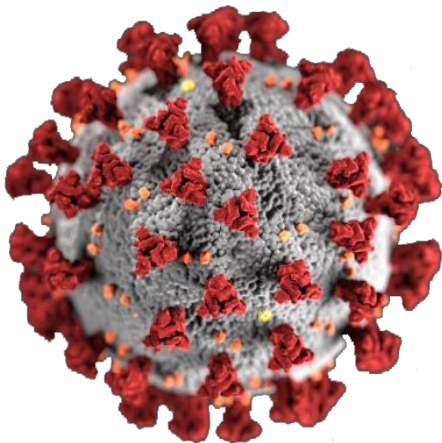


# Singapore from the Frontlines



## Matthias Maiwald

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Dept. Pathology & Lab. Medicine  
KK Women's & Children's Hospital, Singapore  
Adj. Assoc. Prof., Dept. Microbiology & Immunology,  
Yong Loo Lin School of Medicine, National University of Singapore

matthias (dot) maiwald (at) singhealth (dot) com (dot) sg

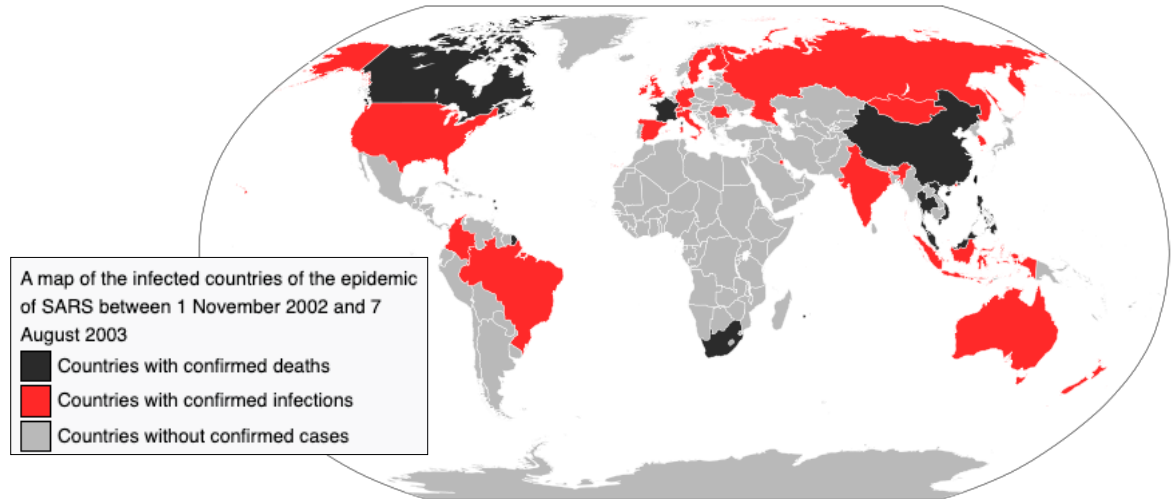
# Singapore was hit quite badly by the 2003 SARS outbreak

Probable cases of SARS by country and territory,  
1 November 2002 – 31 July 2003<sup>[5]</sup>

Country or region	Cases	Deaths	Fatality (%)
 Mainland China <sup>[a]</sup>	5,327	349	6.6
 Hong Kong	1,755	299	17.0
 Taiwan <sup>[b][6][7]</sup>	346	73	21.1
 Canada	251	44	17.5
 Singapore	238	33	13.9
 Vietnam	63	5	7.9
Total excluding Mainland China	2,769	454	16.4
<b>Total (29 territories)</b>	<b>8,096</b>	<b>811</b>	<b>9.6</b>

a. <sup>^</sup> Figures for China exclude Hong Kong, Macau and Taiwan, which are reported separately by the WHO.

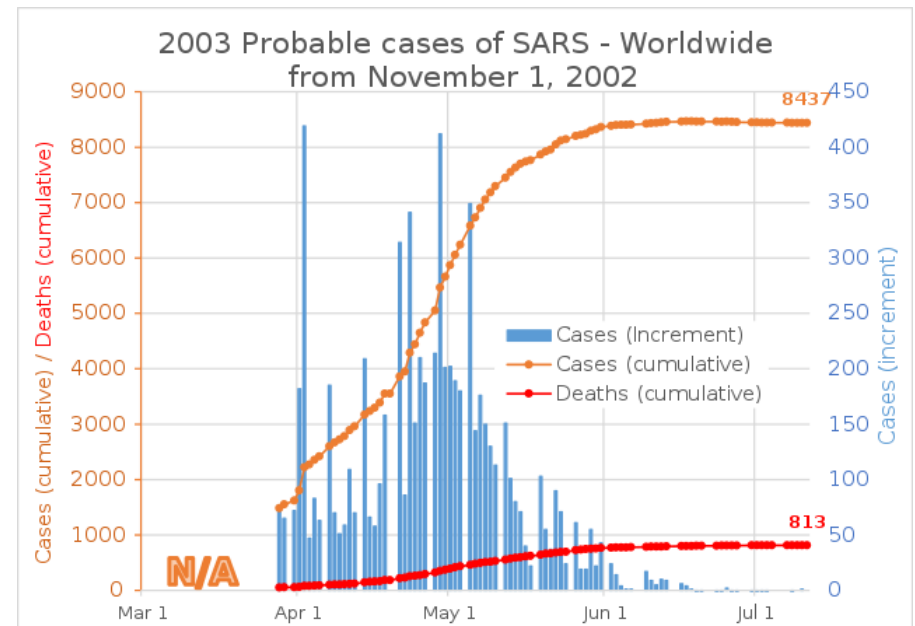
b. <sup>^</sup> After 11 July 2003, 325 Taiwanese cases were 'discarded'. Laboratory information was insufficient or incomplete for 135 of the discarded cases; 101 of these patients died.



Singapore also had 5 deaths among healthcare workers

## Painful Lesson:

- Due to its exposed location as trade and travel hub, SG is extremely vulnerable to imported infections!



Images: Wikipedia

# Since 2003, Singapore kept doing pandemic planning: Our hospital's Emerging Infectious Diseases Pages

Page from  
**2015**  
(when MERS,  
Ebola and  
Flu A H7N9  
were around)

http://infopedia/KKH/Departments/Emerging%20Infecti infopedia

Home News Hub Work Services Groups IT Applications People Directory Divisions & Departments

KKH > Departments > Emerging Infectious Diseases > Documents and References

## Emerging Infectious Diseases Preparedness KKH Updates

### MERS-CoV/H7N9/Ebola Virus Disease Information & References

General	Inpatient References	Outpatient References
<a href="#">Appendix 1 - Areas Affected by Emerging Infectious Diseases (Updated 3 Jul 2015)</a>	<a href="#">Appendix 7 - Emerging Infectious Diseases Management Plan - Obstetric (Updated 20 Jan 2015)</a>	<a href="#">Appendix 2A - Screening and Management of Suspected Ebola Virus Disease at CE Triage, O&amp;G 24-Hour Clinic, Delivery Suite, SOCs (Updated 20 Jan 2015)</a>
<a href="#">Appendix 4 - Checklist for Screening PATIENT'S Travel History (Two-tier) (Updated 3 Jun 2015)</a>	<a href="#">Appendix 8 - Emerging Infectious Diseases Management Plan - Gynae (Updated 2 Oct 2014)</a>	<a href="#">Appendix 2B - Ebola Virus Disease PPE Matrix (Uploaded 20 Jan 2015)</a>
<a href="#">Appendix 19 - Checklist for Screening PERSONS ACCOMPANYING Patients At-Risk of EID to be Admitted (Updated 3 Jun 2015)</a>	<a href="#">Appendix 9 - Emerging Infectious Diseases Management Plan - Wards/Delivery Suite/ICUs (Updated 1 Jul 2015)</a>	<a href="#">Appendix 2 - Screening and Management of Suspected</a>

# Screening Procedures from 2015

	1st screen Screening staff		2nd Screen Ward staff		MERS-CoV <input type="checkbox"/>	H7N9 <input type="checkbox"/>	Ebola <input type="checkbox"/>
	Yes	No	Yes	No	South Korea & Middle-East (last 14 days)	China (last 10 days)	Africa (last 21 days)
1) Travel history or resident of country (refer Appendix 1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
2) Close contact with confirmed or suspect case	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Last 14 days	Last 10 days	Last 21 days
3) Symptoms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Fever or cough or SOB		Fever
Tick if any of symptoms present	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			Vomiting, Diarrhoea, Headache, Abdominal pain, Sore throat, Rash, Red eyes, Bleeding, (mucous membranes/ venipuncture sites)

## Novel Coronavirus (MERS)

### • SOUTH KOREA

### • MIDDLE EAST

The Arabian Peninsula & neighbouring countries in the Middle East includes:-

- Jordan
- Kuwait
- Lebanon
- Oman
- Qatar
- Saudi Arabia
- United Arab Emirates (UAE)
- Yemen

## Ebola Virus Disease

The affected areas in Africa includes:-

- Guinea
- Liberia
- Sierra Leone

## Influenza A (H7N9)

### • CHINA

The affected municipalities / provinces in China includes:-

- |             |    |
|-------------|----|
| - Anhui     | 安徽 |
| - Beijing   | 北京 |
| - Fujian    | 福建 |
| - Guangdong | 广东 |
| - Guizhou   | 贵州 |
| - Guangxi   | 广西 |
| - Hebei     | 河北 |
| - Henan     | 河南 |
| - Hunan     | 湖南 |
| - Jiangxi   | 江西 |
| - Jiangsu   | 江苏 |
| - Jilin     | 吉林 |
| - Shandong  | 山东 |
| - Shanghai  | 上海 |
| - Xinjiang  | 新疆 |
| - Zhejiang  | 浙江 |

## MERS-CoV & H7N9

If patient has (1 or 2) +3

- Staff must don **Full PPE**. Patient to wear surgical mask.
- Admit patient to the ward with negative pressure room.

## Ebola

Refer to Appendix 2B for **Enhanced Ebola PPE** matrix

\* If patient is a '**Suspect**' case -

- Send to TTSH

\* If patient is an '**At-Risk (Low Risk/ High Risk)**' case

- Admit to Ward 46 (negative pressure with isolation room), or
- Delivery Suite Room 1-4 (when in labour).

For all other scenarios, discuss with ID physician



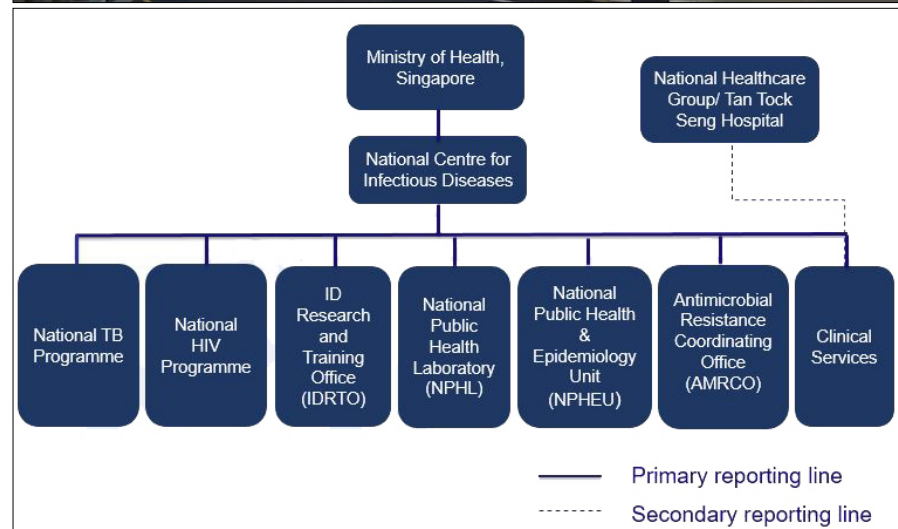
# Exercise “Sparrowhawk” (I and II)

- Mock patient with serious infection arrives at the hospital
- Role-play
- Conducted for Ebola 2015 – Enhanced PPE with respirators
- For “Respiratory X” disease – Full PPE with N95 mask, eye protection, gowns, gloves



# Singapore National Centre for Infectious Diseases (NCID)

- Purpose-built medical facility within the public healthcare system
- 17 wards, 330 beds, 2 ICUs
- High-level isolation ward capable of handling Ebola, Marburg, anthrax
- Research and diagnostic facilities
- National Public Health Laboratory (NPHL)
- Formally opened on 7 Sept. 2019 (just in time)



Images: Wikipedia (top), NCID (bottom)



# KK Women's and Children's Hospital (KKH)

- 830-bed pediatric & OB/Gyn hospital
- Tertiary-level academic teaching hospital for National University of Singapore (NUS) and Duke-NUS
- **My workplace** -- I am a clinical microbiologist at the hospital's Department of Pathology & Laboratory Medicine
- Relatively small microbiology section



# 4 Jan 2020 – The Straits Times

A8

TOP OF THE NEWS

| THE STRAITS TIMES | SATURDAY, JANUARY 4, 2020 |



Wuhan

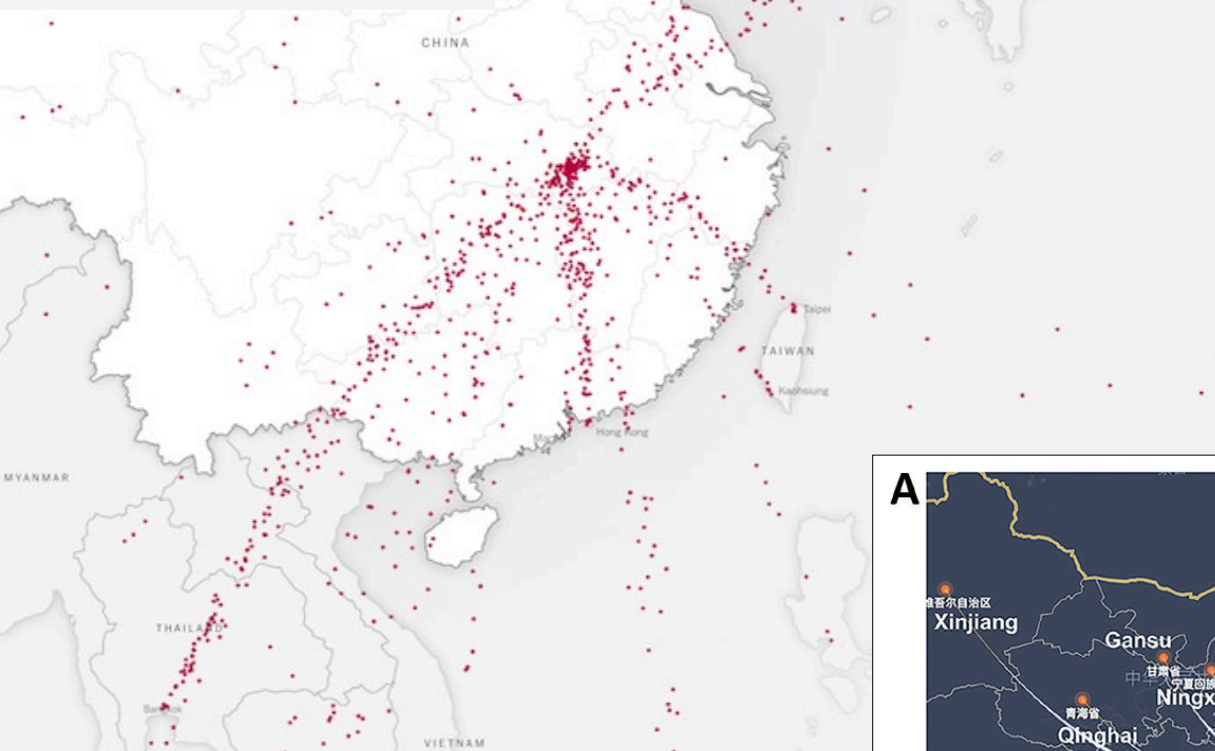


# How the Virus Got Out

By Jin Wu, Welyi Cai, Derek Watkins and James Glanz March 22, 2020

The most extensive travel restrictions to stop an outbreak in human history haven't been enough. We analyzed the movements of hundreds of millions of people to show why.

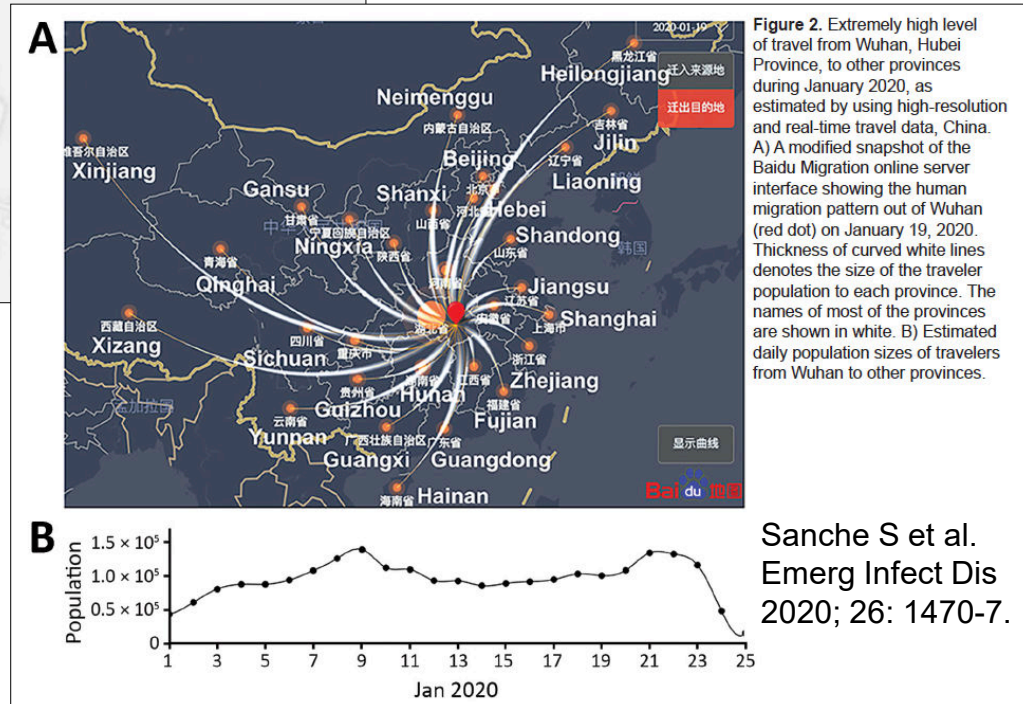
The New York Times



## Wuhan “Exodus”

- Wuhan Lockdown  
23 Jan 2020
- About 5 million people left Wuhan
- Chinese New Year  
25-26 Jan 2020
- Biggest yearly travel period

- Travel inside China
- Travel to Thailand, Singapore, Bali, Hong Kong, Taiwan, Japan, S. Korea (→ “First Wave”)



# Laboratory testing for 2019 novel coronavirus (2019-nCoV) in suspected human cases

Interim guidance  
17 January 2020

[WHO/2019-nCoV/laboratory/2020.3](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/laboratory-guidance)



World Health Organization

**PCR protocol  
available  
13 Jan 2020**

Berlin, 13.01.2020

<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/laboratory-guidance>

## Diagnostic detection of Wuhan coronavirus 2019 by real-time RT-PCR

-Protocol and preliminary evaluation as of Jan 13, 2020-

Victor Corman, Tobias Bleicker, Sebastian Brünink, Christian Drosten  
Charité Virology, Berlin, Germany

Olfert Landt, Tib-Molbiol, Berlin, Germany

Marion Koopmans  
Erasmus MC, Rotterdam, The Netherlands

Maria Zambon  
Public Health England, London

Additional advice by Malik Peiris, University of Hong Kong

## RESEARCH

### Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR

Victor M Corman<sup>1</sup>, Olfert Landt<sup>2</sup>, Marco Kaiser<sup>2</sup>, Richard Molenkamp<sup>3</sup>, Adam Meijer<sup>4</sup>, Daniel KW Chu<sup>5</sup>, Tobias Bleicker<sup>1</sup>, Sebastian Brünink<sup>1</sup>, Julia Schneider<sup>1</sup>, Marie Luisa Schmidt<sup>1</sup>, Daphne GJC Mulders<sup>3</sup>, Bart L Haagmans<sup>3</sup>, Bas van der Veer<sup>4</sup>, Sharon van den Brink<sup>4</sup>, Lisa Wijsman<sup>4</sup>, Gabriel Goderski<sup>4</sup>, Jean-Louis Romette<sup>6</sup>, Joanna Ellis<sup>7</sup>, Maria Zambon<sup>8</sup>, Malik Peiris<sup>5</sup>, Herman Goossens<sup>8</sup>, Chantal Reusken<sup>4</sup>, Marion PG Koopmans<sup>3</sup>, Christian Drosten<sup>1</sup>

1. Charité – Universitätsmedizin Berlin Institute of Virology, Berlin, Germany and German Centre for Infection Research (DZIF), Berlin, Germany
2. Tib-Molbiol, Berlin, Germany
3. Department of Viroscience, Erasmus MC, Rotterdam, the Netherlands
4. National Institute for Public Health and the Environment (RIVM), Bilthoven, the Netherlands
5. University of Hong Kong, Hong Kong, China
6. Université d'Aix-Marseille, Marseille, France
7. Public Health England, London, United Kingdom
8. Department of Medical Microbiology, Vaccine and Infectious Diseases Institute, University of Antwerp, Antwerp, Belgium

Correspondence: Christian Drosten ([christian.drosten@charite.de](mailto:christian.drosten@charite.de))

#### Citation style for this article:

Corman Victor M, Landt Olfert, Kaiser Marco, Molenkamp Richard, Meijer Adam, Chu Daniel KW, Bleicker Tobias, Brünink Sebastian, Schneider Julia, Schmidt Marie Luisa, Mulders Daphne GJC, Haagmans Bart L, van der Veer Bas, van den Brink Sharon, Wijsman Lisa, Goderski Gabriel, Romette Jean-Louis, Ellis Joanna, Zambon Maria, Peiris Malik, Goossens Herman, Reusken Chantal, Koopmans Marion PG, Drosten Christian. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill. 2020;25(3):pii=2000045. <https://doi.org/10.2807/1560-7917.ES.2020.25.3.2000045>

Article submitted on 21 Jan 2020 / accepted on 22 Jan 2020 / published on 23 Jan 2020

## Early PCR Assays (Jan 2020) 2020)

- Drosten Group, Charité, Berlin Germany
- School of Public Health, University of Hong Kong, Hong (Leo Poon, Daniel Chu and Malik Peiris)
- China CDC (National Institute for Viral Disease Control and Prevention)
- Department of Medical Sciences, Ministry of Public Health, Thailand
- National Institute of Infectious Diseases, Tokyo, Japan



23 Jan. 2020

Singapore

## Singapore confirms first case of Wuhan virus



Employees at Singapore's National Centre for Infectious Diseases putting on protective gear before carrying out testing for the novel coronavirus.

SINGAPORE: Singapore on Thursday (Jan 23) announced a confirmed case of the Wuhan virus, a new coronavirus that has sickened hundreds of people and killed at least 17.

In a media briefing on Thursday evening, the Ministry of Health said the patient is a 66-year-old Chinese man. The Wuhan resident, who arrived in Singapore with his family on Jan 20, flew from Guangzhou via China Southern flight CZ351.

He is currently in isolation at the Singapore General Hospital and is in stable condition.

► **READ: Wuhan virus - Number of confirmed cases in China exceeds 570**

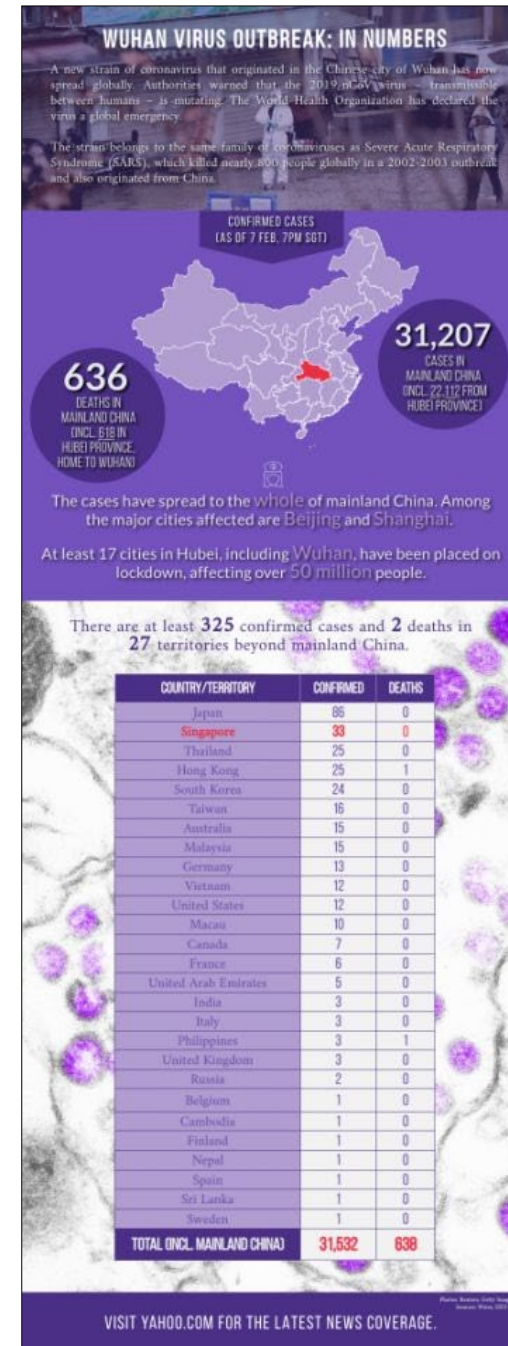
► **READ: Wuhan virus - What we know about the fatalities**

► **READ: "Verge of tears" - Residents of virus-hit Wuhan call for support amid food shortage worries**

25 Jan. 2020



7 Feb. 2020





# Adoption of Testing in Singapore

## National Public Health Laboratory (NPHL)

- Designed own PCR (N gene, ORF1ab gene); JAMA 2020

JAMA | Original Investigation

### Epidemiologic Features and Clinical Course of Patients Infected With SARS-CoV-2 in Singapore

Barnaby Edward Young, MB, BChir; Sean Wei Xiang Ong, MBBS; Shirin Kalimuddin, MPH; Jenny G. Low, MPH; Seow Yen Tan, MBBS; Jiashen Loh, MBBS; Oon-Tek Ng, MPH; Kalisvar Marimuthu, MBBS; Li Wei Ang, MSc; Tze Minn Mak, PhD; Sok Kiang Lau, PhD; Danielle E. Anderson, PhD; Kian Sing Chan, MBBS; Thean Yen Tan, MBBS; Tong Yong Ng, MBBS; Lin Cui, PhD; Zubaidah Said, MSc; Lalitha Kurupatham, MPH; Mark I-Cheng Chen, PhD; Monica Chan, MBBS; Shawn Vasoo, MBBS; Lin-Fa Wang, PhD; Boon Huan Tan, PhD; Raymond Tzer Pin Lin, MBBS; Vernon Jian Ming Lee, PhD; Yee-Sin Leo, MPH; David Chien Lye, MBBS; for the Singapore 2019 Novel Coronavirus Outbreak Research Team

JAMA. 2020;323(15):1488-1494. doi:10.1001/jama.2020.3204  
Published online March 3, 2020. Corrected on March 20, 2020.

## Singapore General Hospital (SGH) Dept. Molecular Pathology

- Adopted German assay late Jan.

## Other Hospital Labs (public & private)

- Received panels of coded samples from NPHL; when all correct, approval for testing by Ministry of Health (MOH)

## We at KKH

- PCR testing approved 11 Feb.

## Subsequently

- Commercial PCR kits became available
  - TIB Molbiol Berlin, Germany
  - Fortitude Kit, A\*Star Singapore
  - Roche cobas 6800 or 8800
- Ramping up test capacity (~500/day in our small lab)
- Some bigger labs 1500-2000 per day
- Serology (Abbott IgG) started at KKH 22 May
- Singapore (pop. 6.6 m) aims at test capacity 40,000 PCRs per day

# Biosafety of Testing

- Needed to design lab protocols
  - (1) Microbiology & Mol. Micro. Lab
  - (2) Other Clinical Laboratories
    - (a) “Respiratory type” specimens (higher risk)
    - (b) “Non-respiratory” specimens (lower risk)

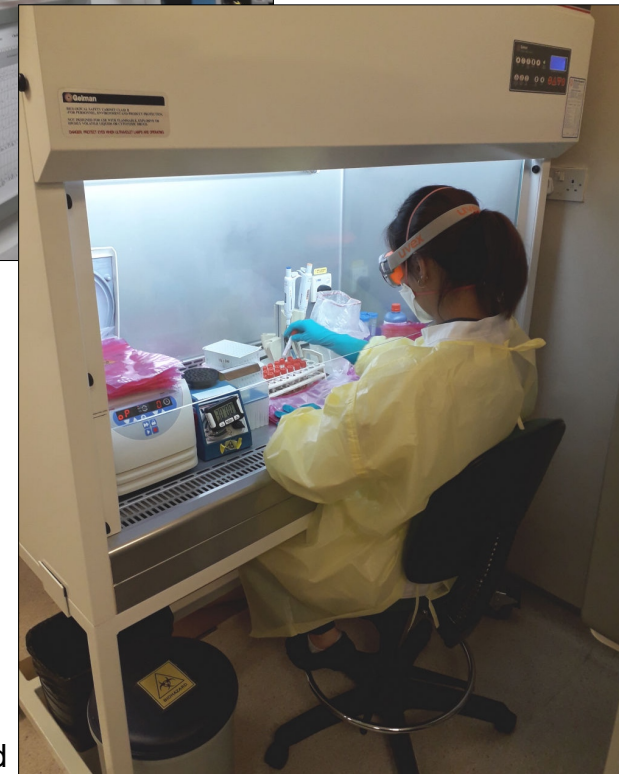
- COVID suspect specimens double-bagged and labeled



- For (a): Biosafety cabinets (BSCs), goggles, N95 masks, gowns, gloves for specimen processing
- Pregnant women & staff on immunosuppressant medication exempted



Our “Hunting Trophy Wall”

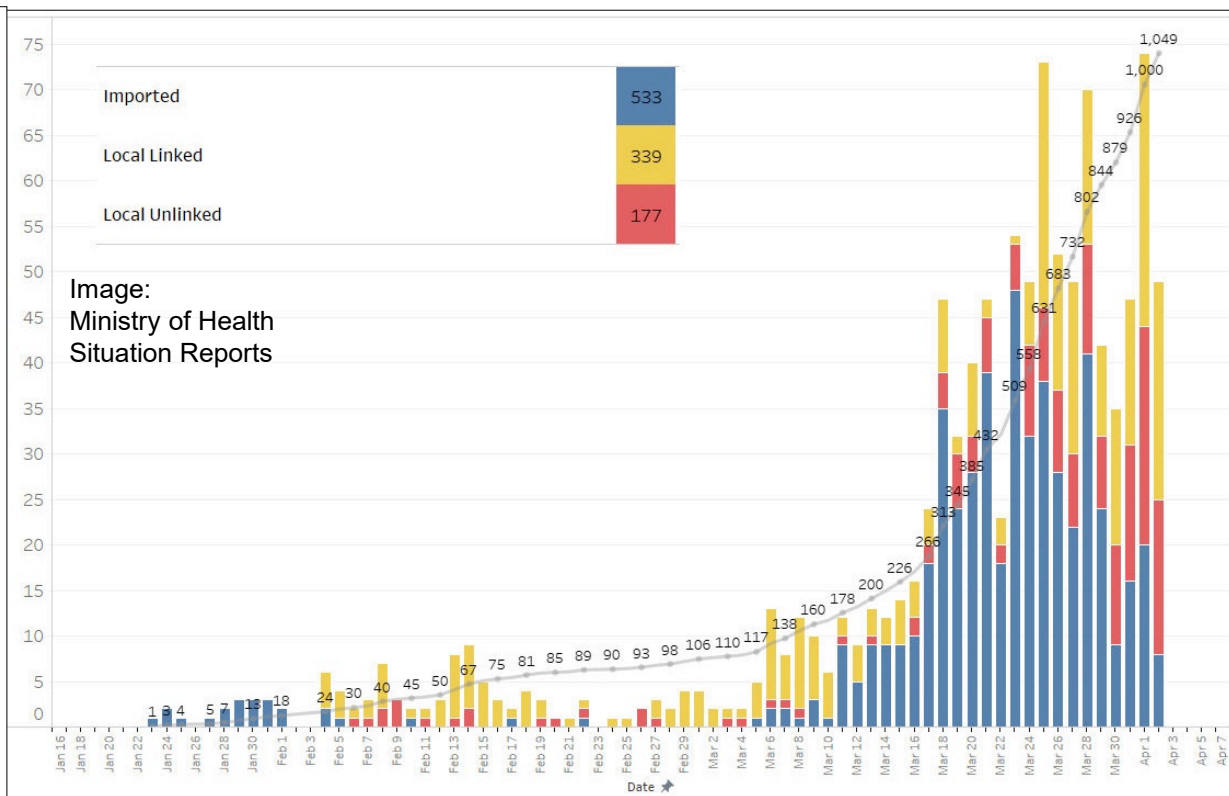
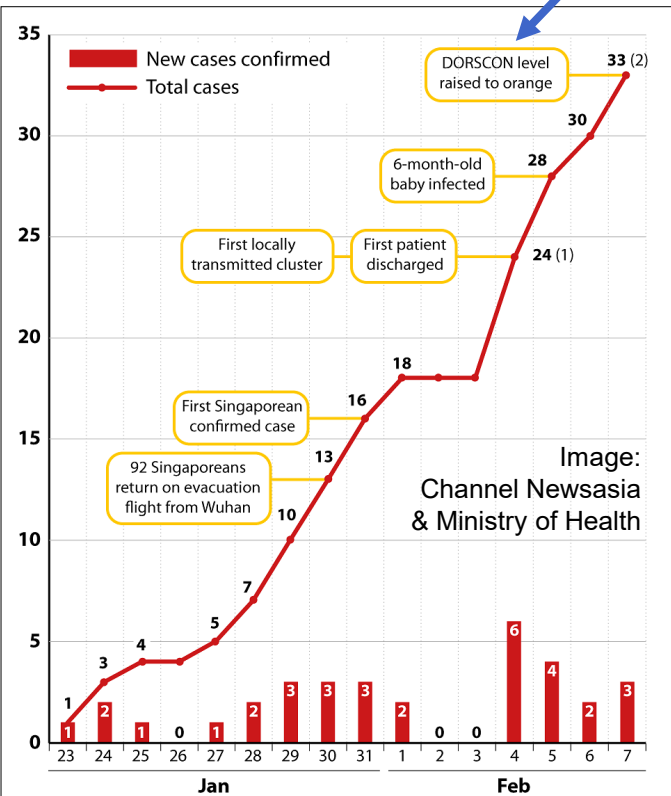


# Early COVID-19 Timeline in SG

## Timeline until 7 Feb

DORSCON (Disease Outbreak Response System Condition)  
Level raised to **ORANGE** 7 Feb

## Timeline until 2 Apr



Chinese nationals visiting from Wuhan, then Singaporeans returning from Wuhan

Start of local transmission in Singapore

"1st Wave": Imported cases from China

"2nd Wave": Early local clusters and local transmission

"3rd Wave": Returning Singaporeans and SG residents from overseas



# PPE Measures at the Hospital

## Triage

- **Counter Staff:** surg. mask (ext. use); **Clin. Staff:** N95 mask (ext.)

## Patient Care

- **Suspected/confirmed pats.:** N95 mask + goggles (ext. use) + gown + gloves (single use)
- **Non-suspect patients:** surg. mask (ext. use)

## Aerosol-generating Procedures

- **Suspected/confirmed pats.:** N95 + goggles (or PAPR) + gown + gloves (all single use)
- **Other pats.:** N95 mask + goggles (ext. use) + gown + gloves (single use)

## Environmental Cleaning

- N95 mask + goggles (ext. use) + gown + gloves (single use)

## Admin. Staff, Patients, Visitors

- Surgical mask (ext. use); or cloth mask

## Notes

- Ext. use = extended use for one shift  
(N95 mask in new zip-lock bag or plastic lunch box when temporarily removed)

# Other Measures during DORSCON Orange

## Hospital Staff

- All staff to take temperature 2 x daily and record on staff intranet
- Anyone with fever, flu-like sympt., sore throat, runny nose MUST report to staff clinic, get COVID-19 tested and placed on 5 d mandatory home quarantine (10 k fines for breach)

## Leave

- All leave outside SG is disallowed, including conferences
- Staff arriving from other countries must serve 14 d Stay-Home Notice (SHN)

## Meetings, Education, Research

- Inter-hospital movement of HCWs restricted, incl. resident rostering
- Meetings & education via teleconferencing (Zoom, WebEx)
- Research is restricted; guidelines issued

## Patients, Visitors

- Visitor access registration & control; only 1 visitor per patient
- Elective procedures & clinic visits restricted
- Isolation wards for suspect/confirmed pats.; discharge when PCR neg. on 2 consec. days

# Patient Categories & Indications for Testing

	Before 26 March	From 26 March	From 8 May
1.	Suspect/Confirmed Case fulfilling MOH criteria	Meet MOH's suspect case definition	Meet MOH's suspect case definition
2.	Enhanced Surveillance for Community-Acq. Pneumonia (inpat. & outpatient)	Pneumonia surveillance (inpatient or outpatient)	Other clinical, e.g. fever, ARI, atypical symptoms
3.	ARI/ Other Conditions fulfilling KKH At-risk criteria (includes travel history/ pre-surgery/ etc)	Other clinical conditions, e.g. fever, ARI, atypical symptoms	Surveillance of confirmed case
4.	N/A	Surveillance of confirmed case	Other reasons not clinically indicated, e.g. patient's request (chargeable)
5.	Pats. not fulfilling MOH criteria or KKH at-risk criteria (chargeable)	Other reasons not clinically indicated (chargeable)	N/A

- Patient Categories evolved during the pandemic
- MOH = Ministry of Health; ARI = Acute Respiratory Infection; KKH = KK Women's and Children's Hospital



# Case of Paucisymptomatic Child

- 6 mo/old infant admitted for testing & isolation b/c mother was infected
- Asymptomatic except mild fever 38.5°C
- Low Ct value 13.7  
≈ 6 billion virus copies per NP swab
- NP samples pos. up to day 16
- Child likely highly infectious

- Our lab's lowest recorded Ct value:  
9.7 (in an adult)  
≈ 100 billion virus copies per NP swab

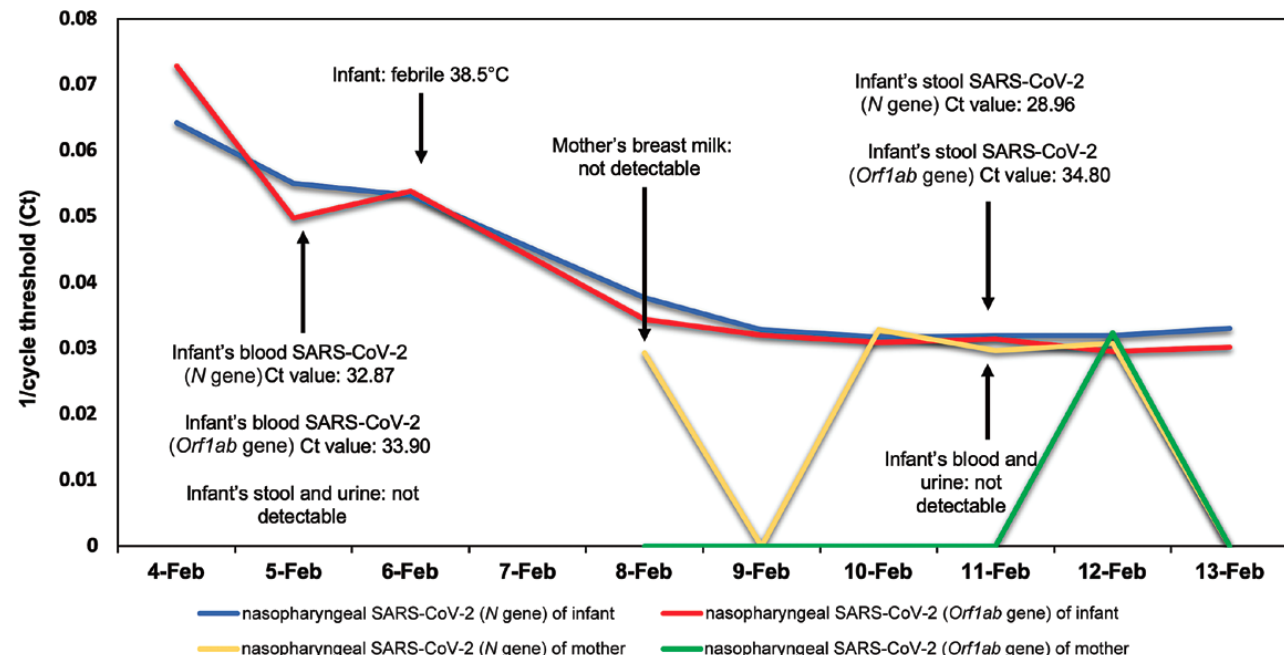
## A Well Infant With Coronavirus Disease 2019 With High Viral Load

Kai-qian Kam,<sup>1</sup> Chee Fu Yung,<sup>1</sup> Lin Cui,<sup>2</sup> Raymond Tzer Pin Lin,<sup>2</sup> Tze Minn Mak,<sup>2</sup> Matthias Maiwald,<sup>3</sup> Jiahui Li,<sup>1</sup> Chia Yin Chong,<sup>1</sup> Karen Nadua,<sup>1</sup> Natalie Woon Hui Tan,<sup>1</sup> and Koh Cheng Thoon<sup>1</sup>

<sup>1</sup>Infectious Disease Service, Department of Pediatrics, KK Women's and Children's Hospital, Singapore, Singapore, <sup>2</sup>National Public Health Laboratory, National Centre for Infectious Diseases, Singapore, Singapore, and <sup>3</sup>Department of Pathology and Laboratory Medicine, KK Women's and Children's Hospital, Singapore, Singapore

A well 6-month-old infant with coronavirus disease 2019 (COVID-19) had persistently positive nasopharyngeal swabs up to day 16 of admission. This case highlights the difficulties in establishing the true incidence of COVID-19, as asymptomatic individuals can excrete the virus. These patients may play important roles in human-to-human transmission in the community.

**Keywords.** COVID-19; SARS-CoV-2; infant; 2019 novel coronavirus. Clin. Infect. Dis. Online Ahead of Print.



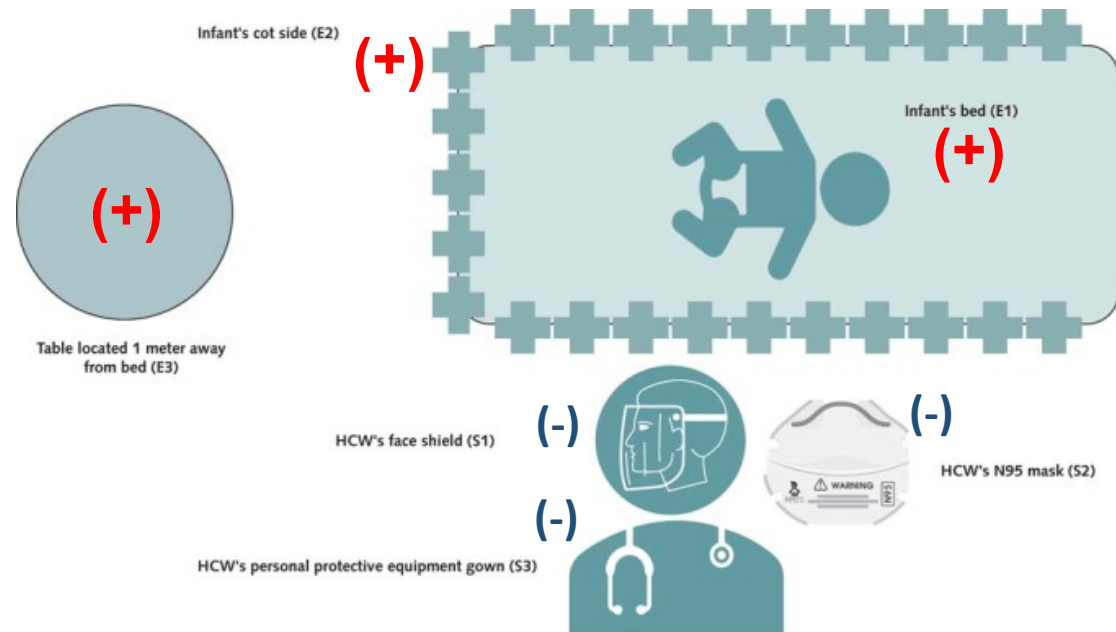
## Environment of Infected Child

- 6 mo/old infant with high viral load
- Paucisymptomatic
- In isolation room
- Sampled & tested:  
Bed, Cot Rail, Table (+)  
HCW's face shield, N95 mask, gown (-)
- Infected but well infants with no resp. symptoms can easily contaminate environment
- Child likely highly infectious

Yung CF, Kam KQ, Wong MSY, Maiwald M, Tan YK, Tan BH, Thoon KC.  
Ann Intern Med. 2020 Apr 1; M20-0942.  
Online ahead of print.

### Environment and Personal Protective Equipment Tests for SARS-CoV-2 in the Isolation Room of an Infant With Infection

*Background:* Severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) is suspected to be spread from an infected person to a susceptible host primarily via droplet and possibly direct contact (1). The roles of transmission by indirect contact (fomites) or by long-range airborne route are uncertain. Currently, there are no data on the risk for transmission from infants or young children with coronavirus disease 2019 (COVID-19) who may be asymptomatic or pauci-symptomatic.



Ct Value	S1	S2	S3	E1	E2	E3
SARS-CoV-2 RdRp Ct value	ND	ND	ND	28.7	33.3	29.7
SARS-CoV-2 E-gene Ct value	ND	ND	ND	32.8	37.8	33.5

# Clinical Utility of Buccal Swabs for Severe Acute Respiratory Syndrome Coronavirus 2 Detection in Coronavirus Disease 2019–Infected Children

Kai-qian Kam,<sup>1,3,5</sup> Chee Fu Yung,<sup>1,3,4</sup> Matthias Maiwald,<sup>2,3,6</sup> Chia Yin Chong,<sup>1,3,4,5</sup> Han Yang Soong,<sup>2</sup> Liat Hui Loo,<sup>2</sup> Natalie Woon Hui Tan,<sup>1,3,4,5</sup> Jiahui Li,<sup>1,3,5</sup> Karen Donceras Nadua,<sup>1,3,5</sup> and Koh Cheng Thoon<sup>1,3,4,5</sup>

<sup>1</sup>Infectious Disease Service, Department of Pediatrics, KK Women's and Children's Hospital, Singapore; <sup>2</sup>Department of Pathology and Laboratory Medicine, KK Women's and Children's Hospital, Singapore; <sup>3</sup>Duke-NUS Medical School, Singapore; <sup>4</sup>Lee Kong Chian School of Medicine, Imperial College London, Nanyang Technological University, Singapore; <sup>5</sup>Yong Loo Lin School of Medicine, National University of Singapore, Singapore; and <sup>6</sup>Department of Microbiology and Immunology, National University of Singapore, Singapore

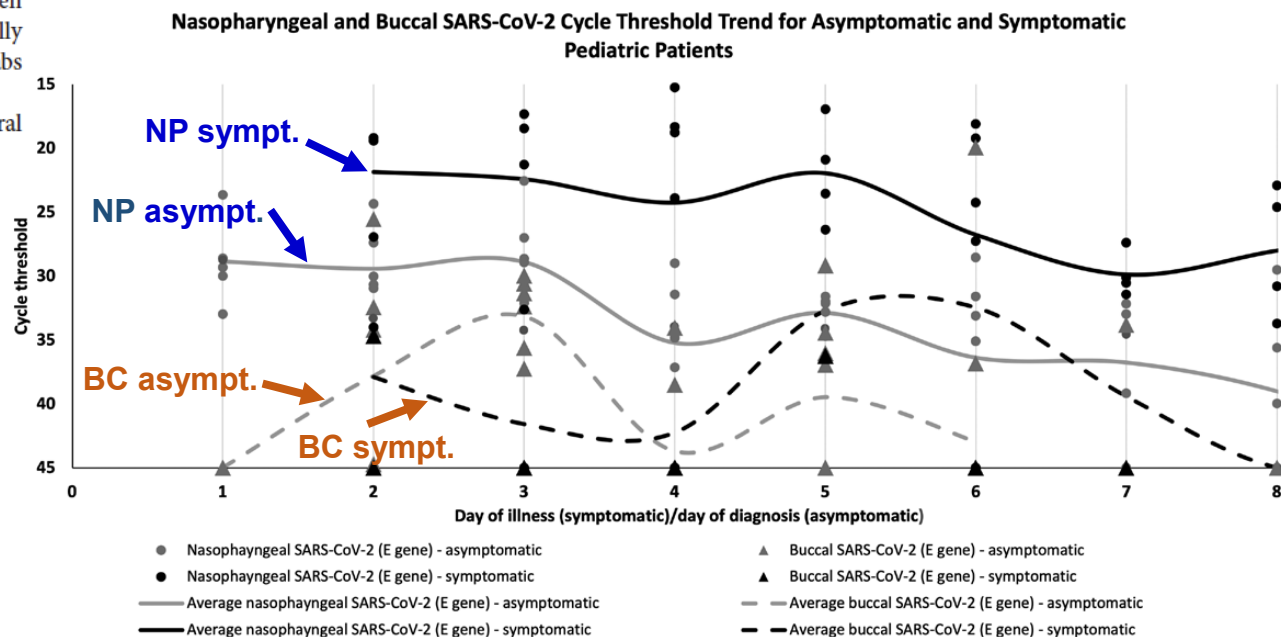
Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was detected from at least 1 buccal specimen in 9 of 11 coronavirus disease 2019 (COVID-19)–infected children (81.8%). Viral loads in buccal specimens were substantially lower than those in nasopharyngeal specimens. Buccal swabs are not good as COVID-19 screening specimens in children.

**Keywords.** COVID-19; buccal; saliva; SARS-CoV-2; viral load.

J Pediatric Infect Dis Soc.  
2020 May 28; p1aa068.  
Online ahead of print.

## Buccal swabs vs. NP swabs

- 11 infected children; 6 asympt., 5 symptomatic
- Symptomatic all had mild illness
- Buccal swabs are less invasive, easier
- Buccal & NP collected same day, same session
- 2/11 children had neg. buccal swabs (82% sens.)
- Buccal swab Ct values avg. 10.7 higher than NP (**P<0.001; factor 1000**) --> not a good specimen



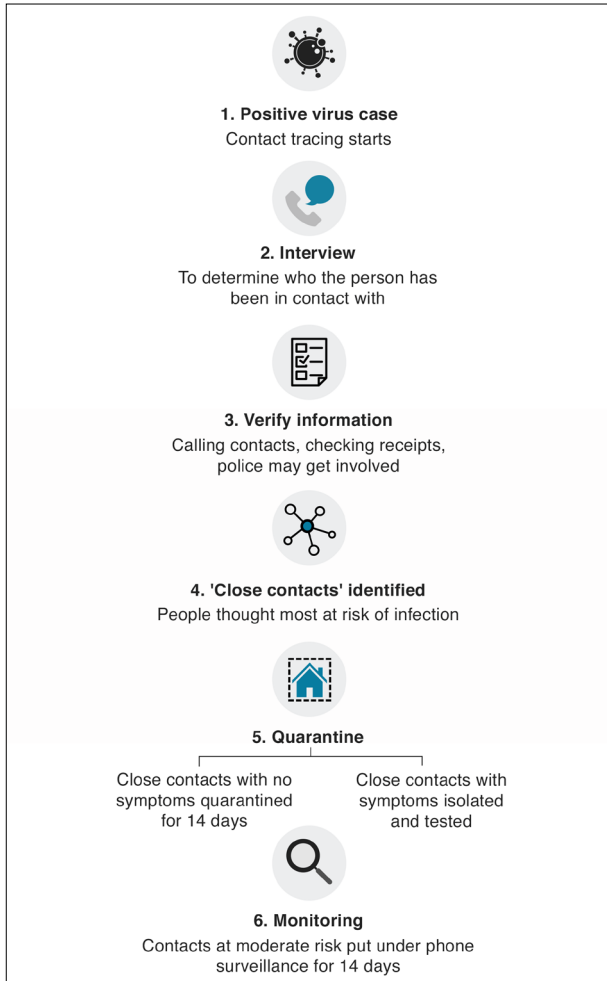
Cycle threshold 45 = undetectable



# Public Health Measures

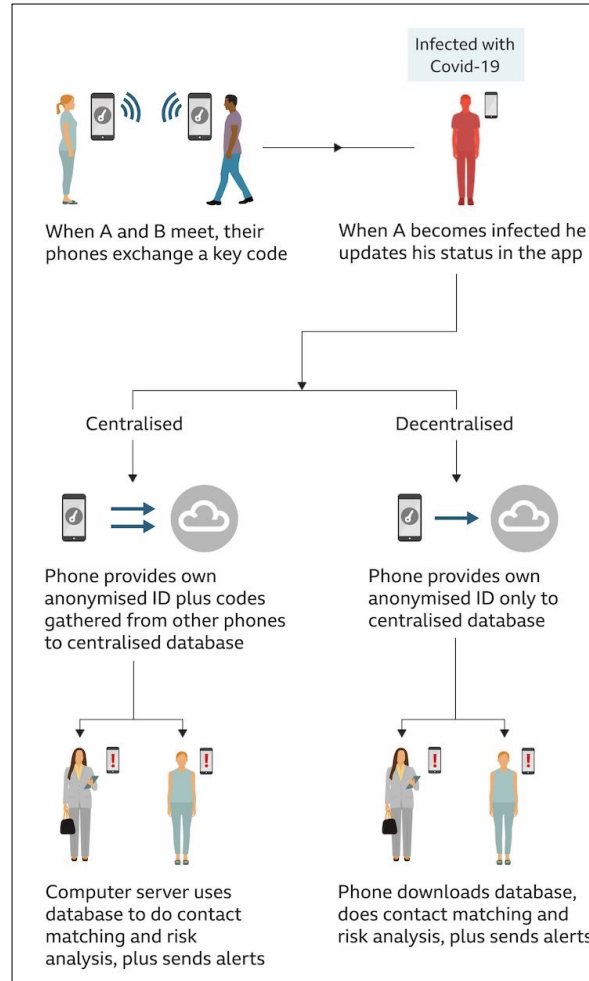
## Singapore has been exemplary in contact tracing, isolating and identifying clusters

### Classical Contact Tracing



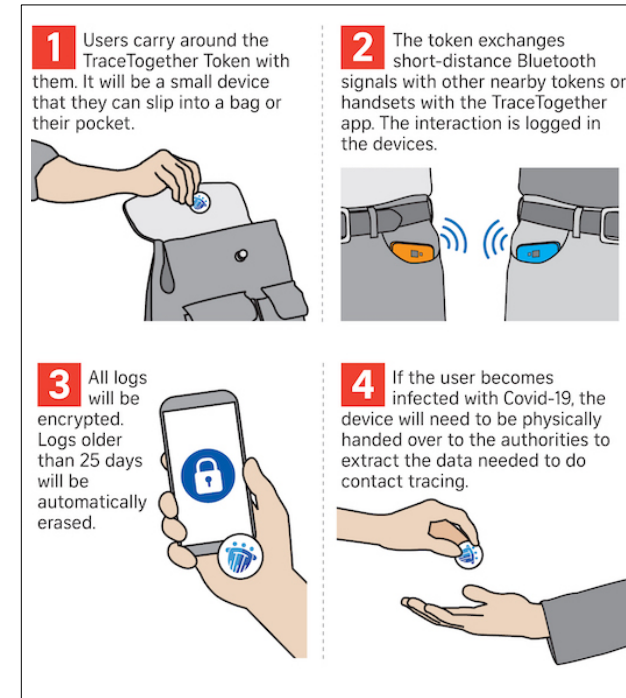
Source: BBC and MOH

### Smartphone App TraceTogether



Source: BBC News

### TraceTogether Token



Source: Straits Times and MOH

# Coronavirus Jokes

Um nicht mit  
Coronavirus in  
Verbindung gebracht  
zu werden:  
Mexikanische  
Biermarke in "Ebola"  
umbenannt

VON DER POSTILLON  
22. JANUAR 2020

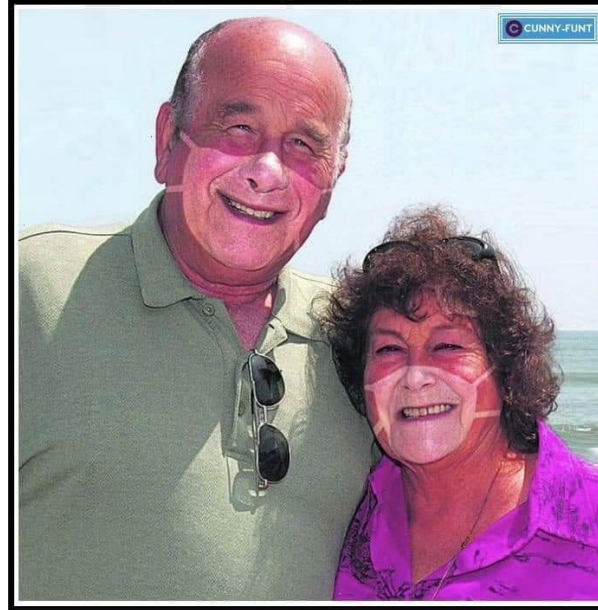
In order not  
to be  
associated with  
Coronavirus,  
Mexican beer  
brand renamed  
in "Ebola"



"It is over.  
You may come  
out again".  
German  
Chancellor  
Merkel



**TED AND MARCIA JUST BACK FROM  
THEIR WONDERFUL HOLIDAY IN ITALY**



Source: Tagesschau.de



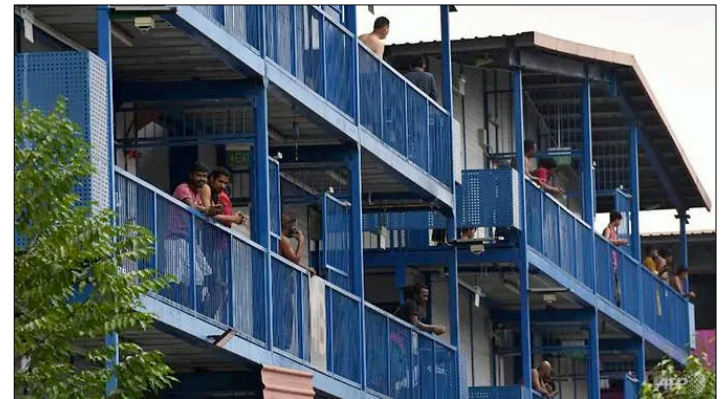


# A Turn of Events

- Until late March, SG did extremely well
- Cases were under control with aggressive isolation and contact tracing efforts
- Shops, schools were open, public life unaffected

## Then, cases emerged at Foreign-Worker Dormitories (from 30 March)

- SG has ~300,000 low-income foreign workers, mostly in construction (e.g. India, Bangladesh, Myanmar)
- Housed in cramped conditions, e.g. 15-20 people in one bedroom
- Virus got foothold, spread like 'wildfire'
- All dormitories quarantined (Armed Forces involved)
- Comprehensive testing and relocation strategy to Government Quarantine Facilities (GQFs)





# Subsequent Timeline in SG

## Timeline until 17 Apr

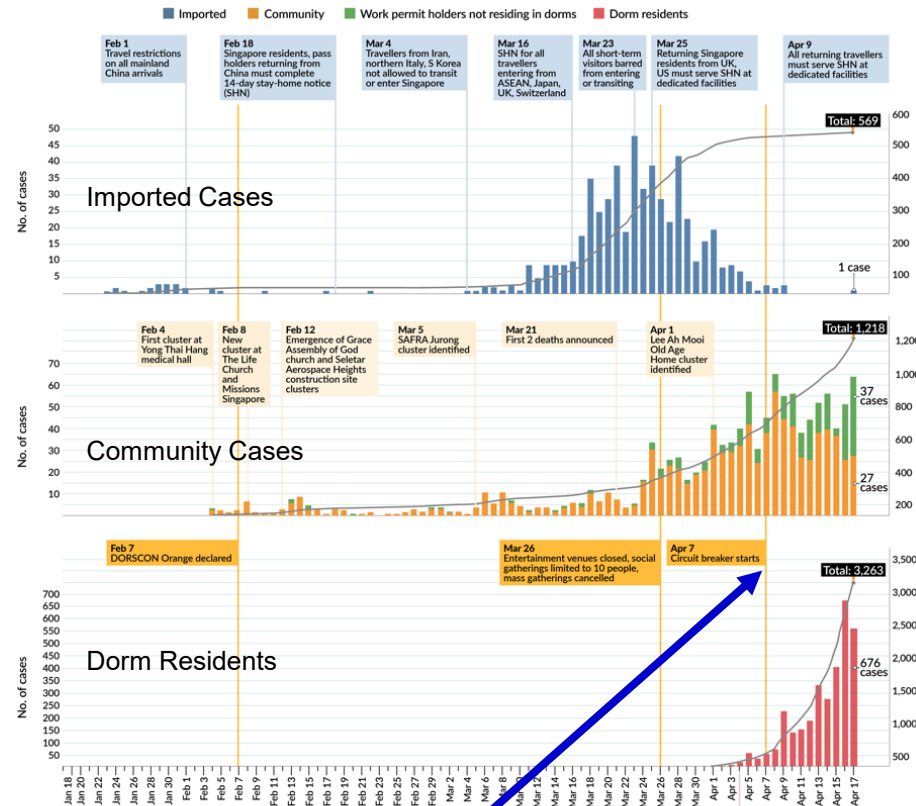


Image: Channel NewsAsia & Ministry of Health

## Timeline until 11 Jul

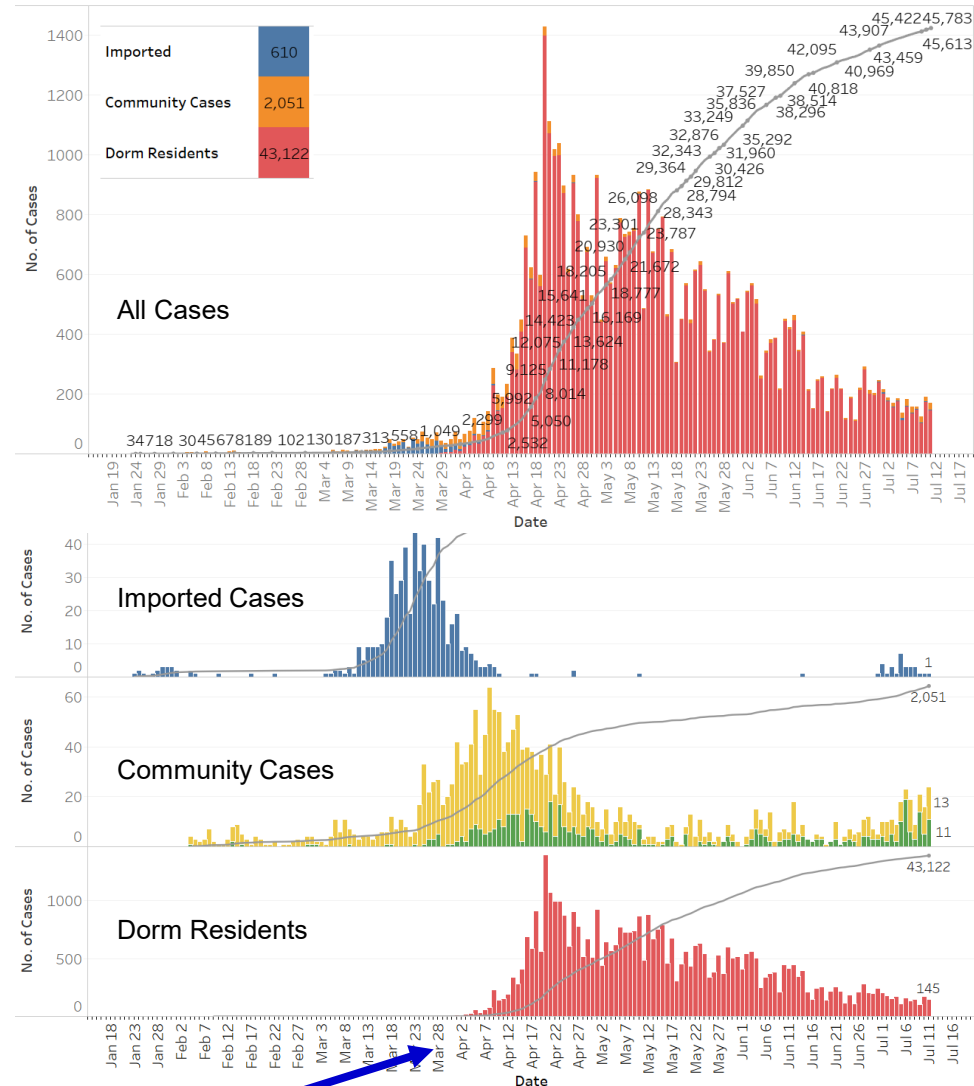


Image: Ministry of Health Situation Reports

30 Mar: Start of dorm cases

"4th Wave"

--> 3 distinct epi curves

7 Apr: Start of "Circuit Breaker", i.e. SG lockdown

- School closures, only essential businesses open
- Public mask wearing, social distancing

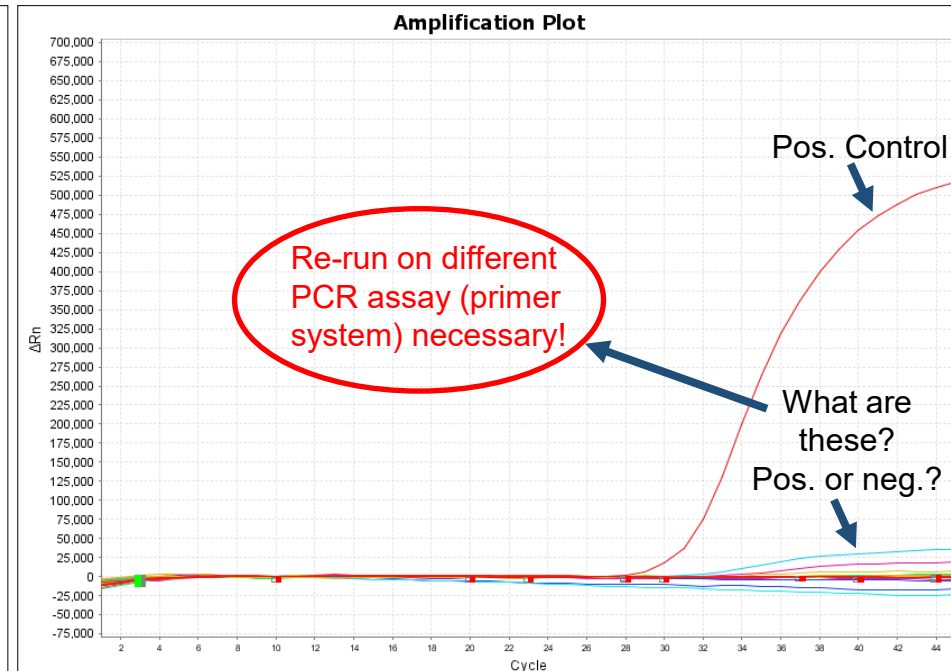
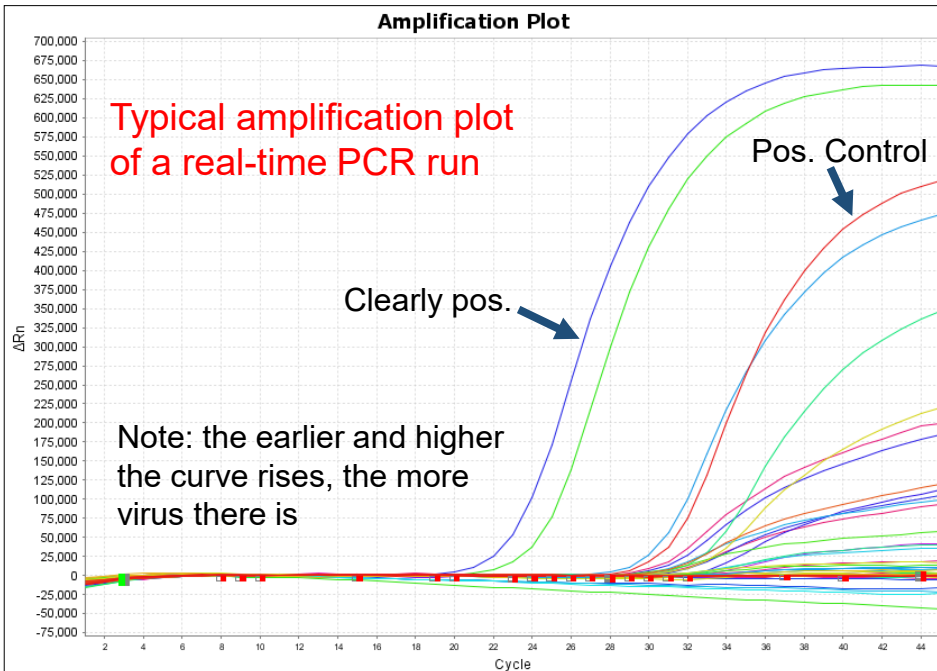
From 2 Jun: Reopening in phases

# Coping with Increased Testing

- To cope with increasing test demand, MOH set up **Testing Operations Centre (TOC)**
- TOC would allocate cases from **dorms** and **Government Quarantine Facilities (GQFs)** across all public and private labs

## Testing in high-prevalence settings is difficult!

- Many samples with low-level or borderline amplification curves (stages of infection)
- Extensive re-testing with confirmatory assays is necessary!



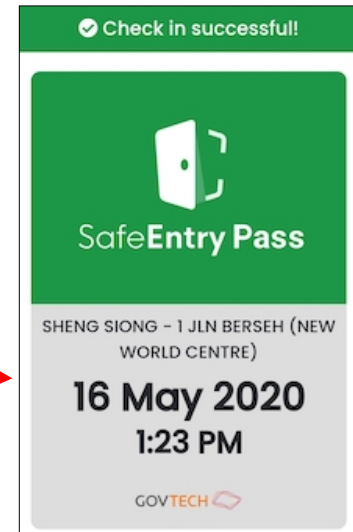
# Measures for the General Public

## Before April 2020

- Relatively normal situation; public life not much affected
- Some panic-buying after DORSCON Orange 7 Feb; quickly subsided

## From 7 Apr: “Circuit Breaker”

- School closures, only essential businesses open, public mask wearing (cloth or surg.)
- Only takeout at restaurants, gatherings restricted (only families), no gyms
- No religious gatherings, travel restrictions, working from home
- Public accepted these measures well, but economic conseq. & hardship
- Access control/recording in public places & shopping centers



## Reopening in Phases from 2 June

- "Safe Reopening" (phase 1), "Safe Transition" (phase 2) and "Safe Nation" (phase 3)



# Conclusions and Outlook

- Singapore generally managed the crisis very well – benefitted from preparedness
- As of 2 July, 44,000 cases, 26 deaths – remarkably low death rate
- Outbreak in the foreign workers' dormitories constituted a lapse of attention to this vulnerable part of the population – resulted in rapid spread; majority of SG's cases

## On the Ground

- Work on the ground was challenging
- So far no major PPE shortages – stockpiled before the pandemic
- Temporary lab reagent shortages – overcome with centralized procurement & alternatives

## Capacity Building & Maintaining

- Completion of NCID (long planned) in 2019 was fortuitous
- Our lab was underresourced & understaffed – improved & rec'd help from hospital leaders
- Capability of Lab-Developed Tests (LDTs) “saved” us in the lab
- Maintaining clinical & lab capacity, staffing & skill sets essential for outbreak response

## Future

- Unclear how pandemic will progress – unlikely relief before vaccine (2021?) availability