第20回みちのくウイルス塾
2021年7月17日

COVID-19のパンデミックはなぜ起きたのか？パンデミックは防ぐことはできなかったのか？

東北大学・医学系研究科・微生物学分野
押谷　仁

パンデミック(Pandemic)とは？

- 世界規模の大流行（Pan＋Epidemic）のこと
- インフルエンザのパンデックを指すことが多いが、他の感染症でも使われることがある

  （例）HIVパンデミック・コレラパンデミック

新興感染症（Emerging Infectious Diseases）とは？

新興感染症とはヒトの間で初めて出現したものか、もしくは以前からあったものが急速にその数あるいは地理的範囲を拡大したもの。

(WHO)

グローバル化と新興感染症

1990

From the National Institute of Allergy and Infectious Diseases, the Fogarty International Center of the National Institutes of Health, and the Rockefeller University

Emerging Viruses: The Evolution of Viruses and Viral Diseases

Stephen S. Morse and Ann Schluederberg

From the Rockefeller University, New York, New York, and the National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland

Challenged by the sudden appearance of AIDS as a major public health crisis, the National Institute of Allergy and Infectious Diseases and the Fogarty International Center of the National Institutes of Health (NIH), together with The Rockefeller University, jointly sponsored the conference "Emerging Viruses: The Evolution of Viruses and Viral Diseases" held 1–3 May 1989 in Washington, DC. It was convened to consider the mechanisms of viral emergence [1] and possible strategies for anticipating, detecting, and preventing the emergence of new viral diseases in the future. To provide a broad perspective, participants comprised virologists, infectious disease specialists, theoretical biologists, historians, epidemiologists, ecologists, and molecular biologists (see below for program and participants).

Theoretical Considerations

The enormity of the problem was outlined in the keynote address by Lederberg, who said that humankind's only real competitors for dominion of the planet are viruses, which can serve as both parasites and genetic elements in their hosts. Not only do they have considerable genetic plasticity, enabling them to evolve in new directions, but their genetic and metabolic entanglements with cells uniquely position them to mediate subtle, cumulative evolutionary changes in their hosts as well. Their effects are not always so subtle, however; viruses also can decimate a population. The fact that natural selection in the long run favors mutualism offers only limited encouragement to the human race, as too many people might suffer as the result of viral mutation before an equilibrium could be reached. [2]

According to May and Anderson [3, 4], coevolution of virus and host can follow several possible lines, and pathogens may not always evolve towards lower virulence. In a model developed by Levin (described in [3]), for example, a virus strain that kills much faster will not be favored over a less-virulent strain if it has a modest transmission advantage, but it will prevail if it is much more readily transmitted than the less-virulent strain. Examples such as myxomatosis in Australia support the notion that in the tradeoff between transmissibility and virulence, many viruses evolve toward a middle course, favoring transmissibility but allowing them to retain some virulence. Viruses that are transmissible over a long time (e.g., human immunodeficiency virus [HIV]) have a selective advantage even when their effective rates of transmission are relatively low [5].

Although mathematical approaches offer useful insights, May and Haase caution that models will often prove inadequate in predicting outcomes because viral emergence and host interactions are complex, being dependent on both genetics of the host and external conditions. For example, as discussed by Lovejoy, there are many examples of disease emergence precipitated by environmental change, but it is impossible at present to predict or model accurately how global warming or other possible environmental changes will affect viral disease emergence.

Historical Lessons on Disease Emergence

According to McNeill [6], the most striking examples of emergence of infectious diseases arose from new patterns of human movement, leading to new contacts across what had previously been geographic boundaries that contained a disease. Examples are the introduction of smallpox into the Americas and of syphilis into Europe.

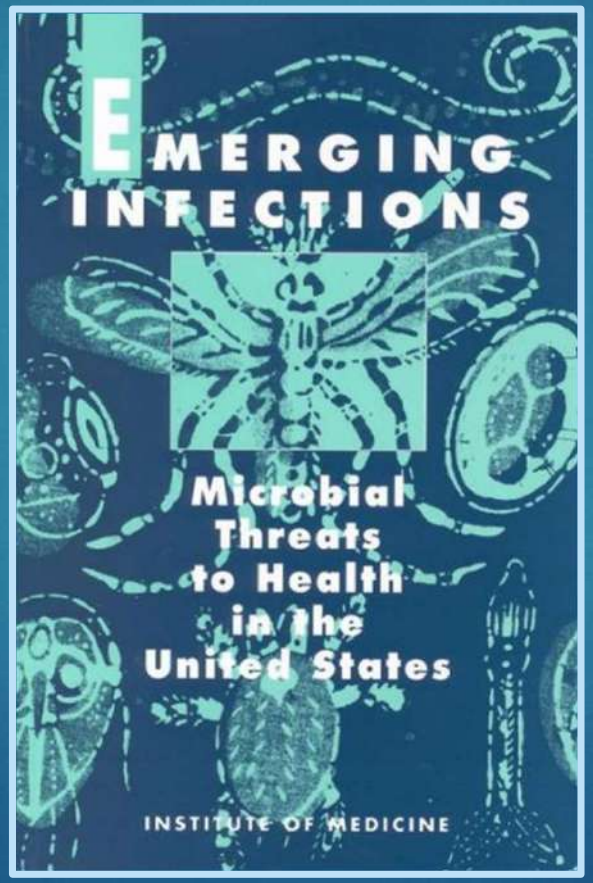
Disease emergence resulting from expanded geographic boundaries of viruses or their vectors was a recurring theme discussed in talks by Johnson, Monath, Evans, Shope, and others. Yellow fever probably emerged in the New World as a result of the African slave trade, which brought *Aedes aegypti* in water containers of ships. Similarly, the rise of dengue hemorrhagic fever in Southeast Asia in the late 1940s is attributed to rapid migration to cities with open water storage, which favored proliferation of the mosquito or other suitable

Received 11 December 1989; revised 18 January 1990.
Financial support: National Foundation for Infectious Diseases, Hoffman-La Roche, Lilly Research Laboratories, and Merck Sharp & Dohme Research Laboratories (for the conference); RR-03121 and RR-01180, National Institutes of Health (to S. S. M.).
Reprints and correspondence: Dr. Stephen S. Morse, the Rockefeller University, 1230 York Ave., Box 2, New York, NY 10021-6399.
The Journal of Infectious Diseases 1990;162:1-7

0022-1899/90/6201-0001$01.00

Journal of Infectious Diseases

1992



Institute of Medicine, 1992

1995

RESOLUTION OF THE WORLD HEALTH ASSEMBLY
RESOLUTION DE L'ASSEMBLÉE MONDIALE DE LA SANTÉ
РЕЗОЛЮЦИЯ ВСЕМИРНОЙ АССАМБЛЕИ ЗДРАВООХРАНЕНИЯ
RESOLUCION DE LA ASAMBLEA MUNDIAL DE LA SALUD

FORTY-EIGHTH WORLD HEALTH ASSEMBLY **WHA48.13**

Agenda item 19 12 May 1995

Communicable diseases prevention and control: new, emerging, and re-emerging infectious diseases

The Forty-eighth World Health Assembly,

Having considered the report of the Director-General on new, emerging, and re-emerging infectious diseases;[1]

Recalling resolutions WHA39.27 on rational use of drugs, WHA44.8 and WHA46.36 on tuberculosis, WHA45.35 on human immunodeficiency virus, WHA46.31 on dengue prevention and control, WHA46.32 on malaria, and WHA46.6 on emergency and humanitarian relief;

Aware that with the increasing global population many are forced to live under conditions of overcrowding, inadequate housing, and poor hygiene; that more frequent international travel leads to rapid global exchange of human pathogens; that changes in health technology and food production, as well as its distribution (including international trade) and handling, create new opportunities for human pathogens; that human behavioural changes expose large segments of the global population to diseases not previously experienced; that expanding areas of human habitation expose thousands of people to enzootic pathogens previously unknown as causes of human disease; and that microbes continue to evolve and adapt to their environment, leading to the appearance of new pathogens;

Aware also of the continued threat of well-known diseases such as influenza and meningococcal infections, and of tuberculosis, cholera and plague, once thought to be conquered, and the growing danger of diseases transmitted by vectors no longer controlled, such as dengue haemorrhagic fever and yellow fever;

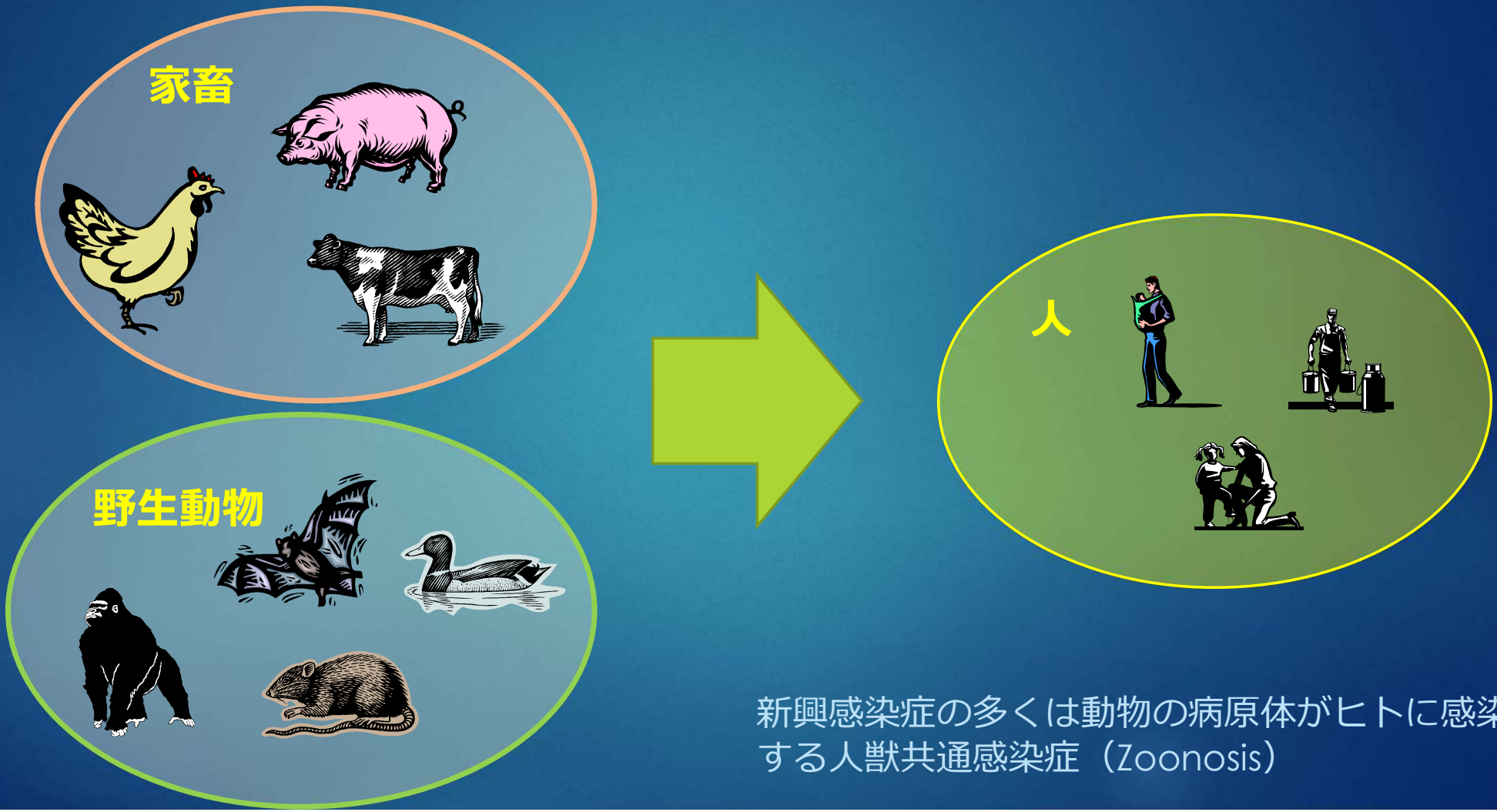
Concerned at the lack of coordinated global surveillance to monitor, report and respond to new, emerging, and re-emerging infectious diseases, by the general absence of the diagnostic capabilities necessary to identify accurately pathogenic microorganisms and the insufficient numbers of trained health care professionals to investigate these infectious diseases;

Alarmed by the increasing frequency of antimicrobial resistance in bacterial pathogens, which can make some diseases such as tuberculosis virtually untreatable with currently available antibiotics,

[1] Document A48/15.

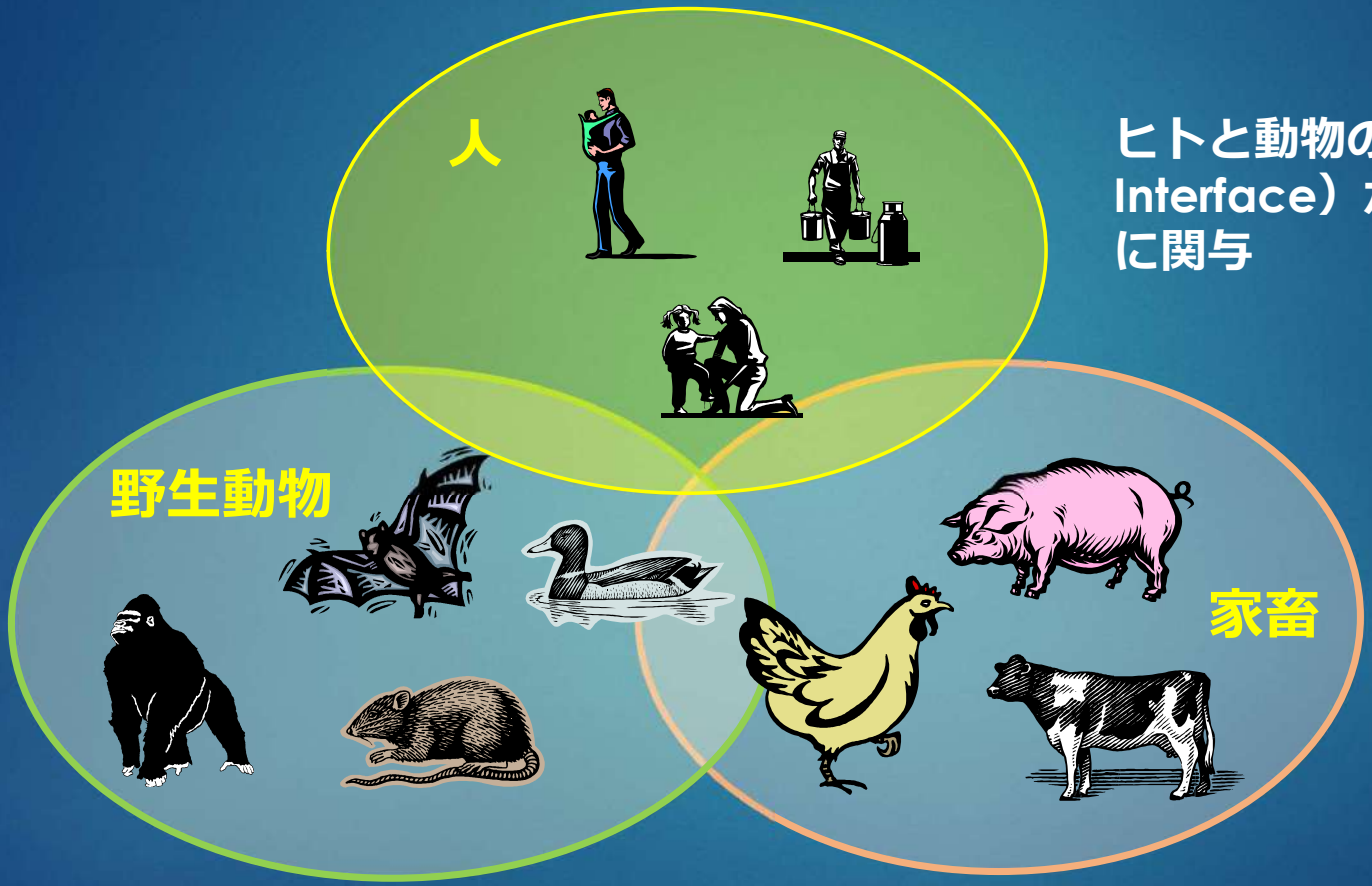
WHO, World Health Assembly, May 1995

新興感染症はどこからやってくるのか？



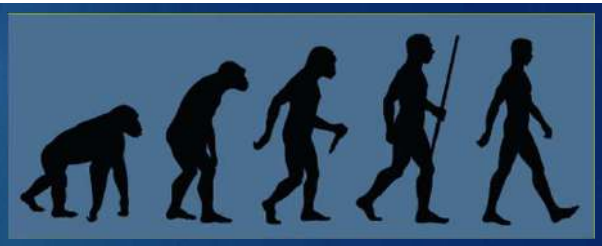
新興感染症の多くは動物の病原体がヒトに感染する人獣共通感染症（Zoonosis）

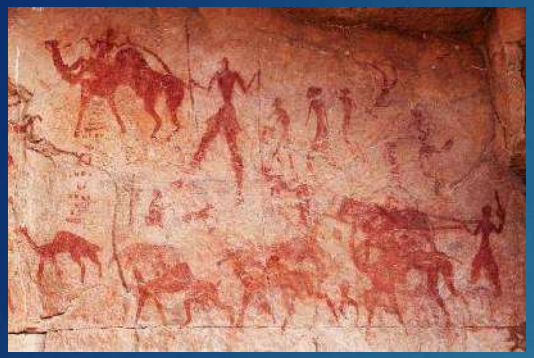
新興感染症のリスク



ヒトと動物の接点（Human-animal Interface）が新興感染症出現のリスクに関与

文明の進化と感染症





狩猟・採取社会

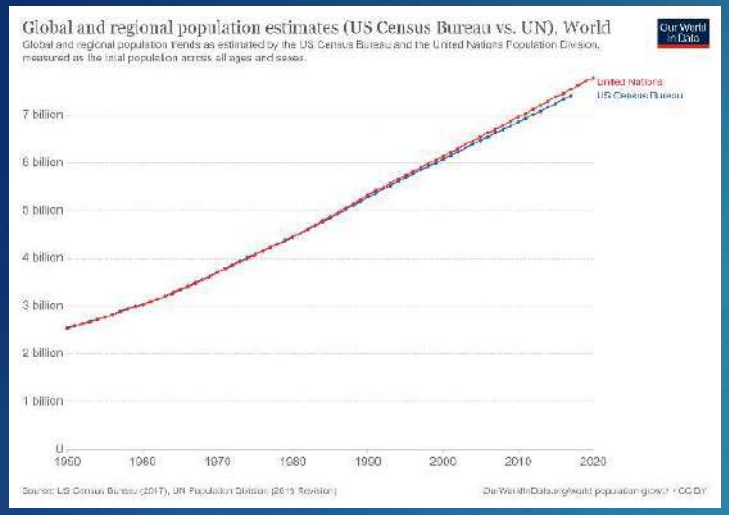
農耕・牧畜社会

中世ー産業革命

グローバル化

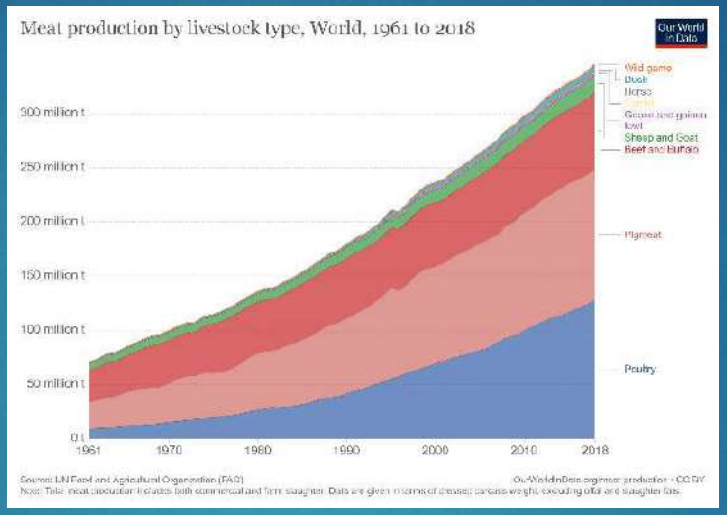
新興感染症のリスク

新興感染症の出現リスクの増大の背景



Our World in Data

人口増加



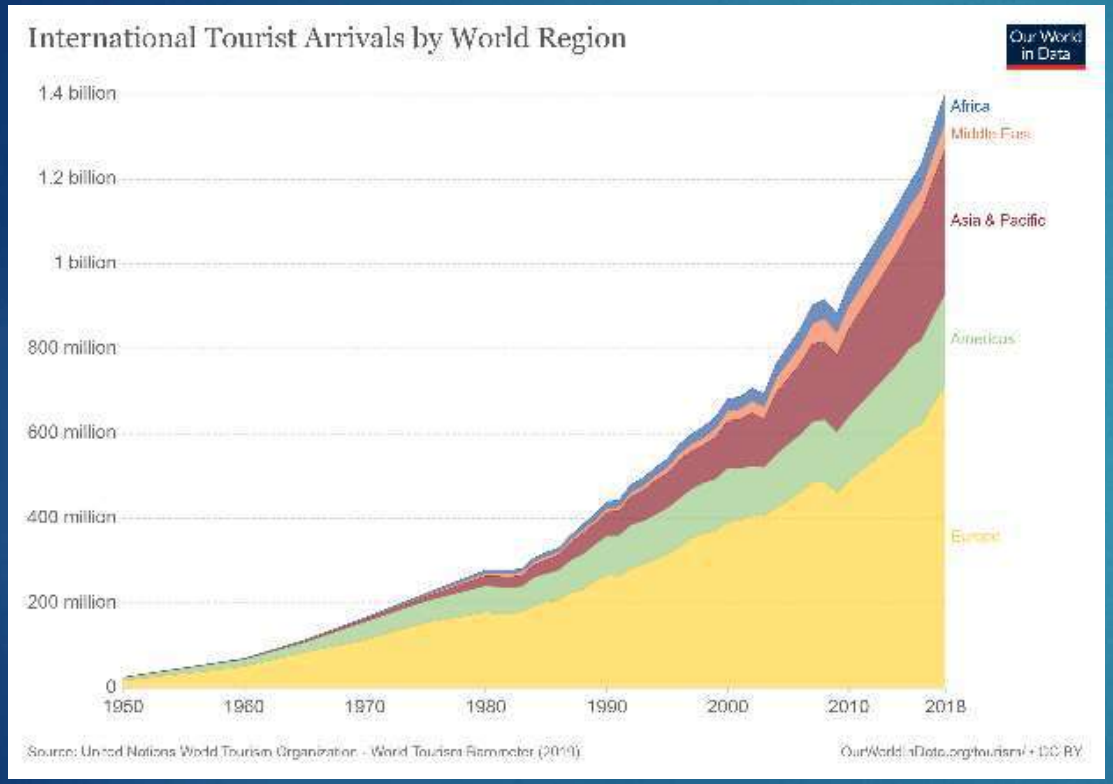
Our World in Data

家畜の増加

森林破壊

ヒトと動物の接点（Human-animal Interface）が増える
ことにより新興感染症出現のリスクが増大

新興感染症拡大リスクの増大の背景

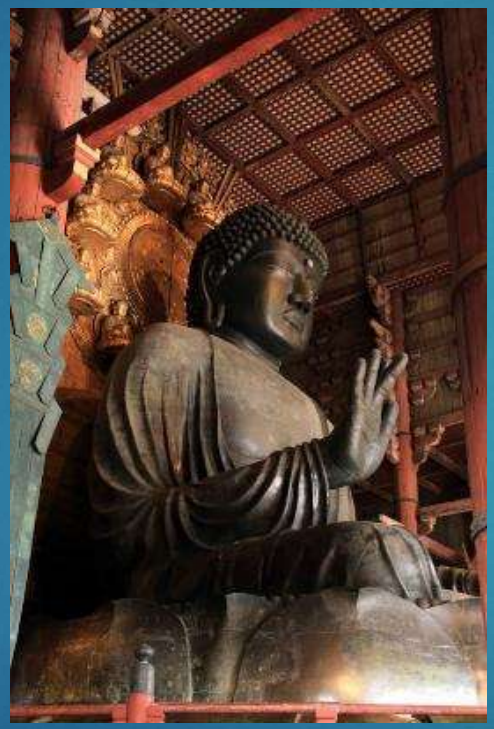


新興感染症の歴史：天然痘

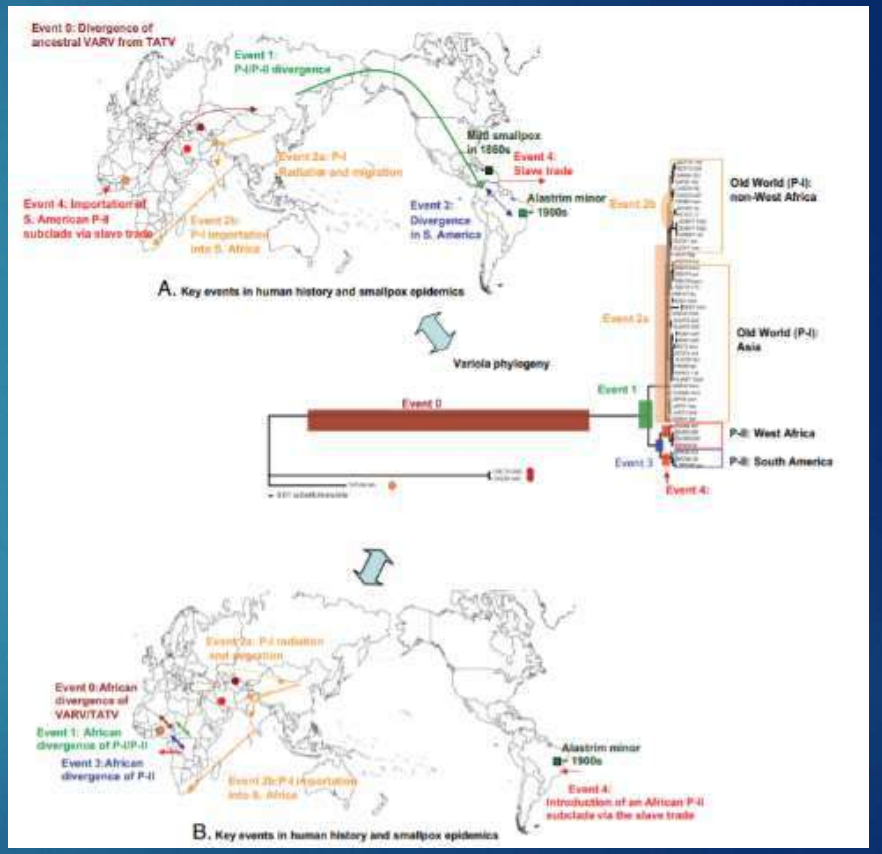
Ramesses V
(died in 1145 BC)

WHO

752年建立

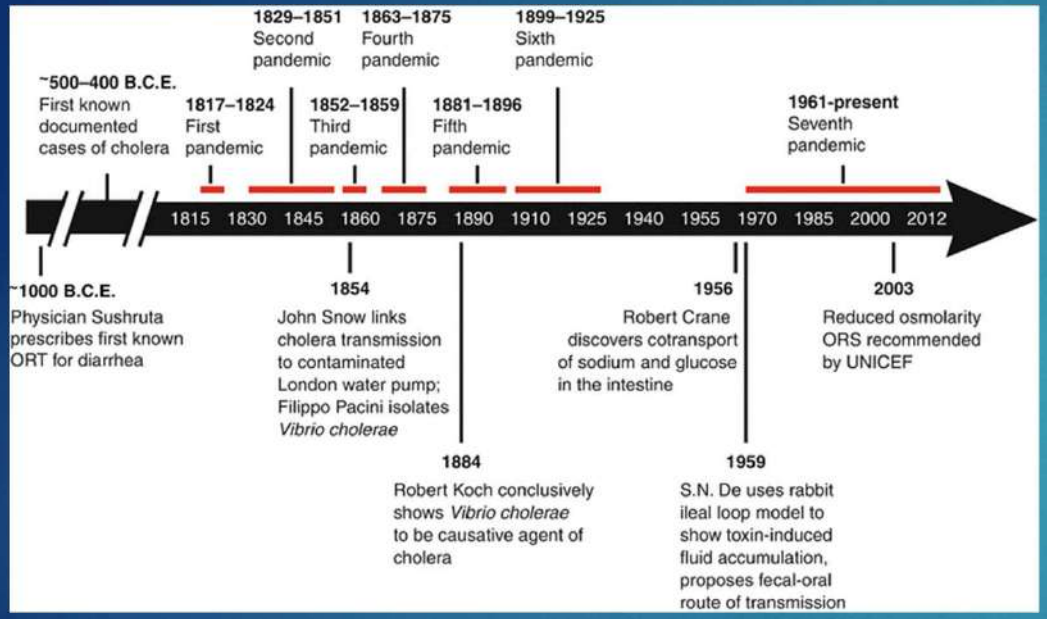


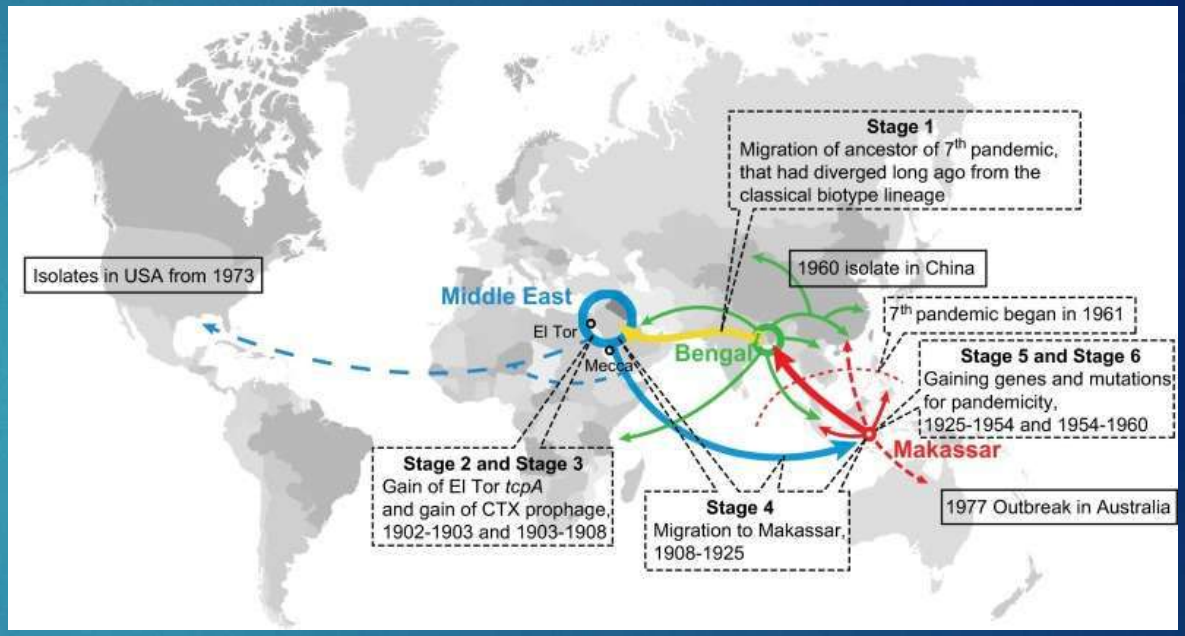
天平の疫病（735-737年）
100万人以上が死亡（？）



Lu Y et al. PNAS October 2, 2007 104 (40) 15787-1579

コレラのパンデミックの歴史

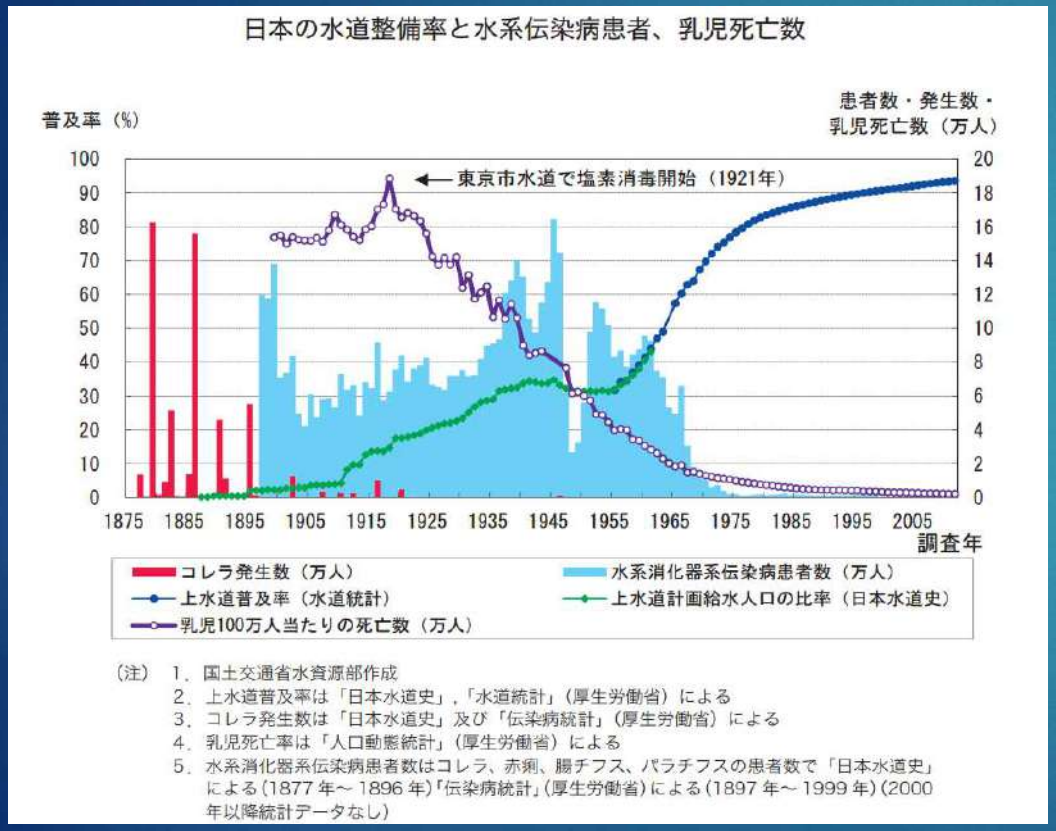




- Richard A.L., DiRita V.J. (2013) Cholera. The Prokaryotes. Springer

Hu D et al. PNAS. 2016

明治時代のコレラの流行



国土交通省　日本の水

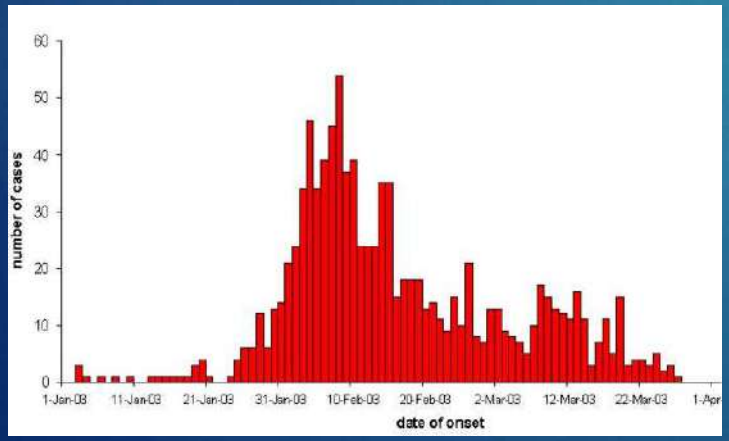
叢塚・仙台市水の森

21世紀の主な新興感染症の流行

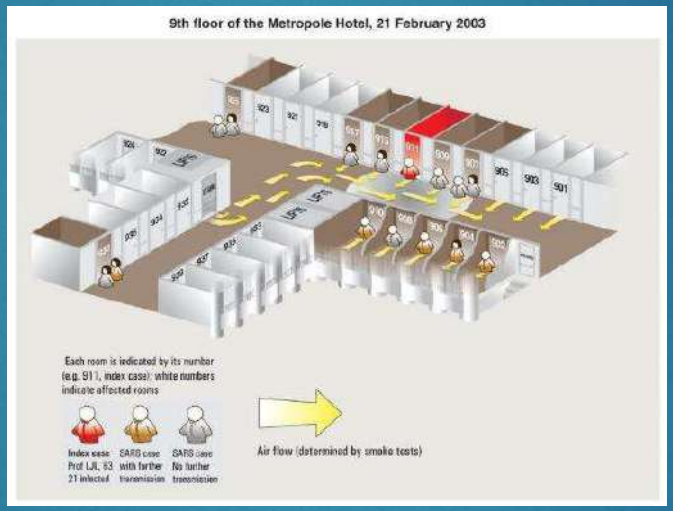
流行した感染症	発生年	発生国	直接の人的被害
重症急性呼吸器症候群（SARS）	2003	アジアを中心に世界の29の国と地域	感染者8,096名・死亡者774名
鳥インフルエンザA(H5N1)	2003年～	アジア・中東・ヨーロッパ・アフリカなどの広範な地域	感染者850名・死亡者449名 (2016年4月4日時点)
新型インフルエンザA(H1N1)	2009年	全世界	全世界での死亡者20万人　(推計)
中東呼吸器症候群（MERS）	2012年～	サウジアラビアなどの中東諸国・韓国など	感染者2,562名・死亡者881名 (2020年10月時点)
鳥インフルエンザA(H7N9)	2013年～	中国	感染者1,567名・死亡者615名 (2018年9月5日時点)
エボラウイルス感染症	2013～2016年	ギニア・シエラレオネ・リベリアなど	感染者28,610名・死亡者11,308名
ジカウイルス感染症	2013年～	中南米など	数百万人が感染・小頭症の多発
新型コロナウイルス（COVID-19)	2019年～	全世界	感染者1.3億人以上、死者　300万人 以上（2021年4月時点）

SARS（Severe acute respiratory syndrome）2002-2003

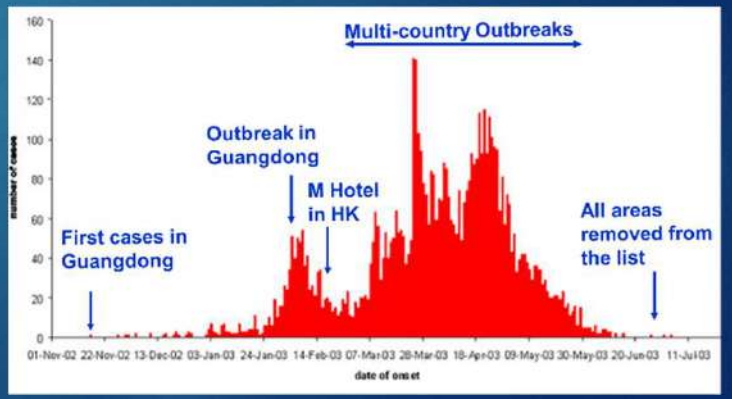
Znong NS et al. Lancet, 362, 2003



WHO

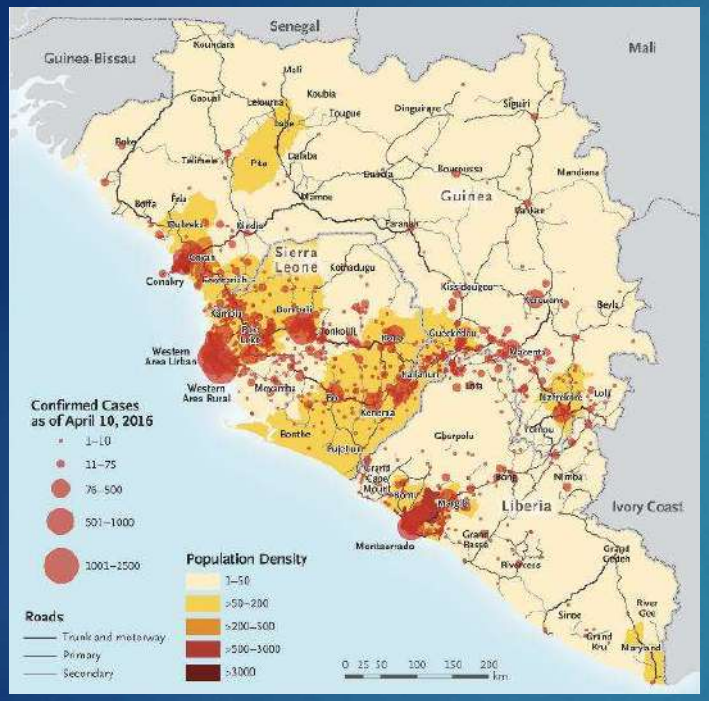


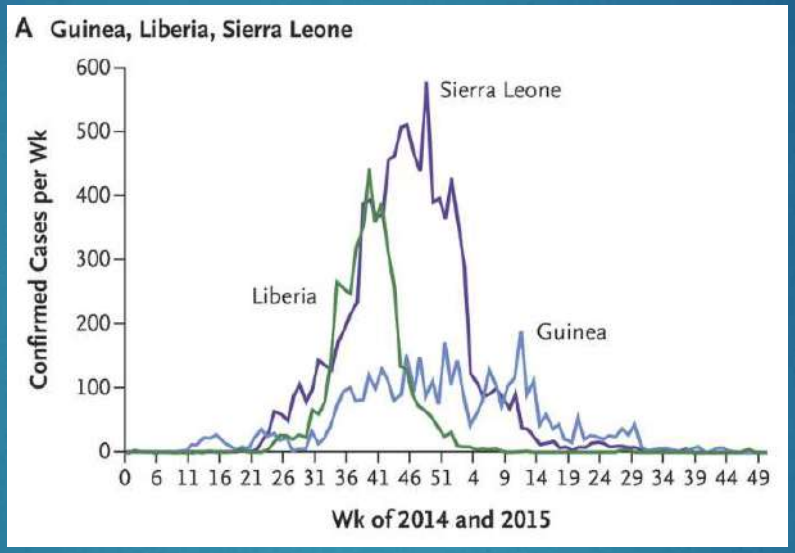
WHO/WPRO: SARS How a global epidemic was stopped



WHO

西アフリカのエボラウイルス病流行 2014-2016



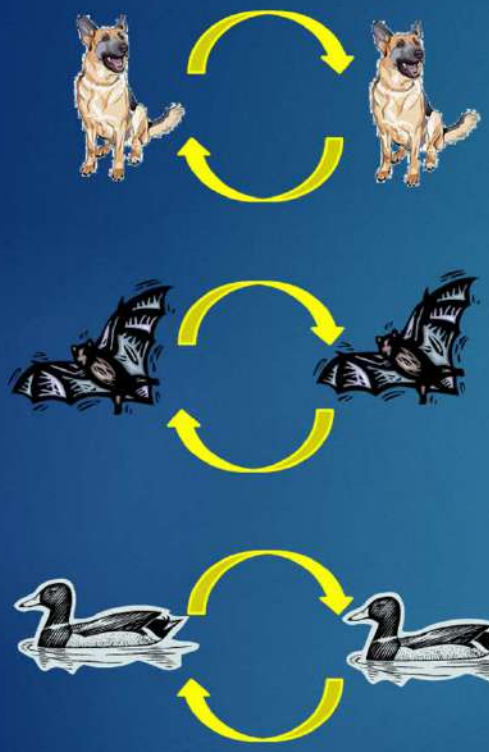


N Engl J Med 2016; 375:587-596

Liberia, Dec, 2014

西アフリカのギニア・シエラレオネ・リベリアの3か国を中心に28000人以上の感染者と11000人以上の死者が発生する大規模流行が起きた。

動物からヒトへの感染



散発的な動物–ヒト感染のみ
（例：狂犬病）

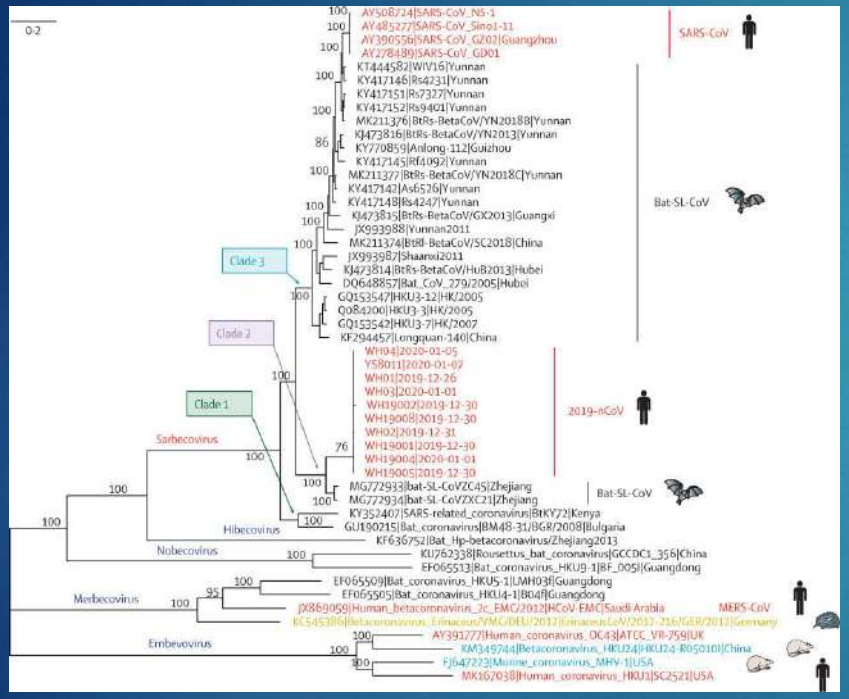
限定的（地域・期間）なヒトからヒト
への感染（例：エボラウイルス病）

世界的な流行（パンデミック）を
起こしヒトの感染症として定着
（例：インフルエンザ）

SARS・
エボラウイルス病

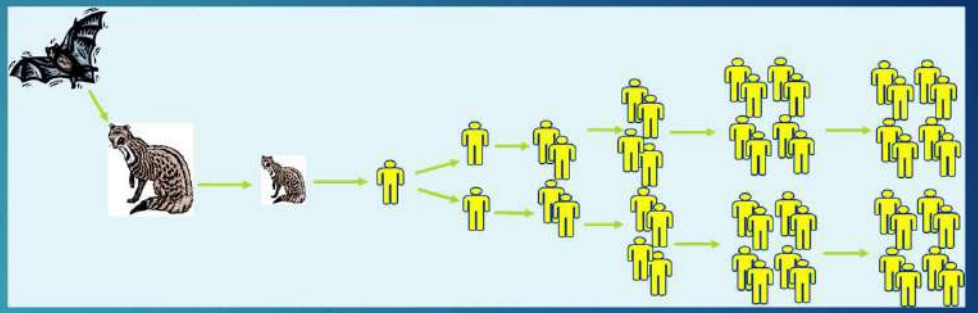
COVID-19

SARSとCOVID-19の共通点と違い

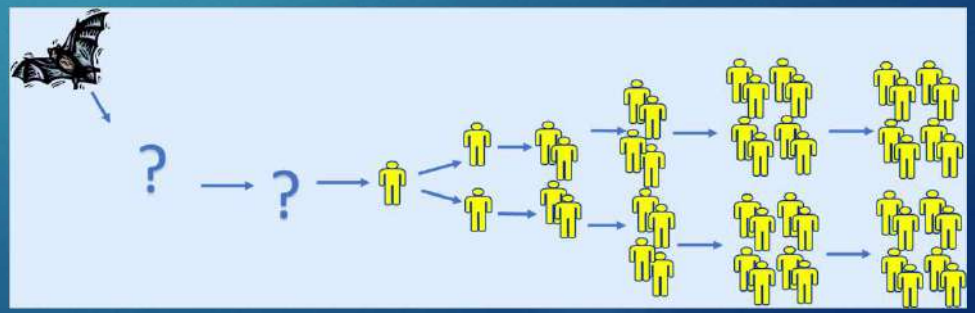


Lancet. 2020, 6736(20)30251-8

SARS（SARS-CoV）

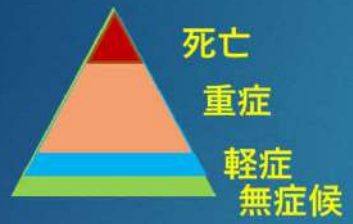


COVID-19（SARS-CoV-2）

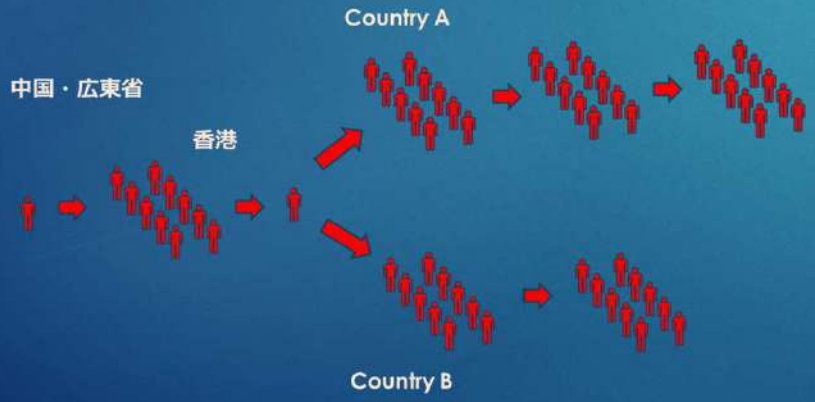


SARSとCOVID-19の違い

SARS

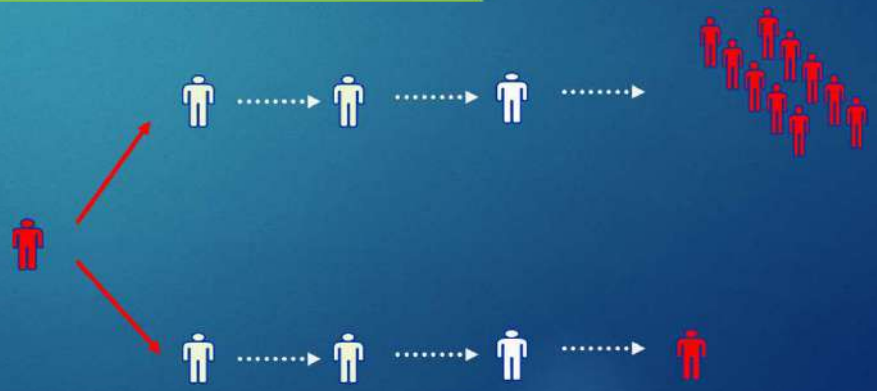


致死率は10%程度



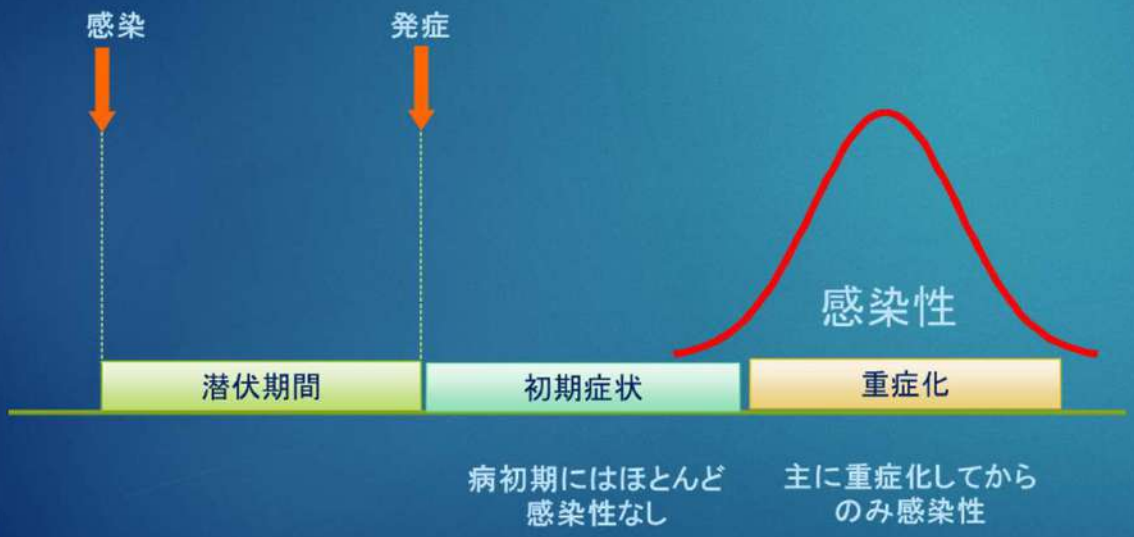
COVID-19

致死率は2%未満

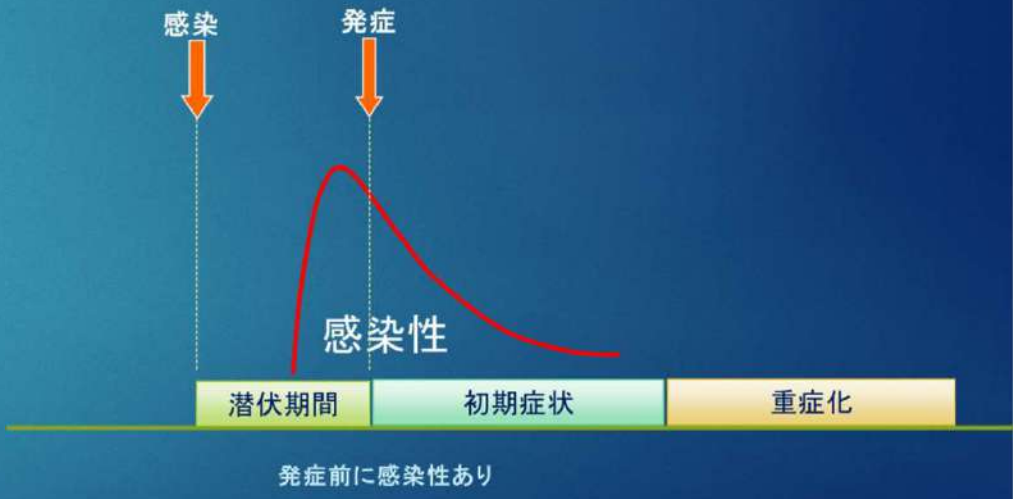


SARSとCOVID-19の違い

SARS



COVID-19



SARSとCOVID-19の病態の違い

SARS

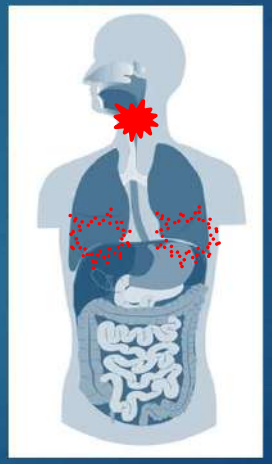
重症度－高
感染性―低

COVID-19

重症度－高
感染性―低

重症度－高
感染性―高

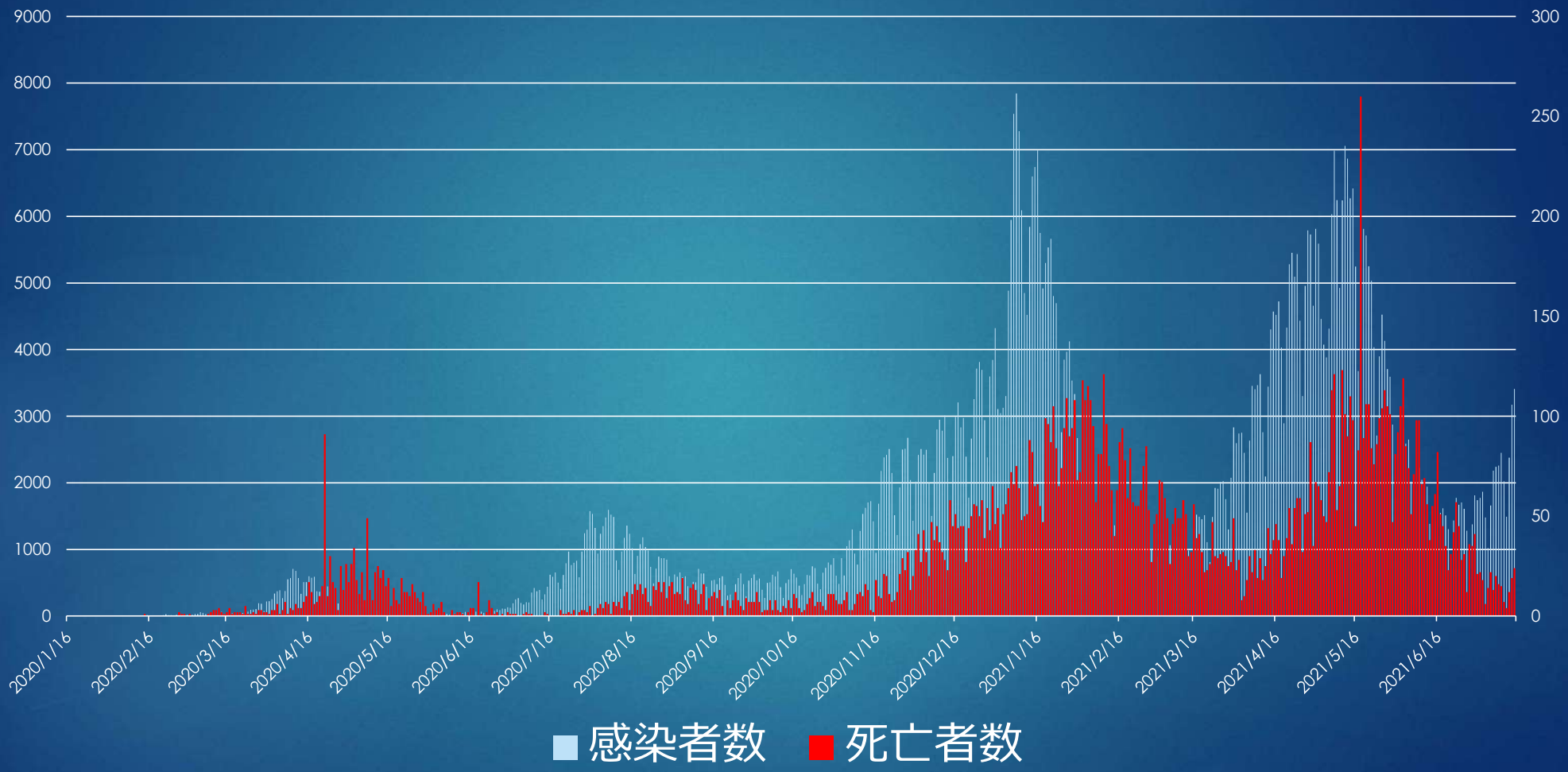
重症度－低
感染性―高



日本のCOVID-19感染者・重症者・死亡者の年齢分布
（2021年4月13日時点）

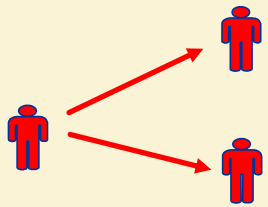
厚生労働省「データからわかるー新型コロナウイルス感染症情報」

日本における感染者数・死亡者数の推移



厚生労働省オープンデータのデータから作図（2021年7月15日まで）

基本再生産数（R_0）



平均して，1人の感染者が何人に感染させるかという指標

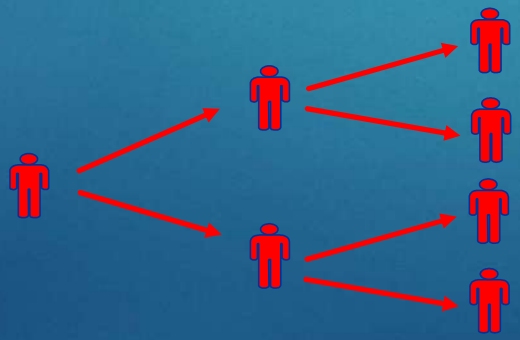
$R_0 = 1$

定常状態

$R_0 < 1$

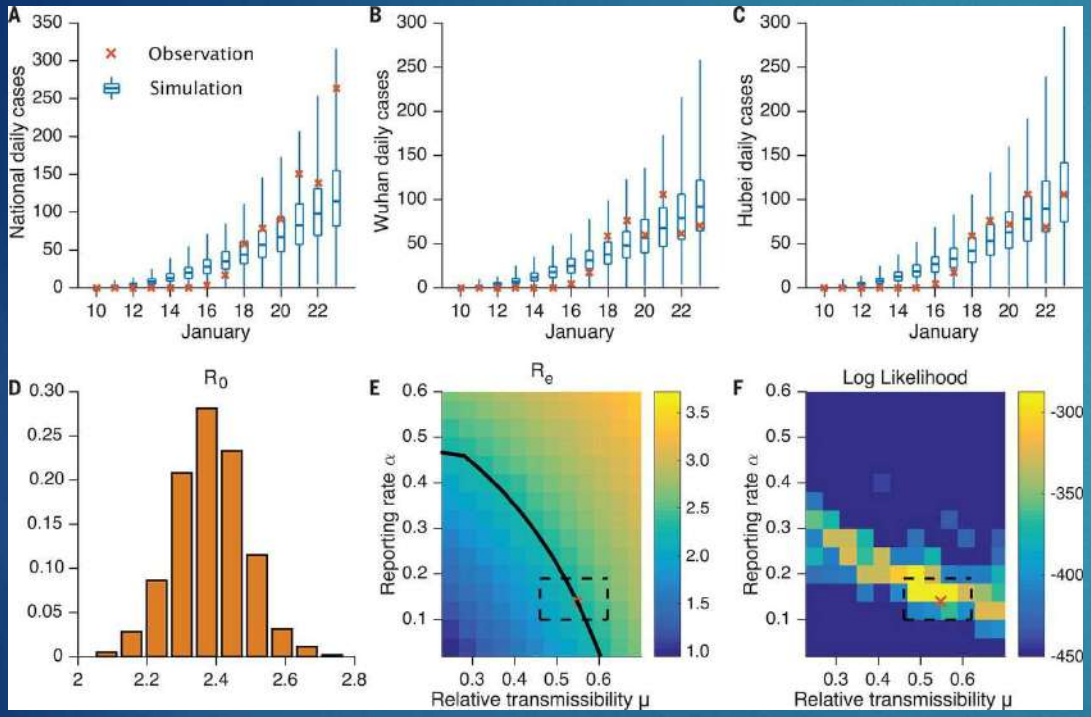
流行は収束

$R_0 > 1$



流行は拡大

COVID-19の基本再生産数



Science Vol. 368, Issue 6490, pp. 489-493

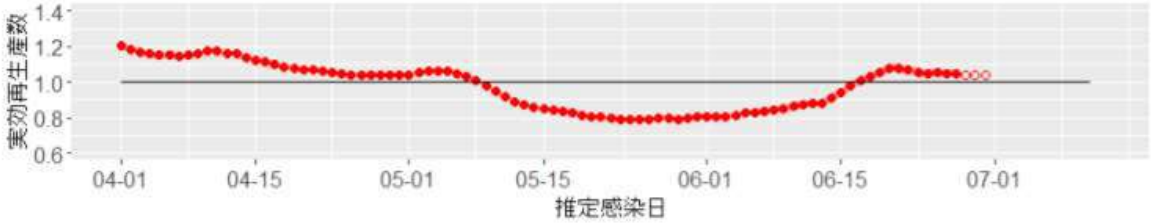
基本再生産数（R_0）＝2.5
世代時間（Generation Time）＝5日
と仮定して、100人（Day 0）から感染者が始まったとする

Day 0：100人
Day 5：250人
Day 10：625人
Day 15：1562人
Day 20：3906人
Day 25：9765人
Day 30：24414人

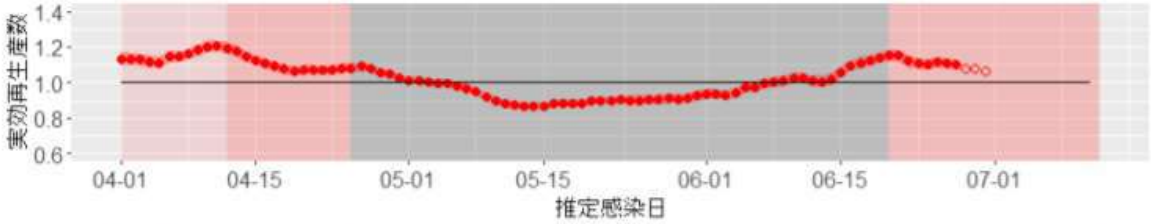
30日間で感染者は240倍

全国の実効再生産数（推定感染日毎）：7月13日作成

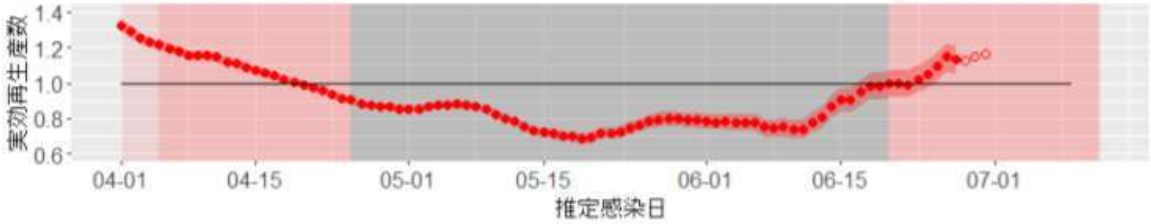
全国
6月27日時点Rt=1.05 (1.02-1.07)



首都圏：東京、神奈川、千葉、埼玉
6月27日時点Rt=1.10 (1.07-1.13)



関西圏：大阪、京都、兵庫
6月27日時点Rt=1.13 (1.05-1.21)



実効再生産数は推定感染日（発症日あるいは発症日不明例については推定発症日から潜伏期間をさかのぼることで推定）ごとにCori et al. AJE 2013の方法（window time=7）で推定した。16日前までの推定値を赤丸、報告の遅れのために過小推定となっている可能性が高い13日から15日前までの推定値を白丸で表し、それよりも直近の値は表示していない。括弧内の値と図中の赤帯は95%信頼区間を表す。
なお、発症日の入力率、公表率は自治体によりばらつきが大きく、また事後的に修正される可能性があるため、値は暫定値である。

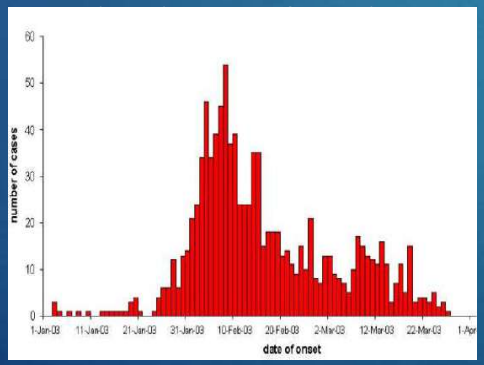
Center for Surveillance, Immunization, and Epidemiologic Research 2

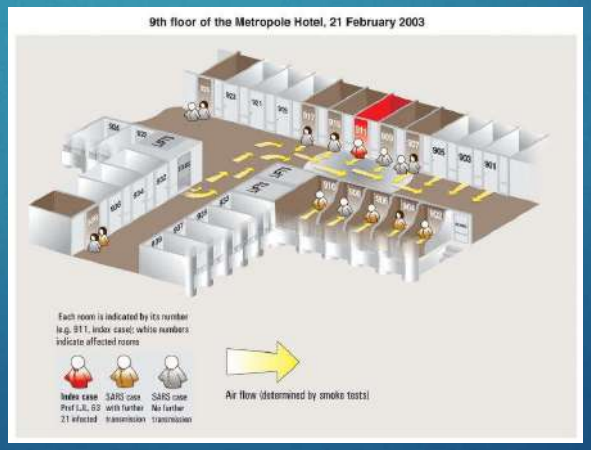
SARSへの初期対応

- 2003年2月11日：広東省当局が原因不明の肺炎について記者会見。同日WHO西太平洋事務局が中国政府に情報提供を求める。
- 2003年2月14日：中国政府からの回答があり「非典型肺炎」の流行が広東省で2002年11月16日からあり、現在までに305例の入院と5例の死亡、流行はすでに沈静化との回答。
- 2003年2月23日：WHOのチームが北京着。広東省への調査の許可は下りず、情報も提供されず。

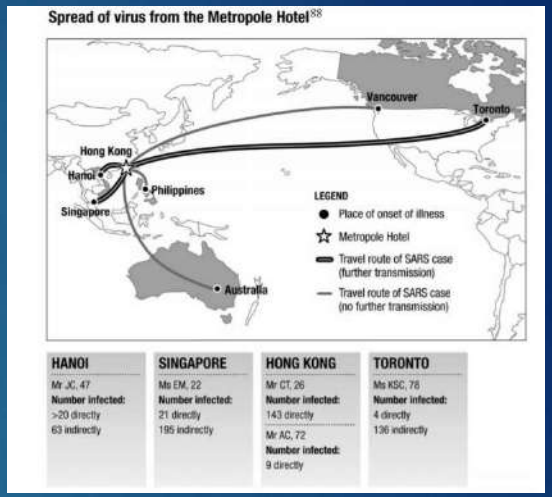
SARSの国際的な流行の拡散

Znong NS et al. Lancet, 362, 2003





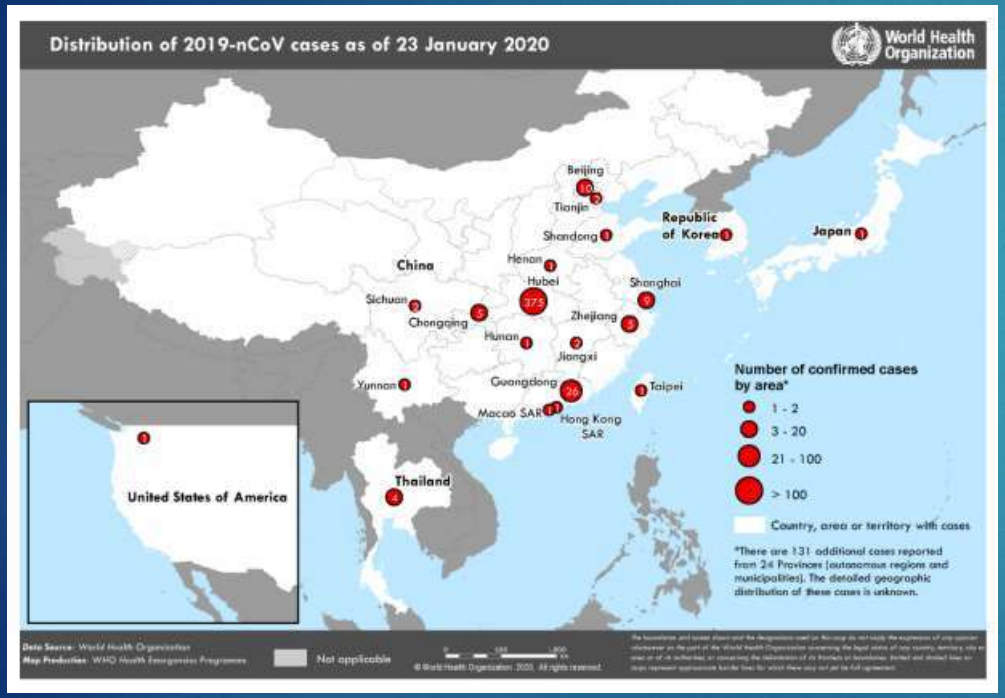
WHO/WPRO: SARS How a global epidemic was stopped



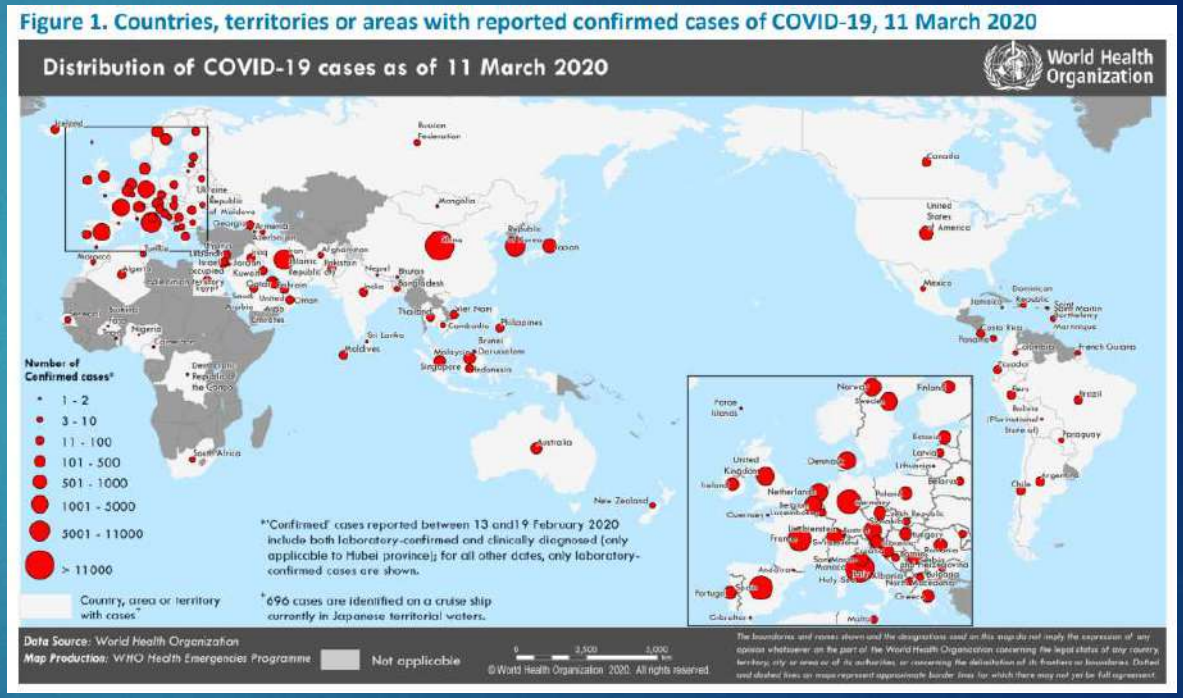
The Independent SARS Commission, the government of Ontario

COVID-19の世界への拡散

2020年1月23日



2020年3月11日

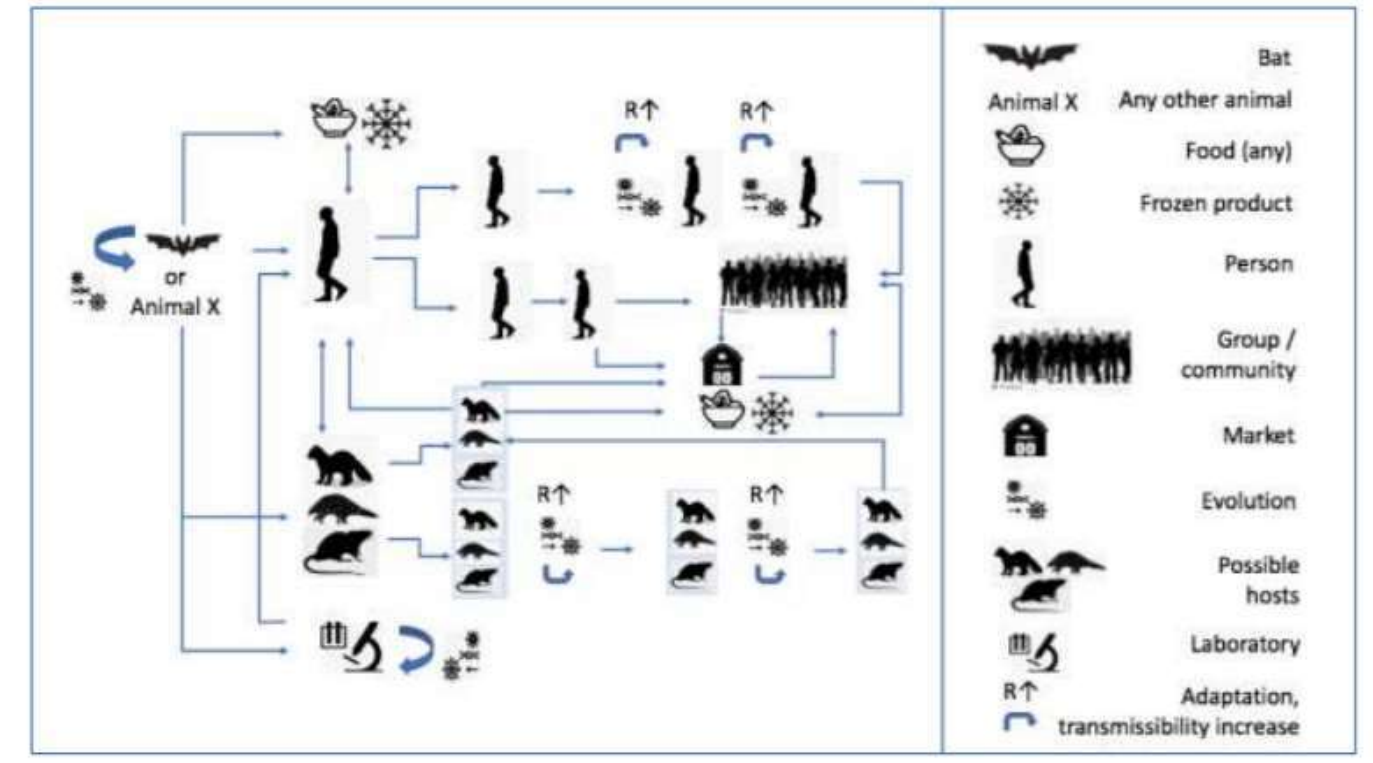


COVID-19の起源

WHO-convened Global Study of Origins of SARS-CoV-2:
China Part

Joint WHO-China Study
14 January-10 February 2021

Joint Report



COVID-19についてのWHOからの最初の報告

World Health Organization

Emergencies preparedness, response

- Home
- Alert and response operations
- Diseases
- Biorisk reduction
- Disease outbreak news

Pneumonia of unknown cause – China

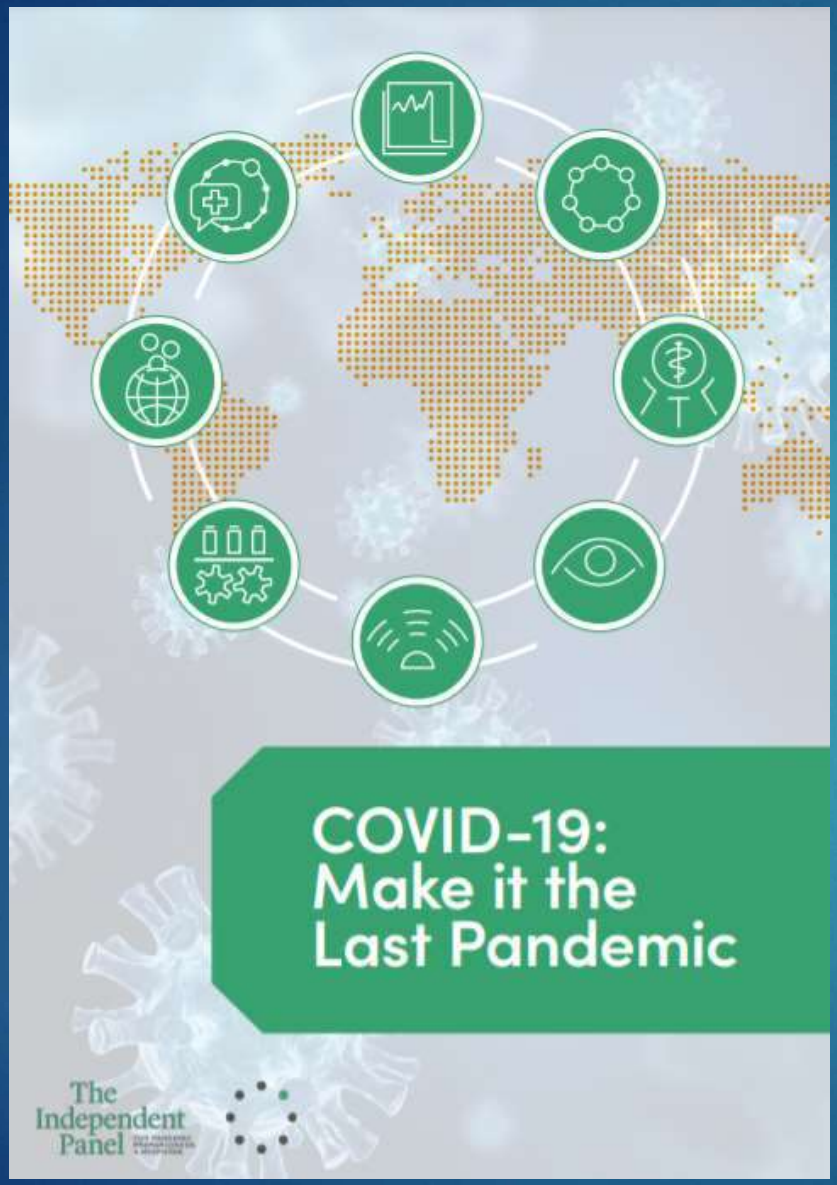
Disease outbreak news
5 January 2020

On 31 December 2019, the WHO China Country Office was informed of cases of pneumonia of unknown etiology (unknown cause) detected in Wuhan City, Hubei Province of China. As of 3 January 2020, a total of 44 patients with pneumonia of unknown etiology have been reported to WHO by the national authorities in China. Of the 44 cases reported, 11 are severely ill, while the remaining 33 patients are in stable condition. According to media reports, the concerned market in Wuhan was closed on 1 January 2020 for environmental sanitation and disinfection.

The causal agent has not yet been identified or confirmed. On 1 January 2020, WHO requested further information from national authorities to assess the risk.

National authorities report that all patients are isolated and receiving treatment in Wuhan medical institutions. The clinical signs and symptoms are mainly fever, with a few patients having difficulty in breathing, and chest radiographs showing invasive lesions of both lungs.

On 31 December 2019, the WHO China Country Office was informed of cases of pneumonia of unknown etiology (unknown cause) detected in Wuhan City, Hubei Province of China.



Rt Hon. Helen Clark
Co-Chair

H.E. Ellen Johnson Sirleaf
Co-Chair

Mauricio Cárdenas
Aya Chebbi
Mark Dybul
Michel Kazatchkine
Joanne Liu
Precious Matsoso
David Miliband
Thoraya Obaid
Preeti Sudan
Ernesto Zedillo
Zhong Nanshan

国際社会の最初の流行の検知

- On 30 December 2019, the Wuhan Municipal Health Commission issued two urgent notices to hospital networks in the city about cases of pneumonia of unknown origin linked to the Huanan Seafood Market.
- On the morning of 31 December, Chinese business publication Finance Sina reported on one of the notices issued by the Wuhan Municipal Health Commission.
- This report was replicated and picked up by several disease surveillance systems, including the Centers for Disease Control, Taiwan, China, which in turn contacted WHO via email through the IHR (2005) reporting system, requesting further information.

武汉市卫生健康委员会

市卫生健康委关于报送不明原因肺炎救治情况的紧急通知

各有关医疗机构：

根据上级紧急通知，我市华南海鲜市场陆续出现不明原因肺炎病人。为做好应对工作，请各单位立即清查统计近一周接诊过的具有类似特点的不明原因肺炎病人，于今日下午4点前将统计表（盖章扫描件）报送至市卫健委医政医管处邮箱。

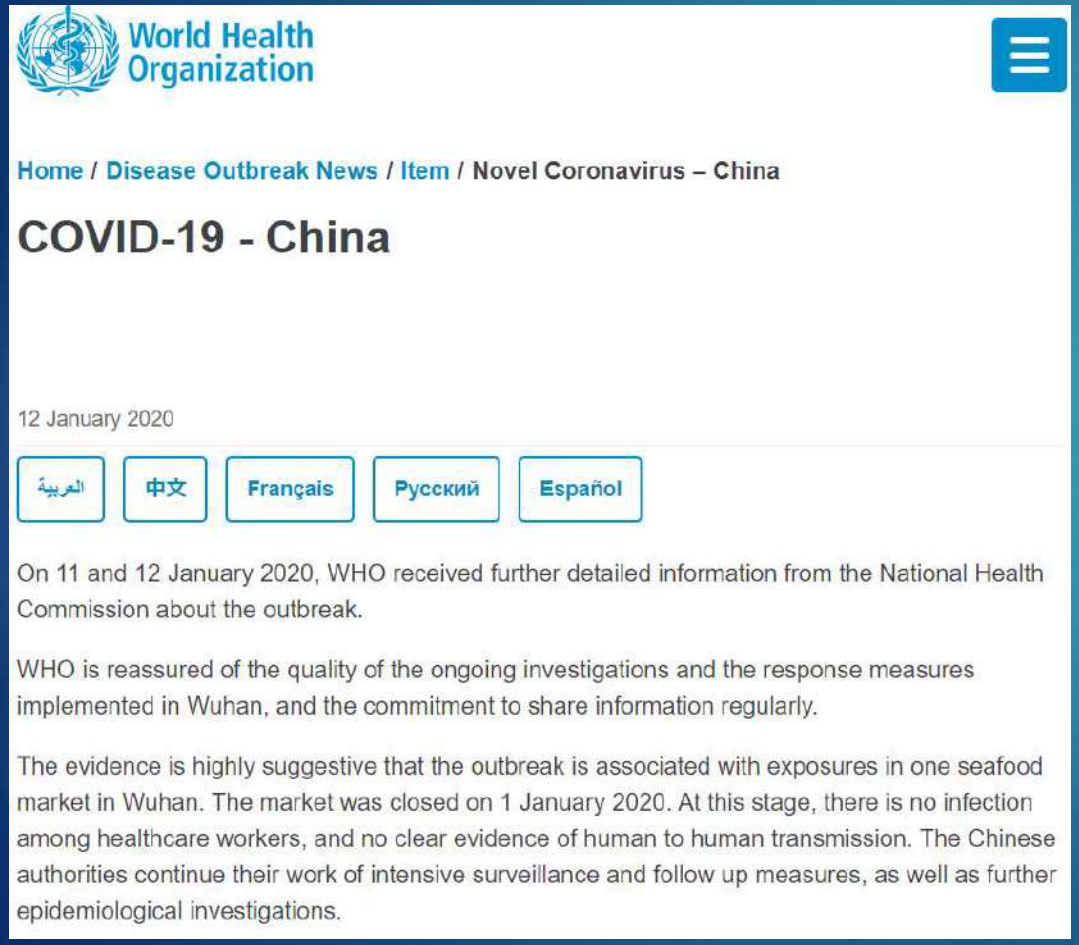
附件：相关信息上报表

WHO Independent Panel Report

国際社会の最初の流行の検知

- A machine translation of the Finance Sina report was published on the website of the Program for Monitoring Emerging Diseases (ProMED).
- The WHO Country Office in China took note of the bulletin shortly after it was posted and immediately informed the IHR focal point in the WHO Western Pacific Regional Office (WPRO).
- On 1 January 2020, WPRO formally requested further information; and on 3 January it requested verification under the IHR (2005) Article 10 procedures.
- The Chinese National Health Commission and the Country Office met for a technical briefing on 3 January and provided initial information about the first set of 44 reported cases during the briefing and by email.

WHOからの第2報, 2020年1月12日



World Health Organization

Home / Disease Outbreak News / Item / Novel Coronavirus – China

COVID-19 - China

12 January 2020

العربية | 中文 | Français | Русский | Español

On 11 and 12 January 2020, WHO received further detailed information from the National Health Commission about the outbreak.

WHO is reassured of the quality of the ongoing investigations and the response measures implemented in Wuhan, and the commitment to share information regularly.

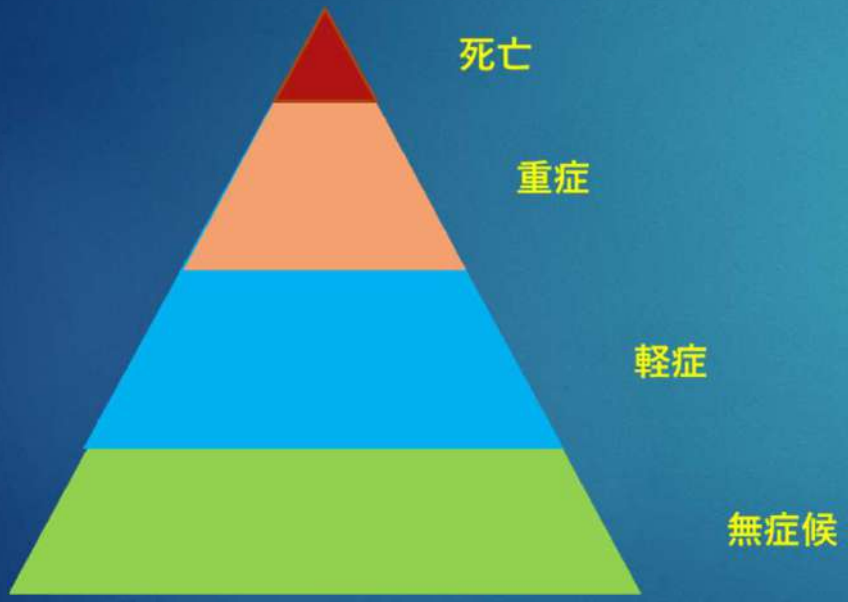
The evidence is highly suggestive that the outbreak is associated with exposures in one seafood market in Wuhan. The market was closed on 1 January 2020. At this stage, there is no infection among healthcare workers, and no clear evidence of human to human transmission. The Chinese authorities continue their work of intensive surveillance and follow up measures, as well as further epidemiological investigations.

The government reports that there is no clear evidence that the virus passes easily from person to person.

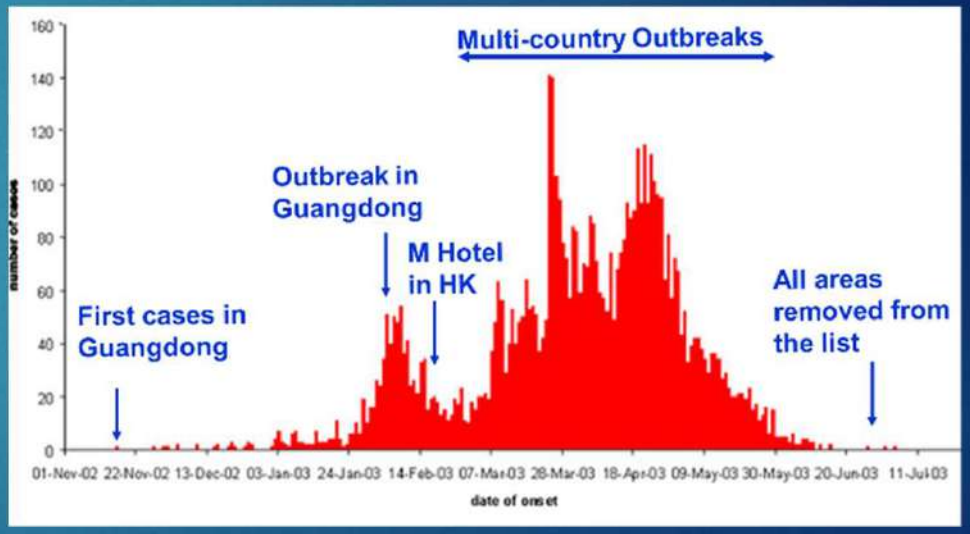
WHO does not recommend any specific health measures for travellers. In case of symptoms suggestive of respiratory illness either during or after travel, travellers are encouraged to seek medical attention and share travel history with their healthcare provider.

この時点で世界は何を見誤っていたのか？

COVID-19



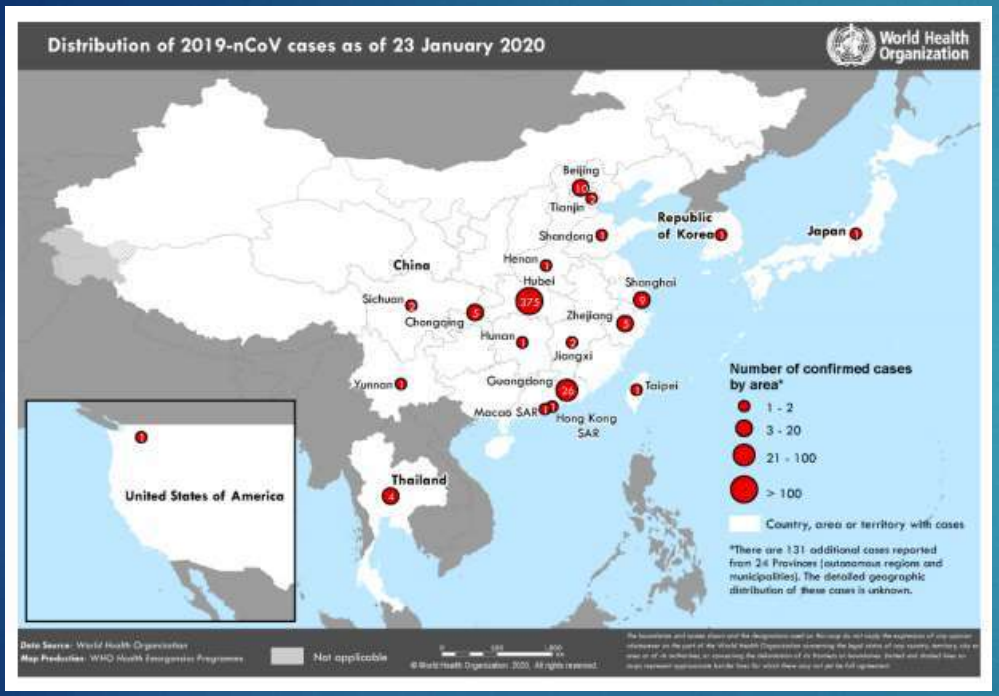
Probable cases of SARS by week of onset



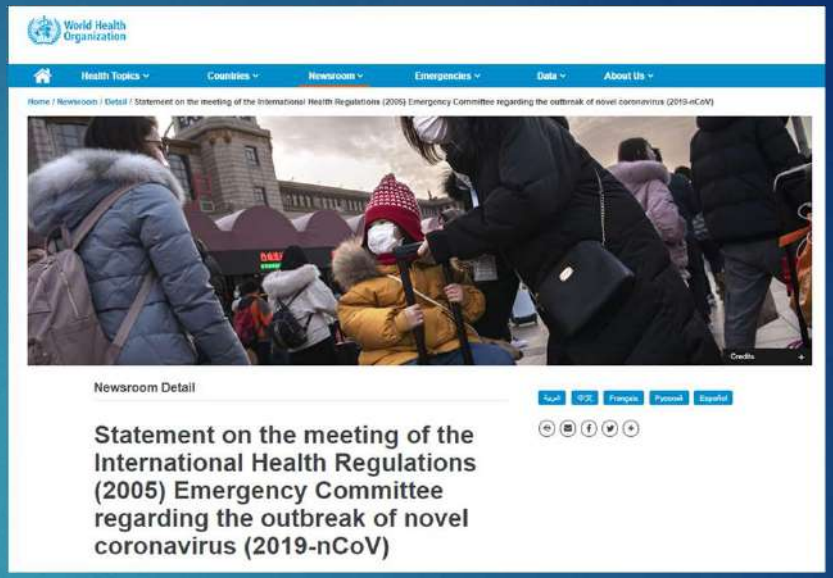
WHO

最初の緊急委員会（1月23日）

2020年1月23日



WHO Situation Report Jan 23, 2020



Conclusions and Advice

- On 22 January, the members of the Emergency Committee expressed **divergent views on whether this event constitutes a PHEIC or not.** At that time, **the advice was that the event did not constitute a PHEIC**, but the Committee members agreed on the urgency of the situation and suggested that the Committee should be reconvened in a matter of days to examine the situation further.
- After the announcement of new containment measures in Wuhan on 22 January, the Director-General asked the Emergency Committee **to reconvene on 23 January to study the information provided by Chinese authorities** about the most recent epidemiological evolution and the risk-management measures taken.
- **Chinese authorities presented new epidemiological information** that revealed an increase in the number of cases, of suspected cases, of affected provinces, and the proportion of deaths in currently reported cases of 4% (17 of 557). **They reported fourth-generation cases in Wuhan and second-generation cases outside Wuhan, as well as some clusters outside Hubei province. They explained that strong containment measures** (closure of public-transportation systems are in place in Wuhan City, as well as other nearby cities). **After this presentation, the EC was informed about the evolution in Japan, Republic of Korea, and Thailand, and that one new possible case had been identified in Singapore.**
- The Committee welcomed the efforts made by China to investigate and contain the current outbreak.
- The following elements were considered as critical:
- **Human-to-human transmission is occurring and a preliminary R0 estimate of 1.4-2.5 was presented.** Amplification has occurred in one health care facility. Of confirmed cases, 25% are reported to be severe. The source is still unknown (most likely an animal reservoir) and the extent of human-to-human transmission is still not clear.
- **Several members considered that it is still too early to declare a PHEIC**, given its restrictive and binary nature.
- Based on these divergent views, the EC formulates the following advice:

当初の中国の状況と世界へのウイルスの拡散

World Health Organization

Novel Coronavirus (2019-nCoV)
SITUATION REPORT - 1
21 JANUARY 2020

Data as reported by: 20 January 2020

SUMMARY

Event highlights from 31 December 2019 to 20 January 2020:

- On 31 December 2019, the WHO China Country Office was informed of cases of pneumonia unknown etiology (unknown cause) detected in Wuhan City, Hubei Province of China. From 31 December 2019 through 3 January 2020, a total of 44 case-patients with pneumonia of unknown etiology were reported to WHO by the national authorities in China. During this reported period, the causal agent was not identified.
- On 11 and 12 January 2020, WHO received further detailed information from the National Health Commission China that the outbreak is associated with exposures in one seafood market in Wuhan City.
- The Chinese authorities identified a new type of coronavirus, which was isolated on 7 January 2020.

I. SURVEILLANCE

Reported incidence of confirmed 2019-nCoV cases

Table 1. Countries, territories or areas with reported confirmed cases of 2019-nCoV, 20 January 2020

WHO Regional Office	Country, territory, area	Total number of confirmed cases
WPRO	China – Hubei Province	258
	China – Guangdong	14
	China – Beijing Municipality	5
	China – Shanghai Municipality	1
	Japan	1
	Republic of Korea	1
SEARO	Thailand	2
Total confirmed cases		282

Articles

Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study

Joseph T Wu*, Kathy Leung*, Gabriel M Leung

Summary

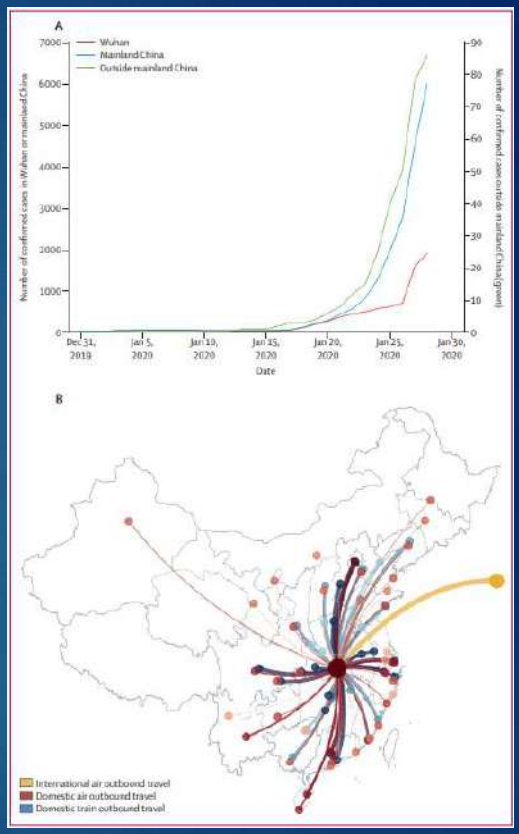
Background Since Dec 31, 2019, the Chinese city of Wuhan has reported an outbreak of atypical pneumonia caused by the 2019 novel coronavirus (2019-nCoV). Cases have been exported to other Chinese cities, as well as internationally, threatening to trigger a global outbreak. Here, we provide an estimate of the size of the epidemic in Wuhan on the basis of the number of cases exported from Wuhan to cities outside mainland China and forecast the extent of the domestic and global public health risks of epidemics, accounting for social and non-pharmaceutical prevention interventions.

Methods We used data from Dec 31, 2019, to Jan 28, 2020, on the number of cases exported from Wuhan internationally (known days of symptom onset from Dec 25, 2019, to Jan 19, 2020) to infer the number of infections in Wuhan from Dec 1, 2019, to Jan 25, 2020. Cases exported domestically were then estimated. We forecasted the national and global spread of 2019-nCoV, accounting for the effect of the metropolitan-wide quarantine of Wuhan and surrounding cities, which began Jan 23–24, 2020. We used data on monthly flight bookings from the Official Aviation Guide and data on human mobility across more than 300 prefecture-level cities in mainland China from the Tencent database. Data on confirmed cases were obtained from the reports published by the Chinese Center for Disease Control and Prevention. Serial interval estimates were based on previous studies of severe acute respiratory syndrome coronavirus (SARS-CoV). A susceptible-exposed-infectious-recovered metapopulation model was used to simulate the epidemics across all major cities in China. The basic reproductive number was estimated using Markov Chain Monte Carlo methods and presented using the resulting posterior mean and 95% credibile interval (CrI).

Findings In our baseline scenario, we estimated that the basic reproductive number for 2019-nCoV was 2·68 (95% CrI 2·47–2·86) and that 75 815 individuals (95% CrI 37 304–130 330) have been infected in Wuhan as of Jan 25, 2020. The epidemic doubling time was 6·4 days (95% CrI 5·8–7·1). We estimated that in the baseline scenario, Chongqing, Beijing, Shanghai, Guangzhou, and Shenzhen had imported 461 (95% CrI 227–805), 113 (57–193), 98 (49–168), 111 (56–191), and 80 (40–139) infections from Wuhan, respectively. If the transmissibility of 2019-nCoV were similar everywhere domestically and over time, we inferred that epidemics are already growing exponentially in multiple major cities of China with a lag time behind the Wuhan outbreak of about 1–2 weeks.

Published Online January 31, 2020
https://doi.org/10.1016/S0140-6736(20)30260-9
This online publication has been corrected. The corrected version first appeared at thelancet.com on February 4, 2020

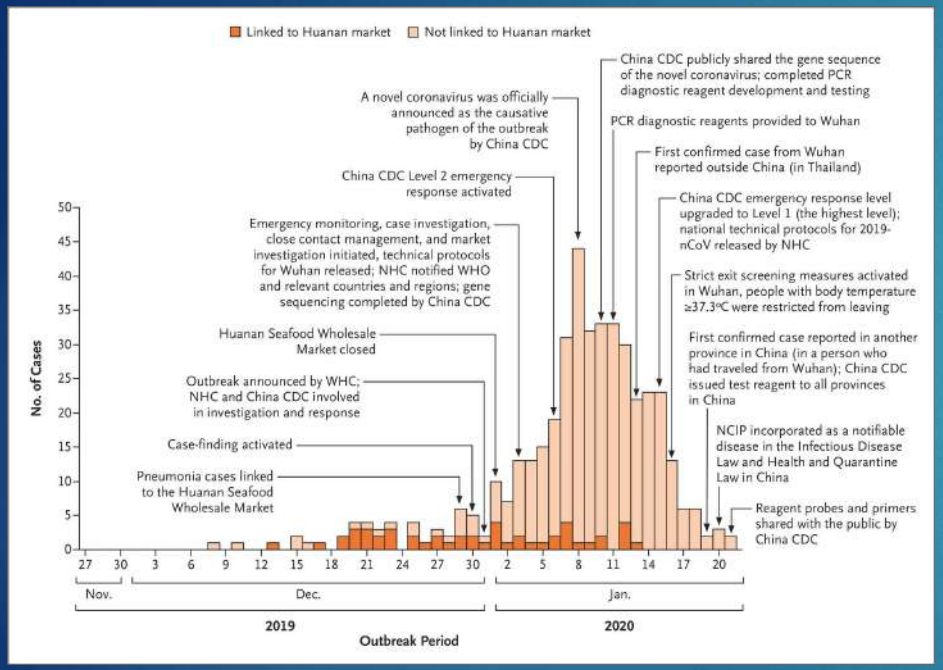
*Contributed equally
WHO Collaborating Centre for Infectious Disease Epidemiology and Control, School of Public Health, Li Ka Shing Faculty of Medicine, University of Hong Kong, Hong Kong, China (Prof J T Wu PhD, K Leung PhD, Prof G M Leung MD)
Correspondence to: Prof Joseph T Wu, School of Public Health, Li Ka Shing Faculty of Medicine, University of Hong Kong, Hong Kong, China
joewu@hku.hk



75 815 individuals (95% CI 37 304–130 330) have been infected in Wuhan as of Jan 25, 2020

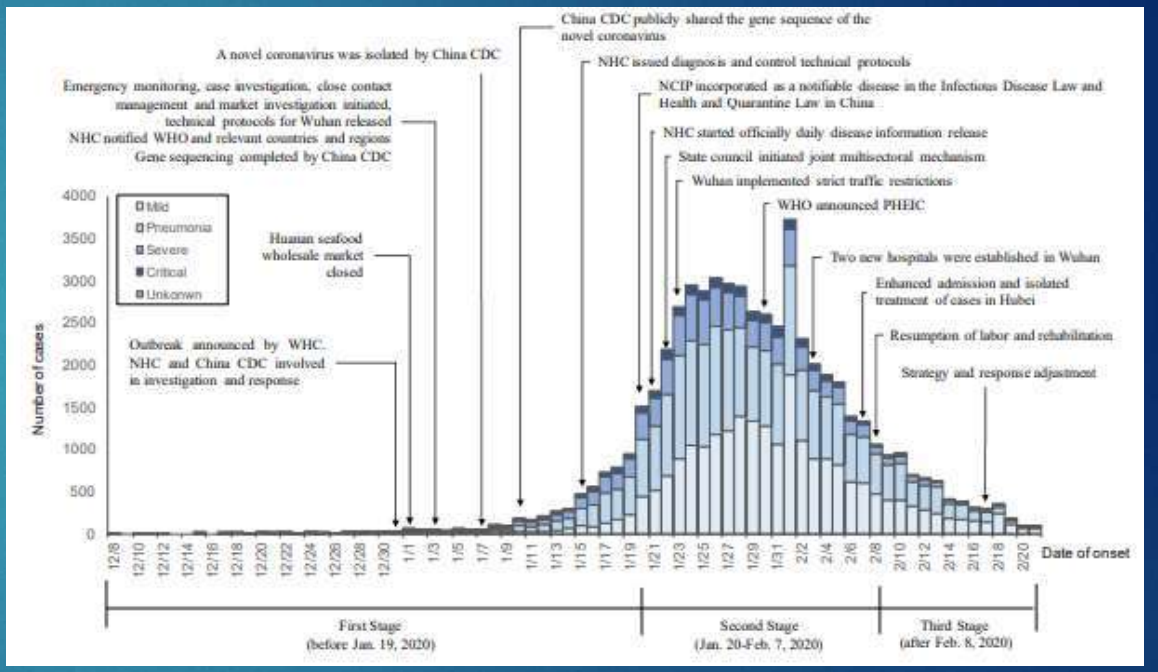
武漢の流行初期の実態

初期の流行調査による武漢での流行曲線
（1月29日発表）



NEJM. January 29, 2020 DOI: 10.1056/NEJMoa2001316

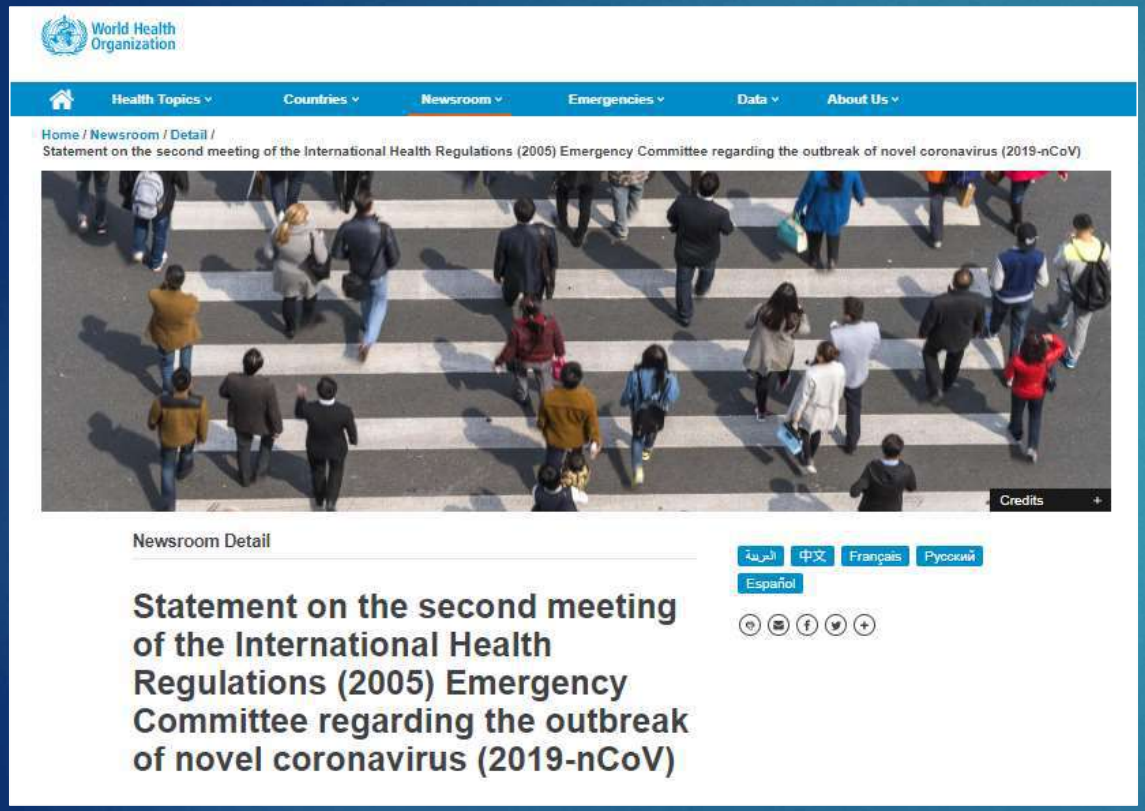
2月中旬時点のデータによる流行曲線



Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)
16-24 February 2020

As of 20 February, 2020, a cumulative total of 75,465 COVID-19 cases were reported in China

Public Health Emergency of international concern (1月30日)

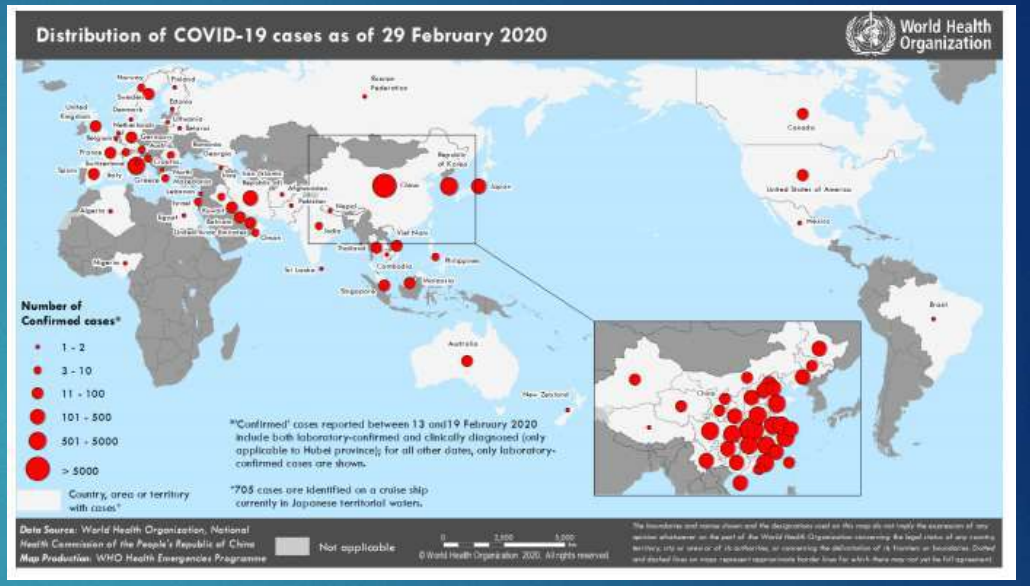


Conclusions and advice

- **The Committee welcomed the leadership and political commitment of the very highest levels of Chinese government** their commitment to transparency, and the efforts made to investigate and contain the current outbreak. China quickly identified the virus and shared its sequence, so that other countries could diagnose it quickly and protect themselves, which has resulted in the rapid development of diagnostic tools.
- The very strong measures the country has taken include daily contact with WHO and comprehensive multi-sectoral approaches to prevent further spread. It has also taken public health measures in other cities and provinces; is conducting studies on the severity and transmissibility of the virus, and sharing data and biological material. The country has also agreed to work with other countries who need their support. **The measures China has taken are good not only for that country but also for the rest of the world.**
- The Committee acknowledged the leading role of WHO and its partners.
- The Committee also acknowledged that there are still many unknowns, cases have now been reported in five WHO regions in one month, and human-to-human transmission has occurred outside Wuhan and outside China.
- **The Committee believes that it is still possible to interrupt virus spread** provided that countries put in place strong measures to detect disease early, isolate and treat cases, trace contacts, and promote social distancing measures commensurate with the risk. It is important to note that as the situation continues to evolve, so will the strategic goals and measures to prevent and reduce spread of the infection. The Committee agreed that the outbreak now meets the criteria for a Public Health Emergency of International Concern and proposed the following advice to be issued as Temporary Recommendations.
- **The Committee emphasized that the declaration of a PHEIC should be seen in the spirit of support and appreciation for China** its people, and the actions China has taken on the frontlines of this outbreak, with transparency, and, it is to be hoped, with success. In line with the need for global solidarity, the Committee felt that a global coordinated effort is needed to enhance preparedness in other regions of the world that may need additional support for that.

COVID-19の国際的な流行の拡散

WHO Situation Report Feb 12, 2020

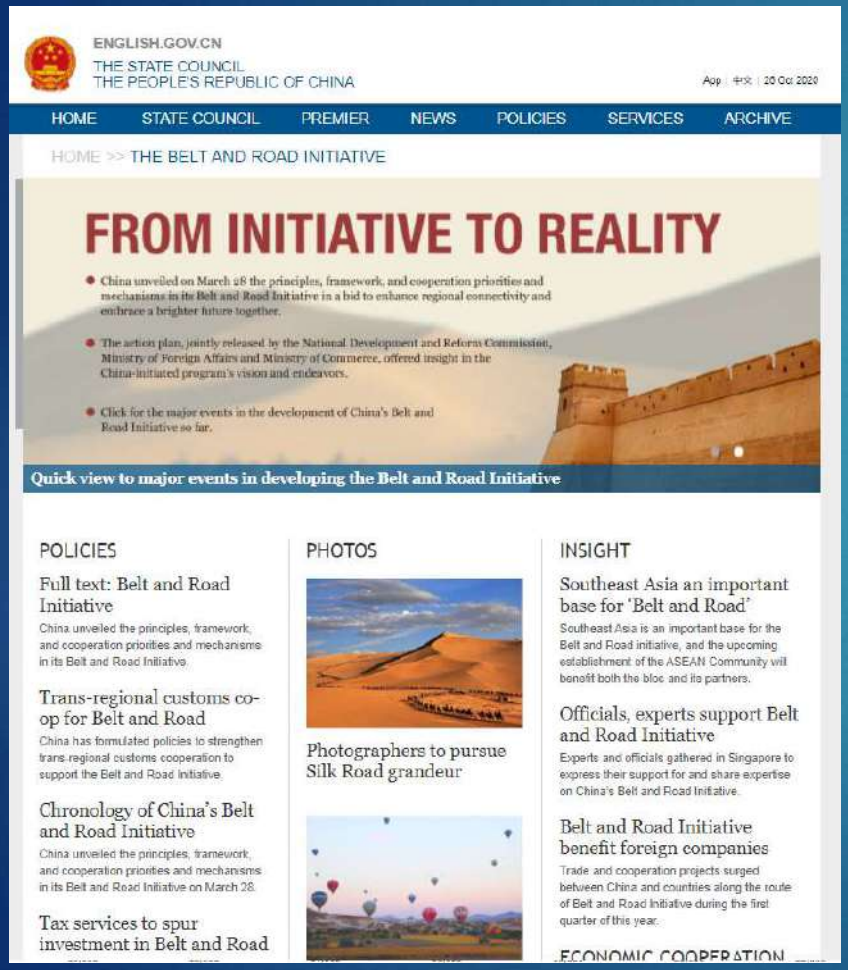


WHO Situation Report Feb 29, 2020

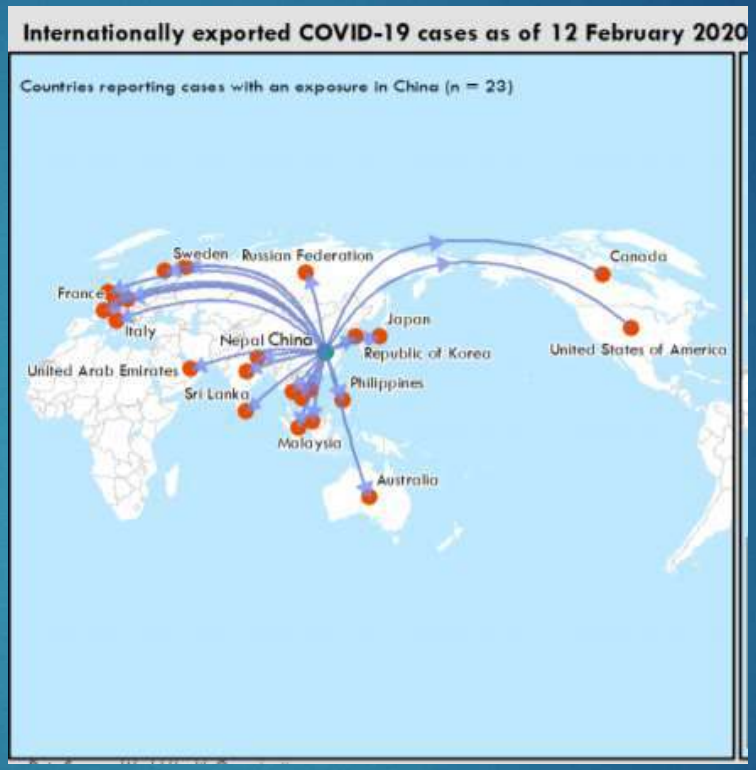
2020年2月29日時点でのCOVID-19感染者（上位4か国）

- 中国：79,394
- 韓国：3,150
- イタリア：888
- イラン：388
- 日本：230

COVID-19の流行拡大の背景



State Council People's Republic of China



2020年2月29日時点でのCOVID-19感染者（上位4か国）

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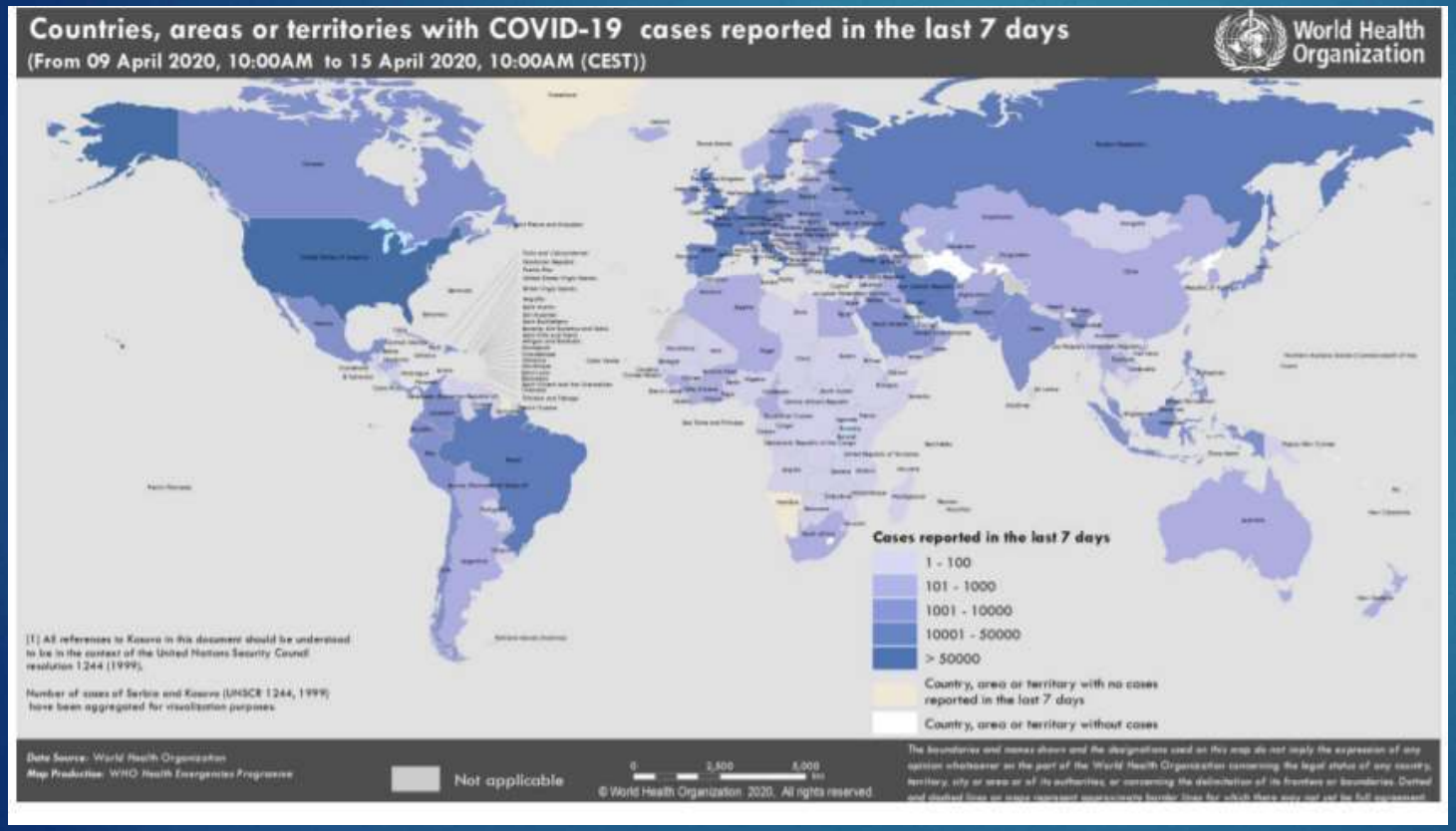
COVID-19の流行拡大の背景

国土交通省・観光庁

COVID-19の流行拡大の背景



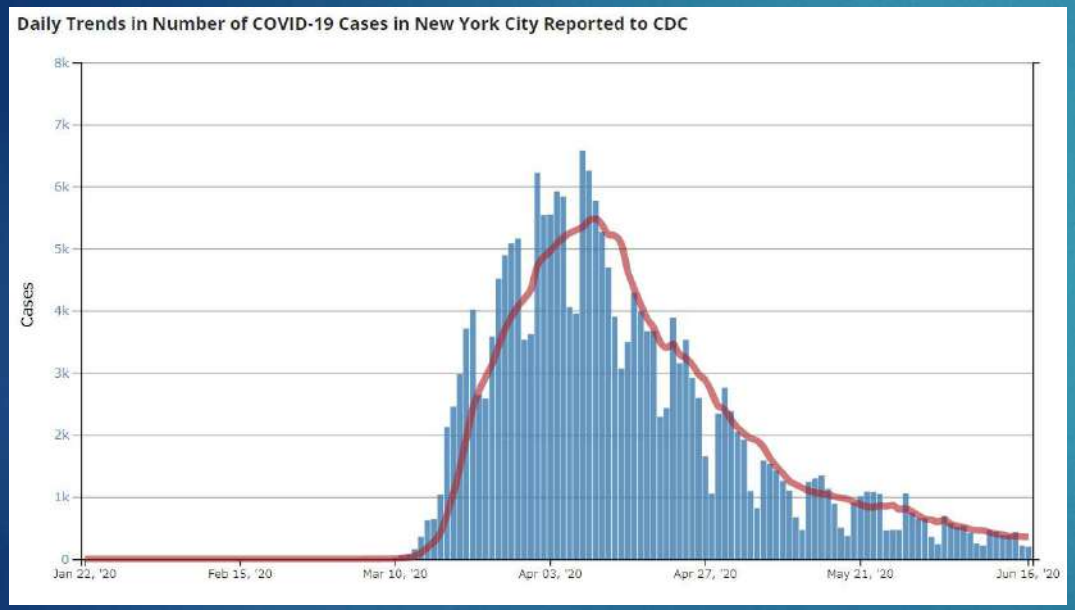
2020年4月15日時点でのCOVID-19感染者（上位8か国）

- アメリカ：578,268
- スペイン：172,541
- イタリア：127,584
- ドイツ：127,584
- フランス：102,533
- イギリス：93,877
- 中国：83,745
- イラン：74,877

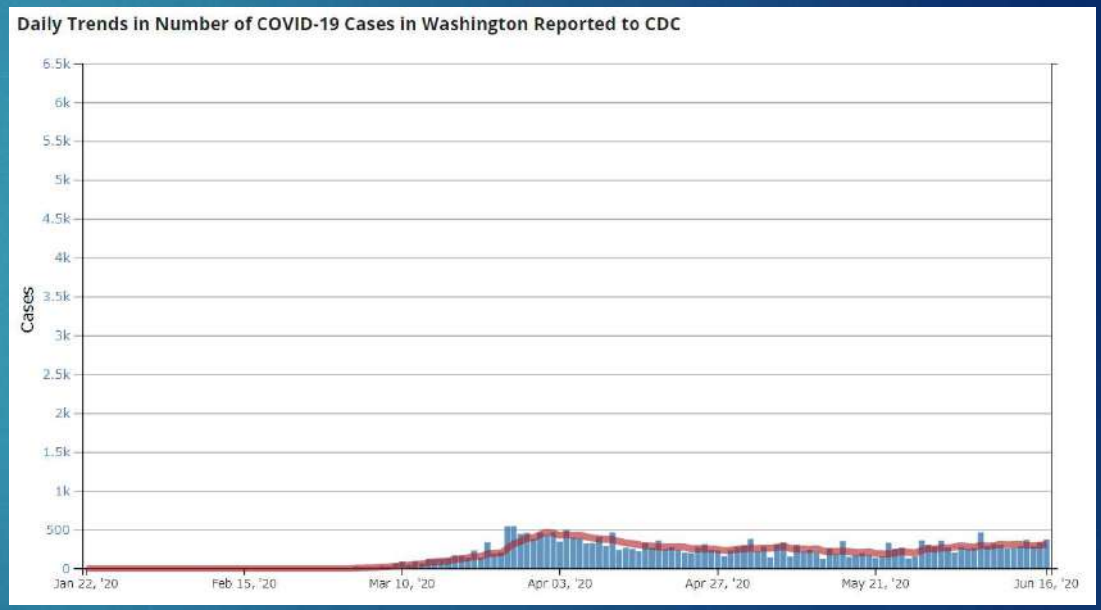
(日本：8,100)

アメリカでの初期例の検知の遅れ

New York City

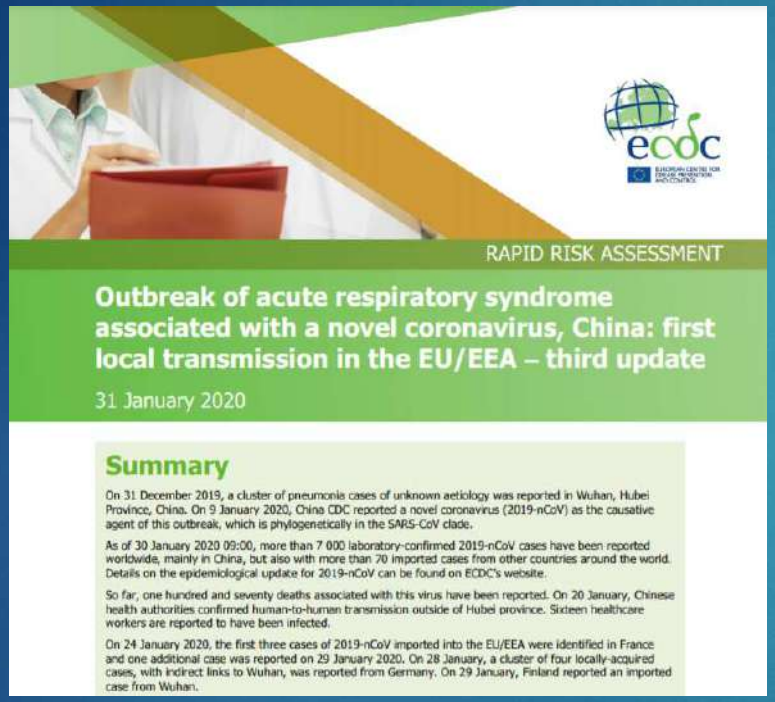


Washington State



US CDC COVID Data Tracker

ヨーロッパの対応の遅れ



RAPID RISK ASSESSMENT

Outbreak of acute respiratory syndrome associated with a novel coronavirus, China: first local transmission in the EU/EEA – third update

31 January 2020

Summary

On 31 December 2019, a cluster of pneumonia cases of unknown aetiology was reported in Wuhan, Hubei Province, China. On 9 January 2020, China CDC reported a novel coronavirus (2019-nCoV) as the causative agent of this outbreak, which is phylogenetically in the SARS-CoV clade.

As of 30 January 2020 09:00, more than 7 000 laboratory-confirmed 2019-nCoV cases have been reported worldwide, mainly in China, but also with more than 70 imported cases from other countries around the world. Details on the epidemiological update for 2019-nCoV can be found on ECDC's website.

So far, one hundred and seventy deaths associated with this virus have been reported. On 20 January, Chinese health authorities confirmed human-to-human transmission outside of Hubei province. Sixteen healthcare workers are reported to have been infected.

On 24 January 2020, the first three cases of 2019-nCoV imported into the EU/EEA were identified in France and one additional case was reported on 29 January 2020. On 28 January, a cluster of four locally-acquired cases, with indirect links to Wuhan, was reported from Germany. On 29 January, Finland reported an imported case from Wuhan.

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→ Coronavirus (COVID-19) | Rules, guidance and support

Home > Coronavirus (COVID-19) > Health and wellbeing during coronavirus

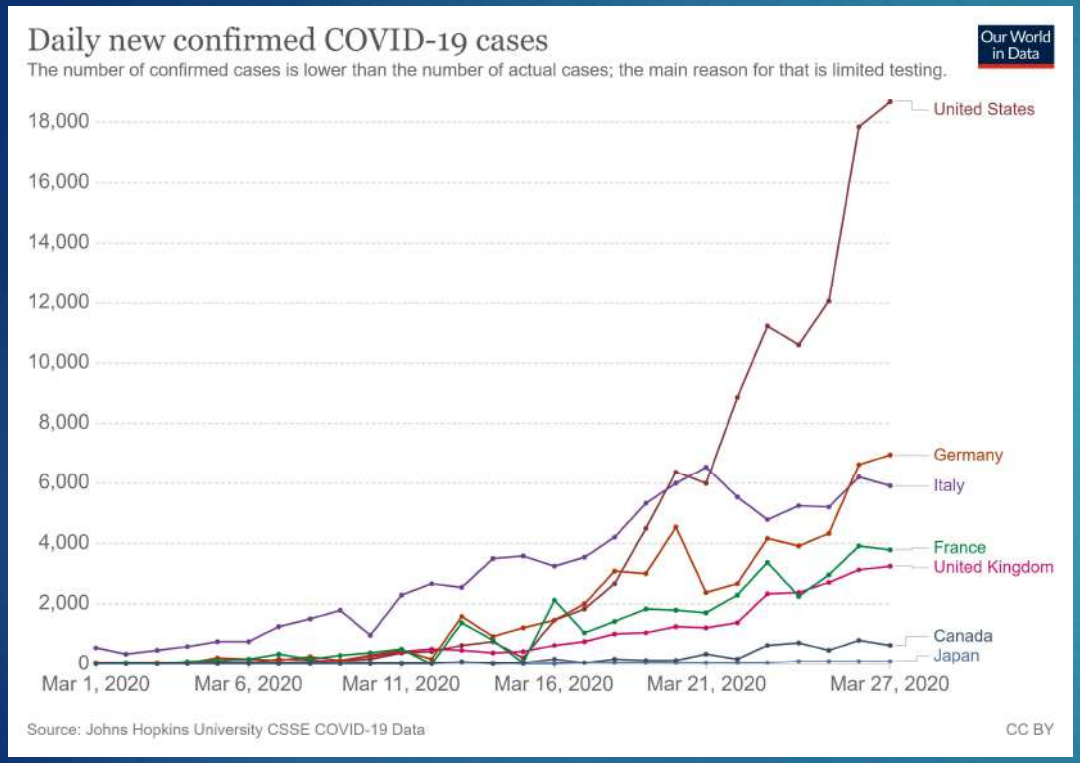
Press release

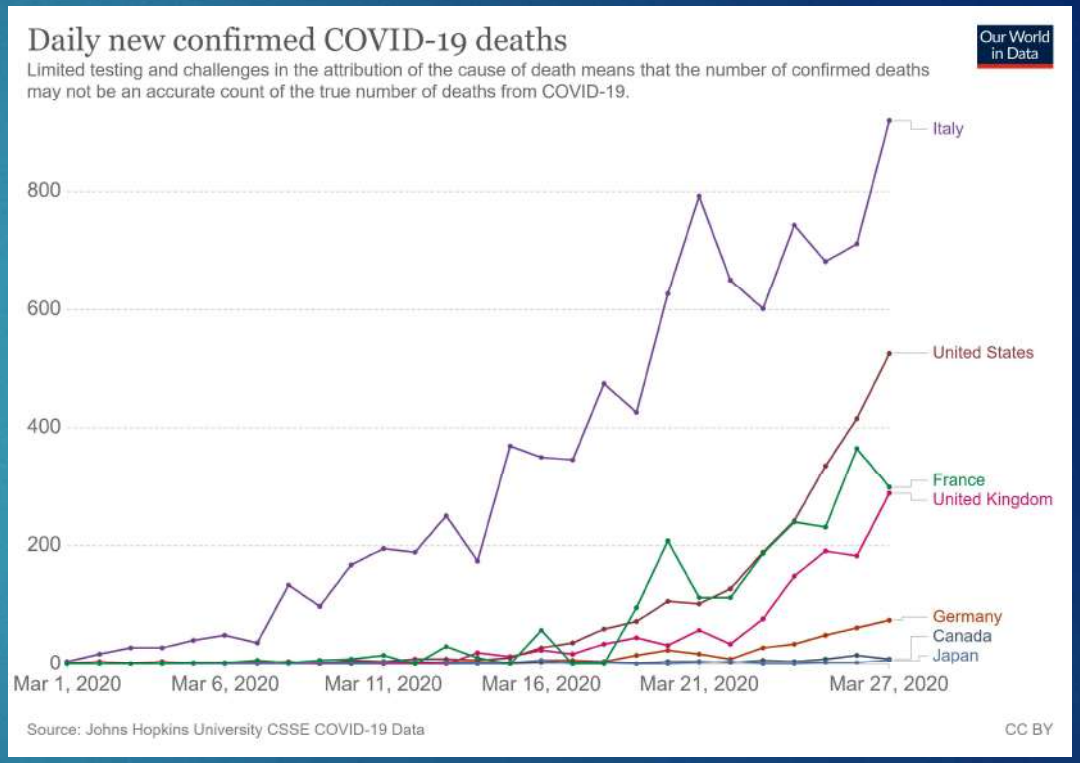
COVID-19: government announces moving out of contain phase and into delay

The government has announced that we are moving out of the contain phase and into delay, in response to the ongoing coronavirus outbreak.

assuming that cases in the EU/EEA are detected in a timely manner and that rigorous IPC measures are applied, the likelihood of sustained human-to-human transmission within the EU/EEA is currently very low to low;

欧米先進国の初期対応の遅れ





Our World in Data

2020年3月11日時点の世界の状況

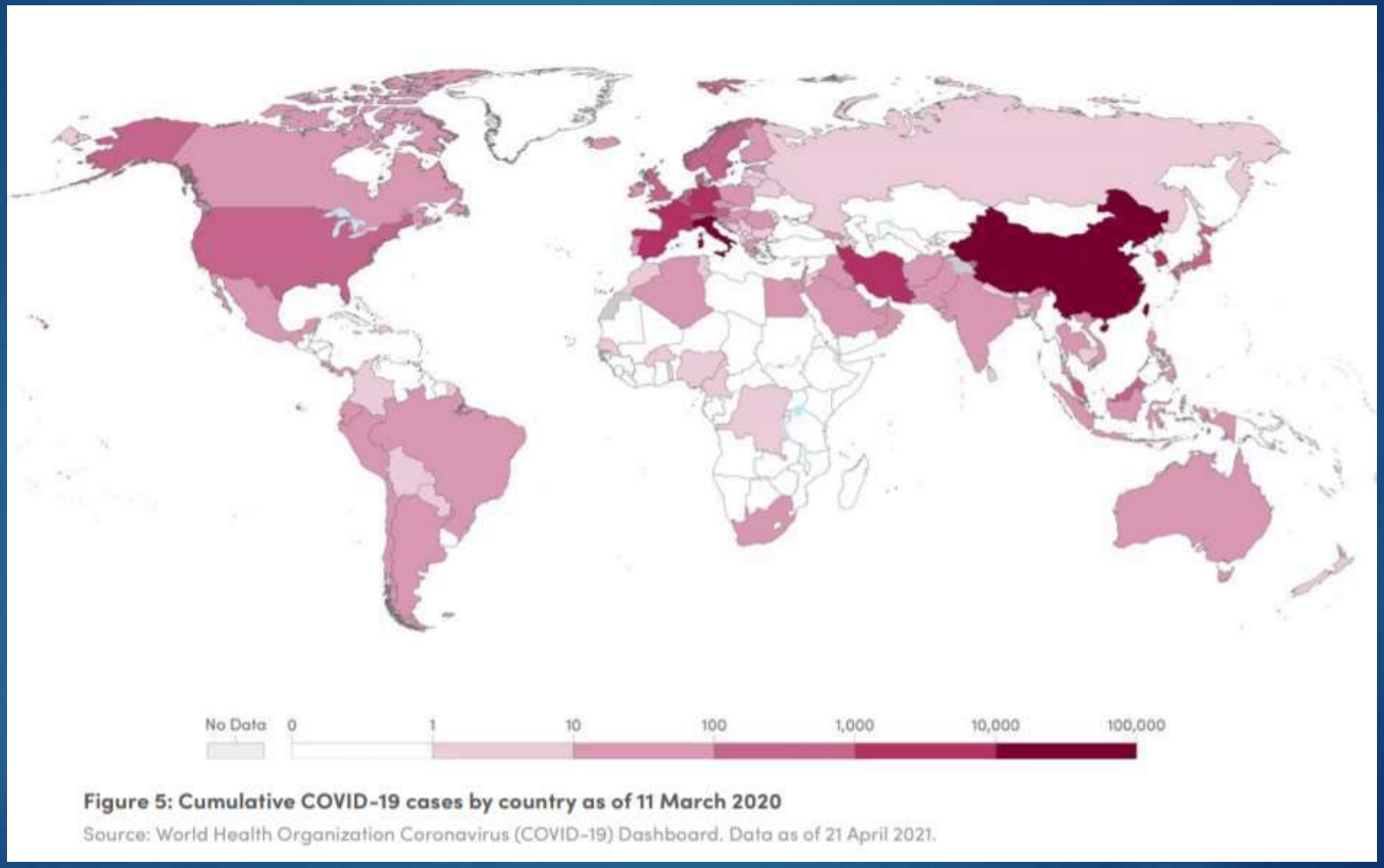
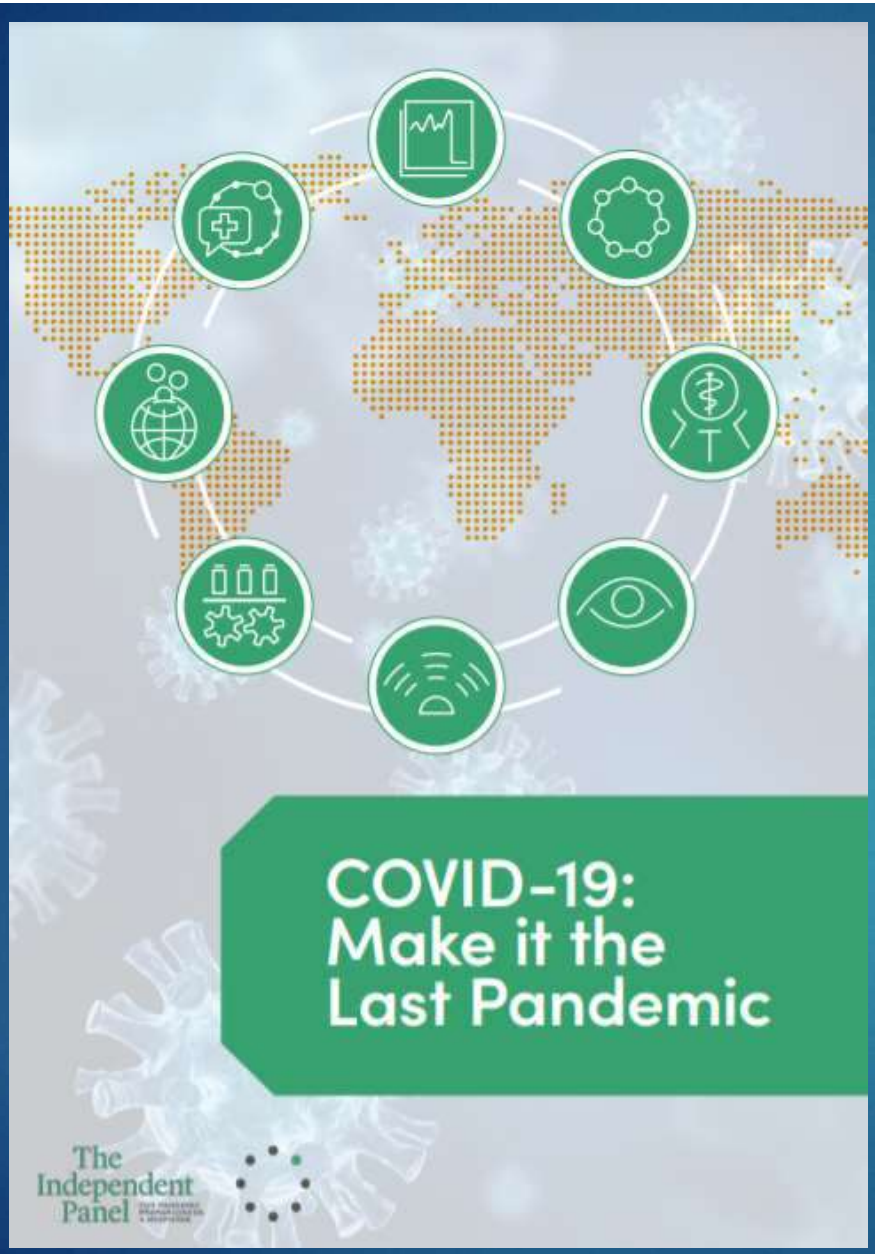


Figure 5: Cumulative COVID-19 cases by country as of 11 March 2020

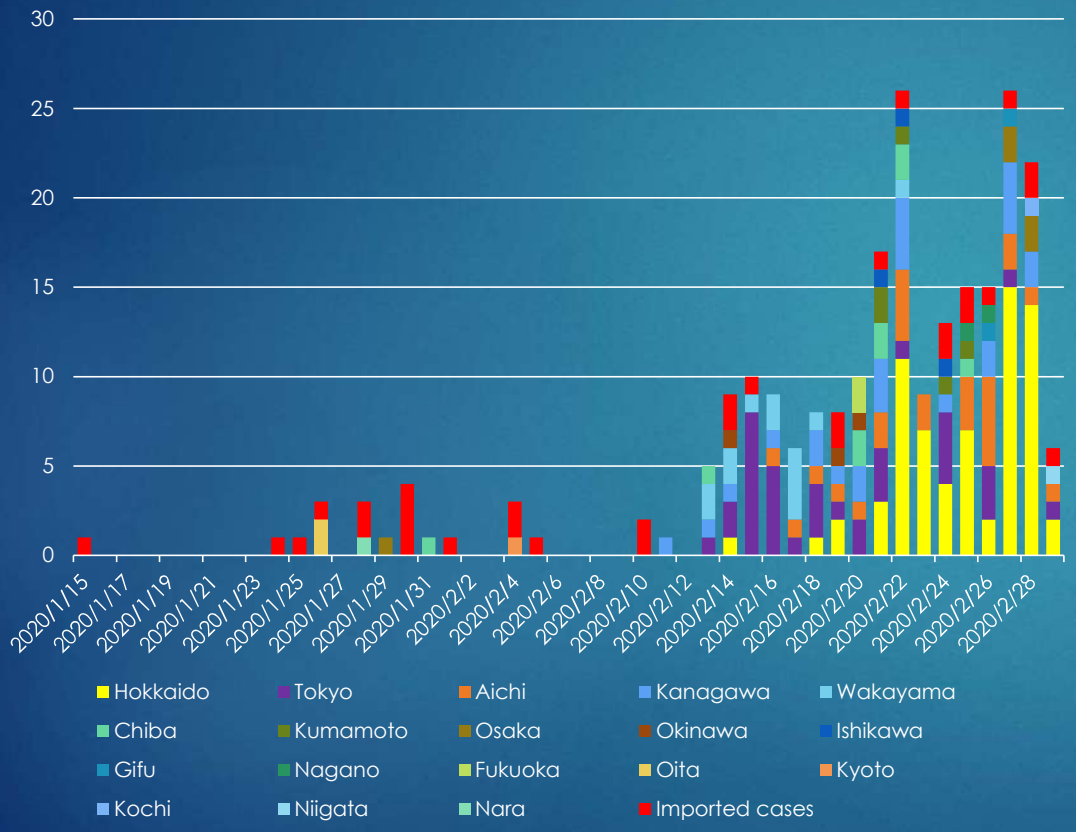
Source: World Health Organization Coronavirus (COVID-19) Dashboard. Data as of 21 April 2021.

Independent Panel Report

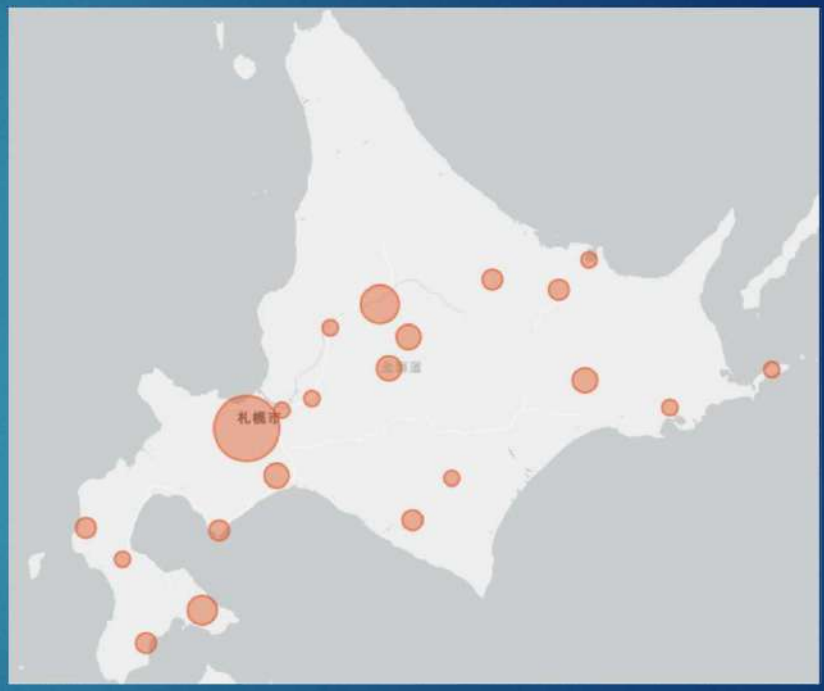


It is glaringly obvious to the Panel that **February 2020 was a lost month**, when steps could and should have been taken to curtail the epidemic and forestall the pandemic.

日本の初期対応



2020年2月の北海道での確定例の分布

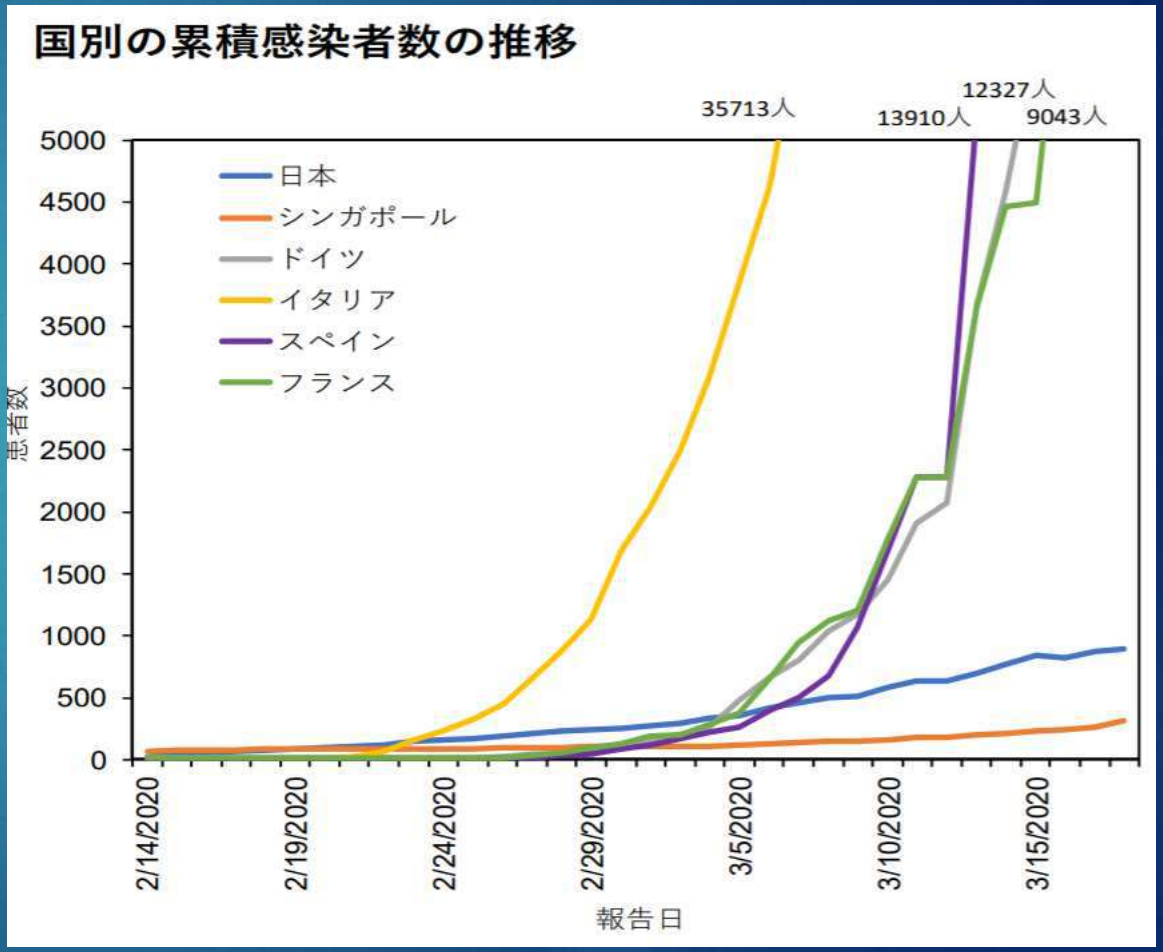


日本の新型コロナウイルス対策の目的

社会・経済機能への影響を最小限としながら・感染拡大の抑制効果を最大限にする

これからとるべき対策の最大の目標は・感染の拡大のスピードを抑制し・可能な限り重症者の発生と死亡数を減らすこと

2020年2月24日　新型コロナウイルス感染症対策専門家会議



新型コロナウイルス感染症対策専門家会議
「新型コロナウイルス感染症対策の状況分析・提言」（2020 年 3 月 19 日）

クラスター対策

厚生労働省クラスター対策班

2020年2月25日設置

J-STAGE Browse About J-STAGE News and PR Support

Japanese Journal of Infectious Diseases

Journal home Advance online publication Journal issue About the journal

J-STAGE home / Japanese Journal of Infectious ... / Advance online publication / Article overview

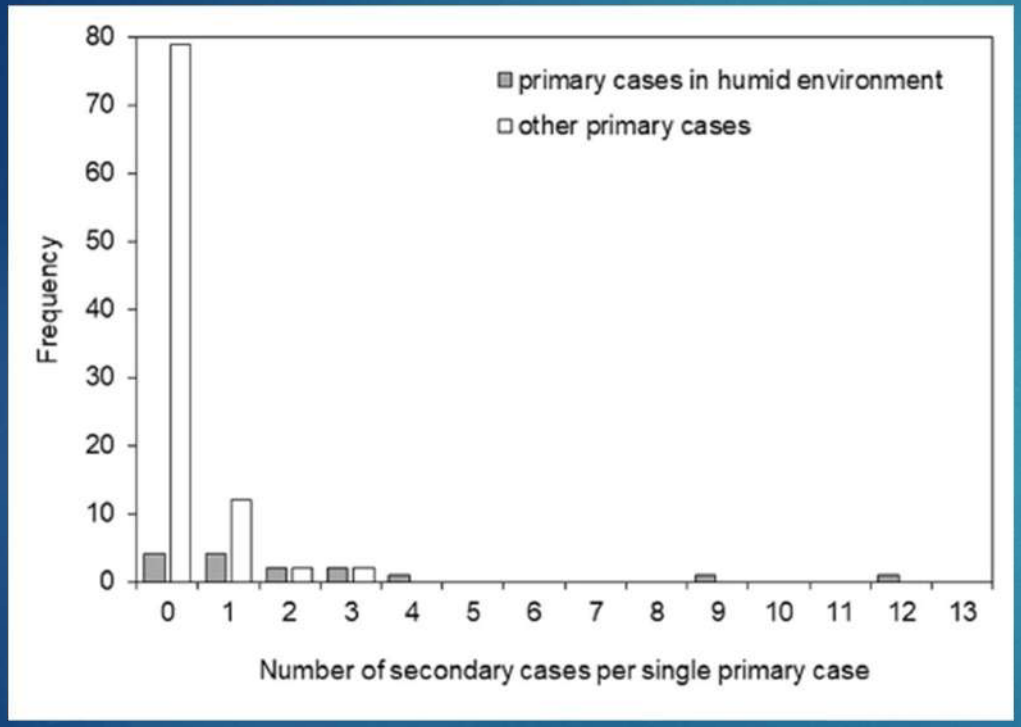
Cluster-based approach to Coronavirus Disease 2019 (COVID-19) response in Japan—February–April 2020

Hitoshi Oshitani, The Experts Members of The National COVID-19 Cluster Taskforce at Ministry of Health, Labour and Welfare, Japan

Author information

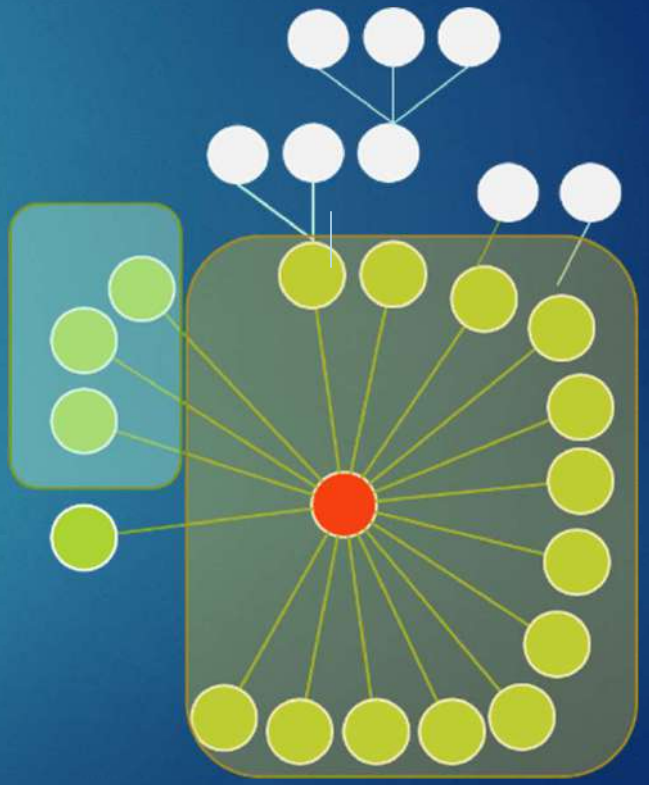
Keywords: COVID-19, Health policy, Cluster, Coronavirus Disease, Public health, Japan

COVID-19伝播の異質性

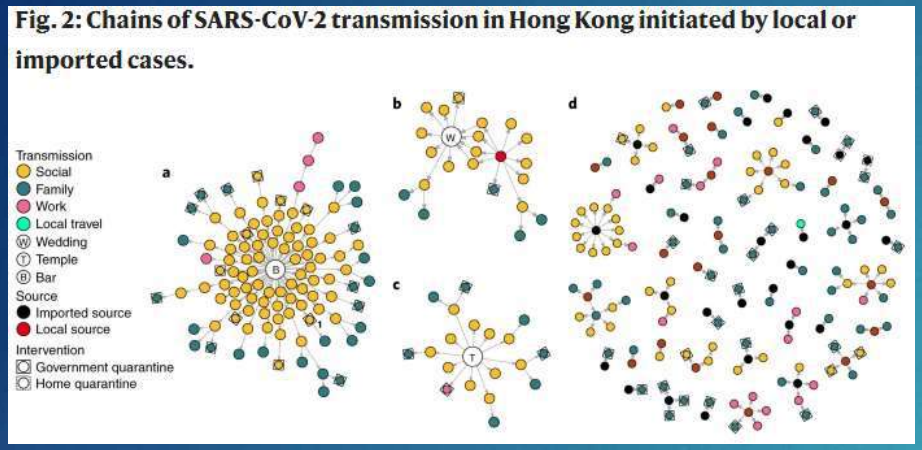


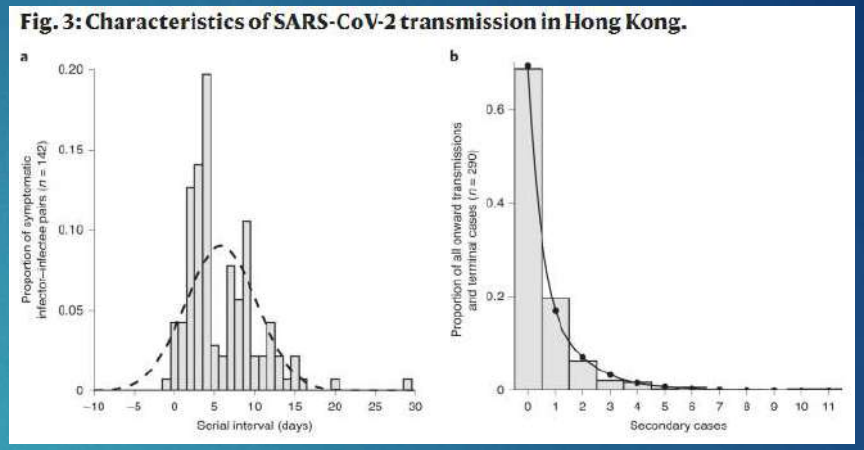
Nishiura H et al. MedRxiv https://doi.org/10.1101/2020.02.28.20029272

2020年2月に検知された感染伝播

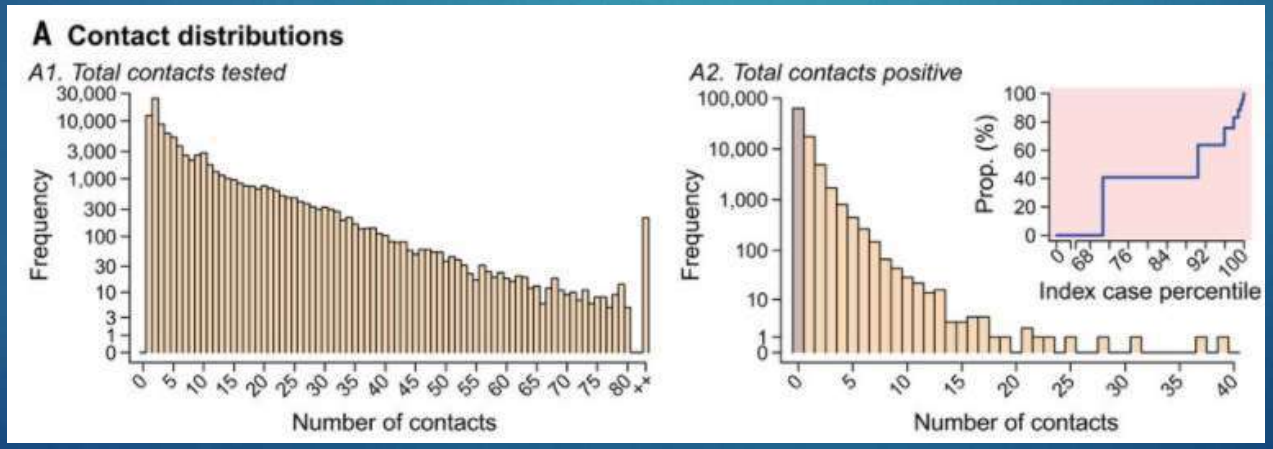


COVID-19の異質性



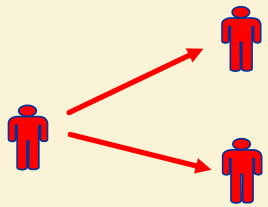


Adam DC et al. Nature Med. 26.1714–1719 (2020)



Laxminarayan R. Science: 370, 6517, 691-697(2020)

基本再生産数（R_0）



平均して，1人の感染者が何人に感染させるかという指標

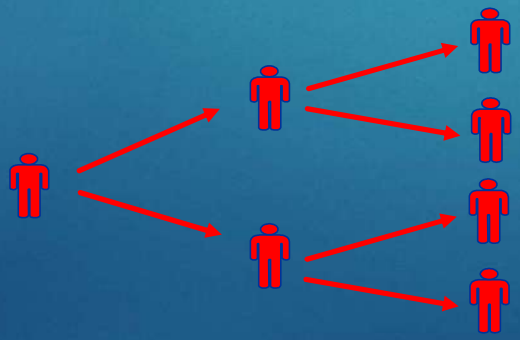
$R_0 = 1$

定常状態

$R_0 < 1$

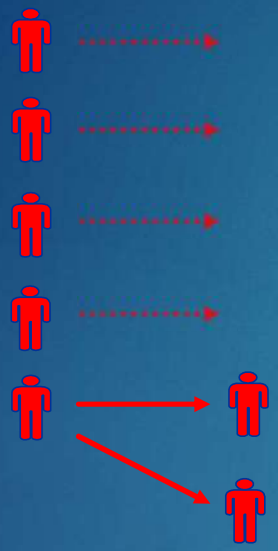
流行は収束

$R_0 > 1$



流行は拡大

なぜ感染連鎖は継続するのか？



2次感染を起こさない

R_0=2/5=0.4

持続感染は起きない

2次感染を起こさない

クラスター
(super-spreading event)

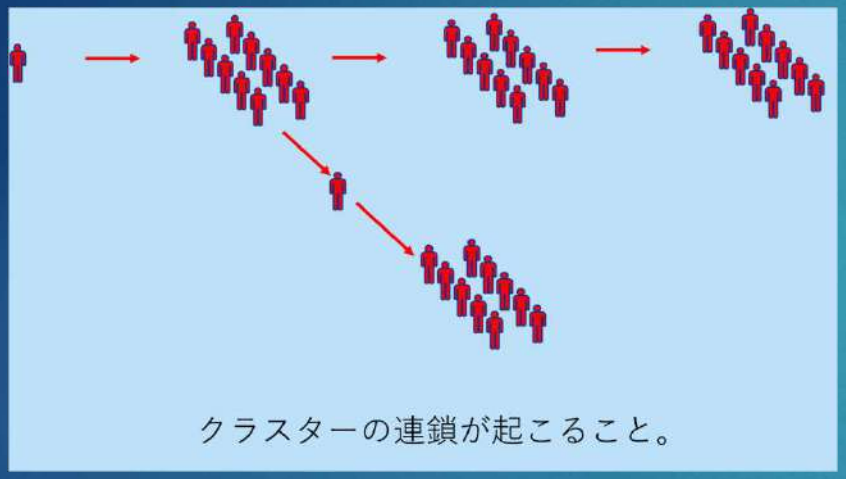
R_0=10/5=2

持続感染が起きる

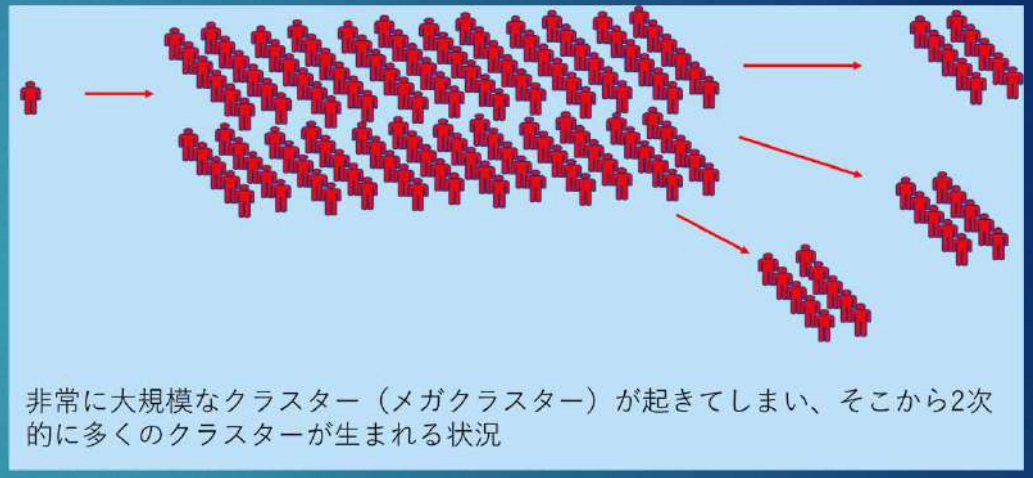
Overdispersion of COVID-19 transmission gives the virus an Achilles' heel

Sneppen K et. al. PNAS 2021 Vol. 118 No. 14 e2016623118

急速な感染拡大の起こる条件



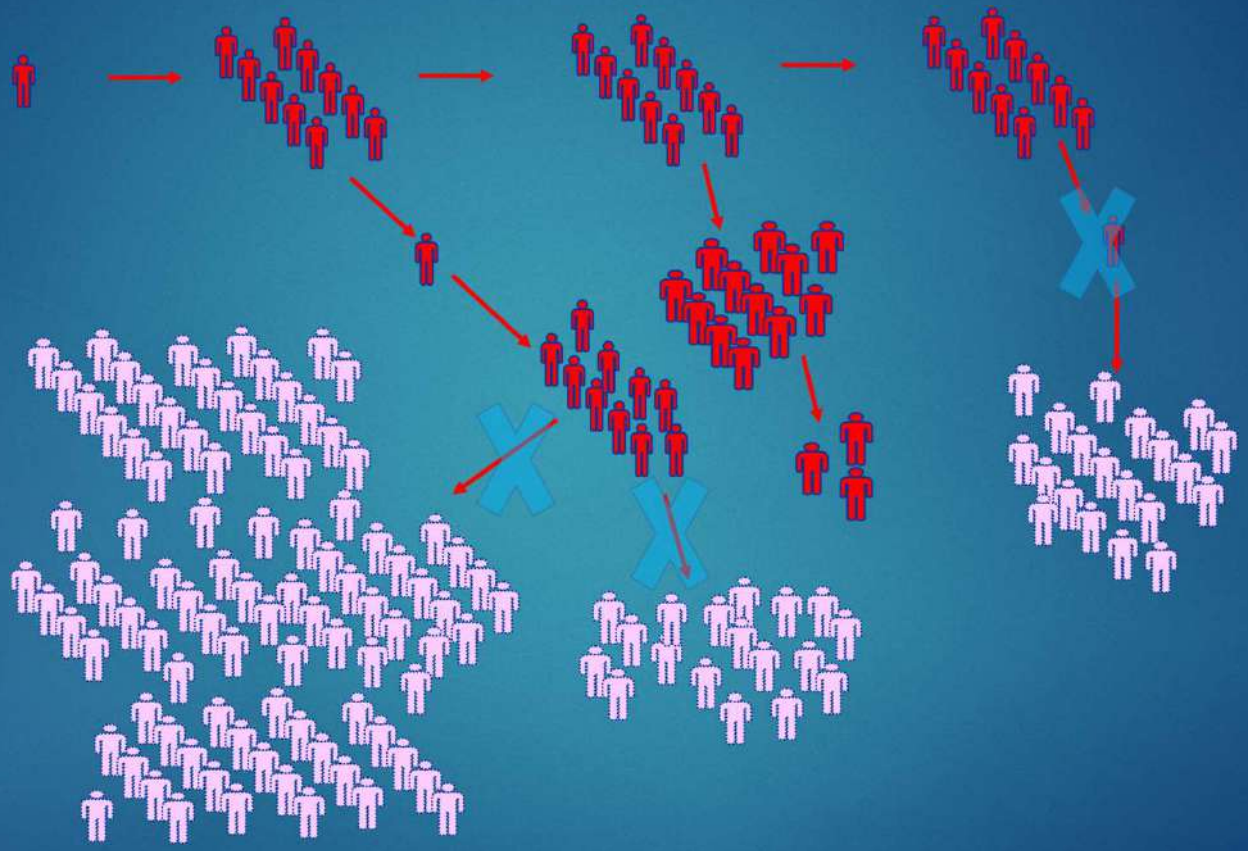
クラスターの連鎖が起こること。



非常に大規模なクラスター（メガクラスター）が起きてしまい、そこから2次的に多くのクラスターが生まれる状況

公衆衛生学会クラスター対策研修会（2020年3月29日）

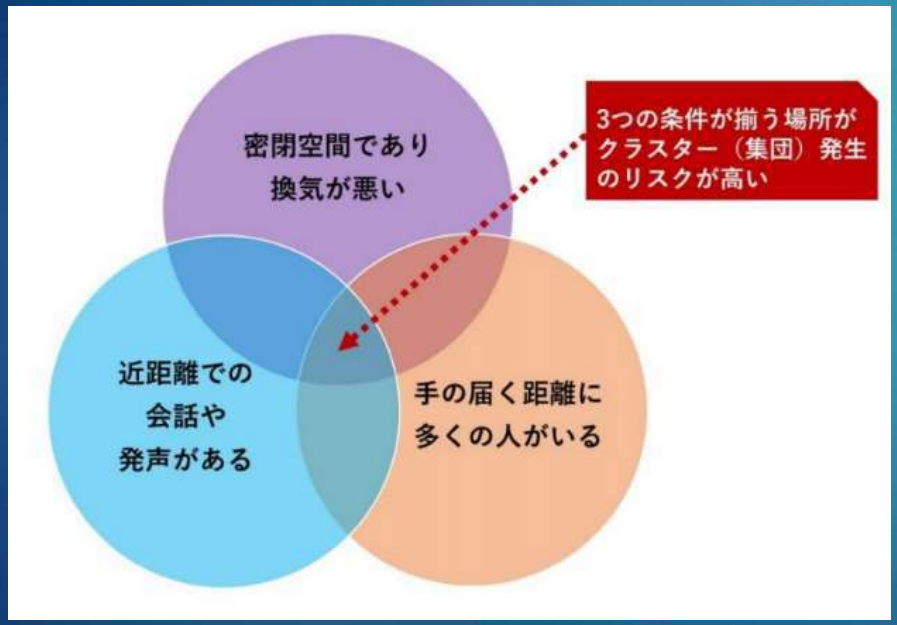
クラスター対策の意義（1）



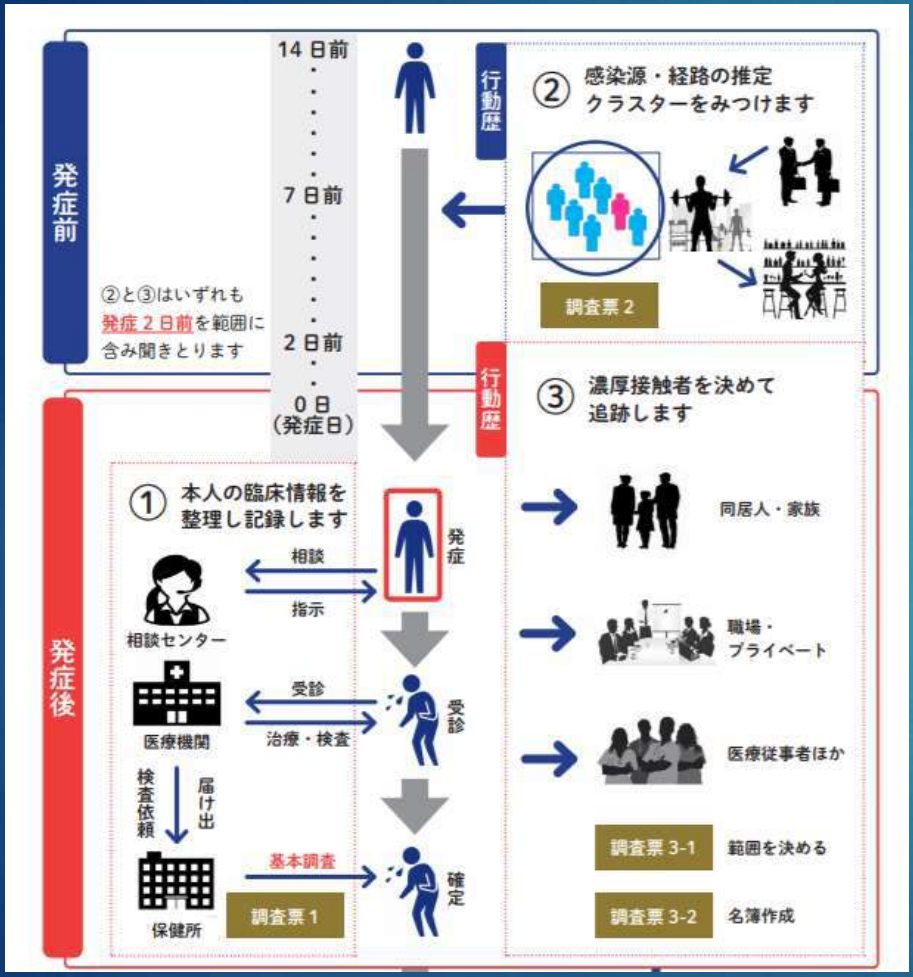
クラスター連鎖を未然に防ぐことができる

クラスター対策の意義

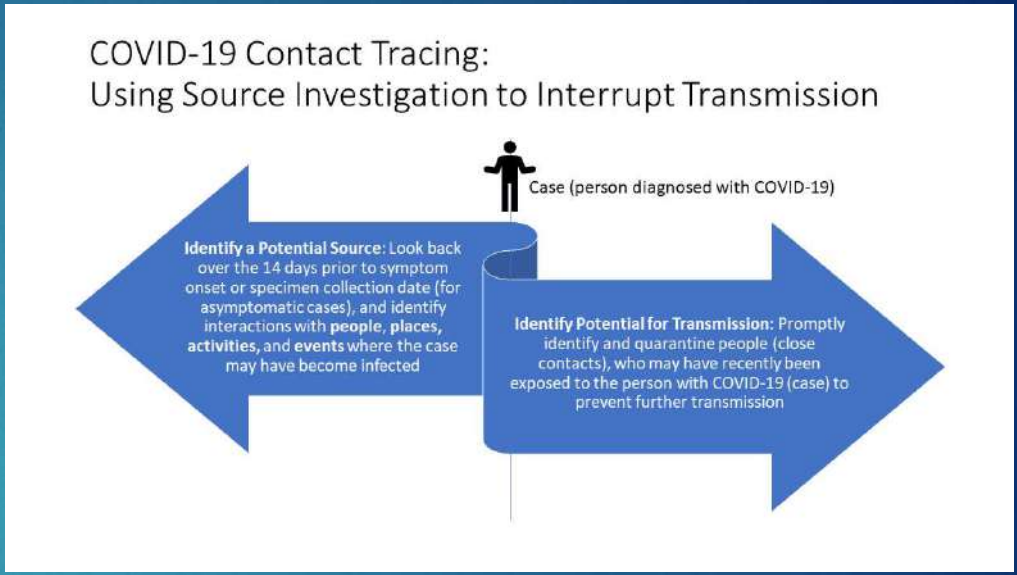
- 3密条件（密閉・密集・密接）



積極的疫学調査（Contact Tracing）

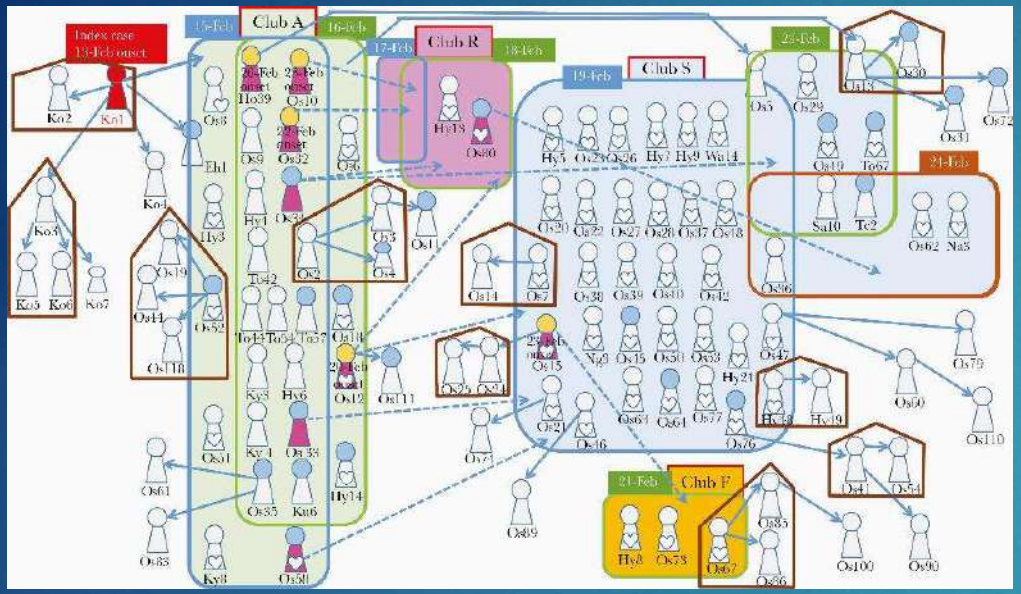


保健師のための積極的疫学調査ガイド
［新型コロナウイルス感染症］

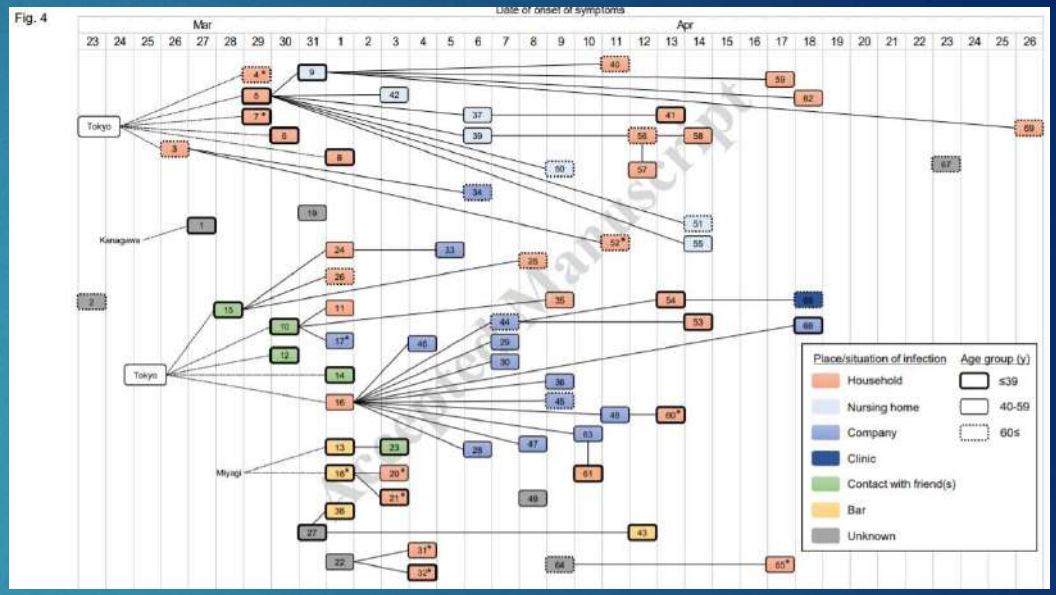


COVID-19 Source Investigation
Updated Feb. 23, 2021 US CDC

日本におけるクラスターの検知



Sugano N et al. J Infect Dis. Vol 222, 2020

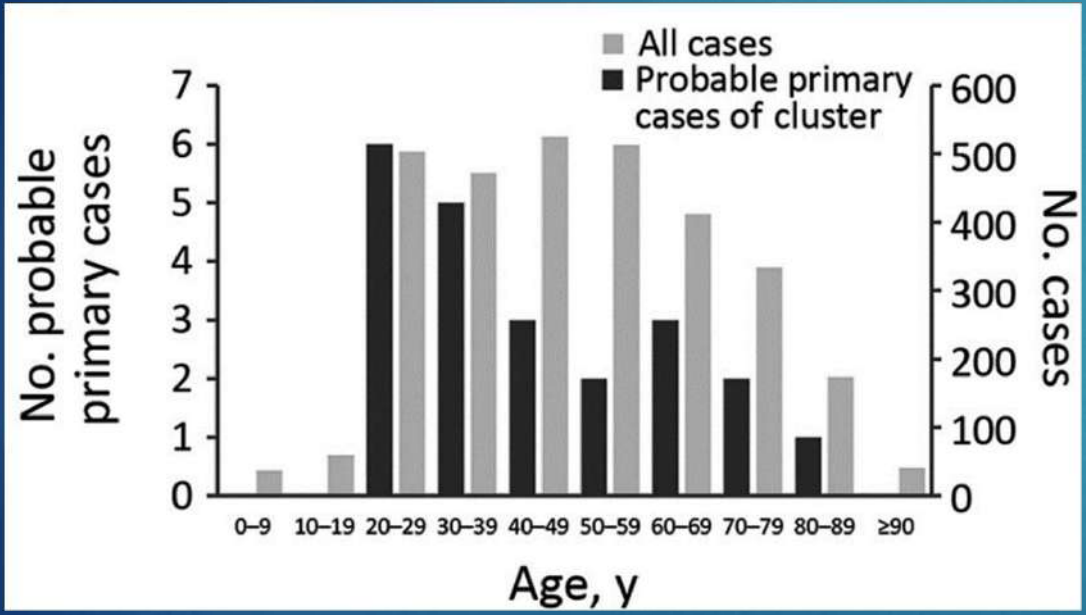


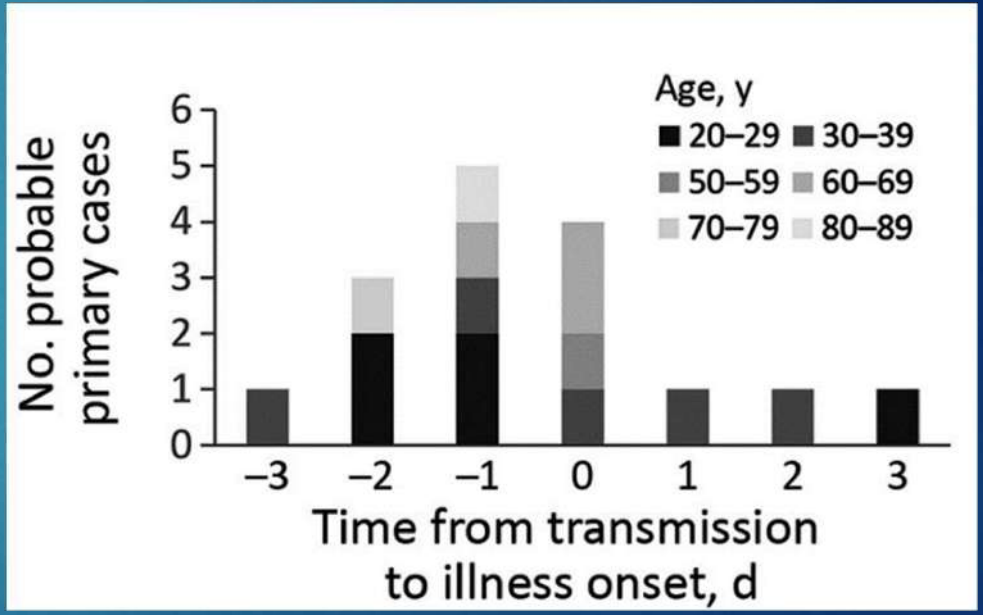
Seto J et al. Jpn J Infect Dis. 2021 Mar 31.

誰がクラスターを起こしているのか？

約半数クラスーは20_30代の人が発端となっている

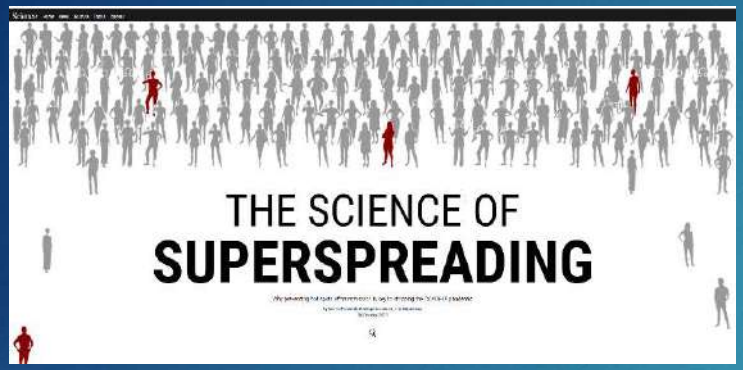
40%以上は発症前の人が発端となっている

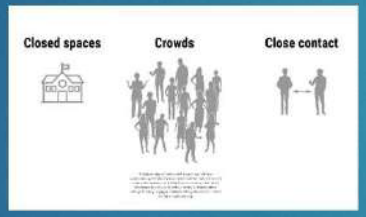


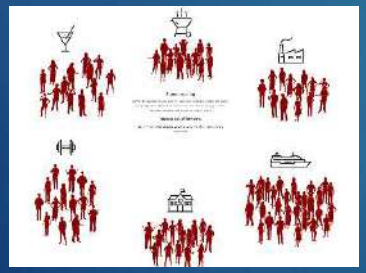


Furuse Y et al. Emerg Infect Dis. 2020;26(9):2176-2179.

クラスター対策の国際的認知

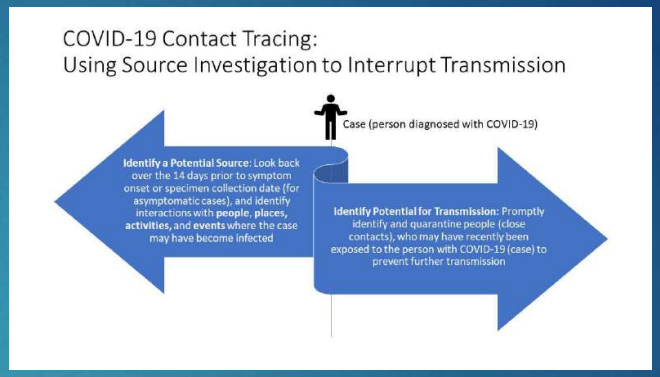






https://vis.sciencemag.org/covid-clusters/

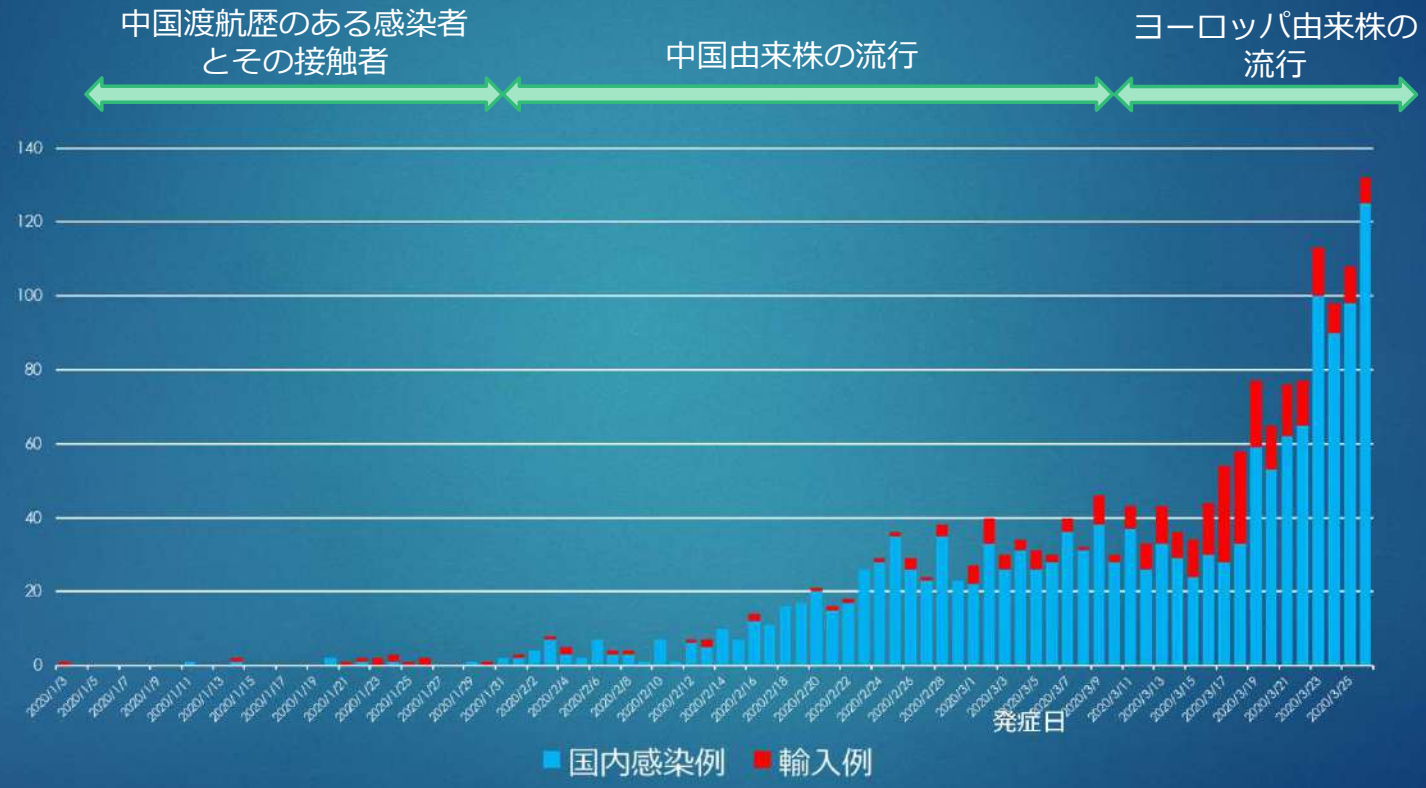
Science



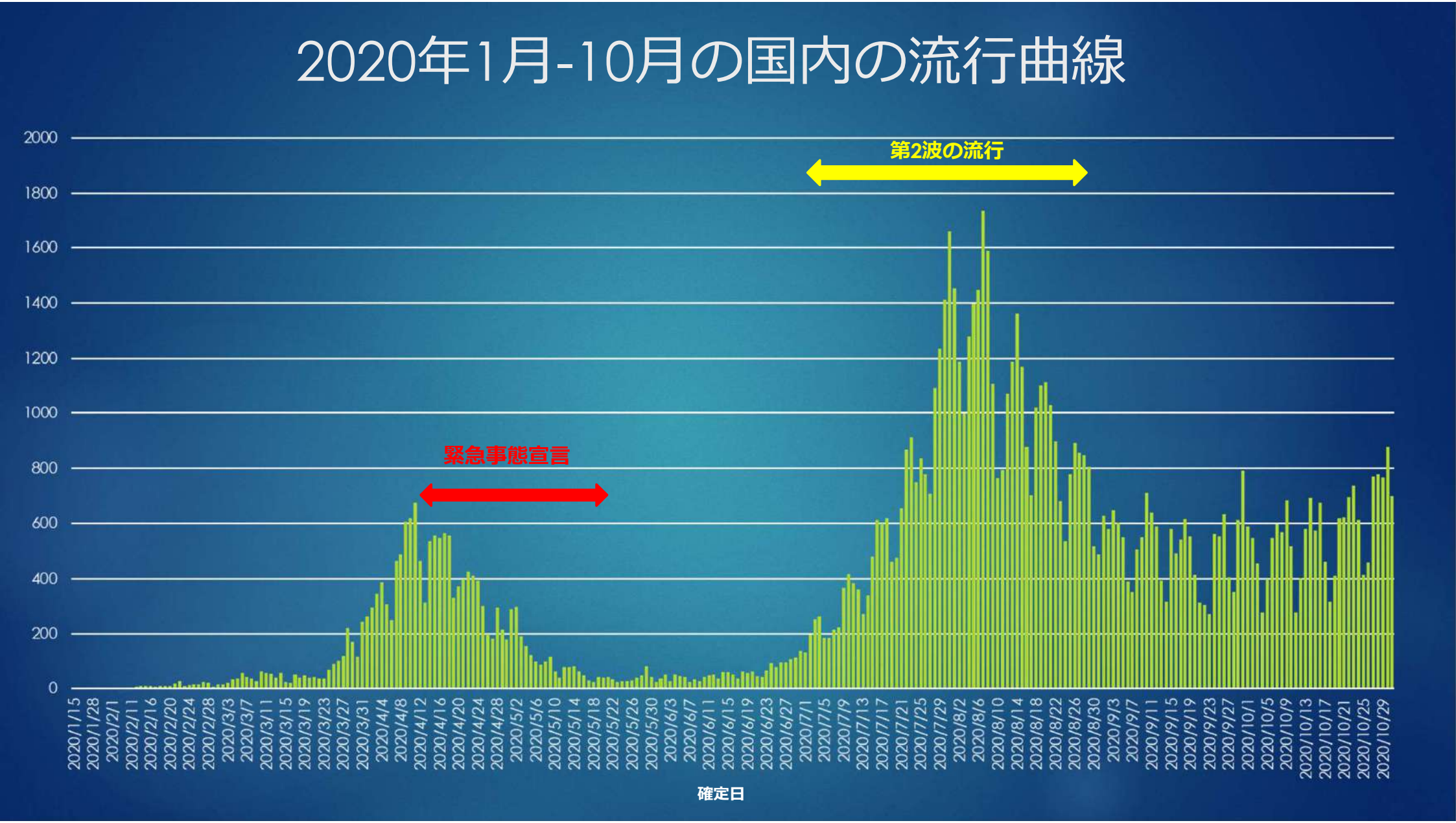
COVID-19 Source Investigation
Updated Feb. 23, 2021 US CDC

WHO WPRO

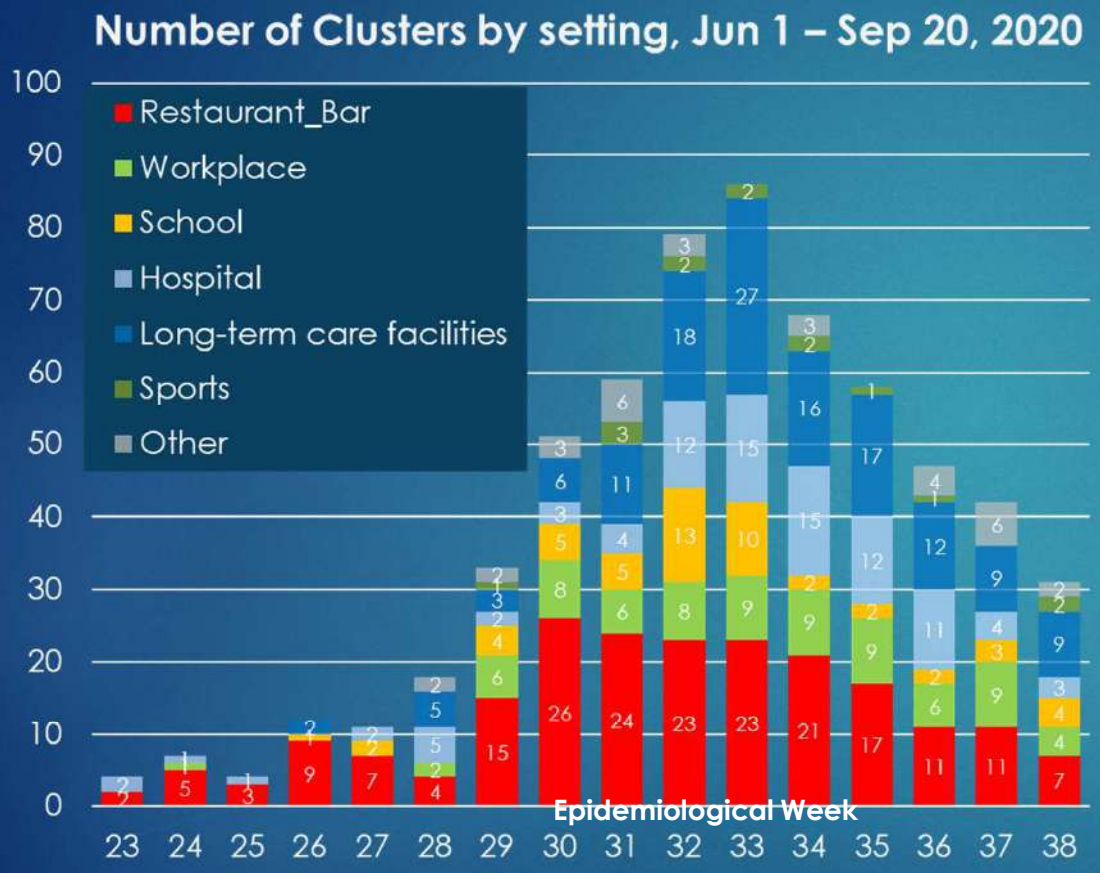
2020年1－3月の流行

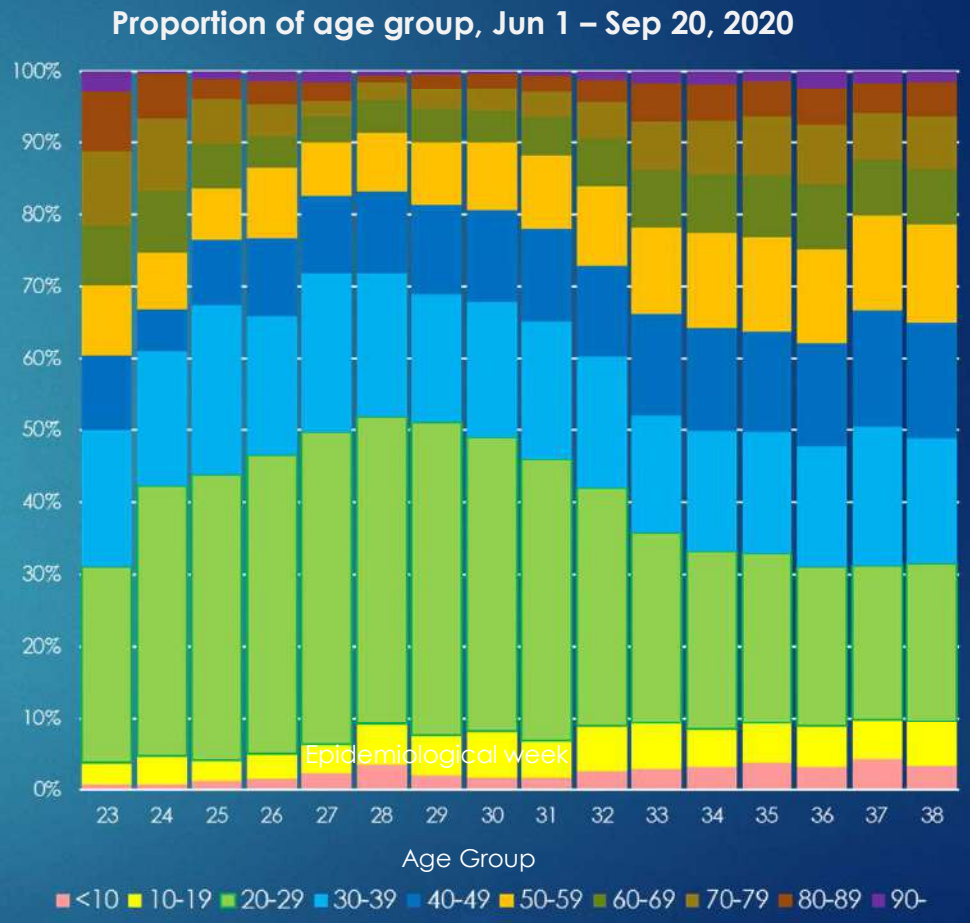


2020年1月-10月の国内の流行曲線

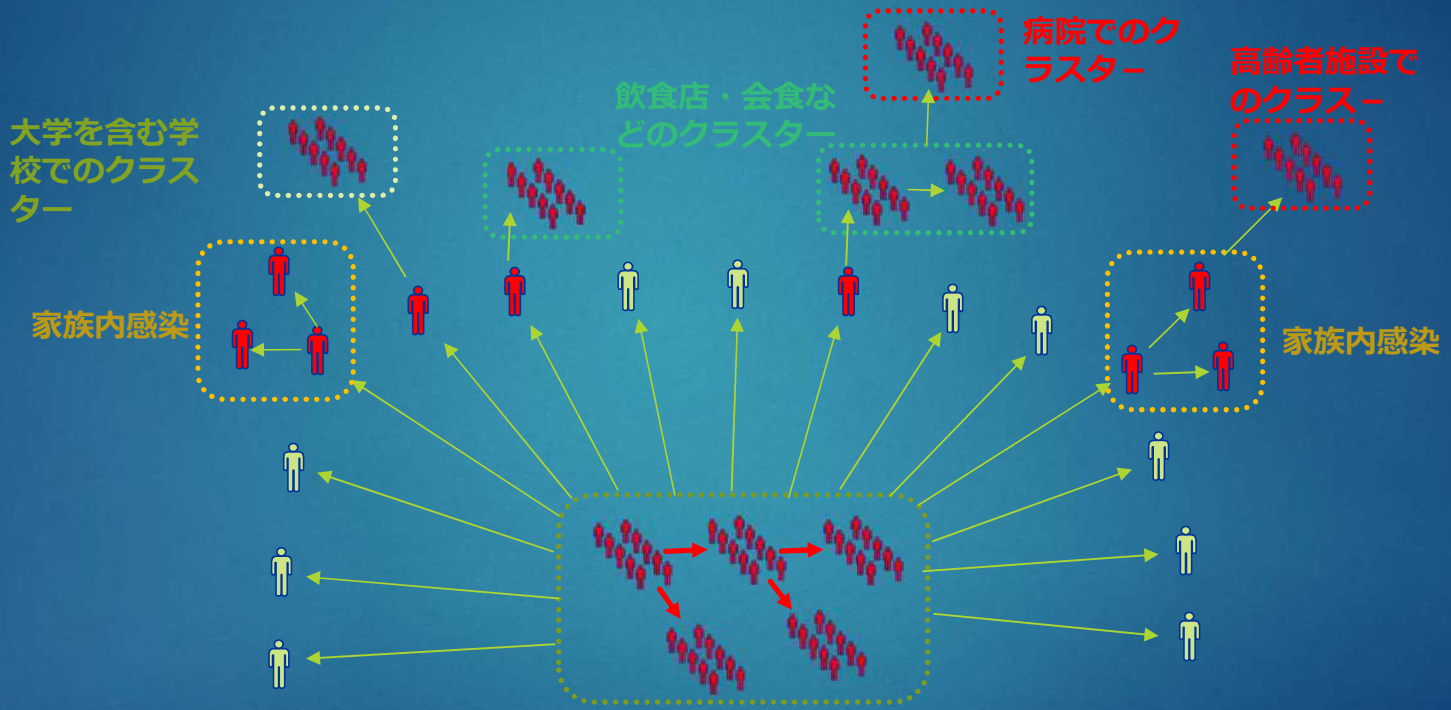


第２波の疫学的特徴


Number of Clusters by setting, Jun 1 – Sep 20, 2020
Restaurant_Bar
Workplace
School
Hospital
Long-term care facilities
Sports
Other
Epidemiological Week

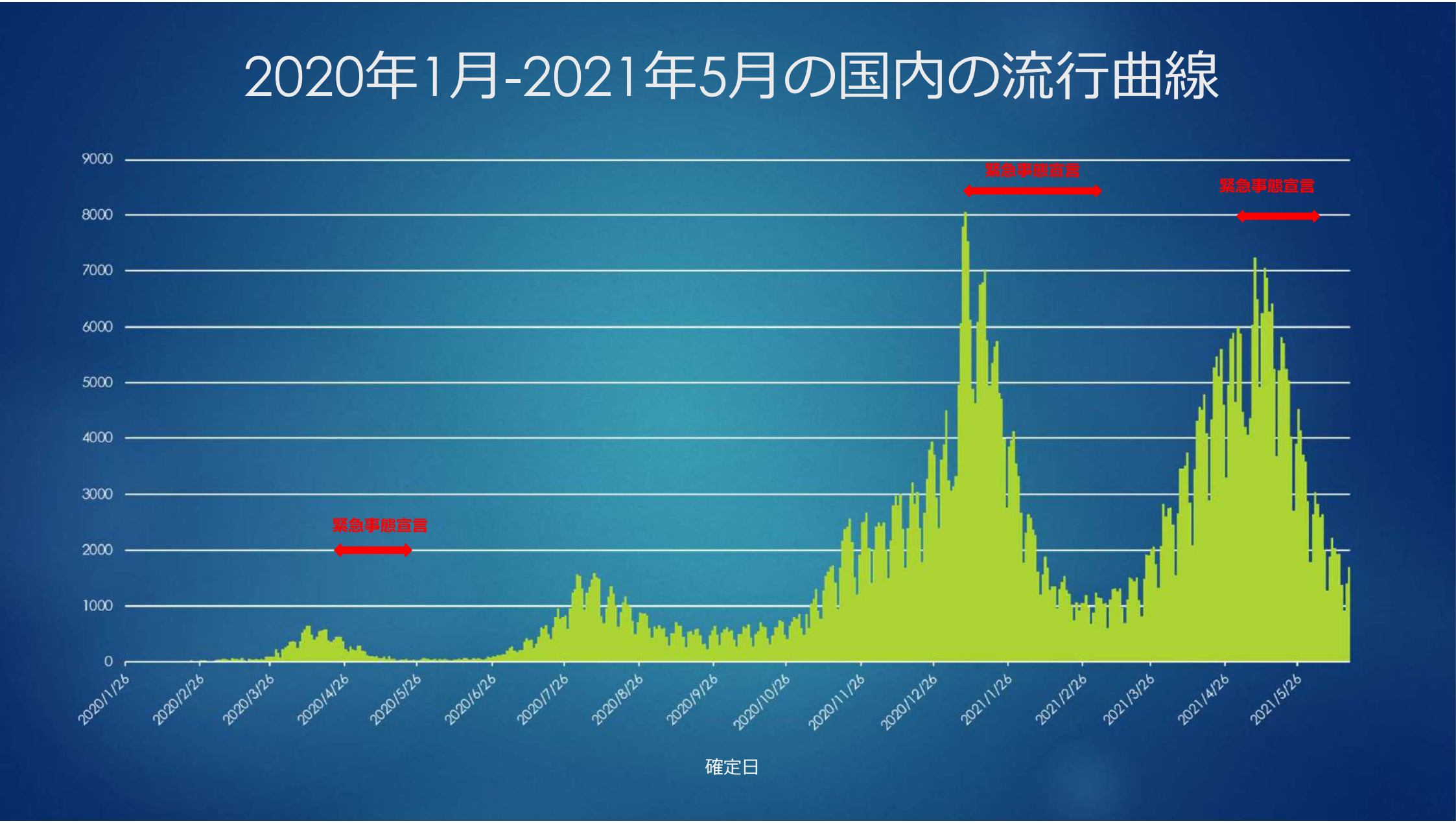

Proportion of age group, Jun 1 – Sep 20, 2020
Epidemiological week
Age Group
<10
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-

第2波の伝播パターン

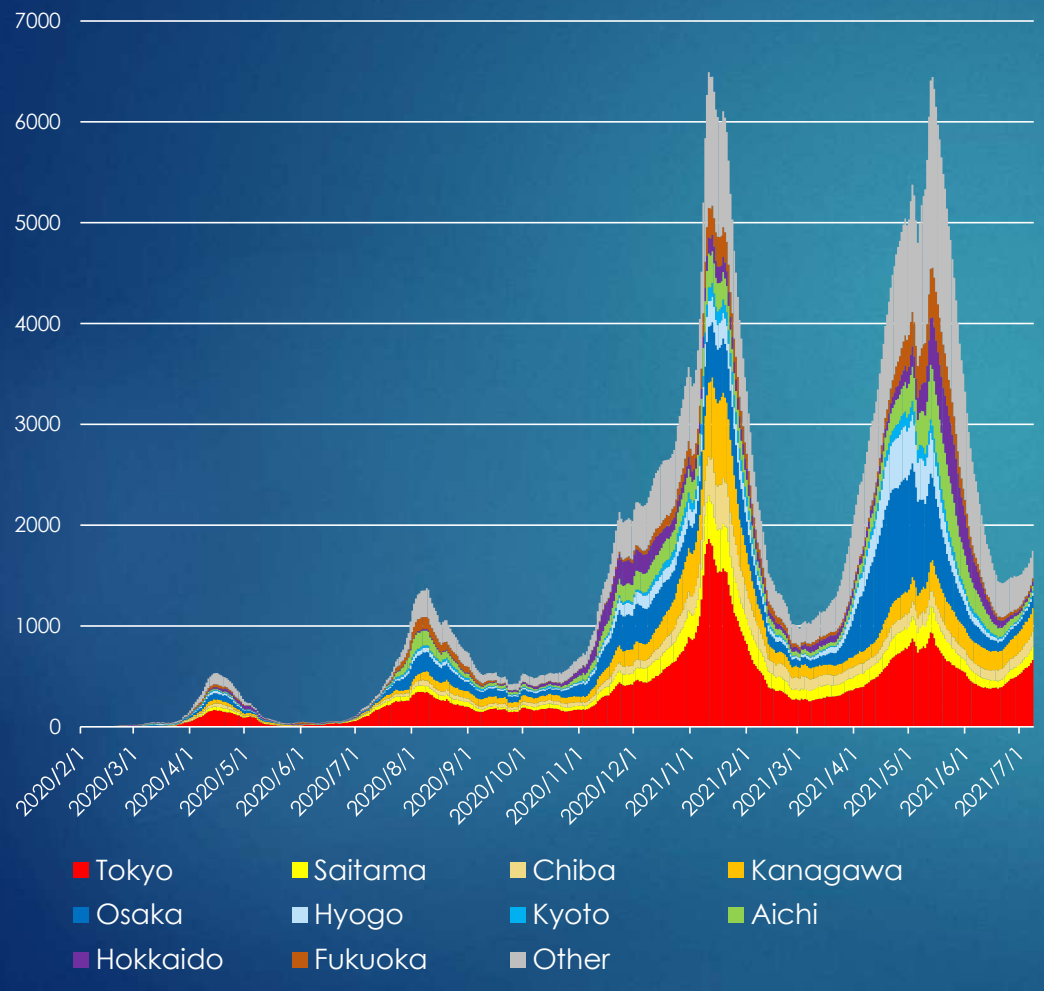


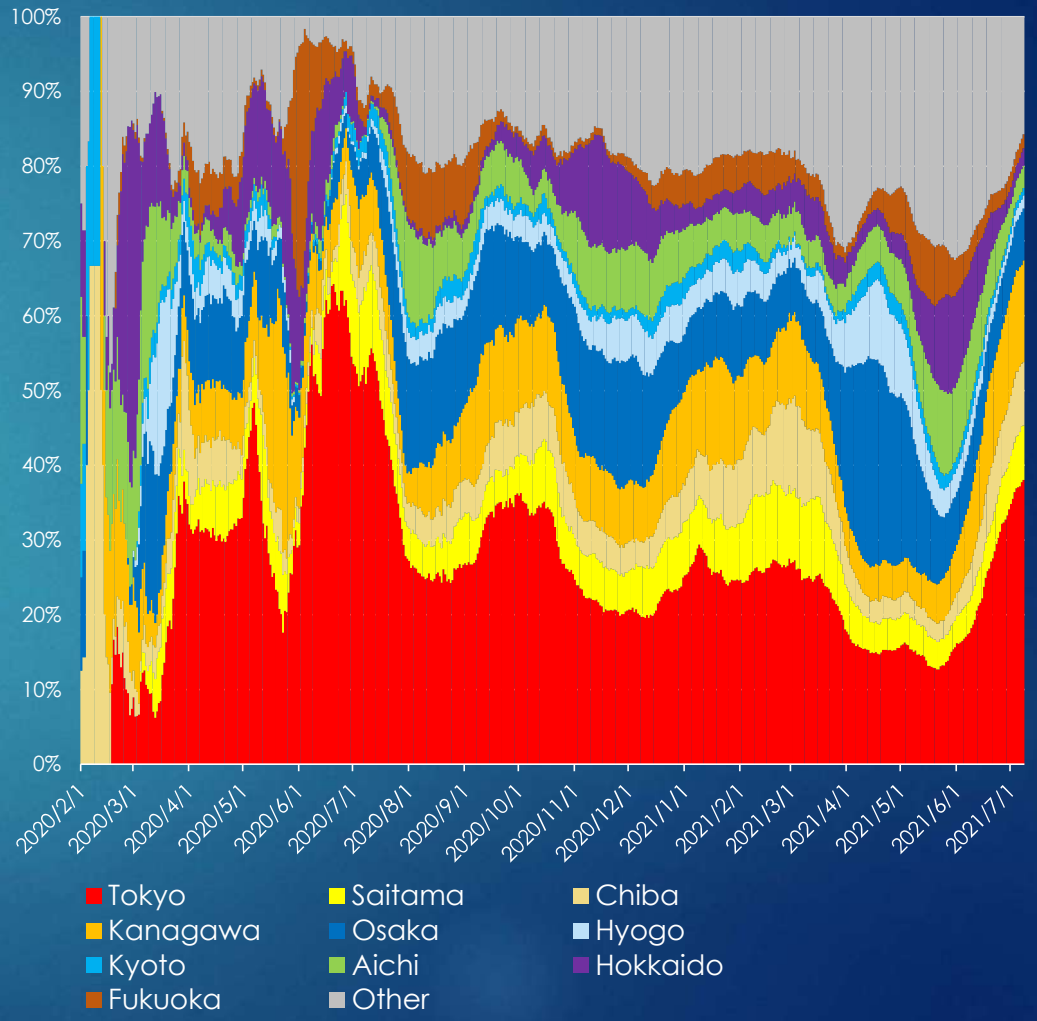
都市部での接待をともなう飲食店とそれに関連する一定規模のクラスター連鎖

2020年1月-2021年5月の国内の流行曲線

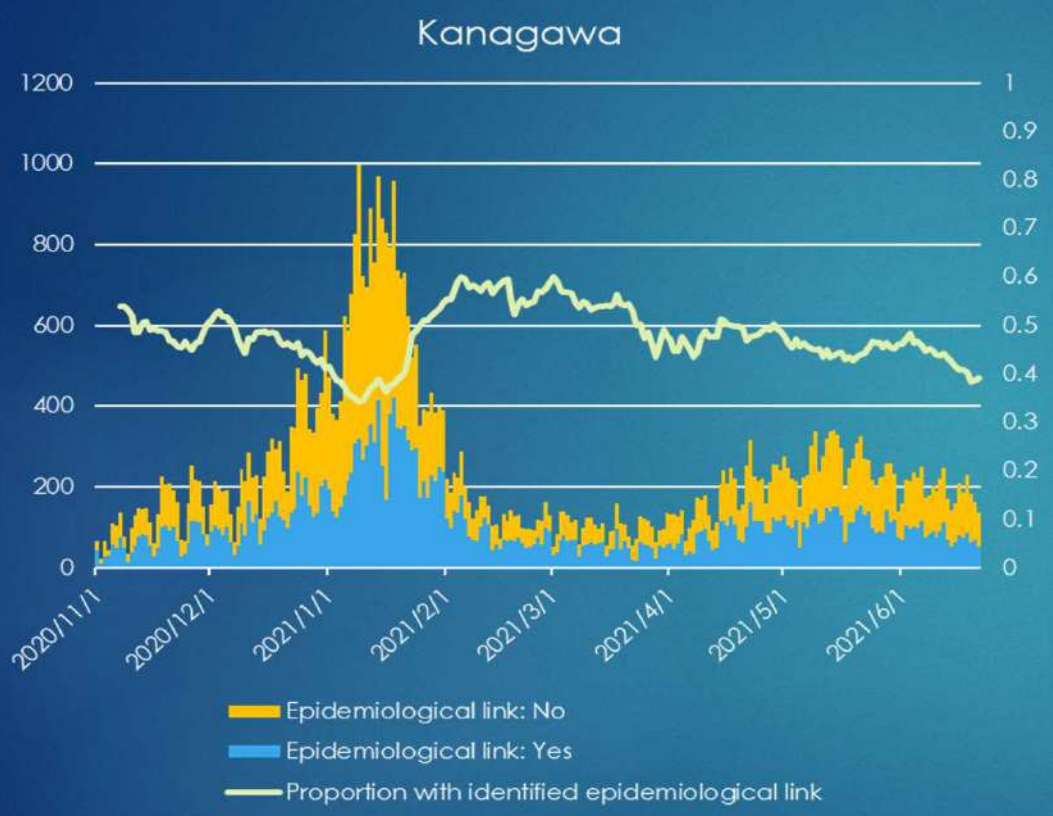


主な都道府県の感染者数と全国の感染者に占める割合

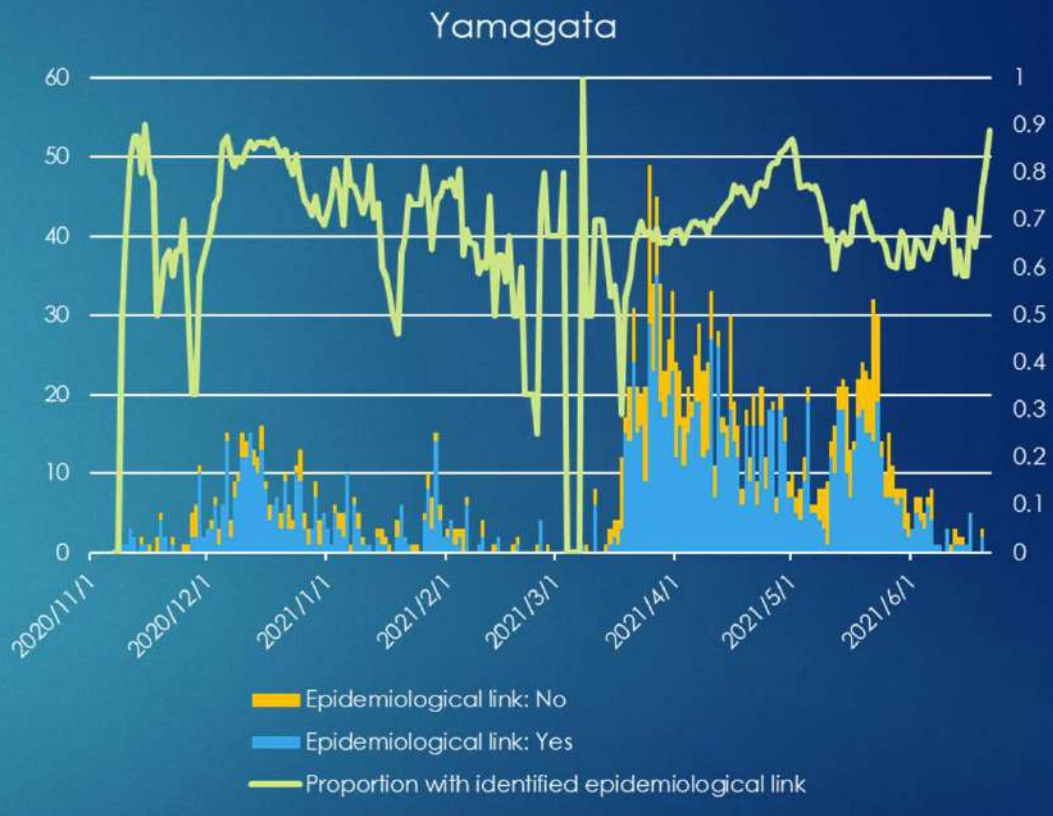




疫学リンクの判明率の違い



Population: 9.2 million
Total number of confirmed cases; 65,599
Overall proportion with epidemiological link：45.7%



Population: 1.08 million
Total number of confirmed cases; 2,020
Overall proportion with epidemiological link：71.4%

都道府県ごとの感染者数と人口当たりの感染者数

As of June 17, 2021, a total of 777,843 cases have been confirmed, including 167,868 (21.6%) in Tokyo and 102,144 (13.1%) in Osaka

A：イスラエルでの集団接種成績（2021年3月24日）
（実施者：イスラエル政府等）

○ イスラエル保健省が、国家公衆衛生調査データを利用して実施した**後ろ向きコホート研究の査読前（プレプリント）論文**

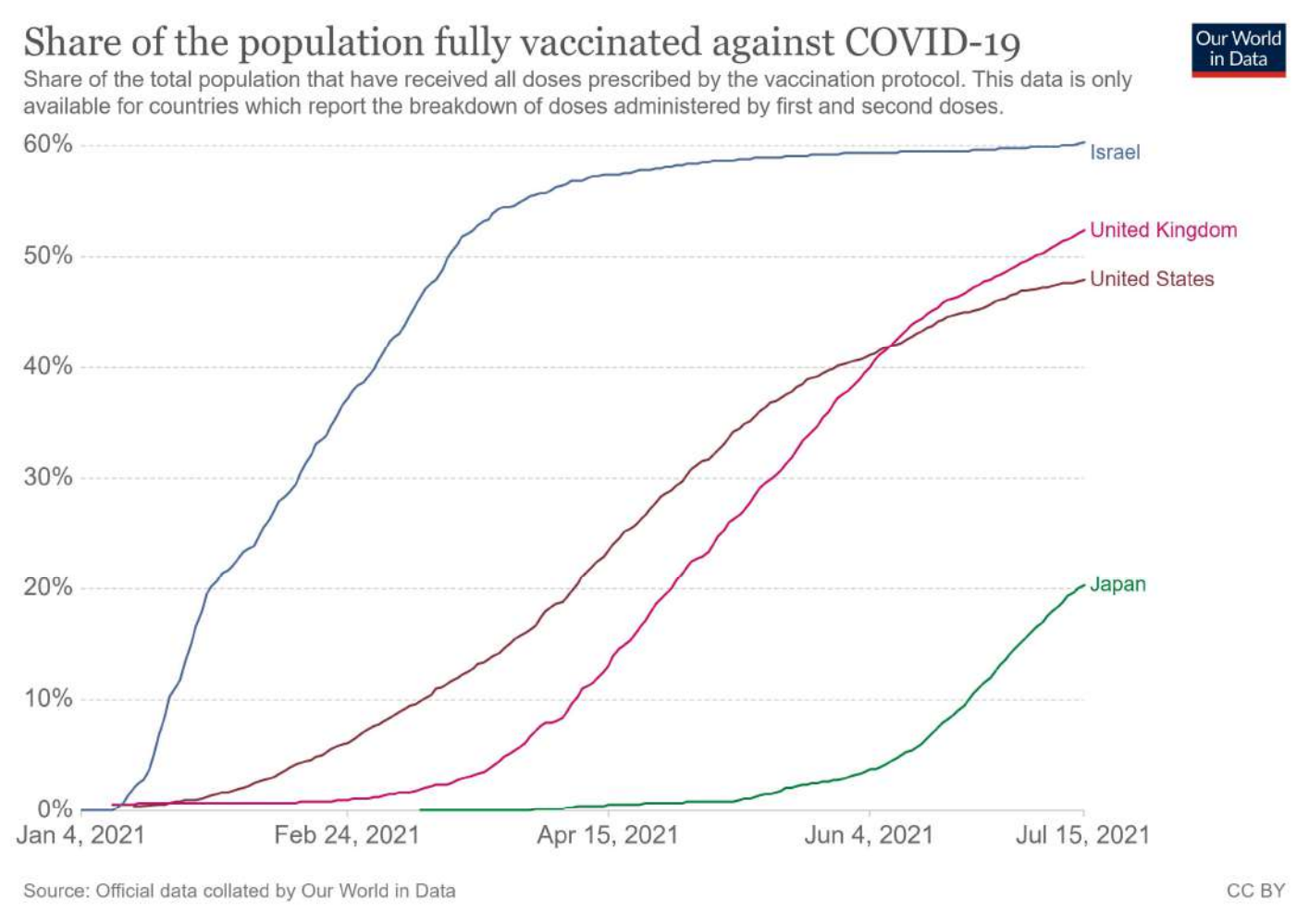
○ 全国民をカバーする医療保険で用いられるID番号を通じ、各種調査・医療データ等を結合して解析を行った。
具体的には、1/24から3/6までの期間、PCR検査結果の報告、コロナ様症状の有無の問診調査、新型コロナでの入院患者等の国家データベース情報を、ID番号により個人レベルでリンクさせ解析した。

○ 結果：
BNT162b2 2回目接種から7日以後のワクチン有効率（VE）の推定値は以下のとおり。
VEの推定値は、BNT162b2の2回目接種14日以後はさらに高かった。

（2回接種7日以後）	発生率（10万人・日当たり）		ワクチン有効率（VE）（調整後）
	非接種者	2回接種者	
SARS-CoV-2感染	116.2	5.3	94·1%（93·4–94·7）
無症候性感染	54.6	3.2	90·4%（89·1–91.5）
症候性感染	40.9	1.4	96·3%（95·9–96·7）
入院症例	5.0	0.5	96·0%（95·2–96·6）
重度および重大な入院	2.8	0.3	96·2%（95·5–96·8）
死亡	0.5	0.1	93·3%（91·5–94·8）

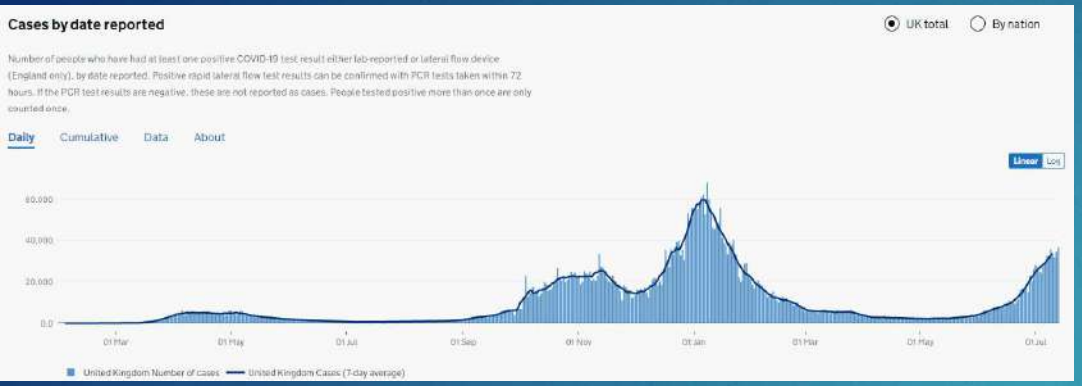
○ **疫学研究であり、バイアスを考慮する必要**がある。

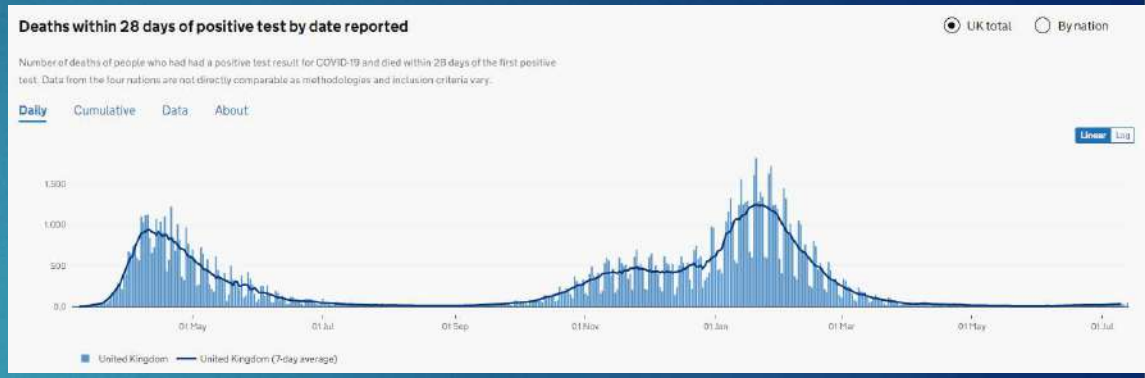
各国のワクチン接種率

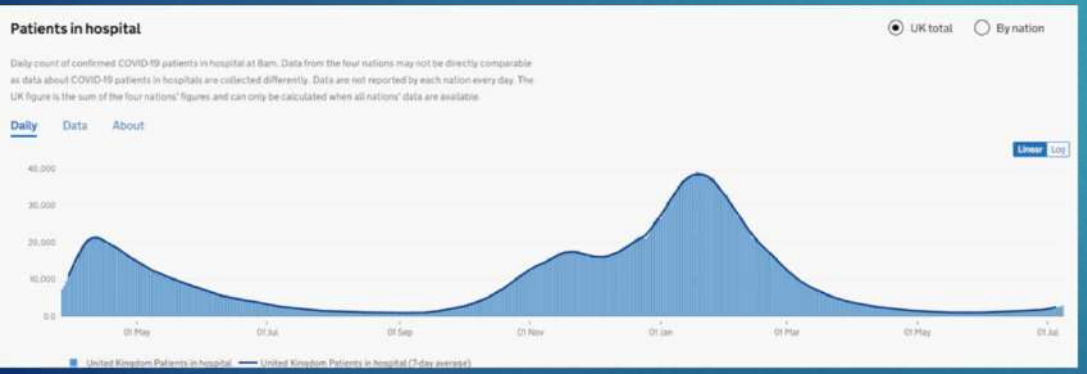


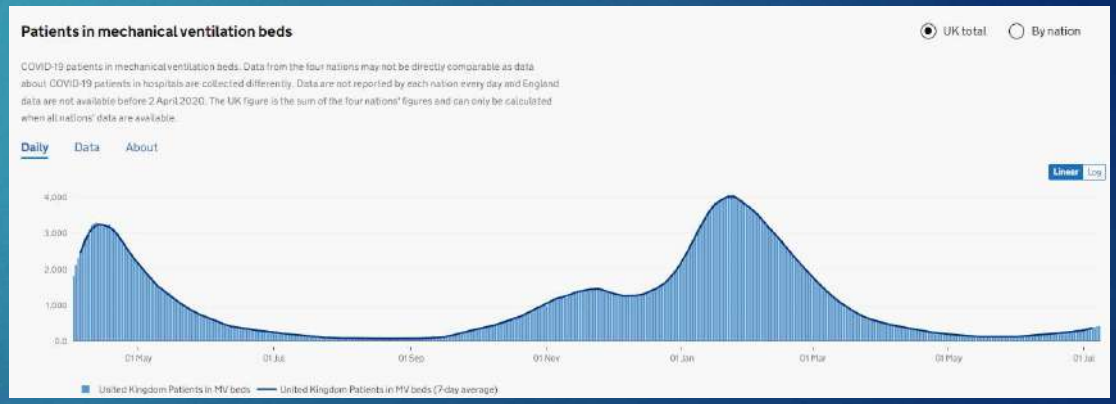
Our World in Data

英国の感染状況



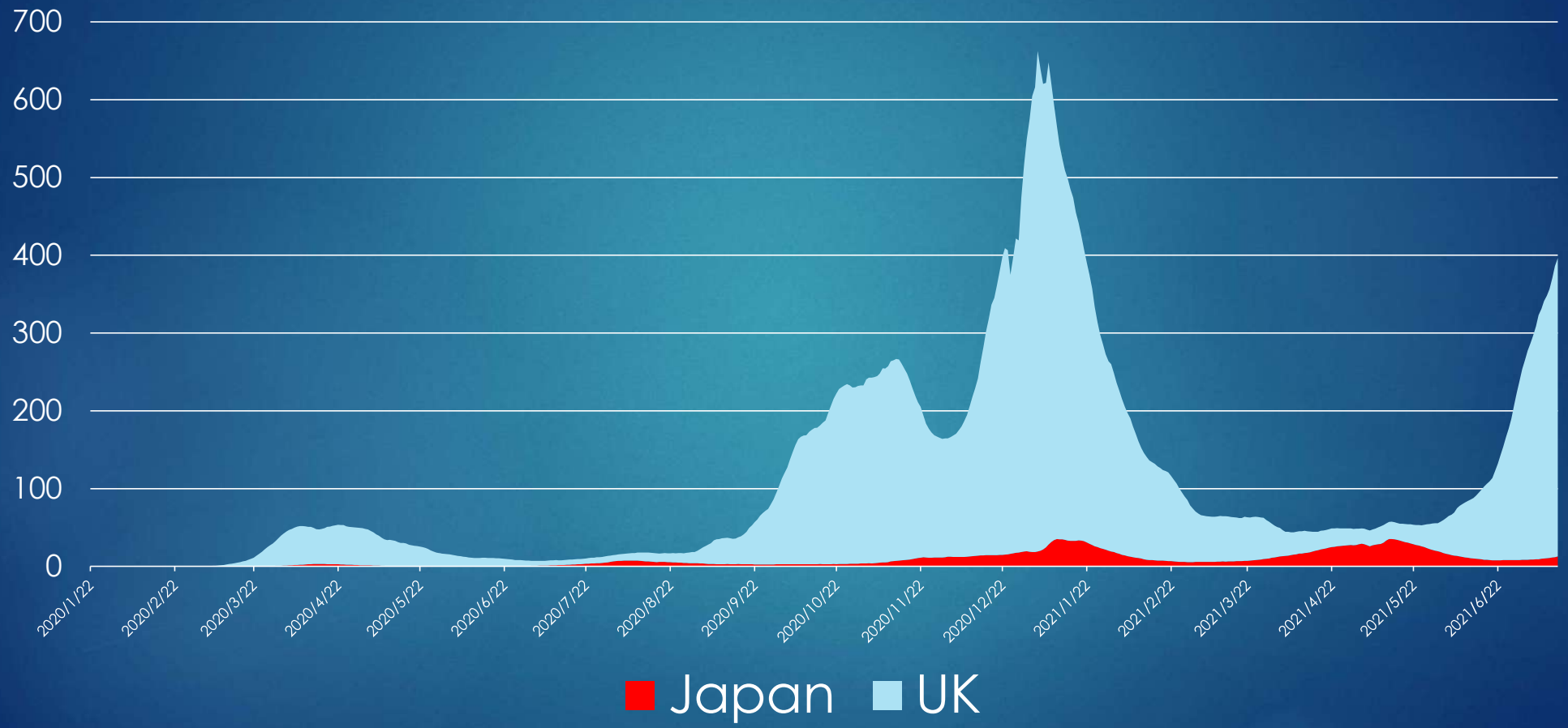




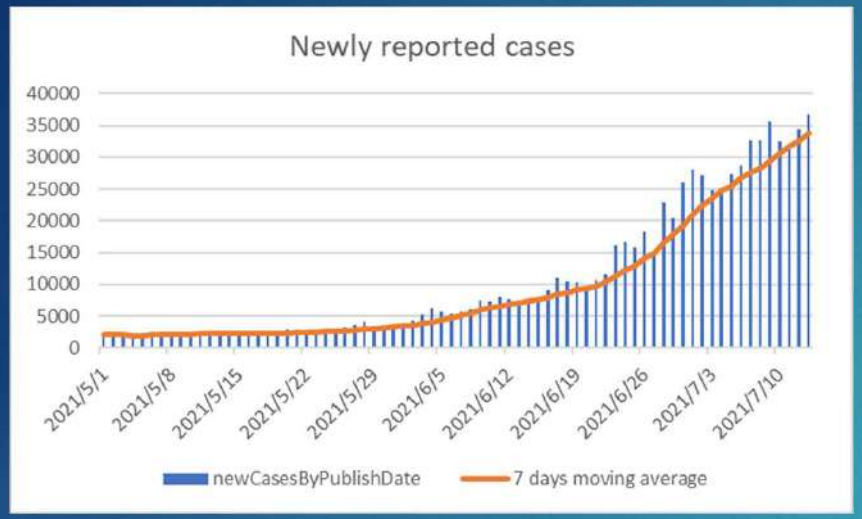


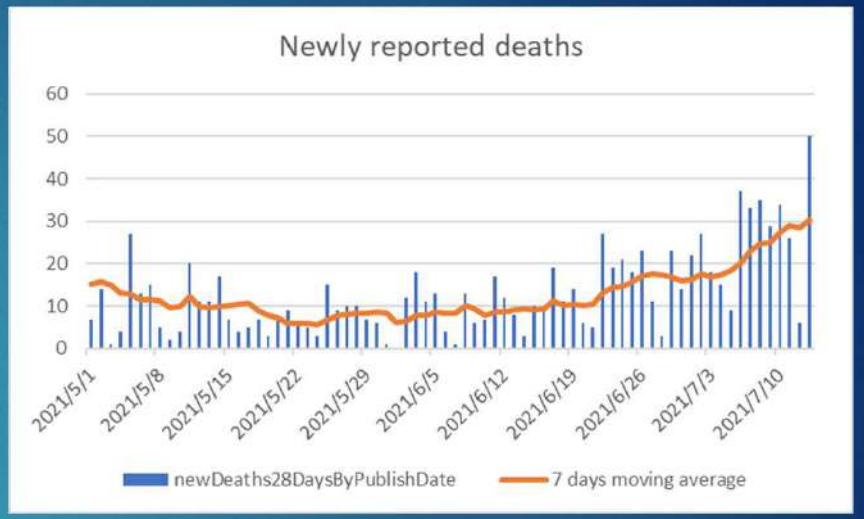
GOV.UK Coronavirus (COVID-19) in the UK

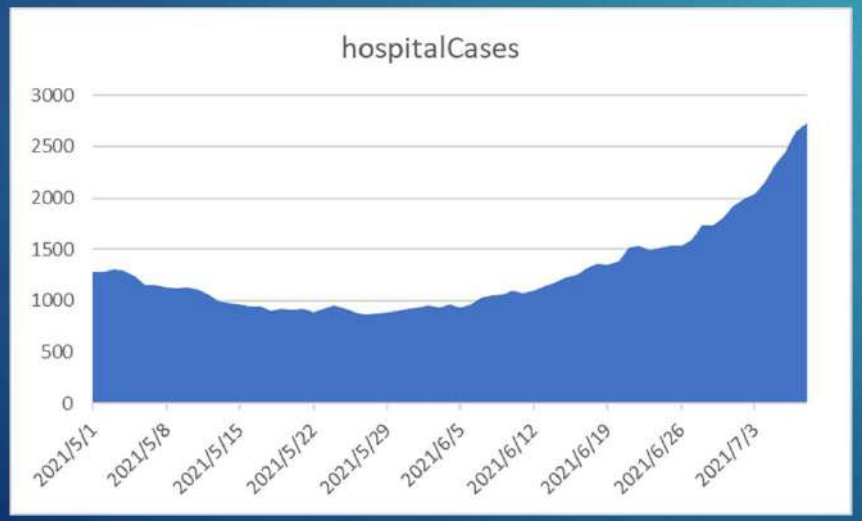
日本と英国の直近1週間の人口10万あたりの感染者数

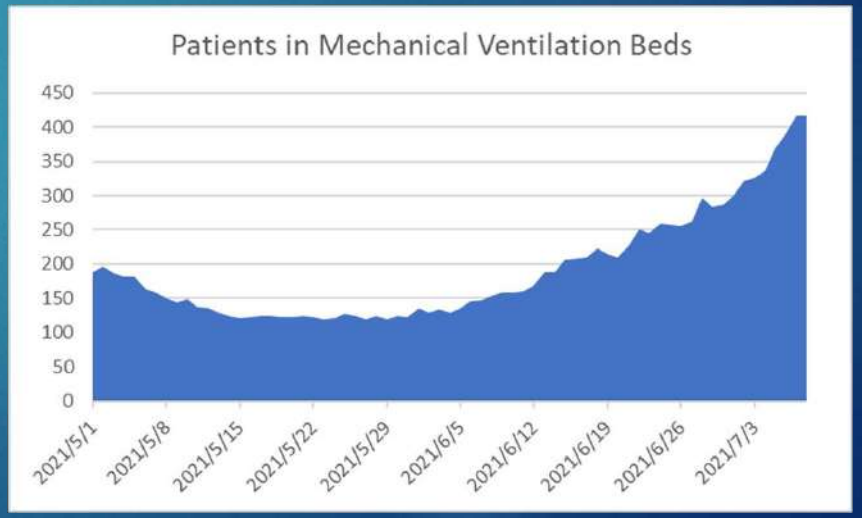


直近の英国の感染状況



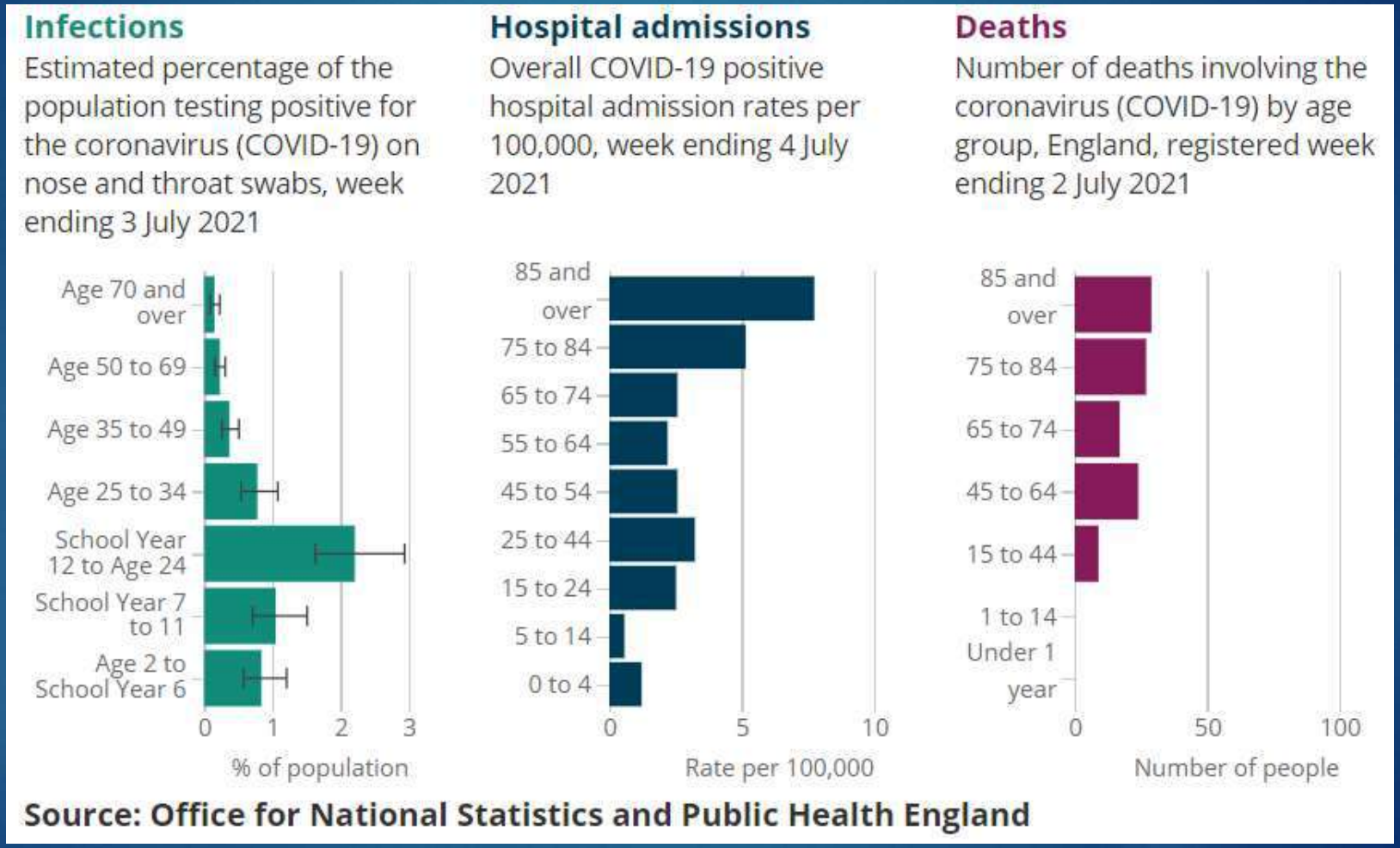






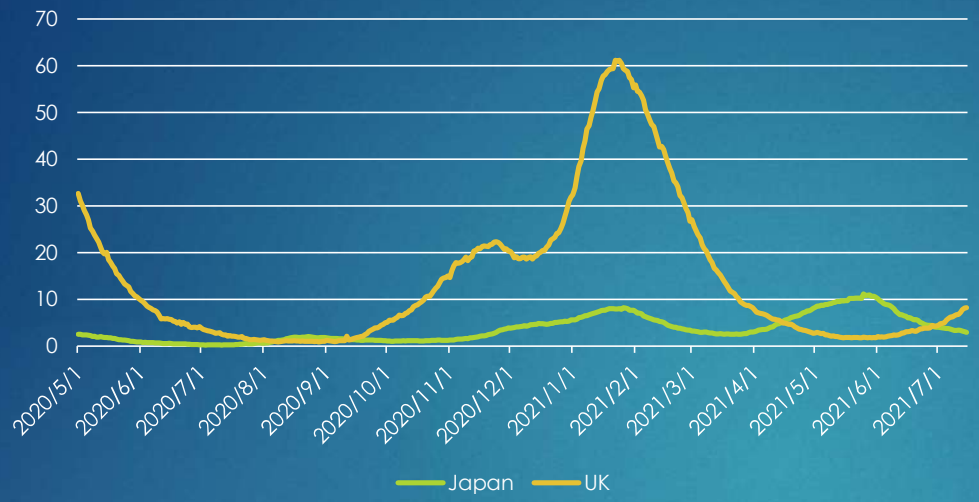
GOV.UK Coronavirus (COVID-19) in the UK

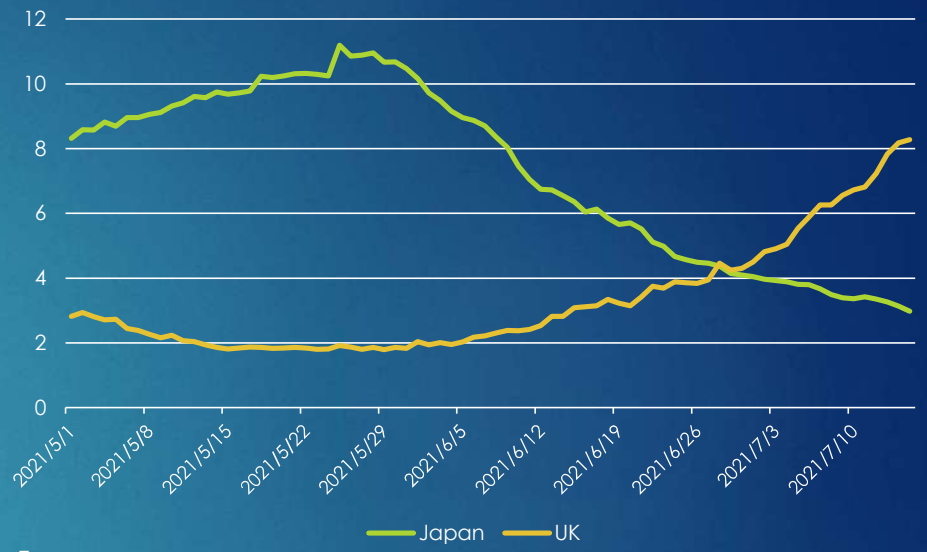
イングランドの直近1週間の感染者数・入院患者・死亡者の年齢分布



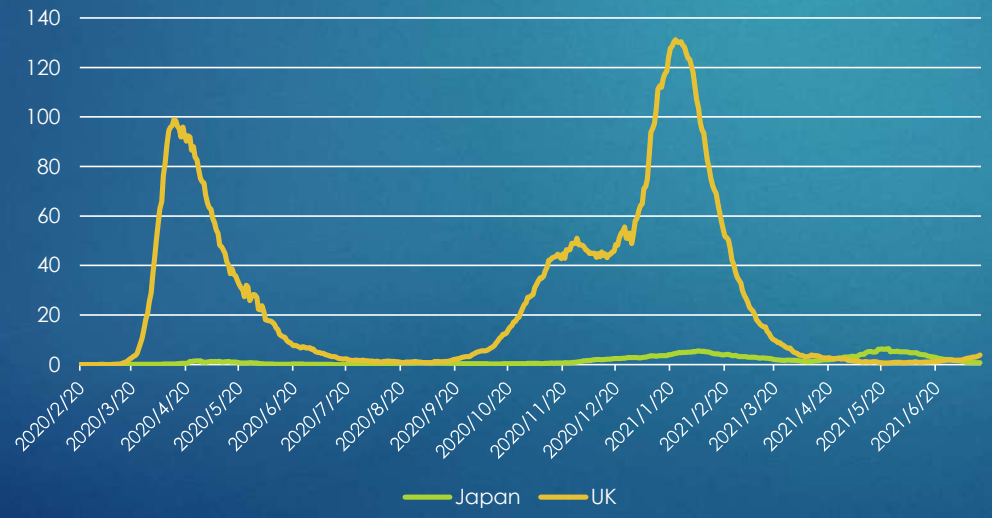
日本と英国の人口あたりの重症者・死亡者の比較

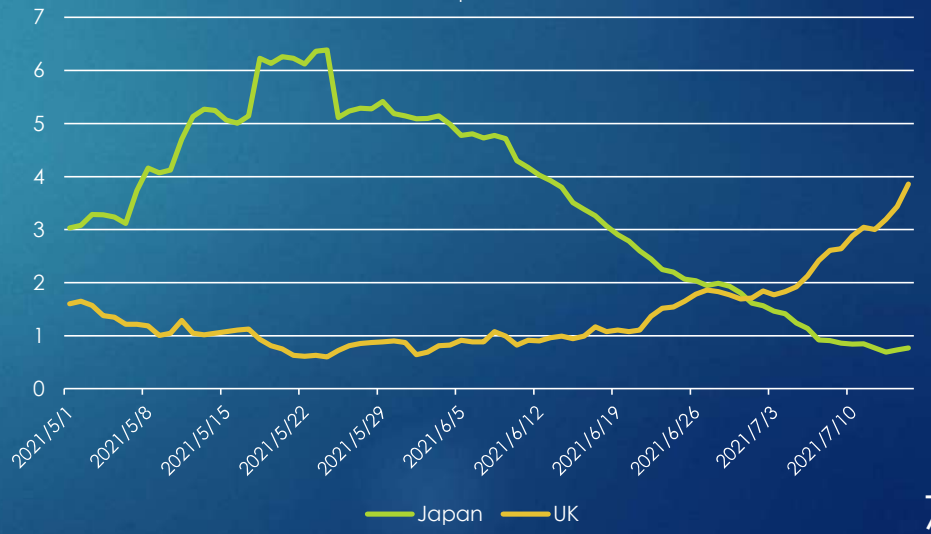
重症の入院患者（人口10万あたり）



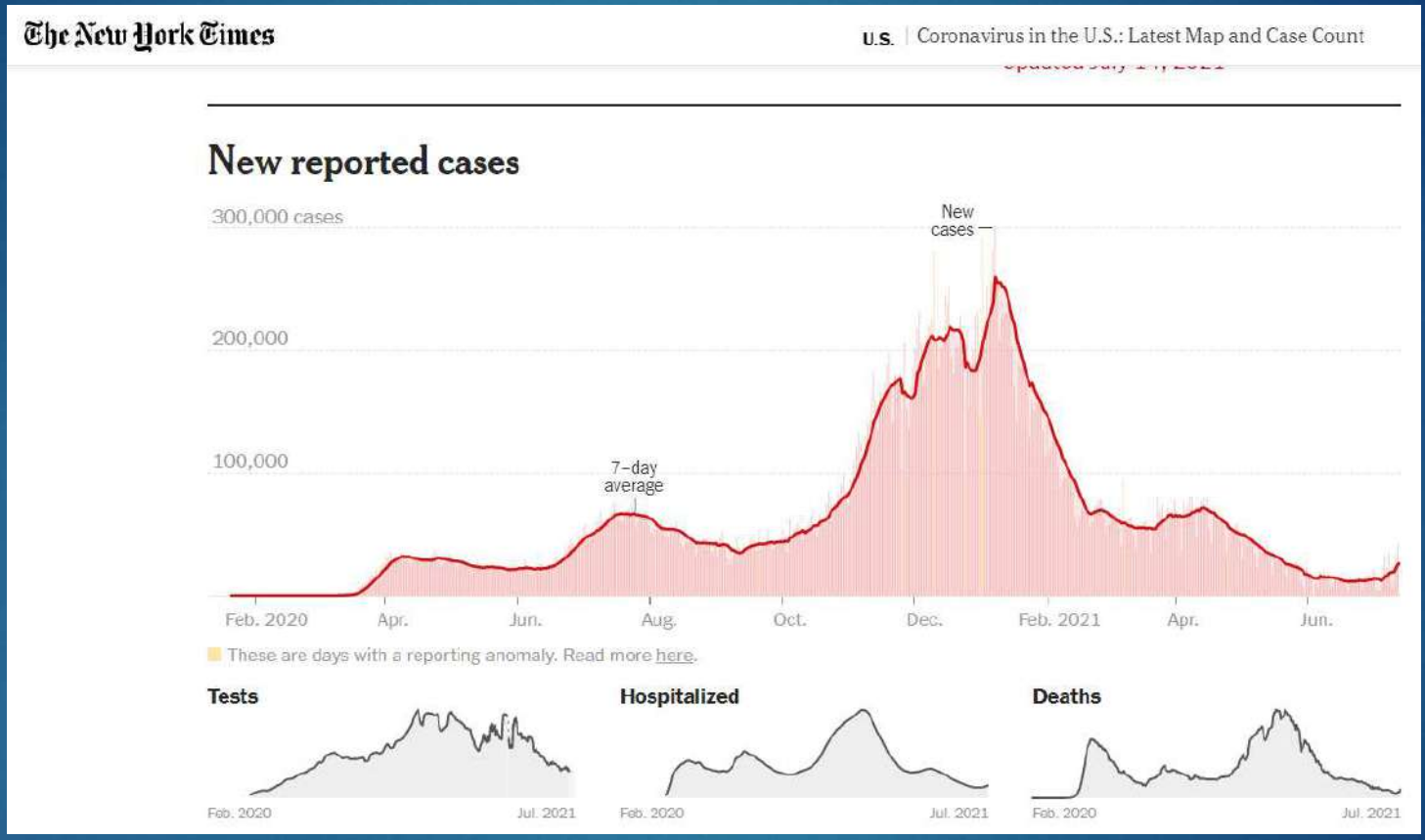


直近1週間の新規死亡者（人口100万あたり）





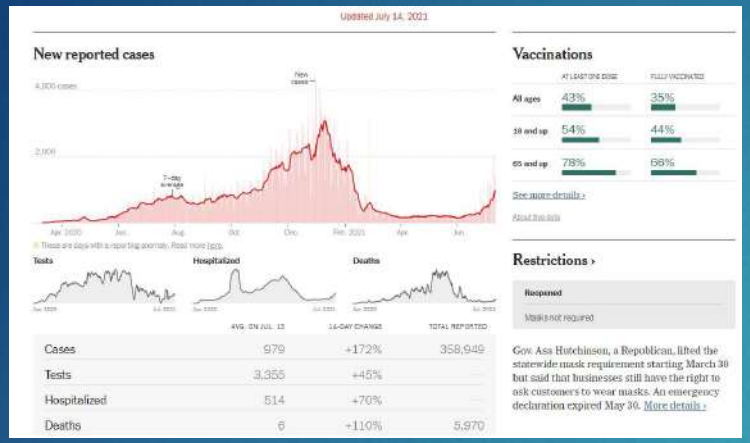
アメリカの状況



July 13：41,278 new cases, 825 deaths
7-day average: 19,700 cases, 25,611 hospitalization, 330 deaths

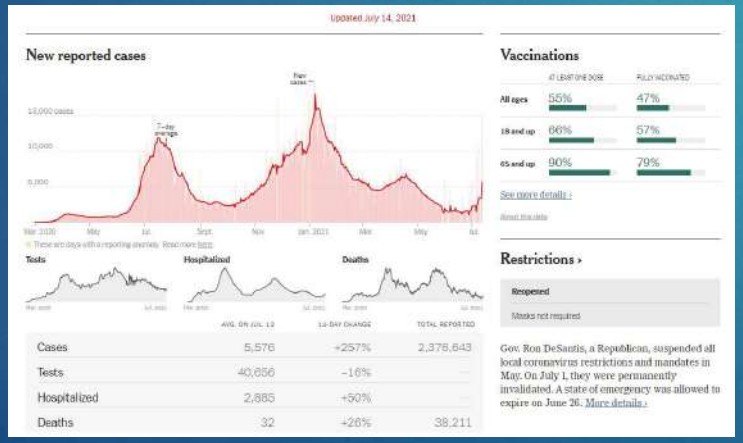
アメリカの主な週の状況

Arkansas

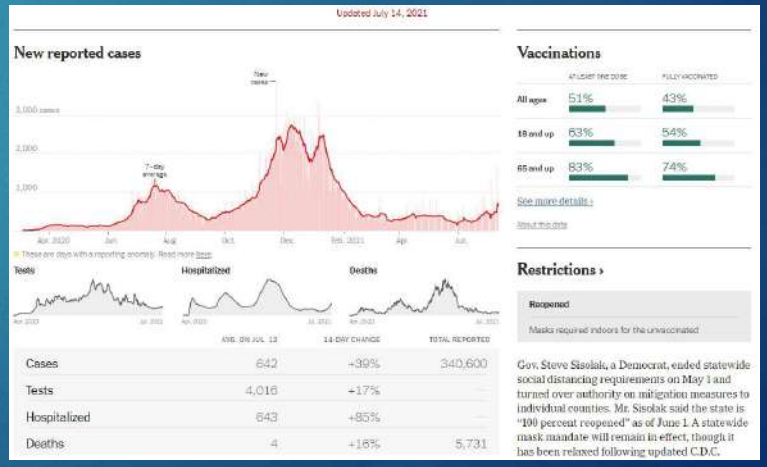


Missouri

Florida

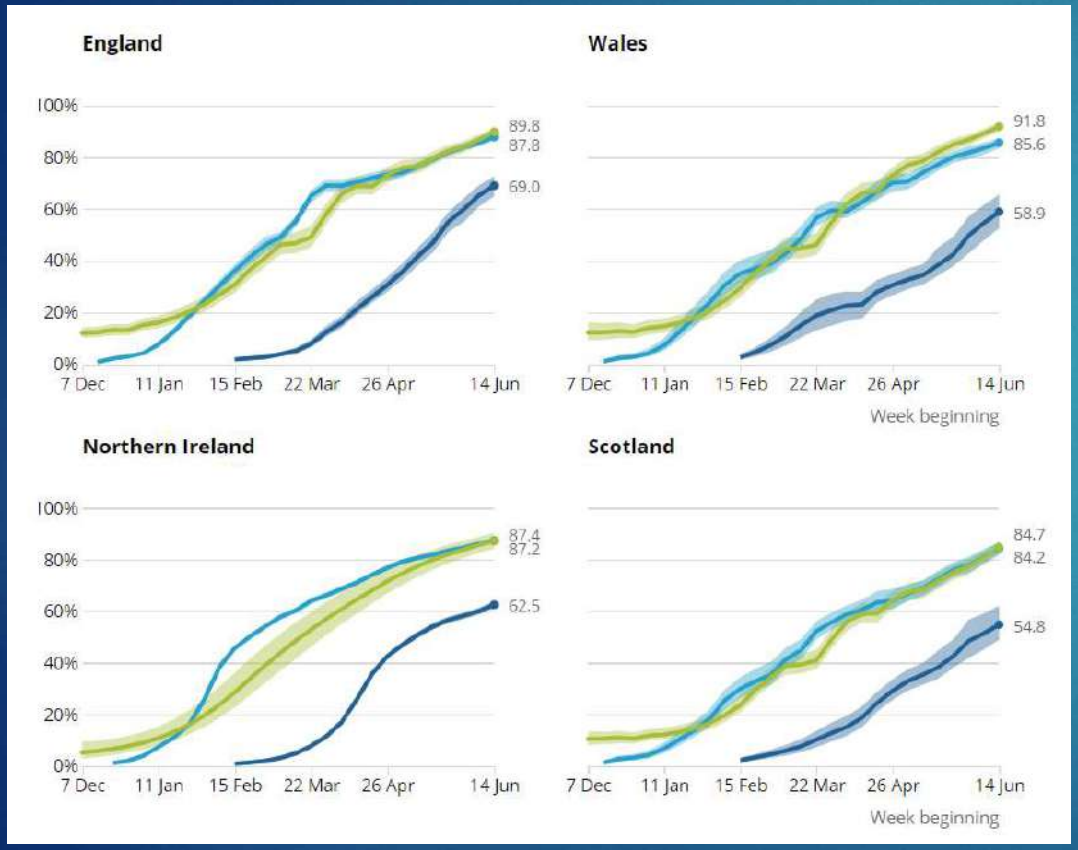


Nevada

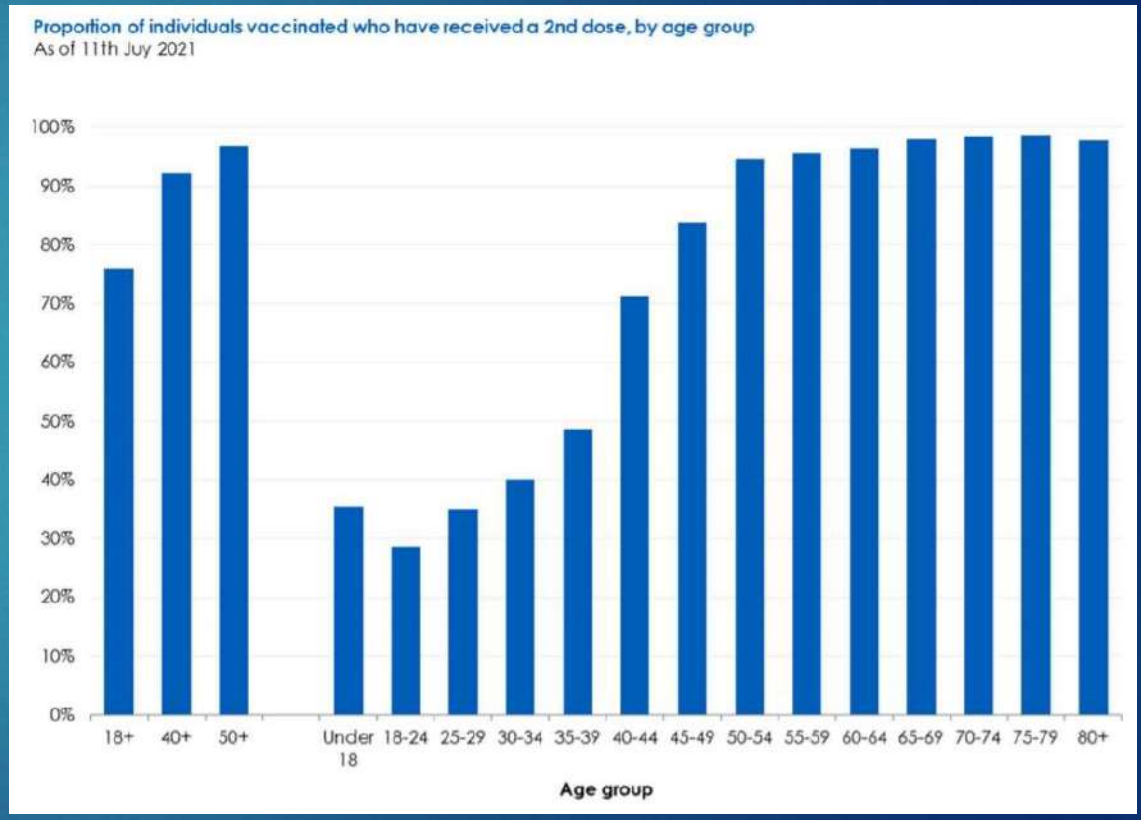


New York Times

英国のワクチン接種状況

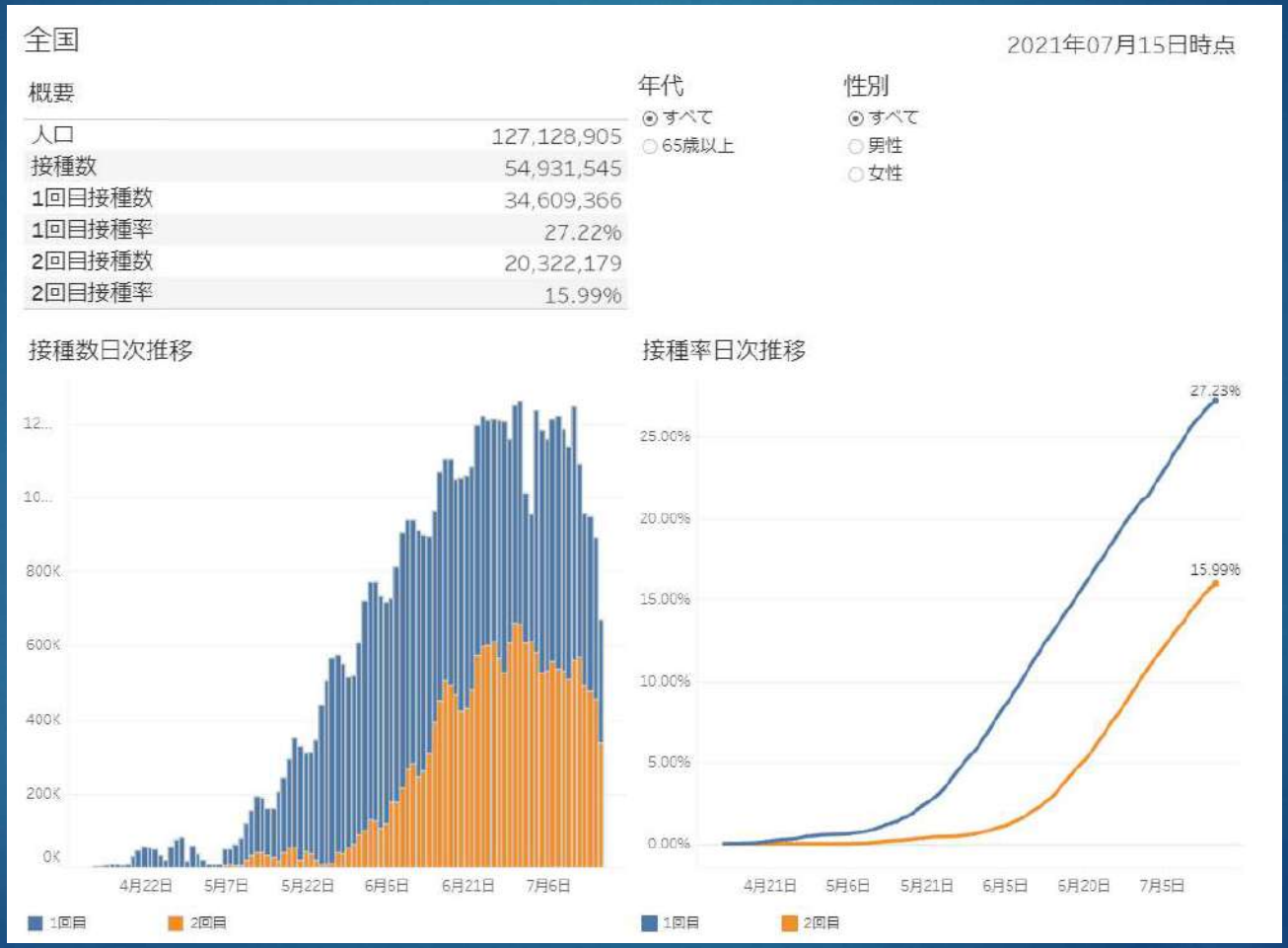


National Statistics Office

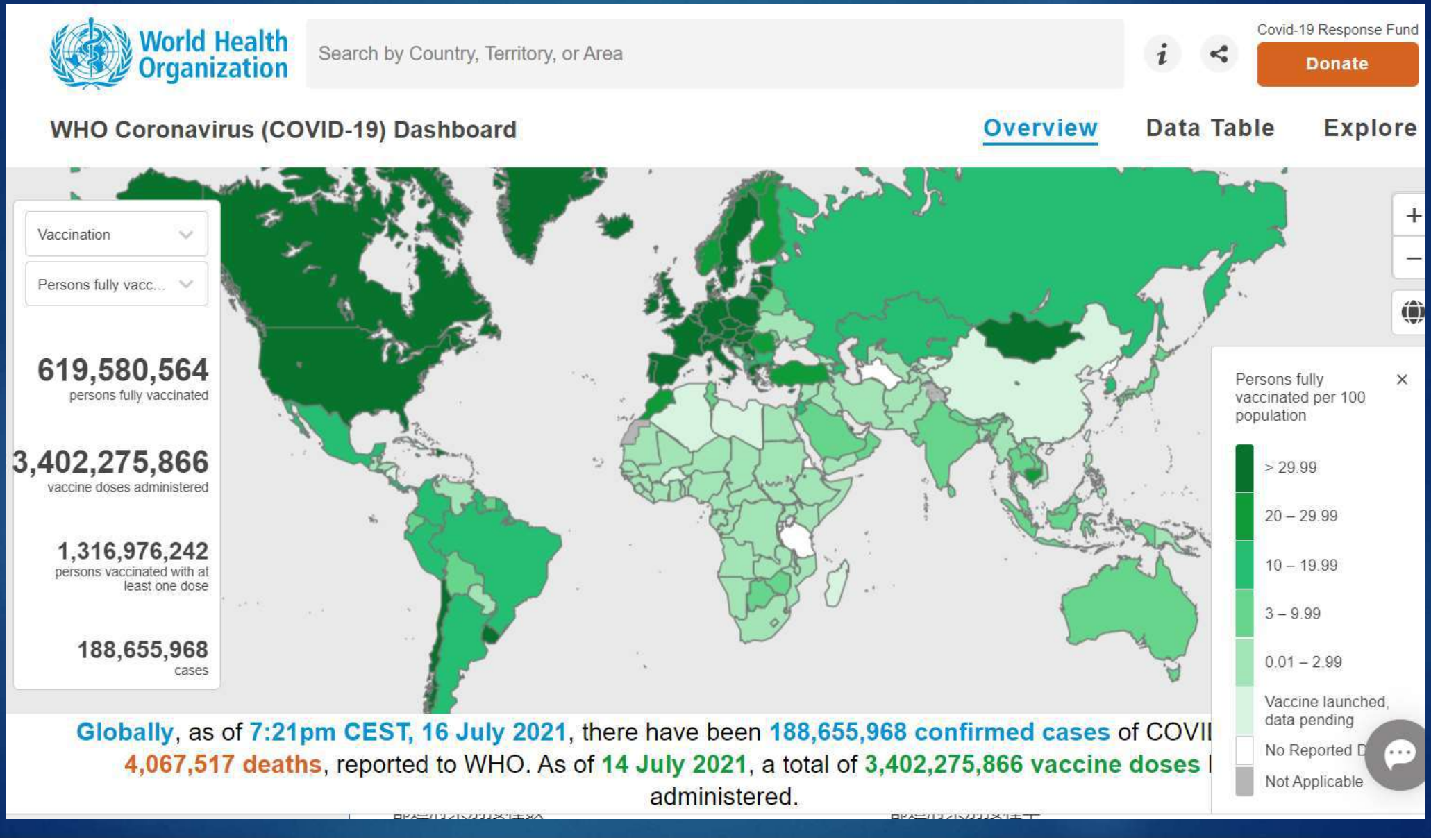


NHS England

日本のワクチン接種状況



内閣府ワクチン接種状況ダッシュボード


World Health Organization
Search by Country, Territory, or Area
Covid-19 Response Fund
Donate
WHO Coronavirus (COVID-19) Dashboard
Overview
Data Table
Explore
Vaccination
Persons fully vacc...
619,580,564
persons fully vaccinated
3,402,275,866
vaccine doses administered
1,316,976,242
persons vaccinated with at least one dose
188,655,968
cases
Persons fully vaccinated per 100 population
> 29.99
20 – 29.99
10 – 19.99
3 – 9.99
0.01 – 2.99
Vaccine launched, data pending
No Reported D
Not Applicable
Globally, as of 7:21pm CEST, 16 July 2021, there have been 188,655,968 confirmed cases of COVI
4,067,517 deaths, reported to WHO. As of 14 July 2021, a total of 3,402,275,866 vaccine doses
administered.