| **18 February 2020 (Guangdong Team)** | Shenzhen, Guangdong | Shenzhen customs at the airport |
| | Shenzhen, Guangdong | Shenzhen No.3 People's Hospital |
| | Shenzhen, Guangdong | Shenzhen Center for Disease Control and Prevention |
| | Shenzhen, Guangdong | Meeting at Tencent |
| **19 February 2020 (Guangdong Team)** | Shenzhen, Guangdong | Qiaoxiang community |
| | Shenzhen to Guangzhou | Visit to Futian High-speed Train Station, and travel to Guangzhou by train |
| | Guangzhou | Guangzhou Panyu Sanatorium |
| | Guangzhou | Guangdong Laboratory of Regenerative Medicine and Health |
| | Guangzhou | Guangzhou Tiyudongzhihui wet market |
| | Guangzhou | First Workshop with The People's government of Guangdong Province |
| **20 February 2020 (Guangdong Team)** | Guangzhou | Guangdong Provincial Center for Disease Control and Prevention |
| | Guangzhou | Renmin road campus of Guangzhou Women and Children Medical Center |
| | Guangzhou | The second Workshop with The People's government of Guangdong Province |
| **18 February 2020 (Sichuan Team)** | Beijing to Chengdu | |
| | Sichuan | Site visit to Chengdu Shuangliu International Airport |
| | | Meeting with the Governor of Sichuan Provincial People's Government |
| | | Site visit to Yong'an Township Central hospital with fever clinic |
| | | Site visit to home community of Yong'an township |
| **19 February 2020 (Sichuan Team)** | | Symposium with provincial and municipal authorities |
| | | Sichuan Center for Disease Control and Prevention |
| | | Site visit to West China Hospital- Designated COVID-19 hospital |
| **20 February 2020 (Sichuan Team)** | | Site visit to Chengdu Women and Children's hospital |
| | | Site visit to Pharmaceutical Logistics center |
| | | Site visit to East Chengdu railway station |

| | | |
|---|---|---|
| | | Site visit to Chengdu Public Health Clinical Centre- Designated COVID 19 hospital |
| **Sichuan and Guangdong teams reconvene in Guangzhou** | | |
| **21-24 February 2020** | | Analyze major findings; Meetings of the WHO-China Joint mission to finalize the report |
| **Feb 22 (Wuhan Team)** | Guangzhou to Wuhan | Select team members only |
| **23 February (Wuhan Team)** | | Site visit to Guanggu Campus of Wuhan Tongji Hospital |
| | | Site visit to Mobile Cabin Hospital in Wuhan Sports Center |
| | | Workshop with relevant departments of the Joint Prevention and Control Mechanism of Hubei Province |
| | | Feedback Meeting with Minister Ma, NHC at the Wuhan Conference Center |
| **24 February 2020** | Guangzhou to Beijing | Finalize report, WHO-Joint Press conference in Beijing |

## C. Detailed Technical Findings

### Response management, case and contact management, risk communication and community engagement

The response structures in China were rapidly put in place according to existing emergency plans and aligned from the top to the bottom. This was replicated at the four levels of government (national provincial, prefecture and county/district).

#### *Organizational structure and response mechanism*

**Response activation at the national level:** COVID-19 prevention and control mechanisms were initiated immediately after the outbreak was declared and nine working groups were set up to coordinate the response: a) Coordination b) Epidemic prevention and control c) Medical treatment d) Research e) Public communication f) Foreign affairs g) Medical material support h) Life maintenance supplies and i) Social stability. Each working group has a ministerial level leader. Emergency response laws and regulations for the emergency response to public health emergencies, prevention and control of infectious diseases have been developed or updated to guide the response.

**Response activation in provinces**: Each province set up a similar structure to manage the outbreak. The response is organized at the levels of national, provincial, prefecture, county/district and the community. By 29 January, all provinces across China had launched the highest level of response for major public health emergencies.

#### *Response Strategy*

A clear strategy was developed, and goals were well articulated and communicated across the entire response architecture. This strategy was rapidly adapted and adjusted to the outbreak, both in terms of the epidemiological situation over time and in different parts of the country.

The epidemiological situation has been used to define location into four areas:

- In areas without cases, the strategy in these areas is to "strictly prevent introduction". This includes quarantine arrangements in transportation hubs, monitoring for temperature changes, strengthening of triage arrangements, use of fever clinics, and ensuring normal economic and social operations.
- In areas with sporadic cases, the strategy is focused on "reducing importation, stopping transmission and providing appropriate treatment".
- In areas with community clusters, the strategy is focussed on "stopping transmission, preventing exportation, and strengthening treatment".
- In areas with community transmission, the strictest prevention and control strategies are being implemented, the entry and exit of people from these areas has been stopped and public health and medical treatment measures are comprehensively strengthened.

*Main control measures implemented in China*

The main control measures implemented in China are as follows and are illustrated in Figures 6A-6D, representing the national level response and examples of the response at the Provincial and municipal levels:

**Monitoring and reporting:** COVID-19 was included in the statutory reporting of infectious diseases on 20 January and plans were formulated to strengthen diagnosis, monitoring, and reporting.

**Strengthening ports of entry and quarantine:** The Customs Department launched the emergency plan for public health emergencies at ports across the country and restarted the health declaration card system for entry and exit into cities as well as strict monitoring of the temperature of entry and exit passengers.

**Treatment:** For severe or critical patients, the principle of "Four Concentrations" was implemented: i.e. concentrating patients, medical experts, resources and treatment into special centres. All cities and districts transformed relevant hospitals, increased the number of designated hospitals, dispatched medical staff, and set up expert groups for consultation, so as to minimise mortality of severe patients. Medical resources from all over China have been mobilized to support the medical treatment of patients in Wuhan.

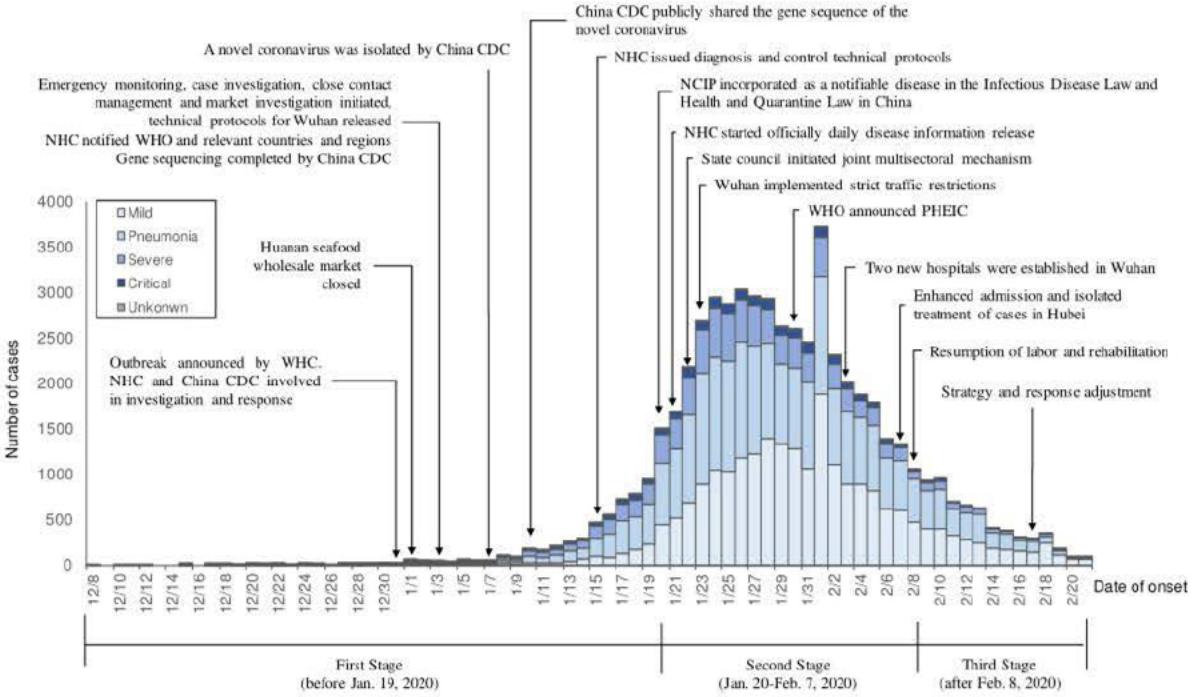
**Epidemiological investigation and close contact management:** Strong epidemiological investigations are being carried out for cases, clusters, and contacts to identify the source of infection and implement targeted control measures, such as contact tracing.

**Social distancing**: At the national level, the State Council extended the Spring Festival holiday in 2020, all parts of the country actively cancelled or suspended activities like sport events, cinema, theatre, and schools and colleges in all parts of the country postponed re-opening after the holiday. Enterprises and institutions have staggered their return to work. Transportation Departments setup thousands of health and quarantine stations in national service areas, and in entrances and exits for passengers at stations. Hubei Province adopted the most stringent traffic control measures, such as suspension of urban public transport, including subway, ferry and long-distance passenger transport. Every citizen has to wear a mask in public. Home support mechanisms were established. As a consequence of all of these measures, public life is very reduced.

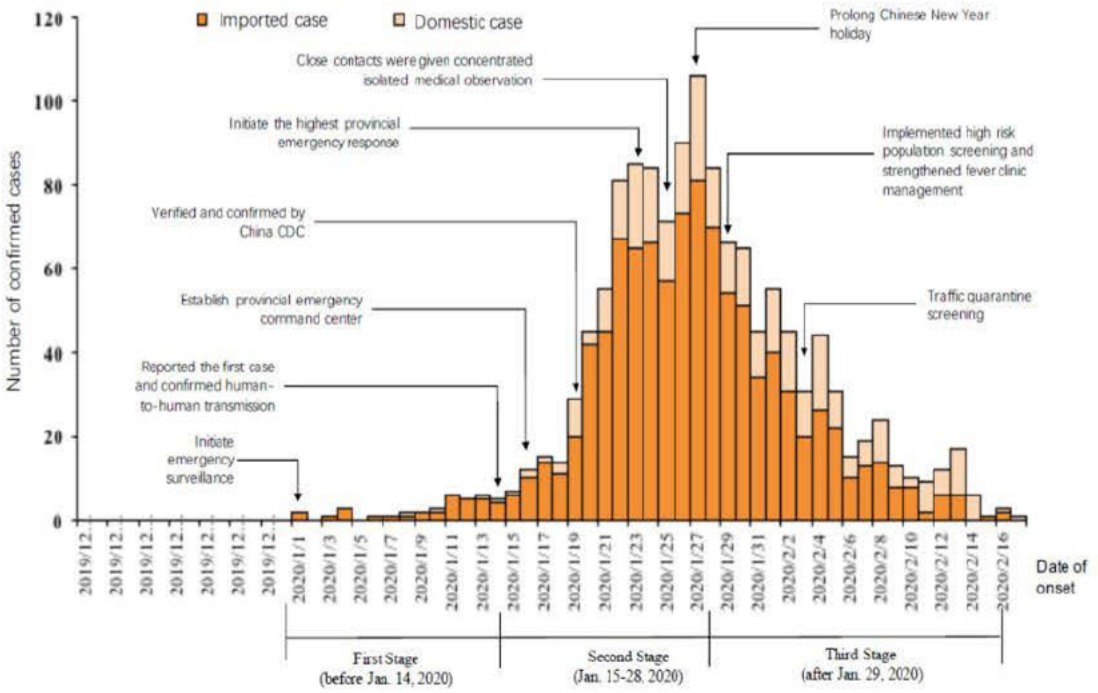
**Funding and material support:** Payment of health insurance was taken over by the state, as well as the work to improve accessibility and affordability of medical materials, provide personal protection materials, and ensure basic living materials for affected people.

**Emergency material support:** The government restored production and expanded production capacity, organized key enterprises that have already started to exceed current production capacity, supported local enterprises to expand imports, and used cross-border e-commerce platforms and enterprises to help import medical materials and improve the ability to guarantee supplies.

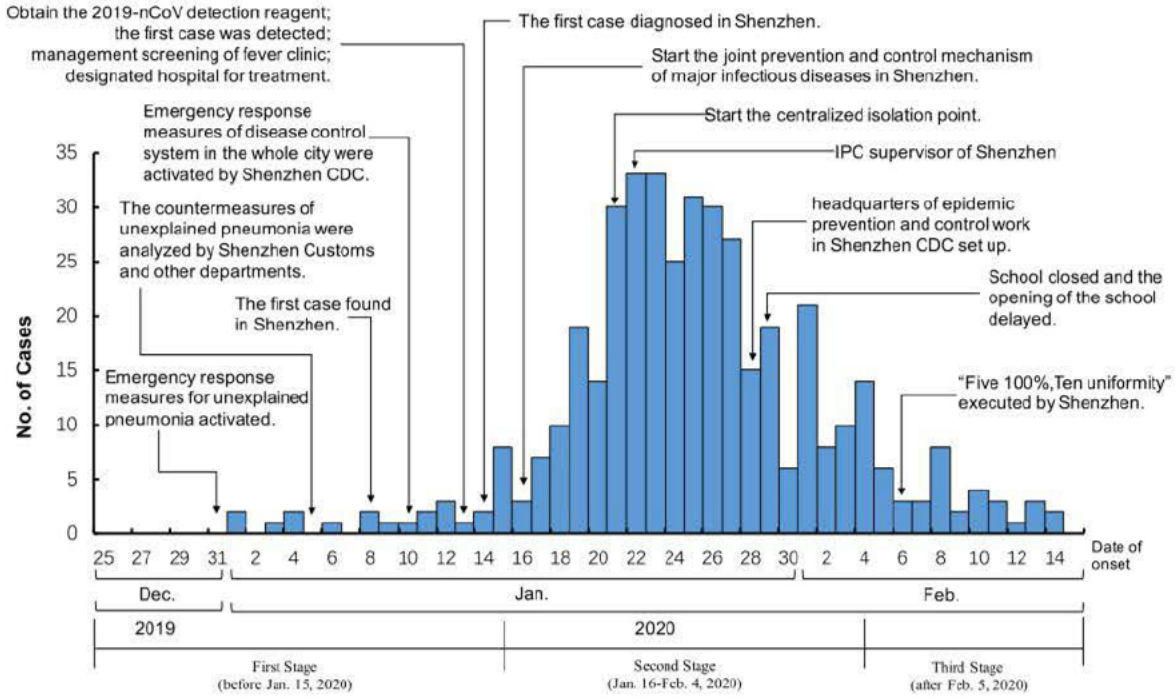
**A**


China CDC publicly shared the gene sequence of the novel coronavirus
A novel coronavirus was isolated by China CDC
NHC issued diagnosis and control technical protocols
Emergency monitoring, case investigation, close contact management and market investigation initiated, technical protocols for Wuhan released
NCIP incorporated as a notifiable disease in the Infectious Disease Law and Health and Quarantine Law in China
NHC notified WHO and relevant countries and regions
Gene sequencing completed by China CDC
NHC started officially daily disease information release
State council initiated joint multisectoral mechanism
Wuhan implemented strict traffic restrictions
WHO announced PHEIC
Mild
Pneumonia
Severe
Critical
Unkonwn
Huanan seafood wholesale market closed
Two new hospitals were established in Wuhan
Enhanced admission and isolated treatment of cases in Hubei
Resumption of labor and rehabilitation
Outbreak announced by WHC. NHC and China CDC involved in investigation and response
Strategy and response adjustment
Number of cases
Date of onset
First Stage (before Jan. 19, 2020)
Second Stage (Jan. 20-Feb. 7, 2020)
Third Stage (after Feb. 8, 2020)

**B**


Imported case
Domestic case
Prolong Chinese New Year holiday
Close contacts were given concentrated isolated medical observation
Initiate the highest provincial emergency response
Implemented high risk population screening and strengthened fever clinic management
Verified and confirmed by China CDC
Establish provincial emergency command center
Traffic quarantine screening
Reported the first case and confirmed human-to-human transmission
Initiate emergency surveillance
Number of confirmed cases
Date of onset
First Stage (before Jan. 14, 2020)
Second Stage (Jan. 15-28, 2020)
Third Stage (after Jan. 29, 2020)

**C**




**D**

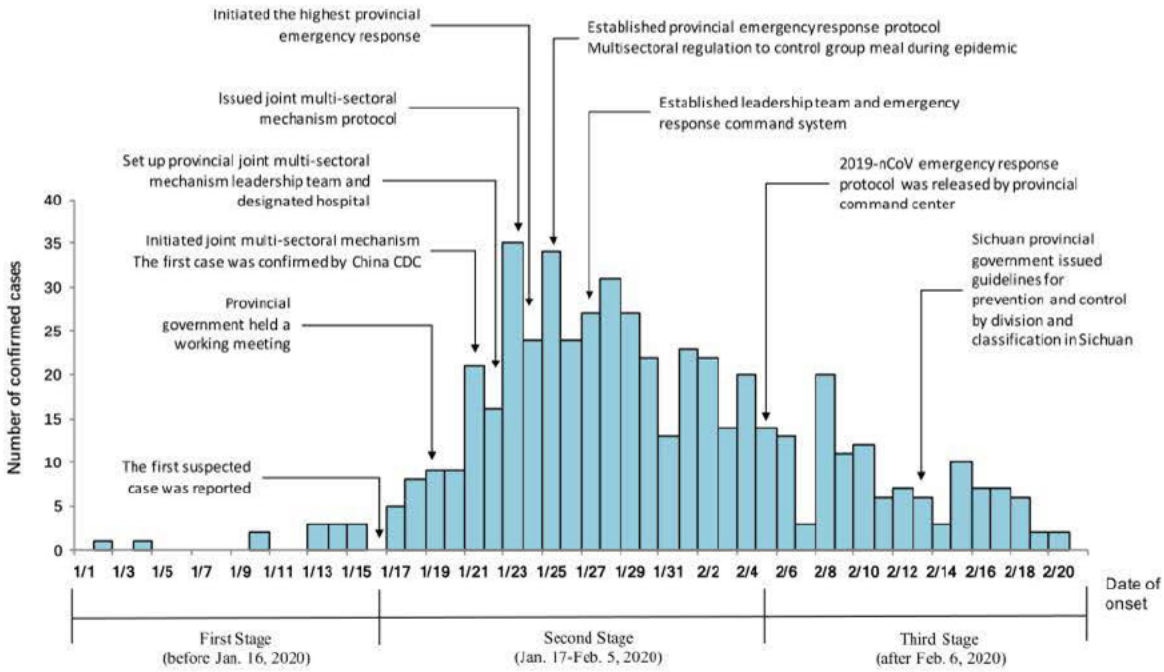



**Figure 6. COVID-19 epidemic curves and major intervention measures in China as implemented at a) the national level b) in Guangdong province, c) in Shenzhen municipality and d) in Sichuan province**

### *Risk communications (information release, public and media communications)*

**International and interregional cooperation and information sharing:** From 3 January 2020, information on COVID-19 cases has been reported to WHO daily. Full genome sequences of the new virus were shared with WHO and the international community immediately after the pathogen was identified on 7 January. From 13 to 14 January, a group of technical experts from Hong Kong SAR, Macao SAR and Taiwan, China visited Wuhan. From 20-21 January, a World Health Organization team visited Wuhan. A set of nucleic acid primers and probes for PCR detection for COVID-19 was released on 21 January.

**Daily updates:** The National Health Commission announces the epidemic situation every day and holds daily press conferences to respond to emerging issues. The government also frequently invites experts to share scientific knowledge on COVID-19 and to address public concerns.

**Psychological care:** This is provided to patients and the public. Governments at all levels, NGOs and all sectors of society developed guidelines for emergency psychological crisis intervention and guidelines for public psychological self-support and counselling. A hotline for mental health services has been established for the public.

**IT platform:** China has capitalized on the use of technology, big data and AI for COVID-19 preparedness, readiness and response. Authoritative and reliable information, medical guidance, access to online services, provision of educational tools and remote work tools have been developed in and used across China. These services have increased accessibility to health services, reduced misinformation and minimized the impact of fake news.

### *Social mobilization and community engagement*

Civil society organizations (community centers and public health centers) have been mobilized to support prevention and response activities. The community has largely accepted the prevention and control measures and is fully participating in the management of self-isolation and enhancement of public compliance. Community volunteers are organized to support self-isolation and help isolated residents at home to solve practical life difficulties. Measures were taken to limit the movement of the population through home-based support. Up to now, outside of Hubei, 30 provinces have registered and managed more than 5 million people coming from Wuhan.

## Clinical case management and infection prevention and control

The main **signs and symptoms** of COVID-19 include fever, dry cough, fatigue, sputum production, shortness of breath, myalgia or arthralgia, sore throat, and headache. Nausea or vomiting has been reported in a small percentage of patients (5%). On 14 February, China CDC described the clinical features, outcomes, laboratory and radiologic findings of 44 672 laboratory-confirmed cases. Only 965 (2.2%) were under 20 years of age and there is just one recorded death (0.1%) in this age group. Most patients (77.8%) were aged 30 to 69 years. Patients aged over 80 years had a CFR of 14.8%. The CFR was highest in those with

comorbidities including cardiovascular, diabetes, chronic respiratory disease, hypertension and cancer.

As opposed to Influenza A(H1N1)pdm09, **pregnant women** do not appear to be at higher risk of severe disease. In an investigation of 147 pregnant women (64 confirmed, 82 suspected and 1 asymptomatic), 8% had severe disease and 1% were critical.

**Severe cases** are defined as tachypnoea (≧30 breaths/ min) or oxygen saturation ≤93% at rest, or PaO2/FIO2 <300 mmHg. **Critical cases** are defined as respiratory failure requiring mechanical ventilation, shock or other organ failure that requires intensive care. About a quarter of severe and critical cases require mechanical ventilation while the remaining 75% require only oxygen supplementation.

China has a principle of **early identification**, early isolation, early diagnosis and early treatment. Early identification of suspect cases is critical to containment efforts and occurs via a process of temperature screening and questioning at entrances to many institutions, communities, travel venues (airports, train stations) and hospitals. Many hospitals have fever clinics that were established and maintained since the SARS outbreak. In China, laboratory tests were originally requested according to the case definitions, which included an epidemiological link to Hubei or other confirmed cases. However, more recently, a more **liberal clinical testing regimen** allows clinicians to test with a low index of suspicion.

**Suspect cases** are isolated in normal pressure single rooms, wear a surgical mask (for source control). Staff in China wear a cap, eye protection, n95 masks, gown and gloves (single use only). In Wuhan it is necessary for most suspects to be cohorted in a normal pressure isolation ward. Staff wear PPE continuously, changing it only when they leave the ward.

**PCR test results** are returned the same day. If positive, patients are transported to designated hospitals (including negative pressure ambulances in some cities). All patients, including the mild and asymptomatic, with a positive test are admitted. The designated hospitals are known and are strategically placed with at least one per district/county. Positive cases are cohorted by gender. Negative tested patients are managed based on clinical needs. All patients are evaluated with a respiratory multiplex to look for other diagnoses. This can add to the reassurance that a negative COVID-19 test reflects a lack of infection with COVID-19.

In Wuhan, there are 45 **designated hospitals**, 6 of which are designated for critical patients, and 39 for severe patients and/or any patients >65 years old. There are an additional 10 temporary hospitals reconstructed from gymnasium and exhibition centers, which are for mild patients. Other surge measures undertaken in Wuhan include two new temporary hospitals with 2600 beds, plus many makeshift hospitals to increase bed capacity. Bed capacity within Wuhan has increased to >50,000.

Patients are treated according to the **National Clinical guidelines** (edition 6) released by the China National Health Commission (NHC). There are no specific antiviral or immune modulating agents proven (or recommended) to improve outcomes. All patients are monitored by regular pulse oximetry. The guidelines include supportive care by clinical category (mild, moderate, severe and critical), as well as the role of investigational

treatments such as chloroquine, phosphate, lopinavir/ritonavir, alpha interferon, ribavirin, arbidol. The application of intubation/invasive ventilation and ECMO in critically ill patients can improve survival. The Joint Mission Team was told of ECMO use in four patients at one hospital with one death and three who appeared to be improving. Clearly, though ECMO is very resource consumptive, any health system would need to carefully weigh the benefits. There is widespread use of Traditional Chinese Medicines (TCM), for which the affects must be fully evaluated.

Patients with COVID-19 are not permitted **visitors**. Staff use coveralls, masks, eye cover, and gloves, removing PPE only when they leave the ward.

**Patients are discharged** after clinical recovery (afebrile >3 days, resolution of symptoms and radiologic improvement) and 2 negative PCR tests taken 24 hours apart. Upon discharge, they are asked to minimise family and social contact and to wear a mask. There are expectations of clinical trial results within a matter of weeks, which will see further opportunities for treatment.

There are guidelines for **elderly care** specifically targeting prevention in individuals and introduction of COVID-19 to nursing homes.

Training programmes by video conference nationally are scaled up to inform staff of best practice and to ensure PPE usage. **Clinical champions** are created to disperse knowledge and provide local expertise.

Maintenance of usual healthcare activities is maintained by hospital zoning (e.g. clean/contaminated sections of the healthcare facility).

## Laboratory, diagnostics and virology

The virus found to cause COVID-19 was initially isolated from a clinical sample on 7 January. It is notable that within weeks following the identification of the virus, a series of reliable and sensitive **diagnostic tools** were developed and deployed. On 16 January, the first RT-PCR assays for COVID-19 were distributed to Hubei. Real-time PCR kits were distributed to all the provinces on 19 January and were provided to Hong Kong SAR and Macao SAR on 21 January. Information regarding viral sequences and PCR primers and probes was shared with WHO and the international community by China CDC on 12 January 2020. To facilitate product development and research on the new virus, COVID-19 virus sequences were uploaded to the GISAID Database by China.

By 23 February, there were 10 kits for detection of COVID-19 approved in China by the NMPA, including 6 RT-PCR kits, 1 isothermal amplification kit, 1 virus sequencing product and 2 colloidal gold antibody detection kits. Several other tests are entered in the emergency approval procedure. Currently, there are at least 6 local producers of PCR test kits approved by NMPA. Overall, producers have the capacity to produce and distribute as many as 1,650,000 tests/week.

**Specimens** from both the upper respiratory tract (URT; nasopharyngeal and oropharyngeal) and lower respiratory tract (LRT; expectorated sputum, endotracheal aspirate, or bronchoalveolar lavage) are collected for COVID-19 testing by PCR.

COVID-19 virus has been detected in respiratory, fecal and blood specimens. According to preliminary data from Guangzhou CDC as of 20 February, virus can initially be detected in upper respiratory samples 1-2 days prior to symptom onset and persist for 7-12 days in moderate cases and up to 2 weeks in severe cases. Viral RNA has been detected in feces in up to 30% of patients from day 5 following onset of symptoms and has been noted for up to 4-5 weeks in moderate cases. However, it is not clear whether this correlates with the presence of infectious virus. While live virus has been cultured from stool in some cases, the role of fecal-oral transmission is not yet well understood. COVID-19 has been isolated from the clinical specimens using human airway epithelial cells, Vero E6 and Huh-7 cell lines.

**Serological diagnostics** are rapidly being developed but are not yet widely used. Joint Mission members met with local research teams at the China CDC, Guangzhou Regenerative Medicine and Health Guangdong Laboratory. The teams reported on the development of tests for IgM, IgG and IgM+IgG using rapid test platforms utilizing chemiluminiscence. ELISA assays are also under development.

## Research & Development

The government of China has initiated a series of major emergency research programs on virus genomics, antivirals, traditional Chinese medicines, clinical trials, vaccines, diagnostics and animal models. Research includes fundamental basic research and human subjects research. For the purpose of this report, human studies are limited to those involving IRB approval and informed consent. Other forms of human subjects investigations are included in the sections on epidemiology in this report. Well-focused, robust research conducted in the setting of an outbreak has the potential of saving many lives by identifying the most effective ways to prevent, diagnose and treat disease.

Since the COVID-19 virus has a genome identity of 96% to a bat SARS-like coronavirus and 86%-92% to a pangolin SARS-like coronavirus, an animal source for COVID-19 is highly likely. This was corroborated by the high number of RT-PCR positive environmental samples taken from the Huanan Seafood Market in Wuhan.

At least 8 **nucleic acid-based methods** for direct detection of COVID-19 and two colloidal gold antibody detection kits have been approved in China by the NMPA. Several other tests are close to approval. It will be important to compare the sensitivities and specificities of these and future serologic tests. Development of rapid and accurate **point-of-care tests** which perform well in field settings are especially useful if the test can be incorporated into presently commercially available multiplex respiratory virus panels. This would markedly improve early detection and isolation of infected patients and, by extension, identification of contacts. **Rapid IgM and IgG antibody testing** are also important ways to facilitate early diagnosis. Standard serologic testing can be used for retrospective diagnoses in the context of serosurveys that help better understand the full spectrum of COVID-19 infection.

A variety of **repurposed drugs and investigational drugs** have been identified. Screening NMPA approved drug libraries and other chemical libraries have identified novel agents. Hundreds of clinical trials involving remdesivir, chloroquine, favipiravir, chloroquine, convalescent plasma, TCM and other interventions are planned or underway. Rapid completion of the most important of these studies is critical to identifying truly effective therapies. However, evaluation of investigational agents requires adequately powered, randomized, controlled trials with realistic eligibility criteria and appropriate stratification of patients. It is important for there to be a degree of coordination between those conducting studies within and beyond China.

The development of a safe and effective **vaccine** for this highly communicable respiratory virus is an important epidemic control measure. Recombinant protein, mRNA, DNA, inactivated whole virus and recombinant adenovirus vaccines are being developed and some are now entering animal studies. Vaccine safety is of prime concern in the area of coronavirus infection in view of the past experience of disease enhancement by inactivated whole virus measles vaccine and similar reports in animal experiments with SARS coronavirus vaccines. It will be important that these vaccine candidates rapidly move into appropriate clinical trials.

The ideal **animal model** for studying routes of virus transmission, pathogenesis, antiviral therapy, vaccine and immune responses has yet to be found. The ACE2 transgenic mouse model and Macaca Rhesus model are already used in research laboratories. Systematically addressing which models can accurately mimic human infection is required.

There is a global rush for masks, hand hygiene products and other personal protective equipment. The relative importance of **non-pharmaceutical control measures** including masks, hand hygiene, and social distancing require further research to quantify their impact.

There are distinct patterns of intra-familial transmission of COVID-19. It is unclear whether or not there are host factors, including genetic factors, that influence susceptibility or disease course. COVID-19 has a varied clinical course and a precise description of that course is not available. In addition, the long-term consequences of COVID-19 are unknown. An observational cohort study of patients with COVID-19 enrolled from the time of diagnosis (with appropriate controls) could provide in-depth information about clinical, virologic and immunologic characteristics of COVID-19. Table 1 summarizes priority research areas with immediate to longer term goals.

**Table 1 Priority research areas with immediate, intermediate and longer-term goals**

| Immediate Goals | Intermediate Goals | Long-term goals |
|---|---|---|
| **Diagnostics:** RNA assays, antibody & antigen assays, point of care detection | Diagnostics: Multiplex diagnostic platforms | Diagnostics: Prognostic markers |
| **Therapeutics:** Remdesivir, favipiravir, chloroquine, plasma, TCM | Therapeutics: intravenous immunoglobulin (IVIg) | Therapeutics: Innovative approaches (CRISPR-CAS; RNAi; Cell-based; positive hits from library screening) |
| **Vaccines:** Development of animal models | Vaccines: mRNA candidates and candidate viral vectors | Vaccines: inactivated candidates and subunit candidates |

## D. Knowledge Gaps

Knowledge gaps and key questions to be answered to guide control strategies include:

### *Source of infection*

- Animal origin and natural reservoir of the virus
- Human-animal interface of the original event
- Early cases whose exposure could not be identified

### *The pathogenesis and virulence evolution of the virus*

### *Transmission dynamics*

- Modes of Transmission:
    - Role of aerosol transmission in non-health care settings
    - Role of fecal-oral transmission
- Viral shedding in various periods of the clinical course in different biological samples (i.e. upper and lower respiratory tract, saliva, faeces, urine)
    - Before symptom onset and among asymptomatic cases
    - During the symptomatic period
    - After the symptomatic period / during clinical recovery

### *Risk factors for infection*

- Behavioral and socio-economic risk factors for infection in
    - Households / institutions
    - the Community
- Risk factors for asymptomatic infection
- Risk factors for nosocomial infection
    - among health care workers
    - among patients

### *Surveillance and monitoring*

- Monitoring community transmission through existing
    - ILI surveillance
    - SARI surveillance
- The outbreak trend and intervention dynamics
    - Basic reproduction numbers in various stages of the epidemic
    - The epidemic's relation to seasonality

*Laboratory and diagnostics*

- Sensitivity and specificity of different nucleic acid (PCR, NAATs and rapid tests), antibody and antigen tests
- Post-infection antibody titers and the duration of protection
- Sero-prevalence among
    - Health care workers
    - General population
    - Children

*Clinical management of severe and critically ill patients*

- Value of ECMO in the management of critically ill patients
- Best practice using mechanical ventilation in the management of critically ill patients
- Re-evaluation of the role of steroids in the management of severe and critically ill patients
- Identification of factors associated with successful clinical management and outcome
- Determination of the effectiveness of Traditional Chinese Medicines (TCM)
- Determination the effectiveness of additional investigational treatment options (e.g. intravenous immunoglobulin/IVIg, convalescent plasma)

*Prevention and control measures*

- Key epidemic indicators that inform evidence-based control strategy decision making and adjustments
- Effectiveness of infection prevention and control (IPC) measures in various health care settings
- Effectiveness of entry and exit screening
- Effectiveness of the public health control measures and their socio-economic impact
    - Restriction of movement
    - Social distancing
    - School and workplace closures
    - Wearing mask in general public
    - Mandatory quarantine
    - Voluntary quarantine with active surveillance

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## E. Operational & Technical Recommendations

### Operational/programmatic recommendations

- Reassess risk and capacities based on different stages of the outbreak; approve different measures during the different phases of the response; assess different stages of the response; reach a balance between response and social development
- Initiate a timely scientific evidence based, efficient and flexible joint multi-sectoral mechanism, which is driven by strong government leadership

### Technical recommendations

#### *Epidemiology and transmission*

- Continue enhanced surveillance across the country through existing respiratory disease systems, including ILI, SARI or pneumonia surveillance systems
- Prioritize early investigations, including household transmission studies, age-stratified sero-epidemiologic surveys including children, case-control studies, cluster investigations, and serologic studies in health care workers

#### *Severity*

- Continue to share information on patient management, disease progression and factors leading to severe disease and favorable outcomes
- Review and analyze the possible factors associated with the disease severity, which may include:
    - natural history studies to better understand disease progression in mild, severe and fatal patients
    - medical chart reviews about disease severity among vulnerable groups, (e.g. those with underlying conditions, older age groups, pregnant women and children) to develop appropriate standards of care
    - evaluation of factors leading to favorable outcomes (e.g. early identification and care)

#### *Clinical care and infection prevention and control*

- Suspect patients who have not yet been tested should be isolated in single normal pressure rooms; cohorting of positive cases is acceptable
- Physicians and all health care workers need to maintain a high level of clinical alert for COVID-19
- For affected countries, standardize training for clinical care and IPC and scale with the development of local (e.g. district level) experts
- Ensure concurrent testing for other viral pathogens to support a negative COVID-19 test
- Ensure maintenance of usual and essential services during the outbreak

- Ensure processes are in place for infection prevention among the most vulnerable, including the elderly
- Ensure readiness to provide clinical care and to meet IPC needs, including:
    a. anticipated respiratory support requirements (e.g. pulse oximeters, oxygen, and invasive support where appropriate)
    b. national guidelines for clinical care and IPC, revised for COVID-19
    c. nationally standardised trainings for disease understanding and PPE use for HCWs
    d. community engagement
    e. PPE and Medication stockpiles
    f. early identification protocols; triage, temperature screening, holding bays (triage, including pulse oximetry)
    g. treatment protocols including designated facilities, patient transportation
    h. enhanced uptake of influenza and pneumococcal vaccine according to national guidelines
    i. laboratory testing
    j. rapid response teams

*Laboratory and virology*

- Continue to perform whole genome analysis of COVID-19 viruses isolated from different times and places, to evaluate virus evolution
- Conduct pathogenesis studies using biopsy/post-mortem specimens of COVID-19 patients or infected animal models
- Evaluate available nucleic acid PCR diagnostics
- Rapidly develop and evaluate rapid/point-of-care diagnostics and serologic assays
- Conduct further study to interpret the result of positive COVID-19 RNA detection in feces in patients recovering from COVID-19
- Enhance international cooperation, especially in terms of biosafety and information sharing for increased understanding of the COVID-19 virus and traceability of the virus
- Consider monitoring proinflammatory cytokines via multiplex assays to predict the development of "cytokine storm"

*Research and development*

- Additional effort should be made to find the animal source, including the natural reservoir and any intermediate amplification host, to prevent any new epidemic foci or resurgence of similar epidemics

- Efforts should be made to consistently evaluate existing and future diagnostic tests for detection of COVID-19 using a harmonized set of standards for laboratory tests and a biorepository that can be used for evaluating these tests
- Consider the establishment of a centralized research program in China to oversee that portfolio and ensure the most promising research (vaccines, treatments, pathogenesis) are adequately supported and studied first; program staff dedicated to the clinical research would work at the clinical research site(s) to decrease the research workload of the clinicians at the site
- Consider including one or more sites within China in the ongoing and future multi-center, international trials; Chinese investigators should be actively engaged in international trials
- Continue to develop additional animal models, making every effort to ensure these mimic human infection and virus transmission as closely as possible
- Conduct studies to determine which of the commonly used forms of PPE are most effective in controlling the spread of COVID-19

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| **Date:** | 2020/03/08 19:55:08 |
| **Priority:** | Normal |
| **Type:** | Note |

Team:

This is interesting. (b) (5)

Thanks,

Tony

Paper attached.

Dalton, Craig and Corbett, Stephen and Katelaris, Anthea, Pre-Emptive Low Cost Social Distancing and Enhanced Hygiene Implemented before Local COVID-19 Transmission Could Decrease the Number and Severity of Cases. (March 5, 2020). Available at SSRN: https://ssrn.com/abstract=3549276 or http://dx.doi.org/10.2139/ssrn.3549276

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**Date:** February 28, 2020 at 6:32:40 AM EST
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# Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)

16-24 February 2020

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# I. The Mission

## Goal and Objectives

The overall goal of the Joint Mission was to rapidly inform national (China) and international planning on next steps in the response to the ongoing outbreak of the novel coronavirus disease (COVID-19[1]) and on next steps in readiness and preparedness for geographic areas not yet affected.

The major objectives of the Joint Mission were as follows:

- To enhance understanding of the evolving COVID-19 outbreak in China and the nature and impact of ongoing containment measures;
- To share knowledge on COVID-19 response and preparedness measures being implemented in countries affected by or at risk of importations of COVID-19;
- To generate recommendations for adjusting COVID-19 containment and response measures in China and internationally; and
- To establish priorities for a collaborative programme of work, research and development to address critical gaps in knowledge and response and readiness tools and activities.

## Members & Method of Work

The Joint Mission consisted of 25 national and international experts from China, Germany, Japan, Korea, Nigeria, Russia, Singapore, the United States of America and the World Health Organization (WHO). The Joint Mission was headed by Dr Bruce Aylward of WHO and Dr Wannian Liang of the People's Republic of China. The full list of members and their affiliations is available in Annex A. The Joint Mission was implemented over a 9-day period from 16-24 February 2020. The schedule of work is available in Annex B.

The Joint Mission began with a detailed workshop with representatives of all of the principal ministries that are leading and/or contributing to the response in China through the National Prevention and Control Task Force. A series of in-depth meetings were then conducted with national level institutions responsible for the management, implementation and evaluation of the response, particularly the National Health Commission and the China Centers for Disease Control and Prevention (China CDC). To gain first-hand knowledge on the field level implementation and impact of the national and local response strategy, under a range of epidemiologic and provincial contexts, visits were conducted to Beijing Municipality and the provinces of Sichuan (Chengdu), Guangdong (Guangzhou, Shenzhen) and Hubei (Wuhan). The field visits included community centers and health clinics, country/district hospitals, COVID-19 designated hospitals, transportations hubs (air, rail, road), a wet market, pharmaceutical and personal protective equipment (PPE) stocks warehouses, research institutions, provincial health commissions, and local Centers for

[1] In the Chinese version of this report, COVID-19 is referred to throughout as novel coronavirus pneumonia or NCP, the term by which COVID-19 is most widely known in the People's Republic of China.

Disease Control (provincial and prefecture). During these visits, the team had detailed discussion and consultations with Provincial Governors, municipal Mayors, their emergency operations teams, senior scientists, frontline clinical, public health and community workers, and community neighbourhood administrators. The Joint Mission concluded with working sessions to consolidate findings, generate conclusions and propose suggested actions.

To achieve its goal, the Joint Mission gave particular focus to addressing key questions related to the natural history and severity of COVID-19, the transmission dynamics of the COVID-19 virus in different settings, and the impact of ongoing response measures in areas of high (community level), moderate (clusters) and low (sporadic cases or no cases) transmission.

The findings in this report are based on the Joint Mission's review of national and local governmental reports, discussions on control and prevention measures with national and local experts and response teams, and observations made and insights gained during site visits. The figures have been produced using information and data collected during site visits and with the agreement of the relevant groups. References are available for any information in this report that has already been published in journals.

The final report of the Joint Mission was submitted on 28 February 2020.

# II. Major findings

The major findings are described in six sections: the virus, the outbreak, transmission dynamics, disease progression and severity, the China response and knowledge gaps. More detailed descriptions of technical findings are provided in Annex C.

## The virus

On 30 December 2019, three bronchoalveolar lavage samples were collected from a patient with pneumonia of unknown etiology – a surveillance definition established following the SARS outbreak of 2002-2003 – in Wuhan Jinyintan Hospital. Real-time PCR (RT-PCR) assays on these samples were positive for pan-Betacoronavirus. Using Illumina and nanopore sequencing, the whole genome sequences of the virus were acquired. Bioinformatic analyses indicated that the virus had features typical of the coronavirus family and belonged to the Betacoronavirus 2B lineage. Alignment of the full-length genome sequence of the COVID-19 virus and other available genomes of Betacoronavirus showed the closest relationship was with the bat SARS-like coronavirus strain BatCov RaTG13, identity 96%.

Virus isolation was conducted with various cell lines, such as human airway epithelial cells, Vero E6, and Huh-7. Cytopathic effects (CPE) were observed 96 hours after inoculation. Typical crown-like particles were observed under transmission electron microscope (TEM) with negative staining. The cellular infectivity of the isolated viruses could be completely neutralized by the sera collected from convalescent patients. Transgenic human ACE2 mice and Rhesus monkey intranasally challenged by this virus isolate induced multifocal pneumonia with interstitial hyperplasia. The COVID-19 virus was subsequently detected and isolated in the lung and intestinal tissues of the challenged animals.

Whole genome sequencing analysis of 104 strains of the COVID-19 virus isolated from patients in different localities with symptom onset between the end of December 2019 and mid-February 2020 showed 99.9% homology, without significant mutation (Figure 1).

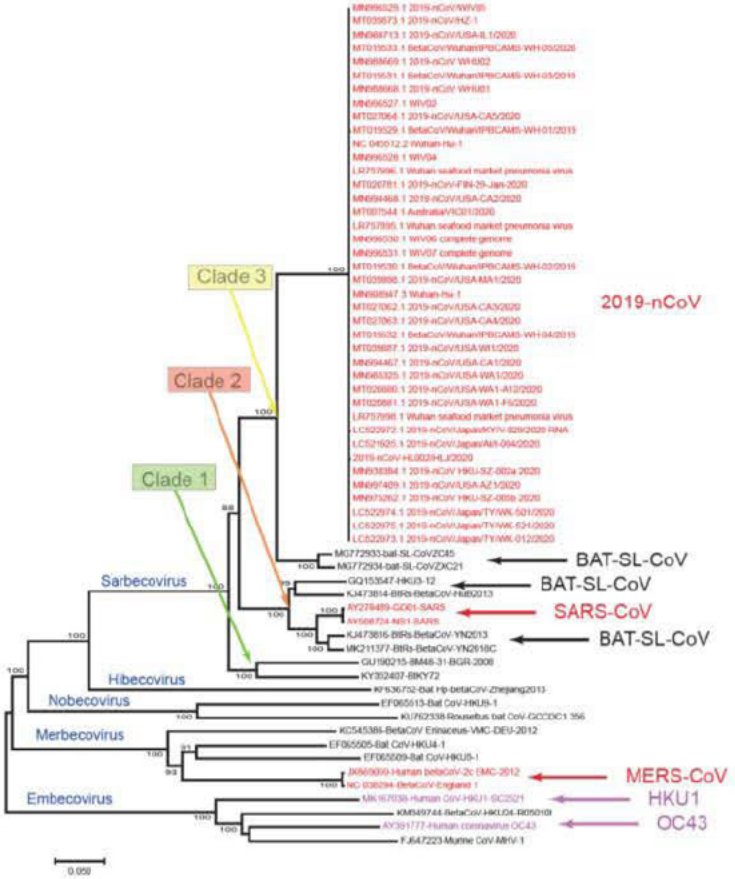


**Figure 1. Phylogenetic analysis of the COVID-19 virus and its closely related reference genomes**

Note: COVID-19 virus is referred to as 2019-nCoV in the figure, the interim virus name WHO announced early in the outbreak.

Post-mortem samples from a 50-year old male patient from Wuhan were taken from the lung, liver, and heart. Histological examination showed bilateral diffuse alveolar damage with cellular fibromyxoid exudates. The lung showed evident desquamation of pneumocytes and hyaline membrane formation, indicating acute respiratory distress syndrome (ARDS). Lung tissue also displayed cellular and fibromyxoid exudation, desquamation of pneumocytes and pulmonary oedema. Interstitial mononuclear inflammatory infiltrates, dominated by lymphocytes, were seen in both lungs. Multinucleated syncytial cells with atypical enlarged pneumocytes characterized by large nuclei, amphophilic granular cytoplasm, and prominent nucleoli were identified in the intra-alveolar spaces, showing viral cytopathic-like changes. No obvious intranuclear or intracytoplasmic viral inclusions were identified.

## The outbreak

As of 20 February 2020, a cumulative total of 75,465 COVID-19 cases were reported in China. Reported cases are based on the National Reporting System (NRS) between the

National and Provincial Health Commissions. The NRS issues daily reports of newly recorded confirmed cases, deaths, suspected cases, and contacts. A daily report is provided by each province at 0300hr in which they report cases from the previous day.

The epidemic curves presented in Figures 2 and 3 are generated using China's National Infectious Disease Information System (IDIS), which requires each COVID-19 case to be reported electronically by the responsible doctor as soon as a case has been diagnosed. It includes cases that are reported as asymptomatic and data are updated in real time. Individual case reporting forms are downloaded after 2400hr daily. Epidemiologic curves for Wuhan, Hubei (outside of Wuhan), China (outside Hubei) and China by symptom onset are provided in Figure 2.

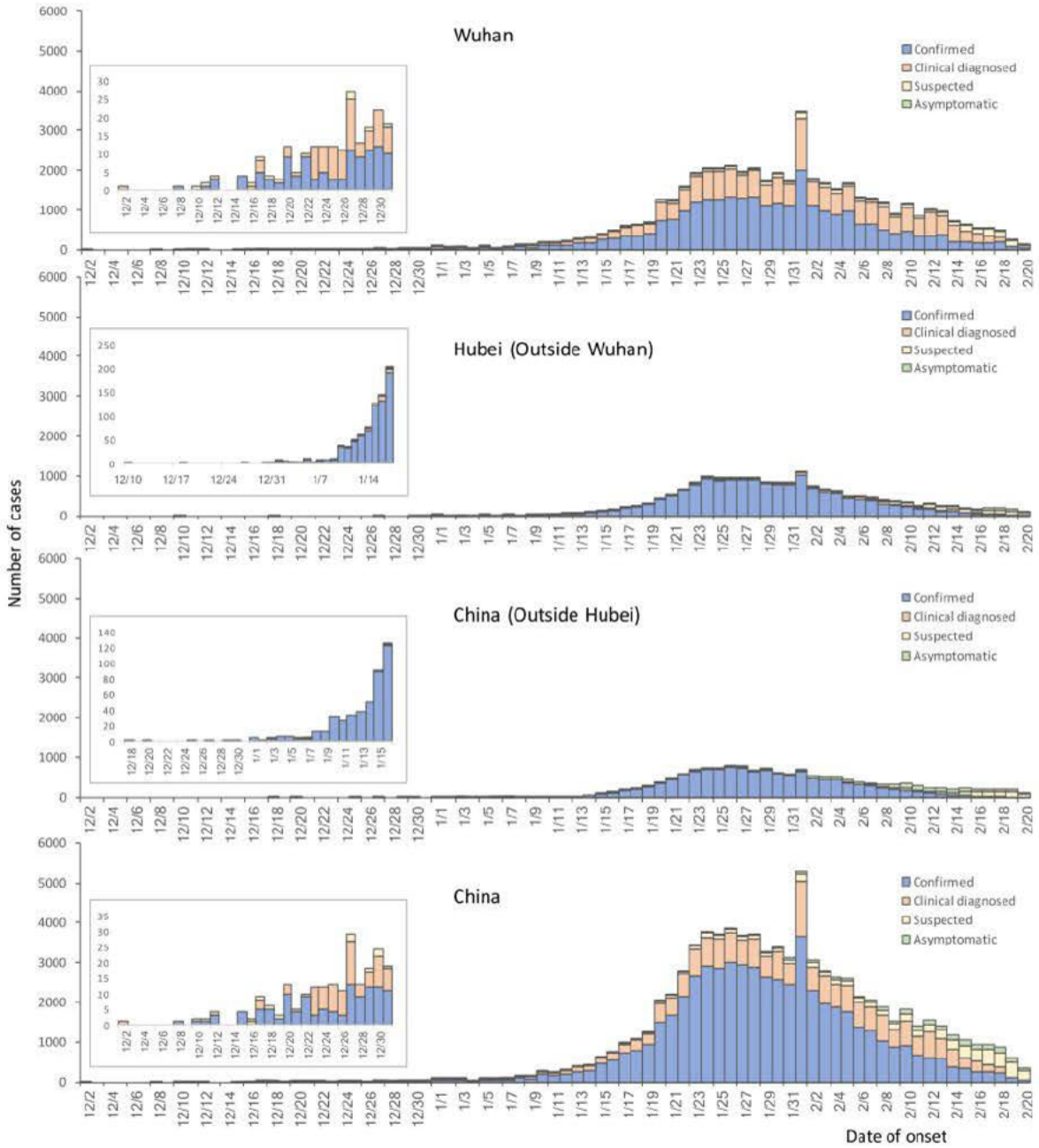


**Figure 2 Epidemiologic curve of COVID-19 laboratory confirmed cases, by date of onset of illness, reported in China, as of 20 February 2020**

Figure 3 presents epidemic curves of laboratory-confirmed cases, by symptom onset and separately by date of report, at 5, 12, and 20 February 2020. Figures 2 and 3 illustrate that the epidemic rapidly grew from 10-22 January, reported cases peaked and plateaued between 23 January and 27 January, and have been steadily declining since then, apart from the spike that was reported on 1 February (note: at a major hospital in Wuhan, fever clinic patients fell from a peak of 500/day in late January to average 50/day since mid-February).

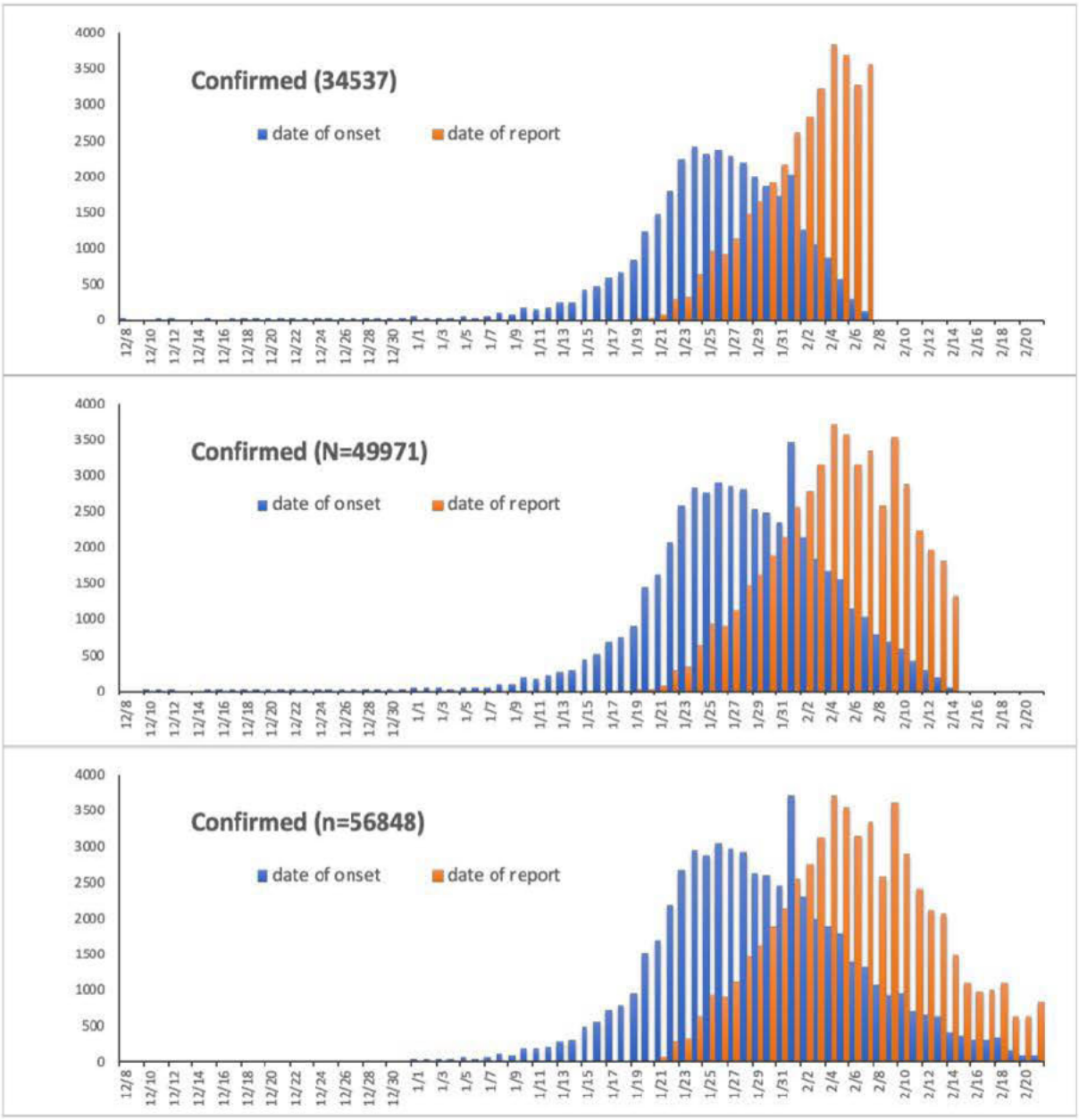


**Figure 3. Epidemic curves by symptom onset and date of report as of 5 February (top panel), 12 February (middle panel) and 20 February 2020 (lower panel) for laboratory confirmed COVID-19 cases for all of China**

Based on these epidemic curves, the published literature, and our on-site visits in Wuhan (Hubei), Guangdong (Shenzhen and Guangzhou), Sichuan (Chengdu), and Beijing, the Joint Mission team has made the following epidemiological observations:

### *Demographic characteristics*

Among 55,924 laboratory confirmed cases reported as of 20 February 2020, the median age is 51 years (range 2 days-100 years old; IQR 39-63 years old) with the majority of cases (77.8%) aged between 30–69 years. Among reported cases, 51.1% are male, 77.0% are from Hubei and 21.6% are farmers or laborers by occupation.

### *Zoonotic origins*

COVID-19 is a zoonotic virus. From phylogenetics analyses undertaken with available full genome sequences, bats appear to be the reservoir of COVID-19 virus, but the intermediate host(s) has not yet been identified. However, three important areas of work are already underway in China to inform our understanding of the zoonotic origin of this outbreak. These include early investigations of cases with symptom onset in Wuhan throughout December 2019, environmental sampling from the Huanan Wholesale Seafood Market and other area markets, and the collection of detailed records on the source and type of wildlife species sold at the Huanan market and the destination of those animals after the market was closed.

### *Routes of transmission*

COVID-19 is transmitted via droplets and fomites during close unprotected contact between an infector and infectee. Airborne spread has not been reported for COVID-19 and it is not believed to be a major driver of transmission based on available evidence; however, it can be envisaged if certain aerosol-generating procedures are conducted in health care facilities. Fecal shedding has been demonstrated from some patients, and viable virus has been identified in a limited number of case reports. However, the fecal-oral route does not appear to be a driver of COVID-19 transmission; its role and significance for COVID-19 remains to be determined. Viral shedding is discussed in the Technical Findings (Annex C).

### *Household transmission*

In China, human-to-human transmission of the COVID-19 virus is largely occurring in families. The Joint Mission received detailed information from the investigation of clusters and some household transmission studies, which are ongoing in a number of Provinces. Among 344 clusters involving 1308 cases (out of a total 1836 cases reported) in Guangdong Province and Sichuan Province, most clusters (78%-85%) have occurred in families. Household transmission studies are currently underway, but preliminary studies ongoing in Guangdong estimate the secondary attack rate in households ranges from 3-10%.

### *Contact Tracing*

China has a policy of meticulous case and contact identification for COVID-19. For example, in Wuhan more than 1800 teams of epidemiologists, with a minimum of 5 people/team, are tracing tens of thousands of contacts a day. Contact follow up is painstaking, with a high percentage of identified close contacts completing medical observation. Between 1% and 5% of contacts were subsequently laboratory confirmed cases of COVID-19, depending on location. For example:

- As of 17 February, in Shenzhen City, among 2842 identified close contacts, 2842 (100%) were traced and 2240 (72%) have completed medical observation. Among the close contacts, 88 (2.8%) were found to be infected with COVID-19.

- As of 17 February, in Sichuan Province, among 25493 identified close contacts, 25347 (99%) were traced and 23178 (91%) have completed medical observation. Among the close contacts, 0.9% were found to be infected with COVID-19.
- As of 20 February, in Guangdong Province, among 9939 identified close contacts, 9939 (100%) were traced and 7765 (78%) have completed medical observation. Among the close contacts, 479 (4.8%) were found to be infected with COVID-19.

### *Testing at fever clinics and from routine ILI/SARI surveillance*

The Joint Mission systematically enquired about testing for COVID-19 from routine respiratory disease surveillance systems to explore if COVID-19 is circulating more broadly and undetected in the community in China. These systems could include RT-PCR testing of COVID-19 virus in influenza-like-illness (ILI) and severe acute respiratory infection (SARI) surveillance systems, as well as testing of results among all visitors to fever clinics.

In Wuhan, COVID-19 testing of ILI samples (20 per week) in November and December 2019 and in the first two weeks of January 2020 found no positive results in the 2019 samples, 1 adult positive in the first week of January, and 3 adults positive in the second week of January; all children tested were negative for COVID-19 although a number were positive for influenza. In Guangdong, from 1-14 January, only 1 of more than 15000 ILI/SARI samples tested positive for the COVID-19 virus. In one hospital in Beijing, there were no COVID-19 positive samples among 1910 collected from 28 January 2019 to 13 February 2020. In a hospital in Shenzhen, 0/40 ILI samples were positive for COVID-19.

Within the fever clinics in Guangdong, the percentage of samples that tested positive for the COVID-19 virus has decreased over time from a peak of 0.47% positive on 30 January to 0.02% on 16 February. Overall in Guangdong, 0.14% of approximately 320,000 fever clinic screenings were positive for COVID-19.

### *Susceptibility*

As COVID-19 is a newly identified pathogen, there is no known pre-existing immunity in humans. Based on the epidemiologic characteristics observed so far in China, everyone is assumed to be susceptible, although there may be risk factors increasing susceptibility to infection. This requires further study, as well as to know whether there is neutralising immunity after infection.

## The transmission dynamics

Inferring from Figures 2 and 3, and based on our observations at the national and provincial/municipal levels during the Joint Mission, we summarize and interpret the transmission dynamics of COVID-19 thus far. It is important to note that transmission dynamics of any outbreak are inherently contextual. For COVID-19, we observe four major types of transmission dynamics during the epidemic growth phase and in the post-control period, and highlight what is known about transmission in children, as follows:

### *Transmission in Wuhan*

Early cases identified in Wuhan are believed to be have acquired infection from a zoonotic source as many reported visiting or working in the Huanan Wholesale Seafood Market. As of 25 February, an animal source has not yet been identified.

At some point early in the outbreak, some cases generated human-to-human transmission chains that seeded the subsequent community outbreak prior to the implementation of the comprehensive control measures that were rolled out in Wuhan. The dynamics likely approximated mass action and radiated from Wuhan to other parts of Hubei province and China, which explains a relatively high $R_0$ of 2-2.5.

The *cordon sanitaire* around Wuhan and neighboring municipalities imposed since 23 January 2020 has effectively prevented further exportation of infected individuals to the rest of the country.

### *Transmission in Hubei, other than Wuhan*

In the prefectures immediately adjoining Wuhan (Xiaogan, Huanggang, Jingzhou and Ezhou), transmission is less intense. For other prefectures, due to fewer transport links and human mobility flows with Wuhan, the dynamics are more closely aligned with those observed in the other areas of the country. Within Hubei, the implementation of control measures (including social distancing) has reduced the community force of infection, resulting in the progressively lower incident reported case counts.

### *Transmission in China outside of Hubei*

Given Wuhan's transport hub status and population movement during the Chinese New Year (chunyun), infected individuals quickly spread throughout the country, and were particularly concentrated in cities with the highest volume of traffic with Wuhan. Some of these imported seeds generated limited human-to-human transmission chains at their destination.

Given the Wuhan/Hubei experience, a comprehensive set of interventions, including aggressive case and contact identification, isolation and management and extreme social distancing, have been implemented to interrupt the chains of transmission nationwide. To date, most of the recorded cases were imported from or had direct links to Wuhan/Hubei. Community transmission has been very limited. Most locally generated cases have been clustered, the majority of which have occurred in households, as summarized above.

Of note, the highly clustered nature of local transmission may explain a relatively high $R_0$ (2-2.5) in the absence of interventions and low confirmed case counts with intense quarantine and social distancing measures.

### *Special settings*

We note that instances of transmission have occurred within health care settings prisons and other closed settings. At the present time, it is not clear what role these settings and groups play in transmission. However, they do not appear to be major drivers of the overall epidemic dynamics. Specifically, we note:

(a) **Transmission in health care settings and among health care workers (HCW)** – The Joint Mission discussed nosocomial infection in all locations visited during the Mission. As of 20 February 2020, there were 2,055 COVID-19 laboratory-confirmed cases reported among HCW from 476 hospitals across China. The majority of HCW cases (88%) were reported from Hubei.

Remarkably, more than 40,000 HCW have been deployed from other areas of China to support the response in Wuhan. Notwithstanding discrete and limited instances of nosocomial outbreaks (e.g. a nosocomial outbreak involving 15 HCW in Wuhan), transmission within health care settings and amongst health care workers does not appear to be a major transmission feature of COVID-19 in China. The Joint Mission learned that, among the HCW infections, most were identified early in the outbreak in Wuhan when supplies and experience with the new disease was lower. Additionally, investigations among HCW suggest that many may have been infected within the household rather than in a health care setting. Outside of Hubei, health care worker infections have been less frequent (i.e. 246 of the total 2055 HCW cases). When exposure was investigated in these limited cases, the exposure for most was reported to have been traced back to a confirmed case in a household.

The Joint Team noted that attention to the prevention of infection in health care workers is of paramount importance in China. Surveillance among health care workers identified factors early in the outbreak that placed HCW at higher risk of infection, and this information has been used to modify policies to improve protection of HCW.

(b) **Transmission in closed settings** – There have been reports of COVID-19 transmission in prisons (Hubei, Shandong, and Zhejiang, China), hospitals (as above) and in a long-term living facility. The close proximity and contact among people in these settings and the potential for environmental contamination are important factors, which could amplify transmission. Transmission in these settings warrants further study.

### *Children*

Data on individuals aged 18 years old and under suggest that there is a relatively low attack rate in this age group (2.4% of all reported cases). Within Wuhan, among testing of ILI samples, no children were positive in November and December of 2019 and in the first two weeks of January 2020. From available data, and in the absence of results from serologic studies, it is not possible to determine the extent of infection among children, what role children play in transmission, whether children are less susceptible or if they present differently clinically (i.e. generally milder presentations). The Joint Mission learned that infected children have largely been identified through contact tracing in households of adults. Of note, people interviewed by the Joint Mission Team could not recall episodes in which transmission occurred from a child to an adult.

## The signs, symptoms, disease progression and severity

Symptoms of COVID-19 are non-specific and the disease presentation can range from no symptoms (asymptomatic) to severe pneumonia and death. As of 20 February 2020 and

based on 55924 laboratory confirmed cases, typical **signs and symptoms** include: fever (87.9%), dry cough (67.7%), fatigue (38.1%), sputum production (33.4%), shortness of breath (18.6%), sore throat (13.9%), headache (13.6%), myalgia or arthralgia (14.8%), chills (11.4%), nausea or vomiting (5.0%), nasal congestion (4.8%), diarrhea (3.7%), and hemoptysis (0.9%), and conjunctival congestion (0.8%).

People with COVID-19 generally develop signs and symptoms, including mild respiratory symptoms and fever, on an average of 5-6 days after infection (mean incubation period 5-6 days, range 1-14 days).

Most people infected with COVID-19 virus have mild disease and recover. Approximately 80% of laboratory confirmed patients have had **mild to moderate disease**, which includes non-pneumonia and pneumonia cases, 13.8% have **severe disease** (dyspnea, respiratory frequency ≥30/minute, blood oxygen saturation ≤93%, PaO2/FiO2 ratio <300, and/or lung infiltrates >50% of the lung field within 24-48 hours) and 6.1% are **critical** (respiratory failure, septic shock, and/or multiple organ dysfunction/failure). **Asymptomatic infection** has been reported, but the majority of the relatively rare cases who are asymptomatic on the date of identification/report went on to develop disease. The proportion of truly asymptomatic infections is unclear but appears to be relatively rare and does not appear to be a major driver of transmission.

Individuals at **highest risk** for severe disease and death include people aged over 60 years and those with underlying conditions such as hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer. Disease in **children** appears to be relatively rare and mild with approximately 2.4% of the total reported cases reported amongst individuals aged under 19 years. A very small proportion of those aged under 19 years have developed severe (2.5%) or critical disease (0.2%).

As of 20 February, 2114 of the 55,924 laboratory confirmed cases have died (**crude fatality ratio** [CFR[2]] 3.8%) (note: at least some of whom were identified using a case definition that included pulmonary disease). The overall CFR varies by location and intensity of transmission (i.e. 5.8% in Wuhan vs. 0.7% in other areas in China). In China, the overall CFR was higher in the early stages of the outbreak (17.3% for cases with symptom onset from 1-10 January) and has reduced over time to 0.7% for patients with symptom onset after 1 February (Figure 4). The Joint Mission noted that the standard of care has evolved over the course of the outbreak.

Mortality increases with age, with the highest mortality among people over 80 years of age (CFR 21.9%). The CFR is higher among males compared to females (4.7% vs. 2.8%). By occupation, patients who reported being retirees had the highest CFR at 8.9%. While patients who reported no comorbid conditions had a CFR of 1.4%, patients with comorbid conditions had much higher rates: 13.2% for those with cardiovascular disease, 9.2% for diabetes, 8.4% for hypertension, 8.0% for chronic respiratory disease, and 7.6% for cancer.

[2] The Joint Mission acknowledges the known challenges and biases of reporting crude CFR early in an epidemic.

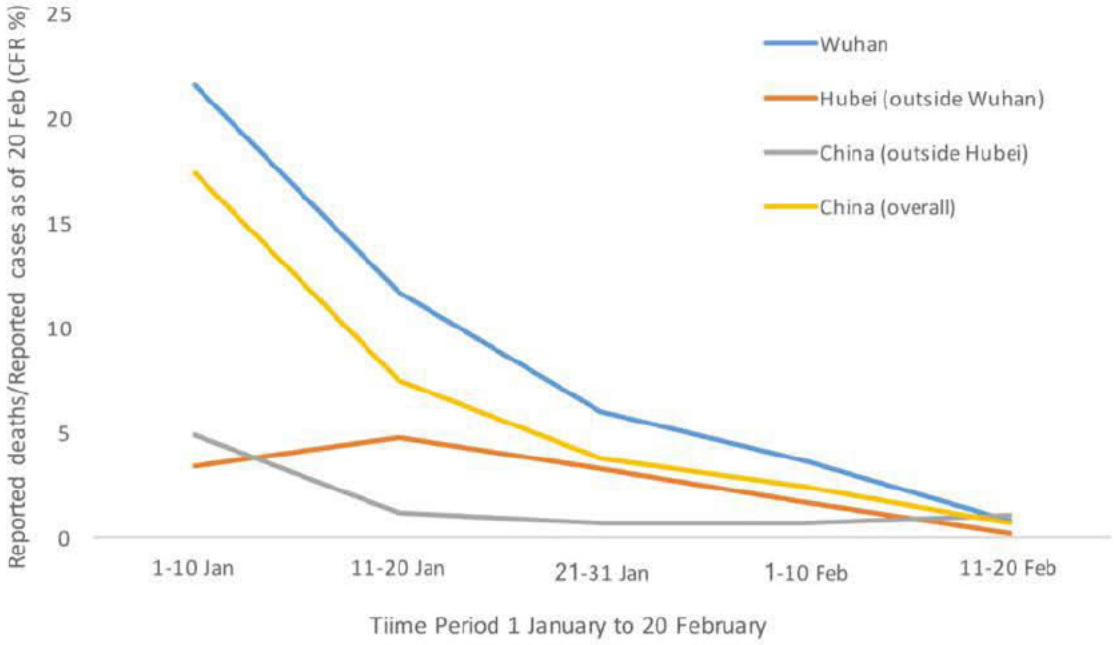


**Figure 4 Case fatality ratio (reported deaths among total cases) for COVID-19 in China over time and by location, as of 20 February 2020**

Data on the **progression of disease** is available from a limited number of reported hospitalized cases (Figure 5). Based on available information, the median time from symptom onset to laboratory confirmation nationally decreased from 12 days (range 8-18 days) in early January to 3 days (1-7) by early February 2020, and in Wuhan from 15 days (10-21) to 5 days (3-9), respectively. This has allowed for earlier case and contact identification, isolation and treatment.

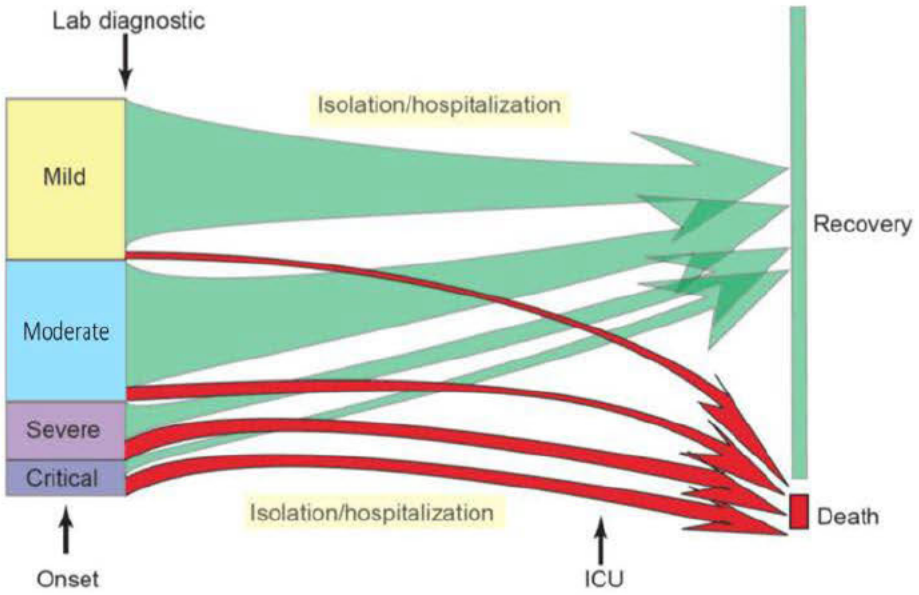


**Figure 5. Pattern of disease progression for COVID-19 in China**

Note: the relative size of the boxes for disease severity and outcome reflect the proportion of cases reported as of 20 February 2020. The size of the arrows indicates the proportion of cases who recovered or died. Disease definitions are described above. Moderate cases have a mild form of pneumonia.

Using available preliminary data, the median time from onset to clinical recovery for mild cases is approximately 2 weeks and is 3-6 weeks for patients with severe or critical disease. Preliminary data suggests that the time period from onset to the development of severe disease, including hypoxia, is 1 week. Among patients who have died, the time from symptom onset to outcome ranges from 2-8 weeks.

An increasing number of patients have **recovered**; as of 20 February, 18264 (24%) reported cases have recovered. Encouragingly, a report on 20 February from the Guangdong CDC suggests that of 125 severe cases identified in Guangdong, 33 (26.4%) have recovered and been released from hospital, and 58 (46.4%) had improved and were reclassified as having mild/moderate disease (i.e. + milder pneumonia). Among severe cases reported to date, 13.4% have died. Early identification of cases and contacts allows for earlier treatment.

## The China response

Upon the detection of a cluster of pneumonia cases of unknown etiology in Wuhan, the CPC Central Committee and the State Council launched the national emergency response. A **Central Leadership Group for Epidemic Response** and the **Joint Prevention and Control Mechanism** of the State Council were established. General Secretary Xi Jinping personally directed and deployed the prevention and control work and requested that the prevention and control of the COVID-19 outbreak be the top priority of government at all levels. Prime Minister Li Keqiang headed the Central Leading Group for Epidemic Response and went to Wuhan to inspect and coordinate the prevention and control work of relevant departments and provinces (autonomous regions and municipalities) across the country. Vice Premier Sun Chunlan, who has been working on the frontlines in Wuhan, has led and coordinated the frontline prevention and control of the outbreak.

The prevention and control measures have been implemented rapidly, from the early stages in Wuhan and other key areas of Hubei, to the current overall national epidemic. It has been undertaken in **three main phases**, with two important events defining those phases. First, COVID-19 was included in the statutory report of Class B infectious diseases and border health quarantine infectious diseases on 20 January 2020, which marked the transition from the initial partial control approach to the comprehensive adoption of various control measures in accordance with the law. The second event was the State Council's issuing, on 8 February 2020, of The Notice on Orderly Resuming Production and Resuming Production in Enterprises, which indicated that China's national epidemic control work had entered a stage of overall epidemic prevention and control together with the restoration of normal social and economic operations.

### *The first stage*

During the early stage of the outbreak, the main strategy focused on preventing the exportation of cases from Wuhan and other priority areas of Hubei Province, and preventing the importation of cases by other provinces; the overall aim was to control the source of infection, block transmission and prevent further spread. The response mechanism was initiated with multi-sectoral involvement in joint prevention and control measures. Wet markets were closed, and efforts were made to identify the zoonotic source. Information on the epidemic was notified to WHO on 3 January, and whole genome sequences of the COVID-19 virus were shared with WHO on 10 January. Protocols for COVID-19 diagnosis and

treatment, surveillance, epidemiological investigation, management of close contacts, and laboratory testing were formulated, and relevant surveillance activities and epidemiological investigations conducted. Diagnostic testing kits were developed, and wildlife and live poultry markets were placed under strict supervision and control measures.

### *The second stage*

During the second stage of the outbreak, the main strategy was to reduce the intensity of the epidemic and to slow down the increase in cases. In Wuhan and other priority areas of Hubei Province, the focus was on actively treating patients, reducing deaths, and preventing exportations. In other provinces, the focus was on preventing importations, curbing the spread of the disease and implementing joint prevention and control measures. Nationally, wildlife markets were closed and wildlife captive-breeding facilities were cordoned off. On 20 January, COVID-19 was included in the notifiable report of Class B infectious diseases and border health quarantine infectious diseases, with temperature checks, health care declarations, and quarantine against COVID-19 instituted at transportation depots in accordance with the law. On 23 January, Wuhan implemented strict traffic restrictions. The protocols for diagnosis, treatment and epidemic prevention and control were improved; case isolation and treatment were strengthened.

Measures were taken to ensure that all cases were treated, and close contacts were isolated and put under medical observation. Other measures implemented included the extension of the Spring Festival holiday, traffic controls, and the control of transportation capacity to reduce the movement of people; mass gathering activities were also cancelled. Information about the epidemic and prevention and control measures was regularly released. Public risk communications and health education were strengthened; allocation of medical supplies was coordinated, new hospitals were built, reserve beds were used and relevant premises were repurposed to ensure that all cases could be treated; efforts were made to maintain a stable supply of commodities and their prices to ensure the smooth operation of society.

### *The third stage*

The third stage of the outbreak focused on reducing clusters of cases, thoroughly controlling the epidemic, and striking a balance between epidemic prevention and control, sustainable economic and social development, the unified command, standardized guidance, and scientific evidence-based policy implementation. For Wuhan and other priority areas of Hubei Province, the focus was on patient treatment and the interruption of transmission, with an emphasis on concrete steps to fully implement relevant measures for the testing, admitting and treating of all patients. A risk-based prevention and control approach was adopted with differentiated prevention and control measures for different regions of the country and provinces. Relevant measures were strengthened in the areas of epidemiological investigation, case management and epidemic prevention in high-risk public places.

New technologies were applied such as the use of big data and artificial intelligence (AI) to strengthen contact tracing and the management of priority populations. Relevant health insurance policies were promulgated on "health insurance payment, off-site settlement, and financial compensation". All provinces provided support to Wuhan and priority areas in Hubei Province in an effort to quickly curb the spread of the disease and provide timely clinical treatment. Pre-school preparation was improved, and work resumed in phases and

batches. Health and welfare services were provided to returning workers in a targeted and 'one-stop' manner. Normal social operations are being restored in a stepwise fashion; knowledge about disease prevention is being popularized to improve public health literacy and skills; and a comprehensive program of emergency scientific research is being carried out to develop diagnostics, therapeutics and vaccines, delineate the spectrum of the disease, and identify the source of the virus.

### Knowledge gaps

Since the start of the COVID-19 outbreak, there have been extensive attempts to better understand the virus and the disease in China. It is remarkable how much knowledge about a new virus has been gained in such a short time. However, as with all new diseases, and only 7 weeks after this outbreak began, key knowledge gaps remain. Annex D summarizes the key unknowns in a number of areas including the source of infection, pathogenesis and virulence of the virus, transmissibility, risk factors for infection and disease progression, surveillance, diagnostics, clinical management of severe and critically ill patients, and the effectiveness of prevention and control measures. The timely filling of these knowledge gaps is imperative to enhance control strategies.

## III. Assessment

The Joint Mission drew four major conclusions from its work in China and four major conclusions from its knowledge of the broader global response to COVID-19. Recommendations are offered in five major areas to inform the ongoing response globally and in China.

### The China Response & Next Steps

1. **In the face of a previously unknown virus, China has rolled out perhaps the most ambitious, agile and aggressive disease containment effort in history. The strategy that underpinned this containment effort was initially a national approach that promoted universal temperature monitoring, masking, and hand washing. However, as the outbreak evolved, and knowledge was gained, a science and risk-based approach was taken to tailor implementation. Specific containment measures were adjusted to the provincial, county and even community context, the capacity of the setting, and the nature of novel coronavirus transmission there.**

   While the fundamental principles of this strategy have been consistent since its launch, there has been constant refinement of specific aspects to incorporate new knowledge on the novel coronavirus, the COVID-19 disease, and COVID-19 containment, as rapidly as that knowledge has emerged. The remarkable speed with which Chinese scientists and public health experts isolated the causative virus, established diagnostic tools, and determined key transmission parameters, such as the route of spread and incubation period, provided the vital evidence base for China's strategy, gaining invaluable time for the response.

As striking, has been the uncompromising rigor of strategy application that proved to be a hallmark in every setting and context where it was examined. There has also been a relentless focus on improving key performance indicators, for example constantly enhancing the speed of case detection, isolation and early treatment. The implementation of these containment measures has been supported and enabled by the innovative and aggressive use of cutting edge technologies, from shifting to online medical platforms for routine care and schooling, to the use of 5G platforms to support rural response operations.

2. **Achieving China's exceptional coverage with and adherence to these containment measures has only been possible due to the deep commitment of the Chinese people to collective action in the face of this common threat. At a community level this is reflected in the remarkable solidarity of provinces and cities in support of the most vulnerable populations and communities. Despite ongoing outbreaks in their own areas, Governors and Mayors have continued to send thousands of health care workers and tons of vital PPE supplies into Hubei province and Wuhan city.**

   At the individual level, the Chinese people have reacted to this outbreak with courage and conviction. They have accepted and adhered to the starkest of containment measures – whether the suspension of public gatherings, the month-long 'stay at home' advisories or prohibitions on travel. Throughout an intensive 9-days of site visits across China, in frank discussions from the level of local community mobilizers and frontline health care providers to top scientists, Governors and Mayors, the Joint Mission was struck by the sincerity and dedication that each brings to this COVID-19 response.

3. **China's bold approach to contain the rapid spread of this new respiratory pathogen has changed the course of a rapidly escalating and deadly epidemic. A particularly compelling statistic is that on the first day of the advance team's work there were 2478 newly confirmed cases of COVID-19 reported in China. Two weeks later, on the final day of this Mission, China reported 409 newly confirmed cases. This decline in COVID-19 cases across China is real.**

   Several sources of data support this conclusion, including the steep decline in fever clinic visits, the opening up of treatment beds as cured patients are discharged, and the challenges to recruiting new patients for clinical trials. Based on a comparison of crude attack rates across provinces, the Joint Mission estimates that this truly all-of-Government and all-of-society approach that has been taken in China has averted or at least delayed hundreds of thousands of COVID-19 cases in the country. By extension, the reduction that has been achieved in the force of COVID-19 infection in China has also played a significant role in protecting the global community and creating a stronger first line of defense against international spread. Containing this outbreak, however, has come at great cost and sacrifice by China and its people, in both human and material terms.

   While the scale and impact of China's COVID-19 operation has been remarkable, it has also highlighted areas for improvement in public health emergency response capacity.

These include overcoming any obstacles to act immediately on early alerts, to massively scale-up capacity for isolation and care, to optimize the protection of frontline health care workers in all settings, to enhance collaborative action on priority gaps in knowledge and tools, and to more clearly communicate key data and developments internationally.

4. **China is already, and rightfully, working to bolster its economy, reopen its schools and return to a more normal semblance of its society, even as it works to contain the remaining chains of COVID-19 transmission. Appropriately, a science-based, risk-informed and phased approach is being taken, with a clear recognition and readiness of the need to immediately react to any new COVID-19 cases or clusters as key elements of the containment strategy are lifted.**

   Despite the declining case numbers, across China every province, city and community visited is urgently escalating their investments in acute care beds and public health capacity. It is crucial that this continues. Fifty thousand infected COVID-19 patient are still under treatment, across the country. However, the Joint Mission has come to understand the substantial knowledge, experience and capacities that China has rapidly built during this crisis. Consequently, it endorses China's working assumption that in most provinces and municipalities it should soon be possible to manage a resurgence in COVID-19 cases, using even more tailored and sustainable approaches that are anchored in very rapid case detection, instant activation of key containment activities, direct oversight by top leadership, and broad community engagement.

   As China works to resume a more normal level of societal and economic activity, it is essential that the world recognizes and reacts positively to the rapidly changing, and decreasing, risk of COVID-19 in the country. China's rapid return to full connectivity with the world, and to full productivity and economic output, is vital to China and to the world. The world urgently needs access to China's experience in responding to COVID-19, as well as the material goods it brings to the global response. It is even more urgent now, with escalating COVID-19 outbreaks outside of China, to constantly reassess any restrictions on travel and/or trade to China that go beyond the recommendations of the IHR Emergency Committee on COVID-19.

## The Global Response & Next Steps

1. **The COVID-19 virus is a new pathogen that is highly contagious, can spread quickly, and must be considered capable of causing enormous health, economic and societal impacts in any setting. It is not SARS and it is not influenza. Building scenarios and strategies only on the basis of well-known pathogens risks failing to exploit all possible measures to slow transmission of the COVID-19 virus, reduce disease and save lives.**

   COVID-19 is not SARS and it is not influenza. It is a new virus with its own characteristics. For example, COVID-19 transmission in children appears to be limited compared with influenza, while the clinical picture differs from SARS. Such differences, while based on limited data, may be playing a role in the apparent efficacy of rigorously

applied non-pharmaceutical, public health measures to interrupt chains of human-to-human transmission in a range of settings in China. The COVID-19 virus is unique among human coronaviruses in its combination of high transmissibility, substantial fatal outcomes in some high-risk groups, and ability to cause huge societal and economic disruption. For planning purposes, it must be assumed that the global population is susceptible to this virus. As the animal origin of the COVID-19 virus is unknown at present, the risk of reintroduction into previously infected areas must be constantly considered.

The novel nature, and our continuously evolving understanding, of this coronavirus demands a tremendous agility in our capacity to rapidly adapt and change our readiness and response planning as has been done continually in China. This is an extraordinary feat for a country of 1.4 billion people.

2. **China's uncompromising and rigorous use of non-pharmaceutical measures to contain transmission of the COVID-19 virus in multiple settings provides vital lessons for the global response. This rather unique and unprecedented public health response in China reversed the escalating cases in both Hubei, where there has been widespread community transmission, and in the importation provinces, where family clusters appear to have driven the outbreak.**

   Although the timing of the outbreak in China has been relatively similar across the country, transmission chains were established in a wide diversity of settings, from mega-cities in the north and south of the country, to remote communities. However, the rapid adaptation and tailoring of China's strategy demonstrated that containment can be adapted and successfully operationalized in a wide range of settings.

   China's experience strongly supports the efficacy and effectiveness of anchoring COVID-19 readiness and rapid response plans in a thorough assessment of local risks and of utilizing a differentiated risk-based containment strategy to manage the outbreak in areas with no cases vs. sporadic cases vs. clusters of cases vs. community-level transmission. Such a strategy is essential for ensuring a sustainable approach while minimizing the socio-economic impact.

3. **Much of the global community is not yet ready, in mindset and materially, to implement the measures that have been employed to contain COVID-19 in China. These are the only measures that are currently proven to interrupt or minimize transmission chains in humans. Fundamental to these measures is extremely proactive surveillance to immediately detect cases, very rapid diagnosis and immediate case isolation, rigorous tracking and quarantine of close contacts, and an exceptionally high degree of population understanding and acceptance of these measures.**

   Achieving the high quality of implementation needed to be successful with such measures requires an unusual and unprecedented speed of decision-making by top leaders, operational thoroughness by public health systems, and engagement of society.

Given the damage that can be caused by uncontrolled, community-level transmission of this virus, such an approach is warranted to save lives and to gain the weeks and months needed for the testing of therapeutics and vaccine development. Furthermore, as the majority of new cases outside of China are currently occurring in high and middle-income countries, a rigorous commitment to slowing transmission in such settings with non-pharmaceutical measures is vital to achieving a second line of defense to protect low income countries that have weaker health systems and coping capacities.

The time that can be gained through the full application of these measures – even if just days or weeks – can be invaluable in ultimately reducing COVID-19 illness and deaths. This is apparent in the huge increase in knowledge, approaches and even tools that has taken place in just the 7 weeks since this virus was discovered through the rapid scientific work that has been done in China.

4. **The time gained by rigorously applying COVID-19 containment measures must be used more effectively to urgently enhance global readiness and rapidly develop the specific tools that are needed to ultimately stop this virus.**

   COVID-19 is spreading with astonishing speed; COVID-19 outbreaks in any setting have very serious consequences; and there is now strong evidence that non-pharmaceutical interventions can reduce and even interrupt transmission. Concerningly, global and national preparedness planning is often ambivalent about such interventions. However, to reduce COVID-19 illness and death, near-term readiness planning must embrace the large-scale implementation of high-quality, non-pharmaceutical public health measures. These measures must fully incorporate immediate case detection and isolation, rigorous close contact tracing and monitoring/quarantine, and direct population/community engagement.

   A huge array of COVID-19 studies, scientific research projects and product R&D efforts are ongoing in China and globally. This is essential and to be encouraged and supported. However, such a large number of projects and products needs to be prioritized. Without prioritizing, this risks compromising the concentration of attention and resources and collaboration required to cut timelines by precious weeks and months. While progress has been made, the urgency of the COVID-19 situation supports an even more ruthless prioritization of research in the areas of diagnostics, therapeutics and vaccines.

   Similarly, there is a long list of proposed studies on the origins of COVID-19, the natural history of the disease, and the virus's transmission dynamics. However, the urgency of responding to cases and saving lives makes it difficult for policy makers to consider and act on such comprehensive lists. This can be addressed by balancing studies with the immediate public health and clinical needs of the response. Studies can be prioritized in terms of the largest knowledge gaps that can be most rapidly addressed to have greatest immediate impact on response operations and patient management. This suggests prioritizing studies to identify risk factors for transmission in households, institutions and the community; convenience sampling for this virus in the population using existing surveillance systems; age-stratified sero-epidemiologic surveys; the analysis of clinical case series; and cluster investigations.

# IV. Major Recommendations

## For China

1. Maintain an appropriate level of emergency management protocols, depending on the assessed risk in each area and recognizing the real risk of new cases and clusters of COVID-19 as economic activity resumes, movement restrictions are lifted, and schools reopen;

2. Carefully monitor the phased lifting of the current restrictions on movement and public gatherings, beginning with the return of workers and migrant labor, followed by the eventual reopening of schools and lifting other measures;

3. Further strengthen the readiness of emergency management mechanisms, public health institutions (e.g. CDCs), medical facilities, and community engagement mechanisms to ensure sustained capacity to immediately launch containment activities in response to any resurgence in cases;

4. Prioritize research that rapidly informs response and risk management decisions, particularly household and health care facility studies, age-stratified sero-epidemiologic surveys and rigorous investigation of the animal-human interface; establish a centralized research program to fast-track the most promising rapid diagnostics and serologic assays, the testing of potential antivirals and vaccine candidates, and Chinese engagement in selected multi-country trials; and

5. As the country with the greatest knowledge on COVID-19, further enhance the systematic and real-time sharing of epidemiologic data, clinical results and experience to inform the global response.

## For countries with imported cases and/or outbreaks of COVID-19

1. Immediately activate the highest level of national Response Management protocols to ensure the all-of-government and all-of-society approach needed to contain COVID-19 with non-pharmaceutical public health measures;

2. Prioritize active, exhaustive case finding and immediate testing and isolation, painstaking contact tracing and rigorous quarantine of close contacts;

3. Fully educate the general public on the seriousness of COVID-19 and their role in preventing its spread;

4. Immediately expand surveillance to detect COVID-19 transmission chains, by testing all patients with atypical pneumonias, conducting screening in some patients with upper respiratory illnesses and/or recent COVID-19 exposure, and adding testing for the COVID-19 virus to existing surveillance systems (e.g. systems for influenza-like-illness and SARI); and

5. Conduct multi-sector scenario planning and simulations for the deployment of even more stringent measures to interrupt transmission chains as needed (e.g. the suspension of large-scale gatherings and the closure of schools and workplaces).

## For uninfected countries

1. Prepare to immediately activate the highest level of emergency response mechanisms to trigger the all-of-government and all-of society approach that is essential for early containment of a COVID-19 outbreak;

2. Rapidly test national preparedness plans in light of new knowledge on the effectiveness of non-pharmaceutical measures against COVID-19; incorporate rapid detection, largescale case isolation and respiratory support capacities, and rigorous contact tracing and management in national COVID-19 readiness and response plans and capacities;

3. Immediately enhance surveillance for COVID-19 as rapid detection is crucial to containing spread; consider testing all patients with atypical pneumonia for the COVID-19 virus, and adding testing for the virus to existing influenza surveillance systems;

4. Begin now to enforce rigorous application of infection prevention and control measures in all healthcare facilities, especially in emergency departments and outpatient clinics, as this is where COVID-19 will enter the health system; and

5. Rapidly assess the general population's understanding of COVID-19, adjust national health promotion materials and activities accordingly, and engage clinical champions to communicate with the media.

## For the public

1. Recognize that COVID-19 is a new and concerning disease, but that outbreaks can managed with the right response and that the vast majority of infected people will recover;

2. Begin now to adopt and rigorously practice the most important preventive measures for COVID-19 by frequent hand washing and always covering your mouth and nose when sneezing or coughing;

3. Continually update yourself on COVID-19 and its signs and symptoms (i.e. fever and dry cough), because the strategies and response activities will constantly improve as new information on this disease is accumulating every day; and

4. Be prepared to actively support a response to COVID-19 in a variety of ways, including the adoption of more stringent 'social distancing' practices and helping the high-risk elderly population.

## For the international community

1. Recognize that true solidarity and collaboration is essential between nations to tackle the common threat that COVID-19 represents and operationalize this principle;

2. Rapidly share information as required under the International Health Regulations (IHR) including detailed information about imported cases to facilitate contact tracing and inform containment measures that span countries;

3. Recognize the rapidly changing risk profile of COVID-19 affected countries and continually monitor outbreak trends and control capacities to reassess any 'additional health measures' that significantly interfere with international travel and trade.

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# Annexes

## A. WHO-China Joint Mission Members

| | |
|---|---|
| **Bruce AYLWARD** | Team Lead WHO-China Joint Mission on COVID-19, Senior Advisor to the Director-General, World Health Organization, Geneva, Switzerland |
| **Wannian LIANG** | Team Lead WHO-China Joint Mission on COVID-19, Head of Expert Panel, National Health Commission |
| **Xiaoping DONG** | Director and Researcher, Center for Global Public Health, Chinese Center for Disease Control and Prevention |
| **Tim ECKMANNS** | Head of Unit, Healthcare-associated Infections, Surveillance of Antibiotic Resistance and Consumption, Robert Koch Institute, Berlin, Germany |
| **Dale FISHER** | Professor of Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore |
| **Chikwe IHEKWEAZU** | Director General, Nigeria Centre for Disease Control, Nigeria Centre for Disease Control, Abuja, Nigeria |
| **Clifford LANE** | Clinical Director, National Institute of Allergy and Infectious Diseases, US National Institutes of Health, Bethesda, United States |
| **Jong-Koo LEE** | Professor of Family Medicine, Seoul National University College of Medicine, Seoul, Republic of Korea |
| **Gabriel LEUNG** | Dean of Medicine, Helen and Francis Zimmern Professor in Population Health, The University of Hong Kong, Hong Kong SAR, China |
| **Jiangtao LIN** | Director and Professor, Department of Pulmonary and Critical Care Medicine, China-Japan Friendship Hospital, National Clinical Research Center for Respiratory Diseases, Beijing |
| **Haiying LIU** | Deputy Director and Researcher, Institute of Pathogen Biology, Chinese Academy of Medical Sciences, Beijing China |
| **Natalia PSHENICHNAYA** | Head of International Department and Consultant, Center of Infectious Diseases, National Medical Research Center of Phthisiopulmonology and Infectious Diseases, Moscow, Russia |
| **Aleksandr SEMENOV** | Deputy Director, Saint Petersburg Pasteur Institute, Saint Petersburg, Russia |
| **Hitoshi TAKAHASHI** | Senior Research Scientist, Influenza Virus Research Center, National Institute of Infectious Diseases, Tokyo, Japan |
| **Maria VAN KERKHOVE** | Head of Unit, Emerging Diseases & Zoonoses, Global Infectious Hazard Preparedness, World Health Organization, Geneva, Switzerland |
| **Bin WANG** | Deputy Team Leader, Deputy Director General, Disease Prevention and Control Bureau, National Health Commission |
| **Guangfa WANG** | Director, Department of Respiratory and Critical Care Medicine, Peking University First Hospital |
| **Fan WU** | Vice Dean, Shanghai Medical College, Fudan University |
| **Zhongze WU** | Director, Compliance and Enforcement Division, Department of Wildlife Conservation, National Forestry and Grassland Administration |
| **Zunyou WU** | Chief Epidemiologist, Chinese Center for Disease Control and Prevention |
| **Jun XING** | Head of Unit, Country Capacity for International Health Regulations, Health Security Preparedness, World Health Organization, Geneva, Switzerland |
| **Kwok-Yung YUEN** | Chair Professor and Co-Director of State Key Laboratory of Emerging Infectious Diseases, Department of Microbiology, The University of Hong Kong |
| **Weigong ZHOU** | Medical Officer, Influenza Division, National Center for Immunization and Respiratory Diseases, US Centers for Disease Control and Prevention, Atlanta, United States |
| **Yong ZHANG** | Assistant Director and Researcher, National Institute for Viral Disease Control and prevention, Chinese Center for Disease Control and Prevention. |
| **Lei ZHOU** | Chief and Researcher, Branch for Emerging Infectious Disease, Public Health Emergency Center, Chinese Center for Disease Control and Prevention |

## B. Summary Agenda of the Mission

| Dates | Location | Activities |
|---|---|---|
| **10-15 February 2020 (Advance Team)** | Beijing | Advance Team and WHO Country team meetings with national counterparts and institutions |
| **16 February 2020** | Beijing | Meeting with the full international team for briefing at the WHO Country office |
| | Beijing | Workshop at the National Health Commission (NHC) with relevant departments of the Joint Prevention and Control Mechanism of the State Council |
| **17 February 2020** | Beijing | Site visit to Beijing Ditan Hospital |
| | Beijing | Site visit to Anhuali community and health service station, Anzhen street, Chaoyang District, Beijing |
| | Beijing | Workshop with Chinese Center for Disease Control and Prevention |
| **18 February 2020 (Guangdong Team)** | Shenzhen, Guangdong | Shenzhen customs at the airport |
| | Shenzhen, Guangdong | Shenzhen No.3 People's Hospital |
| | Shenzhen, Guangdong | Shenzhen Center for Disease Control and Prevention |
| | Shenzhen, Guangdong | Meeting at Tencent |
| **19 February 2020 (Guangdong Team)** | Shenzhen, Guangdong | Qiaoxiang community |
| | Shenzhen to Guangzhou | Visit to Futian High-speed Train Station, and travel to Guangzhou by train |
| | Guangzhou | Guangzhou Panyu Sanatorium |
| | Guangzhou | Guangdong Laboratory of Regenerative Medicine and Health |
| | Guangzhou | Guangzhou Tiyudongzhihui wet market |
| | Guangzhou | First Workshop with The People's government of Guangdong Province |
| **20 February 2020 (Guangdong Team)** | Guangzhou | Guangdong Provincial Center for Disease Control and Prevention |
| | Guangzhou | Renmin road campus of Guangzhou Women and Children Medical Center |
| | Guangzhou | The second Workshop with The People's government of Guangdong Province |
| **18 February 2020 (Sichuan Team)** | Beijing to Chengdu | |
| | Sichuan | Site visit to Chengdu Shuangliu International Airport |
| | | Meeting with the Governor of Sichuan Provincial People's Government |
| | | Site visit to Yong'an Township Central hospital with fever clinic |
| | | Site visit to home community of Yong'an township |
| **19 February 2020 (Sichuan Team)** | | Symposium with provincial and municipal authorities |
| | | Sichuan Center for Disease Control and Prevention |
| | | Site visit to West China Hospital- Designated COVID-19 hospital |
| **20 February 2020 (Sichuan Team)** | | Site visit to Chengdu Women and Children's hospital |
| | | Site visit to Pharmaceutical Logistics center |
| | | Site visit to East Chengdu railway station |

| | | |
|---|---|---|
| | | Site visit to Chengdu Public Health Clinical Centre- Designated COVID 19 hospital |
| **Sichuan and Guangdong teams reconvene in Guangzhou** | | |
| **21-24 February 2020** | | Analyze major findings; Meetings of the WHO-China Joint mission to finalize the report |
| **Feb 22 (Wuhan Team)** | Guangzhou to Wuhan | Select team members only |
| **23 February (Wuhan Team)** | | Site visit to Guanggu Campus of Wuhan Tongji Hospital |
| | | Site visit to Mobile Cabin Hospital in Wuhan Sports Center |
| | | Workshop with relevant departments of the Joint Prevention and Control Mechanism of Hubei Province |
| | | Feedback Meeting with Minister Ma, NHC at the Wuhan Conference Center |
| **24 February 2020** | Guangzhou to Beijing | Finalize report, WHO-Joint Press conference in Beijing |

## C. Detailed Technical Findings

### Response management, case and contact management, risk communication and community engagement

The response structures in China were rapidly put in place according to existing emergency plans and aligned from the top to the bottom. This was replicated at the four levels of government (national provincial, prefecture and county/district).

#### *Organizational structure and response mechanism*

**Response activation at the national level:** COVID-19 prevention and control mechanisms were initiated immediately after the outbreak was declared and nine working groups were set up to coordinate the response: a) Coordination b) Epidemic prevention and control c) Medical treatment d) Research e) Public communication f) Foreign affairs g) Medical material support h) Life maintenance supplies and i) Social stability. Each working group has a ministerial level leader. Emergency response laws and regulations for the emergency response to public health emergencies, prevention and control of infectious diseases have been developed or updated to guide the response.

**Response activation in provinces**: Each province set up a similar structure to manage the outbreak. The response is organized at the levels of national, provincial, prefecture, county/district and the community. By 29 January, all provinces across China had launched the highest level of response for major public health emergencies.

#### *Response Strategy*

A clear strategy was developed, and goals were well articulated and communicated across the entire response architecture. This strategy was rapidly adapted and adjusted to the outbreak, both in terms of the epidemiological situation over time and in different parts of the country.

The epidemiological situation has been used to define location into four areas:

- In areas without cases, the strategy in these areas is to "strictly prevent introduction". This includes quarantine arrangements in transportation hubs, monitoring for temperature changes, strengthening of triage arrangements, use of fever clinics, and ensuring normal economic and social operations.
- In areas with sporadic cases, the strategy is focused on "reducing importation, stopping transmission and providing appropriate treatment".
- In areas with community clusters, the strategy is focussed on "stopping transmission, preventing exportation, and strengthening treatment".
- In areas with community transmission, the strictest prevention and control strategies are being implemented, the entry and exit of people from these areas has been stopped and public health and medical treatment measures are comprehensively strengthened.

*Main control measures implemented in China*

The main control measures implemented in China are as follows and are illustrated in Figures 6A-6D, representing the national level response and examples of the response at the Provincial and municipal levels:

**Monitoring and reporting:** COVID-19 was included in the statutory reporting of infectious diseases on 20 January and plans were formulated to strengthen diagnosis, monitoring, and reporting.

**Strengthening ports of entry and quarantine:** The Customs Department launched the emergency plan for public health emergencies at ports across the country and restarted the health declaration card system for entry and exit into cities as well as strict monitoring of the temperature of entry and exit passengers.

**Treatment:** For severe or critical patients, the principle of "Four Concentrations" was implemented: i.e. concentrating patients, medical experts, resources and treatment into special centres. All cities and districts transformed relevant hospitals, increased the number of designated hospitals, dispatched medical staff, and set up expert groups for consultation, so as to minimise mortality of severe patients. Medical resources from all over China have been mobilized to support the medical treatment of patients in Wuhan.

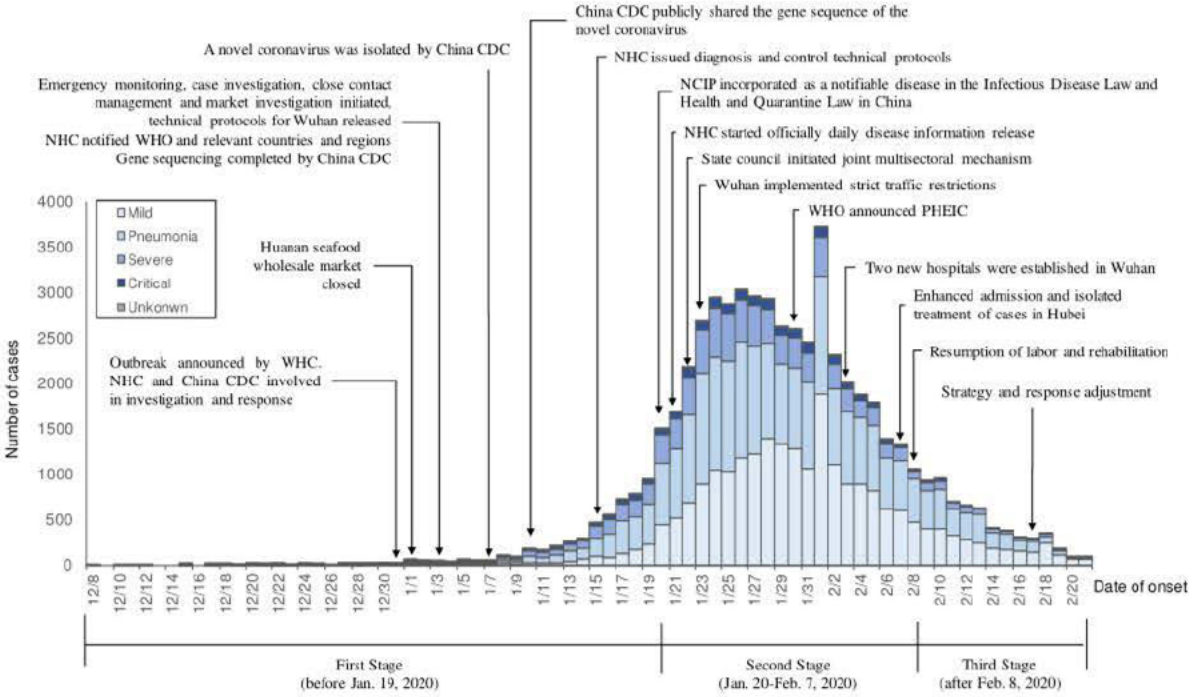
**Epidemiological investigation and close contact management:** Strong epidemiological investigations are being carried out for cases, clusters, and contacts to identify the source of infection and implement targeted control measures, such as contact tracing.

**Social distancing**: At the national level, the State Council extended the Spring Festival holiday in 2020, all parts of the country actively cancelled or suspended activities like sport events, cinema, theatre, and schools and colleges in all parts of the country postponed re-opening after the holiday. Enterprises and institutions have staggered their return to work. Transportation Departments setup thousands of health and quarantine stations in national service areas, and in entrances and exits for passengers at stations. Hubei Province adopted the most stringent traffic control measures, such as suspension of urban public transport, including subway, ferry and long-distance passenger transport. Every citizen has to wear a mask in public. Home support mechanisms were established. As a consequence of all of these measures, public life is very reduced.

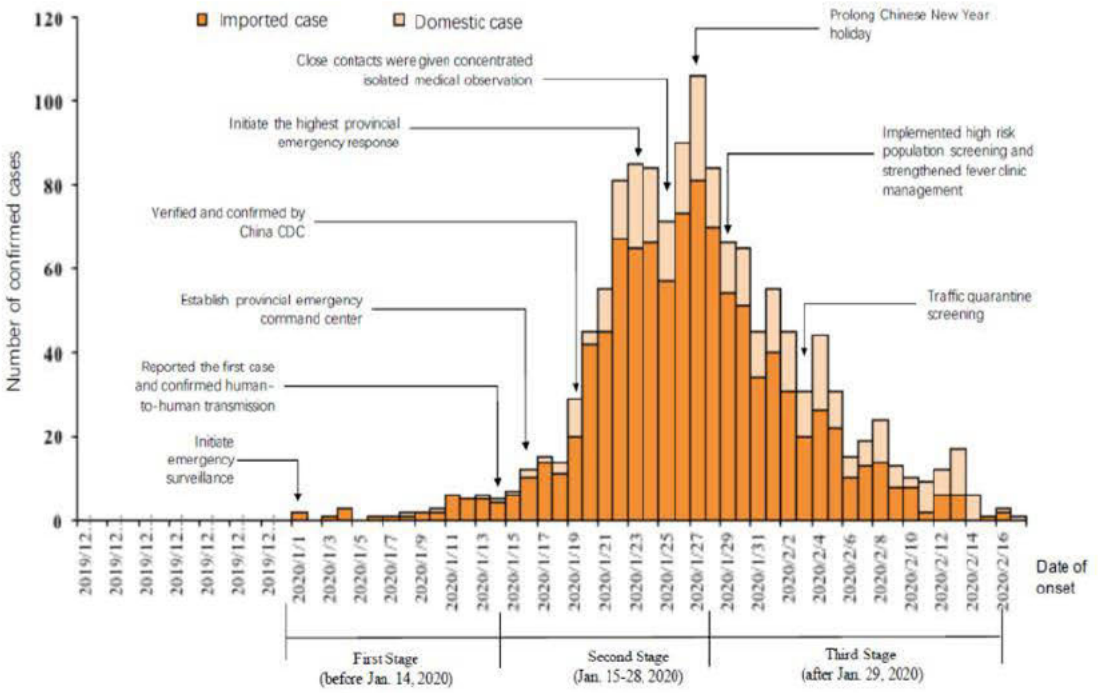
**Funding and material support:** Payment of health insurance was taken over by the state, as well as the work to improve accessibility and affordability of medical materials, provide personal protection materials, and ensure basic living materials for affected people.

**Emergency material support:** The government restored production and expanded production capacity, organized key enterprises that have already started to exceed current production capacity, supported local enterprises to expand imports, and used cross-border e-commerce platforms and enterprises to help import medical materials and improve the ability to guarantee supplies.

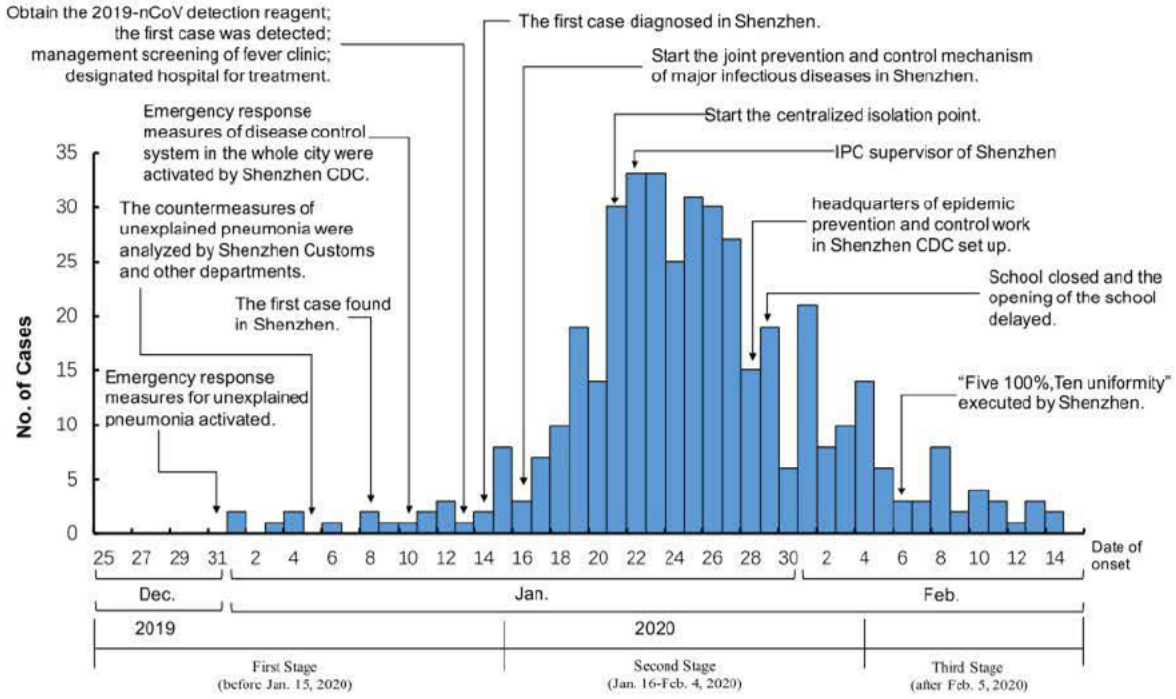
**A**


China CDC publicly shared the gene sequence of the novel coronavirus
A novel coronavirus was isolated by China CDC
NHC issued diagnosis and control technical protocols
Emergency monitoring, case investigation, close contact management and market investigation initiated, technical protocols for Wuhan released
NCIP incorporated as a notifiable disease in the Infectious Disease Law and Health and Quarantine Law in China
NHC notified WHO and relevant countries and regions
Gene sequencing completed by China CDC
NHC started officially daily disease information release
State council initiated joint multisectoral mechanism
Wuhan implemented strict traffic restrictions
WHO announced PHEIC
Mild
Pneumonia
Severe
Critical
Unkonwn
Huanan seafood wholesale market closed
Two new hospitals were established in Wuhan
Enhanced admission and isolated treatment of cases in Hubei
Resumption of labor and rehabilitation
Outbreak announced by WHC. NHC and China CDC involved in investigation and response
Strategy and response adjustment
Number of cases
Date of onset
First Stage (before Jan. 19, 2020)
Second Stage (Jan. 20-Feb. 7, 2020)
Third Stage (after Feb. 8, 2020)

**B**


Imported case
Domestic case
Prolong Chinese New Year holiday
Close contacts were given concentrated isolated medical observation
Initiate the highest provincial emergency response
Implemented high risk population screening and strengthened fever clinic management
Verified and confirmed by China CDC
Establish provincial emergency command center
Traffic quarantine screening
Reported the first case and confirmed human-to-human transmission
Initiate emergency surveillance
Number of confirmed cases
Date of onset
First Stage (before Jan. 14, 2020)
Second Stage (Jan. 15-28, 2020)
Third Stage (after Jan. 29, 2020)

**C**




**D**

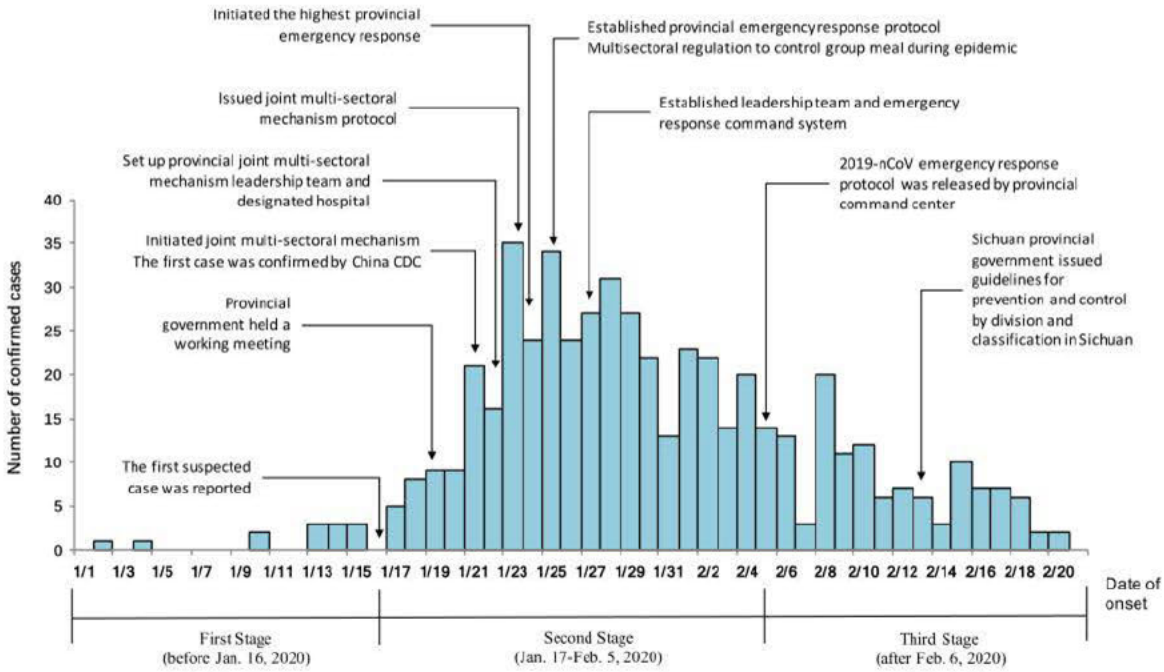



**Figure 6. COVID-19 epidemic curves and major intervention measures in China as implemented at a) the national level b) in Guangdong province, c) in Shenzhen municipality and d) in Sichuan province**

### *Risk communications (information release, public and media communications)*

**International and interregional cooperation and information sharing:** From 3 January 2020, information on COVID-19 cases has been reported to WHO daily. Full genome sequences of the new virus were shared with WHO and the international community immediately after the pathogen was identified on 7 January. On 10 January, an expert group involving Hong Kong, Macao and Taiwanese technical experts and a World Health Organization team was invited to visit Wuhan. A set of nucleic acid primers and probes for PCR detection for COVID-19 was released on 21 January.

**Daily updates:** The National Health Commission announces the epidemic situation every day and holds daily press conferences to respond to emerging issues. The government also frequently invites experts to share scientific knowledge on COVID-19 and to address public concerns.

**Psychological care:** This is provided to patients and the public. Governments at all levels, NGOs and all sectors of society developed guidelines for emergency psychological crisis intervention and guidelines for public psychological self-support and counselling. A hotline for mental health services has been established for the public.

**IT platform:** China has capitalized on the use of technology, big data and AI for COVID-19 preparedness, readiness and response. Authoritative and reliable information, medical guidance, access to online services, provision of educational tools and remote work tools have been developed in and used across China. These services have increased accessibility to health services, reduced misinformation and minimized the impact of fake news.

### *Social mobilization and community engagement*

Civil society organizations (community centers and public health centers) have been mobilized to support prevention and response activities. The community has largely accepted the prevention and control measures and is fully participating in the management of self-isolation and enhancement of public compliance. Community volunteers are organized to support self-isolation and help isolated residents at home to solve practical life difficulties. Measures were taken to limit the movement of the population through home-based support. Up to now, outside of Hubei, 30 provinces have registered and managed more than 5 million people coming from Wuhan.

## Clinical case management and infection prevention and control

The main **signs and symptoms** of COVID-19 include fever, dry cough, fatigue, sputum production, shortness of breath, myalgia or arthralgia, sore throat, and headache. Nausea or vomiting has been reported in a small percentage of patients (5%). On 14 February, China CDC described the clinical features, outcomes, laboratory and radiologic findings of 44 672 laboratory-confirmed cases. Only 965 (2.2%) were under 20 years of age and there is just one recorded death (0.1%) in this age group. Most patients (77.8%) were aged 30 to 69 years. Patients aged over 80 years had a CFR of 14.8%. The CFR was highest in those with

comorbidities including cardiovascular, diabetes, chronic respiratory disease, hypertension and cancer.

As opposed to Influenza A(H1N1)pdm09, **pregnant women** do not appear to be at higher risk of severe disease. In an investigation of 147 pregnant women (64 confirmed, 82 suspected and 1 asymptomatic), 8% had severe disease and 1% were critical.

**Severe cases** are defined as tachypnoea (≧30 breaths/ min) or oxygen saturation ≤93% at rest, or PaO2/FIO2 <300 mmHg. **Critical cases** are defined as respiratory failure requiring mechanical ventilation, shock or other organ failure that requires intensive care. About a quarter of severe and critical cases require mechanical ventilation while the remaining 75% require only oxygen supplementation.

China has a principle of **early identification**, early isolation, early diagnosis and early treatment. Early identification of suspect cases is critical to containment efforts and occurs via a process of temperature screening and questioning at entrances to many institutions, communities, travel venues (airports, train stations) and hospitals. Many hospitals have fever clinics that were established and maintained since the SARS outbreak. In China, laboratory tests were originally requested according to the case definitions, which included an epidemiological link to Hubei or other confirmed cases. However, more recently, a more **liberal clinical testing regimen** allows clinicians to test with a low index of suspicion.

**Suspect cases** are isolated in normal pressure single rooms, wear a surgical mask (for source control). Staff in China wear a cap, eye protection, n95 masks, gown and gloves (single use only). In Wuhan it is necessary for most suspects to be cohorted in a normal pressure isolation ward. Staff wear PPE continuously, changing it only when they leave the ward.

**PCR test results** are returned the same day. If positive, patients are transported to designated hospitals (including negative pressure ambulances in some cities). All patients, including the mild and asymptomatic, with a positive test are admitted. The designated hospitals are known and are strategically placed with at least one per district/county. Positive cases are cohorted by gender. Negative tested patients are managed based on clinical needs. All patients are evaluated with a respiratory multiplex to look for other diagnoses. This can add to the reassurance that a negative COVID-19 test reflects a lack of infection with COVID-19.

In Wuhan, there are 45 **designated hospitals**, 6 of which are designated for critical patients, and 39 for severe patients and/or any patients >65 years old. There are an additional 10 temporary hospitals reconstructed from gymnasium and exhibition centers, which are for mild patients. Other surge measures undertaken in Wuhan include two new temporary hospitals with 2600 beds, plus many makeshift hospitals to increase bed capacity. Bed capacity within Wuhan has increased to >50,000.

Patients are treated according to the **National Clinical guidelines** (edition 6) released by the China National Health Commission (NHC). There are no specific antiviral or immune modulating agents proven (or recommended) to improve outcomes. All patients are monitored by regular pulse oximetry. The guidelines include supportive care by clinical category (mild, moderate, severe and critical), as well as the role of investigational

treatments such as chloroquine, phosphate, lopinavir/ritonavir, alpha interferon, ribavirin, arbidol. The application of intubation/invasive ventilation and ECMO in critically ill patients can improve survival. The Joint Mission Team was told of ECMO use in four patients at one hospital with one death and three who appeared to be improving. Clearly, though ECMO is very resource consumptive, any health system would need to carefully weigh the benefits. There is widespread use of Traditional Chinese Medicines (TCM), for which the affects must be fully evaluated.

Patients with COVID-19 are not permitted **visitors**. Staff use coveralls, masks, eye cover, and gloves, removing PPE only when they leave the ward.

**Patients are discharged** after clinical recovery (afebrile >3 days, resolution of symptoms and radiologic improvement) and 2 negative PCR tests taken 24 hours apart. Upon discharge, they are asked to minimise family and social contact and to wear a mask. There are expectations of clinical trial results within a matter of weeks, which will see further opportunities for treatment.

There are guidelines for **elderly care** specifically targeting prevention in individuals and introduction of COVID-19 to nursing homes.

Training programmes by video conference nationally are scaled up to inform staff of best practice and to ensure PPE usage. **Clinical champions** are created to disperse knowledge and provide local expertise.

Maintenance of usual healthcare activities is maintained by hospital zoning (e.g. clean/contaminated sections of the healthcare facility).

## Laboratory, diagnostics and virology

The virus found to cause COVID-19 was initially isolated from a clinical sample on 7 January. It is notable that within weeks following the identification of the virus, a series of reliable and sensitive **diagnostic tools** were developed and deployed. On 16 January, the first RT-PCR assays for COVID-19 were distributed to Hubei. Real-time PCR kits were distributed to all the provinces on 19 January and were provided to Hong Kong SAR and Macao SAR on 21 January. Information regarding viral sequences and PCR primers and probes was shared with WHO and the international community by China CDC on 12 January 2020. To facilitate product development and research on the new virus, COVID-19 virus sequences were uploaded to the GISAID Database by China.

By 23 February, there were 10 kits for detection of COVID-19 approved in China by the NMPA, including 6 RT-PCR kits, 1 isothermal amplification kit, 1 virus sequencing product and 2 colloidal gold antibody detection kits. Several other tests are entered in the emergency approval procedure. Currently, there are at least 6 local producers of PCR test kits approved by NMPA. Overall, producers have the capacity to produce and distribute as many as 1,650,000 tests/week.

**Specimens** from both the upper respiratory tract (URT; nasopharyngeal and oropharyngeal) and lower respiratory tract (LRT; expectorated sputum, endotracheal aspirate, or bronchoalveolar lavage) are collected for COVID-19 testing by PCR.

COVID-19 virus has been detected in respiratory, fecal and blood specimens. According to preliminary data from Guangzhou CDC as of 20 February, virus can initially be detected in upper respiratory samples 1-2 days prior to symptom onset and persist for 7-12 days in moderate cases and up to 2 weeks in severe cases. Viral RNA has been detected in feces in up to 30% of patients from day 5 following onset of symptoms and has been noted for up to 4-5 weeks in moderate cases. However, it is not clear whether this correlates with the presence of infectious virus. While live virus has been cultured from stool in some cases, the role of fecal-oral transmission is not yet well understood. COVID-19 has been isolated from the clinical specimens using human airway epithelial cells, Vero E6 and Huh-7 cell lines.

**Serological diagnostics** are rapidly being developed but are not yet widely used. Joint Mission members met with local research teams at the China CDC, Guangzhou Regenerative Medicine and Health Guangdong Laboratory. The teams reported on the development of tests for IgM, IgG and IgM+IgG using rapid test platforms utilizing chemiluminiscence. ELISA assays are also under development.

## Research & Development

The government of China has initiated a series of major emergency research programs on virus genomics, antivirals, traditional Chinese medicines, clinical trials, vaccines, diagnostics and animal models. Research includes fundamental basic research and human subjects research. For the purpose of this report, human studies are limited to those involving IRB approval and informed consent. Other forms of human subjects investigations are included in the sections on epidemiology in this report. Well-focused, robust research conducted in the setting of an outbreak has the potential of saving many lives by identifying the most effective ways to prevent, diagnose and treat disease.

Since the COVID-19 virus has a genome identity of 96% to a bat SARS-like coronavirus and 86%-92% to a pangolin SARS-like coronavirus, an animal source for COVID-19 is highly likely. This was corroborated by the high number of RT-PCR positive environmental samples taken from the Huanan Seafood Market in Wuhan.

At least 8 **nucleic acid-based methods** for direct detection of COVID-19 and two colloidal gold antibody detection kits have been approved in China by the NMPA. Several other tests are close to approval. It will be important to compare the sensitivities and specificities of these and future serologic tests. Development of rapid and accurate **point-of-care tests** which perform well in field settings are especially useful if the test can be incorporated into presently commercially available multiplex respiratory virus panels. This would markedly improve early detection and isolation of infected patients and, by extension, identification of contacts. **Rapid IgM and IgG antibody testing** are also important ways to facilitate early diagnosis. Standard serologic testing can be used for retrospective diagnoses in the context of serosurveys that help better understand the full spectrum of COVID-19 infection.

A variety of **repurposed drugs and investigational drugs** have been identified. Screening NMPA approved drug libraries and other chemical libraries have identified novel agents. Hundreds of clinical trials involving remdesivir, chloroquine, favipiravir, chloroquine, convalescent plasma, TCM and other interventions are planned or underway. Rapid completion of the most important of these studies is critical to identifying truly effective therapies. However, evaluation of investigational agents requires adequately powered, randomized, controlled trials with realistic eligibility criteria and appropriate stratification of patients. It is important for there to be a degree of coordination between those conducting studies within and beyond China.

The development of a safe and effective **vaccine** for this highly communicable respiratory virus is an important epidemic control measure. Recombinant protein, mRNA, DNA, inactivated whole virus and recombinant adenovirus vaccines are being developed and some are now entering animal studies. Vaccine safety is of prime concern in the area of coronavirus infection in view of the past experience of disease enhancement by inactivated whole virus measles vaccine and similar reports in animal experiments with SARS coronavirus vaccines. It will be important that these vaccine candidates rapidly move into appropriate clinical trials.

The ideal **animal model** for studying routes of virus transmission, pathogenesis, antiviral therapy, vaccine and immune responses has yet to be found. The ACE2 transgenic mouse model and Macaca Rhesus model are already used in research laboratories. Systematically addressing which models can accurately mimic human infection is required.

There is a global rush for masks, hand hygiene products and other personal protective equipment. The relative importance of **non-pharmaceutical control measures** including masks, hand hygiene, and social distancing require further research to quantify their impact.

There are distinct patterns of intra-familial transmission of COVID-19. It is unclear whether or not there are host factors, including genetic factors, that influence susceptibility or disease course. COVID-19 has a varied clinical course and a precise description of that course is not available. In addition, the long-term consequences of COVID-19 are unknown. An observational cohort study of patients with COVID-19 enrolled from the time of diagnosis (with appropriate controls) could provide in-depth information about clinical, virologic and immunologic characteristics of COVID-19. Table 1 summarizes priority research areas with immediate to longer term goals.

**Table 1 Priority research areas with immediate, intermediate and longer-term goals**

| Immediate Goals | Intermediate Goals | Long-term goals |
|---|---|---|
| **Diagnostics:** RNA assays, antibody & antigen assays, point of care detection | Diagnostics: Multiplex diagnostic platforms | Diagnostics: Prognostic markers |
| **Therapeutics:** Remdesivir, favipiravir, chloroquine, plasma, TCM | Therapeutics: intravenous immunoglobulin (IVIg) | Therapeutics: Innovative approaches (CRISPR-CAS; RNAi; Cell-based; positive hits from library screening) |
| **Vaccines:** Development of animal models | Vaccines: mRNA candidates and candidate viral vectors | Vaccines: inactivated candidates and subunit candidates |

## D. Knowledge Gaps

Knowledge gaps and key questions to be answered to guide control strategies include:

### *Source of infection*

- Animal origin and natural reservoir of the virus
- Human-animal interface of the original event
- Early cases whose exposure could not be identified

### *The pathogenesis and virulence evolution of the virus*

### *Transmission dynamics*

- Modes of Transmission:
    - Role of aerosol transmission in non-health care settings
    - Role of fecal-oral transmission
- Viral shedding in various periods of the clinical course in different biological samples (i.e. upper and lower respiratory tract, saliva, faeces, urine)
    - Before symptom onset and among asymptomatic cases
    - During the symptomatic period
    - After the symptomatic period / during clinical recovery

### *Risk factors for infection*

- Behavioral and socio-economic risk factors for infection in
    - Households / institutions
    - the Community
- Risk factors for asymptomatic infection
- Risk factors for nosocomial infection
    - among health care workers
    - among patients

### *Surveillance and monitoring*

- Monitoring community transmission through existing
    - ILI surveillance
    - SARI surveillance
- The outbreak trend and intervention dynamics
    - Basic reproduction numbers in various stages of the epidemic
    - The epidemic's relation to seasonality

*Laboratory and diagnostics*

- Sensitivity and specificity of different nucleic acid (PCR, NAATs and rapid tests), antibody and antigen tests
- Post-infection antibody titers and the duration of protection
- Sero-prevalence among
    - Health care workers
    - General population
    - Children

*Clinical management of severe and critically ill patients*

- Value of ECMO in the management of critically ill patients
- Best practice using mechanical ventilation in the management of critically ill patients
- Re-evaluation of the role of steroids in the management of severe and critically ill patients
- Identification of factors associated with successful clinical management and outcome
- Determination of the effectiveness of Traditional Chinese Medicines (TCM)
- Determination the effectiveness of additional investigational treatment options (e.g. intravenous immunoglobulin/IVIg, convalescent plasma)

*Prevention and control measures*

- Key epidemic indicators that inform evidence-based control strategy decision making and adjustments
- Effectiveness of infection prevention and control (IPC) measures in various health care settings
- Effectiveness of entry and exit screening
- Effectiveness of the public health control measures and their socio-economic impact
    - Restriction of movement
    - Social distancing
    - School and workplace closures
    - Wearing mask in general public
    - Mandatory quarantine
    - Voluntary quarantine with active surveillance

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## E. Operational & Technical Recommendations

### Operational/programmatic recommendations

- Reassess risk and capacities based on different stages of the outbreak; approve different measures during the different phases of the response; assess different stages of the response; reach a balance between response and social development
- Initiate a timely scientific evidence based, efficient and flexible joint multi-sectoral mechanism, which is driven by strong government leadership

### Technical recommendations

#### *Epidemiology and transmission*

- Continue enhanced surveillance across the country through existing respiratory disease systems, including ILI, SARI or pneumonia surveillance systems
- Prioritize early investigations, including household transmission studies, age-stratified sero-epidemiologic surveys including children, case-control studies, cluster investigations, and serologic studies in health care workers

#### *Severity*

- Continue to share information on patient management, disease progression and factors leading to severe disease and favorable outcomes
- Review and analyze the possible factors associated with the disease severity, which may include:
    - natural history studies to better understand disease progression in mild, severe and fatal patients
    - medical chart reviews about disease severity among vulnerable groups, (e.g. those with underlying conditions, older age groups, pregnant women and children) to develop appropriate standards of care
    - evaluation of factors leading to favorable outcomes (e.g. early identification and care)

#### *Clinical care and infection prevention and control*

- Suspect patients who have not yet been tested should be isolated in single normal pressure rooms; cohorting of positive cases is acceptable
- Physicians and all health care workers need to maintain a high level of clinical alert for COVID-19
- For affected countries, standardize training for clinical care and IPC and scale with the development of local (e.g. district level) experts
- Ensure concurrent testing for other viral pathogens to support a negative COVID-19 test
- Ensure maintenance of usual and essential services during the outbreak

- Ensure processes are in place for infection prevention among the most vulnerable, including the elderly
- Ensure readiness to provide clinical care and to meet IPC needs, including:
    a. anticipated respiratory support requirements (e.g. pulse oximeters, oxygen, and invasive support where appropriate)
    b. national guidelines for clinical care and IPC, revised for COVID-19
    c. nationally standardised trainings for disease understanding and PPE use for HCWs
    d. community engagement
    e. PPE and Medication stockpiles
    f. early identification protocols; triage, temperature screening, holding bays (triage, including pulse oximetry)
    g. treatment protocols including designated facilities, patient transportation
    h. enhanced uptake of influenza and pneumococcal vaccine according to national guidelines
    i. laboratory testing
    j. rapid response teams

*Laboratory and virology*

- Continue to perform whole genome analysis of COVID-19 viruses isolated from different times and places, to evaluate virus evolution
- Conduct pathogenesis studies using biopsy/post-mortem specimens of COVID-19 patients or infected animal models
- Evaluate available nucleic acid PCR diagnostics
- Rapidly develop and evaluate rapid/point-of-care diagnostics and serologic assays
- Conduct further study to interpret the result of positive COVID-19 RNA detection in feces in patients recovering from COVID-19
- Enhance international cooperation, especially in terms of biosafety and information sharing for increased understanding of the COVID-19 virus and traceability of the virus
- Consider monitoring proinflammatory cytokines via multiplex assays to predict the development of "cytokine storm"

*Research and development*

- Additional effort should be made to find the animal source, including the natural reservoir and any intermediate amplification host, to prevent any new epidemic foci or resurgence of similar epidemics

- Efforts should be made to consistently evaluate existing and future diagnostic tests for detection of COVID-19 using a harmonized set of standards for laboratory tests and a biorepository that can be used for evaluating these tests
- Consider the establishment of a centralized research program in China to oversee that portfolio and ensure the most promising research (vaccines, treatments, pathogenesis) are adequately supported and studied first; program staff dedicated to the clinical research would work at the clinical research site(s) to decrease the research workload of the clinicians at the site
- Consider including one or more sites within China in the ongoing and future multi-center, international trials; Chinese investigators should be actively engaged in international trials
- Continue to develop additional animal models, making every effort to ensure these mimic human infection and virus transmission as closely as possible
- Conduct studies to determine which of the commonly used forms of PPE are most effective in controlling the spread of COVID-19

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|---|---|
| **From:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6)> |
| **To:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane (b) (6) |
| **Subject:** | RE: Letter from WHO Director-General, Dr Tedros Adhanom Ghebreyesus |
| **Date:** | 2020/02/13 13:57:54 |
| **Priority:** | Normal |
| **Type:** | Note |

Go to China if they ask. (b) (5)

**Anthony S. Fauci, MD**
**Director**
**National Institute of Allergy and Infectious Diseases**
**Building 31, Room 7A-03**
**31 Center Drive, MSC 2520**
**National Institutes of Health**
**Bethesda, MD 20892-2520**
**Phone:** (b) (6)
**FAX: (301) 496-4409**
**E-mail:** (b) (6)


**From:** Lane, Cliff (NIH/NIAID) [E] < (b) (6) >
**Sent:** Thursday, February 13, 2020 1:46 PM
**To:** Office of the Director-General < (b) (6) >
**Cc:** SCHWARTLANDER, Bernhard F. <s (b) (6) >; DRURY, Patrick Anthony < (b) (6) >; (b) (6); (b) (6); Handley, Gray (NIH/NIAID) [E] < (b) (6) >; Fauci, Anthony (NIH/NIAID) [E] < (b) (6) >
**Subject:** Re: Letter from WHO Director-General, Dr Tedros Adhanom Ghebreyesus

Thank-you for the invitation to participate in this important mission. I am currently en route to Japan (communicating via onboard WiFi) to explore the possibility of rapidly implementing a study of the drug remdesivir in the context of the current cases in that country.

I have sent a message to my supervisor Dr. Fauci (copied) that I could attempt to change plans after arrival in Tokyo depending upon where I am felt to be of most value.

I am very appreciative of having received the invitation.

Sincerely,

Cliff Lane

On Feb 13, 2020, at 1:23 PM, Office of the Director-General
< (b) (6) > wrote:

Dear Dr Lane,
Please find attached for your kind and urgent attention, a letter from Dr Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization.
Best regards.
Office of the Director-General
World Health Organization
<Scanned from a Xerox Multifunction Printer.pdf>

| | |
|---|---|
| **Sender:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Recipient:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane (b) (6) |
| **Sent Date:** | 2020/02/13 13:57:53 |
| **Delivered Date:** | 2020/02/13 13:57:54 |

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|---|---|
| **From:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane (b) (6) |
| **To:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Subject:** | Draft email from Dr. Fauci to OGA |
| **Date:** | 2020/02/03 12:21:56 |
| **Priority:** | Normal |
| **Type:** | Note |

In response to the request from WHO via OGA [redacted] (b) (5)

| | |
|---|---|
| **Sender:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane (b) (6) |
| **Recipient:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Sent Date:** | 2020/02/03 12:21:58 |
| **Delivered Date:** | 2020/02/03 12:21:56 |

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|---|---|
| **From:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane (b) (6) |
| **To:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Subject:** | Re: 2019 novel Coronavirus Global research and innovation forum: towards a research roadmap Feb 11-12, 2020 Geneva WHO HQ |
| **Date:** | 2020/02/01 07:35:10 |
| **Priority:** | Normal |
| **Type:** | Note |

They have already individually reached out to multiple NIAID staff.

(b) (5)

Cliff

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**From:** Anthony Fauci < (b) (6) >
**Date:** Saturday, February 1, 2020 at 7:32 AM
**To:** "Lane, Cliff (NIH/NIAID) [E]" < (b) (6) >
**Subject:** FW: 2019 novel Coronavirus Global research and innovation forum: towards a research roadmap Feb 11-12, 2020 Geneva WHO HQ

Cliff:

Whom should I nominate? See yellow highlight

Tony

---

**From:** SWAMINATHAN, Soumya &lt (b) (6) >
**Sent:** Saturday, February 1, 2020 7:19 AM
**To:** Fauci, Anthony (NIH/NIAID) [E] < (b) (6) >
**Subject:** 2019 novel Coronavirus Global research and innovation forum: towards a research roadmap Feb 11-12, 2020 Geneva WHO HQ

Dear Tony

I am delighted to inform you that WHO is organizing a global research partners forum on February 11th and 12th in Geneva, to discuss research priorities related to the novel Corona virus. The expected outcome is a research roadmap with clearly defined priorities and a governance framework to take each thematic area forward. Several thematic areas will be considered at the meeting, namely: virus, diagnostics; natural history and transmission; clinical; therapeutics; vaccines; ethics; regulatory science; animal health; data/samples analysis and sharing and; social sciences. We believe that this meeting will be critical in consensus building on the most important research questions, as well as in building global partnerships and collaborations to take this work forward.

This meeting is being organized in partnership with GLOPID R and is being supported by the Bill and Melinda Gates foundation, DFID, Wellcome Trust and several other partners. The secretariat within WHO is the R&D blueprint, co-chaired by Dr Mike Ryan and myself.

As the head of an agency that would play an important role in addressing this new viral outbreak, either by undertaking or funding research, or both, I take great pleasure in inviting you to this meeting. I apologize for the short notice, but you will understand that we have had to plan this in the past few days, keeping in mind the evolving situation.

Kindly let me know if you (or your nominee) will be able to attend and if you need any support from us. Please copy [redacted] (b) (6) and [redacted] (b) (6) in your response.

With best wishes,

Soumya

Dr Soumya Swaminathan

Chief Scientist

PS: Sorry if this is a duplication – just want to make sure the key people receive the invite. Sorry about the short notice!

| | |
|---|---|
| **Sender:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane [redacted] (b) (6) |
| **Recipient:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci [redacted] (b) (6) |
| **Sent Date:** | 2020/02/01 07:35:10 |

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|---|---|
| **From:** | Lane, Cliff (NIH/NIAID) [E] </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2D7E368A3137473BBCE161547A82F2DE-CLANE> |
| **To:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci [redacted] (b) (6) |
| **Subject:** | Fwd: PALM Manuscript update |
| **Date:** | 2019/11/24 16:53:01 |
| **Priority:** | Normal |
| **Type:** | Note |

FYI - comments from WHO on the galleys. This language had been in the prior two versions without comment/concerns by anyone.

Begin forwarded message:

**From:** "DIAZ, Janet Victoria" <[redacted] (b) (6)>
**Date:** November 24, 2019 at 10:20:32 AM EST
**To:** "Lane, Cliff (NIH/NIAID) [E]" <[redacted] (b) (6)>
**Cc:** "[redacted] (b) (6)" <[redacted] (b) (6)>,
"Dodd, Lori (NIH/NIAID) [E]" <[redacted] (b) (6)>
**Subject: Re: PALM Manuscript update**

Hi Cliff,
Many thanks for this galley proof, overall excellent.
We have had some internal discussions at WHO with our leadership, and there are two important changes suggested.

[redacted] (b) (5)

Warm regards,
Janet
&# (b) (6) whatsapp

(b) (5)

(b) (5)

**From:** Lane, Cliff (NIH/NIAID) [E] < (b) (6) >
**Sent:** 22 November 2019 19:14
**To:** Dodd, Lori (NIH/NIAID) [E] < (b) (6) >; Davey, Richard (NIH/NIAID) [E]
< (b) (6) >; Albert, Sara (NIH) [C] < (b) (6) >; Camara,
Modet < (b) (6) >; (b) (6)
< (b) (6) >; (b) (6)
< (b) (6) >; Sivahera, Billy < (b) (6) >; Walker,
Robert (OS/ASPR/BARDA) < (b) (6) >; (b) (6)
< (b) (6) >; (b) (6)
< (b) (6) >; (b) (6)
< (b) (6) >; (b) (6)
< (b) (6) >; Lusakibanza, Mariano
< (b) (6) >; (b) (6)
< (b) (6) >; Olivier Tshiani < (b) (6) >;
(b) (6) < (b) (6) >; Mukumbayi, Philippe
< (b) (6) >; Sabue Mulangu 2 < (b) (6) >;
(b) (6) < (b) (6) >; (b) (6)
< (b) (6) >; (b) (6) < (b) (6) >;
Bonnett, Tyler (NIH) [C] < (b) (6) >; Crozier, Ian (NIH) [C]
< (b) (6) >; Duvenhage, Michael (NIH) [C]
< (b) (6) >; Proffitt, Calvin (NIH) [C]
< (b) (6) >; Teitelbaum, Marc (NIH) [C]
< (b) (6) >; (b) (6)
< (b) (6) >; Rebecca GRAIS
< (b) (6) >; Aboulhab, Jamila (NIH/NIAID) [E]
< (b) (6) >; Barrett, Kevin (NIH/NIAID) [E]

< (b) (6) >; Cahill, Kelly (NIH/NIAID) [E] < (b) (6) >; Cone, Katherine (NIH/NIAID) [E] < (b) (6) >; Dighero-Kemp, Bonnie (NIH/NIAID) [C] < (b) (6) >; Eckes, Risa (NIH/NIAID) [E] &lt (b) (6) >; Hensley, Lisa (NIH/NIAID) [E] < (b) (6) >; Herpin, Betsey (NIH/NIAID) [E] < (b) (6) >; Higgs, Elizabeth (NIH/NIAID) [E] < (b) (6) >; Ledgerwood, Julie (NIH/NIAID) [E] < (b) (6) >; Pierson, Jerome (NIH/NIAID) [E] < (b) (6) >; Proschan, Michael (NIH/NIAID) [E] < (b) (6) >; Smolskis, Mary (NIH/NIAID) [E] < (b) (6) >; Sow, Ydrissa (NIH/NIAID) [E] < (b) (6) >; Tierney, John (NIH/NIAID) [E] <j (b) (6) >; (b) (6) < (b) (6) >; Sumathi Sivapalasingam < (b) (6) >; Gettinger, Nikki < (b) (6) >; DIAZ, Janet Victoria < (b) (6) >; Vallee, David < (b) (6) >; (b) (6) < (b) (6) >; Steve AHUKA < (b) (6) >

**Subject:** PALM Manuscript update

Dear members of the PALM writing team,
Attached are the galley proof for the primary article and an updated supplement that will accompany the article. Please let us know any must changes due to factual errors (including misspellings) by Sunday, 1:00 PM EDT.
Thank-you again for all you efforts.
Sincerely,
Cliff, Lori and Sabue

| | |
|---|---|
| **Sender:** | Lane, Cliff (NIH/NIAID) [E] </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2D7E368A3137473BBCE161547A82F2DE-CLANE> |
| **Recipient:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Sent Date:** | 2019/11/24 16:53:00 |
| **Delivered Date:** | 2019/11/24 16:53:01 |

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|---|---|
| **From:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane (b) (6) |
| **To:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Subject:** | Close to final PALM Manuscript and Supplement |
| **Date:** | 2019/11/22 17:22:36 |
| **Priority:** | Normal |
| **Type:** | Note |

As discussed.
Cliff

| | |
|---|---|
| **Sender:** | Lane, Cliff (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=2d7e368a3137473bbce161547a82f2de-clane (b) (6) |
| **Recipient:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Sent Date:** | 2019/11/22 17:22:34 |
| **Delivered Date:** | 2019/11/22 17:22:36 |

**The PALM Consortium: A randomized controlled trial of Ebola virus disease therapeutics in the Democratic Republic of the Congo**

(b) (5)

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| **From:** | Lane, Cliff (NIH/NIAID) [E] </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2D7E368A3137473BBCE161547A82F2DE-CLANE> |
| **To:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Subject:** | Re: Do you have Mike Ryan's e-mail address? |
| **Date:** | 2019/10/31 04:35:59 |
| **Priority:** | Normal |
| **Type:** | Note |

(b) (6)

On Oct 30, 2019, at 6:58 PM, Fauci, Anthony (NIH/NIAID) [E] < (b) (6) > wrote:

**Anthony S. Fauci, MD**
**Director**
**National Institute of Allergy and Infectious Diseases**
**Building 31, Room 7A-03**
**31 Center Drive, MSC 2520**
**National Institutes of Health**
**Bethesda, MD 20892-2520**
**Phone:** (b) (6)
**FAX: (301) 496-4409**
**E-mail:** (b) (6)


| | |
|---|---|
| **Sender:** | Lane, Cliff (NIH/NIAID) [E] </O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=2D7E368A3137473BBCE161547A82F2DE-CLANE> |
| **Recipient:** | Fauci, Anthony (NIH/NIAID) [E] /o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=df38103d75134f658ae2d356f0396b94-afauci (b) (6) |
| **Sent Date:** | 2019/10/31 04:35:58 |
| **Delivered Date:** | 2019/10/31 04:35:59 |

**From:** Sorenson, Robert (NIH/NIAID) [C]
**Sent:** Thu, 22 Oct 2020 17:49:37 +0000
**To:** Carver, Trea (NIH) [C]
**Cc:** Lane, Cliff (NIH/NIAID) [E];Higgs, Elizabeth (NIH/NIAID) [E]
**Subject:** Papers for 2:00 pm
**Attachments:** 22Oct20 PPERR Short TOC for Dr Lane.docx, 22Oct20 PPERR TOC Annotated.docx, Springer MRW Program Info For Auths.pdf

Hi Trea, hope you are well. Here are papers for our meeting coming up. The main one we will focus on is the PPERR Short Toc. Bob

Robert A. Sorenson
Policy Advisor and Editor (C)
Division of Clinical Research
National Institute of Allergy and Infectious Diseases
National Institutes of Health
Tel.: (b) (6)

*Principles and Practice of Emergency Response Research*

**Shorter TOC**

October 22, 2020

(b) (5)

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(b) (5)

***Principles and Practice of Emergency Response Research***

**Draft Annotated TOC: Includes Selected Outlines and Notes on Drafts Received**

October 22, 2020

(For editors only; contains frank comments on drafts received.)

(b) (5)

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[redacted]

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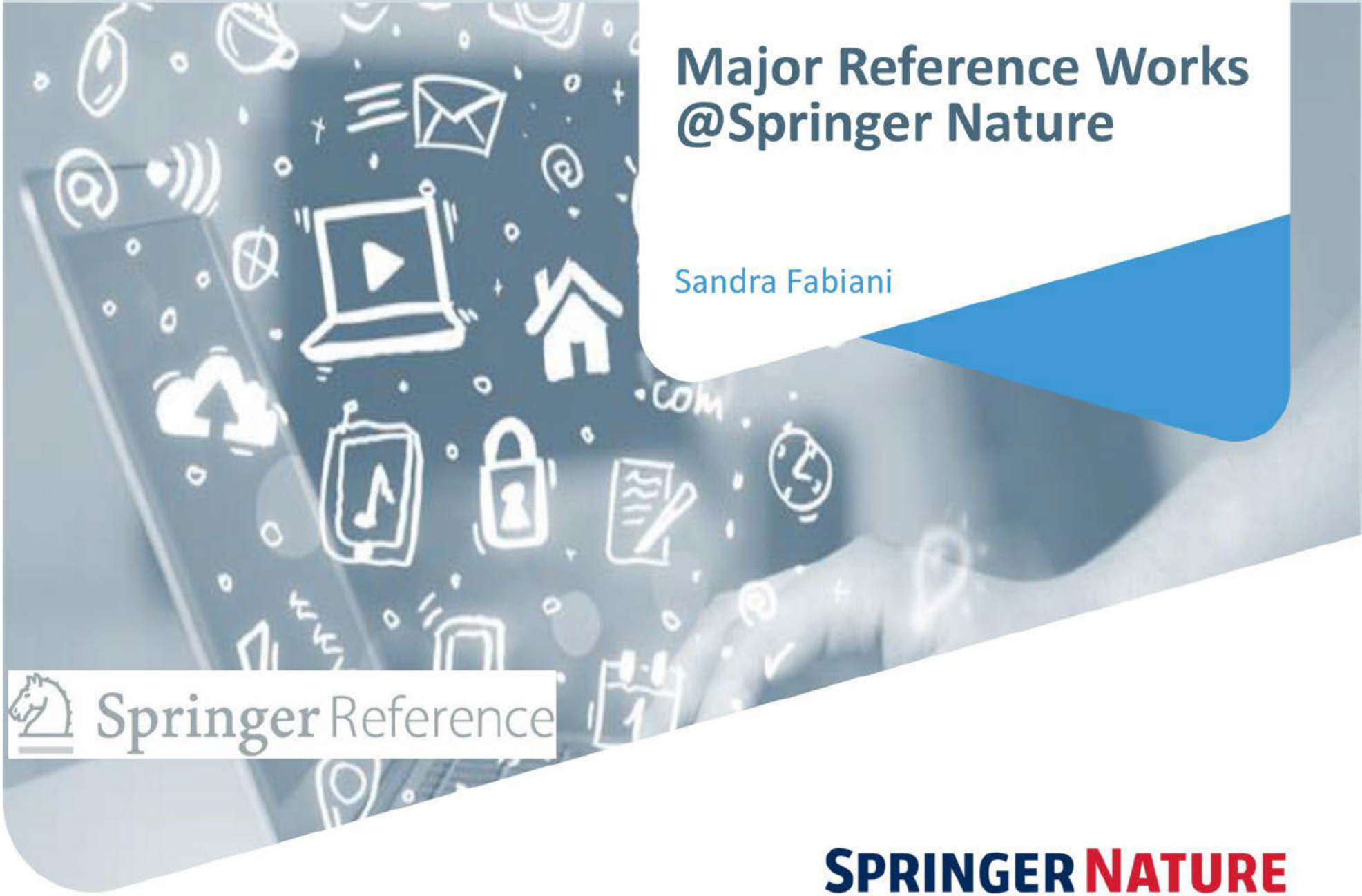
[redacted]

# Major Reference Works @Springer Nature

Sandra Fabiani

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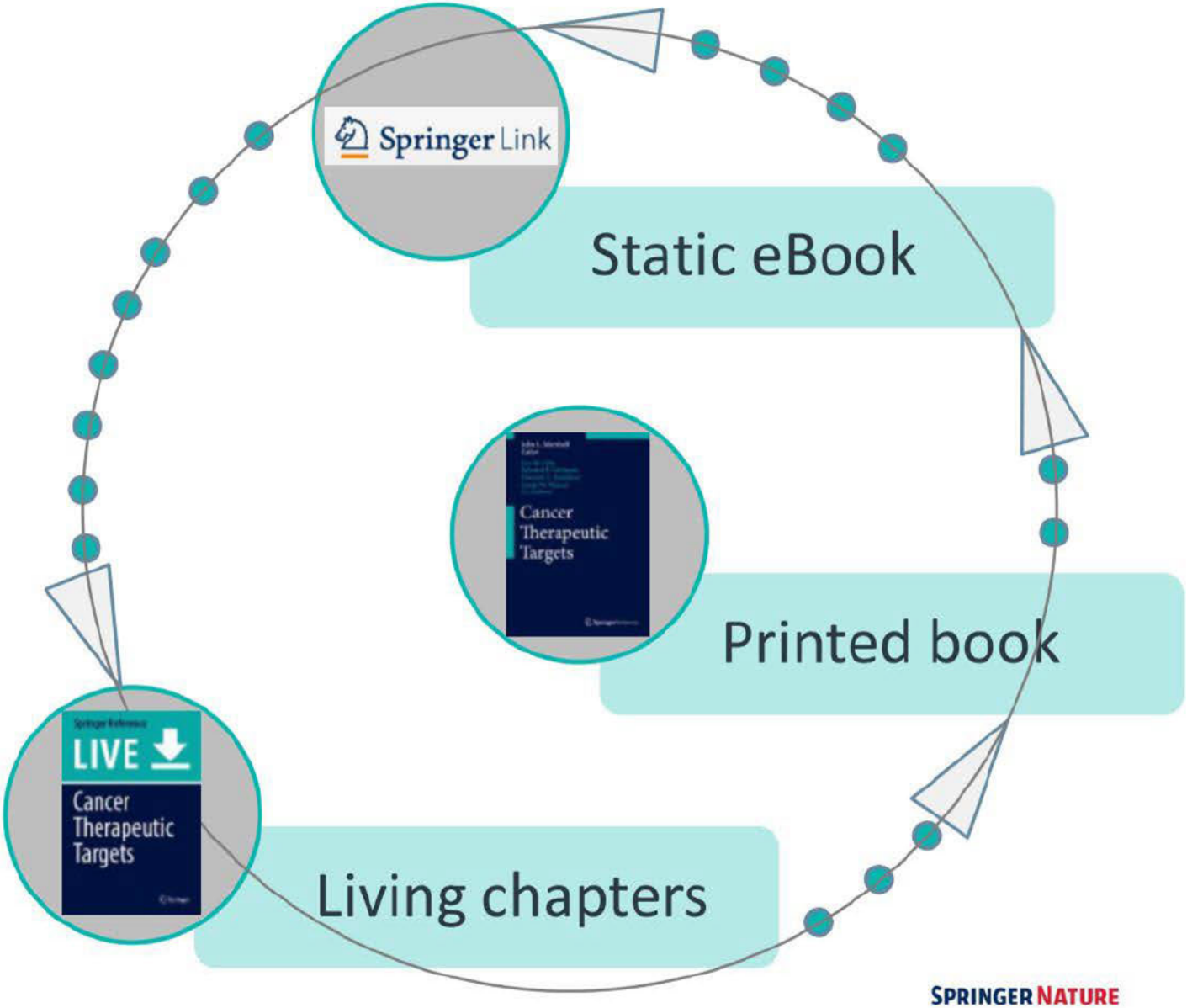

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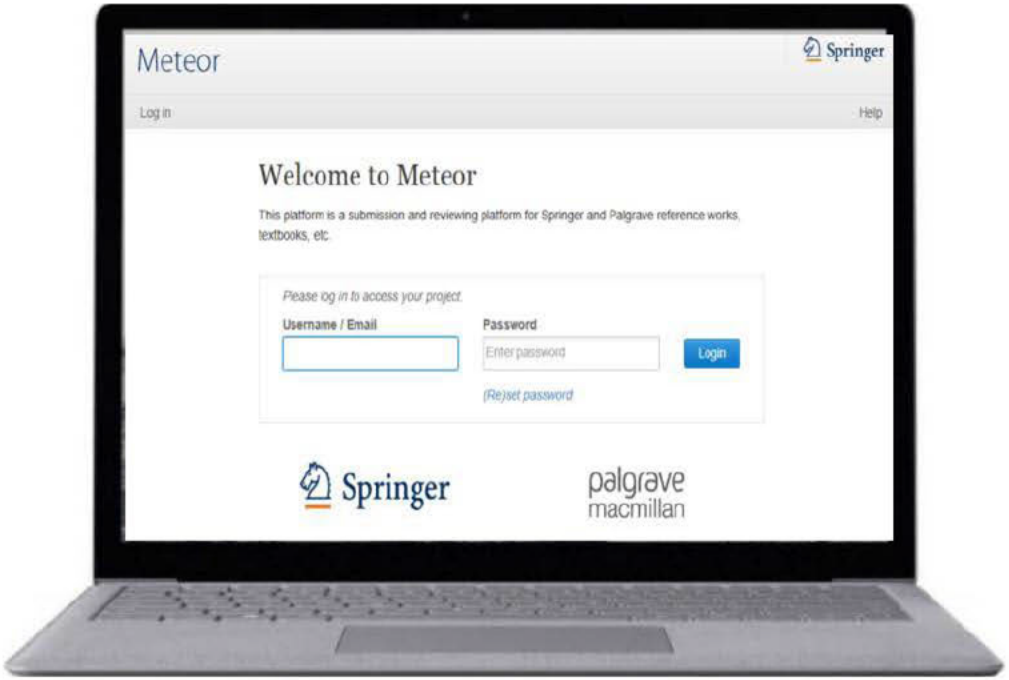

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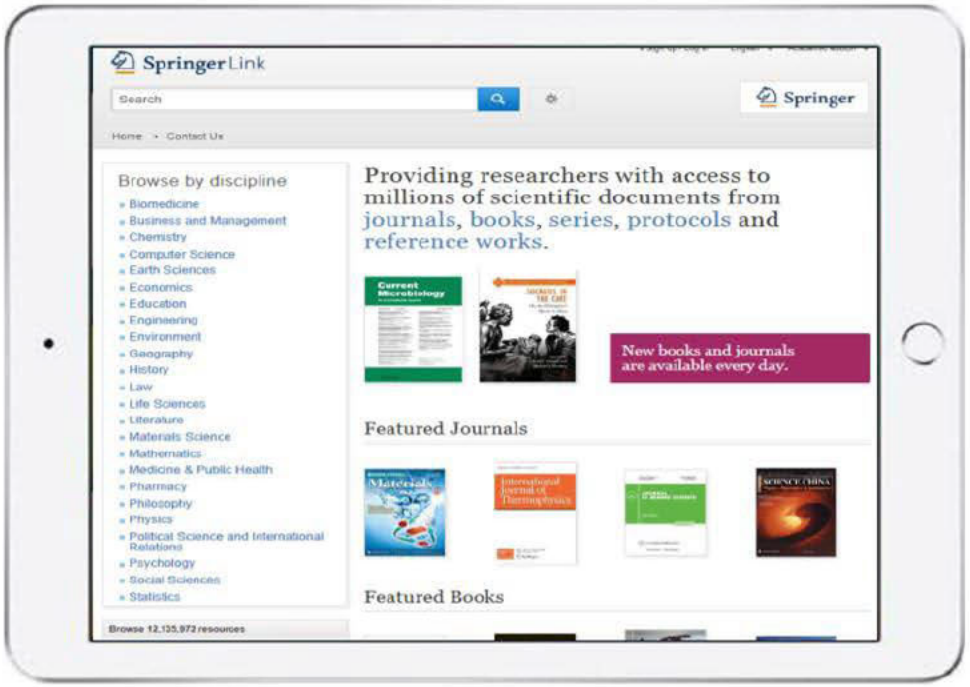

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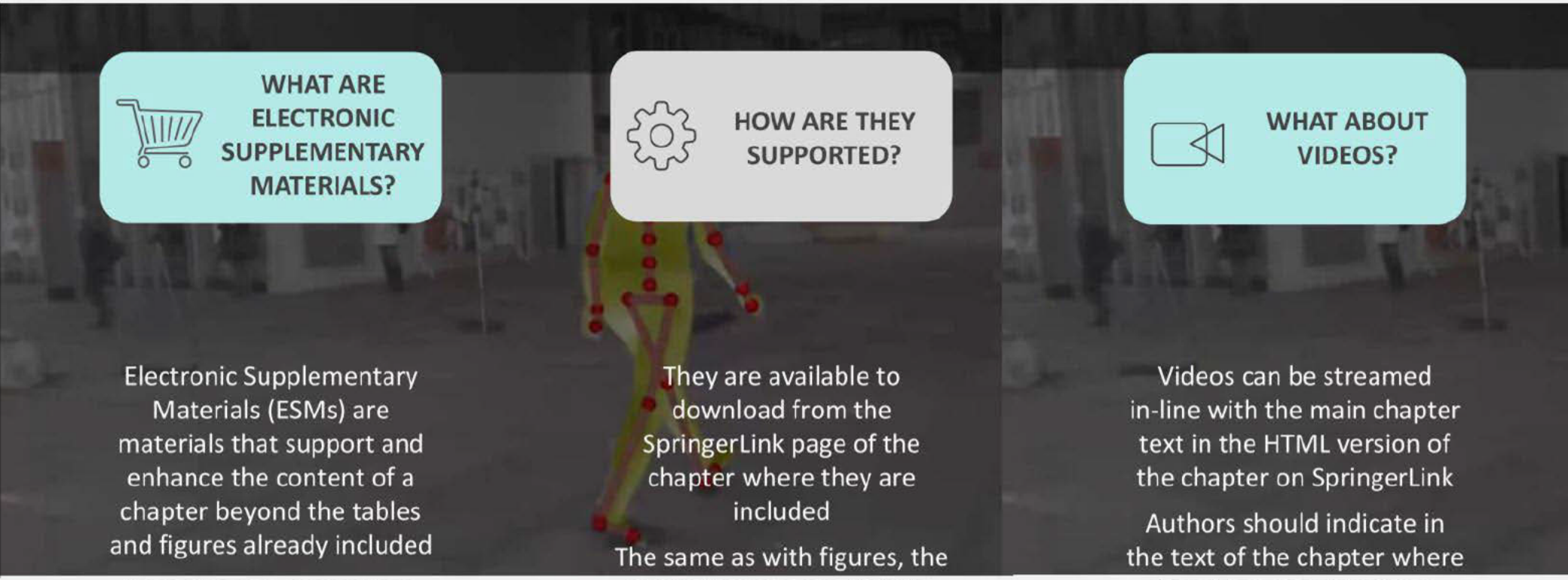

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# Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)

16-24 February 2020

# Table of Contents

# I. The Mission

## Goal and Objectives

The overall goal of the Joint Mission was to rapidly inform national (China) and international planning on next steps in the response to the ongoing outbreak of the novel coronavirus disease (COVID-19[1]) and on next steps in readiness and preparedness for geographic areas not yet affected.

The major objectives of the Joint Mission were as follows:

- To enhance understanding of the evolving COVID-19 outbreak in China and the nature and impact of ongoing containment measures;
- To share knowledge on COVID-19 response and preparedness measures being implemented in countries affected by or at risk of importations of COVID-19;
- To generate recommendations for adjusting COVID-19 containment and response measures in China and internationally; and
- To establish priorities for a collaborative programme of work, research and development to address critical gaps in knowledge and response and readiness tools and activities.

## Members & Method of Work

The Joint Mission consisted of 25 national and international experts from China, Germany, Japan, Korea, Nigeria, Russia, Singapore, the United States of America and the World Health Organization (WHO). The Joint Mission was headed by Dr Bruce Aylward of WHO and Dr Wannian Liang of the People's Republic of China. The full list of members and their affiliations is available in Annex A. The Joint Mission was implemented over a 9-day period from 16-24 February 2020. The schedule of work is available in Annex B.

The Joint Mission began with a detailed workshop with representatives of all of the principal ministries that are leading and/or contributing to the response in China through the National Prevention and Control Task Force. A series of in-depth meetings were then conducted with national level institutions responsible for the management, implementation and evaluation of the response, particularly the National Health Commission and the China Centers for Disease Control and Prevention (China CDC). To gain first-hand knowledge on the field level implementation and impact of the national and local response strategy, under a range of epidemiologic and provincial contexts, visits were conducted to Beijing Municipality and the provinces of Sichuan (Chengdu), Guangdong (Guangzhou, Shenzhen) and Hubei (Wuhan). The field visits included community centers and health clinics, country/district hospitals, COVID-19 designated hospitals, transportations hubs (air, rail, road), a wet market, pharmaceutical and personal protective equipment (PPE) stocks warehouses, research institutions, provincial health commissions, and local Centers for

[1] In the Chinese version of this report, COVID-19 is referred to throughout as novel coronavirus pneumonia or NCP, the term by which COVID-19 is most widely known in the People's Republic of China.

Disease Control (provincial and prefecture). During these visits, the team had detailed discussion and consultations with Provincial Governors, municipal Mayors, their emergency operations teams, senior scientists, frontline clinical, public health and community workers, and community neighbourhood administrators. The Joint Mission concluded with working sessions to consolidate findings, generate conclusions and propose suggested actions.

To achieve its goal, the Joint Mission gave particular focus to addressing key questions related to the natural history and severity of COVID-19, the transmission dynamics of the COVID-19 virus in different settings, and the impact of ongoing response measures in areas of high (community level), moderate (clusters) and low (sporadic cases or no cases) transmission.

The findings in this report are based on the Joint Mission's review of national and local governmental reports, discussions on control and prevention measures with national and local experts and response teams, and observations made and insights gained during site visits. The figures have been produced using information and data collected during site visits and with the agreement of the relevant groups. References are available for any information in this report that has already been published in journals.

The final report of the Joint Mission was submitted on 28 February and updated 11 March.

# II. Major findings

The major findings are described in six sections: the virus, the outbreak, transmission dynamics, disease progression and severity, the China response and knowledge gaps. More detailed descriptions of technical findings are provided in Annex C.

## The virus

On 30 December 2019, three bronchoalveolar lavage samples were collected from a patient with pneumonia of unknown etiology – a surveillance definition established following the SARS outbreak of 2002-2003 – in Wuhan Jinyintan Hospital. Real-time PCR (RT-PCR) assays on these samples were positive for pan-Betacoronavirus. Using Illumina and nanopore sequencing, the whole genome sequences of the virus were acquired. Bioinformatic analyses indicated that the virus had features typical of the coronavirus family and belonged to the Betacoronavirus 2B lineage. Alignment of the full-length genome sequence of the COVID-19 virus and other available genomes of Betacoronavirus showed the closest relationship was with the bat SARS-like coronavirus strain BatCov RaTG13, identity 96%.

Virus isolation was conducted with various cell lines, such as human airway epithelial cells, Vero E6, and Huh-7. Cytopathic effects (CPE) were observed 96 hours after inoculation. Typical crown-like particles were observed under transmission electron microscope (TEM) with negative staining. The cellular infectivity of the isolated viruses could be completely neutralized by the sera collected from convalescent patients. Transgenic human ACE2 mice and Rhesus monkey intranasally challenged by this virus isolate induced multifocal pneumonia with interstitial hyperplasia. The COVID-19 virus was subsequently detected and isolated in the lung and intestinal tissues of the challenged animals.

Whole genome sequencing analysis of 104 strains of the COVID-19 virus isolated from patients in different localities with symptom onset between the end of December 2019 and mid-February 2020 showed 99.9% homology, without significant mutation (Figure 1).

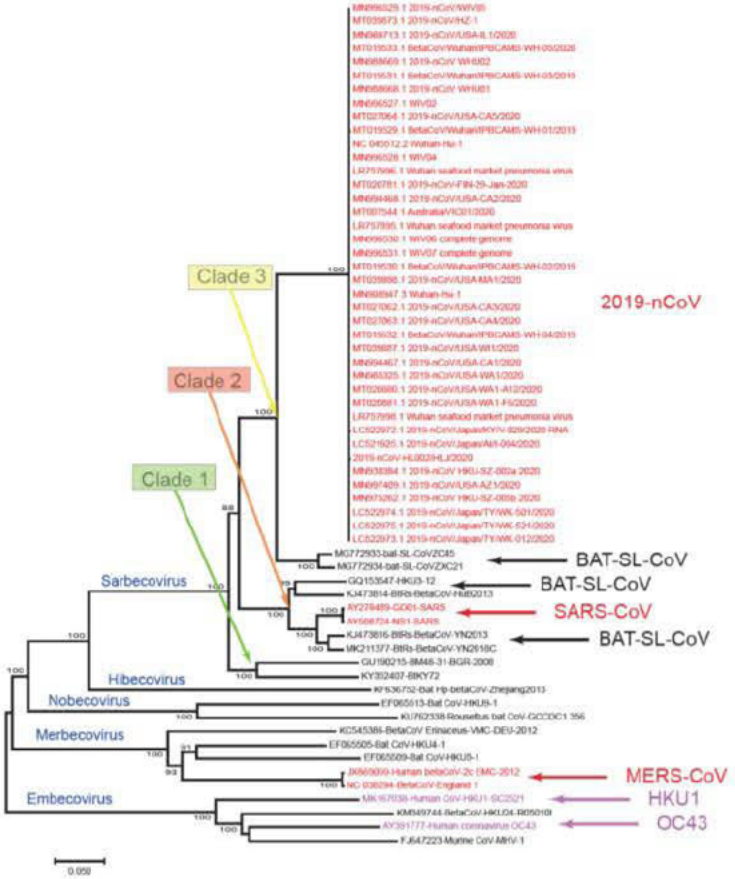


**Figure 1. Phylogenetic analysis of the COVID-19 virus and its closely related reference genomes**

Note: COVID-19 virus is referred to as 2019-nCoV in the figure, the interim virus name WHO announced early in the outbreak.

Post-mortem samples from a 50-year old male patient from Wuhan were taken from the lung, liver, and heart. Histological examination showed bilateral diffuse alveolar damage with cellular fibromyxoid exudates. The lung showed evident desquamation of pneumocytes and hyaline membrane formation, indicating acute respiratory distress syndrome (ARDS). Lung tissue also displayed cellular and fibromyxoid exudation, desquamation of pneumocytes and pulmonary oedema. Interstitial mononuclear inflammatory infiltrates, dominated by lymphocytes, were seen in both lungs. Multinucleated syncytial cells with atypical enlarged pneumocytes characterized by large nuclei, amphophilic granular cytoplasm, and prominent nucleoli were identified in the intra-alveolar spaces, showing viral cytopathic-like changes. No obvious intranuclear or intracytoplasmic viral inclusions were identified.

## The outbreak

As of 20 February 2020, a cumulative total of 75,465 COVID-19 cases were reported in China. Reported cases are based on the National Reporting System (NRS) between the

National and Provincial Health Commissions. The NRS issues daily reports of newly recorded confirmed cases, deaths, suspected cases, and contacts. A daily report is provided by each province at 0300hr in which they report cases from the previous day.

The epidemic curves presented in Figures 2 and 3 are generated using China's National Infectious Disease Information System (IDIS), which requires each COVID-19 case to be reported electronically by the responsible doctor as soon as a case has been diagnosed. It includes cases that are reported as asymptomatic and data are updated in real time. Individual case reporting forms are downloaded after 2400hr daily. Epidemiologic curves for Wuhan, Hubei (outside of Wuhan), China (outside Hubei) and China by symptom onset are provided in Figure 2.

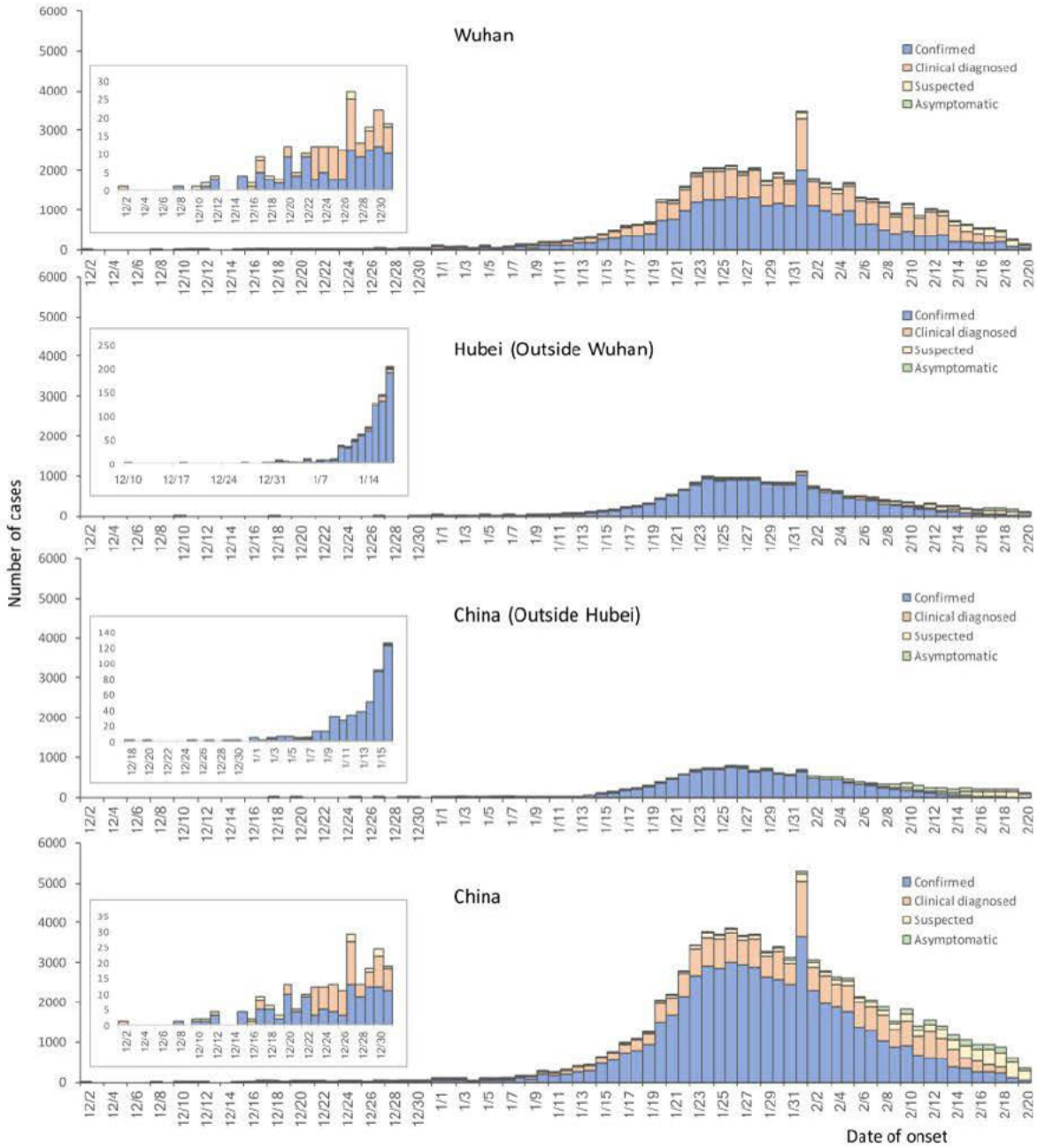


**Figure 2 Epidemiologic curve of COVID-19 laboratory confirmed cases, by date of onset of illness, reported in China, as of 20 February 2020**

Figure 3 presents epidemic curves of laboratory-confirmed cases, by symptom onset and separately by date of report, at 5, 12, and 20 February 2020. Figures 2 and 3 illustrate that the epidemic rapidly grew from 10-22 January, reported cases peaked and plateaued between 23 January and 27 January, and have been steadily declining since then, apart from the spike that was reported on 1 February (note: at a major hospital in Wuhan, fever clinic patients fell from a peak of 500/day in late January to average 50/day since mid-February).

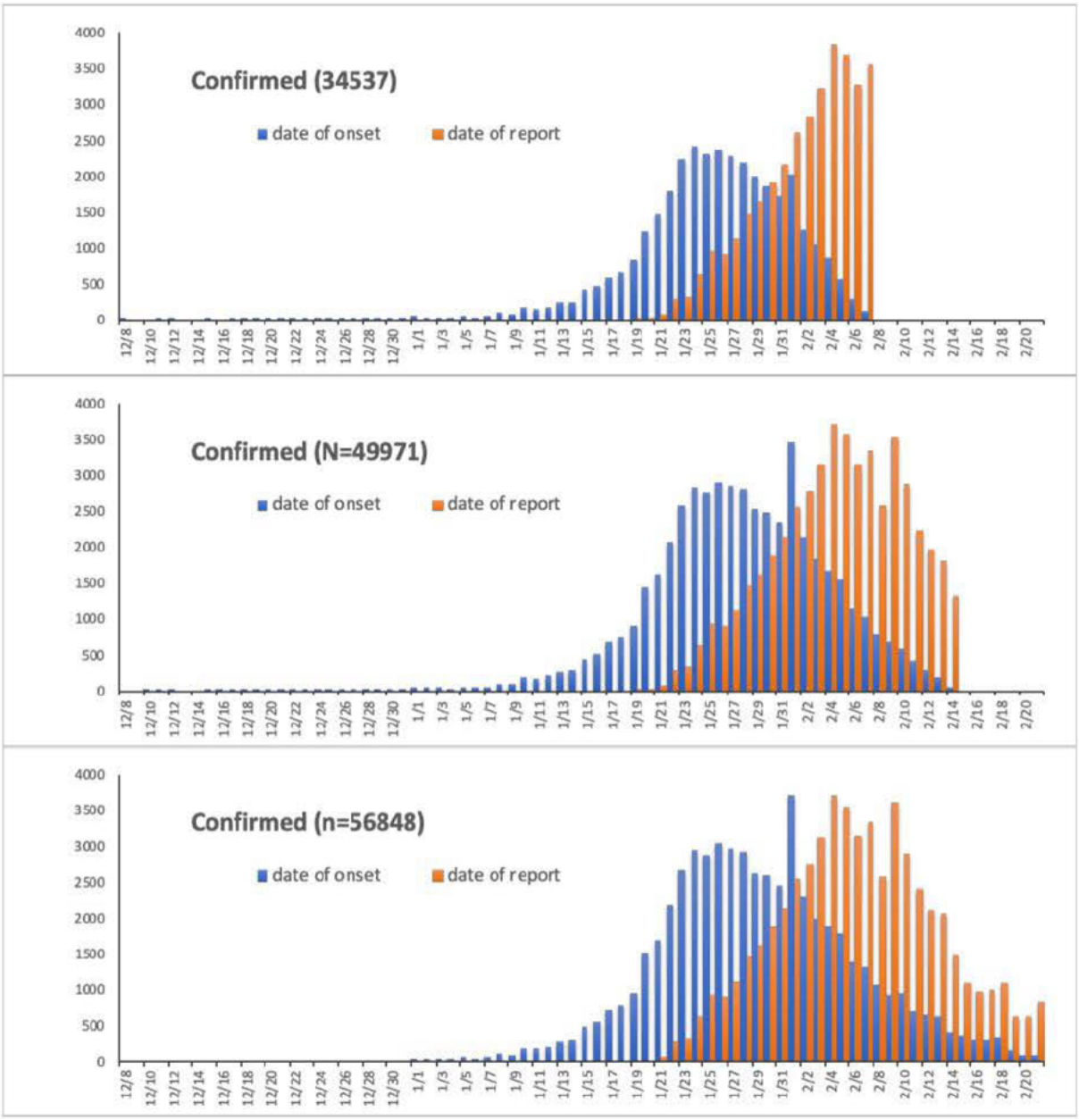


**Figure 3. Epidemic curves by symptom onset and date of report as of 5 February (top panel), 12 February (middle panel) and 20 February 2020 (lower panel) for laboratory confirmed COVID-19 cases for all of China**

Based on these epidemic curves, the published literature, and our on-site visits in Wuhan (Hubei), Guangdong (Shenzhen and Guangzhou), Sichuan (Chengdu), and Beijing, the Joint Mission team has made the following epidemiological observations:

### *Demographic characteristics*

Among 55,924 laboratory confirmed cases reported as of 20 February 2020, the median age is 51 years (range 2 days-100 years old; IQR 39-63 years old) with the majority of cases (77.8%) aged between 30–69 years. Among reported cases, 51.1% are male, 77.0% are from Hubei and 21.6% are farmers or laborers by occupation.

### *Zoonotic origins*

COVID-19 is a zoonotic virus. From phylogenetics analyses undertaken with available full genome sequences, bats appear to be the reservoir of COVID-19 virus, but the intermediate host(s) has not yet been identified. However, three important areas of work are already underway in China to inform our understanding of the zoonotic origin of this outbreak. These include early investigations of cases with symptom onset in Wuhan throughout December 2019, environmental sampling from the Huanan Wholesale Seafood Market and other area markets, and the collection of detailed records on the source and type of wildlife species sold at the Huanan market and the destination of those animals after the market was closed.

### *Routes of transmission*

COVID-19 is transmitted via droplets and fomites during close unprotected contact between an infector and infectee. Airborne spread has not been reported for COVID-19 and it is not believed to be a major driver of transmission based on available evidence; however, it can be envisaged if certain aerosol-generating procedures are conducted in health care facilities. Fecal shedding has been demonstrated from some patients, and viable virus has been identified in a limited number of case reports. However, the fecal-oral route does not appear to be a driver of COVID-19 transmission; its role and significance for COVID-19 remains to be determined. Viral shedding is discussed in the Technical Findings (Annex C).

### *Household transmission*

In China, human-to-human transmission of the COVID-19 virus is largely occurring in families. The Joint Mission received detailed information from the investigation of clusters and some household transmission studies, which are ongoing in a number of Provinces. Among 344 clusters involving 1308 cases (out of a total 1836 cases reported) in Guangdong Province and Sichuan Province, most clusters (78%-85%) have occurred in families. Household transmission studies are currently underway, but preliminary studies ongoing in Guangdong estimate the secondary attack rate in households ranges from 3-10%.

### *Contact Tracing*

China has a policy of meticulous case and contact identification for COVID-19. For example, in Wuhan more than 1800 teams of epidemiologists, with a minimum of 5 people/team, are tracing tens of thousands of contacts a day. Contact follow up is painstaking, with a high percentage of identified close contacts completing medical observation. Between 1% and 5% of contacts were subsequently laboratory confirmed cases of COVID-19, depending on location. For example:

- As of 17 February, in Shenzhen City, among 2842 identified close contacts, 2842 (100%) were traced and 2240 (79%) have completed medical observation. Among the close contacts, 88 (3.1%) were found to be infected with COVID-19.

- As of 17 February, in Sichuan Province, among 25493 identified close contacts, 25347 (99%) were traced and 23178 (91%) have completed medical observation. Among the close contacts, 0.9% were found to be infected with COVID-19.
- As of 20 February, in Guangdong Province, among 9939 identified close contacts, 9939 (100%) were traced and 7765 (78%) have completed medical observation. Among the close contacts, 479 (4.8%) were found to be infected with COVID-19.

### *Testing at fever clinics and from routine ILI/SARI surveillance*

The Joint Mission systematically enquired about testing for COVID-19 from routine respiratory disease surveillance systems to explore if COVID-19 is circulating more broadly and undetected in the community in China. These systems could include RT-PCR testing of COVID-19 virus in influenza-like-illness (ILI) and severe acute respiratory infection (SARI) surveillance systems, as well as testing of results among all visitors to fever clinics.

In Wuhan, COVID-19 testing of ILI samples (20 per week) in November and December 2019 and in the first two weeks of January 2020 found no positive results in the 2019 samples, 1 adult positive in the first week of January, and 3 adults positive in the second week of January; all children tested were negative for COVID-19 although a number were positive for influenza. In Guangdong, from 1-14 January, only 1 of more than 15000 ILI/SARI samples tested positive for the COVID-19 virus. In one hospital in Beijing, there were no COVID-19 positive samples among 1910 collected from 28 January 2019 to 13 February 2020. In a hospital in Shenzhen, 0/40 ILI samples were positive for COVID-19.

Within the fever clinics in Guangdong, the percentage of samples that tested positive for the COVID-19 virus has decreased over time from a peak of 0.47% positive on 30 January to 0.02% on 16 February. Overall in Guangdong, 0.14% of approximately 320,000 fever clinic screenings were positive for COVID-19.

### *Susceptibility*

As COVID-19 is a newly identified pathogen, there is no known pre-existing immunity in humans. Based on the epidemiologic characteristics observed so far in China, everyone is assumed to be susceptible, although there may be risk factors increasing susceptibility to infection. This requires further study, as well as to know whether there is neutralising immunity after infection.

## The transmission dynamics

Inferring from Figures 2 and 3, and based on our observations at the national and provincial/municipal levels during the Joint Mission, we summarize and interpret the transmission dynamics of COVID-19 thus far. It is important to note that transmission dynamics of any outbreak are inherently contextual. For COVID-19, we observe four major types of transmission dynamics during the epidemic growth phase and in the post-control period, and highlight what is known about transmission in children, as follows:

### *Transmission in Wuhan*

Early cases identified in Wuhan are believed to be have acquired infection from a zoonotic source as many reported visiting or working in the Huanan Wholesale Seafood Market. As of 25 February, an animal source has not yet been identified.

At some point early in the outbreak, some cases generated human-to-human transmission chains that seeded the subsequent community outbreak prior to the implementation of the comprehensive control measures that were rolled out in Wuhan. The dynamics likely approximated mass action and radiated from Wuhan to other parts of Hubei province and China, which explains a relatively high $R_0$ of 2-2.5.

The *cordon sanitaire* around Wuhan and neighboring municipalities imposed since 23 January 2020 has effectively prevented further exportation of infected individuals to the rest of the country.

### *Transmission in Hubei, other than Wuhan*

In the prefectures immediately adjoining Wuhan (Xiaogan, Huanggang, Jingzhou and Ezhou), transmission is less intense. For other prefectures, due to fewer transport links and human mobility flows with Wuhan, the dynamics are more closely aligned with those observed in the other areas of the country. Within Hubei, the implementation of control measures (including social distancing) has reduced the community force of infection, resulting in the progressively lower incident reported case counts.

### *Transmission in China outside of Hubei*

Given Wuhan's transport hub status and population movement during the Chinese New Year (chunyun), infected individuals quickly spread throughout the country, and were particularly concentrated in cities with the highest volume of traffic with Wuhan. Some of these imported seeds generated limited human-to-human transmission chains at their destination.

Given the Wuhan/Hubei experience, a comprehensive set of interventions, including aggressive case and contact identification, isolation and management and extreme social distancing, have been implemented to interrupt the chains of transmission nationwide. To date, most of the recorded cases were imported from or had direct links to Wuhan/Hubei. Community transmission has been very limited. Most locally generated cases have been clustered, the majority of which have occurred in households, as summarized above.

Of note, the highly clustered nature of local transmission may explain a relatively high $R_0$ (2-2.5) in the absence of interventions and low confirmed case counts with intense quarantine and social distancing measures.

### *Special settings*

We note that instances of transmission have occurred within health care settings prisons and other closed settings. At the present time, it is not clear what role these settings and groups play in transmission. However, they do not appear to be major drivers of the overall epidemic dynamics. Specifically, we note:

(a) **Transmission in health care settings and among health care workers (HCW)** – The Joint Mission discussed nosocomial infection in all locations visited during the Mission. As of 20 February 2020, there were 2,055 COVID-19 laboratory-confirmed cases reported among HCW from 476 hospitals across China. The majority of HCW cases (88%) were reported from Hubei.

Remarkably, more than 40,000 HCW have been deployed from other areas of China to support the response in Wuhan. Notwithstanding discrete and limited instances of nosocomial outbreaks (e.g. a nosocomial outbreak involving 15 HCW in Wuhan), transmission within health care settings and amongst health care workers does not appear to be a major transmission feature of COVID-19 in China. The Joint Mission learned that, among the HCW infections, most were identified early in the outbreak in Wuhan when supplies and experience with the new disease was lower. Additionally, investigations among HCW suggest that many may have been infected within the household rather than in a health care setting. Outside of Hubei, health care worker infections have been less frequent (i.e. 246 of the total 2055 HCW cases). When exposure was investigated in these limited cases, the exposure for most was reported to have been traced back to a confirmed case in a household.

The Joint Team noted that attention to the prevention of infection in health care workers is of paramount importance in China. Surveillance among health care workers identified factors early in the outbreak that placed HCW at higher risk of infection, and this information has been used to modify policies to improve protection of HCW.

(b) **Transmission in closed settings** – There have been reports of COVID-19 transmission in prisons (Hubei, Shandong, and Zhejiang, China), hospitals (as above) and in a long-term living facility. The close proximity and contact among people in these settings and the potential for environmental contamination are important factors, which could amplify transmission. Transmission in these settings warrants further study.

### *Children*

Data on individuals aged 18 years old and under suggest that there is a relatively low attack rate in this age group (2.4% of all reported cases). Within Wuhan, among testing of ILI samples, no children were positive in November and December of 2019 and in the first two weeks of January 2020. From available data, and in the absence of results from serologic studies, it is not possible to determine the extent of infection among children, what role children play in transmission, whether children are less susceptible or if they present differently clinically (i.e. generally milder presentations). The Joint Mission learned that infected children have largely been identified through contact tracing in households of adults. Of note, people interviewed by the Joint Mission Team could not recall episodes in which transmission occurred from a child to an adult.

## The signs, symptoms, disease progression and severity

Symptoms of COVID-19 are non-specific and the disease presentation can range from no symptoms (asymptomatic) to severe pneumonia and death. As of 20 February 2020 and

based on 55924 laboratory confirmed cases, typical **signs and symptoms** include: fever (87.9%), dry cough (67.7%), fatigue (38.1%), sputum production (33.4%), shortness of breath (18.6%), sore throat (13.9%), headache (13.6%), myalgia or arthralgia (14.8%), chills (11.4%), nausea or vomiting (5.0%), nasal congestion (4.8%), diarrhea (3.7%), and hemoptysis (0.9%), and conjunctival congestion (0.8%).

People with COVID-19 generally develop signs and symptoms, including mild respiratory symptoms and fever, on an average of 5-6 days after infection (mean incubation period 5-6 days, range 1-14 days).

Most people infected with COVID-19 virus have mild disease and recover. Approximately 80% of laboratory confirmed patients have had **mild to moderate disease**, which includes non-pneumonia and pneumonia cases, 13.8% have **severe disease** (dyspnea, respiratory frequency ≥30/minute, blood oxygen saturation ≤93%, PaO2/FiO2 ratio <300, and/or lung infiltrates >50% of the lung field within 24-48 hours) and 6.1% are **critical** (respiratory failure, septic shock, and/or multiple organ dysfunction/failure). **Asymptomatic infection** has been reported, but the majority of the relatively rare cases who are asymptomatic on the date of identification/report went on to develop disease. The proportion of truly asymptomatic infections is unclear but appears to be relatively rare and does not appear to be a major driver of transmission.

Individuals at **highest risk** for severe disease and death include people aged over 60 years and those with underlying conditions such as hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer. Disease in **children** appears to be relatively rare and mild with approximately 2.4% of the total reported cases reported amongst individuals aged under 19 years. A very small proportion of those aged under 19 years have developed severe (2.5%) or critical disease (0.2%).

As of 20 February, 2114 of the 55,924 laboratory confirmed cases have died (**crude fatality ratio** [CFR[2]] 3.8%) (note: at least some of whom were identified using a case definition that included pulmonary disease). The overall CFR varies by location and intensity of transmission (i.e. 5.8% in Wuhan vs. 0.7% in other areas in China). In China, the overall CFR was higher in the early stages of the outbreak (17.3% for cases with symptom onset from 1-10 January) and has reduced over time to 0.7% for patients with symptom onset after 1 February (Figure 4). The Joint Mission noted that the standard of care has evolved over the course of the outbreak.

Mortality increases with age, with the highest mortality among people over 80 years of age (CFR 21.9%). The CFR is higher among males compared to females (4.7% vs. 2.8%). By occupation, patients who reported being retirees had the highest CFR at 8.9%. While patients who reported no comorbid conditions had a CFR of 1.4%, patients with comorbid conditions had much higher rates: 13.2% for those with cardiovascular disease, 9.2% for diabetes, 8.4% for hypertension, 8.0% for chronic respiratory disease, and 7.6% for cancer.

[2] The Joint Mission acknowledges the known challenges and biases of reporting crude CFR early in an epidemic.

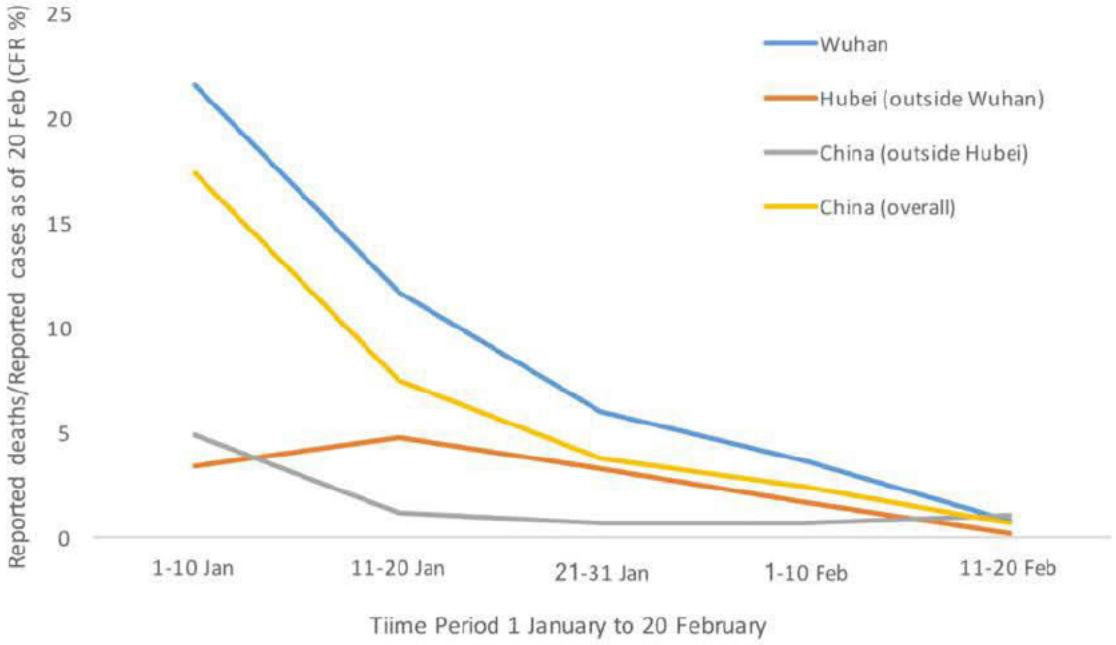


**Figure 4 Case fatality ratio (reported deaths among total cases) for COVID-19 in China over time and by location, as of 20 February 2020**

Data on the **progression of disease** is available from a limited number of reported hospitalized cases (Figure 5). Based on available information, the median time from symptom onset to laboratory confirmation nationally decreased from 12 days (range 8-18 days) in early January to 3 days (1-7) by early February 2020, and in Wuhan from 15 days (10-21) to 5 days (3-9), respectively. This has allowed for earlier case and contact identification, isolation and treatment.

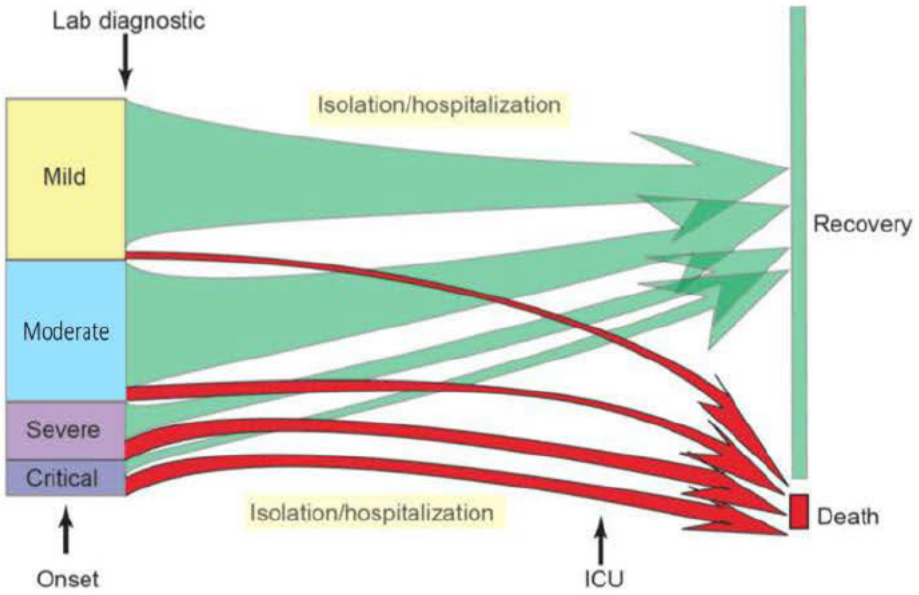


**Figure 5. Pattern of disease progression for COVID-19 in China**

Note: the relative size of the boxes for disease severity and outcome reflect the proportion of cases reported as of 20 February 2020. The size of the arrows indicates the proportion of cases who recovered or died. Disease definitions are described above. Moderate cases have a mild form of pneumonia.

Using available preliminary data, the median time from onset to clinical recovery for mild cases is approximately 2 weeks and is 3-6 weeks for patients with severe or critical disease. Preliminary data suggests that the time period from onset to the development of severe disease, including hypoxia, is 1 week. Among patients who have died, the time from symptom onset to outcome ranges from 2-8 weeks.

An increasing number of patients have **recovered**; as of 20 February, 18264 (24%) reported cases have recovered. Encouragingly, a report on 20 February from the Guangdong CDC suggests that of 125 severe cases identified in Guangdong, 33 (26.4%) have recovered and been released from hospital, and 58 (46.4%) had improved and were reclassified as having mild/moderate disease (i.e. + milder pneumonia). Among severe cases reported to date, 13.4% have died. Early identification of cases and contacts allows for earlier treatment.

## The China response

Upon the detection of a cluster of pneumonia cases of unknown etiology in Wuhan, the CPC Central Committee and the State Council launched the national emergency response. A **Central Leadership Group for Epidemic Response** and the **Joint Prevention and Control Mechanism** of the State Council were established. General Secretary Xi Jinping personally directed and deployed the prevention and control work and requested that the prevention and control of the COVID-19 outbreak be the top priority of government at all levels. Prime Minister Li Keqiang headed the Central Leading Group for Epidemic Response and went to Wuhan to inspect and coordinate the prevention and control work of relevant departments and provinces (autonomous regions and municipalities) across the country. Vice Premier Sun Chunlan, who has been working on the frontlines in Wuhan, has led and coordinated the frontline prevention and control of the outbreak.

The prevention and control measures have been implemented rapidly, from the early stages in Wuhan and other key areas of Hubei, to the current overall national epidemic. It has been undertaken in **three main phases**, with two important events defining those phases. First, COVID-19 was included in the statutory report of Class B infectious diseases and border health quarantine infectious diseases on 20 January 2020, which marked the transition from the initial partial control approach to the comprehensive adoption of various control measures in accordance with the law. The second event was the State Council's issuing, on 8 February 2020, of The Notice on Orderly Resuming Production and Resuming Production in Enterprises, which indicated that China's national epidemic control work had entered a stage of overall epidemic prevention and control together with the restoration of normal social and economic operations.

### *The first stage*

During the early stage of the outbreak, the main strategy focused on preventing the exportation of cases from Wuhan and other priority areas of Hubei Province, and preventing the importation of cases by other provinces; the overall aim was to control the source of infection, block transmission and prevent further spread. The response mechanism was initiated with multi-sectoral involvement in joint prevention and control measures. Wet markets were closed, and efforts were made to identify the zoonotic source. Information on the epidemic was notified to WHO on 3 January, and whole genome sequences of the COVID-19 virus were shared with WHO on 10 January. Protocols for COVID-19 diagnosis and

treatment, surveillance, epidemiological investigation, management of close contacts, and laboratory testing were formulated, and relevant surveillance activities and epidemiological investigations conducted. Diagnostic testing kits were developed, and wildlife and live poultry markets were placed under strict supervision and control measures.

### *The second stage*

During the second stage of the outbreak, the main strategy was to reduce the intensity of the epidemic and to slow down the increase in cases. In Wuhan and other priority areas of Hubei Province, the focus was on actively treating patients, reducing deaths, and preventing exportations. In other provinces, the focus was on preventing importations, curbing the spread of the disease and implementing joint prevention and control measures. Nationally, wildlife markets were closed and wildlife captive-breeding facilities were cordoned off. On 20 January, COVID-19 was included in the notifiable report of Class B infectious diseases and border health quarantine infectious diseases, with temperature checks, health care declarations, and quarantine against COVID-19 instituted at transportation depots in accordance with the law. On 23 January, Wuhan implemented strict traffic restrictions. The protocols for diagnosis, treatment and epidemic prevention and control were improved; case isolation and treatment were strengthened.

Measures were taken to ensure that all cases were treated, and close contacts were isolated and put under medical observation. Other measures implemented included the extension of the Spring Festival holiday, traffic controls, and the control of transportation capacity to reduce the movement of people; mass gathering activities were also cancelled. Information about the epidemic and prevention and control measures was regularly released. Public risk communications and health education were strengthened; allocation of medical supplies was coordinated, new hospitals were built, reserve beds were used and relevant premises were repurposed to ensure that all cases could be treated; efforts were made to maintain a stable supply of commodities and their prices to ensure the smooth operation of society.

### *The third stage*

The third stage of the outbreak focused on reducing clusters of cases, thoroughly controlling the epidemic, and striking a balance between epidemic prevention and control, sustainable economic and social development, the unified command, standardized guidance, and scientific evidence-based policy implementation. For Wuhan and other priority areas of Hubei Province, the focus was on patient treatment and the interruption of transmission, with an emphasis on concrete steps to fully implement relevant measures for the testing, admitting and treating of all patients. A risk-based prevention and control approach was adopted with differentiated prevention and control measures for different regions of the country and provinces. Relevant measures were strengthened in the areas of epidemiological investigation, case management and epidemic prevention in high-risk public places.

New technologies were applied such as the use of big data and artificial intelligence (AI) to strengthen contact tracing and the management of priority populations. Relevant health insurance policies were promulgated on "health insurance payment, off-site settlement, and financial compensation". All provinces provided support to Wuhan and priority areas in Hubei Province in an effort to quickly curb the spread of the disease and provide timely clinical treatment. Pre-school preparation was improved, and work resumed in phases and

batches. Health and welfare services were provided to returning workers in a targeted and 'one-stop' manner. Normal social operations are being restored in a stepwise fashion; knowledge about disease prevention is being popularized to improve public health literacy and skills; and a comprehensive program of emergency scientific research is being carried out to develop diagnostics, therapeutics and vaccines, delineate the spectrum of the disease, and identify the source of the virus.

### Knowledge gaps

Since the start of the COVID-19 outbreak, there have been extensive attempts to better understand the virus and the disease in China. It is remarkable how much knowledge about a new virus has been gained in such a short time. However, as with all new diseases, and only 7 weeks after this outbreak began, key knowledge gaps remain. Annex D summarizes the key unknowns in a number of areas including the source of infection, pathogenesis and virulence of the virus, transmissibility, risk factors for infection and disease progression, surveillance, diagnostics, clinical management of severe and critically ill patients, and the effectiveness of prevention and control measures. The timely filling of these knowledge gaps is imperative to enhance control strategies.

## III. Assessment

The Joint Mission drew four major conclusions from its work in China and four major conclusions from its knowledge of the broader global response to COVID-19. Recommendations are offered in five major areas to inform the ongoing response globally and in China.

### The China Response & Next Steps

1. **In the face of a previously unknown virus, China has rolled out perhaps the most ambitious, agile and aggressive disease containment effort in history. The strategy that underpinned this containment effort was initially a national approach that promoted universal temperature monitoring, masking, and hand washing. However, as the outbreak evolved, and knowledge was gained, a science and risk-based approach was taken to tailor implementation. Specific containment measures were adjusted to the provincial, county and even community context, the capacity of the setting, and the nature of novel coronavirus transmission there.**

   While the fundamental principles of this strategy have been consistent since its launch, there has been constant refinement of specific aspects to incorporate new knowledge on the novel coronavirus, the COVID-19 disease, and COVID-19 containment, as rapidly as that knowledge has emerged. The remarkable speed with which Chinese scientists and public health experts isolated the causative virus, established diagnostic tools, and determined key transmission parameters, such as the route of spread and incubation period, provided the vital evidence base for China's strategy, gaining invaluable time for the response.

As striking, has been the uncompromising rigor of strategy application that proved to be a hallmark in every setting and context where it was examined. There has also been a relentless focus on improving key performance indicators, for example constantly enhancing the speed of case detection, isolation and early treatment. The implementation of these containment measures has been supported and enabled by the innovative and aggressive use of cutting edge technologies, from shifting to online medical platforms for routine care and schooling, to the use of 5G platforms to support rural response operations.

2. **Achieving China's exceptional coverage with and adherence to these containment measures has only been possible due to the deep commitment of the Chinese people to collective action in the face of this common threat. At a community level this is reflected in the remarkable solidarity of provinces and cities in support of the most vulnerable populations and communities. Despite ongoing outbreaks in their own areas, Governors and Mayors have continued to send thousands of health care workers and tons of vital PPE supplies into Hubei province and Wuhan city.**

   At the individual level, the Chinese people have reacted to this outbreak with courage and conviction. They have accepted and adhered to the starkest of containment measures – whether the suspension of public gatherings, the month-long 'stay at home' advisories or prohibitions on travel. Throughout an intensive 9-days of site visits across China, in frank discussions from the level of local community mobilizers and frontline health care providers to top scientists, Governors and Mayors, the Joint Mission was struck by the sincerity and dedication that each brings to this COVID-19 response.

3. **China's bold approach to contain the rapid spread of this new respiratory pathogen has changed the course of a rapidly escalating and deadly epidemic. A particularly compelling statistic is that on the first day of the advance team's work there were 2478 newly confirmed cases of COVID-19 reported in China. Two weeks later, on the final day of this Mission, China reported 409 newly confirmed cases. This decline in COVID-19 cases across China is real.**

   Several sources of data support this conclusion, including the steep decline in fever clinic visits, the opening up of treatment beds as cured patients are discharged, and the challenges to recruiting new patients for clinical trials. Based on a comparison of crude attack rates across provinces, the Joint Mission estimates that this truly all-of-Government and all-of-society approach that has been taken in China has averted or at least delayed hundreds of thousands of COVID-19 cases in the country. By extension, the reduction that has been achieved in the force of COVID-19 infection in China has also played a significant role in protecting the global community and creating a stronger first line of defense against international spread. Containing this outbreak, however, has come at great cost and sacrifice by China and its people, in both human and material terms.

   While the scale and impact of China's COVID-19 operation has been remarkable, it has also highlighted areas for improvement in public health emergency response capacity.

These include overcoming any obstacles to act immediately on early alerts, to massively scale-up capacity for isolation and care, to optimize the protection of frontline health care workers in all settings, to enhance collaborative action on priority gaps in knowledge and tools, and to more clearly communicate key data and developments internationally.

4. **China is already, and rightfully, working to bolster its economy, reopen its schools and return to a more normal semblance of its society, even as it works to contain the remaining chains of COVID-19 transmission. Appropriately, a science-based, risk-informed and phased approach is being taken, with a clear recognition and readiness of the need to immediately react to any new COVID-19 cases or clusters as key elements of the containment strategy are lifted.**

   Despite the declining case numbers, across China every province, city and community visited is urgently escalating their investments in acute care beds and public health capacity. It is crucial that this continues. Fifty thousand infected COVID-19 patient are still under treatment, across the country. However, the Joint Mission has come to understand the substantial knowledge, experience and capacities that China has rapidly built during this crisis. Consequently, it endorses China's working assumption that in most provinces and municipalities it should soon be possible to manage a resurgence in COVID-19 cases, using even more tailored and sustainable approaches that are anchored in very rapid case detection, instant activation of key containment activities, direct oversight by top leadership, and broad community engagement.

   As China works to resume a more normal level of societal and economic activity, it is essential that the world recognizes and reacts positively to the rapidly changing, and decreasing, risk of COVID-19 in the country. China's rapid return to full connectivity with the world, and to full productivity and economic output, is vital to China and to the world. The world urgently needs access to China's experience in responding to COVID-19, as well as the material goods it brings to the global response. It is even more urgent now, with escalating COVID-19 outbreaks outside of China, to constantly reassess any restrictions on travel and/or trade to China that go beyond the recommendations of the IHR Emergency Committee on COVID-19.

## The Global Response & Next Steps

1. **The COVID-19 virus is a new pathogen that is highly contagious, can spread quickly, and must be considered capable of causing enormous health, economic and societal impacts in any setting. It is not SARS and it is not influenza. Building scenarios and strategies only on the basis of well-known pathogens risks failing to exploit all possible measures to slow transmission of the COVID-19 virus, reduce disease and save lives.**

   COVID-19 is not SARS and it is not influenza. It is a new virus with its own characteristics. For example, COVID-19 transmission in children appears to be limited compared with influenza, while the clinical picture differs from SARS. Such differences, while based on limited data, may be playing a role in the apparent efficacy of rigorously

applied non-pharmaceutical, public health measures to interrupt chains of human-to-human transmission in a range of settings in China. The COVID-19 virus is unique among human coronaviruses in its combination of high transmissibility, substantial fatal outcomes in some high-risk groups, and ability to cause huge societal and economic disruption. For planning purposes, it must be assumed that the global population is susceptible to this virus. As the animal origin of the COVID-19 virus is unknown at present, the risk of reintroduction into previously infected areas must be constantly considered.

The novel nature, and our continuously evolving understanding, of this coronavirus demands a tremendous agility in our capacity to rapidly adapt and change our readiness and response planning as has been done continually in China. This is an extraordinary feat for a country of 1.4 billion people.

2. **China's uncompromising and rigorous use of non-pharmaceutical measures to contain transmission of the COVID-19 virus in multiple settings provides vital lessons for the global response. This rather unique and unprecedented public health response in China reversed the escalating cases in both Hubei, where there has been widespread community transmission, and in the importation provinces, where family clusters appear to have driven the outbreak.**

   Although the timing of the outbreak in China has been relatively similar across the country, transmission chains were established in a wide diversity of settings, from mega-cities in the north and south of the country, to remote communities. However, the rapid adaptation and tailoring of China's strategy demonstrated that containment can be adapted and successfully operationalized in a wide range of settings.

   China's experience strongly supports the efficacy and effectiveness of anchoring COVID-19 readiness and rapid response plans in a thorough assessment of local risks and of utilizing a differentiated risk-based containment strategy to manage the outbreak in areas with no cases vs. sporadic cases vs. clusters of cases vs. community-level transmission. Such a strategy is essential for ensuring a sustainable approach while minimizing the socio-economic impact.

3. **Much of the global community is not yet ready, in mindset and materially, to implement the measures that have been employed to contain COVID-19 in China. These are the only measures that are currently proven to interrupt or minimize transmission chains in humans. Fundamental to these measures is extremely proactive surveillance to immediately detect cases, very rapid diagnosis and immediate case isolation, rigorous tracking and quarantine of close contacts, and an exceptionally high degree of population understanding and acceptance of these measures.**

   Achieving the high quality of implementation needed to be successful with such measures requires an unusual and unprecedented speed of decision-making by top leaders, operational thoroughness by public health systems, and engagement of society.

Given the damage that can be caused by uncontrolled, community-level transmission of this virus, such an approach is warranted to save lives and to gain the weeks and months needed for the testing of therapeutics and vaccine development. Furthermore, as the majority of new cases outside of China are currently occurring in high and middle-income countries, a rigorous commitment to slowing transmission in such settings with non-pharmaceutical measures is vital to achieving a second line of defense to protect low income countries that have weaker health systems and coping capacities.

The time that can be gained through the full application of these measures – even if just days or weeks – can be invaluable in ultimately reducing COVID-19 illness and deaths. This is apparent in the huge increase in knowledge, approaches and even tools that has taken place in just the 7 weeks since this virus was discovered through the rapid scientific work that has been done in China.

4. **The time gained by rigorously applying COVID-19 containment measures must be used more effectively to urgently enhance global readiness and rapidly develop the specific tools that are needed to ultimately stop this virus.**

   COVID-19 is spreading with astonishing speed; COVID-19 outbreaks in any setting have very serious consequences; and there is now strong evidence that non-pharmaceutical interventions can reduce and even interrupt transmission. Concerningly, global and national preparedness planning is often ambivalent about such interventions. However, to reduce COVID-19 illness and death, near-term readiness planning must embrace the large-scale implementation of high-quality, non-pharmaceutical public health measures. These measures must fully incorporate immediate case detection and isolation, rigorous close contact tracing and monitoring/quarantine, and direct population/community engagement.

   A huge array of COVID-19 studies, scientific research projects and product R&D efforts are ongoing in China and globally. This is essential and to be encouraged and supported. However, such a large number of projects and products needs to be prioritized. Without prioritizing, this risks compromising the concentration of attention and resources and collaboration required to cut timelines by precious weeks and months. While progress has been made, the urgency of the COVID-19 situation supports an even more ruthless prioritization of research in the areas of diagnostics, therapeutics and vaccines.

   Similarly, there is a long list of proposed studies on the origins of COVID-19, the natural history of the disease, and the virus's transmission dynamics. However, the urgency of responding to cases and saving lives makes it difficult for policy makers to consider and act on such comprehensive lists. This can be addressed by balancing studies with the immediate public health and clinical needs of the response. Studies can be prioritized in terms of the largest knowledge gaps that can be most rapidly addressed to have greatest immediate impact on response operations and patient management. This suggests prioritizing studies to identify risk factors for transmission in households, institutions and the community; convenience sampling for this virus in the population using existing surveillance systems; age-stratified sero-epidemiologic surveys; the analysis of clinical case series; and cluster investigations.

# IV. Major Recommendations

## For China

1. Maintain an appropriate level of emergency management protocols, depending on the assessed risk in each area and recognizing the real risk of new cases and clusters of COVID-19 as economic activity resumes, movement restrictions are lifted, and schools reopen;

2. Carefully monitor the phased lifting of the current restrictions on movement and public gatherings, beginning with the return of workers and migrant labor, followed by the eventual reopening of schools and lifting other measures;

3. Further strengthen the readiness of emergency management mechanisms, public health institutions (e.g. CDCs), medical facilities, and community engagement mechanisms to ensure sustained capacity to immediately launch containment activities in response to any resurgence in cases;

4. Prioritize research that rapidly informs response and risk management decisions, particularly household and health care facility studies, age-stratified sero-epidemiologic surveys and rigorous investigation of the animal-human interface; establish a centralized research program to fast-track the most promising rapid diagnostics and serologic assays, the testing of potential antivirals and vaccine candidates, and Chinese engagement in selected multi-country trials; and

5. As the country with the greatest knowledge on COVID-19, further enhance the systematic and real-time sharing of epidemiologic data, clinical results and experience to inform the global response.

## For countries with imported cases and/or outbreaks of COVID-19

1. Immediately activate the highest level of national Response Management protocols to ensure the all-of-government and all-of-society approach needed to contain COVID-19 with non-pharmaceutical public health measures;

2. Prioritize active, exhaustive case finding and immediate testing and isolation, painstaking contact tracing and rigorous quarantine of close contacts;

3. Fully educate the general public on the seriousness of COVID-19 and their role in preventing its spread;

4. Immediately expand surveillance to detect COVID-19 transmission chains, by testing all patients with atypical pneumonias, conducting screening in some patients with upper respiratory illnesses and/or recent COVID-19 exposure, and adding testing for the COVID-19 virus to existing surveillance systems (e.g. systems for influenza-like-illness and SARI); and

5. Conduct multi-sector scenario planning and simulations for the deployment of even more stringent measures to interrupt transmission chains as needed (e.g. the suspension of large-scale gatherings and the closure of schools and workplaces).

## For uninfected countries

1. Prepare to immediately activate the highest level of emergency response mechanisms to trigger the all-of-government and all-of society approach that is essential for early containment of a COVID-19 outbreak;

2. Rapidly test national preparedness plans in light of new knowledge on the effectiveness of non-pharmaceutical measures against COVID-19; incorporate rapid detection, largescale case isolation and respiratory support capacities, and rigorous contact tracing and management in national COVID-19 readiness and response plans and capacities;

3. Immediately enhance surveillance for COVID-19 as rapid detection is crucial to containing spread; consider testing all patients with atypical pneumonia for the COVID-19 virus, and adding testing for the virus to existing influenza surveillance systems;

4. Begin now to enforce rigorous application of infection prevention and control measures in all healthcare facilities, especially in emergency departments and outpatient clinics, as this is where COVID-19 will enter the health system; and

5. Rapidly assess the general population's understanding of COVID-19, adjust national health promotion materials and activities accordingly, and engage clinical champions to communicate with the media.

## For the public

1. Recognize that COVID-19 is a new and concerning disease, but that outbreaks can managed with the right response and that the vast majority of infected people will recover;

2. Begin now to adopt and rigorously practice the most important preventive measures for COVID-19 by frequent hand washing and always covering your mouth and nose when sneezing or coughing;

3. Continually update yourself on COVID-19 and its signs and symptoms (i.e. fever and dry cough), because the strategies and response activities will constantly improve as new information on this disease is accumulating every day; and

4. Be prepared to actively support a response to COVID-19 in a variety of ways, including the adoption of more stringent 'social distancing' practices and helping the high-risk elderly population.

## For the international community

1. Recognize that true solidarity and collaboration is essential between nations to tackle the common threat that COVID-19 represents and operationalize this principle;

2. Rapidly share information as required under the International Health Regulations (IHR) including detailed information about imported cases to facilitate contact tracing and inform containment measures that span countries;

3. Recognize the rapidly changing risk profile of COVID-19 affected countries and continually monitor outbreak trends and control capacities to reassess any 'additional health measures' that significantly interfere with international travel and trade.

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# Annexes

## A. WHO-China Joint Mission Members

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|---|---|
| **Bruce AYLWARD** | Team Lead WHO-China Joint Mission on COVID-19, Senior Advisor to the Director-General, World Health Organization, Geneva, Switzerland |
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| **Guangfa WANG** | Director, Department of Respiratory and Critical Care Medicine, Peking University First Hospital |
| **Fan WU** | Vice Dean, Shanghai Medical College, Fudan University |
| **Zhongze WU** | Director, Compliance and Enforcement Division, Department of Wildlife Conservation, National Forestry and Grassland Administration |
| **Zunyou WU** | Chief Epidemiologist, Chinese Center for Disease Control and Prevention |
| **Jun XING** | Head of Unit, Country Capacity for International Health Regulations, Health Security Preparedness, World Health Organization, Geneva, Switzerland |
| **Kwok-Yung YUEN** | Chair Professor and Co-Director of State Key Laboratory of Emerging Infectious Diseases, Department of Microbiology, The University of Hong Kong |
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| **Yong ZHANG** | Assistant Director and Researcher, National Institute for Viral Disease Control and prevention, Chinese Center for Disease Control and Prevention. |
| **Lei ZHOU** | Chief and Researcher, Branch for Emerging Infectious Disease, Public Health Emergency Center, Chinese Center for Disease Control and Prevention |

## B. Summary Agenda of the Mission

| Dates | Location | Activities |
|---|---|---|
| **10-15 February 2020 (Advance Team)** | Beijing | Advance Team and WHO Country team meetings with national counterparts and institutions |
| **16 February 2020** | Beijing | Meeting with the full international team for briefing at the WHO Country office |
| | Beijing | Workshop at the National Health Commission (NHC) with relevant departments of the Joint Prevention and Control Mechanism of the State Council |
| **17 February 2020** | Beijing | Site visit to Beijing Ditan Hospital |
| | Beijing | Site visit to Anhuali community and health service station, Anzhen street, Chaoyang District, Beijing |
| | Beijing | Workshop with Chinese Center for Disease Control and Prevention |
| **18 February 2020 (Guangdong Team)** | Shenzhen, Guangdong | Shenzhen customs at the airport |
| | Shenzhen, Guangdong | Shenzhen No.3 People's Hospital |
| | Shenzhen, Guangdong | Shenzhen Center for Disease Control and Prevention |
| | Shenzhen, Guangdong | Meeting at Tencent |
| **19 February 2020 (Guangdong Team)** | Shenzhen, Guangdong | Qiaoxiang community |
| | Shenzhen to Guangzhou | Visit to Futian High-speed Train Station, and travel to Guangzhou by train |
| | Guangzhou | Guangzhou Panyu Sanatorium |
| | Guangzhou | Guangdong Laboratory of Regenerative Medicine and Health |
| | Guangzhou | Guangzhou Tiyudongzhihui wet market |
| | Guangzhou | First Workshop with The People's government of Guangdong Province |
| **20 February 2020 (Guangdong Team)** | Guangzhou | Guangdong Provincial Center for Disease Control and Prevention |
| | Guangzhou | Renmin road campus of Guangzhou Women and Children Medical Center |
| | Guangzhou | The second Workshop with The People's government of Guangdong Province |
| **18 February 2020 (Sichuan Team)** | Beijing to Chengdu | |
| | Sichuan | Site visit to Chengdu Shuangliu International Airport |
| | | Meeting with the Governor of Sichuan Provincial People's Government |
| | | Site visit to Yong'an Township Central hospital with fever clinic |
| | | Site visit to home community of Yong'an township |
| **19 February 2020 (Sichuan Team)** | | Symposium with provincial and municipal authorities |
| | | Sichuan Center for Disease Control and Prevention |
| | | Site visit to West China Hospital- Designated COVID-19 hospital |
| **20 February 2020 (Sichuan Team)** | | Site visit to Chengdu Women and Children's hospital |
| | | Site visit to Pharmaceutical Logistics center |
| | | Site visit to East Chengdu railway station |

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|---|---|---|
| | | Site visit to Chengdu Public Health Clinical Centre- Designated COVID 19 hospital |
| **Sichuan and Guangdong teams reconvene in Guangzhou** | | |
| **21-24 February 2020** | | Analyze major findings; Meetings of the WHO-China Joint mission to finalize the report |
| **Feb 22 (Wuhan Team)** | Guangzhou to Wuhan | Select team members only |
| **23 February (Wuhan Team)** | | Site visit to Guanggu Campus of Wuhan Tongji Hospital |
| | | Site visit to Mobile Cabin Hospital in Wuhan Sports Center |
| | | Workshop with relevant departments of the Joint Prevention and Control Mechanism of Hubei Province |
| | | Feedback Meeting with Minister Ma, NHC at the Wuhan Conference Center |
| **24 February 2020** | Guangzhou to Beijing | Finalize report, WHO-Joint Press conference in Beijing |

## C. Detailed Technical Findings

### Response management, case and contact management, risk communication and community engagement

The response structures in China were rapidly put in place according to existing emergency plans and aligned from the top to the bottom. This was replicated at the four levels of government (national provincial, prefecture and county/district).

#### *Organizational structure and response mechanism*

**Response activation at the national level:** COVID-19 prevention and control mechanisms were initiated immediately after the outbreak was declared and nine working groups were set up to coordinate the response: a) Coordination b) Epidemic prevention and control c) Medical treatment d) Research e) Public communication f) Foreign affairs g) Medical material support h) Life maintenance supplies and i) Social stability. Each working group has a ministerial level leader. Emergency response laws and regulations for the emergency response to public health emergencies, prevention and control of infectious diseases have been developed or updated to guide the response.

**Response activation in provinces**: Each province set up a similar structure to manage the outbreak. The response is organized at the levels of national, provincial, prefecture, county/district and the community. By 29 January, all provinces across China had launched the highest level of response for major public health emergencies.

#### *Response Strategy*

A clear strategy was developed, and goals were well articulated and communicated across the entire response architecture. This strategy was rapidly adapted and adjusted to the outbreak, both in terms of the epidemiological situation over time and in different parts of the country.

The epidemiological situation has been used to define location into four areas:

- In areas without cases, the strategy in these areas is to "strictly prevent introduction". This includes quarantine arrangements in transportation hubs, monitoring for temperature changes, strengthening of triage arrangements, use of fever clinics, and ensuring normal economic and social operations.
- In areas with sporadic cases, the strategy is focused on "reducing importation, stopping transmission and providing appropriate treatment".
- In areas with community clusters, the strategy is focussed on "stopping transmission, preventing exportation, and strengthening treatment".
- In areas with community transmission, the strictest prevention and control strategies are being implemented, the entry and exit of people from these areas has been stopped and public health and medical treatment measures are comprehensively strengthened.

*Main control measures implemented in China*

The main control measures implemented in China are as follows and are illustrated in Figures 6A-6D, representing the national level response and examples of the response at the Provincial and municipal levels:

**Monitoring and reporting:** COVID-19 was included in the statutory reporting of infectious diseases on 20 January and plans were formulated to strengthen diagnosis, monitoring, and reporting.

**Strengthening ports of entry and quarantine:** The Customs Department launched the emergency plan for public health emergencies at ports across the country and restarted the health declaration card system for entry and exit into cities as well as strict monitoring of the temperature of entry and exit passengers.

**Treatment:** For severe or critical patients, the principle of "Four Concentrations" was implemented: i.e. concentrating patients, medical experts, resources and treatment into special centres. All cities and districts transformed relevant hospitals, increased the number of designated hospitals, dispatched medical staff, and set up expert groups for consultation, so as to minimise mortality of severe patients. Medical resources from all over China have been mobilized to support the medical treatment of patients in Wuhan.

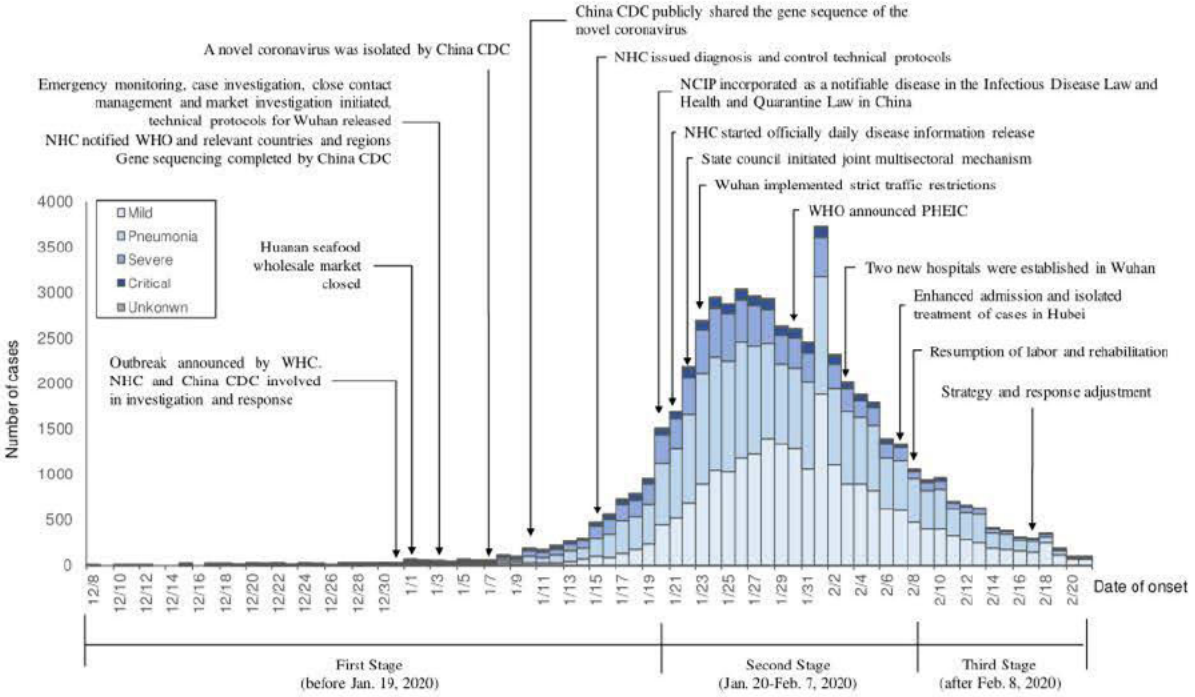
**Epidemiological investigation and close contact management:** Strong epidemiological investigations are being carried out for cases, clusters, and contacts to identify the source of infection and implement targeted control measures, such as contact tracing.

**Social distancing**: At the national level, the State Council extended the Spring Festival holiday in 2020, all parts of the country actively cancelled or suspended activities like sport events, cinema, theatre, and schools and colleges in all parts of the country postponed re-opening after the holiday. Enterprises and institutions have staggered their return to work. Transportation Departments setup thousands of health and quarantine stations in national service areas, and in entrances and exits for passengers at stations. Hubei Province adopted the most stringent traffic control measures, such as suspension of urban public transport, including subway, ferry and long-distance passenger transport. Every citizen has to wear a mask in public. Home support mechanisms were established. As a consequence of all of these measures, public life is very reduced.

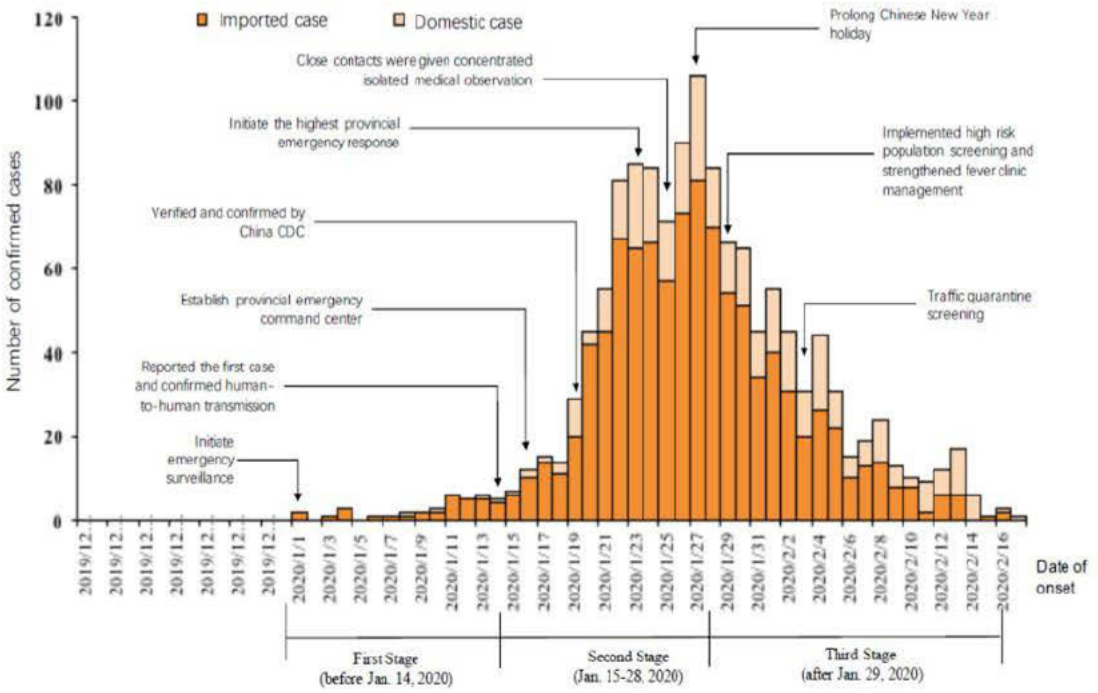
**Funding and material support:** Payment of health insurance was taken over by the state, as well as the work to improve accessibility and affordability of medical materials, provide personal protection materials, and ensure basic living materials for affected people.

**Emergency material support:** The government restored production and expanded production capacity, organized key enterprises that have already started to exceed current production capacity, supported local enterprises to expand imports, and used cross-border e-commerce platforms and enterprises to help import medical materials and improve the ability to guarantee supplies.

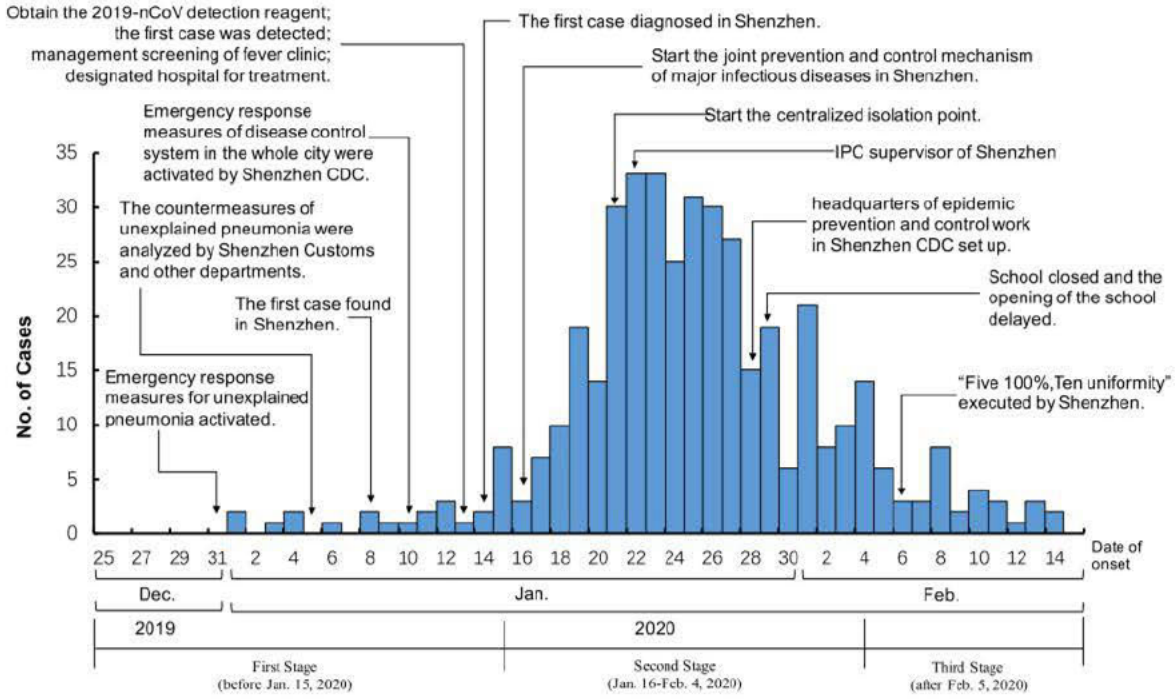
**A**


China CDC publicly shared the gene sequence of the novel coronavirus
A novel coronavirus was isolated by China CDC
NHC issued diagnosis and control technical protocols
Emergency monitoring, case investigation, close contact management and market investigation initiated, technical protocols for Wuhan released
NCIP incorporated as a notifiable disease in the Infectious Disease Law and Health and Quarantine Law in China
NHC notified WHO and relevant countries and regions
Gene sequencing completed by China CDC
NHC started officially daily disease information release
State council initiated joint multisectoral mechanism
Wuhan implemented strict traffic restrictions
WHO announced PHEIC
Mild
Pneumonia
Severe
Critical
Unkonwn
Huanan seafood wholesale market closed
Two new hospitals were established in Wuhan
Enhanced admission and isolated treatment of cases in Hubei
Resumption of labor and rehabilitation
Outbreak announced by WHC. NHC and China CDC involved in investigation and response
Strategy and response adjustment
Number of cases
Date of onset
First Stage (before Jan. 19, 2020)
Second Stage (Jan. 20-Feb. 7, 2020)
Third Stage (after Feb. 8, 2020)

**B**


Imported case
Domestic case
Prolong Chinese New Year holiday
Close contacts were given concentrated isolated medical observation
Initiate the highest provincial emergency response
Implemented high risk population screening and strengthened fever clinic management
Verified and confirmed by China CDC
Establish provincial emergency command center
Traffic quarantine screening
Reported the first case and confirmed human-to-human transmission
Initiate emergency surveillance
Number of confirmed cases
Date of onset
First Stage (before Jan. 14, 2020)
Second Stage (Jan. 15-28, 2020)
Third Stage (after Jan. 29, 2020)

**C**




**D**

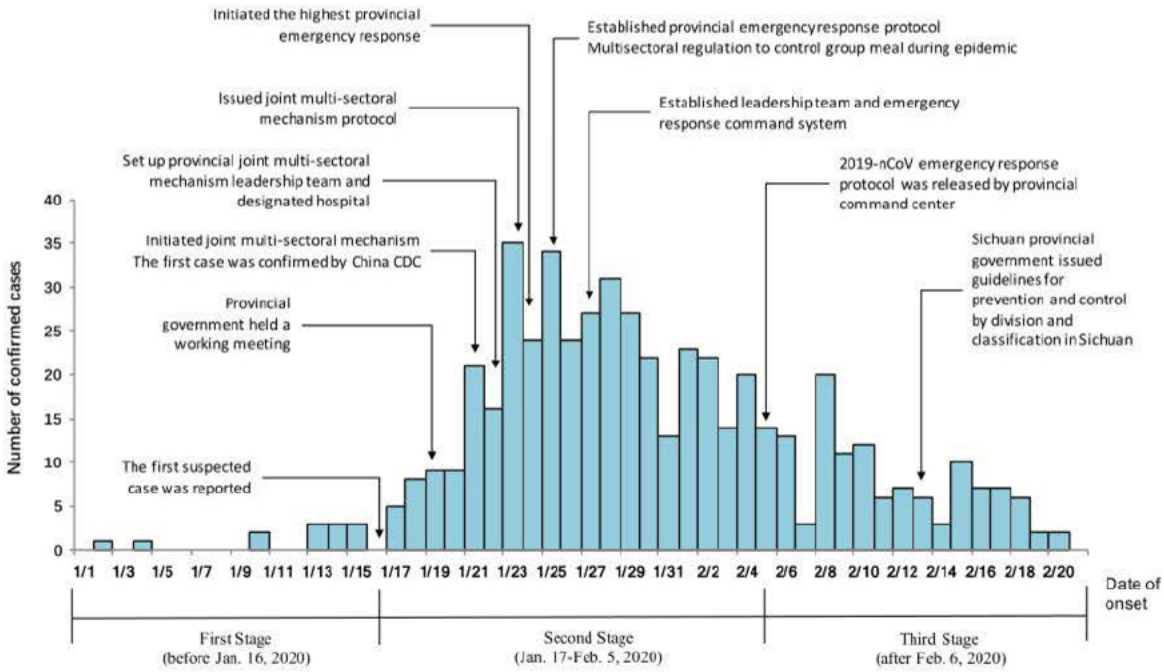



**Figure 6. COVID-19 epidemic curves and major intervention measures in China as implemented at a) the national level b) in Guangdong province, c) in Shenzhen municipality and d) in Sichuan province**

### *Risk communications (information release, public and media communications)*

**International and interregional cooperation and information sharing:** From 3 January 2020, information on COVID-19 cases has been reported to WHO daily. Full genome sequences of the new virus were shared with WHO and the international community immediately after the pathogen was identified on 7 January. From 13 to 14 January, a group of technical experts from Hong Kong SAR, Macao SAR and Taiwan, China visited Wuhan. From 20-21 January, a World Health Organization team visited Wuhan. A set of nucleic acid primers and probes for PCR detection for COVID-19 was released on 21 January.

**Daily updates:** The National Health Commission announces the epidemic situation every day and holds daily press conferences to respond to emerging issues. The government also frequently invites experts to share scientific knowledge on COVID-19 and to address public concerns.

**Psychological care:** This is provided to patients and the public. Governments at all levels, NGOs and all sectors of society developed guidelines for emergency psychological crisis intervention and guidelines for public psychological self-support and counselling. A hotline for mental health services has been established for the public.

**IT platform:** China has capitalized on the use of technology, big data and AI for COVID-19 preparedness, readiness and response. Authoritative and reliable information, medical guidance, access to online services, provision of educational tools and remote work tools have been developed in and used across China. These services have increased accessibility to health services, reduced misinformation and minimized the impact of fake news.

### *Social mobilization and community engagement*

Civil society organizations (community centers and public health centers) have been mobilized to support prevention and response activities. The community has largely accepted the prevention and control measures and is fully participating in the management of self-isolation and enhancement of public compliance. Community volunteers are organized to support self-isolation and help isolated residents at home to solve practical life difficulties. Measures were taken to limit the movement of the population through home-based support. Up to now, outside of Hubei, 30 provinces have registered and managed more than 5 million people coming from Wuhan.

## Clinical case management and infection prevention and control

The main **signs and symptoms** of COVID-19 include fever, dry cough, fatigue, sputum production, shortness of breath, myalgia or arthralgia, sore throat, and headache. Nausea or vomiting has been reported in a small percentage of patients (5%). On 14 February, China CDC described the clinical features, outcomes, laboratory and radiologic findings of 44 672 laboratory-confirmed cases. Only 965 (2.2%) were under 20 years of age and there is just one recorded death (0.1%) in this age group. Most patients (77.8%) were aged 30 to 69 years. Patients aged over 80 years had a CFR of 14.8%. The CFR was highest in those with

comorbidities including cardiovascular, diabetes, chronic respiratory disease, hypertension and cancer.

As opposed to Influenza A(H1N1)pdm09, **pregnant women** do not appear to be at higher risk of severe disease. In an investigation of 147 pregnant women (64 confirmed, 82 suspected and 1 asymptomatic), 8% had severe disease and 1% were critical.

**Severe cases** are defined as tachypnoea (≧30 breaths/ min) or oxygen saturation ≤93% at rest, or PaO2/FIO2 <300 mmHg. **Critical cases** are defined as respiratory failure requiring mechanical ventilation, shock or other organ failure that requires intensive care. About a quarter of severe and critical cases require mechanical ventilation while the remaining 75% require only oxygen supplementation.

China has a principle of **early identification**, early isolation, early diagnosis and early treatment. Early identification of suspect cases is critical to containment efforts and occurs via a process of temperature screening and questioning at entrances to many institutions, communities, travel venues (airports, train stations) and hospitals. Many hospitals have fever clinics that were established and maintained since the SARS outbreak. In China, laboratory tests were originally requested according to the case definitions, which included an epidemiological link to Hubei or other confirmed cases. However, more recently, a more **liberal clinical testing regimen** allows clinicians to test with a low index of suspicion.

**Suspect cases** are isolated in normal pressure single rooms, wear a surgical mask (for source control). Staff in China wear a cap, eye protection, n95 masks, gown and gloves (single use only). In Wuhan it is necessary for most suspects to be cohorted in a normal pressure isolation ward. Staff wear PPE continuously, changing it only when they leave the ward.

**PCR test results** are returned the same day. If positive, patients are transported to designated hospitals (including negative pressure ambulances in some cities). All patients, including the mild and asymptomatic, with a positive test are admitted. The designated hospitals are known and are strategically placed with at least one per district/county. Positive cases are cohorted by gender. Negative tested patients are managed based on clinical needs. All patients are evaluated with a respiratory multiplex to look for other diagnoses. This can add to the reassurance that a negative COVID-19 test reflects a lack of infection with COVID-19.

In Wuhan, there are 45 **designated hospitals**, 6 of which are designated for critical patients, and 39 for severe patients and/or any patients >65 years old. There are an additional 10 temporary hospitals reconstructed from gymnasium and exhibition centers, which are for mild patients. Other surge measures undertaken in Wuhan include two new temporary hospitals with 2600 beds, plus many makeshift hospitals to increase bed capacity. Bed capacity within Wuhan has increased to >50,000.

Patients are treated according to the **National Clinical guidelines** (edition 6) released by the China National Health Commission (NHC). There are no specific antiviral or immune modulating agents proven (or recommended) to improve outcomes. All patients are monitored by regular pulse oximetry. The guidelines include supportive care by clinical category (mild, moderate, severe and critical), as well as the role of investigational

treatments such as chloroquine, phosphate, lopinavir/ritonavir, alpha interferon, ribavirin, arbidol. The application of intubation/invasive ventilation and ECMO in critically ill patients can improve survival. The Joint Mission Team was told of ECMO use in four patients at one hospital with one death and three who appeared to be improving. Clearly, though ECMO is very resource consumptive, any health system would need to carefully weigh the benefits. There is widespread use of Traditional Chinese Medicines (TCM), for which the affects must be fully evaluated.

Patients with COVID-19 are not permitted **visitors**. Staff use coveralls, masks, eye cover, and gloves, removing PPE only when they leave the ward.

**Patients are discharged** after clinical recovery (afebrile >3 days, resolution of symptoms and radiologic improvement) and 2 negative PCR tests taken 24 hours apart. Upon discharge, they are asked to minimise family and social contact and to wear a mask. There are expectations of clinical trial results within a matter of weeks, which will see further opportunities for treatment.

There are guidelines for **elderly care** specifically targeting prevention in individuals and introduction of COVID-19 to nursing homes.

Training programmes by video conference nationally are scaled up to inform staff of best practice and to ensure PPE usage. **Clinical champions** are created to disperse knowledge and provide local expertise.

Maintenance of usual healthcare activities is maintained by hospital zoning (e.g. clean/contaminated sections of the healthcare facility).

## Laboratory, diagnostics and virology

The virus found to cause COVID-19 was initially isolated from a clinical sample on 7 January. It is notable that within weeks following the identification of the virus, a series of reliable and sensitive **diagnostic tools** were developed and deployed. On 16 January, the first RT-PCR assays for COVID-19 were distributed to Hubei. Real-time PCR kits were distributed to all the provinces on 19 January and were provided to Hong Kong SAR and Macao SAR on 21 January. Information regarding viral sequences and PCR primers and probes was shared with WHO and the international community by China CDC on 12 January 2020. To facilitate product development and research on the new virus, COVID-19 virus sequences were uploaded to the GISAID Database by China.

By 23 February, there were 10 kits for detection of COVID-19 approved in China by the NMPA, including 6 RT-PCR kits, 1 isothermal amplification kit, 1 virus sequencing product and 2 colloidal gold antibody detection kits. Several other tests are entered in the emergency approval procedure. Currently, there are at least 6 local producers of PCR test kits approved by NMPA. Overall, producers have the capacity to produce and distribute as many as 1,650,000 tests/week.

**Specimens** from both the upper respiratory tract (URT; nasopharyngeal and oropharyngeal) and lower respiratory tract (LRT; expectorated sputum, endotracheal aspirate, or bronchoalveolar lavage) are collected for COVID-19 testing by PCR.

COVID-19 virus has been detected in respiratory, fecal and blood specimens. According to preliminary data from Guangzhou CDC as of 20 February, virus can initially be detected in upper respiratory samples 1-2 days prior to symptom onset and persist for 7-12 days in moderate cases and up to 2 weeks in severe cases. Viral RNA has been detected in feces in up to 30% of patients from day 5 following onset of symptoms and has been noted for up to 4-5 weeks in moderate cases. However, it is not clear whether this correlates with the presence of infectious virus. While live virus has been cultured from stool in some cases, the role of fecal-oral transmission is not yet well understood. COVID-19 has been isolated from the clinical specimens using human airway epithelial cells, Vero E6 and Huh-7 cell lines.

**Serological diagnostics** are rapidly being developed but are not yet widely used. Joint Mission members met with local research teams at the China CDC, Guangzhou Regenerative Medicine and Health Guangdong Laboratory. The teams reported on the development of tests for IgM, IgG and IgM+IgG using rapid test platforms utilizing chemiluminiscence. ELISA assays are also under development.

## Research & Development

The government of China has initiated a series of major emergency research programs on virus genomics, antivirals, traditional Chinese medicines, clinical trials, vaccines, diagnostics and animal models. Research includes fundamental basic research and human subjects research. For the purpose of this report, human studies are limited to those involving IRB approval and informed consent. Other forms of human subjects investigations are included in the sections on epidemiology in this report. Well-focused, robust research conducted in the setting of an outbreak has the potential of saving many lives by identifying the most effective ways to prevent, diagnose and treat disease.

Since the COVID-19 virus has a genome identity of 96% to a bat SARS-like coronavirus and 86%-92% to a pangolin SARS-like coronavirus, an animal source for COVID-19 is highly likely. This was corroborated by the high number of RT-PCR positive environmental samples taken from the Huanan Seafood Market in Wuhan.

At least 8 **nucleic acid-based methods** for direct detection of COVID-19 and two colloidal gold antibody detection kits have been approved in China by the NMPA. Several other tests are close to approval. It will be important to compare the sensitivities and specificities of these and future serologic tests. Development of rapid and accurate **point-of-care tests** which perform well in field settings are especially useful if the test can be incorporated into presently commercially available multiplex respiratory virus panels. This would markedly improve early detection and isolation of infected patients and, by extension, identification of contacts. **Rapid IgM and IgG antibody testing** are also important ways to facilitate early diagnosis. Standard serologic testing can be used for retrospective diagnoses in the context of serosurveys that help better understand the full spectrum of COVID-19 infection.

A variety of **repurposed drugs and investigational drugs** have been identified. Screening NMPA approved drug libraries and other chemical libraries have identified novel agents. Hundreds of clinical trials involving remdesivir, chloroquine, favipiravir, chloroquine, convalescent plasma, TCM and other interventions are planned or underway. Rapid completion of the most important of these studies is critical to identifying truly effective therapies. However, evaluation of investigational agents requires adequately powered, randomized, controlled trials with realistic eligibility criteria and appropriate stratification of patients. It is important for there to be a degree of coordination between those conducting studies within and beyond China.

The development of a safe and effective **vaccine** for this highly communicable respiratory virus is an important epidemic control measure. Recombinant protein, mRNA, DNA, inactivated whole virus and recombinant adenovirus vaccines are being developed and some are now entering animal studies. Vaccine safety is of prime concern in the area of coronavirus infection in view of the past experience of disease enhancement by inactivated whole virus measles vaccine and similar reports in animal experiments with SARS coronavirus vaccines. It will be important that these vaccine candidates rapidly move into appropriate clinical trials.

The ideal **animal model** for studying routes of virus transmission, pathogenesis, antiviral therapy, vaccine and immune responses has yet to be found. The ACE2 transgenic mouse model and Macaca Rhesus model are already used in research laboratories. Systematically addressing which models can accurately mimic human infection is required.

There is a global rush for masks, hand hygiene products and other personal protective equipment. The relative importance of **non-pharmaceutical control measures** including masks, hand hygiene, and social distancing require further research to quantify their impact.

There are distinct patterns of intra-familial transmission of COVID-19. It is unclear whether or not there are host factors, including genetic factors, that influence susceptibility or disease course. COVID-19 has a varied clinical course and a precise description of that course is not available. In addition, the long-term consequences of COVID-19 are unknown. An observational cohort study of patients with COVID-19 enrolled from the time of diagnosis (with appropriate controls) could provide in-depth information about clinical, virologic and immunologic characteristics of COVID-19. Table 1 summarizes priority research areas with immediate to longer term goals.

**Table 1 Priority research areas with immediate, intermediate and longer-term goals**

| Immediate Goals | Intermediate Goals | Long-term goals |
|---|---|---|
| **Diagnostics:** RNA assays, antibody & antigen assays, point of care detection | Diagnostics: Multiplex diagnostic platforms | Diagnostics: Prognostic markers |
| **Therapeutics:** Remdesivir, favipiravir, chloroquine, plasma, TCM | Therapeutics: intravenous immunoglobulin (IVIg) | Therapeutics: Innovative approaches (CRISPR-CAS; RNAi; Cell-based; positive hits from library screening) |
| **Vaccines:** Development of animal models | Vaccines: mRNA candidates and candidate viral vectors | Vaccines: inactivated candidates and subunit candidates |

## D. Knowledge Gaps

Knowledge gaps and key questions to be answered to guide control strategies include:

### *Source of infection*

- Animal origin and natural reservoir of the virus
- Human-animal interface of the original event
- Early cases whose exposure could not be identified

### *The pathogenesis and virulence evolution of the virus*

### *Transmission dynamics*

- Modes of Transmission:
    - Role of aerosol transmission in non-health care settings
    - Role of fecal-oral transmission
- Viral shedding in various periods of the clinical course in different biological samples (i.e. upper and lower respiratory tract, saliva, faeces, urine)
    - Before symptom onset and among asymptomatic cases
    - During the symptomatic period
    - After the symptomatic period / during clinical recovery

### *Risk factors for infection*

- Behavioral and socio-economic risk factors for infection in
    - Households / institutions
    - the Community
- Risk factors for asymptomatic infection
- Risk factors for nosocomial infection
    - among health care workers
    - among patients

### *Surveillance and monitoring*

- Monitoring community transmission through existing
    - ILI surveillance
    - SARI surveillance
- The outbreak trend and intervention dynamics
    - Basic reproduction numbers in various stages of the epidemic
    - The epidemic's relation to seasonality

*Laboratory and diagnostics*

- Sensitivity and specificity of different nucleic acid (PCR, NAATs and rapid tests), antibody and antigen tests
- Post-infection antibody titers and the duration of protection
- Sero-prevalence among
    - Health care workers
    - General population
    - Children

*Clinical management of severe and critically ill patients*

- Value of ECMO in the management of critically ill patients
- Best practice using mechanical ventilation in the management of critically ill patients
- Re-evaluation of the role of steroids in the management of severe and critically ill patients
- Identification of factors associated with successful clinical management and outcome
- Determination of the effectiveness of Traditional Chinese Medicines (TCM)
- Determination the effectiveness of additional investigational treatment options (e.g. intravenous immunoglobulin/IVIg, convalescent plasma)

*Prevention and control measures*

- Key epidemic indicators that inform evidence-based control strategy decision making and adjustments
- Effectiveness of infection prevention and control (IPC) measures in various health care settings
- Effectiveness of entry and exit screening
- Effectiveness of the public health control measures and their socio-economic impact
    - Restriction of movement
    - Social distancing
    - School and workplace closures
    - Wearing mask in general public
    - Mandatory quarantine
    - Voluntary quarantine with active surveillance

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## E. Operational & Technical Recommendations

### Operational/programmatic recommendations

- Reassess risk and capacities based on different stages of the outbreak; approve different measures during the different phases of the response; assess different stages of the response; reach a balance between response and social development
- Initiate a timely scientific evidence based, efficient and flexible joint multi-sectoral mechanism, which is driven by strong government leadership

### Technical recommendations

#### *Epidemiology and transmission*

- Continue enhanced surveillance across the country through existing respiratory disease systems, including ILI, SARI or pneumonia surveillance systems
- Prioritize early investigations, including household transmission studies, age-stratified sero-epidemiologic surveys including children, case-control studies, cluster investigations, and serologic studies in health care workers

#### *Severity*

- Continue to share information on patient management, disease progression and factors leading to severe disease and favorable outcomes
- Review and analyze the possible factors associated with the disease severity, which may include:
    - natural history studies to better understand disease progression in mild, severe and fatal patients
    - medical chart reviews about disease severity among vulnerable groups, (e.g. those with underlying conditions, older age groups, pregnant women and children) to develop appropriate standards of care
    - evaluation of factors leading to favorable outcomes (e.g. early identification and care)

#### *Clinical care and infection prevention and control*

- Suspect patients who have not yet been tested should be isolated in single normal pressure rooms; cohorting of positive cases is acceptable
- Physicians and all health care workers need to maintain a high level of clinical alert for COVID-19
- For affected countries, standardize training for clinical care and IPC and scale with the development of local (e.g. district level) experts
- Ensure concurrent testing for other viral pathogens to support a negative COVID-19 test
- Ensure maintenance of usual and essential services during the outbreak

- Ensure processes are in place for infection prevention among the most vulnerable, including the elderly
- Ensure readiness to provide clinical care and to meet IPC needs, including:
    a. anticipated respiratory support requirements (e.g. pulse oximeters, oxygen, and invasive support where appropriate)
    b. national guidelines for clinical care and IPC, revised for COVID-19
    c. nationally standardised trainings for disease understanding and PPE use for HCWs
    d. community engagement
    e. PPE and Medication stockpiles
    f. early identification protocols; triage, temperature screening, holding bays (triage, including pulse oximetry)
    g. treatment protocols including designated facilities, patient transportation
    h. enhanced uptake of influenza and pneumococcal vaccine according to national guidelines
    i. laboratory testing
    j. rapid response teams

*Laboratory and virology*

- Continue to perform whole genome analysis of COVID-19 viruses isolated from different times and places, to evaluate virus evolution
- Conduct pathogenesis studies using biopsy/post-mortem specimens of COVID-19 patients or infected animal models
- Evaluate available nucleic acid PCR diagnostics
- Rapidly develop and evaluate rapid/point-of-care diagnostics and serologic assays
- Conduct further study to interpret the result of positive COVID-19 RNA detection in feces in patients recovering from COVID-19
- Enhance international cooperation, especially in terms of biosafety and information sharing for increased understanding of the COVID-19 virus and traceability of the virus
- Consider monitoring proinflammatory cytokines via multiplex assays to predict the development of "cytokine storm"

*Research and development*

- Additional effort should be made to find the animal source, including the natural reservoir and any intermediate amplification host, to prevent any new epidemic foci or resurgence of similar epidemics

- Efforts should be made to consistently evaluate existing and future diagnostic tests for detection of COVID-19 using a harmonized set of standards for laboratory tests and a biorepository that can be used for evaluating these tests
- Consider the establishment of a centralized research program in China to oversee that portfolio and ensure the most promising research (vaccines, treatments, pathogenesis) are adequately supported and studied first; program staff dedicated to the clinical research would work at the clinical research site(s) to decrease the research workload of the clinicians at the site
- Consider including one or more sites within China in the ongoing and future multi-center, international trials; Chinese investigators should be actively engaged in international trials
- Continue to develop additional animal models, making every effort to ensure these mimic human infection and virus transmission as closely as possible
- Conduct studies to determine which of the commonly used forms of PPE are most effective in controlling the spread of COVID-19

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**From:** UMALI DALANGIN, Khristeen
**Sent:** Fri, 14 Feb 2020 13:41:13 +0000
**To:** Handley, Gray (NIH/NIAID) [E];Lane, Cliff (NIH/NIAID) [E]
**Cc:** Elvander, Erika (OS/OGA);Arthur, Ray (CDC/DDPHSIS/CGH/DGHP);DRURY, Patrick Anthony;CAYABYAB, Ramoncito;ParrishFuentes, Adrienne L (Beijing) (b) (6));SCHWARTLANDER, Bernhard F.;GALEA, Gauden;Stewart Simonson (b) (6);NICHOLS, Phyllis Jane;Zhou, Weigong (CDC/DDID/NCIRD/ID)
**Subject:** RE: GOARN Pre-deployment package ¦ Drs Weigong ZHOU & Cliff LANE ¦ Mission to China ¦ COVID-2019
**Attachments:** 20200211 Confidential questionnaire prior duty travel.pdf, Medical Certificate Fitness for Work_2019 Version1_24 02 2016_.docx

Dear Gray,

Thanks for your message and very appreciate the efforts.

Please find attached a copy of the medical questionnaire and medical certificate which are mandatory for this deployment. Would it help if you contact the US Embassy in Tokyo to assist Cliff?

Best,

Khristeen

---

**From:** Handley, Gray (NIH/NIAID) [E] (b) (6)
**Sent:** Friday, February 14, 2020 2:28 PM
**To:** NICHOLS, Phyllis Jane (b) (6); UMALI DALANGIN, Khristeen (b) (6)
**Cc:** Lane, Cliff (NIH/NIAID) [E] (b) (6); Elvander, Erika (OS/OGA) (b) (6); (b) (6); DRURY, Patrick Anthony (b) (6); CAYABYAB, Ramoncito (b) (6); ParrishFuentes, Adrienne L (Beijing) (b) (6) (b) (6); SCHWARTLANDER, Bernhard F. (b) (6); GALEA, Gauden (b) (6); Stewart Simonson (b) (6) (b) (6)
**Subject:** FW: GOARN Pre-deployment package ¦ Drs Weigong ZHOU & Cliff LANE ¦ Mission to China ¦ COVID-2019

Dear GOARN Colleagues,

Over the last 24 hours we have been in active communication with WHO and Chinese officials to assure that Dr. Lane is able to participate in the WHO/GOARN Mission in China. This has been complicated by the fact that Dr. Lane was in transit to Japan when he received the invitation to participate in this mission. Upon arrival in Tokyo, he has made special efforts to obtain a visa, which was facilitated by the Chinese Embassy in Washington, WHO and the U.S. Embassy in Beijing.

I apologize that we were unaware of the list you have provided of necessary actions. I have attached the requested itinerary, passport face page and CV. Also attached is the completed visa application form. Dr. Lane will complete the security training upon arrival in Beijing. As for his medical clearance, Dr. Lane is a full-time U.S. Federal employee who maintains full medical clearance to practice as a research clinician in U.S. Facilities including the NIH Clinical Research Center.

Please let us know if anything more is needed.

One urgent need we have is an assurance that Dr. Lane will be met at the airport upon arrival and transported to the hotel. We also need confirmation of the hotel arrangements WHO/GOARN has made for members of the mission. If you can help with these matters, we would much appreciate it.

Thank you.

F. Gray Handley
Associate Director for International Research Affairs
National Institute of Allergy and Infectious Diseases
National Institute of Health
U.S. Department of Health and Human Services

Tel: (b) (6) 5601 Fishers Lane, Room 1E50
Fax: 301 480 2954 Bethesda, MD 20892-9802
(b) (6)



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**From:** Marston, Barbara J. (CDC/DDPHSIS/CGH/DPDM) (b) (6)
**Sent:** Friday, February 14, 2020 3:08 AM
**To:** NICHOLS, Phyllis Jane (b) (6); Lane, Cliff (NIH/NIAID) [E] (b) (6); Handley, Gray (NIH/NIAID) [E] (b) (6); Lane, Cliff (NIH/NIAID) [E] (b) (6); Elvander, Erika (OS/OGA) (b) (6); Arthur, Ray (CDC/DDPHSIS/CGH/DGHP) (b) (6)
**Cc**: AZZIZ-BAUMGARTNER, Eduardo (b) (6); UMALI DALANGIN, Khristeen (b) (6); Simonds, R. J. (CDC/DDPHSIS/CGH/OD) (b) (6); Roberts, Nathalie A. (CDC/DDPHSIS/CGH/DGHP) (b) (6); DRURY, Patrick Anthony (b) (6); CAYABYAB, Ramoncito (b) (6)
**Subject:** RE: GOARN Pre-deployment package ¦ Drs Weigong ZHOU & Cliff LANE ¦ Mission to China ¦ COVID-2019

HI Phyllis—including others from NIH in case they can help.
Hello WHO friends.
Barb

**From:** NICHOLS, Phyllis Jane (b) (6)
**Sent:** Friday, February 14, 2020 2:48 AM
**To:** (b) (6); ARTHUR, Ray Richard (b) (6)
**Cc:** AZZIZ-BAUMGARTNER, Eduardo (b) (6); UMALI DALANGIN, Khristeen (b) (6); Bresee, Joseph (CDC/DDID/NCIRD/ID) (b) (6); Simonds, R. J. (CDC/DDPHSIS/CGH/OD) (b) (6); Roberts, Nathalie A. (CDC/DDPHSIS/CGH/DGHP) (b) (6); Marston, Barbara J. (CDC/DDPHSIS/CGH/DPDM) (b) (6); DRURY, Patrick Anthony (b) (6); CAYABYAB, Ramoncito (b) (6)
**Subject:** GOARN Pre-deployment package ¦ Drs Weigong ZHOU & Cliff LANE ¦ Mission to China ¦ COVID-2019
**Importance:** High

In the interest of time and having not been copied on any communication we may have received from Cliff, I'm forwarding this to him. Cliff, if you are able to participate, we need your CV, passport photo page, medical clearance, and flight itinerary as soon as possible.

Many thanks,
Phyllis

**Phyllis Nichols**
Operations Coordinator, **Global Outbreak Alert and Response Network (GOARN)**
World Health Organization (WHO)
20 Avenue Appia, Geneva 1211, Switzerland
Email: (b) (6)
https://extranet.who.int/goarn/

---

**From:** UMALI DALANGIN, Khristeen
**Sent:** Thursday, February 13, 2020 5:37 PM
**To:** AZZIZ-BAUMGARTNER, Eduardo (b) (6); Zhou, Weigong (CDC/DDID/NCIRD/ID) (b) (6); (b) (6)
**Cc:** NICHOLS, Phyllis Jane (b) (6); Bresee, Joseph (CDC/DDID/NCIRD/ID) (b) (6); Simonds, R. J. (CDC/DDPHSIS/CGH/OD) (b) (6); Roberts, Nathalie A. (CDC/DDPHSIS/CGH/DGHP) (b) (6); Marston, Barbara J. (CDC/DDPHSIS/CGH/DPDM) (b) (6); DRURY, Patrick Anthony (b) (6); CAYABYAB, Ramoncito (b) (6)
**Subject:** GOARN Pre-deployment package ¦ Drs Weigong ZHOU & Cliff LANE ¦ Mission to China ¦ COVID-2019
**Importance:** High

Dear all,

Please find attached a copy of the pre-deployment package/information for Drs Weigong Zhou and Cliff Lane.

As GOARN Experts, you will be issued with a nil-remuneration consultant contract; **please note:** the contract issued is for insurance purposes only with no remuneration as you will continue receiving your salary and benefits with your current institution. As this is an emergency deployment and in order to avoid any delays in issuing a contract, we need the following mandatory administrative steps which are a pre-requisite for finalizing the deployment formalities:

1. Medical certificate of fitness and a pre-travel questionnaire forms – mandatory for all the members (non-WHO Staff) that are not passing through Geneva. The completed and signed forms must be sent directly WHO Staff Health and Wellbeing Services shws@who.int to expedite approval process.

2. Passport - please send this to us as soon as possible if not done yet.

3. UN Security training or BSAFE security training - the BSAFE is a mandatory requirement. However, in consideration of the exceptional and urgent nature of the mission, WHO Department of Safety and Security (DSS) in China had agreed a security briefing and assistance on the BSAFE be provided to the experts when they arrive in Beijing. In the event that you have already taken the BSAFE training course, may we kindly ask that you send us a copy at (b) (6).

**UN SECURITY AWARENESS TRAINING COURSE- FOR INFO ONLY.**

For any person travelling on behalf of WHO it is mandatory to complete the UN security awareness training course 'BSAFE' through the UNDSS website (https://training.dss.un.org). The main goal of BSAFE is to teach UN personnel how to take better care of themselves and how to engage with security. The course contains vital security information for WHO personnel and is delivered in the shape of a story and through the eyes of staff members.

**IMPORTANT:**
Please treat this as sensitive and not for public communications until we have agreed communications with China. To follow are the special declaration of interest and confidentiality forms which are being developed for this mission.

Thanks to acknowledge receipt of this message.

Best,

Khristeen


Khristeen Umali

Assistant
**Global Outbreak Alert and Response Network**
Division of Emergency Response (WRE)
WHO Health Emergencies Programme (WHE)
World Health Organization
Avenue Appia 20
1211 Geneva 27, Switzerland

Work: (b) (6)
Mobile/WhatsApp: (b) (6)

WORLD HEALTH ORGANIZATION
CONFIDENTIAL MEDICAL QUESTIONNAIRE

ORGANISATION MONDIALE DE LA SANTÉ
QUESTIONNAIRE MEDICAL CONFIDENTIEL

# Confidential questionnaire prior duty travel

Last Name :

First Name :

Gender : Female ☐ Male ☐

Date of Birth: (dd.mm.yyyy)

Phone Number: (incl country code)

Blood Type:

e-mail address :

Dentist's name & address :

**Purpose of travel:** ☐ Mission ☐ Reassignment ☐ Home Leave ☐ Vacation

| Destinations (Country, City, Rural) | Date (dd/mm/yyyy): | |
|---|---|---|
| | from: | to: |
| | from: | to: |
| | from: | to: |

1. Do you have any physical or psychological health conditions requiring on-going health care? ☐ Yes ☐ No

If yes, please provide detail :

2. Are you regularly taking any prescribed medication? ☐ Yes ☐ No

If yes, please provide detail :

3. Do you have any physical or psychological health conditions which could make it difficult for you to travel to a remote area with limited access to health care facilities? ☐ Yes ☐ No

If yes, please provide detail :

4. Have you been hospitalised for at least 2 consecutive days in the last 5 years, or been admitted to an Emergency room in the last 12 months, or have you been absent from work for more than 7 days in the last 12 months? ☐ Yes ☐ No

If yes, please provide detail :

5. Do you have any condition which will need medical, surgical, or psychological intervention or treatment within the next 12 months? ☐ Yes ☐ No

If yes, please provide detail :

6. Are you aware of any other factor which could affect your health or your ability to perform your duties (such as physical symptoms, lifestyle habits or family circumstances)? ☐ Yes ☐ No

If yes, please provide detail :

7. History of malaria — ☐ Yes ☐ No

If yes, please provide detail :

8. Malaria drugs taken in the past — ☐ Yes ☐ No

If yes, please provide detail :

9. Do you have any antimalarial drugs side effects ? — ☐ Yes ☐ No

If yes, please provide detail :

10. Do you have any known allergies or severe reactions to specific food (eggs, chicken, honey, yeast...), medications (neomycin, streptomycin, sulfa drugs...), vaccines, insect bites (bees...), or other things? — ☐ Yes ☐ No

If yes, please provide detail :

For women only: are you pregnant, may be or planning to become pregnant, or lactating? — ☐ Yes ☐ N/A or No

Date : Staff's signature:

## *FOR SHW Use Only:*

File Number: Expiration date of Medical clearance:

Blood Pressure: / Heat Rate: $SpO_2$: % Temperature:

| Vaccinations | Up to date | Given today | Malaria Prophylaxis | Given today | | |
|---|---|---|---|---|---|---|
| DtPolio / Per | ☐ | ☐ | MEFLOQUINE | ☐ No ☐ Yes | Number | |
| Yellow Fever | ☐ | ☐ | DOXYCYCLINE | ☐ No ☐ Yes | Number | |
| Hep A | ☐ | ☐ | MALARONE | ☐ No ☐ Yes | Number | |
| Hep A + B | ☐ | ☐ | Medical kit | ☐ No ☐ Yes | Number | |
| Typhoid | ☐ | ☐ | Mosquito net | ☐ No ☐ Yes | Number | |
| Meningitis | ☐ | ☐ | COARTEM | ☐ No ☐ Yes | Number | |
| Cholera | ☐ | ☐ | Hand rub | ☐ No ☐ Yes | Number | |
| Rabies | ☐ | ☐ | DEET | ☐ No ☐ Yes | Number: | |
| Jap. encephalitis | ☐ | ☐ | Vaccination card | ☐ No ☐ Yes | Number | |
| Measles/MMR | ☐ | ☐ | | | | |
| Influenza | ☐ | ☐ | | | | |
| Polio | ☐ | ☐ | | | | |

Date : Nurse's initials:

World Health Organization

# Medical Certificate of Fitness for Work

**Period of validity: One calendar year as of the date of signature by the attending physician below**

## 1. TO BE COMPLETED BY THE INDIVIDUAL (OR THE TECHNICAL UNIT)

| | | | |
|---|---|---|---|
| Family name | Click here to enter text. | Maiden name | |
| Given name | Click here to enter text. | Gender | ☐ F ☐ M |
| Date of Birth (dd/mm/yyyy) | Click here to enter text. | Nationality | Click here to enter text. |
| ADDRESS & CONTACT DETAILS: | | | |
| Street | Click here to enter text. | City | Click here to enter text. |
| Zip Code | Click here to enter text. | District / State | Click here to enter text. |
| Country | Click here to enter text. | Email address | Click here to enter text. |
| WORK ASSIGNMENT: | | | |
| Description of work assignment | Click here to enter text. | Location of work assignment | Click here to enter text. |
| Expected dates, from: | Click here to enter text. | To | Click here to enter text. |

## 2. TO BE COMPLETED BY THE ATTENDING PHYSICIAN

Instructions: This medical examination is to assess the individual's general state of health in accordance to his/her medical history, and his/her ability to travel, if required, and to perform the work assignment. N.B.: For drivers, this medical examination will also include visual tests. Please ensure that vaccinations are up-to-date, and that malaria prophylaxis is prescribed if needed and in line with WHO recommendations (http://www.who.int/ith/en/).

Mr / Mrs / Miss ..... .....has been examined by me. He/she has been found fit to [travel and] perform the work assignment, and the required inoculations and prophylactic medicines for the country to which he/she is required to travel have been done and / or prescribed as applicable.

Name of the attending physician who examined the individual: .....

Address: .....
.....

**Date:** ..... **Signature:** ..... **Doctor's Stamp:** .....

## 3. TO BE COMPLETED BY THE INDIVIDUAL

I, Mr / Mrs / Miss ..... ..... hereby declare that all information provided by me in the context of the above medical examination is true and complete to the best of my knowledge. I understand that a false statement or a material omission, in particular a failure to disclose a known physical and/or psychological condition, including conditions under investigation, may result in the cancellation of the contract and/or the withdrawal of any offer of a contract with WHO.

I further understand that, if any new medical condition or a substantial change in an existing medical condition, appears during the period of validity of this Medical Certificate of Fitness for Work, or if the location of the work assignment changes, it is my responsibility to inform my attending physician and to provide the responsible WHO Technical Unit with a new Certificate of Fitness for Work.

**Date :** ..... **Signature :** .....

*Please electronically complete and return this questionnaire as soon as possible (preferably within 3 days) to Technical Unit*

**From:** HAN, Mansuk Daniel
**Sent:** Fri, 14 Feb 2020 10:07:32 +0000
**To:**
(b) (6) (b) (6) (b) (6); (b) (6) (b) (6) ; (b) (6);Zhou, Weigong (CDC/DDID/NCIRD/ID);Lane, Cliff (NIH/NIAID) [E]; (b) (6) (b) (6)
**Cc:** DRURY, Patrick Anthony;SCHWARTLANDER, Bernhard F.;MINHAS, Raman;BOMBIN, Marie Sabine
**Subject:** [URGENT] COVID-19: DOI & Confidentiality forms
**Attachments:** (final) DOI_EN_Form_WHO_China Joint mission COVID19.docx, Confidentiality Undertaking for WHO_China Joint Mission.pdf

Dear WHO-China Joint Mission deployees,

Please see attached **Declaration of Interest** and **Confidentiality** forms.

Please complete, sign, and return **both DOI and Confidentiality to me ASAP**.

Thank you, Dan

**Mansuk Daniel HAN**
Technical Officer
WHO HQ, Geneva, Switzerland
Office: (b) (6)
Mobile: (b) (6)
Email: (b) (6)
Skype: (b) (6)
World Health Organization

# DECLARATION OF INTERESTS FOR WHO EXPERTS

WHO's work on global health issues requires the assistance of external experts who **may have interests related to their expertise.** To ensure the highest integrity and public confidence in its activities, WHO requires that experts serving in an advisory role disclose any circumstances that could give rise to a potential conflict of interest related to the subject of the activity in which they will be involved.

All experts serving in an advisory role must disclose any circumstances that could represent a **potential conflict of interest** (i.e., any interest that may affect, or may reasonably be perceived to affect, the expert's objectivity and independence). You must disclose on this Declaration of Interests (DOI) form any financial, professional or other interest relevant to the subject of the work or meeting in which you have been asked to participate in or contribute towards and any interest that could be affected by the outcome of the meeting or work. You must also declare relevant interests of your immediate family members (see definition below) and, if you are aware of it, relevant interests of other parties with whom you have substantial common interests and which may be perceived as unduly influencing your judgement (e.g. employer, close professional associates, administrative unit or department). Please note that not fully completing and disclosing all relevant information on this form may, depending on the circumstances, lead WHO to decide not to appoint you to WHO advisory bodies/functions in the future.

Please complete this form and submit it to WHO Secretariat if possible at least 4 weeks but no later than 2 weeks before the meeting or work. You must also promptly inform the Secretariat if there is any change in this information prior to, or during the course of, the meeting or work. All experts must complete this form before participation in a WHO activity can be confirmed. Please note that not fully completing and disclosing all relevant information on this form may, depending on the circumstances, lead WHO to decide not to appoint you to WHO advisory bodies/functions in the future.

Answering "Yes" to a question on this form does not automatically disqualify you or limit your participation in a WHO activity. Your answers will be reviewed by the Secretariat to determine whether you have a conflict of interest relevant to the subject at hand. One of the outcomes listed in the next paragraph can occur depending on the circumstances (e.g, nature and magnitude of the interest, timeframe and duration of the interest).

The Secretariat may conclude that no potential conflict exists or that the interest is irrelevant or insignificant. If, however, a declared interest is determined to be potentially or clearly significant, one or more of the following three measures for managing the conflict of interest may be applied. The Secretariat (i) allows full participation, with public disclosure of your interest; (ii) mandates partial exclusion (i.e., you will be excluded from that portion of the meeting or work related to the declared interest and from the corresponding decision making process); or (iii) mandates total exclusion (i.e., you will not be able to participate in any part of the meeting or work).

All potentially significant interests will be **disclosed** to the other participants at the start of the activity and you will be asked if there have been any changes. A summary of all declarations and actions taken to manage any declared interests will be **published** in resulting reports and work products. Furthermore, if the objectivity of the work or meeting in which you are involved is subsequently questioned, the contents of your DOI form may be made available by the Secretariat to persons outside WHO if the Director-General considers such disclosure to be in the best interest of the Organization, after consulting with you. Completing this DOI form means that you agree to these conditions.

If you are unable or unwilling to disclose the details of an interest that may pose a real or perceived conflict, you must disclose that a conflict of interest may exist and the Secretariat may decide that you be totally recused from the meeting or work concerned, after consulting with you.

| |
|---|
| Name:<br>Institution:<br>Email: |

**Date and title of meeting or work, including description of subject matter to be considered (if a number of substances or processes are to be evaluated, a list should be attached by the organizer of the activity)**:

WHO-China Joint Mission on COVID-19

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*Please answer each of the questions below. If the answer to any of the questions is "yes", briefly describe the circumstances on the last page of the form.*

*The term "you" refers to yourself and your immediate family members (i.e., spouse (or partner with whom you have a similar close personal relationship) and your children). "Commercial entity" includes any commercial business, an industry association, research institution or other enterprise whose funding is significantly derived from commercial sources with an interest related to the subject of the meeting or work. "Organization" includes a governmental, international or non-profit organization. "Meeting" includes a series or cycle of meetings.*

**EMPLOYMENT AND CONSULTING**

***Within the past 4 years, have you received remuneration from a commercial entity or other organization with an interest related to the subject of the meeting or work?***

1a Employment Yes ☐ No ☐

1b Consulting, including service as a technical or other advisor Yes ☐ No ☐

**RESEARCH SUPPORT**

***Within the past 4 years, have you or has your research unit received support from a commercial entity or other organization with an interest related to the subject of the meeting or work?***

2a Research support, including grants, collaborations, sponsorships, and other funding Yes ☐ No ☐

2b Non-monetary support valued at more than US $1000 overall (include equipment, facilities, research assistants, paid travel to meetings, etc.) Yes ☐ No ☐

Support (including honoraria) for being on a speakers bureau, giving speeches or training for a commercial entity or other organization with an interest related to the subject of the meeting or work?

**INVESTMENT INTERESTS**

***Do you have current investments (valued at more than US $5 000 overall) in a commercial entity with an interest related to the subject of the meeting or work? Please also include indirect investments such as a trust or holding company. You may exclude mutual funds, pension funds or similar investments that are broadly diversified and on which you exercise no control.***

3a Stocks, bonds, stock options, other securities (e.g., short sales) Yes ☐ No ☐

3b Commercial business interests (e.g., proprietorships, partnerships, joint ventures, board memberships, controlling interest in a company) Yes ☐ No ☐

**INTELLECTUAL PROPERTY**

***Do you have any intellectual property rights that might be enhanced or diminished by the outcome of the meeting or work?***

4a Patents, trademarks, or copyrights (including pending applications) Yes ☐ No ☐

4b Proprietary know-how in a substance, technology or process Yes ☐ No ☐

**PUBLIC STATEMENTS AND POSITIONS** (during the past 3 years)

5a As part of a regulatory, legislative or judicial process, have you provided an expert opinion or testimony, related to the subject of the meeting or work, for a commercial entity or other organization? Yes ☐ No ☐

5b Have you held an office or other position, paid or unpaid, where you represented interests or defended a position related to the subject of the meeting or work? Yes ☐ No ☐

**ADDITIONAL INFORMATION**

6a If not already disclosed above, have you worked for the competitor of a product that is the subject of the meeting or work, or will your participation in the meeting or work enable you to obtain access to a competitor's confidential proprietary information, or create for you a personal, professional, financial or business competitive advantage? Yes ☐ No ☐

6b To your knowledge, would the outcome of the meeting or work benefit or adversely affect interests of others with whom you have substantial common personal, professional, financial or business interests (such as your adult children or siblings, close professional colleagues, administrative unit or department)? Yes ☐ No ☐

6c Excluding WHO, has any person or entity paid or contributed towards your travel costs in connection with this WHO meeting or work? Yes ☐ No ☐

6d Have you received any payments (other than for travel costs) or honoraria for speaking publicly on the subject of this WHO meeting or work? Yes ☐ No ☐

6e Is there any other aspect of your background or present circumstances not addressed above that might be perceived as affecting your objectivity or independence? Yes ☐ No ☐

7. **TOBACCO OR TOBACCO PRODUCTS** *(answer without regard to relevance to the subject of the meeting or work)*
Within the past 4 years, have you had employment or received research support or other funding from, or had any other professional relationship with, an entity directly involved in the production, manufacture, distribution or sale of tobacco or tobacco products or representing the interests of any such entity? Yes ☐ No ☐

**EXPLANATION OF "YES" RESPONSES:** If the answer to any of the above questions is **"yes", check above and briefly describe the circumstances on this page. If you do not describe the nature of an interest or if you do not provide the amount or value involved where relevant, the conflict will be assumed to be significant.**

| **Nos. 1 - 4:** **Type of interest, question number and category (e.g., Intellectual Property 4.a copyrights) and basic descriptive details.** | **Name of company, organization, or institution** | **Belongs to you, a family member, employer, research unit or other?** | **Amount of income or value of interest (if not disclosed, is assumed to be significant)** | **Current interest (or year ceased)** |
|---|---|---|---|---|
| | | | | |

**Nos. 5-6: Describe the subject, specific circumstances, parties involved, time frame and other relevant details**

CONSENT TO DISCLOSURE. By completing and signing this form, you consent to the disclosure of any relevant conflicts to other meeting participants and in the resulting report or work product.

**DECLARATION. I hereby declare on my honour that the disclosed information is true and complete to the best of my knowledge.**

**Should there be any change to the above information, I will promptly notify the responsible staff of WHO and complete a new declaration of interests form that describes the changes. This includes any change that occurs before or during the meeting or work itself and through the period up to the publication of the final results or completion of the activity concerned.**

Date: _____ Signature_____

**World Health Organization**  **Organisation mondiale de la Santé**

## CONFIDENTIALITY UNDERTAKING

1. The World Health Organization (WHO) – People's Republic of China Joint Mission on COVID-19 (hereafter referred to as the 'Joint Mission' or 'Mission') will be implemented over a period of 7-10 days (during the 2nd half of February 2020). The overall goal of the Joint Mission is to rapidly inform national and international planning on next steps in the response to the ongoing outbreak of novel coronavirus disease (COVID-19) and on next steps in preparedness for areas not yet affected.

2. The Undersigned, in his/her capacity as an expert advisor to WHO, will participate in the Mission. In connection with the Mission, the Undersigned may receive or otherwise gain access to information (including, but not limited to, concerning the COVID-19 outbreak) which is confidential or proprietary to WHO, to the Government of China and/or to third parties collaborating with them (the "Confidential Information").

3. The Undersigned hereby undertakes to treat the Confidential Information as confidential and proprietary to WHO, the Government of China and/or third parties collaborating with them, and to use the Confidential Information solely for the purpose of performing the Undersigned's responsibilities in connection with the Mission (the "Purpose"), and no other purpose. The Undersigned also agrees to take all reasonable measures to ensure that the Confidential Information is not used, copied, disclosed or otherwise transmitted, in whole or in part, by or on behalf of the Undersigned to any third parties; except for third parties who have a need to know the Confidential Information for the Purpose and who are bound by obligations and restrictions substantially similar to those contained in this Undertaking.

4. The Undersigned shall not be bound by any confidentiality obligations or restrictions on use contained herein if and to the extent that the Undersigned is clearly able to demonstrate that the Confidential Information: (a) was in the public domain at the time of disclosure by or for WHO to the Undersigned; or (b) becomes part of the public domain through no fault of the Undersigned.

5. The Undersigned undertakes not to communicate any of the materials, discussions, outputs, results or recommendations of the Mission to any third parties, except as authorized in writing by WHO.

6. The Undersigned further agrees that any statements or other communications to the media and/or the public concerning the Mission shall be exclusively handled by Mr Bruce Aylward, Head of Mission of the WHO-China Joint Mission on COVID-19, and that the Undersigned shall not make any such statements or communications.

7. Upon WHO's request, the Undersigned shall promptly return to WHO all copies of the Confidential Information.

8. The obligations of the Undersigned hereunder shall survive the termination of the Mission.

9. Any dispute relating to this Undertaking shall be resolved through amicable direct negotiations between the Parties.

10. Nothing in or relating to this Undertaking shall be deemed or construed as a waiver of any of the privileges and immunities enjoyed by WHO, or as submitting WHO to any national court jurisdiction.

Agreed to and accepted by the Undersigned as of the date set forth below.

Name: _____ Date: _____

Signature: _____

**From:** UMALI DALANGIN, Khristeen
**Sent:** Fri, 14 Feb 2020 08:02:29 +0000
**To:**
(b) (6); (b) (6); (b) (6); (b) (6); (b) (6);Lane, Cliff (NIH/NIAID) [E]; (b) (6);Eckmanns, Tim
**Cc:** GALEA, Gauden;PANG, Xinxin;OLOWOKURE, Babatunde;MAHAMUD, Abdi Rahman;HAN, Mansuk Daniel;Handley, Gray (NIH/NIAID) [E]; (b) (6) (b) (6);AZZIZ-BAUMGARTNER, Eduardo;Eduard Salakhov;Sergey Vasiliev;DRURY, Patrick Anthony;Steven T. Smith
**Subject:** RE: WHO/GOARN - Joint China Mission - Visa Applicant Form.pdf

Dear all,

Kindly note the WHO Country Office in China has informed us that the visa authorization letter has been sent to the local Chinese Embassy.

Best,

Khristeen

-----Original Message-----
From: DRURY, Patrick Anthony
Sent: Thursday, February 13, 2020 9:15 PM
To: (b) (6); (b) (6); (b) (6); (b) (6); (b) (6); (b) (6); (b) (6)
Cc: GALEA, Gauden (b) (6); PANG, Xinxin (b) (6); OLOWOKURE, Babatunde (b) (6); MAHAMUD, Abdi Rahman (b) (6); UMALI DALANGIN, Khristeen (b) (6); HAN, Mansuk Daniel (b) (6); Handley, Gray (NIH/NIAID) [E] (b) (6); (b) (6); AZZIZ-BAUMGARTNER, Eduardo (b) (6); Eduard Salakhov (b) (6); Sergey Vasiliev (b) (6); (b) (6)
Subject: WHO/GOARN - Joint China Mission - Visa Applicant Form.pdf

Dear colleagues,

Further to correspondence earlier today from the Director General of WHO, many thanks for your interest and commitment to support the joint China mission and the global COVID-19 response.

Thank you particularly for the copies of passports and biographies/CVs. Tonight these will be shared with the WHO Representative in China who is working with the Chinese ministries to ensure immediate visas.
We would be grateful for your continued support and patience as the crucial visas arrangement are put in place for travel as quickly as possible.

Attached is the visa application form that we would ask each member of the team to complete please. In order to facilitate a rapid turnaround please bring the completed form together with your passport and recent photograph to your respective embassy/consular office and visas should be issued immediately.

Abdi - please also pass to Professors Takahashi Jin, and Jong-Koo Lee in Japan and Korea respectively.

best wishes,
Pat

Pat Drury
Deputy Incident Manager COVID-19
Global Outbreak Alert and Response Network (GOARN) WHO Health Emergency preparedness and Response
(b) (6)

**From:** AYLWARD, Raymond Bruce J.
**Sent:** Fri, 14 Feb 2020 07:44:15 +0000
**To:** Lane, Cliff (NIH/NIAID) [E]
**Subject:** RE: thanks!

Yup

That was my expectation

B

---

**From:** Lane, Cliff (NIH/NIAID) [E] (b) (6)
**Sent:** Friday, February 14, 2020 08:26
**To:** AYLWARD, Raymond Bruce J. (b) (6)
**Subject:** Re: thanks!

Bruce,

Thanks for the note. I think I can be of most help in discussions with the staff involved in the clinical trials. I am sorry that I do not know any specific names.

Cliff

On Feb 13, 2020, at 11:29 PM, AYLWARD, Raymond Bruce J. (b) (6) wrote:

Dear Cliff

On a personal note, a huge thanks for joining and altering plans – it will be well worth it.

I look forward so much to working with you and benefiting from your knowledge and experience.

As I may be able to influence some of the site visit planning/expert consultations, can you let me know of the specific facilities/people that you would see as important for the team to interact with while in your domain (esp. Beijing/Guangdong based).

Very best,

Bruce

---

**From:** DRURY, Patrick Anthony
**Sent:** Thursday, February 13, 2020 23:27
**To:** Lane, Cliff (NIH/NIAID) [E] (b) (6); Office of the Director-General

(b) (6); SCHWARTLANDER, Bernhard F. (b) (6); GALEA, Gauden (b) (6); AYLWARD, Raymond Bruce J. (b) (6); PANG, Xinxin (b) (6)
**Cc:** (b) (6); (b) (6); Handley, Gray (NIH/NIAID) [E] (b) (6); Fauci, Anthony (NIH/NIAID) [E] (b) (6); Carver, Trea (NIH) [C] (b) (6); OLOWOKURE, Babatunde (b) (6); MAHAMUD, Abdi Rahman (b) (6); UMALI DALANGIN, Khristeen (b) (6); HAN, Mansuk Daniel (b) (6); Handley, Gray (NIH/NIAID) [E] (b) (6); (b) (6) (b) (6); AZZIZ-BAUMGARTNER, Eduardo (b) (6); (b) (6)
**Subject:** URGENT: Follow-up Re: Letter from WHO Director-General, Dr Tedros Adhanom Ghebreyesus

Dear Cliff, many thanks for your message.

Thanks for the copies of your passport and biography/CVs. Tonight we shared these with Gauden Galea, the WHO Representative in China who is working with the Chinese ministries directly to ensure immediate visas.

Attached is the visa application form to complete please. Please bring the completed form together with your passport and recent photograph to the Chinese Embassy/Consular Office in Tokyo and visas should be issued immediately.

best wishes,
Pat

Pat Drury
Deputy Incident Manager COVID-19
Global Outbreak Alert and Response Network (GOARN) WHO Health Emergency preparedness and Response
(b) (6)

---

**From:** Lane, Cliff (NIH/NIAID) [E] (b) (6)
**Sent:** 13 February 2020 23:01
**To:** Office of the Director-General (b) (6)
**Cc:** SCHWARTLANDER, Bernhard F. (b) (6); DRURY, Patrick Anthony (b) (6); (b) (6); (b) (6); Handley, Gray (NIH/NIAID) [E] (b) (6); Fauci, Anthony (NIH/NIAID) [E] (b) (6); Carver, Trea (NIH) [C] (b) (6)
**Subject:** Followup Re: Letter from WHO Director-General, Dr Tedros Adhanom Ghebreyesus

Colleagues,

I have been able to alter my itinerary to arrive in Beijing Saturday evening and I am aware arrangements are being made for pickup and accommodations.

The remaining unknown is how to navigate getting a visa given that I will be in Tokyo Saturday day prior to departure.

Any and all suggestions are welcome. I apologize if this is a repeat message.

Cliff Lane

On Feb 13, 2020, at 1:45 PM, Lane, Cliff (NIH/NIAID) [E] (b) (6) wrote:

Thank-you for the invitation to participate in this important mission. I am currently en route to Japan (communicating via onboard WiFi) to explore the possibility of rapidly implementing a study of the drug remdesivir in the context of the current cases in that country.

I have sent a message to my supervisor Dr. Fauci (copied) that I could attempt to change plans after arrival in Tokyo depending upon where I am felt to be of most value.

I am very appreciative of having received the invitation.

Sincerely,

Cliff Lane

On Feb 13, 2020, at 1:23 PM, Office of the Director-General (b) (6) wrote:

Dear Dr Lane,

Please find attached for your kind and urgent attention, a letter from Dr Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization.
Best regards.

Office of the Director-General
World Health Organization

<Scanned from a Xerox Multifunction Printer.pdf>

**From:** DRURY, Patrick Anthony
**Sent:** Thu, 13 Feb 2020 22:26:53 +0000
**To:** Lane, Cliff (NIH/NIAID) [E];Office of the Director-General;SCHWARTLANDER, Bernhard F.;GALEA, Gauden;AYLWARD, Raymond Bruce J.;PANG, Xinxin
**Cc:** (b) (6); (b) (6);Handley, Gray (NIH/NIAID) [E];Fauci, Anthony (NIH/NIAID) [E];Carver, Trea (NIH) [C];OLOWOKURE, Babatunde;MAHAMUD, Abdi Rahman;UMALI DALANGIN, Khristeen;HAN, Mansuk Daniel;Handley, Gray (NIH/NIAID) [E];' (b) (6) ';AZZIZ-BAUMGARTNER, Eduardo;Steven T. Smith
**Subject:** URGENT: Follow-up Re: Letter from WHO Director-General, Dr Tedros Adhanom Ghebreyesus
**Attachments:** 签证申请表Visa Applicant Form.pdf

Dear Cliff, many thanks for your message.

Thanks for the copies of your passport and biography/CVs. Tonight we shared these with Gauden Galea, the WHO Representative in China who is working with the Chinese ministries directly to ensure immediate visas.

Attached is the visa application form to complete please. Please bring the completed form together with your passport and recent photograph to the Chinese Embassy/Consular Office in Tokyo and visas should be issued immediately.

best wishes,
Pat

Pat Drury
Deputy Incident Manager COVID-19
Global Outbreak Alert and Response Network (GOARN) WHO Health Emergency preparedness and Response
(b) (6)

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**From:** Lane, Cliff (NIH/NIAID) [E] (b) (6)
**Sent:** 13 February 2020 23:01
**To:** Office of the Director-General (b) (6)
**Cc:** SCHWARTLANDER, Bernhard F. (b) (6); DRURY, Patrick Anthony (b) (6); (b) (6); (b) (6); Handley, Gray (NIH/NIAID) [E] (b) (6); Fauci, Anthony (NIH/NIAID) [E] (b) (6); Carver, Trea (NIH) [C] (b) (6)
**Subject:** Followup Re: Letter from WHO Director-General, Dr Tedros Adhanom Ghebreyesus

Colleagues,

I have been able to alter my itinerary to arrive in Beijing Saturday evening and I am aware arrangements are being made for pickup and accommodations.

The remaining unknown is how to navigate getting a visa given that I will be in Tokyo Saturday day prior to departure.

Any and all suggestions are welcome. I apologize if this is a repeat message.

Cliff Lane

On Feb 13, 2020, at 1:45 PM, Lane, Cliff (NIH/NIAID) [E] (b) (6) wrote:

Thank-you for the invitation to participate in this important mission. I am currently en route to Japan (communicating via onboard WiFi) to explore the possibility of rapidly implementing a study of the drug remdesivir in the context of the current cases in that country.

I have sent a message to my supervisor Dr. Fauci (copied) that I could attempt to change plans after arrival in Tokyo depending upon where I am felt to be of most value.

I am very appreciative of having received the invitation.

Sincerely,

Cliff Lane

On Feb 13, 2020, at 1:23 PM, Office of the Director-General (b) (6) wrote:

Dear Dr Lane,

Please find attached for your kind and urgent attention, a letter from Dr Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization.
Best regards.

Office of the Director-General
World Health Organization

<Scanned from a Xerox Multifunction Printer.pdf>

# 中华人民共和国签证申请表

## *Visa Application Form of the People's Republic of China*

**(For the Mainland of China only)**

**申请人必须如实、完整、清楚地填写本表格。请逐项在空白处用中文或英文大写字母打印填写，或在□内打√选择。如有关项目不适用，请写"无"。The applicant should fill in this form truthfully , completely and clearly. Please type the answer in capital English letters in the space provided or tick (√) the relevant box to select. <u>If some of the items do not apply, please type N/A or None.</u>**

## 一、个人信息 Part 1: Personal Information

| | | |
|---|---|---|
| 1.1 英文姓名 **Full English name as in passport** | 姓 **Last name** | 粘贴一张近期正面免冠、浅色背景的彩色护照照片。<br>照片/**Photo**<br>**Affix one recent color passport photo (full face, front view, bareheaded and against a plain light colored background).** |
| | 中间名 **Middle name** | |
| | 名 **First name** | |
| **1.2** 中文姓名 **Name in Chinese** | **1.3** 别名或曾用名 **Other name(s)** | |
| **1.4** 性别 **Sex** ☐ 男 **M** ☐ 女 **F** | **1.5** 出生日期 **DOB(yyyy-mm-dd)** | |
| **1.6** 现有国籍 **Current nationality(ies)** | **1.7** 曾有国籍 **Former nationality(ies)** | |
| **1.8** 出生地点(市、省/州、国) **Place of birth(city, province/state,country)** | | |
| **1.9** 身份证/公民证号码 **Local ID/ Citizenship number** | | |
| **1.10** 护照/旅行证件种类 **Passport/Travel document type** | ☐ 外交 **Diplomatic** ☐ 公务、官员 **Service or Official**<br>☐ 普通 **Ordinary** ☐ 其他证件(请说明) **Other (Please specify):** | |
| **1.11** 护照号码 **Passport number** | **1.12** 签发日期 **Date of issue(yyyy-mm-dd)** | |
| **1.13** 签发地点 **Place of issue** | **1.14** 失效日期 **Date of expiry(yyyy-mm-dd)** | |
| **1.15** 当前职业（可选多项） **Current occupation(s)** | ☐ 商人 **Businessperson**<br>☐ 公司职员 **Company employee**<br>☐ 演艺人员 **Entertainer**<br>☐ 工人/农民 **Industrial/Agricultural worker**<br>☐ 学生 **Student**<br>☐ 乘务人员 **Crew member**<br>☐ 自雇 **Self-employed**<br>☐ 无业 **Unemployed**<br>☐ 退休 **Retired**<br>☐ 其他(请说明) **Other (Please specify):** | ☐ 前/现任议员 **Former/incumbent member of parliament**<br>职位 **Position**_____<br>☐ 前/现任政府官员 **Former/incumbent government official**<br>职位 **Position**_____<br>☐军人 **Military personnel**<br>职位 **Position**_____<br>☐ 非政府组织人员 **NGO staff**<br>☐ 宗教人士 **Religious personnel**<br>☐ 新闻从业人员 **Staff of media** |
| **1.16** 受教育程度 **Education** | ☐ 研究生 **Postgraduate** ☐ 大学 **College**<br>☐ 其他(请说明) **Other (Please specify):** | |
| **1.17** 工作单位/学校 **Employer/School** | 名称 **Name** | 联系电话 **Phone number** |
| | 地址 **Address** | 邮政编码 **Zip Code** |

| | |
|---|---|
| **1.18** 家庭住址<br>**Home address** | **1.19** 邮政编码<br>**Zip Code** |
| **1.20** 电话/手机<br>**Home/mobile phone number** | **1.21** 电子邮箱<br>**E-mail address** |
| **1.22** 婚姻状况 **Marital status** ☐ 已婚 **Married** ☐ 单身 **Single** ☐ 其他 **Other(Please specify):** | |

| | 姓名 **Name** | 国籍 **Nationality** | 职业 **Occupation** | 关系 **Relationship** |
|---|---|---|---|---|
| **1.23** 主要家庭成员(配偶、子女、父母等,可另纸)<br>**Major family members（spouse, children,parents,etc.,may type on separate paper）** | | | | |
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|---|---|---|
| **1.24**<br>紧急联络人信息<br>**Emergency Contact** | 姓名<br>**Name** | 手机<br>**Mobile phone number** |
| | 与申请人的关系<br>**Relationship with the applicant** | |
| **1.25** 申请人申请签证时所在的国家或地区 **Country or territory where the applicant is located when applying for this visa** | | |

## 二、旅行信息 Part 2: Travel Information

| | | |
|---|---|---|
| **2.1** 申请入境事由 **Major purpose of your visit** | ☐ 官方访问 **Official Visit**<br>☐ 旅游 **Tourism**<br>☐ 交流、考察、访问 **Non-business visit**<br>☐ 商业贸易 **Business & Trade**<br>☐ 人才引进 **As introduced talent**<br>☐ 执行乘务 **As crew member**<br>☐ 过境 **Transit** | ☐ 常驻外交、领事、国际组织人员 **As resident diplomat, consul or staff of international organization**<br>☐ 永久居留 **As permanent resident**<br>☐ 工作 **Work**<br>☐ 寄养 **As child in foster care** |
| | ☐ 短期探望中国公民或者具有中国永久居留资格的外国人 **Short-term visit to Chinese citizen or foreigner with Chinese permanent residence status** | ☐ 与中国公民或者具有中国永久居留资格的外国人家庭团聚居留超过 **180** 日 **Family reunion for over 180 days with Chinese citizen or foreigner with Chinese permanent residence status** |
| | ☐ 短期探望因工作、学习等事由在中国停留居留的外国人 **Short-term visit to foreigner residing in China due to work, study or other reasons** | ☐ 长期探望因工作、学习等事由在中国居留的外国人 **As accompanying family member of foreigner residing in China due to work, study or other reasons** |
| | ☐ 短期学习 **Short-term study for less than 180 days** | ☐ 长期学习 **Long-term study for over 180 days** |
| | ☐ 短期采访报道 **As journalist for temporary news coverage** | ☐外国常驻中国新闻机构记者 **As resident journalist** |
| | ☐ 其他(请说明)**Other (Please specify):** | |
| **2.2** 计划入境次数 **Intended number of entries** | ☐ 一次(自签发之日起 **3** 个月有效) **One entry valid for 3 months from the date of issue**<br>☐ 二次(自签发之日起 **3-6** 个月有效) **Two entries valid for 3 to 6 months from the date of issue**<br>☐ 半年多次（自签发之日起 **6** 个月有效) **Multiple entries valid for 6 months from the date of issue**<br>☐ 一年多次（自签发之日起 **1** 年有效) **Multiple entries valid for 1 year from the date of issue**<br>☐ 其他（请说明）**Other (Please specify):** | |
| **2.3** 是否申请加急服务 **Are you applying for expressservice?**<br>注：加急服务须经领事官员批准，将加收费用。**Note: Expressservice needs approval of consular officials, and extra fees may apply.** | ☐ 是 **Yes** ☐ 否 **No** | |
| **2.4** 本次行程预计首次抵达中国的日期<br>**Expected date of your first entry into China on this trip (yyyy-mm-dd)** | | |

| | | |
|---|---|---|
| **2.5** 预计行程中单次在华停留的最长天数<br>**Longest intended stay in China among all entries** | | **Days** |
| **2.6** 在中国境内行程（按时间顺序，可附另纸填写）<br>**Itinerary in China (in time sequence, may type on separate paper)** | 日期 **Date** | 详细地址 **Detailed address** |
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| | | |
| **2.7** 谁将承担在中国期间的费用？ **Who will pay for your travel and expenses during your stay in China?** | | |
| **2.8** 中国境内邀请单位或个人信息<br>**Information of inviter in China** | 姓名或名称<br>**Name** | |
| | 地址<br>**Address** | |
| | 联系电话<br>**Phone number** | |
| | 与申请人关系<br>**Relationship with the applicant** | |
| 2.9 是否曾经获得过中国签证？如有，请说明最近一次获得中国签证的时间和地点. **Have you ever been granted a Chinese visa? If applicable, please specify the date and place of the last time you were granted the visa.** | | |
| 2.10 过去 12 个月中访问的其他国家或地区 **Other countries or territories you visited in the last 12 months** | | |

## 三、其他事项 Part 3: Other Information

| | |
|---|---|
| 3.1 是否曾在中国超过签证或居留许可允许的期限停留？ **Have you ever overstayed your visa or residence permit in China?** | ☐是 **Yes** ☐否 **No** |
| 3.2 是否曾经被拒绝签发中国签证，或被拒绝进入中国？ **Have you ever been refused a visa for China, or been refused entry into China?** | ☐是 **Yes** ☐否 **No** |
| 3.3 是否在中国或其他国家有犯罪记录？ **Do you have any criminal record in China or any other country?** | ☐是 **Yes** ☐否 **No** |
| 3.4 是否具有以下任一种情形 **Are you experiencing any of the following conditions?**<br>①严重精神障碍 **Serious mental disorder**<br>②传染性肺结核病 **Infectious pulmonary tuberculosis**<br>③可能危害公共卫生的其他传染病 **Other infectious disease of public health hazards** | ☐是 **Yes** ☐否 **No** |
| 3.5 近 30 日内是否前往过流行性疾病传染的国家或地区？ **Did you visit countries or territories affected by infectious diseases in the last 30 days?** | ☐是 **Yes** ☐否 **No** |
| 3.6 如果对 3.1 到 3.5 的任何一个问题选择“是”，请在下面详细说明。<br>**If you select Yes to any questions from 3.1 to 3.5, please give details below.** | |

3.7 如果有本表未涉及而需专门陈述的其他与签证申请相关的事项，请在此或另纸说明。
**If you have more information about your visa application other than the above to declare,please give details below or type on a separate paper.**

3.8 如申请人护照中的偕行人与申请人一同旅行，请将偕行人照片粘贴在下面并填写偕行人信息。**If someone else travels and shares the same passport with the applicant , please affix their photos and give their information below.**

| 偕行人信息 ***Information*** | 偕行人 1 **Person 1** *粘贴照片于此* ***Affix Photo here*** | 偕行人 2 **Person 2** *粘贴照片于此* ***Affix Photo here*** | 偕行人 3 **Person 3** *粘贴照片于此* ***Affix Photo here*** |
|---|---|---|---|
| 姓名 **Full name** | | | |
| 性别 **Sex** | | | |
| 生日 **DOB(yyyy-mm-dd)** | | | |

## 四、声明及签名 **Part 4: Declaration & Signature**

4.1 我声明，我已阅读并理解此表所有内容要求，并愿就所填报信息和申请材料的真实性承担一切法律后果。
**I hereby declare that I have read and understood all the questions in this application and shall bear all the legal consequences for the authenticity of the information and materials I provided.**
4.2 我理解，能否获得签证、获得何种签证、入境次数以及有效期、停留期等将由领事官员决定，任何不实、误导或填写不完整均可能导致签证申请被拒绝或被拒绝进入中国。
**I understand that whether to issue a visa, type of visa, number of entries, validity and duration of each stay will be determined by consular official, and that any false, misleading or incomplete statement may result in the refusal of a visa for or denial of entry into China.**
4.3 我理解，根据中国法律，申请人即使持有中国签证仍有可能被拒绝入境。
**I understand that, according to Chinese law, applicant may be refused entry into China even if a visa is granted.**

申请人签名
**Applicant's signature:** .....

日期
**Date (yyyy-mm-dd):**.....

注：未满 18 周岁的未成年人须由父母或监护人代签。**Note: The parent or guardian shall sign on behalf of a minor under 18 years of age.**

## 五、他人代填申请表时填写以下内容 **Part 5：If the application form is completed by another person on the applicant's behalf, please fill out the information of the one who completes the form**

| | | | |
|---|---|---|---|
| 5.1 姓名 **Name** | | 5.2 与申请人关系 **Relationship with the applicant** | |
| 5.3 地址 **Address** | | 5.4 电话 **Phone number** | |

5.5 声明 **Declaration**
我声明本人是根据申请人要求而协助填表，证明申请人理解并确认表中所填写内容准确无误。
**I declare that I have assisted in the completion of this form at the request of the applicant and that the applicant understands and agrees that the information provided is true and correct.**

代填人签名/**Signature**: .....

日期/**Date (yyyy-mm-dd)**: .....

**From:** DRURY, Patrick Anthony
**Sent:** Thu, 13 Feb 2020 20:14:43 +0000
**To:**
[redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6); [redacted] (b) (6);Lane, Cliff (NIH/NIAID) [E]; [redacted] (b) (6)
**Cc:** GALEA, Gauden;PANG, Xinxin;OLOWOKURE, Babatunde;MAHAMUD, Abdi Rahman;UMALI DALANGIN, Khristeen;HAN, Mansuk Daniel;Handley, Gray (NIH/NIAID) [redacted] (b) (6);AZZIZ-BAUMGARTNER, Eduardo;Eduard Salakhov;Sergey Vasiliev;Steven T. Smith
**Subject:** WHO/GOARN - Joint China Mission - Visa Applicant Form.pdf
**Attachments:** 签证申请表Visa Applicant Form.pdf

Dear colleagues,

Further to correspondence earlier today from the Director General of WHO, many thanks for your interest and commitment to support the joint China mission and the global COVID-19 response.

Thank you particularly for the copies of passports and biographies/CVs. Tonight these will be shared with the WHO Representative in China who is working with the Chinese ministries to ensure immediate visas.
We would be grateful for your continued support and patience as the crucial visas arrangement are put in place for travel as quickly as possible.

Attached is the visa application form that we would ask each member of the team to complete please. In order to facilitate a rapid turnaround please bring the completed form together with your passport and recent photograph to your respective embassy/consular office and visas should be issued immediately.

Abdi - please also pass to Professors Takahashi Jin, and Jong-Koo Lee in Japan and Korea respectively.

best wishes,
Pat

Pat Drury
Deputy Incident Manager COVID-19
Global Outbreak Alert and Response Network (GOARN)
WHO Health Emergency preparedness and Response
[redacted] (b) (6)

# 中华人民共和国签证申请表

## *Visa Application Form of the People's Republic of China*

**(For the Mainland of China only)**

**申请人必须如实、完整、清楚地填写本表格。请逐项在空白处用中文或英文大写字母打印填写，或在□内打√选择。如有关项目不适用，请写"无"。The applicant should fill in this form truthfully , completely and clearly. Please type the answer in capital English letters in the space provided or tick (√) the relevant box to select. <u>If some of the items do not apply, please type N/A or None.</u>**

## 一、个人信息 Part 1: Personal Information

| | | |
|---|---|---|
| 1.1 英文姓名 **Full English name as in passport** | 姓 **Last name** | 粘贴一张近期正面免冠、浅色背景的彩色护照照片。<br>照片/**Photo**<br>**Affix one recent color passport photo (full face, front view, bareheaded and against a plain light colored background).** |
| | 中间名 **Middle name** | |
| | 名 **First name** | |
| **1.2** 中文姓名 **Name in Chinese** | **1.3** 别名或曾用名 **Other name(s)** | |
| **1.4** 性别 **Sex** ☐ 男 **M** ☐ 女 **F** | **1.5** 出生日期 **DOB(yyyy-mm-dd)** | |
| **1.6** 现有国籍 **Current nationality(ies)** | **1.7** 曾有国籍 **Former nationality(ies)** | |
| **1.8** 出生地点(市、省/州、国) **Place of birth(city, province/state,country)** | | |
| **1.9** 身份证/公民证号码 **Local ID/ Citizenship number** | | |
| **1.10** 护照/旅行证件种类 **Passport/Travel document type** | ☐ 外交 **Diplomatic** ☐ 公务、官员 **Service or Official**<br>☐ 普通 **Ordinary** ☐ 其他证件(请说明) **Other (Please specify):** | |
| **1.11** 护照号码 **Passport number** | **1.12** 签发日期 **Date of issue(yyyy-mm-dd)** | |
| **1.13** 签发地点 **Place of issue** | **1.14** 失效日期 **Date of expiry(yyyy-mm-dd)** | |
| **1.15** 当前职业（可选多项） **Current occupation(s)** | ☐ 商人 **Businessperson**<br>☐ 公司职员 **Company employee**<br>☐ 演艺人员 **Entertainer**<br>☐ 工人/农民 **Industrial/Agricultural worker**<br>☐ 学生 **Student**<br>☐ 乘务人员 **Crew member**<br>☐ 自雇 **Self-employed**<br>☐ 无业 **Unemployed**<br>☐ 退休 **Retired**<br>☐ 其他(请说明) **Other (Please specify):** | ☐ 前/现任议员 **Former/incumbent member of parliament**<br>职位 **Position**_____<br>☐ 前/现任政府官员 **Former/incumbent government official**<br>职位 **Position**_____<br>☐军人 **Military personnel**<br>职位 **Position**_____<br>☐ 非政府组织人员 **NGO staff**<br>☐ 宗教人士 **Religious personnel**<br>☐ 新闻从业人员 **Staff of media** |
| **1.16** 受教育程度 **Education** | ☐ 研究生 **Postgraduate** ☐ 大学 **College**<br>☐ 其他(请说明) **Other (Please specify):** | |
| **1.17** 工作单位/学校 **Employer/School** | 名称 **Name** | 联系电话 **Phone number** |
| | 地址 **Address** | 邮政编码 **Zip Code** |

| | |
|---|---|
| **1.18** 家庭住址<br>**Home address** | **1.19** 邮政编码<br>**Zip Code** |
| **1.20** 电话/手机<br>**Home/mobile phone number** | **1.21** 电子邮箱<br>**E-mail address** |
| **1.22** 婚姻状况 **Marital status** ☐ 已婚 **Married** ☐ 单身 **Single** ☐ 其他 **Other(Please specify):** | |

| | 姓名 **Name** | 国籍 **Nationality** | 职业 **Occupation** | 关系 **Relationship** |
|---|---|---|---|---|
| **1.23** 主要家庭成员(配偶、子女、父母等,可另纸)<br>**Major family members（spouse, children,parents,etc.,may type on separate paper）** | | | | |
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|---|---|---|
| **1.24**<br>紧急联络人信息<br>**Emergency Contact** | 姓名<br>**Name** | 手机<br>**Mobile phone number** |
| | 与申请人的关系<br>**Relationship with the applicant** | |
| **1.25** 申请人申请签证时所在的国家或地区 **Country or territory where the applicant is located when applying for this visa** | | |

## 二、旅行信息 Part 2: Travel Information

| | | |
|---|---|---|
| **2.1** 申请入境事由 **Major purpose of your visit** | ☐ 官方访问 **Official Visit**<br>☐ 旅游 **Tourism**<br>☐ 交流、考察、访问 **Non-business visit**<br>☐ 商业贸易 **Business & Trade**<br>☐ 人才引进 **As introduced talent**<br>☐ 执行乘务 **As crew member**<br>☐ 过境 **Transit** | ☐ 常驻外交、领事、国际组织人员 **As resident diplomat, consul or staff of international organization**<br>☐ 永久居留 **As permanent resident**<br>☐ 工作 **Work**<br>☐ 寄养 **As child in foster care** |
| | ☐ 短期探望中国公民或者具有中国永久居留资格的外国人 **Short-term visit to Chinese citizen or foreigner with Chinese permanent residence status** | ☐ 与中国公民或者具有中国永久居留资格的外国人家庭团聚居留超过 **180** 日 **Family reunion for over 180 days with Chinese citizen or foreigner with Chinese permanent residence status** |
| | ☐ 短期探望因工作、学习等事由在中国停留居留的外国人 **Short-term visit to foreigner residing in China due to work, study or other reasons** | ☐ 长期探望因工作、学习等事由在中国居留的外国人 **As accompanying family member of foreigner residing in China due to work, study or other reasons** |
| | ☐ 短期学习 **Short-term study for less than 180 days** | ☐ 长期学习 **Long-term study for over 180 days** |
| | ☐ 短期采访报道 **As journalist for temporary news coverage** | ☐外国常驻中国新闻机构记者 **As resident journalist** |
| | ☐ 其他(请说明)**Other (Please specify):** | |
| **2.2** 计划入境次数 **Intended number of entries** | ☐ 一次(自签发之日起 **3** 个月有效) **One entry valid for 3 months from the date of issue**<br>☐ 二次(自签发之日起 **3-6** 个月有效) **Two entries valid for 3 to 6 months from the date of issue**<br>☐ 半年多次（自签发之日起 **6** 个月有效) **Multiple entries valid for 6 months from the date of issue**<br>☐ 一年多次（自签发之日起 **1** 年有效) **Multiple entries valid for 1 year from the date of issue**<br>☐ 其他（请说明）**Other (Please specify):** | |
| **2.3** 是否申请加急服务 **Are you applying for expressservice?**<br>注：加急服务须经领事官员批准，将加收费用。**Note: Expressservice needs approval of consular officials, and extra fees may apply.** | ☐ 是 **Yes** ☐ 否 **No** | |
| **2.4** 本次行程预计首次抵达中国的日期<br>**Expected date of your first entry into China on this trip (yyyy-mm-dd)** | | |

| | | |
|---|---|---|
| **2.5** 预计行程中单次在华停留的最长天数<br>**Longest intended stay in China among all entries** | | **Days** |
| **2.6** 在中国境内行程（按时间顺序，可附另纸填写）<br>**Itinerary in China (in time sequence, may type on separate paper)** | 日期 **Date** | 详细地址 **Detailed address** |
| | | |
| | | |
| | | |
| | | |
| | | |
| **2.7** 谁将承担在中国期间的费用？ **Who will pay for your travel and expenses during your stay in China?** | | |
| **2.8** 中国境内邀请单位或个人信息<br>**Information of inviter in China** | 姓名或名称<br>**Name** | |
| | 地址<br>**Address** | |
| | 联系电话<br>**Phone number** | |
| | 与申请人关系<br>**Relationship with the applicant** | |
| 2.9 是否曾经获得过中国签证？如有，请说明最近一次获得中国签证的时间和地点. **Have you ever been granted a Chinese visa? If applicable, please specify the date and place of the last time you were granted the visa.** | | |
| 2.10 过去 12 个月中访问的其他国家或地区 **Other countries or territories you visited in the last 12 months** | | |

## 三、其他事项 Part 3: Other Information

| | |
|---|---|
| 3.1 是否曾在中国超过签证或居留许可允许的期限停留？ **Have you ever overstayed your visa or residence permit in China?** | ☐是 **Yes** ☐否 **No** |
| 3.2 是否曾经被拒绝签发中国签证，或被拒绝进入中国？ **Have you ever been refused a visa for China, or been refused entry into China?** | ☐是 **Yes** ☐否 **No** |
| 3.3 是否在中国或其他国家有犯罪记录？ **Do you have any criminal record in China or any other country?** | ☐是 **Yes** ☐否 **No** |
| 3.4 是否具有以下任一种情形 **Are you experiencing any of the following conditions?**<br>①严重精神障碍 **Serious mental disorder**<br>②传染性肺结核病 **Infectious pulmonary tuberculosis**<br>③可能危害公共卫生的其他传染病 **Other infectious disease of public health hazards** | ☐是 **Yes** ☐否 **No** |
| 3.5 近 30 日内是否前往过流行性疾病传染的国家或地区？ **Did you visit countries or territories affected by infectious diseases in the last 30 days?** | ☐是 **Yes** ☐否 **No** |
| 3.6 如果对 3.1 到 3.5 的任何一个问题选择“是”，请在下面详细说明。<br>**If you select Yes to any questions from 3.1 to 3.5, please give details below.** | |

3.7 如果有本表未涉及而需专门陈述的其他与签证申请相关的事项，请在此或另纸说明。
**If you have more information about your visa application other than the above to declare,please give details below or type on a separate paper.**

3.8 如申请人护照中的偕行人与申请人一同旅行，请将偕行人照片粘贴在下面并填写偕行人信息。**If someone else travels and shares the same passport with the applicant , please affix their photos and give their information below.**

| 偕行人信息 ***Information*** | 偕行人 1 **Person 1** *粘贴照片于此* ***Affix Photo here*** | 偕行人 2 **Person 2** *粘贴照片于此* ***Affix Photo here*** | 偕行人 3 **Person 3** *粘贴照片于此* ***Affix Photo here*** |
|---|---|---|---|
| 姓名 **Full name** | | | |
| 性别 **Sex** | | | |
| 生日 **DOB(yyyy-mm-dd)** | | | |

## 四、声明及签名 **Part 4: Declaration & Signature**

4.1 我声明，我已阅读并理解此表所有内容要求，并愿就所填报信息和申请材料的真实性承担一切法律后果。
**I hereby declare that I have read and understood all the questions in this application and shall bear all the legal consequences for the authenticity of the information and materials I provided.**
4.2 我理解，能否获得签证、获得何种签证、入境次数以及有效期、停留期等将由领事官员决定，任何不实、误导或填写不完整均可能导致签证申请被拒绝或被拒绝进入中国。
**I understand that whether to issue a visa, type of visa, number of entries, validity and duration of each stay will be determined by consular official, and that any false, misleading or incomplete statement may result in the refusal of a visa for or denial of entry into China.**
4.3 我理解，根据中国法律，申请人即使持有中国签证仍有可能被拒绝入境。
**I understand that, according to Chinese law, applicant may be refused entry into China even if a visa is granted.**

申请人签名
**Applicant's signature:** .....

日期
**Date (yyyy-mm-dd):**.....

注：未满 18 周岁的未成年人须由父母或监护人代签。**Note: The parent or guardian shall sign on behalf of a minor under 18 years of age.**

## 五、他人代填申请表时填写以下内容 **Part 5：If the application form is completed by another person on the applicant's behalf, please fill out the information of the one who completes the form**

| | | | |
|---|---|---|---|
| 5.1 姓名 **Name** | | 5.2 与申请人关系 **Relationship with the applicant** | |
| 5.3 地址 **Address** | | 5.4 电话 **Phone number** | |

5.5 声明 **Declaration**
我声明本人是根据申请人要求而协助填表，证明申请人理解并确认表中所填写内容准确无误。
**I declare that I have assisted in the completion of this form at the request of the applicant and that the applicant understands and agrees that the information provided is true and correct.**

代填人签名/**Signature**: .....

日期/**Date (yyyy-mm-dd)**: .....

**From:** Thomas Quinn
**Sent:** Tue, 21 Jan 2020 23:01:53 +0000
**To:** Lane, Cliff (NIH/NIAID) [E];Holland, Steven (NIH/NIAID) [E];Erbelding, Emily (NIH/NIAID) [E];Hynes, Noreen (JHMI);Tom Inglesby
**Subject:** referral
**Attachments:** Kuppalli_Krutika_CV_January_2020.pdf

Colleagues,

While I was chair on the IDSA Global Health Committee I had the opportunity to work with Krutika Kuppalli MD, an ID clinician interested in Biosecurity, Global Health and Emerging Infections. She is moving from (b) (6) to the (b) (6) area and is interested in possible job opportunities. As you will see on her attached CV she has worked extensively overseas and has interest in pursuing similar types of opportunities. She may reach out to you regarding future employment but I wanted to send her CV to you so you are familiar with her background. If you think of anyone else that she should contact, let her know.

Thanks
Tom

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**From:** "Kuppalli, Krutika" (b) (6)
**Date:** Friday, January 17, 2020 at 6:58 PM
**To:** Thomas Quinn (b) (6)
**Subject:** Re: Hi

Hi Dr. Quinn,

Thank you very much for forwarding my CV. I will follow-up with Drs. Lane, Holland, Erbelding, Hynes and Inglesby next week. I really appreciate your assistance. Have a wonderful weekend!

Warm regards
Krutika

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**From:** "Kuppalli, Krutika" (b) (6)
**Date:** Wednesday, January 15, 2020 at 3:59 PM
**To:** Thomas Quinn (b) (6)
**Subject:** Hi

Dr. Quinn,

Hi! How are you? A few people recommended that I reach out to you since we had worked together on the IDSA Global Health Committee since I am currently looking for a position (ideally in the DC/Baltimore area). I hope it is okay for me to email you.

I am currently in a (b) (6), (b) (4) Infectious Diseases position at Stanford Healthcare ValleyCare, a community academic hospital that Stanford University purchased a few years ago. They were looking for an individual who wanted to do primarily community medicine and since that does not align with my long term career interests, my position will be going away at the end of February 2020.

I have a diverse background in global health and have worked in Asia, Africa, and Haiti working on HIV and emerging pathogens. I was the medical director for an ETU in Sierra Leone during the W Africa outbreak and now have research collaborations looking at long term mental health and fertility outcomes in Ebola survivors. I am also involved with multi-country project in Africa trying to understand causes of undifferentiated febrile illness and how climate/environmental factors affect these pathogens. We are in the process of submitting two large grants over the next two months. Finally, I have been active in my efforts surrounding health policy and health security.

As you are aware I have been very involved with the IDSA Global Health Committee and am the current Vice Chair. Within this Committee I have also been spearheading the development of a working group focused on health security and biosecurity aimed at developing guidance documents for outbreak response and pandemic preparedness as well as improving education for trainees. In fact we submitted a proposal for a pre-meeting workshop for IDWeek 2020 focused on health security and the role of the healthcare professional that has garnered a lot of excitement. This is work I am very passionate and enthusiastic about and for this reason have applied for the Johns Hopkins Emerging Leaders in Biosecurity Fellowship.

Ideally, I would be able to find a position that will allow me to continue my clinical service while building my career in academic medicine focused on emerging pathogens, health security, and policy. I have enclosed my CV and would appreciate any ideas or thoughts on where I might consider looking. Thanks in advance for your time.

Warm regards
Krutika

# CURRICULUM VITAE

| | |
|---|---|
| **Name** | Krutika Kuppalli, MD |
| **Mailing Address** | (b) (6) |
| **Physical Address** | (b) (6) |
| **Telephone** | (b) (6) (mobile) |
| **Email** | (b) (6) (Professional) |
| | (b) (6) (Personal) |
| **Place of Birth** | (b) (6) |
| **Citizenship** | United States of America |
| **Languages** | English (Primary)<br>Spanish (Secondary- Intermediate Conversational and Reading)<br>French (Secondary- Basic Conversational)<br>Kannada (Secondary- Basic Conversational) |

## CURRENT AFFILIATIONS

| | |
|---|---|
| May 1, 2018 – Present | Faculty Fellow<br>Center for Innovation in Global Health<br>Department of Medicine<br>Stanford University School of Medicine<br>(Palo Alto, California) |
| December 1, 2017 – Present | Affiliated Assistant Clinical Professor<br>Division of Infectious Diseases and Geographic Medicine<br>Department of Medicine<br>Stanford University School of Medicine<br>(Palo Alto, California) |
| August 2017 – Present | Infectious Diseases Physician<br>Stanford Healthcare<br>ValleyCare Physicians Associates<br>(Pleasanton, California) |
| September 2016 – Present | Disaster Response Physician<br>Heart to Heart International<br>(Lenexa, Kansas) |

## PRIOR TITLES AND AFFILIATIONS

A. Academic Appointments

| | |
|---|---|
| January 2015 – June 2016 | Assistant Professor of Medicine<br>Division of Infectious Diseases<br>Department of Medicine<br>Loyola University Medical Center<br>(Maywood, Illinois) |
| January 2015 – June 2016 | Assistant Professor of Medicine<br>Division of Infectious Diseases<br>Department of Medicine<br>Edward Hines Jr. Veterans Affairs Medical Center<br>(Hines, Illinois) |
| March 2013 - October 2014 | Assistant Professor of Medicine<br>Division of Infectious Diseases<br>Department of Medicine<br>Medical College of Wisconsin<br>(Milwaukee, Wisconsin) |

B. Clinical/Research Appointments

| | |
|---|---|
| September 2017 – January 2019 | Clinical Research Physician<br>Contractor<br>Mapp Biopharmaceutical, Inc.<br>(San Diego, California) |
| January 2017- June 2017 | Senior Technical Advisor/Country Director and Clinical Lead<br>Joint Mobile Emerging Diseases Intervention Clinical Capability (JMEDICC)<br>Austere environments Consortium for Enhanced Sepsis Outcomes (ACESO)<br>The Henry M. Jackson Foundation for the Advancement of Military Medicine<br>(Kampala and Fort Portal, Uganda) |
| January 2015 – June 2016 | Medical Director, Antimicrobial Stewardship Program<br>Loyola University Medical Center<br>(Maywood, Illinois) |
| January 2015 – June 2016 | Medical Director, Outpatient Parenteral Antimicrobial Therapy (OPAT) Program<br>Loyola University Medical Center<br>(Maywood, Illinois) |
| November 2014 - January 2015 | Medical Director, Ebola Treatment Unit<br>Port Loko Government Hospital<br>Partners in Health Ebola Response Team<br>(Port Loko, Sierra Leone) |

| | |
|---|---|
| March 2013 - October 2014 | HIV Physician<br>AIDS Resource Center of Wisconsin (ARCW)<br>(Milwaukee, Wisconsin) |
| July 2011 - March 2013 | Attending Physician<br>Division of Infectious Diseases<br>Department of Medicine<br>University of California, San Diego<br>(La Jolla, California) |

## EDUCATION

| | | | |
|---|---|---|---|
| 2001 | B.S. | Biochemistry/Biology | University of California, San Diego |
| 2001 | B.A. | International Relations | University of California, San Diego |
| 2005 | M.D. | Medicine | Virginia Commonwealth University<br>School of Medicine |

## POSTGRADUATE TRAINING

2005 - 2008 Residency, Primary Care Track, J. Willis Hurst Internal Medicine Residency Program
Emory University School of Medicine, Atlanta, Georgia
Program Director: Stacy Higgins, M.D.

2008 - 2011 Fellowship, Infectious Diseases, Clinical Investigator Track
Emory University School of Medicine, Atlanta, Georgia
Program Director: Wendy S. Armstrong, M.D.

2011 - 2013 Postdoctoral Fellowship, Global Public Health and the Antiviral Research Center
University of California San Diego, San Diego, California
Research Mentor: Susan J. Little, M.D

## LICENSURES

| | |
|---|---|
| 2010 - 2013 | Georgia State Medical License (License No. 65018 - lapsed) |
| 2011 - Present | California State Medical License (License No. A119416) |
| 2013 - 2015 | Wisconsin State Medical License (License No. 60229-20 - lapsed) |
| 2015 – 2017 | Illinois State Medical License (License No. 036-137105 - lapsed) |

## BOARDS

| | | |
|---|---|---|
| 2009 | Diplomate | American Board of Internal Medicine |
| 2011 | Diplomate | American Board of Internal Medicine-Infectious Diseases |

## WORK EXPERIENCE

2017 **Clinical Research Physician – Contractor**
**Mapp Biopharmaceutical, Inc (San Diego, California)**

Mapp Biopharmaceutical, Inc is a small biopharmaceutical company focused on addressing unmet medical needs through the development of life-saving monoclonal antibody treatments against various neglected and tropical infectious diseases. Mapp Biopharmaceutical's development of ZMapp, a humanized triple monoclonal antibody therapeutic for Ebola, was life saving to many with Ebola during the 2014 W. Africa epidemic that led to over 10,000 deaths. One lesson from the 2014 Ebola epidemic was the recognition that greater preparedness was needed for emerging infectious diseases, particularly those with the potential to be used as agents of bioterrorism.

As the Clinical Research Physician, I provided support to the Mapp clinical team for the planning and execution of the Expanded Access Protocol for ZMapp in West and Central Africa. I also utilized my clinical Infectious Diseases training to assist in furthering Mapp's mission of developing and delivering therapeutics against diseases of global importance.

As Clinical Research Physician I performed the following:

1. Provided clinical and technical guidance to the Mapp clinical team and vendors.
2. Assisted in training site personnel on the study protocol.
3. Participated in the development of clinical strategy and trial design.
4. Prepared clinical evaluation plans and reports, study protocols, study amendments, informed consents, study reports, and scientific papers for publication in peer reviewed journals.
5. Served as an expert for execution of clinical research protocols globally, particularly in Africa and India.
6. Assisted in collection, preparation, and analysis of information for institutional special reviews and/or studies.
7. Assisted in preparing and collecting data, reports, records pertinent to all aspects of research related activities.
8. Attended Investigator Meetings (IM) on behalf of the Principal Investigator as needed.
9. Worked with other US government partners, academic institutions, and other partners invested in this project.
10. Advised on other Infectious Diseases therapeutics and clinical trials being performed.

2017 **Disaster Response Physician, Heart to Heart International (Houston, Texas)**

1. Deployed as a first responder volunteer physician to the most severely affected areas of Houston, Texas destroyed by Hurricane Harvey.
2. Assisted in coordinating and providing emergent medical care to a wide range of patients daily.
3. Provided Infectious Diseases expertise to assist in appropriate public health campaigns in the aftermath of the hurricane (Tetanus, vector control, mold exposure, WASH)
4. Assisted in setting up, operating, and working in mobile medical units that provide free medical care to those affected by Hurricane Harvey.

2017 **Senior Technical Advisor/Country Director and Clinical Lead**
**Joint Mobile Emerging Diseases Intervention Clinical Capability (JMEDICC)**
**Austere environments Consortium for Enhanced Sepsis Outcomes (ACESO)**
**The Henry M. Jackson Foundation for the Advancement of Military Medicine**
**(Kampala and Fort Portal, Uganda)**

Technical and clinical lead of a collaboration with the U.S. Department of Defense, The Henry M. Jackson Foundation for the Advancement for Military Medicine (HJF), The Navy Medical Research Center (NMRC), and The United States Army Medical Research Institute for Infectious Diseases (USAMRIID) in the U.S.; The Makerere University Walter Reed Project (MUWRP), The Infectious Diseases Institute (IDI), and Fort Portal Regional Referral Hospital (FPRRH) in Uganda; and multiple international stakeholders to implement a mobile, clinical research response capable of conducting FDA regulated clinical trials of therapeutics and diagnostics during a filovirus outbreak.

As Senior Technical Advisor/Country Director and Clinical Lead I performed the following:

1. Provided technical expertise on the development and implementation of warm-base sepsis clinical research protocols, development of SOPs, assisted with regulatory submission and approvals, and ensured adherence to GCP.
2. Developed and managed training schedules for the clinical research team in relation to the warm-base sepsis clinical research protocols and the IND protocol. Particular emphasis was placed on infection prevention and control.
3. Oversaw all clinical trials and site operations.
4. Worked closely with laboratory, data, regulatory, and logistics leads to ensure coordination of clinical research studies.
5. Lead for Clinical Research Committee that was comprised of national and international experts in the treatment and management of filovirus infection to develop policies and procedures for the isolation unit during the IND clinical trial.
6. Developed relationships with our in-country partners (MUWRP, IDI, and FPRRH), and relevant government and private entities in Uganda (CDC, Ministry of Health, WHO, MSF, National Task Force) necessary for successful implementation of the clinical trials and IND research protocols.
7. Provided technical expertise and support in case management to the Ugandan National Task Force in the development of a Ebola response and

preparedness plan in the wake of the May 2017 EVD outbreak in the Democratic Republic of Congo.

2016 **Disaster Response Physician, Heart to Heart International (Jeremie, Haiti)**

1. Deployed as a volunteer physician to locations in Haiti most severely affected and destroyed by Hurricane Matthew.
2. Assisted in coordinating and providing emergent medical care to hundreds of patients daily.
3. Provided Infectious Diseases expertise and care to patients with a wide range of tropical diseases
4. Assisted in setting up and operating mobile medical units that travelled to remote areas of the country to provide medical care for those impacted by the hurricane.

2014 - 2015 **Medical Director, Ebola Treatment Unit (Port Loko, Sierra Leone)**

1. Medical lead for 70-bed Ebola Treatment Unit at Port Loko Government Hospital at the peak (October-December) of the 2014 W. Africa Ebola epidemic.
2. Helped provide and supervise medical care for suspect and confirmed patients with Ebola.
3. Improved infection prevention control practices in the ETU, hospital, and among healthcare workers.
4. Developed protocols for triage, discharge, and treatment of patients who were suspects and those confirmed to have Ebola.
5. Worked with partners to identify the names, laboratory test results, and serostatus of over dozens of patients who had been in the ETU for approximately 2 months prior to when I became Medical Director of the ETU.
6. Helped re-open the hospital in the midst of the epidemic to provide care for patients with routine medical conditions and post Ebola syndrome.

2010 - 2011 **Fogarty International Clinical Research Fellow (Chennai, India)**

1. Developed, prepared, and submitted the concept and for my Fogarty Fellowship with the guidance of my mentors and was ultimately successful in being awarded the grant to spend one year living and working in India.
2. I spent my 3rd year of Infectious Diseases fellowship implementing a research study I had conceptualized that aimed to understand barriers to care in women with HIV.
3. I navigated obtaining IRB approval at 3 US sites, at my local site in India, Indian country clearance, and obtaining translations/backtranslations of all study related documents prior to site initiation.
4. Assisted in caring for HIV infected patients on the inpatient ward and in the outpatient clinic.
5. Developed three other clinical research studies while in India.
6. One study that I developed, looked at the prevalence of Leptospirosis in HIV infected patients was presented in oral form at the 2011 IDSA conference.

2007 **Global Health Scholar (Addis Ababa, Ethiopia)**

Selected in the first group of residents as part of the Emory Global Health Elective to travel to Ethiopia and work at ALERT and Black Lion Hospital to enhance my global health education.

2000 - 2001 **HIV Counselor (University of California, San Diego)**

Performed education regarding risk factors and transmission routes for HIV. Provided personalized assessments along with pre/post test counseling for individuals coming in for testing.

2000 **Democratic National Convention (Los Angeles, California)**

Worked with the Democratic campaign speechwriting and advance teams to manage and address media inquiries for Presidential nominee Albert Gore and Vice Presidential nominee Joseph Liebermann.

1998 **White House Intern (Washington, D.C.)**

Worked in the correspondence office for Vice President Albert Gore. Assisted with researching and responding to inquiries regarding healthcare, the environment, and global warming.

## COMMITTEE MEMBERSHIP

### American Society of Tropical Medicine and Hygiene (ASTMH)

January 2019 – Present Member, Trainee Committee

1. Co-Coordinator of Speed Networking with the Experts (November 25, 2019)
   Provides informal interactions between senior scientists, physicians, and trainees in order to provide important information on possible career paths in tropical medicine.

### Infectious Diseases Society of America

October 2019 – Present Chair, Global Health Security and Biosecurity Working Group

1. Submitted proposal for IDWeek 2020 pre-meeting workshop "Global Health Security and the Infectious Diseases Physician"

October 2019 – Present Vice Chair, Global Health Committee

October 2018 - 2019 Member, Global Health Committee

1. Co-Coordinator of IDSA Global Health Security Fair (May 10, 2019)
   Hosted an event at the Canon House Building with CDC, USAID, NIH, NETEC, and industry representatives to educate Congressional staff about the challenges and complexities of coordinating outbreak response. Specifically focused on Ebola and the need for continued/increased funding for global health security.

2. IDSA Spokesperson for Global Health

| | |
|---|---|
| September 2019 – Present | Member, Medical Education Community of Practice Mentorship Working Group |

**JMEDICC**

| | |
|---|---|
| January 2017 –May 2017 | Member, Partners Planning Committee<br>- Weekly meeting to discuss updates between U.S. and Ugandan team |
| January 2017 – May 2017 | Member, Laboratory Planning Committee<br>- Weekly meeting to discuss implementation of laboratory capabilities in Uganda |
| January 2017 – May 2017 | Member, Capability Exercise Planning Committee<br>- Weekly meeting to discuss planning and implementation of CAPEX |
| January 2017 – May 2017 | Member, Regulatory Planning Committee<br>- Weekly meeting to discuss regulatory/compliance regarding protocols |
| January 2017 – May 2017 | Chair, Clinical Research Planning Committee<br>-Bi-weekly meeting to discuss planning for ETU and IND study |
| January 2017 – May 2017 | Chair, Clinical Research Planning Sub-Committee<br>-Bi-weekly meeting to discuss planning for sepsis studies |
| January 2017 – May 2017 | Member, JMEDICC Planning Committee<br>-Weekly meeting to discuss updates and planning of the program |
| January 2017 – May 2017 | Co-Chair, Uganda JMEDICC Planning Committee<br>-Bi-weekly meeting to discuss planning for the program in Uganda |
| January 2017 – May 2017 | Member, Scientific Experts Panel<br>- Discuss relevant aspects of Investigational New Drug Protocol |
| January 2017 – May 2017 | Member, ACESO Sepsis Technical Advisory Board<br>- Work on the development of the Interventional Sepsis Protocol |
| January 2017 – May 2017 | Member, Ugandan National Task Force<br>- Assist with developing response plans for outbreaks and public health emergencies |
| March 2017 – May 2017 | Member, Uganda Joint External Evaluation (Internal Committee)<br>- Invited by the Director General to provide expertise regarding **medical countermeasures** and **antimicrobial resistance** as it pertains to Global Health Securities |
| May 2017 | Member, Ugandan Ebola Preparedness Committee<br>- Asked by the MOH to assist in updating the Clinical Management plan of the Ugandan Ebola Preparedness plan |

**Loyola University Medical Center**

February 2015 – June 2016 Medical Director and Chair, Antimicrobial Stewardship Committee

February 2015 – June 2016 Member, Pharmacy and Therapeutics Committee

**YR Gaitonde Centre for AIDS Research and Education (YRG CARE)**

2010 - 2011 Social Media/Outreach
- Developed and maintained the organization's social media accounts

**Virginia Commonwealth University School of Medicine**

2001 - 2003 Co-Chair, Students Making it a Little Easier (SMILE)
- Student outreach program that partnered medical students as buddies and organized outreach activities with children who had malignancies

2002 - 2003 Co-Chair, Legislative Affairs, American Medical Student Association
- Co-Chair for Legislative Affairs

**University of California, San Diego**

1999 - 2001 Student Health Advocate
- Volunteered at student health clinic to learn more about medicine

1999 - 2001 Express to Success
- Student leader who worked with incoming college students to help develop leadership skills

1999 - 2000 Orientation Leader

1998 Co-Chair, Volunteer and Hospitality Committee
- Helped organize volunteers and hospitality for regional residency life conference

1997 - 1998 College Representative to Campus Elections Committee

1997 - 1998 Chair, Apartment Programming Board

## HONORS/AWARDS

**Loyola University Medical Center**

2015 Finalist Trinity Assurance Ltd Grant (Out of 80 in-network hospitals)
- Antimicrobial Stewardship: Improving Patient Centered Outcomes

2015 Midwest Society of General Internal Medicine (SGIM)
- Clinical Vignette Oral Poster Presentation 3rd Place

2014 Infectious Diseases Society of America
- Ebola Service Grant

**University of California, San Diego**

2011 Infectious Diseases Society of America 49th Annual Conference
- One of eight oral abstracts to receive a special citation in conference program

2011 Infectious Diseases Society of America 49th Annual Conference
- Global Health Symposium

2011 Infectious Diseases Society of America
- Fellows Travel Grant

**Emory University**

2010 - 2011 Fogarty International Clinical Research Fellow (YRG CARE-Chennai, India)

2008 Global Health Scholar (Addis Ababa, Ethiopia)

2006 February Intern of the Month, Grady Memorial Hospital

**University of California, San Diego**

2001 Outstanding Graduating Senior Academic and Leadership Excellence Award
- Awarded by faculty to top five graduating seniors for academic and leadership excellence

1998 White House Intern
- Selected among thousands of applicants

1998 Golden Key National Honor Society

1998 Apartment Programming Board, Student of the Year

1997 National Association of Colleges and University Residence Halls (NACURH)
- May Student of the Month Leadership Award

1996 - 2001 Provost's Honors List
- Seven times during college

## TEACHING ACTIVITIES

**JMEDICC Staff Training**

April 2017 " An Observational Study of Sepsis in Uganda"
- Protocol, Case Report Form, and Informed Consent Form training
Fort Portal Regional Referral Hospital (Fort Portal, Uganda)

April 2017 " Review of Inclusion/Exclusion Criteria for Observational Study of Sepsis"

Fort Portal Regional Referral Hospital (Fort Portal, Uganda)

April 2017 " Introduction to Viral Hemorrhagic Fevers"
- Lectured to hospital and study staff
Fort Portal Regional Referral Hospital (Fort Portal, Uganda)

April 2017 " Introduction to Personal Protective Equipment for the ETU"
- Lecture and didactic for hospital and study staff
Fort Portal Regional Referral Hospital (Fort Portal, Uganda)

**Fellow, Resident, and Medical Student Teaching**

April 21, 2015 " Update on 2015 STD Guidelines"
- Lectured to Infectious Diseases fellows on the updated STD guidelines
Loyola University Medical Center (Maywood, Illinois)

December 4, 2013 "Tuberculosis for the Internist"
- Lectured to Internal Medicine residents on clinical presentation, pathogenesis, complications, and treatment of latent and active tuberculosis
Medical College of Wisconsin (Milwaukee, Wisconsin)

November 6, 2013 " Medically Important Parasites"
- Lectured to Internal Medicine Residents on clinical presentation, pathogenesis, complications, and treatment of medically important parasites
Medical College of Wisconsin (Milwaukee, Wisconsin)

August 12, 2013 "Fever of Unknown Origin"
- Lectured to Infectious Diseases Division Monthly Microbiology Conference
Medical College of Wisconsin (Milwaukee, Wisconsin)

2013 - 2014 Infectious Diseases Case Reviews
- Weekly didactic to resident/fellows on preselected Infectious Diseases topics
Medical College of Wisconsin (Milwaukee, Wisconsin)

November 1, 2011 "Emerging Infections in HIV-Infected Individuals"
- Lectured to Emerging Infectious Diseases combined PhD/MD Class
University of California, San Diego (San Diego, California)

May 2012 Microbiology for First year Medical Students
- Lectured and assisted in teaching laboratory portion of microbiology course.
University of California, San Diego (San Diego, California)

June 20, 2008 "HIV-TB Co-Infections at and Urban Indigent Hospital"
- Senior Resident Grand Rounds
Grady Memorial Hospital (Atlanta, Georgia)

**Undergraduate Student Teaching**

2000-2001 Teaching Assistant
- Taught introduction biology twice and an upper division course focused on the pathophysiology of HIV while at UC San Diego

1999-2001 STD Prevention Counselor
- Visited local high schools in San Diego and gave presentations about the different types of STD's, prevention, and contraception

**Peer Teaching**

March 2011 "HIV-2: The Forgotten Disease"
- Lecture to HIV Fellows
Tambaram Tuberculosis Hospital (Chennai, India)

March 2011 "Cytomegalovirus Disease in HIV"
- Lecture to HIV Fellows
Tambaram Tuberculosis Hospital (Chennai, India)

August 2010-2011 Lectures given on a variety of HIV related topics to staff at YRG CARE

**Mentoring**

1. Resident Mentoring: Rachael Persons M.D., Medical College of Wisconsin Graduated (Ob-Gyn)
2. Fellowship Mentoring: Ilya Karagodin M.D., Medical College of Wisconsin (Chief Resident and now a Cardiology Fellow at University of Chicago. Have worked with him on a number of oral presentations)
3. Pharmacy Mentoring: Brian Nelson, University of California San Diego Pharmacy Student (Accepted to Residency at Columbia University in 2013 and is now an ID PharmD at Columbia)
4. Resident Mentoring: Lindsay Boole M.D., Emory University Medical Student (Accepted to Duke University combined Medicine-Global Health Residency in 2011 and received an IDSA student scholarship I nominated her for. Most recently completed a Fogarty Fellowship in Kenya studying sepsis and is a Pulmonary/Critical Care Faculty at Duke University)
5. Pharmacy Mentoring: Tonya Scardina PharmD, BCPS. Loyola University Medical Center Infectious Diseases Pharmacist. Mentored her as she completed the Society of Infectious Diseases Pharmacists Antimicrobial Stewardship Certificate. Awarded in January 2016.
6. Resident Mentoring: April McDougal M.D., Loyola University Medical Center PGY-3 (Resident in Internal Medicine with interest in Infectious Diseases and Global Health).
7. Undergraduate Mentoring: Global Health Minor, Stanford University. (Serve as a mentor to students enrolled in the Global Health Minor).

## MANUSCRIPT REVIEWER

BMC Infectious Diseases
Journal of Clinical Microbiology
PLoS Neglected Tropical Diseases
Malaysian Journal of Medical Sciences
Indian Journal of Critical Care Medicine

## PROFESSIONAL MEMBERSHIPS

| | |
|---|---|
| 2001 - Present | American Medical Association (AMA) |
| 2007 - Present | American College of Physicians-Associate Member (ACP) |
| 2008 - Present | Infectious Disease Society of America (IDSA) |
| 2018- Present | American Society for Tropical Medicine and Hygiene (ASTMH) |
| 2008 – 2011 | American Federation for Medical Research (AFMR) |

## COMPLETED RESEARCH FUNDING

-T32DA023356 (Dr. Steffanie Strathdee, Ph.D.)
National Institutes of Health (NIH)
National Institute on Drug Abuse (NIDA)
Role: Post Doctoral Fellow

- R24TW007988 (Dr. Sten Vermund, M.D.)
National Institutes of Health (NIH)
Fogarty International Center (FIC)
Fogarty International Clinical Research Scholars and Fellows (FICRS-F) Program
Indian Women in South India with HIV: Barriers to Anti-Retroviral Therapy Adherence
Role: Clinical Research Fellow

## RESEARCH

**Stanford University School of Medicine, Division of Infectious Diseases and Geographic Medicine**
August 2019 – Present

**" Epidemiological Analysis of Long-Term Sequelae in Ebola Virus Disease Patients in Sierra Leone"**

- The 2014-2016 West Africa Ebola outbreak led to~11,000 deaths and ~ 28,000 cases in Guinea, Liberia, and Sierra Leone. These non-fatal infections led to male EVD survivors with persistent testicular infections without clinical symptoms of disease who tested negative with blood-based diagnostic assays. Sexual transmission of EVD from disease survivors contributed to the initiation of new chains of transmission during the epidemic. There is a dearth of information regarding the long-term complications in EVD survivors. This includes the persistent impact of EVD on both male and female fertility and conception. Our study aims to assess long-term fertility and other longitudinal healthcare outcomes in EVD survivors.

- **Co-Investigators:** Jason Kindrachuk PhD, Canada Research Chair, Molecular pathogenesis of Emerging and Re-emerging Infectious Diseases, University of Manitoba; Brigadier General Foday Sahr MD, Department of Microbiology, College of Medicine and Allied Sciences, University of Sierra Leone; Military Hospital, Wilberforce, Sierra Leone; Jia Kangbai, Center for International Health, University of Munich, Germany

**Joint Mobile Emerging Diseases Intervention Clinical Capability (JMEDICC)**
January 2017- June 2017

**"An Observational study of Sepsis in Uganda"**

- This is an observational study of patients presenting with sepsis to Fort Portal Regional Referral Hospital in Uganda. The objectives of this study were to 1) describe the spectrum of pathogens (and their anti-microbial susceptibility patterns) causing sepsis, 2) describe the treatment strategies currently in use and characterize response to therapy, 3) identify key diagnostic and prognostic markers and investigate their relationship to common pathogenic pathways, and 4) assess long-term sequelae of sepsis. Briefly, adult patients with suspected infection and evidence of systemic inflammatory response were considered for enrollment. Laboratory testing will augment the testing routinely performed at the hospital microbiology laboratory and will include traditional and experimental/enhanced diagnostic tests and some assays measuring the host-response biomarkers.

- **Co-Investigators:** CDR James Lawler MD MPH, Navy Medical Research Center; Hannah Kibuuka MD, Makerere University Walter Reed Project; Danielle Clark MPH PhD, The Henry Jackson Foundation for the Advancement for Military Medicine; MAJ Anthony Cardille DO, USAMRIID; Karen Martins PhD, USAMRIID, Anne Fox MD, Navy Medical Research Center

**Loyola University Medical Center, Division of Infectious Diseases (LUMC)**
September 2015 – June 2016

**"Incidence of treatment failure and nephrotoxicity in MRSA bacteremia with varying Vancomycin concentrations"**

- The primary objective of this single-center retrospective study is to compare the incidence of treatment failure (based on clinical and microbiological outcomes) among patients whom achieved Vancomycin trough concentrations between 10-15 mg/L to those ≥15 mg/L while being treated for MRSA bacteremia. Secondary objective is to compare the incidence of nephrotoxicity while receiving Vancomycin for treatment of MRSA bacteremia.

- **Co-Investigators:** Tonya Scardina PharmD, BCPS

**University of California San Diego, Division of Infectious Diseases (UCSD)**
September 2011 - January 2013

**"Lead the Way San Diego"**

- The primary aim is to determine the feasibility and acceptability of 2006 Centers for Disease Control and Prevention (CDC) recommendations for routine, voluntary, opt-out, non-risk based HIV testing to further inform efforts to improve uptake of testing. This is a prospective study comparing motivators, barriers, perceptions, and uptake of non-risk based HIV testing among individuals self-selecting for HIV testing at a storefront facility compared to those approached door-to-door living within two central zipcodes in San Diego county (92103 and 92104).

- **Co-Investigators:** Susan J Little, MD, Professor of Medicine, University of California San Diego School of Medicine; Davey M Smith, MD, Professor of Medicine, University of California San Diego School of Medicine and VA Healthsystem of San Diego; Susanne May, PhD, Associate Professor of Biostatistics, University of Washington School of Medicine; Jason A Young, PhD, Assistant Professor of Medicine, University of California San Diego School of Medicine; Christy M Anderson, MAS, University of California San Diego School of Medicine.

**YR Gaitonde Centre for AIDS Research and Education (YRG CARE)**
August 2010 - June 2011

**"Indian Women in South India with HIV: Barriers to Anti-Retroviral Therapy Adherence"**

- The primary aim is to assess social and contextual barriers to ART adherence among HIV infected married women and widows using the ACTG adherence questionnaire and measures of immunologic and virologic response. The secondary aim is to assess barriers to ART adherence such as, social stigma, intimate partner violence, menstrual abnormalities, medication side effects, and distance travelled to clinic

- **Co-Investigators:** Carlos Del Rio, MD, Professor of Medicine and Hubert Chair of Global Health, Emory University, Rollins School of Public Health; Wendy Armstrong, MD, Associate Professor and Program Director Infectious Diseases Fellowship, Emory University School of Medicine; Kenneth Mayer, MD, Professor of Medicine and Community Health, Harvard Medical School, Beth Israel Deaconess Medical Center; and Fenway Institute, Fenway Health; N. Kumarasamy, MBBS, PhD, Chief Medical Officer and Principal Investigator of ACTG International Clinical Trials Unit, YRG CARE (Chennai, India)

**YR Gaitonde Centre for AIDS Research and Educations (YRG CARE)**
September 2010 - June 2011

**"Prevalence of Genital Tract Infections (GTI's) among patients receiving Anti-Retroviral Therapy (ART) over a Decade (2000-2010)"**

- Retrospective review of all patients initiated on ART at YRG CARE to look at prevalence of GTI's, presenting symptoms, and effect on HIV disease progression.

- **Co-Investigators:** Carlos Del Rio, MD, Professor of Medicine and Hubert Chair of Global Health, Emory University, Rollins School of Public Health; Kenneth Mayer, MD, Professor of Medicine and Community Health, Harvard Medical School, Beth Israel Deaconess Medical Center; and Fenway Institute, Fenway Health; Kimberly Workowski, MD, Professor of Medicine, Emory University School of Medicine; N. Kumarasamy, MBBS, PhD, Chief Medical Officer and Principal Investigator of ACTG International Clinical Trials Unit, YRG CARE (Chennai, India).

**YR Gaitonde Centre for AIDS Research and Education (YRG CARE)**
September 2010 - June 2011

**"Menstrual Irregularities in HIV Positive Women in India: Is Immune suppression a factor?"**

- Cross-sectional study of women looking for amenorrhea, dysmenorrhea, and menorrhagia based on CD4 T-cell count.

- **Co-Investigators:** Susan Cu-Uvin, MD, Professor of Obstetrics and Gynecology and Medicine, Director, Global Health Initiative, Brown University School of Medicine; Poongulali Selvamuthu, MBBS, Medical Officer YRG CARE; Carlos Del Rio, MD, Professor of Medicine and Hubert Chair of Global Health, Emory University, Rollins School of Public Health; Kenneth Mayer, MD, Professor of Medicine and Community Health, Harvard Medical School, Beth Israel Deaconess Medical Center; and Fenway Institute, Fenway Health; N. Kumarasamy, MBBS, PhD, Chief Medical Officer and Principal Investigator of ACTG International Clinical Trials Unit, YRG CARE (Chennai, India).

**YR Gaitonde Centre for AIDS Research and Education (YRG CARE)**
September 2010 - January 2012

**"Prevalence and Outcomes of Leptospirosis in Patients with HIV in South India**

- Retrospective study of HIV-infected patients admitted to a tertiary HIV care facility to determine the prevalence, outcomes, and overall morbidity of leptospirosis infection in patients with both diseases.

- **Co-Investigators:** Carlos Del Rio, MD, Professor of Medicine and Hubert Chair of Global Health, Emory University, Rollins School of Public Health; Kenneth Mayer, MD, Professor of Medicine and Community Health, Harvard Medical School, Beth Israel Deaconess Medical Center; and Fenway Institute, Fenway Health; N. Kumarasamy, MBBS, PhD, Chief Medical Officer and Principal Investigator of ACTG International Clinical Trials Unit, YRG CARE (Chennai, India).

**Emory University School of Medicine, Division of Infectious Disease**
June 2006 - June 2010

**"Tuberculosis Patients with HIV at an Urban Indigent-Care Hospital: Complications During Treatment"**

- Retrospective study of patients co-infected with HIV-TB who developed adverse events and were readmitted to Grady Memorial Hospital once started on DOT.

- **Co-Investigator:** Susan Ray, MD, Associate Professor of Medicine, Emory University School of Medicine, Division of Infectious Diseases.

**Stanford University School of Medicine, Division of Pediatrics**
June 2002-August 2002

**"Behavioral Differences in Children with Personality Disorders"**

- Analyzed behavioral differences in children with Obsessive Compulsive Disorder when completing mildly stimulating problem-solving tasks compared to a control group, which consisted of children free of psychological disorders.

- **PI:** Lynne C. Huffman, MD, Professor of Medicine, Division of Pediatrics, Stanford University Department of Pediatrics

## PUBLICATIONS

A. Published and Accepted Manuscripts

Talati N, Rouphael N, **Kuppalli K**, Franco-Paredes C: Spectrum of Central Nervous System Disease Caused by Rapidly Growing Mycobacteria. *Lancet Infect Dis*. 2008; 8 (6): 390-8

**Kuppalli K**, Kotwal-Doshi R, Armstrong WS, Osborn M, Gunthel CJ: Male with fungating skin lesions. *Infectious Diseases in Clinical Practice*. July 2011

**Kuppalli K**, Livorsi D, Talati N, Osborn M: Lemierre's Syndrome due to *Fusobacterium Necrophorum*. *Lancet Infect Dis. 2012;12(10):808-15*

**Kuppalli K**: Systematic Information Improves Adherence to Vaccination Guidelines in Patients With IBD Receiving Anti-TNFα Therapy. PracticeUpdate website. Available at: http://www.practiceupdate.com/c/26021/48/9. Accessed July 13, 2015.

Abidi MZ, D`Souza A, **Kuppalli K**, Ledeboer N, Hari P: CYP2C19*17 genetic polymorphism – An uncommon cause of voriconazole treatment failure. *Diagnostic Microbiology and Infectious Disease*. 2015; http://dx.doi.org/10.1016/j.diagmicrobio.2015.05.002

**Kuppalli K**: Health workers are being killed while trying to fight Ebola in the Congo. *The Hill*. April 24, 2019. https://thehill.com/opinion/healthcare/440439-health-workers-are-being-killed-while-trying-to-fight-ebola-in-the-congo

B. Book Chapters (Published)

**Kuppalli, K**: Neurologic Complications in HIV/AIDS. Chapter 48. 5th Edition. Practical Neurology, LWW. 2016.

## MEDIA APPEARANCES

| | |
|---|---|
| March 10, 2015 | *WJOL Radio*. " Dr. Krutika Kuppalli an Infectious Diseases Specialist Joins Loyola" https://www.youtube.com/watch?v=IPoBRU9-4AM |
| November 17, 2015 | *ABC News*. " Charlie Sheen Reveals He is HIV Positive" http://abc7chicago.com/health/charlie-sheen-reveals-he-is-hiv-positive/1088566/ |
| January 20, 2019 | *Infectious Disease News*. " Tafenoquine prevents P.vivax relapse; further study needed." https://www.healio.com/infectious-disease/emerging-diseases/news/online/%7B1300bb1e-07f8-4748-a87c-ac2bbbd6d7f3%7D/tafenoquine-prevents-p-vivax-relapse-further-study-needed |
| April 24, 2019 | *The Hill*. "Health workers are being killed while trying to fight Ebola in the Congo." https://thehill.com/opinion/healthcare/440439-health-workers-are-being-killed-while-trying-to-fight-ebola-in-the-congo |
| June 11, 2019 | *Contagion Live*. "DRC Ebola Outbreak Tops 2000 Cases." https://www.contagionlive.com/news/drc-ebola-outbreak-tops-2000-confirmed-cases |
| June 19, 2019 | *Healthcare Purchasing News*. "It Takes A Village: Preparing for Outbreaks and Catastrophes." https://www.hpnonline.com/infection-prevention/article/21084697/it-takes-a-village-preparing-for-outbreaks-and-catastrophes |

| | |
|---|---|
| July 15, 2019 | *Medscape*. "Ebola Just 'A Plane Ride Away'." https://www.medscape.com/viewarticle/915456 |
| August 1, 2019 | *Contagion Live*. " One Year of Ebola in DRC: What Makes the North Kivu Province Outbreak Distinct?" https://www.contagionlive.com/news/one-year-of-ebola-in-drc-what-makes-the-north-kivu-province-outbreak-distinct |
| August 13, 2019 | *IDSA*. "Ebola in the DRC: One Year Later" Podcast https://soundcloud.com/idsociety/ebola-in-the-drc-one-year-later-1. |
| October 4, 2019 | "Ebola in the DRC: An update with CDC's Dr. Mary Choi and IDSA's Dr. Krutika Kuppalli from IDWeek 2019" https://vimeo.com/369345288 |
| November 5, 2019 | *S&P Global Market Intelligence*. "China's CanSino Biologics eyes increasing access of its Ebola vaccine in Africa." https://www.spglobal.com/marketintelligence/en/news-insights/trending/xML17kFjidiPXGjzgecrGQ2 |

## RESEARCH PRESENTATIONS AND LECTURES

A. Invited Lectures (International)

**Kuppalli K:** Introduction of the Capability Exercise for the Ebola Isolation Unit at Fort Portal Regional Referral Hospital. Ugandan National Task Force. May 15, 2017. Kampala, Uganda.

**Kuppalli K:** Introduction to JMEDICC. Uganda MSF. April 13, 2017. Kampala, Uganda.

**Kuppalli, K:** HIV-2: The Forgotten Disease. Tambaram Tuberculosis Hospital. March 29, 2011. Chennai, India.

**Kuppalli, K:** Cytomegalovirus Disease in HIV. Tambaram Tuberculosis Hospital. March 29, 2011. Chennai, India.

**Kuppalli, K**: Challenges for a Nurse-Infection Control. HIV/AIDS Nurses Symposium (HANS). January 11, 2011. YRG CARE and M.A. Chidambaram College of Nursing (MACCON). Chennai, India.

B. Invited Lectures (Domestic)

**Kuppalli K:** Ebola: Where are we today? Woods Institute. Stanford University School of Medicine, April 18, 2018. Palo Alto, California.

**Kuppalli K:** Lead The Way San Diego: Feasibility and Acceptability of Non-Risk Based Universal HIV Testing in San Diego. Division of Infectious Diseases, University of Chicago. March 2, 2016. Chicago, Illinois.

**Kuppalli K**: Ebola Lessons from the Frontline. Department of Internal Medicine Grand Rounds. Virginia Commonwealth University School of Medicine. December 3, 2015. Richmond, Virginia.

**Kuppalli K**: Ebola Lessons from the Frontline. Department of Internal Medicine Grand Rounds. Loyola University Medical Center. May 12, 2015. Maywood, Illinois.

**Kuppalli K**: Prevalence and Outcomes of Leptospirosis Infection in HIV Infected Patients in South India Research Conference: Division of Infectious Diseases, Medical College of Wisconsin. November 7, 2013. Milwaukee, Wisconsin.

**Kuppalli K**: Prevalence and Outcomes of Leptospirosis Infection in HIV Infected Patients in South India. Antiviral Research Center (AVRC) Rounds: University of California, San Diego. March 16, 2012 San Diego, California.

**Kuppalli K**: Antiretroviral Adherence in HIV Infected Women in Southern India. Infectious Diseases Senior Research Seminar: Emory University School of Medicine, Division of Infectious Diseases. June 16, 2011. Atlanta, Georgia.

**Kuppalli, K:** Reproductive Health and Medical Adherence in HIV Infected Women in Southern India. Global Health Seminar: University of California, San Diego, Division of Global Public Health. February 24, 2011. La Jolla, California

C. Conference Presentations

Karagodin I, Patel J, **Kuppalli K**: Hypoxemic Respiratory Failure Following Initiation of Highly Active Antiretroviral Therapy in an HIV/AIDS Patient. Poster Presentation. Midwest Society of General Internal Medicine (SGIM). Annual Conference. August 27-28, 2015. Cleveland, Ohio

Abidi MZ, D`Souza A, **Kuppalli K**, Ledeboer N, Hari P. CYP2C19*17 genetic polymorphism and therapeutic challenges in a bone marrow transplant recipient with pulmonary aspergillosis. Poster presentation, Association of Medical Microbiology and Infectious Diseases Canada. April 16-18, 2015. Charlottetown, PEI, Canada.

Abidi MZ, D`Souza A, **Kuppalli K**, Ledeboer N, Hari P. CYP2C19*17 genetic polymorphism and therapeutic challenges in a bone marrow transplant recipient with pulmonary aspergillosis. Poster presentation, 2015 combined annual meeting of Central Society of Clinical and Translational Research and Midwestern Section of the American Federation for Medical Research. April 23-24, 2015. Chicago, Illinois.

Abidi MZ, D`Souza A, **Kuppalli K**, Ledeboer N, Hari P. CYP2C19*17 genetic polymorphism and therapeutic challenges in a bone marrow transplant recipient with pulmonary aspergillosis. Poster presentation, Canadian Blood and Marrow Transplant Group. May 13-16, 2015. Montreal, Canada.

Karagodin I, Patel J, **Kuppalli K**: Hypoxemic Respiratory Failure Following Initiation of Highly Active Antiretroviral Therapy in an HIV/AIDS Patient. Poster Presentation. American College of Physicians (ACP) Wisconsin Chapter. Annual Conference. September 5, 2014. Wisconsin Dells, Wisconsin.

Karagodin I, **Kuppalli K**, Berger M: Group B Streptococcal Lead- Associated Endocarditis in a Poorly Controlled Diabetic. Poster Presentation. 37th Annual Society of General Internal Medicine (SGIM) Conference. April 25, 2014. San Diego, California.

**Kuppalli K**, Chandrasekaran E, Del Rio C, Mayer K, Kumarasamy N. Prevalence and Outcomes of Leptospirosis Infection in HIV Infected Patients in South India. Oral Presentation at 49th Annual IDSA Conference. October 21, 2011. Boston, Massachusetts.

Cosco D, Sakaria S, Rebolledo P, **Kuppalli K**, Andrews B: Building Bridges for Better Health in Ethiopia. Global Health Institute: Scholars Symposium. November 2008. Emory University School of Medicine. Atlanta, Georgia.

**Kuppalli K,** Rebolledo P, Jain S, Franco-Paredes: Cryptococcal Pleural Effusion in a patient with HIV. Poster Presentation, American College of Physicians- Georgia Chapter, Annual Conference. March 2008. Savannah, Georgia.

**Kuppalli K,** Barragan M, Leonard MK, Ray S: Tuberculosis Patients with HIV at an Urban Indigent-Care Hospital: Complications During Treatment. Poster Presentation. Resident Research Day. Emory University School of Medicine. January 2008. Atlanta, Georgia.

**Kuppalli K,** Barragan M, Leonard MK, Ray S: Tuberculosis Patients with HIV at an Urban Indigent-Care Hospital: Complications During Treatment. Poster Presentation. 46th Annual Infectious Disease Society of America (IDSA) Conference, October 2007. San Diego, California.

## NARRATIVE REPORT

### A. Introduction

I am an infectious diseases specialist who devotes 60% of my time to clinical practice at Stanford Healthcare Valleycare, a community academic hospital affiliated with Stanford University School of Medicine, and my remaining time to health policy and global health translational research focused on health security and emerging infections. I completed my clinical training in infectious diseases at Emory University in June 2010. In July 2010, I entered the research phase of my fellowship training, after conceptualizing, developing and ultimately being awarded an NIH funded Fogarty International Clinical Research Fellowship. This allowed me the opportunity to pursue my passion for global health and I moved to Chennai, India to provide medical care and engage in full-time clinical research activities focused on understanding barriers to care in patients infected with HIV/AIDS. Afterwards, I accepted a post-doctoral fellowship in Global Public Health at the University of California San Diego where I continued clinical research focused on barriers to care in patients with HIV/AIDS and understanding emerging infections observed in HIV patients living outside the United States.

At the end of 2014, I had an opportunity to be part of the West Africa Ebola response and served as the Medical Director for one of the busiest Ebola Treatment Units in Sierra Leone. I cared for critically ill patients, trained health care workers, helped develop procedures and protocols, and worked closely with the other in country partners helping to coordinate the response. My work in West Africa led to me moving to Uganda in 2017 to become Senior Technical Advisor and Clinical Lead for a Department of Defense funded project aimed at developing a mobile capacity to run clinical trials for therapeutics in the event of a filovirus outbreak. This allowed me to learn more about the complexities of pandemic preparedness, outbreak response, and global health security as I interfaced with numerous regulatory agencies, governmental and non-governmental partners in the United States and Uganda. Upon returning to the United States, I worked as a contractor with MappBio Pharmaceutical until 2019 to advise on various aspects of their expanded access protocol for ZMapp and continue to work as an infectious diseases physician at Stanford Healthcare Valleycare.

**B. Area of Excellence: Investigation**

Over the last five years, my research efforts have focused on global health security, emerging pathogens, pandemic preparedness, and outbreak response. My research addresses key priorities of the Global Health Security Agenda to improve surveillance systems and capacity to respond to infectious diseases threats in our increasingly interconnected world. I have been involved with health systems strengthening in Uganda and was invited by the Director General to be a member of the Joint External Evaluation committee and provide expertise regarding medical countermeasures and antimicrobial resistance.

Currently, I am working with collaborators on translational research to investigate longitudinal healthcare outcomes of Ebola virus survivors in Sierra Leone. There were about 14,000 EVD cases in Sierra Leone with the non-fatal infections leading to male survivors having persistent testicular infections with negative blood-based diagnostic assays and no evidence of systemic disease. This description of EVD led to sexual transmission of the disease, thereby allowing survivors to initiate new chains of transmission during the epidemic. Despite these observations, there remains a dearth of information regarding long-term health complications in EVD survivors, particularly those with genital tract infections. Our study aims to understand the long-term impact of EVD on male and female fertility and conception as well as other longitudinal healthcare outcomes.

I am involved in research on improving surveillance systems, detection and treatment of emerging and high consequence pathogens, improving clinical management in resource limited settings, and pandemic preparedness.

**C. Areas of Excellence: Advocacy**

As a White House intern during college, I became aware of how the intersection between healthcare and politics impacts the delivery of patient care on a domestic and global level. I envisioned a career that would encompass advocacy, policy, and healthcare. Witnessing the devastation an emerging pathogen such as Ebola can cause both to the individual and across the globe focused my career on pandemic preparedness, outbreak response, and global health security. In 2018 I was accepted as a member of the Infectious Diseases Society of America (IDSA) Global Health Committee (GHC) and have been active in advocating for policy and funding supporting the Global Health Security Agenda. I helped coordinate a outreach event for Congressional staff highlighting the challenges of emerging infectious diseases outbreak response and emphasizing continued U.S. support of ongoing international efforts. I have met with Congressional representatives to discuss importance of funding and policy regarding global health, health security and antimicrobial resistance. The direct results of these meetings led to Speaker Pelosi supporting and introducing legislation related to antimicrobial resistance. In October 2019 I was named Vice Chair of the IDSA GHC, and in this role have spearheaded the development of a national working group comprised of experts focused on Global Health Security (GHS). The group aims to develop GHS training programs for infectious diseases professionals and produce IDSA approved guidance documents for the clinical management of high consequence pathogens and for pandemic event health systems preparedness.

I am also currently an IDSA spokesperson for Global Health and have spoken publically about emerging pathogens, Ebola, outbreak response, and pandemic preparedness.

## D. Teaching and Education

I have been involved in the teaching and mentorship of numerous healthcare professionals domestically and internationally. I have formally mentored an Emory University medical student, a University of California, San Diego pharmacy student, a Medical College of Wisconsin internal medicine resident and medical student, and Loyola University Pharmacist on various research projects, career development, and presentations.

Locally, I currently attend on the inpatient infectious diseases consult service about 10 days a month at Stanford Healthcare Valleycare. In this role, I interact and teach internal medicine residents and physician assistant students who rotate on the hospitalist service.

Nationally, I currently am a member of numerous committees focused on education of trainees. Since 2019 I have been a member to the American Society of Tropical Medicine and Hygeine (ASTMH), Trainee Committee. In this role, I have helped explore and develop ways to improve mentorship, career opportunities, and engagement of our trainees. I also helped coordinate a speed networking mentorship opportunity at our annual meeting in November 2019. I have also been a member of the IDSA Medical Education Community of Practice Mentoring Working Group since 2019 and have worked to develop ways we can improve mentorship, engage trainees, and increase interest in infectious diseases as a career. Finally, in my role as Vice Chair of the IDSA Global Health Committee, I have recently led the development of a working group focused on Global Health Security that has an aim of developing GHS educational programs for infectious diseases professionals. Along these lines, we have developed and submitted a proposal for a pre-meeting workshop titled " The Infectious Diseases Physician and Global Health Security" at IDWeek 2020.

Internationally, I have been involved with the development of numerous research projects while living and working in Ethiopia, India, Sierra Leone, and Haiti. I have also been invited to present on a wide variety of topics including the importance of hand hygiene, infection prevention and control, co-infections seen in HIV patients, sepsis, emerging pathogens, viral hemorrhagic fevers, and personal protective equipment for working in an isolation unite.

While in Sierra Leone and in Uganda I taught important techniques for infection prevention and control. I was involved with teaching healthcare providers on using personal protective equipment in an isolation unit if they were providing care for patients with Ebola. In Sierra Leone and Uganda these trainings were vital to ensuring healthcare providers were able to adequately protect themselves during the Ebola outbreaks. In turn, these trainees became trainers of additional providers to increase capacity of a safe healthcare workforce in resource-limited settings.

## E. Clinical Expertise

My background is in caring for patients living with HIV/AIDS and was the focus of my clinical and research training as an infectious diseases fellow. I continued to strengthen this expertise by moving overseas to India and later to Uganda where I continued to care for patients with advanced HIV/AIDS and the complications related to the disease. My interest in immunecompromised hosts extended to individuals who have solid organ transplants, bone marrow transplants, and oncologic related infections. While on faculty at the Medical College of Wisconsin, I was the primary attending on the inpatient

immunecompromised host service. I still care for patients with SOT, BMT, oncologic related infections, and HIV/AIDS in my current position at Stanford Healthcare Valleycare. I interact, teach, and supervise Stanford University School of Medicine residents and PA students who rotate through the hospitalist service.

**F. Summary**

I am an infectious diseases investigator focused on health policy and global health translational research focused on health security and emerging infections. I have learned a lot having witnessed outbreak response from numerous perspectives; a frontline worker in Sierra Leone, a quarantined patient in a U.S isolation unit, a technical advisor working on preparedness in Uganda, and most recently a consultant for a pharmaceutical company working on medical countermeasures. I have leveraged my prior experiences to advocate for better policies along with greater collaboration and coordination among policy and technical responses during outbreak and preparedness activities. I also believe it is important to understand the long-term social, economic and healthcare outcomes from emerging infections on the communities they affect, which is why I am working with collaborators in Sierra Leone to follow Ebola survivors. Finally, in our increasingly interconnected world, I think it is important to enhance surveillance systems, detection and treatment of emerging and high consequence pathogens, improve clinical management in resource limited settings, and pandemic preparedness. It is for this reason I have spearheaded the creation of a working group within IDSA focused on global health security and biosecurity to see how we can work to address these concerns.

**References available upon request**

**From:** STAG IH Secretariat
**Sent:** Tue, 3 Dec 2019 17:50:29 +0000
**To:** [redacted] (b) (6);David Heymann;(SPmig) DELIA ENRIA;Delia Enria [redacted] (b) (6);Dr Amadou Alpha SALL [redacted] (b) (6);Gary Kobinger;Johan Giesecke;(SPmig) Juliet Bedford [redacted] (b) (6);Lane, Cliff (NIH/NIAID) [E]; [redacted] (b) (6);President_RKI [redacted] (b) (6);Schuchat, Anne MD (CDC/OD);Wieler, Lothar;Ziad Memish
**Cc:** Anita Cicero;Tom Inglesby;AKEN, Jan;BARBESCHI, Maurizio;MATHIS, Margaux Manoua;STAG IH Secretariat
**Subject:** Reading for tomorrow
**Attachments:** 20191129 STAG ST.DOCX

Dear STAG-IH,
Please find attached, Science and Technology advances landscape analysis paper developed by Dr Anita Cicero for tomorrow's 'Responsible Research' discussion. This has been developed as a JHU contribution to the collaborative project with HISI-TAG DURC working group for STAG-IH.
Many thanks to Anita and JHU team!
Nikki

JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH | Center for Health Security

# ADVANCES IN SCIENCE AND TECHNOLOGY SINCE 2013: PROMISES AND DUAL-USE RISKS

**Prepared by Lane Warmbrod and Nancy Connell, Johns Hopkins Center for Health Security**

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