



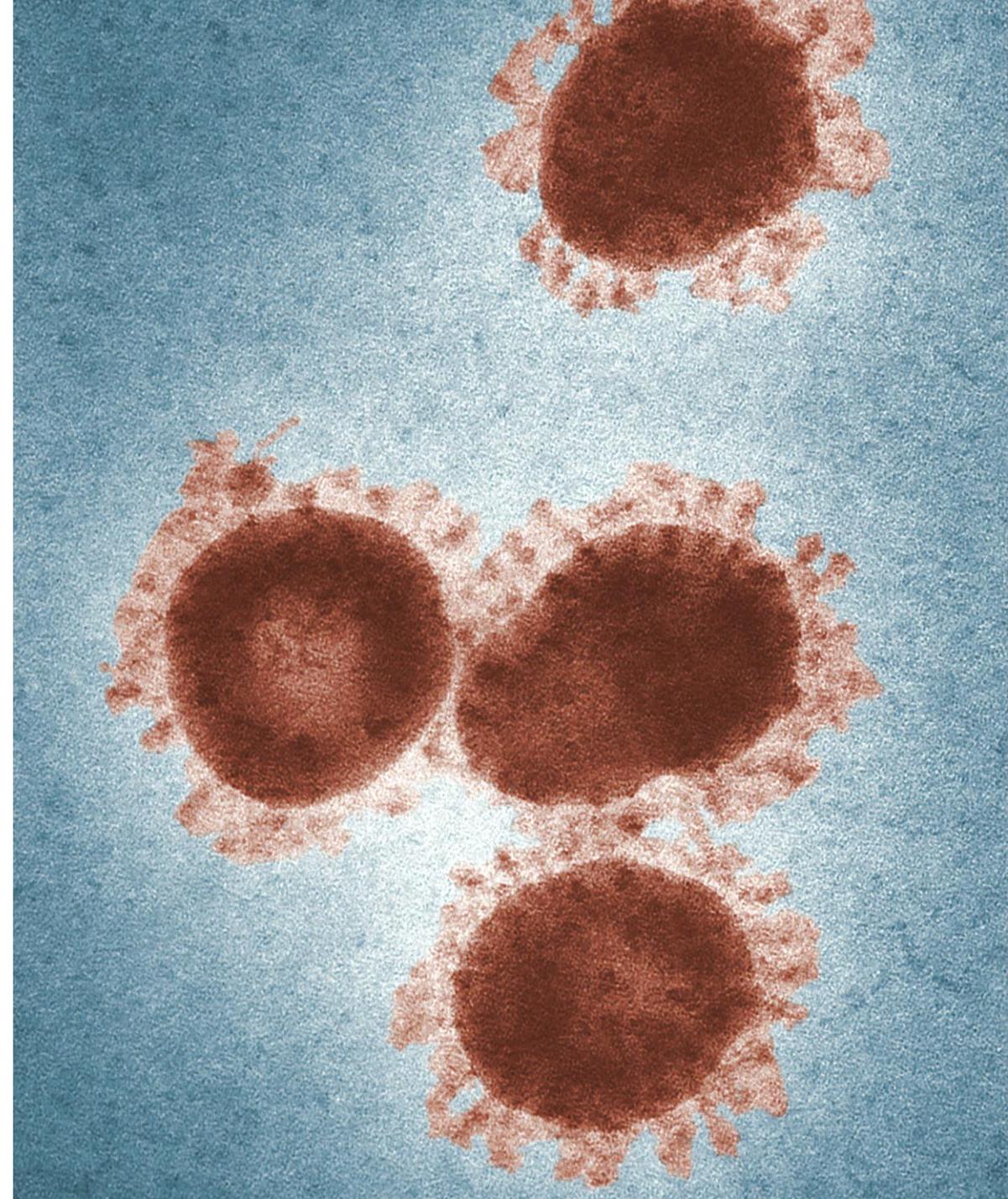
**HKU** LKS Faculty of Medicine  
**Med** School of Public Health  
香港大學公共衛生學院

# Surveillance of communicable diseases

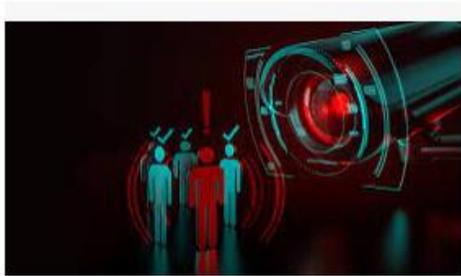
Eric HY Lau

18 February 2022

Seminar on Epidemiology and  
Outbreak Management



# “Surveillance”





- “Public health surveillance is the ongoing, systematic collection, analysis and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know.” (Thacker, 2008)
- Improve situational awareness and responsiveness to health events

# Main purposes of surveillance system

## Case management

- Support interventions in individual cases

## Outbreak detection and management

- Detect and monitor outbreaks
- Estimate the magnitude of disease and risk factors in a target population
- Understand the natural history of a disease or injury
- Identify patterns and changes in agents, conditions, and practices
- Probe epidemiologic investigation

# Purposes of surveillance system

## Programme management

- Evaluation of interventions
- Programme planning and projection
- Support treatment guidance and policy development
- Identify research gap

# Latest Situation of Coronavirus Disease (COVID-19) in Hong Kong

**Vaccine Doses Administered**  
12,115,419  
▲ 93,600

**Population with 1<sup>st</sup> dose**  
5,689,465

**Population with 2<sup>nd</sup> dose**  
5,042,018

**Population with 3<sup>rd</sup> dose**  
1,333,346

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**Confirmed: 19,881**

**Asymptomatic: 2,425**

**Re-positive: 10**

**Tested positive 30,955 ▲ 4285**

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**Local** ▲ 4264    **Imported** ▲ 21

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**Hospitalized**  
4,654  
▲ 472

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**Critical**  
16

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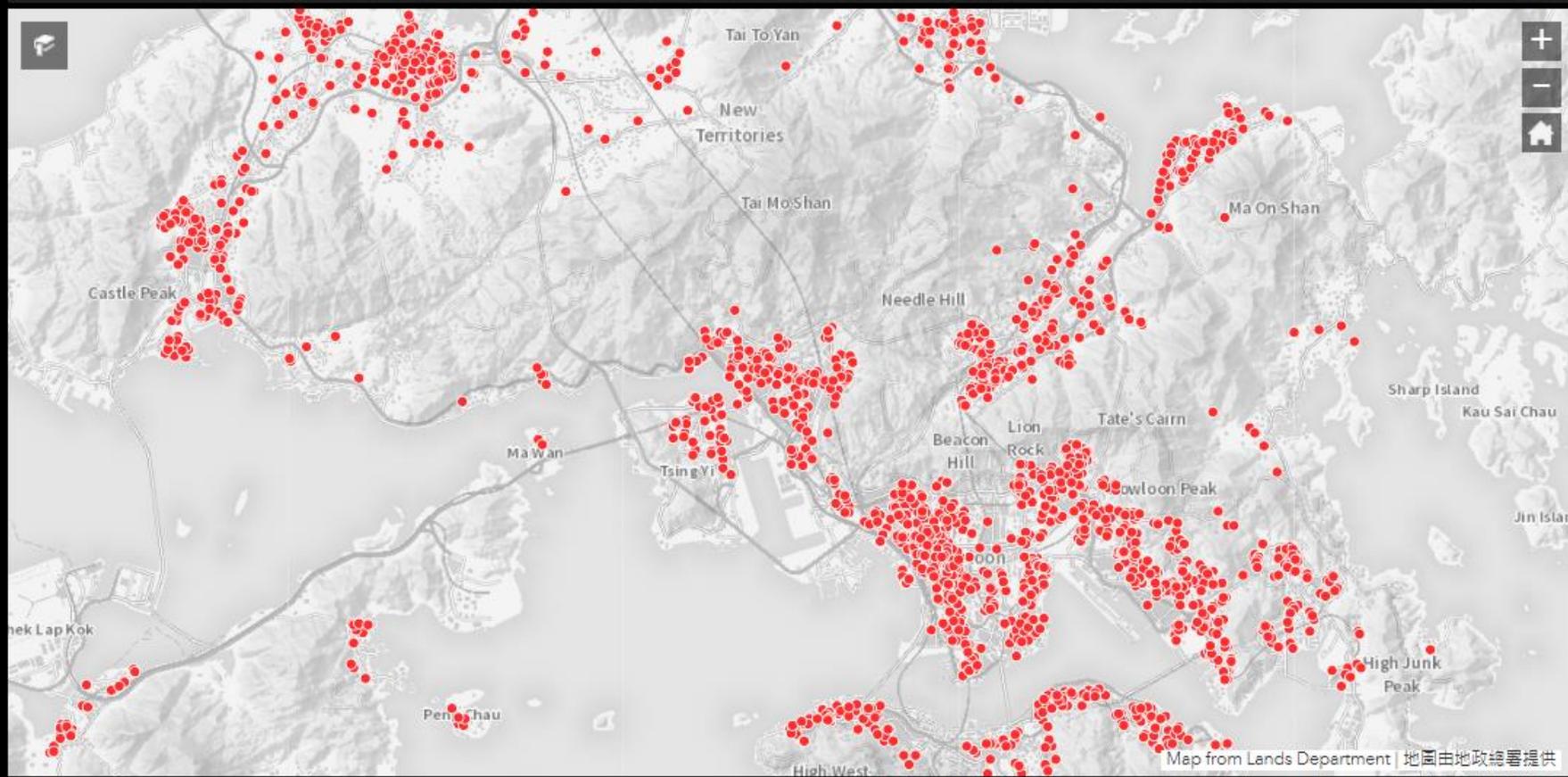
**Death**  
227  
▲ 3

Community Vaccination Services

Compulsory Testing/Testing Services

Search

Within 100 Meters  500



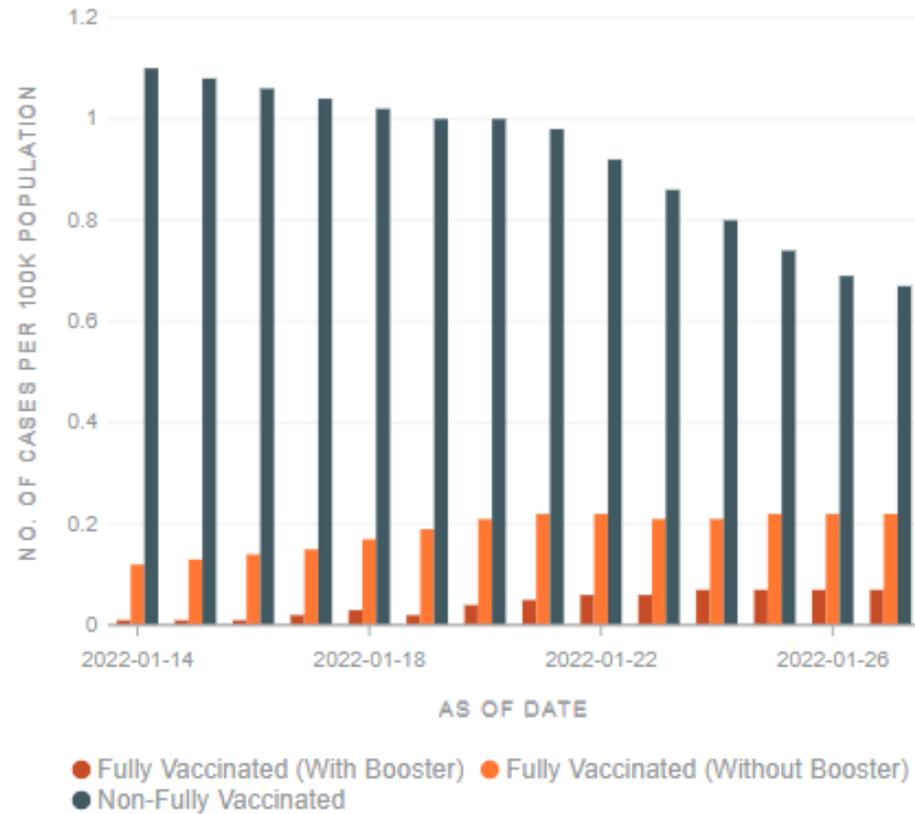
All Districts

- Building with case resided/visited in the past 14 days
- Central & Western 17 Connaught Road West
- Central & Western 18 Upper Station Street
- Central & Western 224-226 Des Voeux Road West
- Central & Western Block 1, 80 Robinson Road
- Central & Western Block 1, Centenary Mansion
- Central & Western Block 1, Dragonfair Garden
- Central & Western Block 1, Robinson Heights
- Central & Western Block 2, Centenary Mansion
- Central & Western Block 3, The Merton
- Central & Western Block A, Smithfield Garden
- Central & Western Block D, Kwun Lung Lau
- Central & Western Block D, Phase 2, Kwan Yick Building
- Central & Western Block T, Wing Wah Mansion
- Central & Western Cimbria Court

Building List

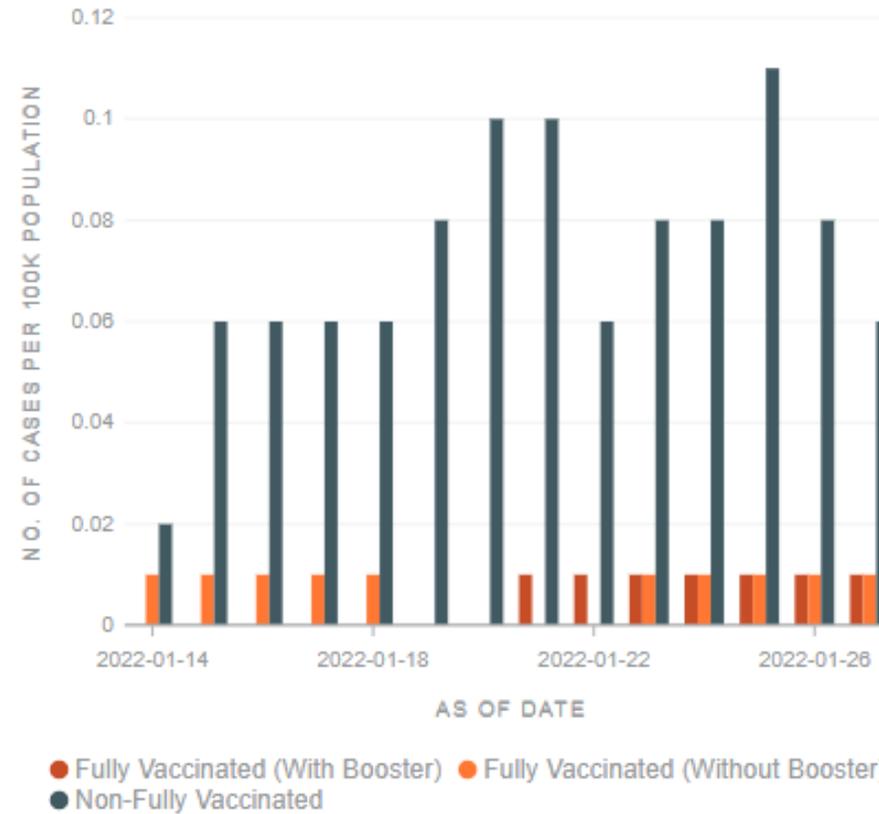
## 7-day moving average of number of active cases in ICU & deaths, per 100k population, by vaccination status

### In ICU



SOURCE: DATA.GOV.SG

### Deceased

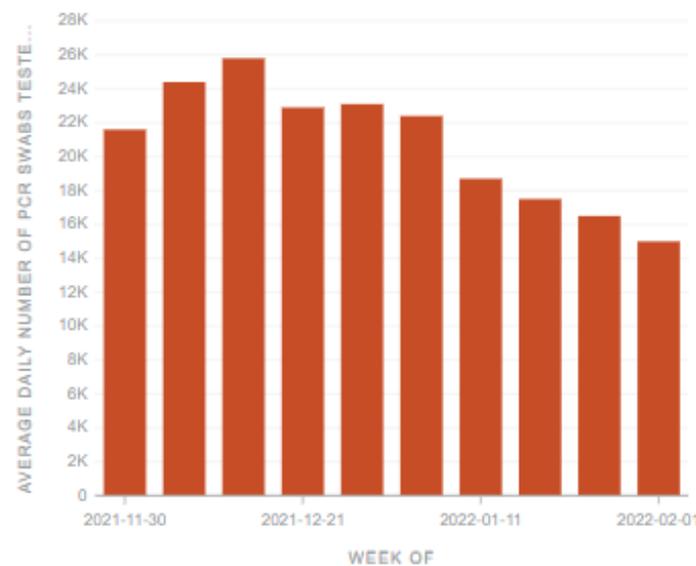


SOURCE: DATA.GOV.SG

## Number of PCR Swabs Tested (as of 14 Feb 2022)

Total PCR Swabs Tested	Average Daily Number of PCR Swabs Tested Over the Past 28 days
23,014,851	~16,800
Average Daily Number of PCR Swabs Tested Over the Past Week	Total PCR Swabs per 1,000,000 Total Population
~17,200	~4,222,900

Average Daily Number of PCR Swabs Tested (Weekly)



SOURCE: DATA.GOV.SG

PCR Test Positivity Rate (%)



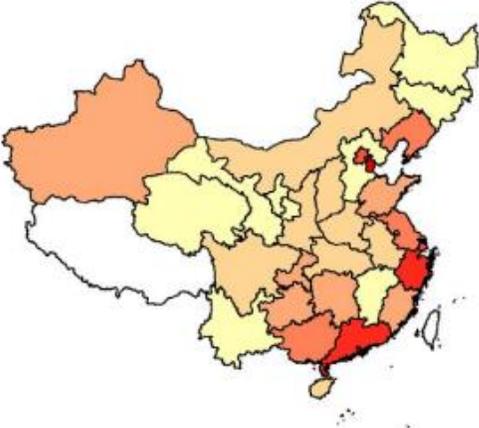
SOURCE: DATA.GOV.SG

Note: Past number of swabs are subject to revision when more swab data is received.

Children

Adults

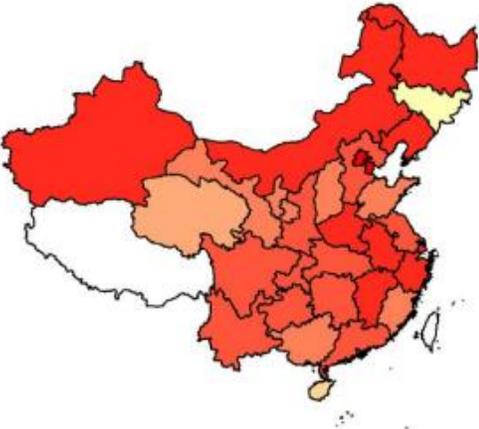
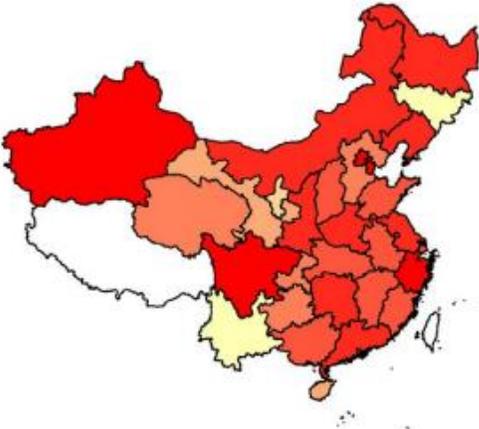
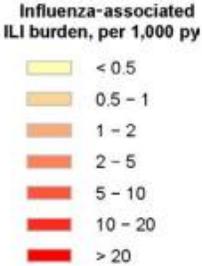
Elderly



2006–2015 (excl 2009)

2006–2015 (excl 2009)

2006–2015 (excl 2009)



2009

2009

2009

- Estimate the burden of influenza-associated ILI consultations
- Surveillance systems:
  - ILI surveillance
  - Virologic surveillance

## Passive approach

- The surveillance organization does not contact potential reporters and leaves the initiative for reporting to others
- Most common for infectious diseases
- Usually less complete reporting but involve less resources
- e.g. sentinel ILI surveillance, AMR in hospitals

## Active approach

- The surveillance organization initiates procedures to obtain reports (regular phone calls or visits)
- e.g. adverse events of special interest (COVID-19 vaccination), regular PSA blood test for low-grade prostate cancer patients

## Event-based surveillance

- Purpose: detect unusual events that might signal an outbreak
- Utilized unstructured information such as media reports, rumors, and other information about health events that could be a serious risk to public health
- e.g. discussion among a network of physicians

## Indicator-based surveillance

- Purpose: outbreak detection and epidemiology
- More structured information such as reports of specific diseases from health care providers to public health officials
- e.g. notifiable disease reporting

# Traditional surveillance systems

- Notifiable disease reporting
- Laboratory-based surveillance
- Sentinel surveillance
- Voluntary report
  
- More specific but may lose timeliness

## Number of notifiable infectious diseases by month in 2021



Disease	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Acute poliomyelitis	0	0	0	0	0	0	0	0	0	0	0	0	0
Amoebic dysentery	0	1	0	2	1	2	0	0	2	0	1	0	9
Anthrax	0	0	0	0	0	0	0	0	0	0	0	0	0
Bacillary dysentery	1	1	1	0	1	0	0	1	1	1	3	5	15
Botulism	0	0	0	0	0	0	0	0	1	0	0	0	1
Chickenpox	82	104	146	124	149	121	119	126	134	148	178	159	1590
Chikungunya fever	0	0	0	0	0	0	0	0	0	0	0	0	0
Cholera	0	0	0	0	0	0	0	0	0	0	0	0	0
Community-associated methicillin-resistant <i>Staphylococcus aureus</i> infection	54												
Coronavirus disease 2019 (COVID-19)*	1606												



MINISTRY OF HEALTH  
SINGAPORE

For Public

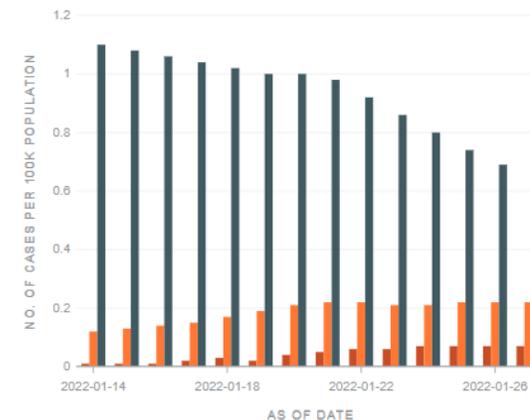
For Healthcare Professionals

e-Services

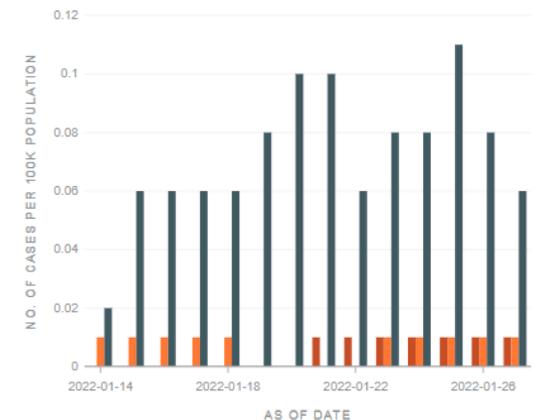
Who We Are

## 7-day moving average of number of active cases in ICU & deaths, per 100k population, by vaccination status

In ICU



Deceased



● Fully Vaccinated (With Booster) 
 ● Fully Vaccinated (Without Booster) 
 ● Non-Fully Vaccinated

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 ● Non-Fully Vaccinated



Search by Country, Territory, or Area

Covid-19 Response Fund

Donate

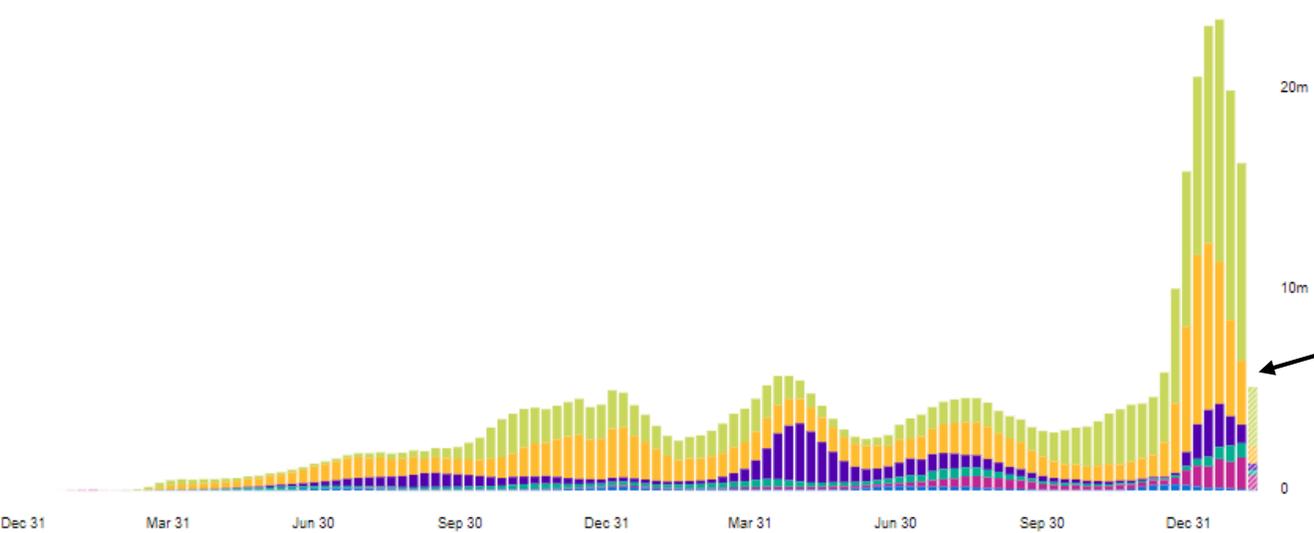
## WHO Coronavirus (COVID-19) Dashboard

[Overview](#) [Measures](#) [Data Table](#) [Explore](#)

### Situation by WHO Region

Line graph icon | Daily | Weekly | Cases | Deaths | Count

Europe	167,611,393 confirmed
Americas	143,864,770 confirmed
South-East Asia	54,599,070 confirmed
Eastern Mediterranean	20,589,856 confirmed
Western Pacific	19,600,215 confirmed
Africa	8,259,115 confirmed



Source: World Health Organization  
Data may be incomplete for the current day or week.

- Most complete surveillance for any (infectious) diseases ever
- Build on existing surveillance capacity for influenza and other communicable diseases

# Objectives of COVID-19 (communicable diseases) surveillance

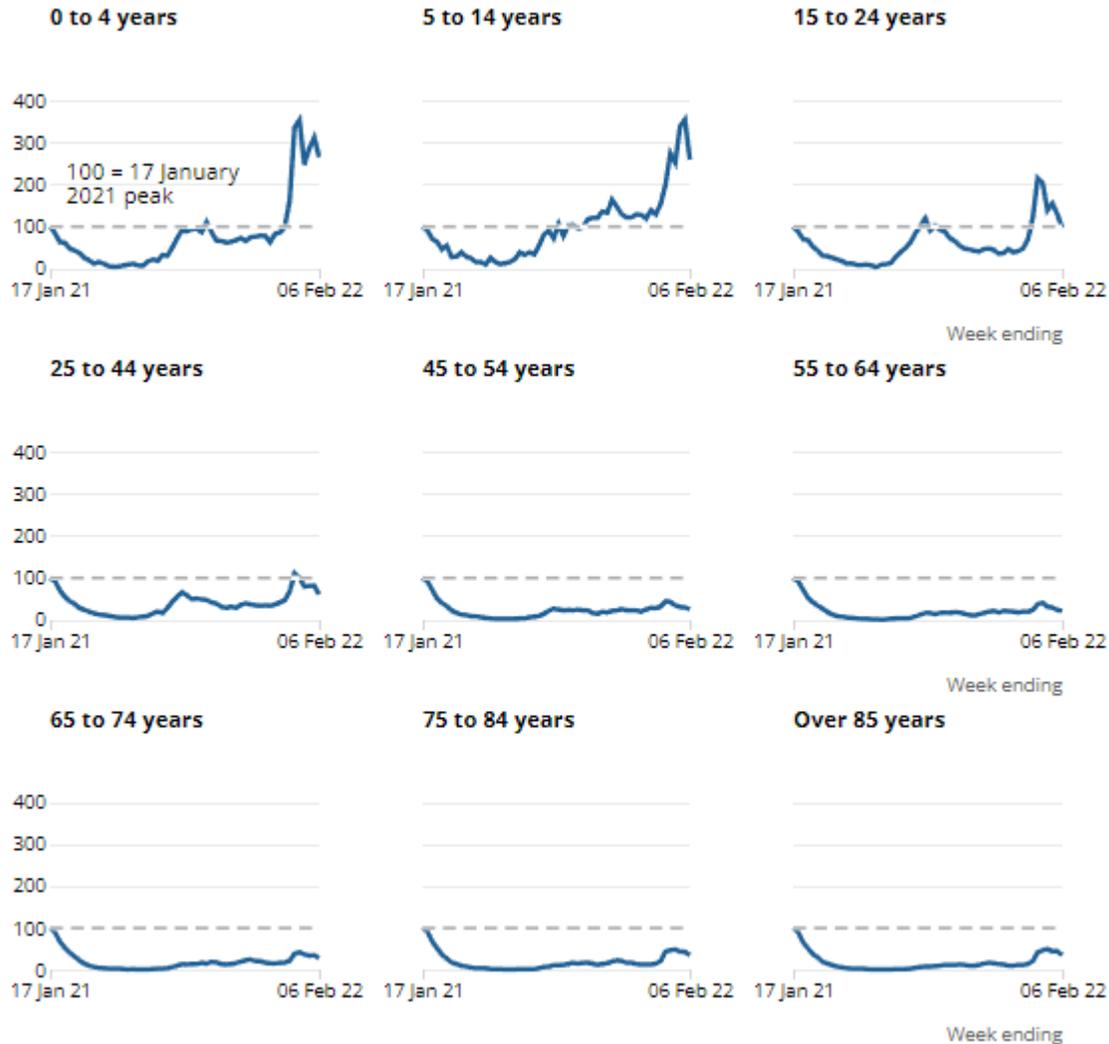
- monitor SARS-COV-2 incidence and COVID-19 morbidity and mortality among different age groups and population groups at higher risk for developing severe disease and death
- track potential epidemiological changes over time
- detect and contain outbreaks of new SARS-CoV-2 variants and continue monitoring the trends of existing variants
- guide the implementation and adjustment of COVID-19 control measures including isolation of cases, contact tracing and quarantine of contacts, while enabling safe resumption of economic and social activities
- evaluate the impact of the pandemic on health care systems and society
- contribute to the understanding of the co-circulation of SARS-CoV-2, influenza, other respiratory viruses and other pathogens.

# Objectives of COVID-19 (communicable diseases) surveillance

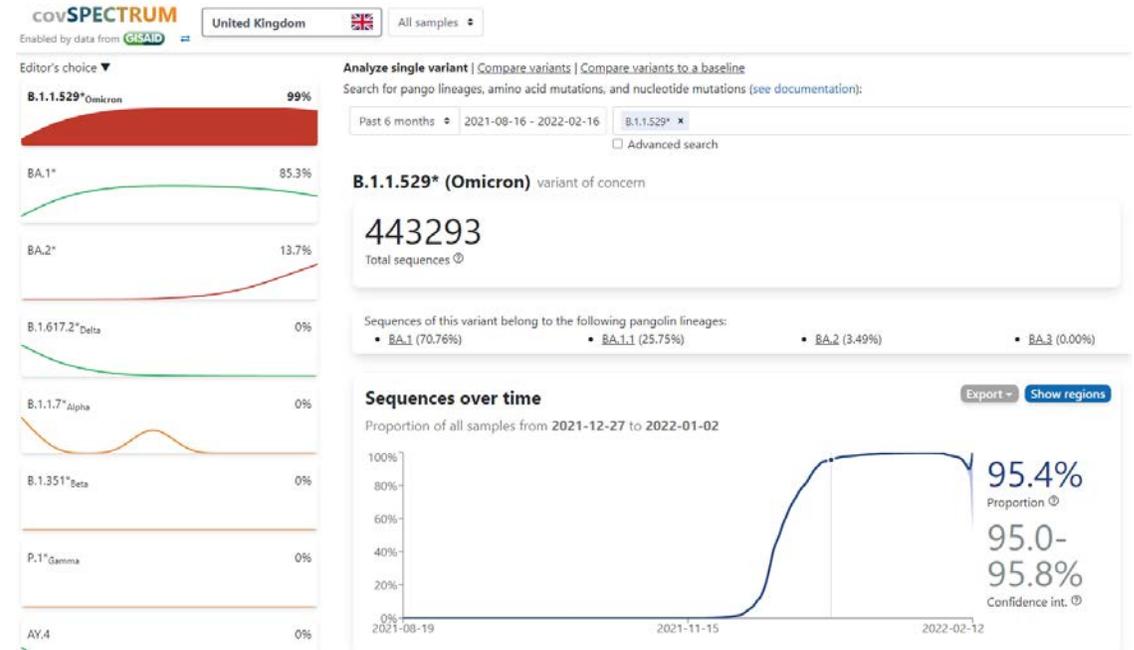
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# Hospitalization by age

COVID-19-positive hospital admissions as a percentage of the rate during the January peak (rate in week ending 17 January 2021 = 100%), by age, England



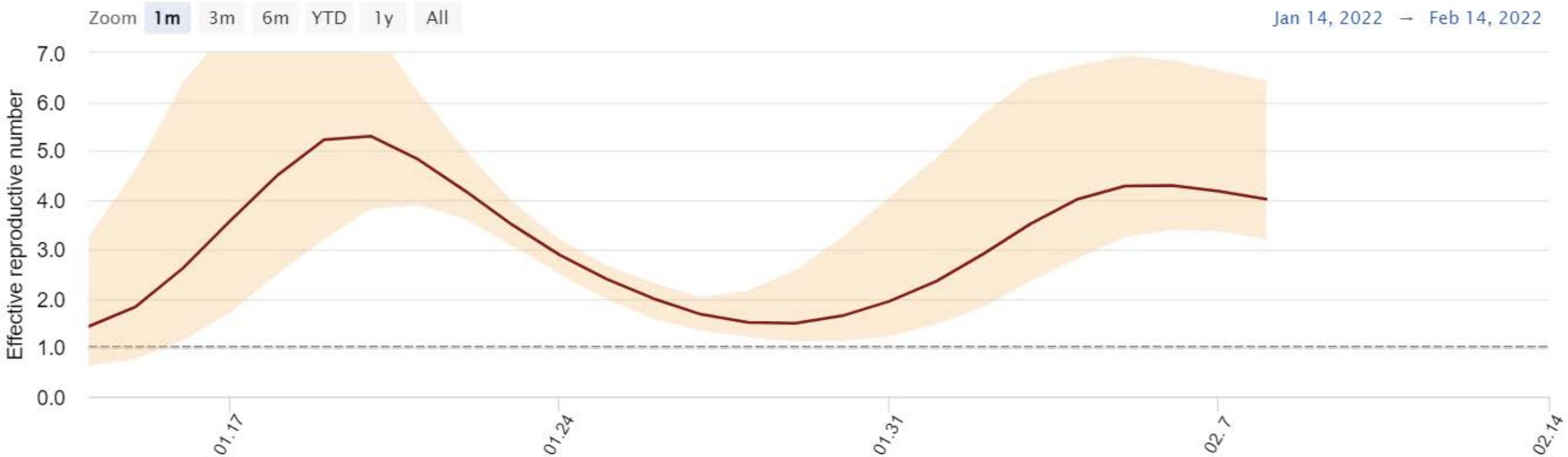
Source: UK Health Security Agency



- Omicron is most prevalent now
- More hospitalization among children who are unvaccinated

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## Real-time effective reproductive number for local cases



<https://covid19.sph.hku.hk/>

- Control measures reduced transmission in late January
- Family gathering during CNY increase transmission

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## Detect and analyze variants of SARS-CoV-2

B.1.1.7, S:484K, C913



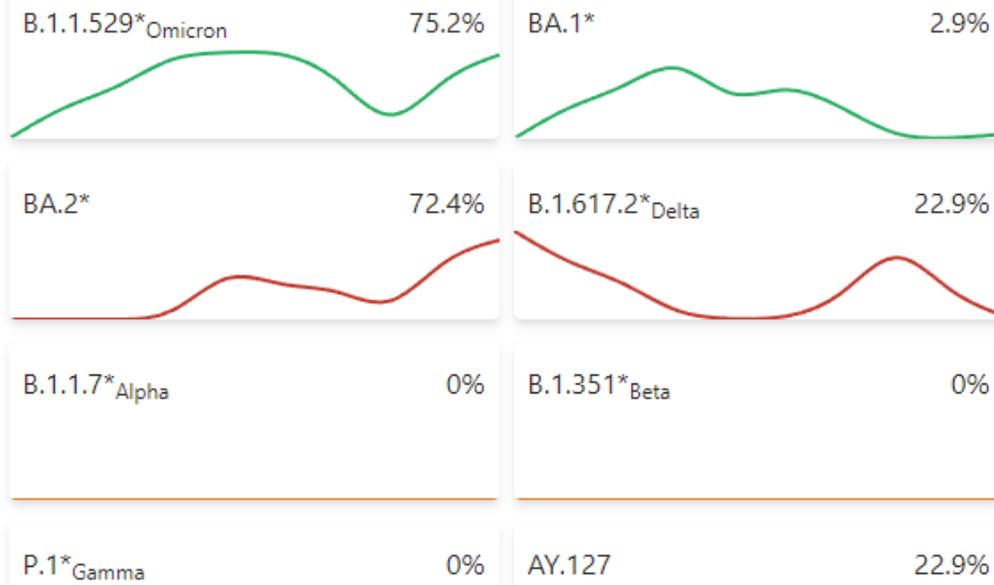
Search

Advanced search

### Known variants

Which variant would you like to explore?

Editor's choice ▼

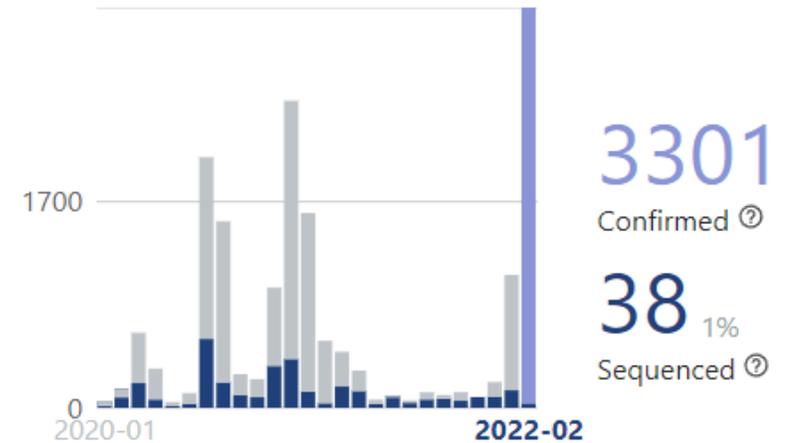


### Sequencing intensity

Export ▼

Show more

Number of sequenced samples on 2022-02



### Metadata Availability

Export ▼

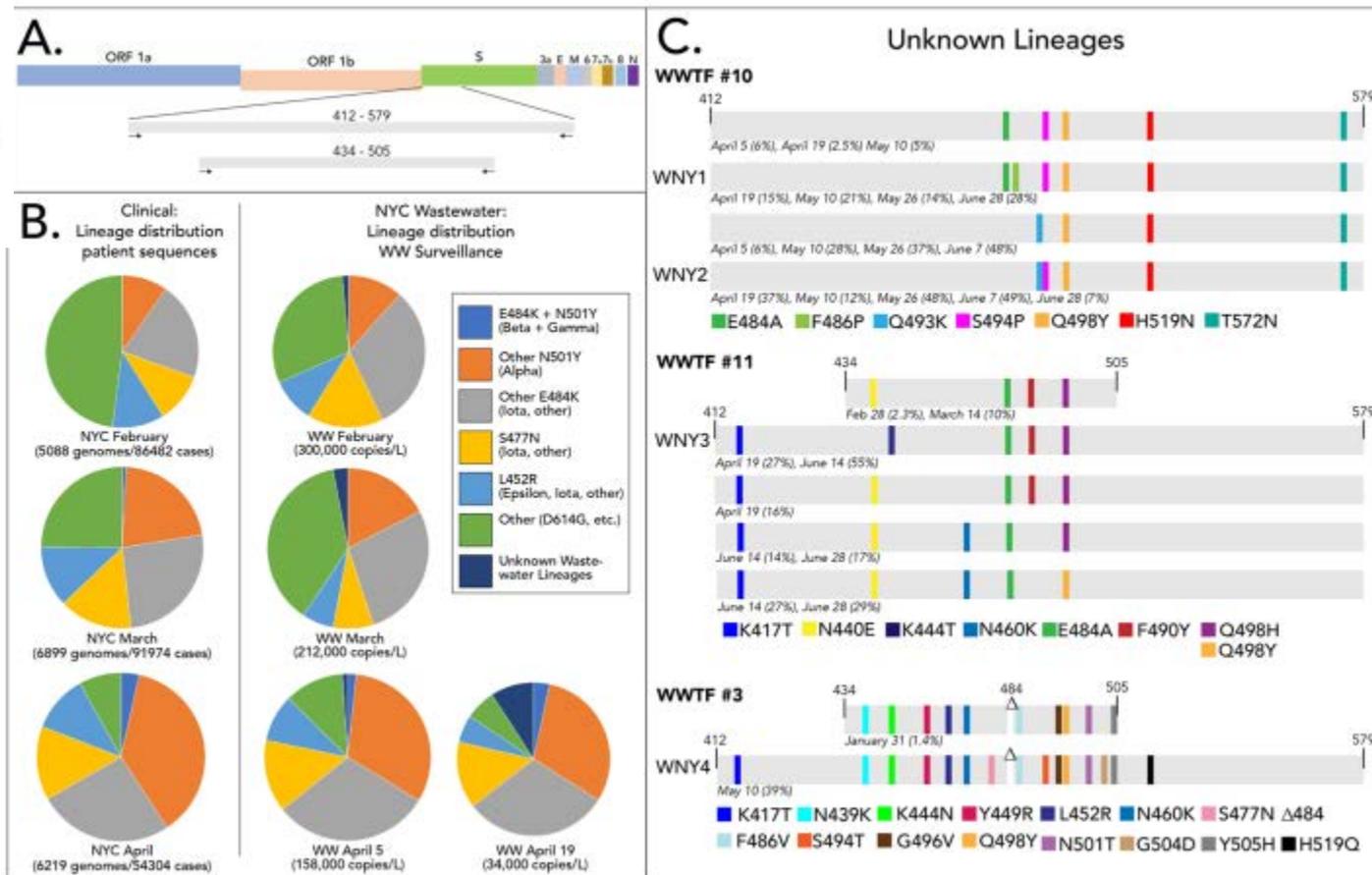
ARTICLE



<https://doi.org/10.1038/s41467-022-28246-3> OPEN

# Tracking cryptic SARS-CoV-2 lineages detected in NYC wastewater

David S. Smyth<sup>1,6</sup>, Monica Trujillo<sup>2,6</sup>, Devon A. Gregory<sup>3,6</sup>, Kristen Cheung<sup>4</sup>, Anna Gao<sup>4</sup>, Maddie Graham<sup>3</sup>, Yue Guan<sup>3</sup>, Caitlyn Guldenpfennig<sup>3</sup>, Irene Hoxie<sup>4</sup>, Sherin Kannoly<sup>4</sup>, Nanami Kubota<sup>4</sup>, Terri D. Lyddon<sup>3</sup>, Michelle Markman<sup>4</sup>, Clayton Rushford<sup>3</sup>, Kaung Myat San<sup>4</sup>, Geena Sompanya<sup>1</sup>, Fabrizio Spagnolo<sup>5</sup>, Reinier Suarez<sup>3</sup>, Emma Teixeira<sup>3</sup>, Mark Daniels<sup>3</sup>, Marc C. Johnson<sup>3,5</sup> & John J. Dennehy<sup>4</sup>



**Fig. 1 Novel SARS-CoV-2 lineages from wastewater. A** Schematic of SARS-CoV-2 and the amplification locations. **B** Distribution of SARS-CoV-2 variants

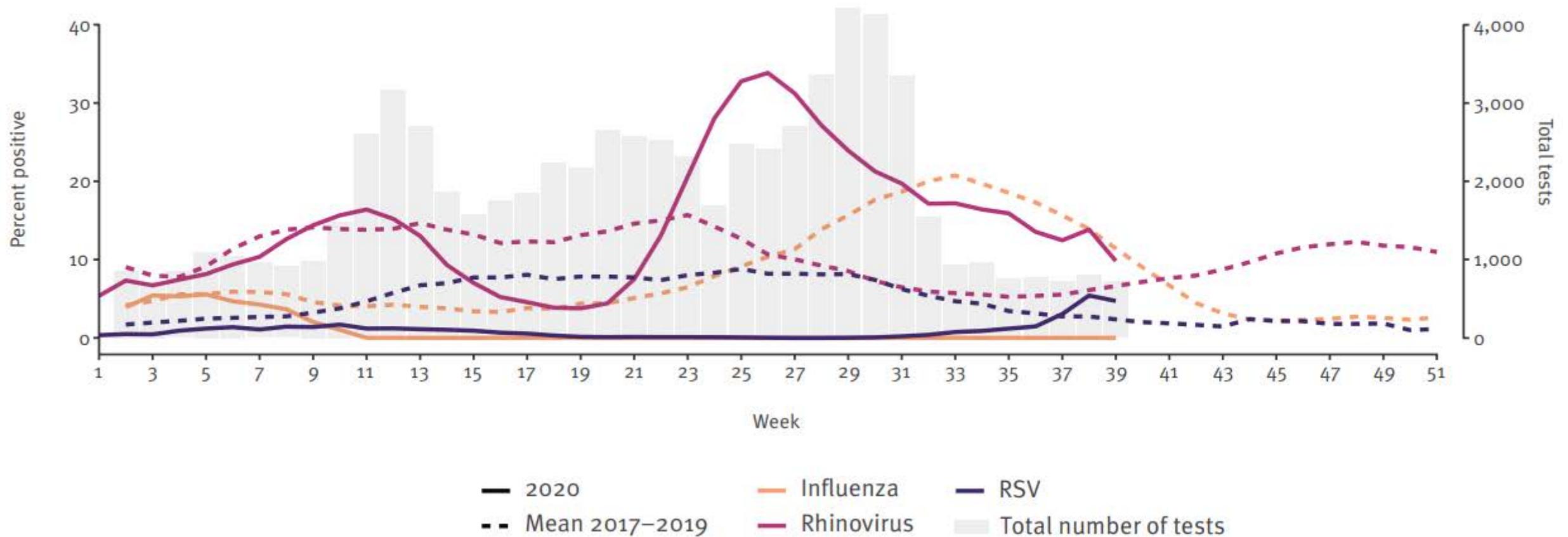
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# Surveillance of multiple pathogens

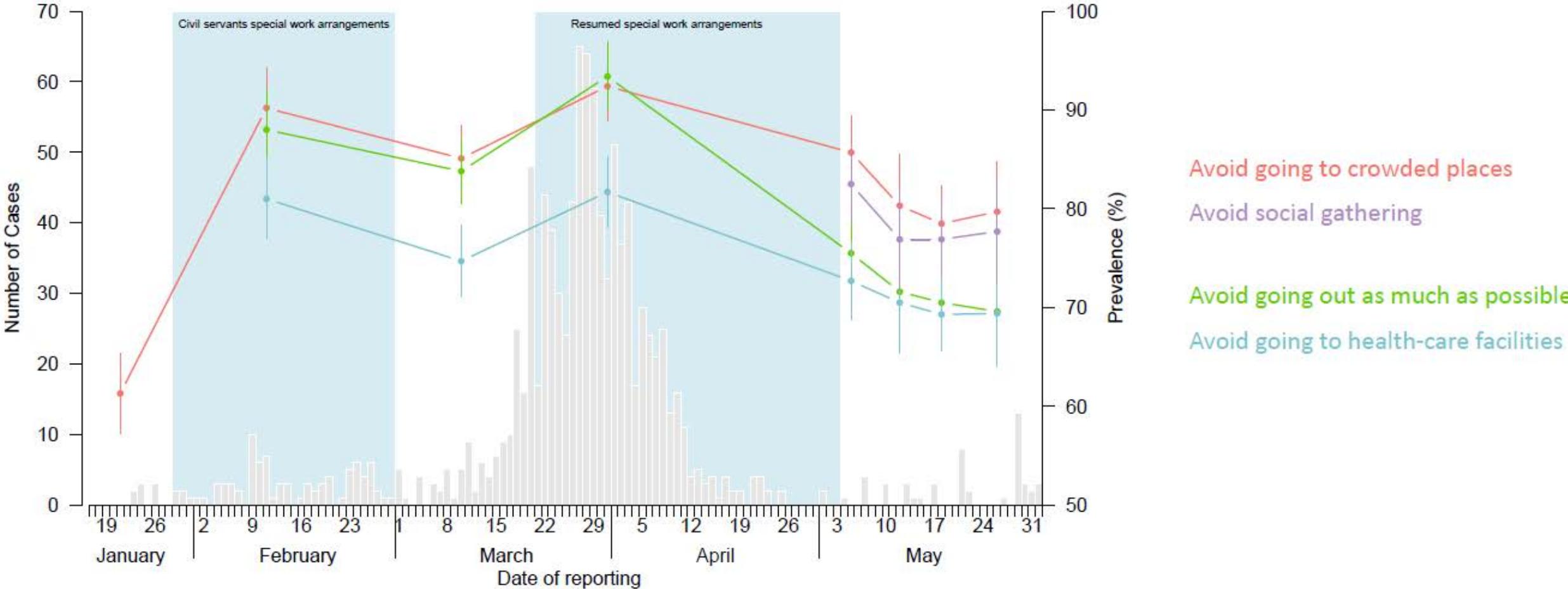
RAPID COMMUNICATION

## Where has all the influenza gone? The impact of COVID-19 on the circulation of influenza and other respiratory viruses, Australia, March to September 2020

Sheena G Sullivan<sup>1</sup>, Sandra Carlson<sup>2</sup>, Allen C Cheng<sup>3,4</sup>, Monique BN Chilver<sup>5</sup>, Dominic E Dwyer<sup>6</sup>, Melissa Irwin<sup>7</sup>, Jen Kok<sup>6</sup>, Kristine Macartney<sup>8,9</sup>, Jennifer MacLachlan<sup>10</sup>, Cara Minney-Smith<sup>11</sup>, David Smith<sup>11,12</sup>, Nigel Stocks<sup>5</sup>, Janette Taylor<sup>6</sup>, Ian G Barr<sup>13</sup>



# Surveillance of public attitude in Hong Kong, 2020



- Completeness
- Timeliness
- Usefulness
- Sensitivity
- Positive predictive value (PPV)
- Specificity
- Representativeness
- Simplicity
- Flexibility
- Acceptability
- Reliability

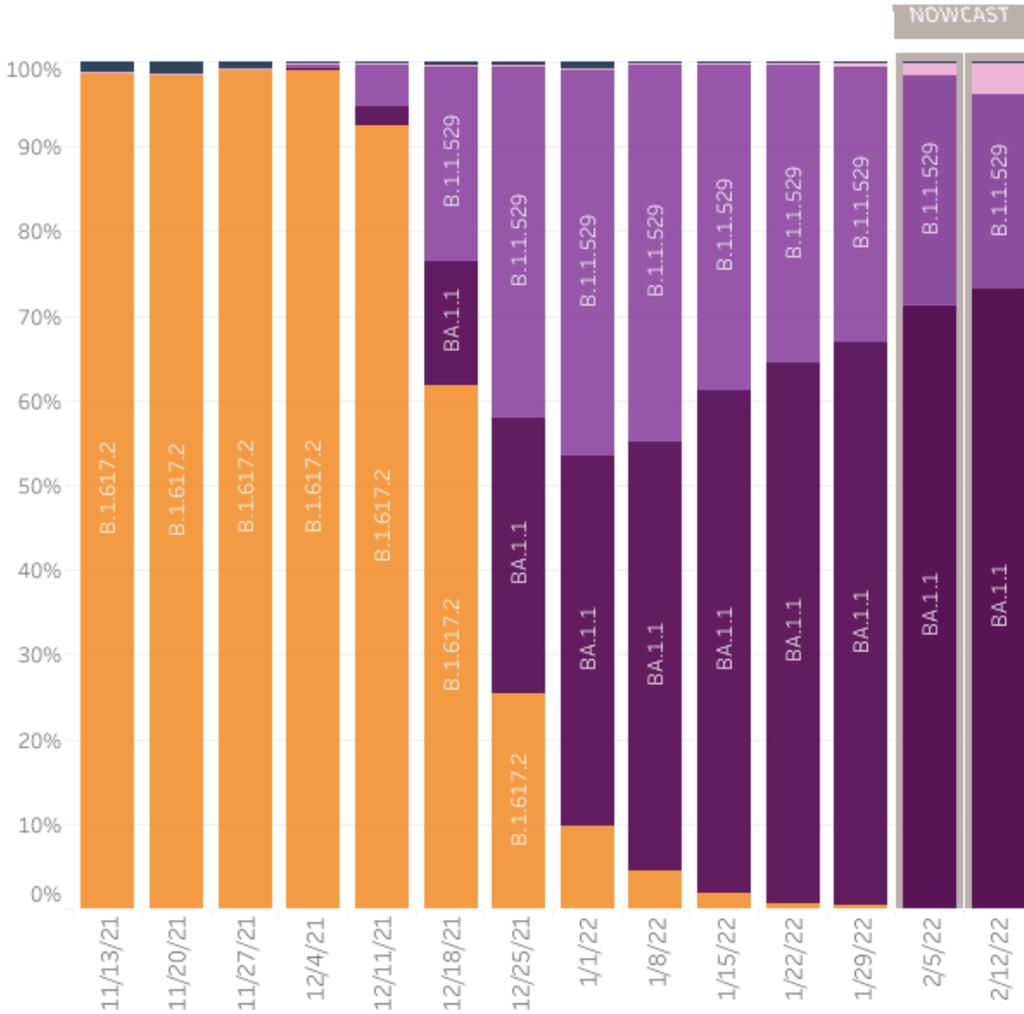
“... ongoing, systematic collection, analysis and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know.”

# Completeness

- Indicators: number of reports, % missing
- ‘zero reporting’
- Monitor reporting fatigue over time
- Identify surveillance sites with low reporting %

- Particularly important for communicable diseases with short generation time
  - Monthly for HIV
  - Weekly for influenza
  - Daily for COVID-19
- Reporting delay
  - Time needed for testing, data collection, transfer, analysis, dissemination etc
  - COVID-19: PCR vs RAT?
- Determined by the surveillance objectives
  - Daily or weekly for outbreak detection
  - Monthly or yearly for monitoring

# COVID Data Tracker



**USA**

WHO label	Lineage #	US Class	%Total	95%PI
Omicron	BA.1.1	VOC	73.2%	69.0-77.1%
	B.1.1.529	VOC	22.9%	19.1-27.1%
	BA.2	VOC	3.9%	2.8-5.3%
Delta	B.1.617.2	VOC	0.0%	0.0-0.0%
Other	Other*		0.0%	0.0-0.0%

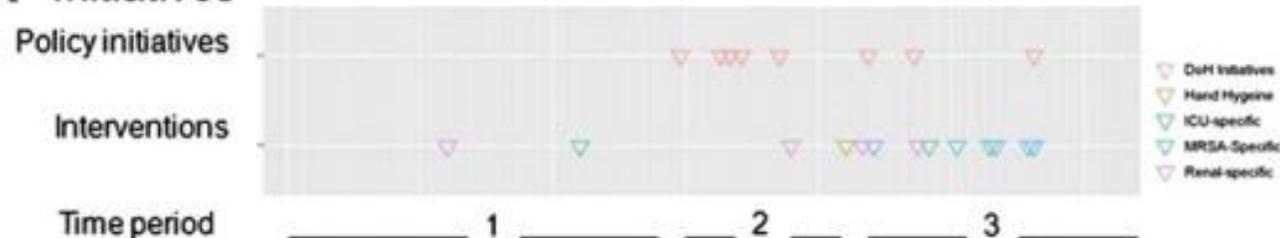
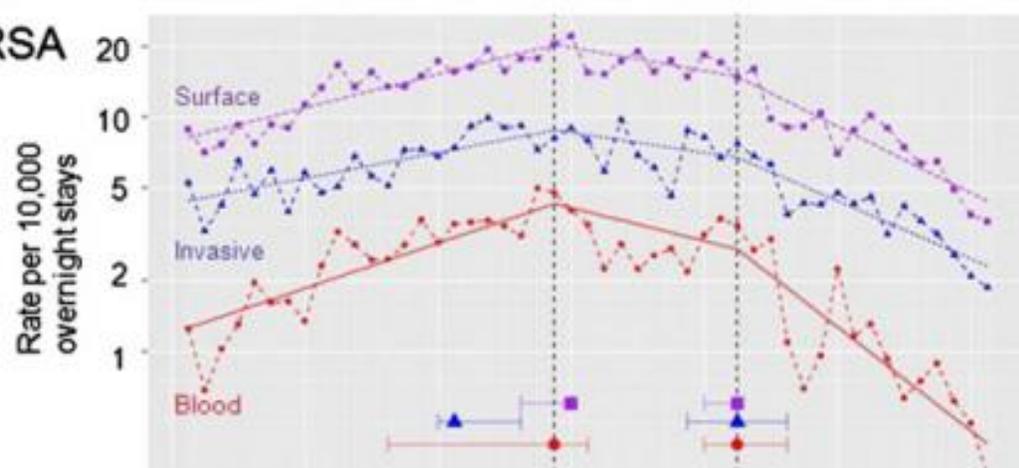
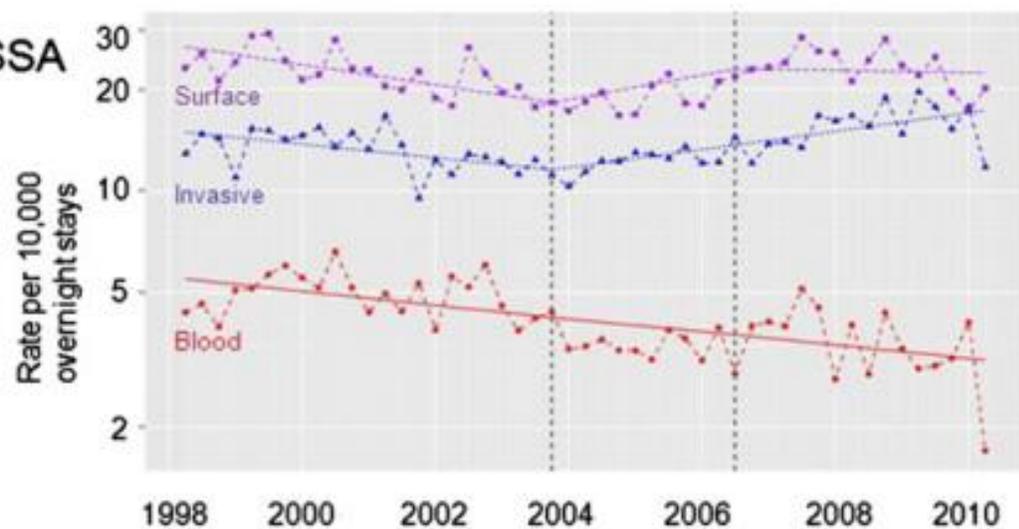
\* Enumerated lineages are US VOC and lineages circulating above 1% nationally in at least one week period. "Other" represents the aggregation of lineages which are circulating <1% nationally during all weeks displayed.

\*\* These data include Nowcast estimates, which are modeled projections that may differ from weighted estimates generated at later dates

# AY.1-AY.133 and their sublineages are aggregated with B.1.617.2. BA.1 and BA.3 are aggregated with B.1.1.529. For regional data, BA.1.1 is also aggregated with B.1.1.529, as it currently cannot be reliably called in

- Nowcasting to improve timeliness
- Omicron BA.2 is <1% based on the latest data (2 weeks ago)
- Surveillance design need to support analytics

- Surveillance objective accomplished?
- Inform prevention or interventions as a result of analysis and interpretation of surveillance data
  - Could feedback to improve surveillance design if gaps are identified
  - e.g. inadequate data resolution on age / population subgroups

**A Initiatives****B MRSA****C MSSA**

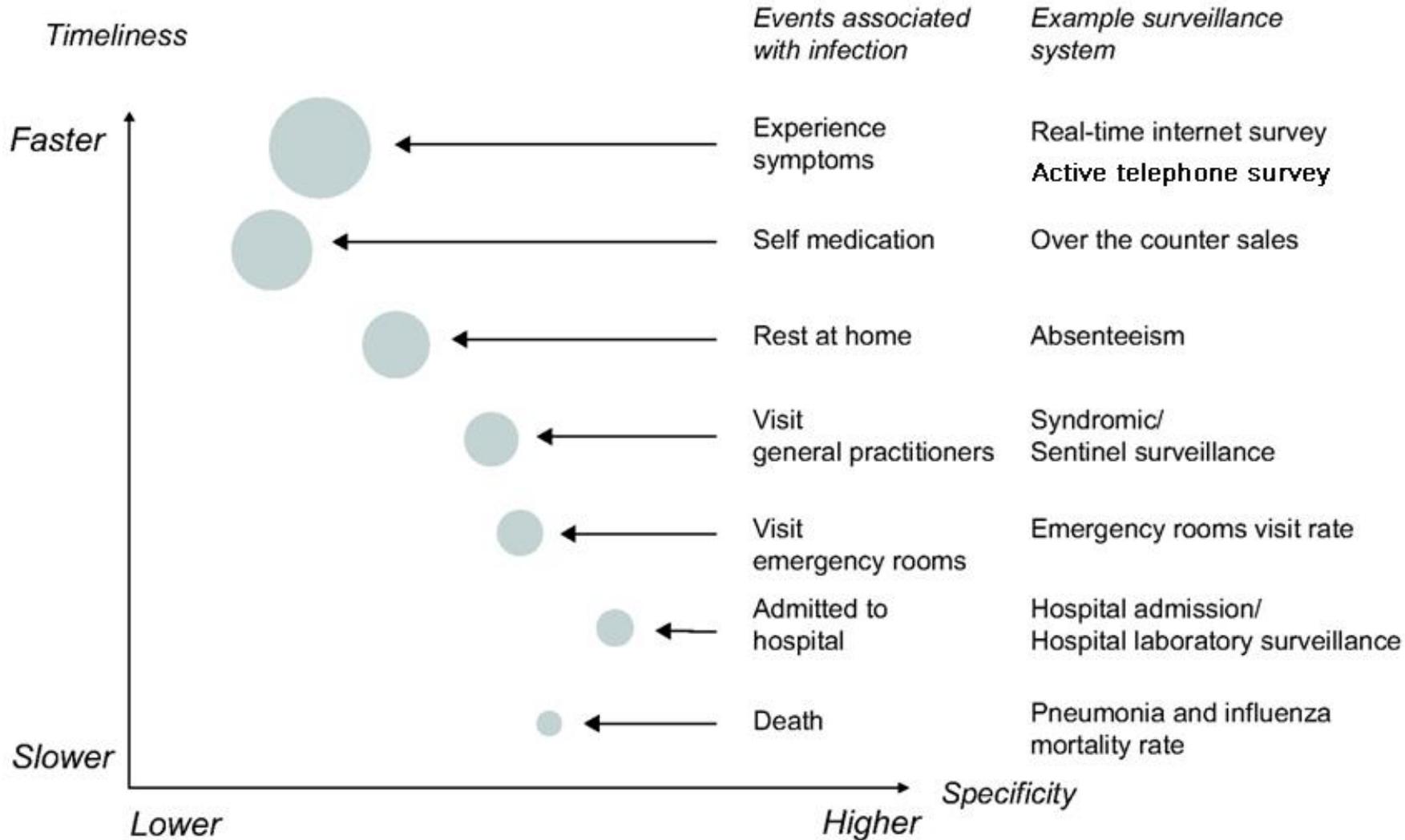
- Inpatients from all acute Oxfordshire hospitals
- Policy initiatives and series of interventions including hand hygiene
- Later decision to institute mandatory surveillance of all *S aureus* bloodstream isolations

# Sensitivity, positive predictive value (PPV) and specificity

- Accuracy in generating or not generating alerts/signals for the surveillance target
- Sensitivity
  - Ability to generate alerts when there is an outbreak
- Specificity
  - Ability to not generating alerts when there is no outbreak
- Positive predictive value
  - When there is a alert, how likely it indicates a real outbreak
  - Affected by the frequency of the outbreak
- Need to avoid alert fatigue by false alarm
  - Especially when monitoring a large number of diseases
  - e.g. difficulty in novel emerging pathogens based on event-based surveillance



# Timeliness and specificity of surveillance systems



## Other attributes of surveillance systems

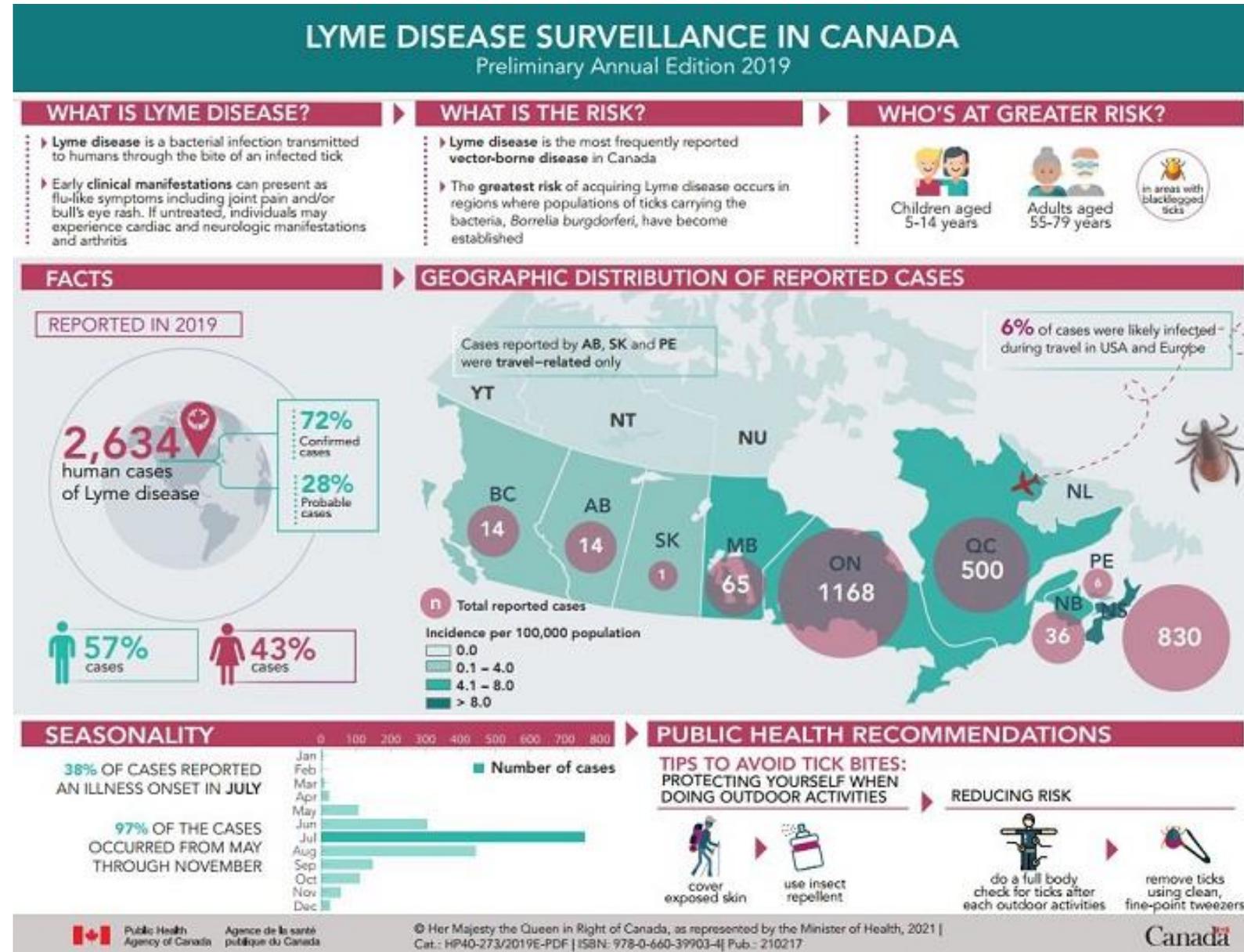
- Representativeness: reflecting the target population
- Simplicity: ease of implementation, e.g. practical case definitions
- Flexibility: modifying coverage, case definition, data collection
- Acceptability for surveillance staff and end users
- Reliability: measurement/procedure replicable?

## More important surveillance attributes for different purposes

Attributes	Purpose of surveillance		
	Case management	Outbreak detection & management	Programme planning & evaluation
Timeliness	✓	✓	
Sensitivity	✓	✓	
Positive predictive value	✓		✓
Negative predictive value		✓	
Data quality	✓		✓
Representativeness			✓
Flexibility		✓	
Stability	✓	✓	
Reliability	✓		✓

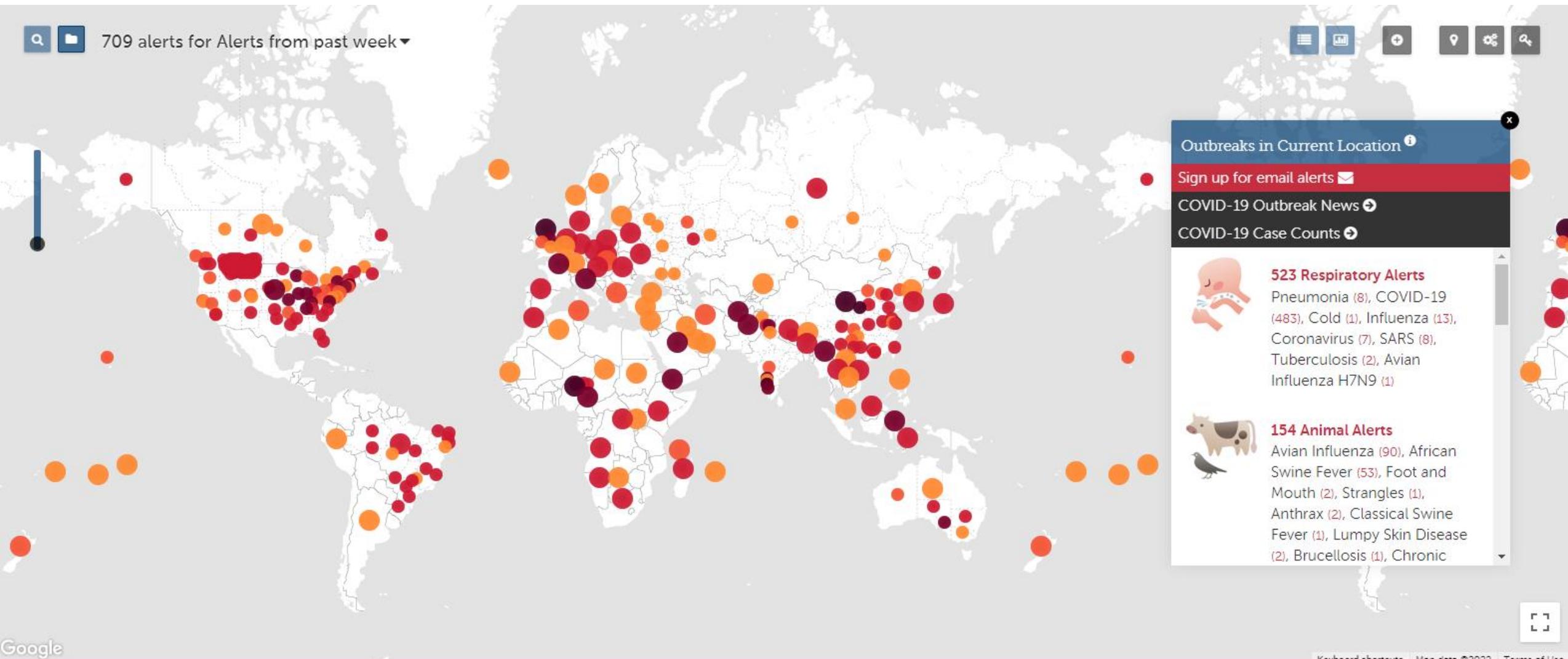
- Completeness, usefulness, acceptability are always important

- Always consider target audience and surveillance purpose
- Include all key information
- Information rich / infographics
- Good use of figures



- Pre-diagnostic data (e.g. over-the-counter-medication, syndromic)
- Digital surveillance
- Social media, search query, natural language processing
- Mobile apps, wearable sensors
- Participatory / crowdsource surveillance
  
- Can be very sensitive and very timely
- But need to deal with noises

709 alerts for Alerts from past week



**Outbreaks in Current Location**

Sign up for email alerts

COVID-19 Outbreak News

COVID-19 Case Counts

**523 Respiratory Alerts**  
Pneumonia (8), COVID-19 (483), Cold (1), Influenza (13), Coronavirus (7), SARS (8), Tuberculosis (2), Avian Influenza H7N9 (1)

**154 Animal Alerts**  
Avian Influenza (90), African Swine Fever (53), Foot and Mouth (2), Strangles (1), Anthrax (2), Classical Swine Fever (1), Lumpy Skin Disease (2), Brucellosis (1), Chronic

## Explore flu trends - Brazil (Experimental)

We've found that certain search terms are good indicators of flu activity. Google Flu Trends uses aggregated Google search data to estimate flu activity. [Learn more »](#)

National

● 2014 ● Past years ▼

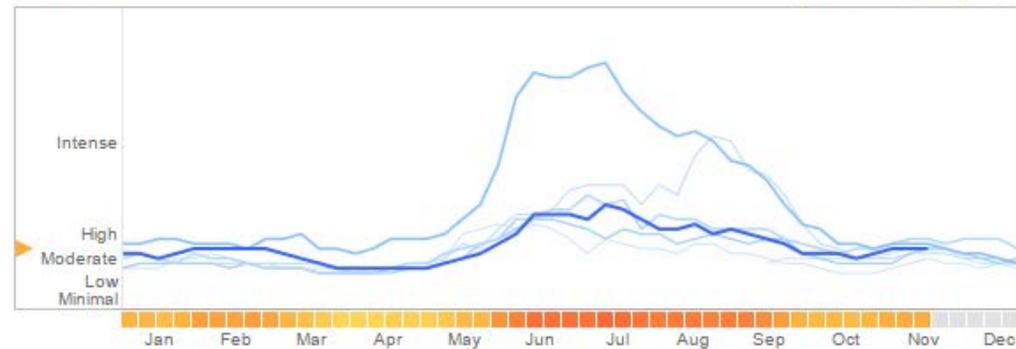


## Dengue trends - Thailand (Experimental)

We've found that certain search terms are good indicators of dengue activity. Google Dengue Trends uses aggregated Google search data to estimate dengue activity. [Learn more »](#)

National

● 2014 ● Past years ▼



# Participatory surveillance

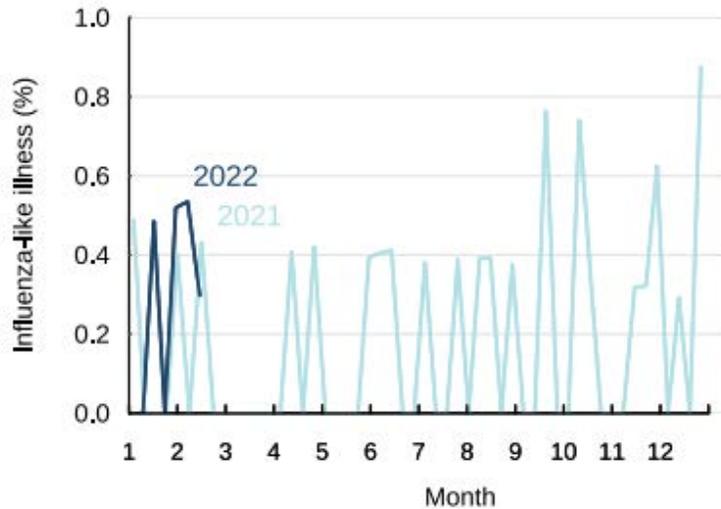


Weekly Report: Hong Kong  
Week ending 13 February 2022  
(Data received up to 10 AM, THURSDAY 17 February)

This week influenza-like illness activity is low  
336 participants this week

Influenza-like illness activity:

Fever and cough: 0.3% this week (influenza-like illness activity is historically low\*)



<https://www.flutracking.sph.hku.hk/>



Weekly Interim Report: Australia  
Week ending 13 February 2022  
(Data received up to 09:00 AM, Thursday 17 February)

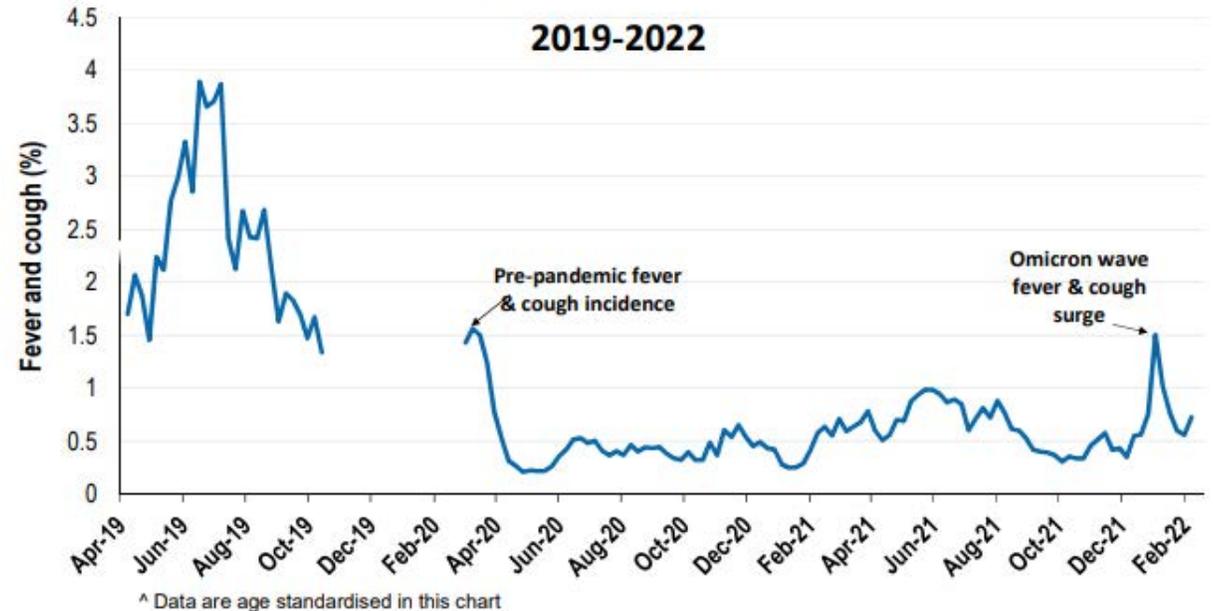
Respiratory illness levels are low, but increasing in <18 year olds

58,515 participants this week

Respiratory illness activity\*:

\*Respiratory illness activity is defined as fever & cough for this report

0.7% this week: respiratory illness activity is low

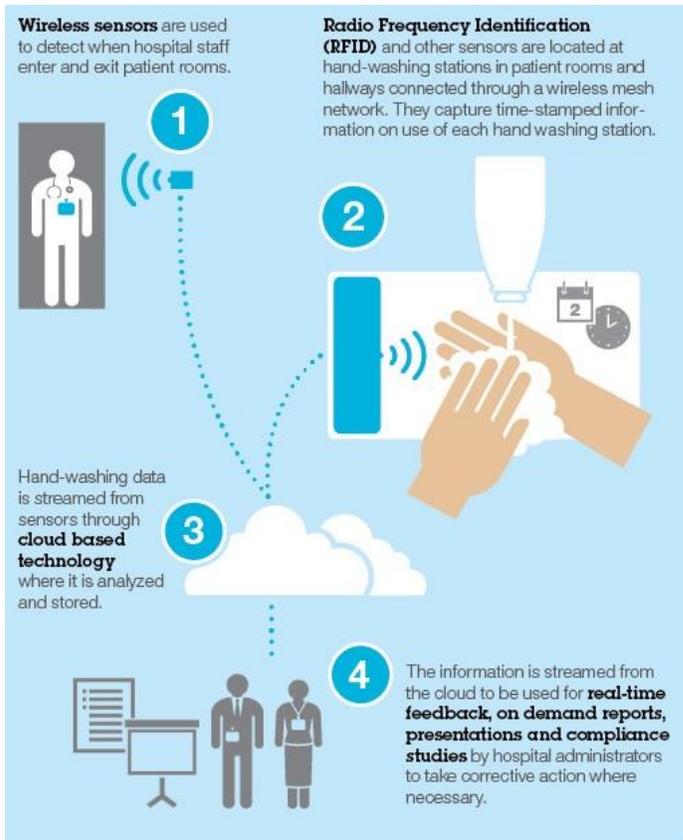


^ Data are age standardised in this chart

<https://info.flutracking.net/>



Digital contact tracing



Compliance of interventions

Indoor temperature and humidity



Smartphone dongle



Tracking cough and sorethroat?



Wearable sensors

# Further considerations and development

- Big data / analytics
- Digital data
- Integrated / complementary surveillance systems
- Connecting hospital-based surveillance to community
- One health

- “Public health surveillance is the ongoing, systematic collection, analysis and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know.” (Thacker, 2008)

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**THANK YOU**