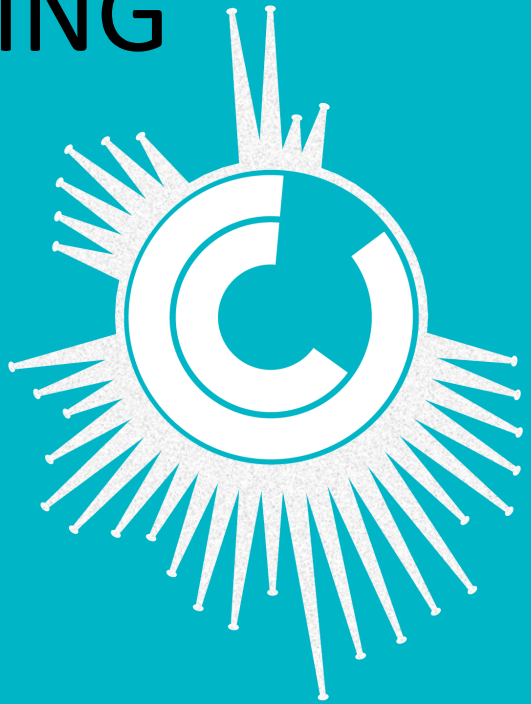
namahn

DATA VISUALIZATION DURING THE COVID-19 PANDEMIC

June 4, 2020

Paul Kahn, p.kahn@neu.edu



Outline of the Talk

- How The Year 2020 All Began
- Creating COVIC
  (COVID-19 Online Visualization Collection)
- Intended Message #1:
  Communicating the Current Medical State,
  Magnitude / Spread
- Intended Message #2: Communicating the
  Current Medical State,
  Supplies
- Transition from Data Visualization to
  Concept Visualization
- Intended Message #3:
  Communicating Transmission and Infection
- Translation from Academic figures to
  News stories
- Intended Message #4: Communicate Risk ,
  Flatten The Curve
- Intended Message #5: Communicate Risk,
  Future Models
- Intended Message #6: Communicate Risk,
  Re-Opening Plans
- COVID-19 Concept Map

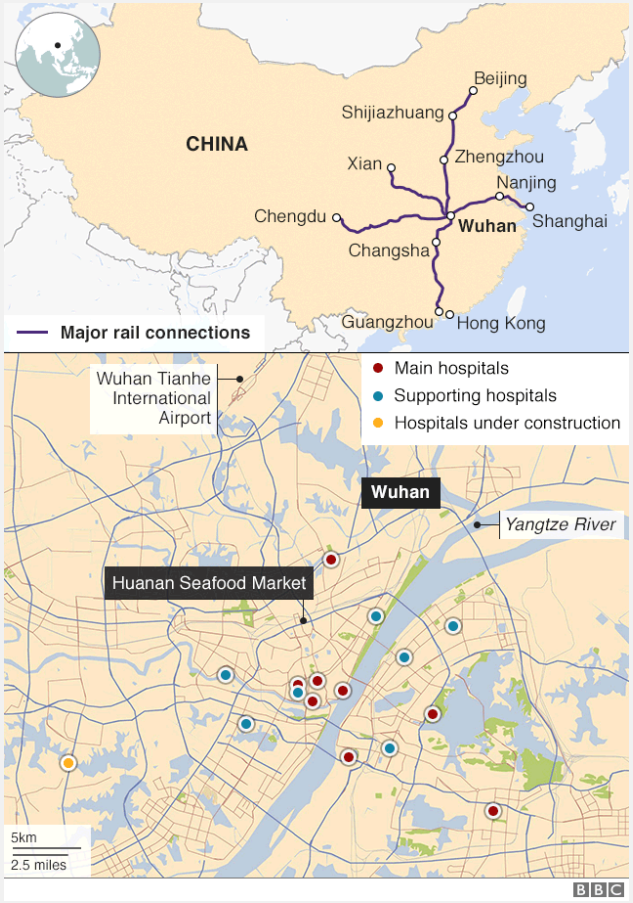
How The Year 2020 All Began (January-February)

The Year 2020 was going to be about

- Tokyo Olympics
- General Elections in the USA
- Brexit
- Climate Change

-- Irene de la Torre-Arenas, BBC

But by early January news of a new infectious disease appeared in Wuhan, China



Map from 24th January 2020

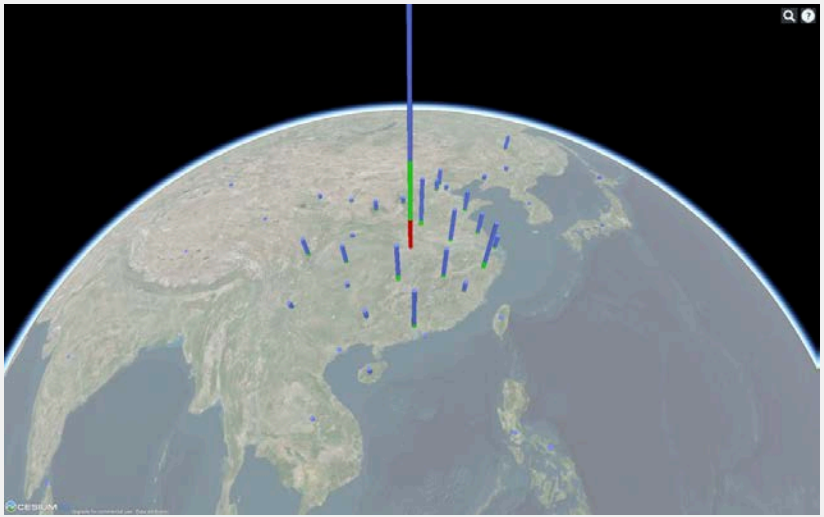
How The Year 2020 All Began (January-February)

The Year 2020 was going to be about

- Tokyo Olympics
- General Elections in the USA
- Brexit
- Climate Change

-- Irene de la Torre-Arenas, BBC

But by early January news of a new infectious disease appeared in Wuhan, China

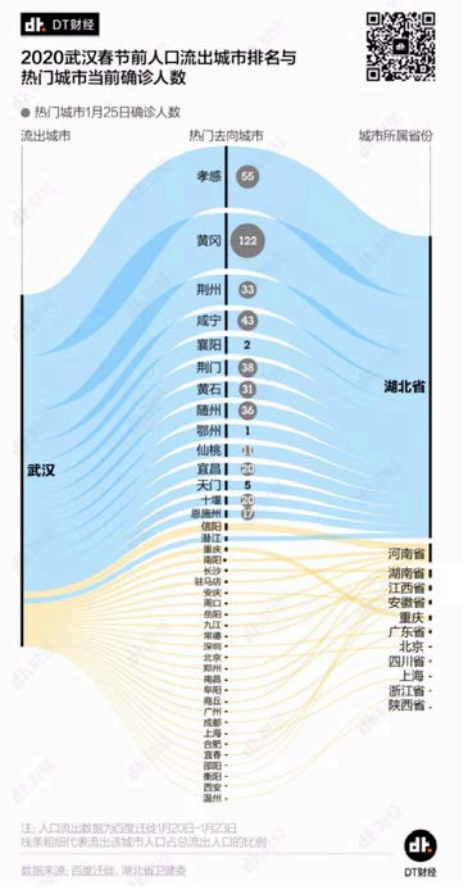


3D visualization of data from the LiveTracker of the Center for Systems Science and Engineering (CSSE) at John Hopkins University, by Institute for Information Design Japan (IIIDJ), February 2, 2020

How The Year 2020 All Began (February)

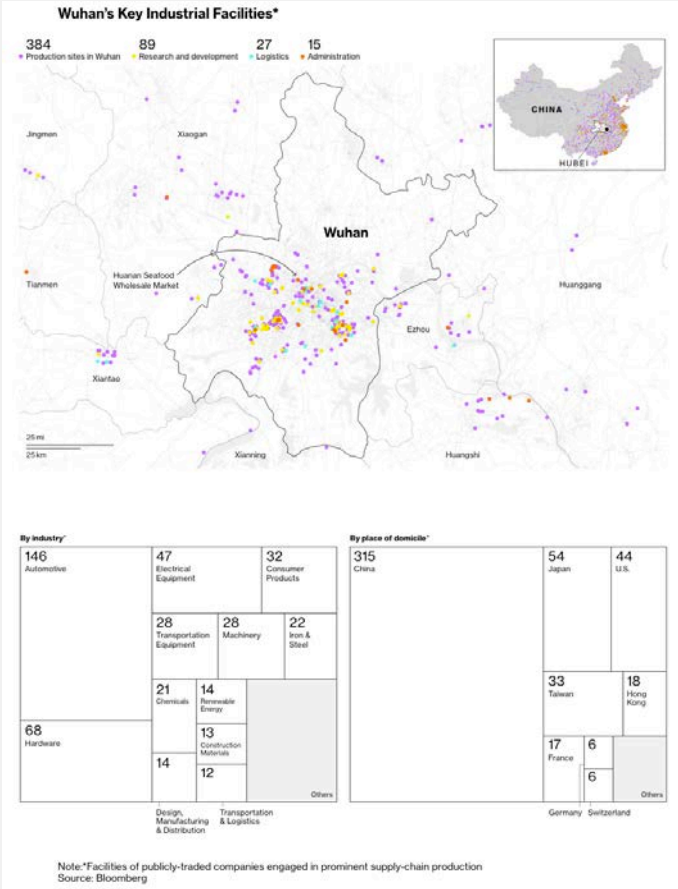
Movement of people from Wuhan to other cities in Hubei Province (blue) and other parts of China (yellow)

DT Finance
January 27, 2020

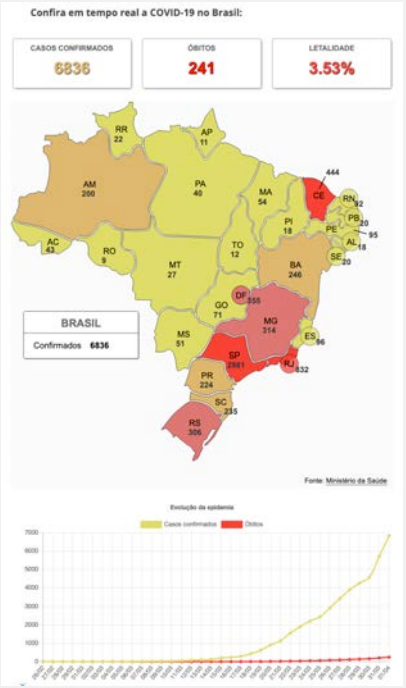


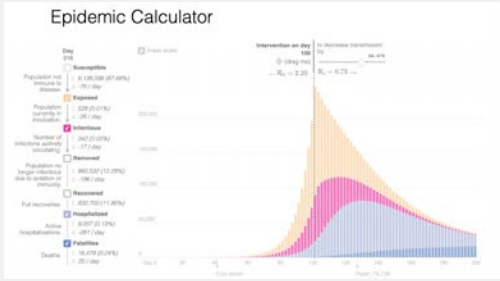
Charting the Global Economic Impact of the Coronavirus (production, research, logistics and administration sites in Wuhan)

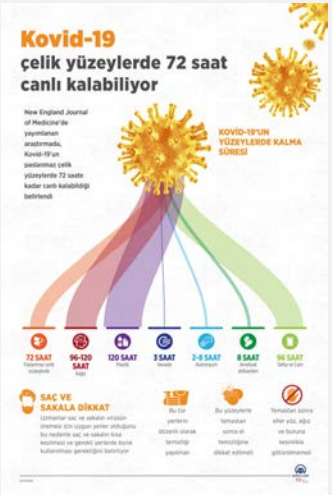
Bloomberg News
February 5, 2020

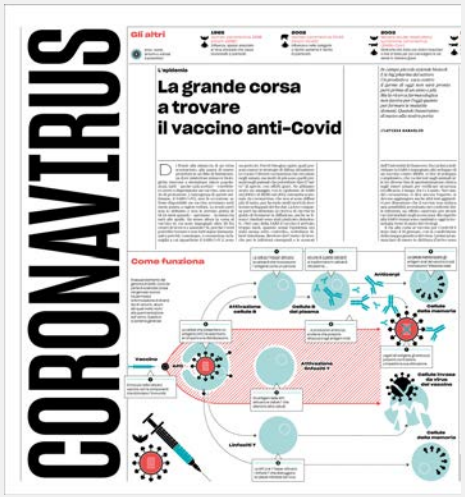


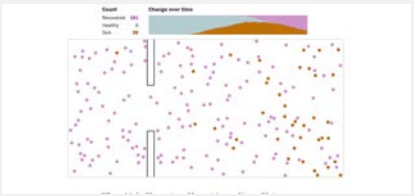
How The Year 2020 All Began (March)

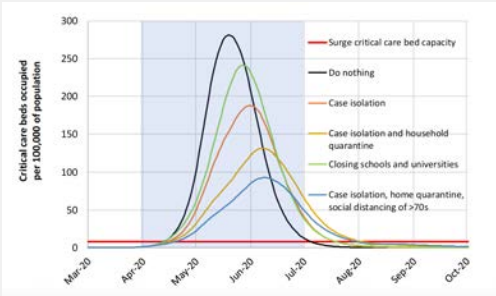












Creating COVIC (COVID-19 Online Visualization Collection)

COVIC 0 – March

- Paul Kahn and Janice Zhang began collecting examples of data visualization related to the COVID-19 pandemic independently in March
- Kahn sent out requests to an international network requesting "*ANY example of visualizing the current pandemic data, past, current or projected*"
- Zhang was also collected examples for her own research, focusing on data visualization types

COVIC 1 – March (100+ items)

- Kahn developed metadata on publisher, language, country and distinguishing types of publications and intended messages
- Zhang examined the joint collection (100+) and developed the first iteration of a formal classification of data visualization types, interaction attributes

Creating COVIC (COVID-19 Online Visualization Collection)

COVIC 2 – April (500+ items)

- Zhang refined and expanded the classification scheme:
  - Data visualization types
  - Visual Technique
  - Interaction Technique
  - Intended Messages
- Hugh Dubberly, members of the Dubberly Design Office, and additional Northeastern graduate students joined the effort

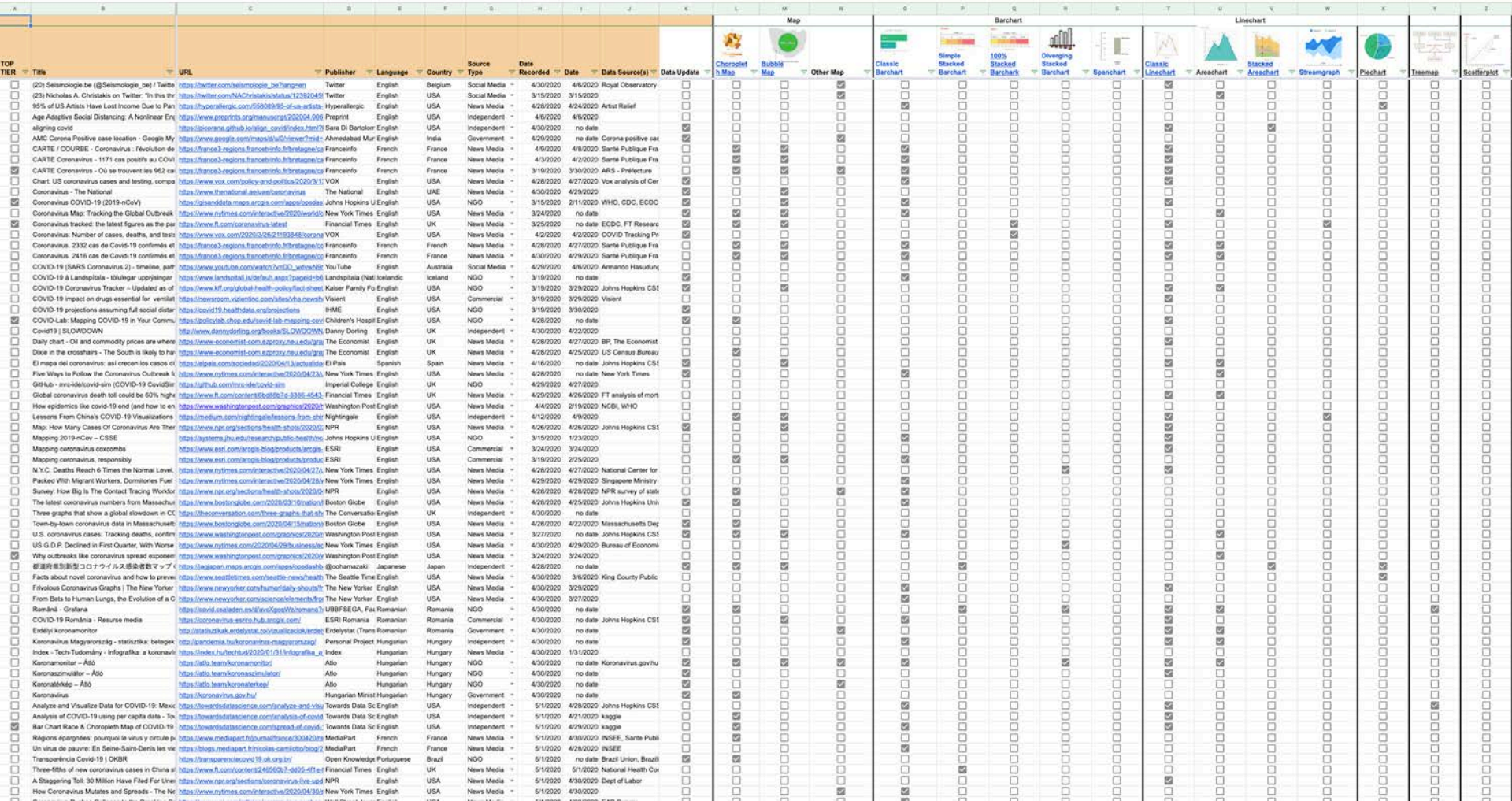
COVIC 3 – May-June (1000+ items)

- Developing a software process for capturing images of all pages
- Engaging seminar students to classify pages
- Designing a web-based application and database to manage the collection

Our Goals for COVIC

- COVIC is an opportunistic collection of visualizations of COVID-19.
- A large fraction of what appears online every day includes visualizations — images used to "explain" some aspect of the situation.
- In a few months, an astonishing number of "representations" have been created, all pointing at the same phenomenon.
- Our goal is to collect and classify these representations, then make the collection available for future research.
- This body of work refers to the same or very similar events, offering an unparalleled opportunity for study.
- It defines both a problem space and a solution space — and illustrates the range of possibilities within that space.
- It also provides a snapshot of information design practice at a moment of inflection, accelerating the transition from print to online representation.

Creating COVIC (COVID-19 Online Visualization Collection)



Preliminary Numbers: Source Type

- About 50% of all the items are from **News Media**.
- **Independent Media** includes self-publishing, Medium publications, and pre-prints of journal articles
- **NGO** includes universities and foundations
- **Peer-Review Publications** are scientific journals
- **Commercial** includes company blogs and website publications
- **Government** includes any government institution
- **Social Media Posts** include Twitter and Facebook

News Media	602	52.3%
Independent Media	132	11.5%
NGO	121	10.5%
Peer-reviewed Publication	97	8.4%
Commercial	84	8.4%
Government	79	6.9%
Social Media Posts	37	3.2%
TOTAL (100%)	1,152	

Preliminary Numbers: Data Visualization Type

- There are more **Linecharts** than **Barcharts**
- There are more **Barcharts** and **Other Charts** than **Maps**.
- There are more **Maps** than **Illustrations**.

LINECHARTS	501
BARCHARTS	436
OTHER CHARTS	345
MAPS	308
ILLUSTRATION	103

Data Visualization Type	#
Choropleth Map	164
Bubble Map	144
Other Map	34
Classic Barchart	269
Simple Stacked Barchart	85
Spanchart	36
Diverging Stacked Barchart	31
100% Stacked Barchart	15
Classic Linechart	384
Areachart	76
Stacked Areachart	32
Streamgraph	9
Scatterplot	52
Heatmap	47
Piechart	36
Bubblechart	36
Treemap	29
Flowchart	26
Network	21
Radar	9
Other Chart	89
Instructional Graphic	58
Scientific Illustration	45

Preliminary Numbers: Language, Country, &c.

- About 80% of the items are in **English.**
- We have examples from 50 countries, but 70% are from **USA** and **UK**.
- About 25% (278) are **Data Update,** designed to load current numbers.
- About 25% (82) of the **Data Update** items are in **Dashboard** format.

Country	#
USA	587
UK	209
China	46
France	42
Italy	29
Japan	18
Germany	16
Brazil	12
Spain	8

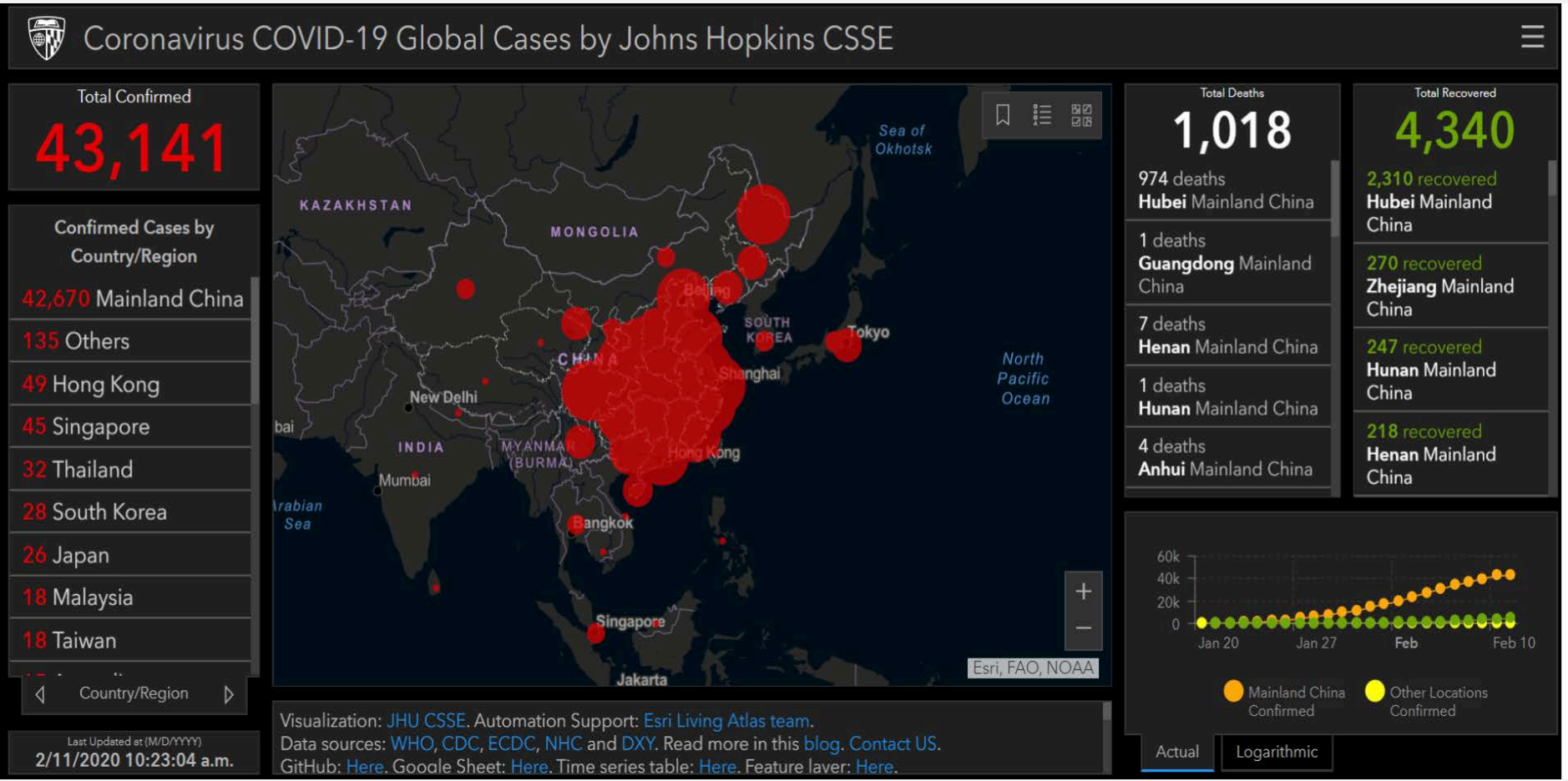
Preliminary Numbers: Intended Message

Intended Messages			
Communicate Current Medical State	284	**MAGNITUDE SPREAD**	234
		SUPPLIES	50
Communicate Current Non-Medical State	121	**ECONOMIC**	46
		SOCIAL	65
		ENVIRONMENT	10
Communicate Risk	110	**HISTORICAL**	27
		FUTURE MODEL	59
		FLATTEN THE CURVE	24
Communicate Transmission and Infection	112		
Provide Data Visualization advice, critique, and resources	36		
Communicate Biomedical Research	64		

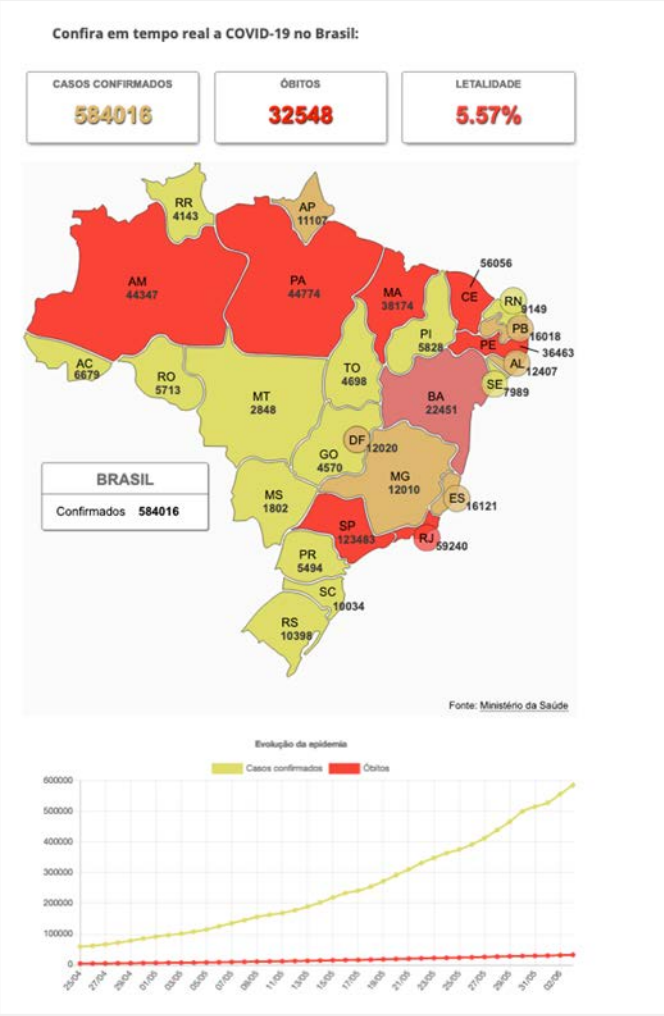
COMMUNICATING THE CURRENT MEDICAL STATE, MAGNITUDE / SPREAD

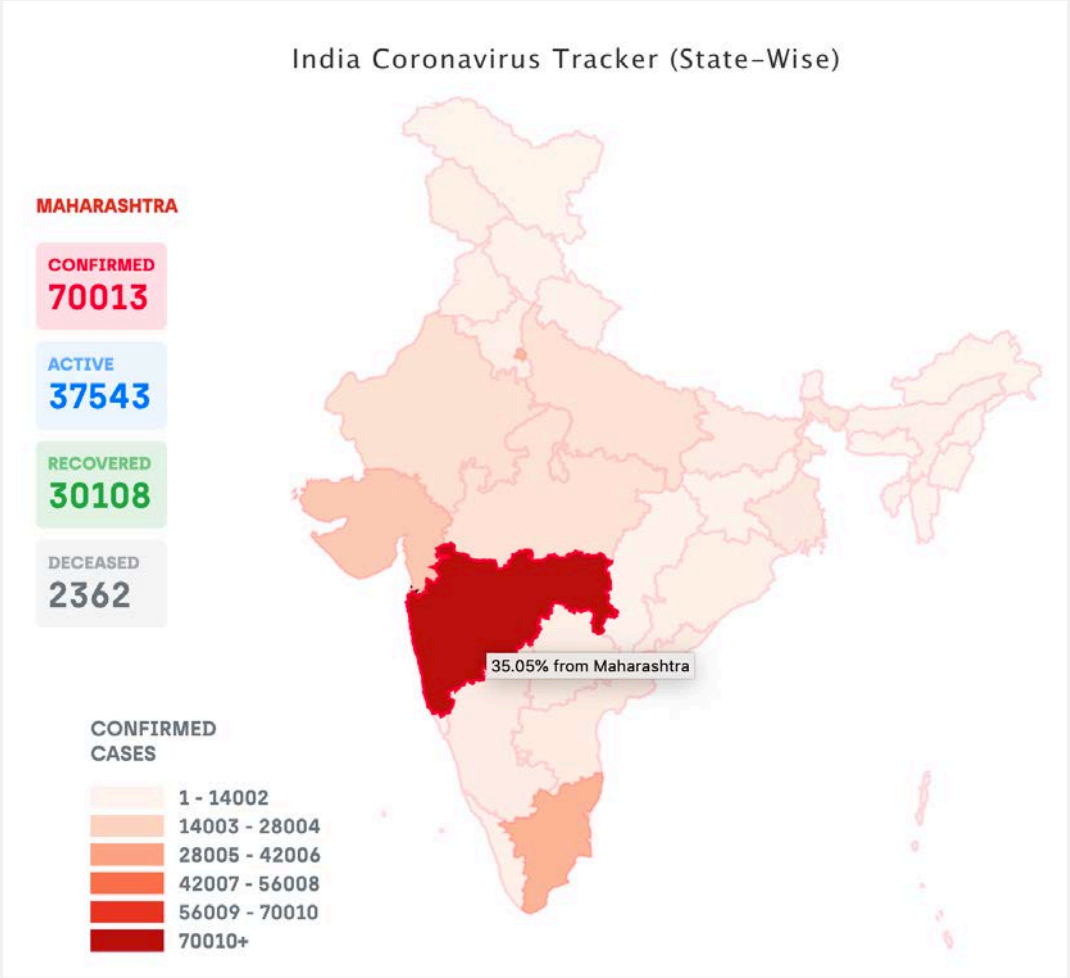
Intended Message #1

Center for Systems Science and Engineering (CSSE) at Johns Hopkins University

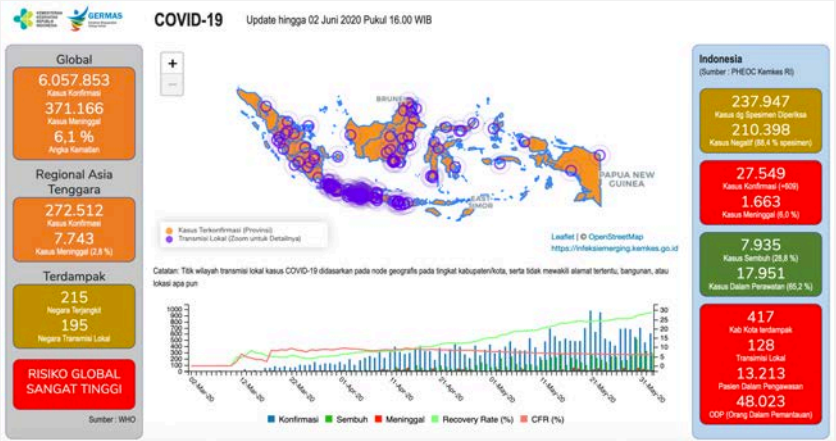


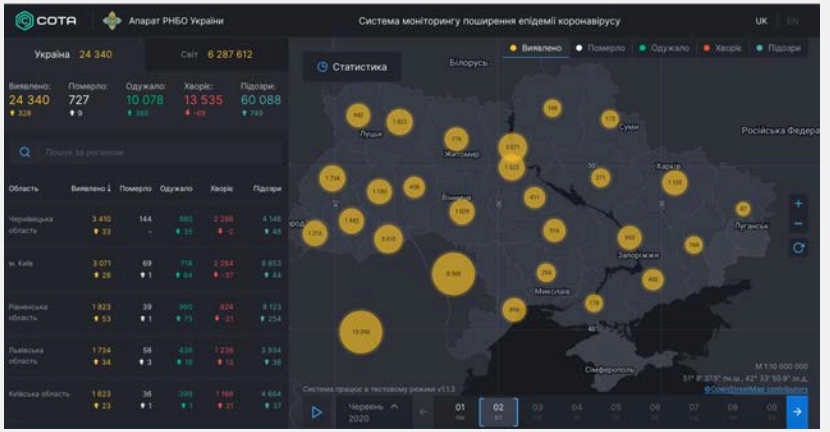
Different ways to represent cases on maps

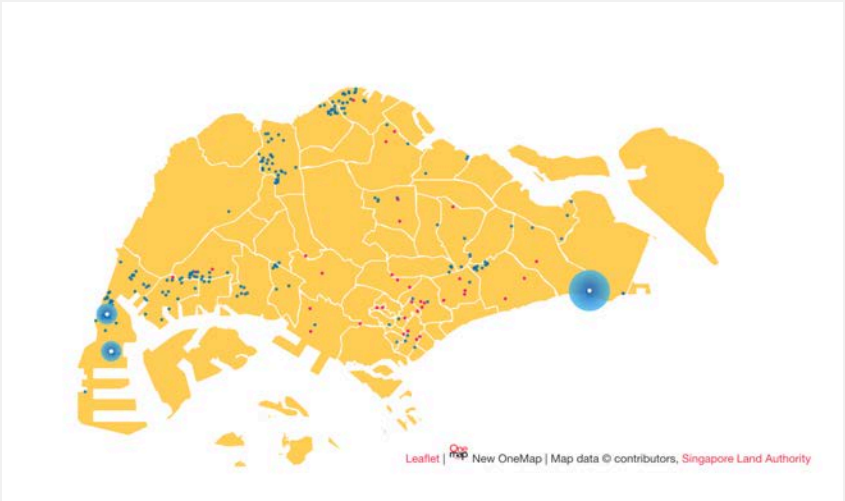


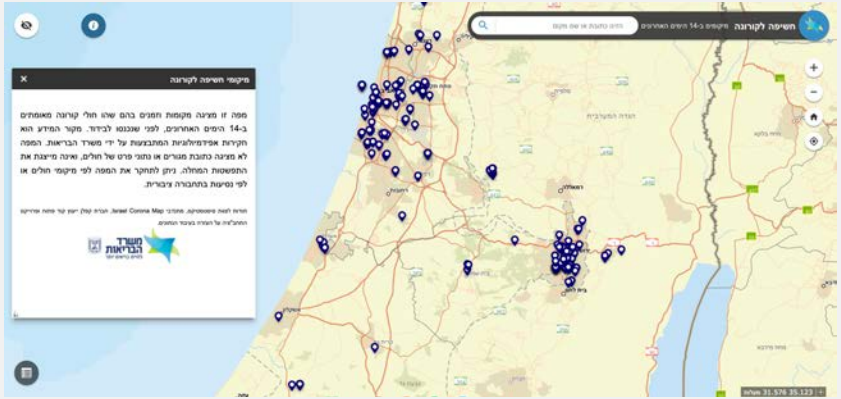


Different ways to represent cases on maps

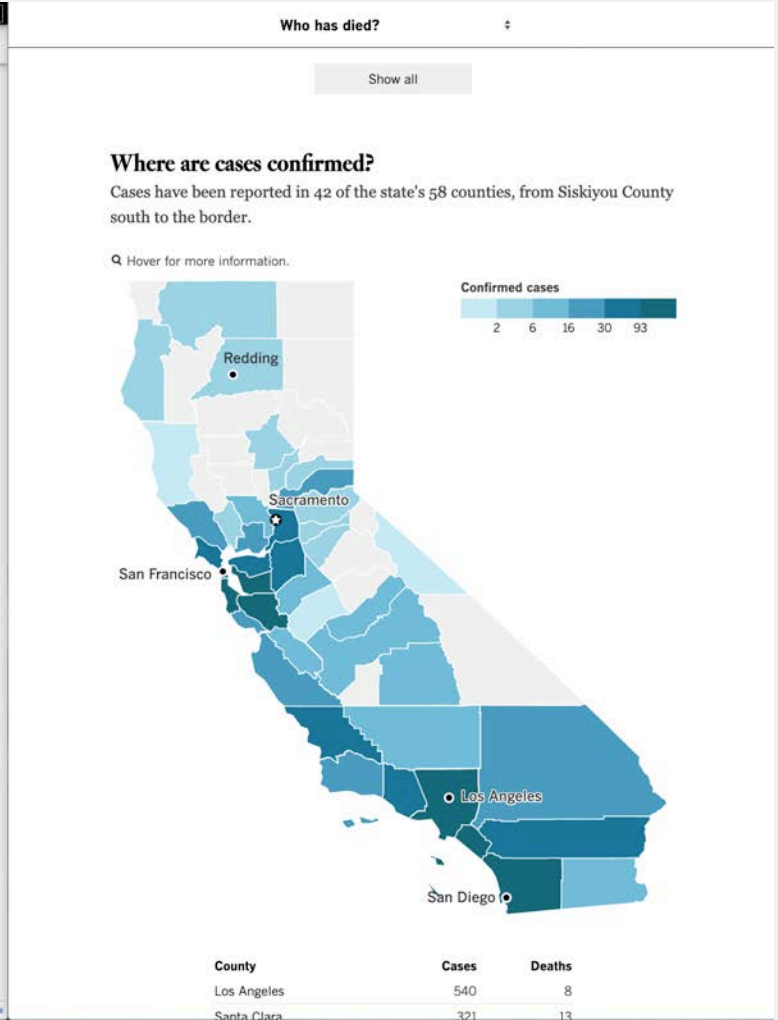




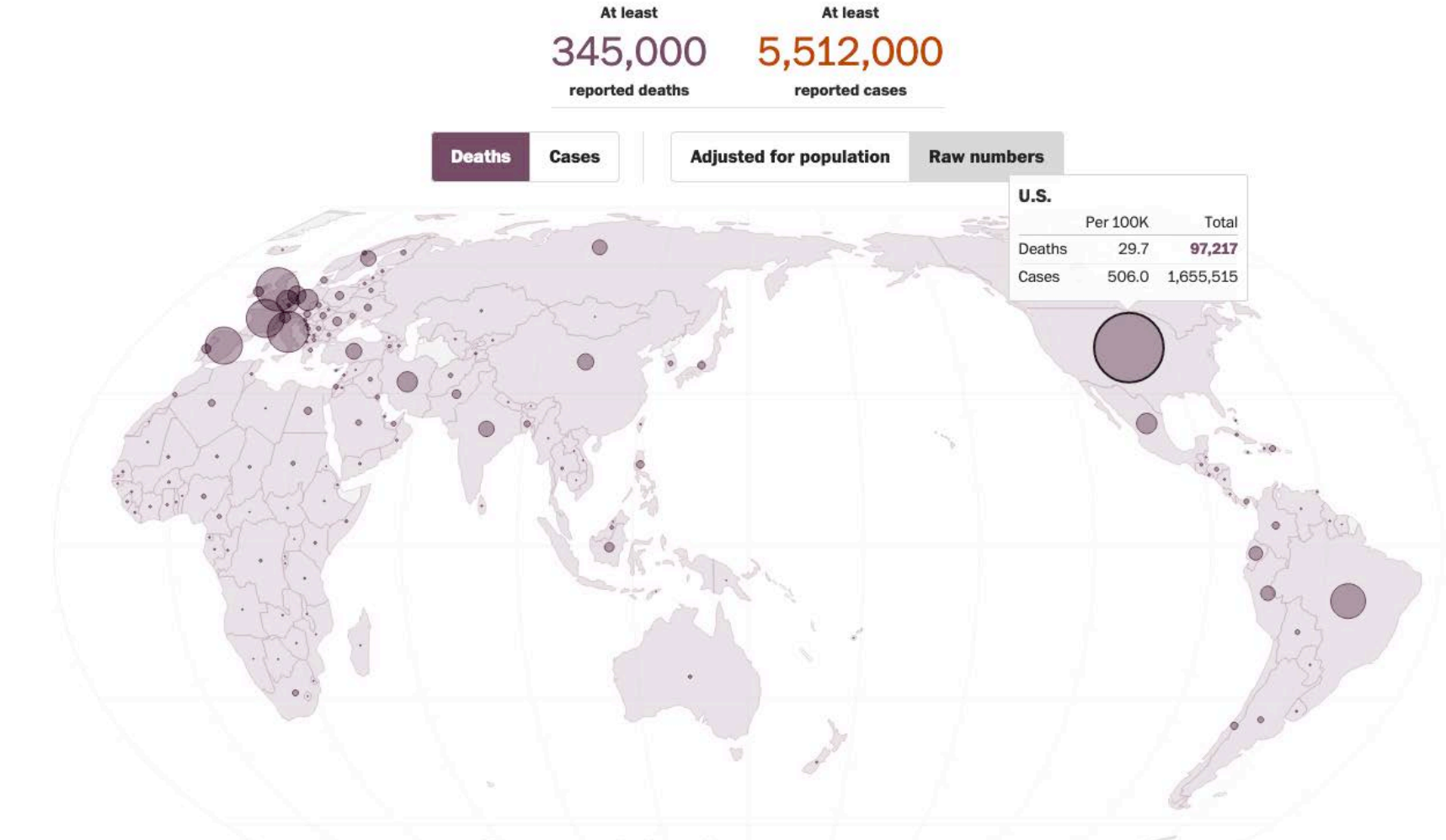




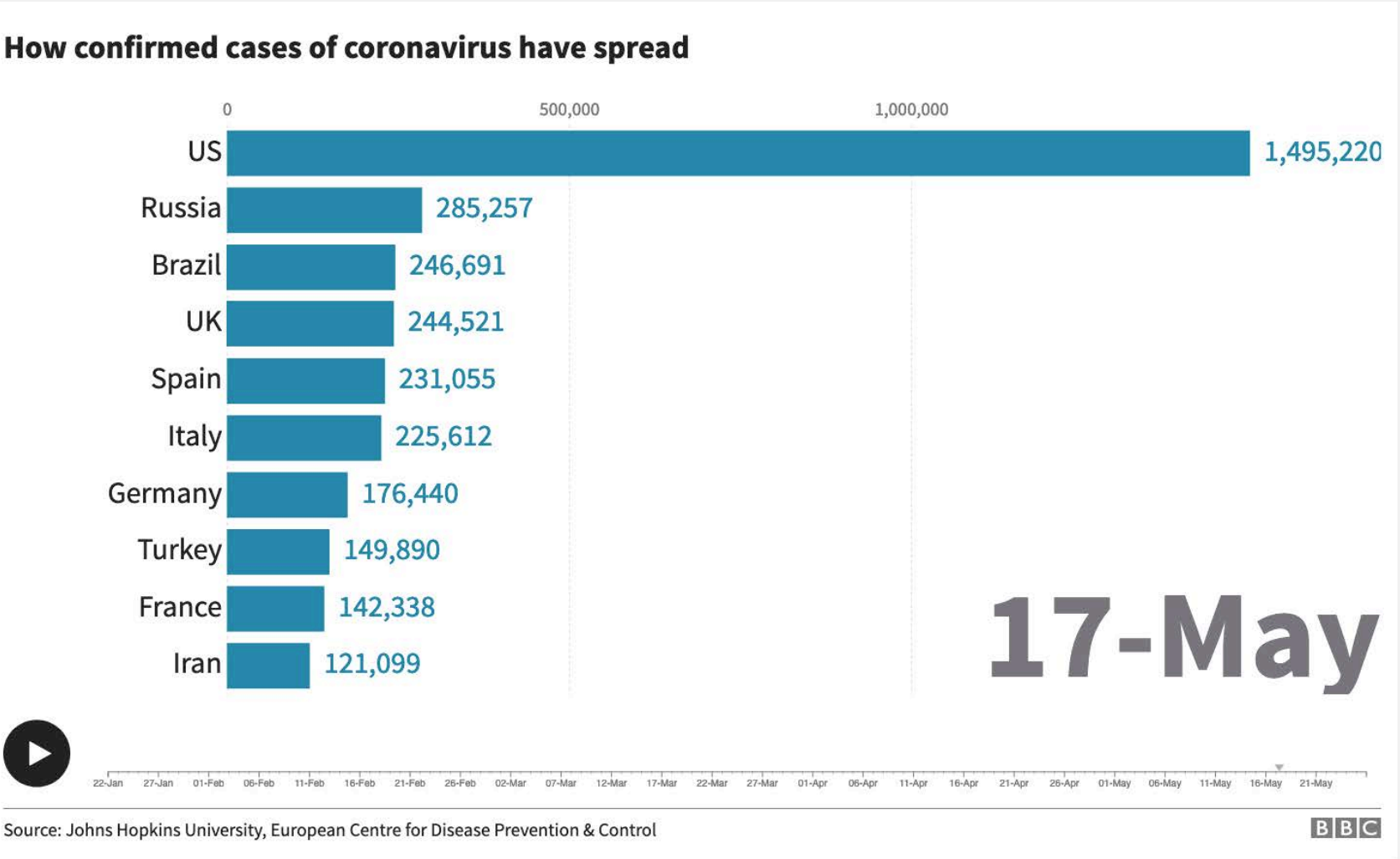
California 3/23/20: Bubble Map (San Francisco Chronicle) vs Choropleth Map (L.A. Times)



Mapping the worldwide spread of the coronavirus | The Washington Post



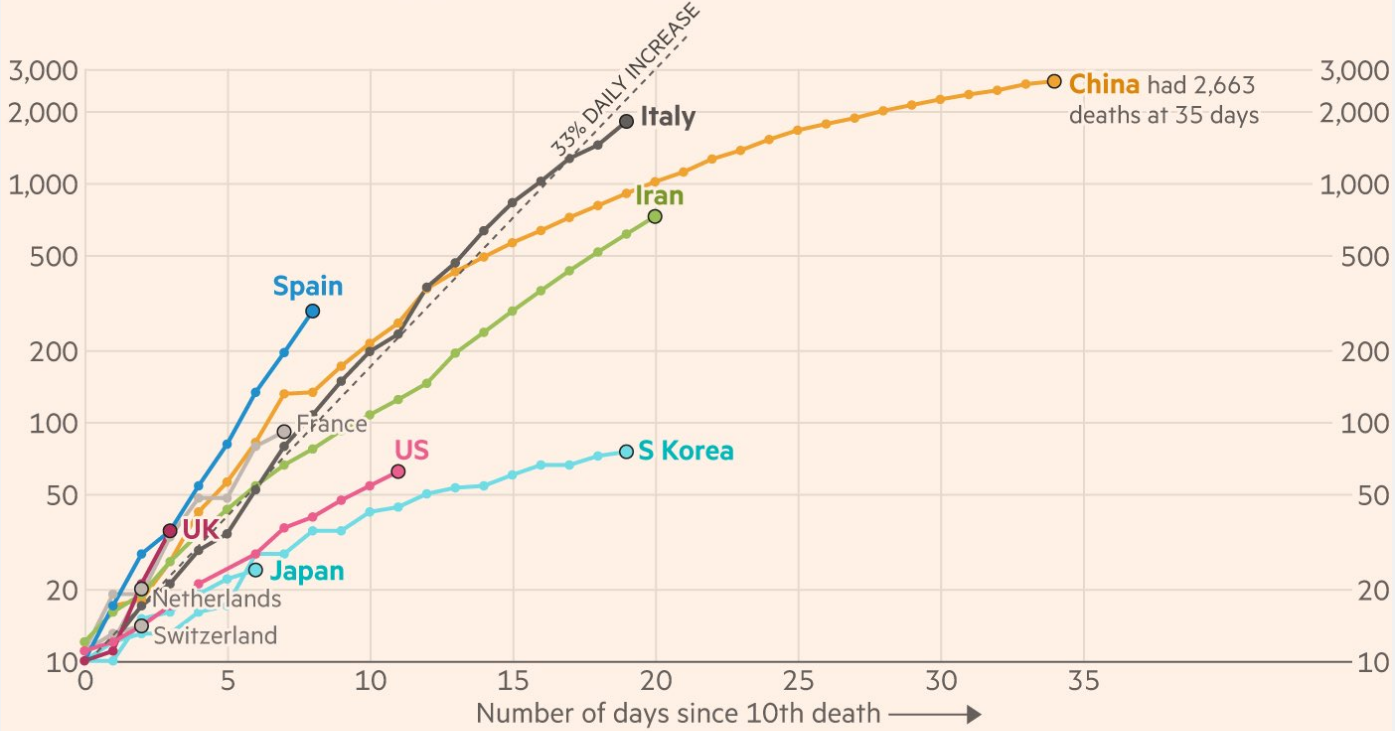
The Barchart Race | BBC



Coronavirus tracked | Financial Times (3/15/20)

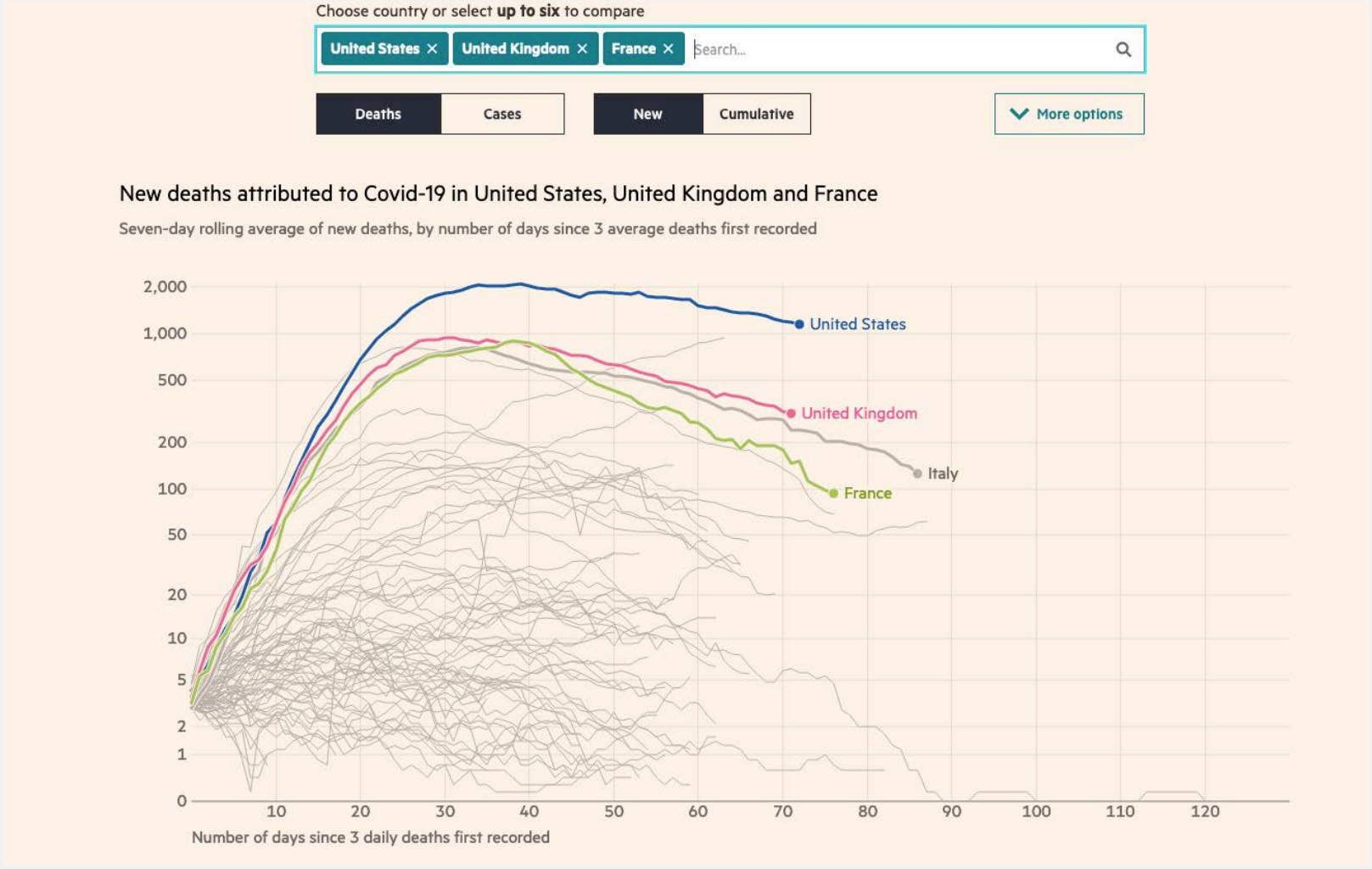
Coronavirus deaths in Italy and Spain are increasing much more rapidly than they did in China

Cumulative number of deaths, by number of days since 10th death

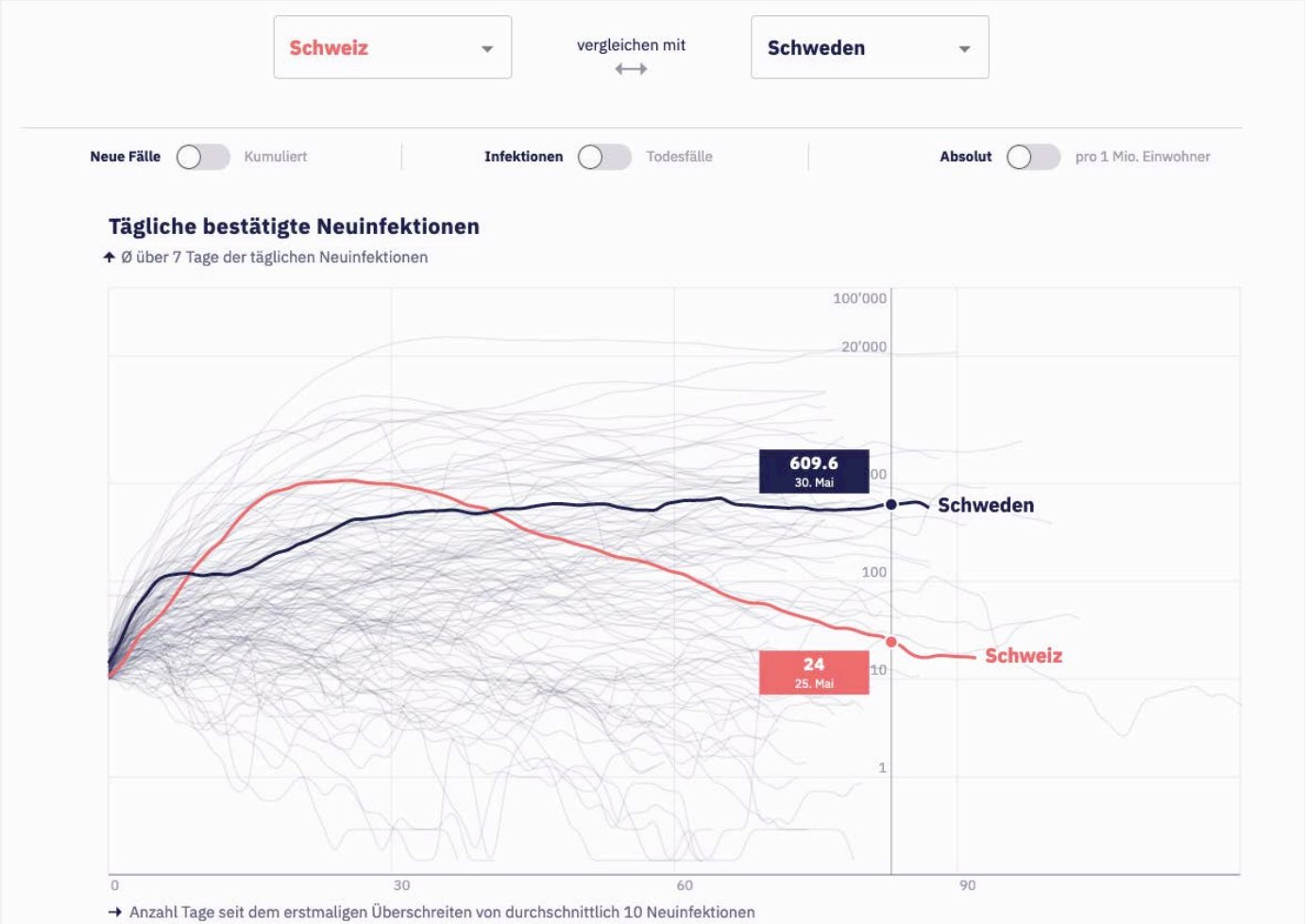


FT graphic: John Burn-Murdoch / @jburnmurdoch
Source: FT analysis of Johns Hopkins University, CSSE. Data updated March 15, 17:00 GMT

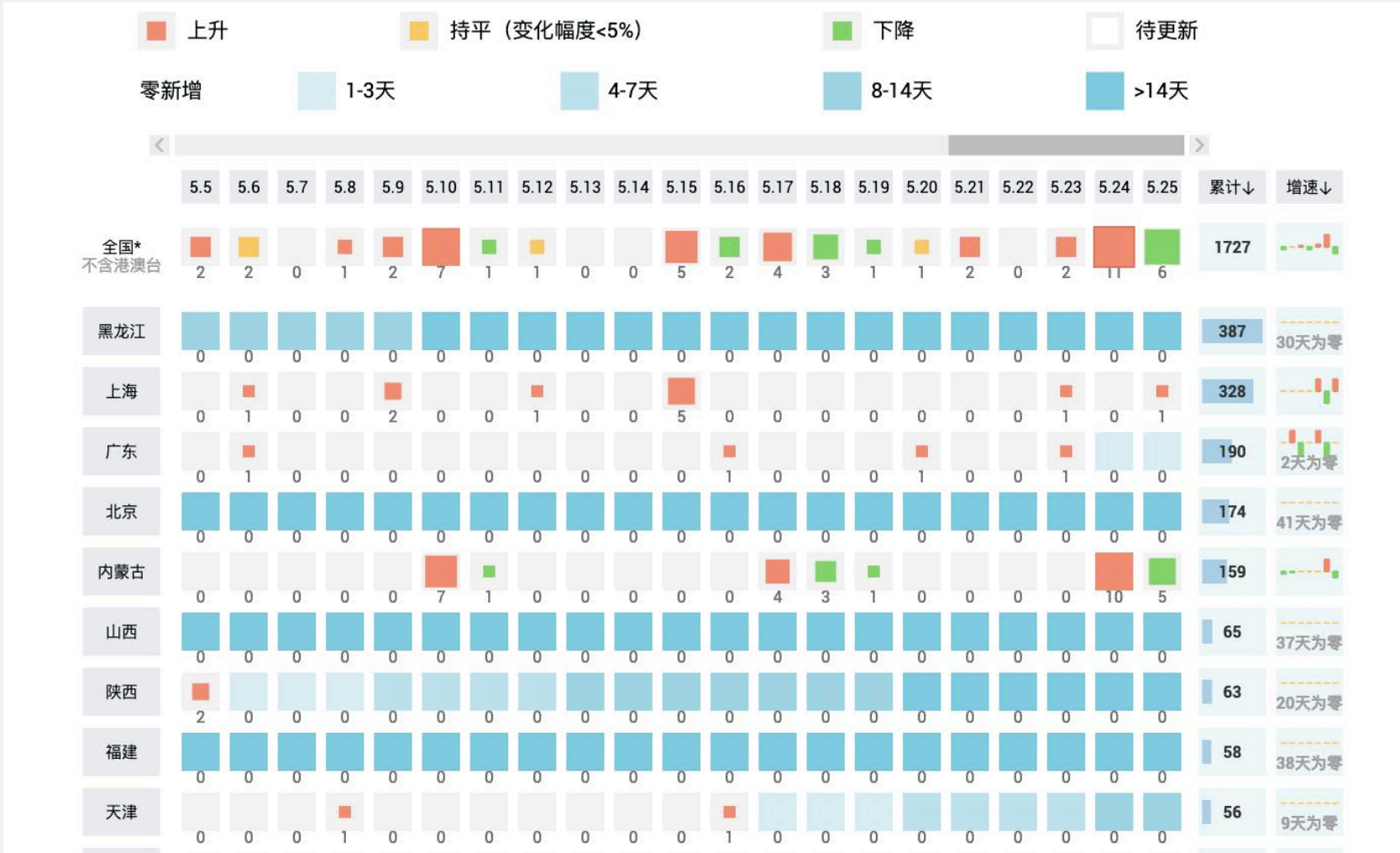
Coronavirus tracked: has the epidemic peaked near you? | Financial Times



The latest figures on the Swiss COVID 19 outbreak | Tages-Anzeiger (Zurich)



COVID-19 Barometer | Visualization and Visual Analytics Laboratory, PKU (China)

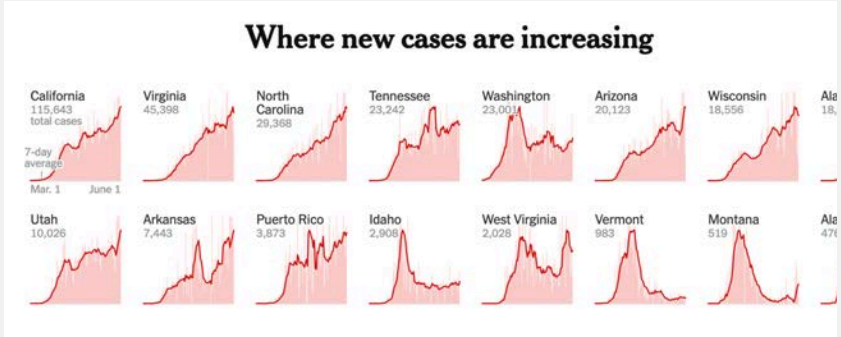


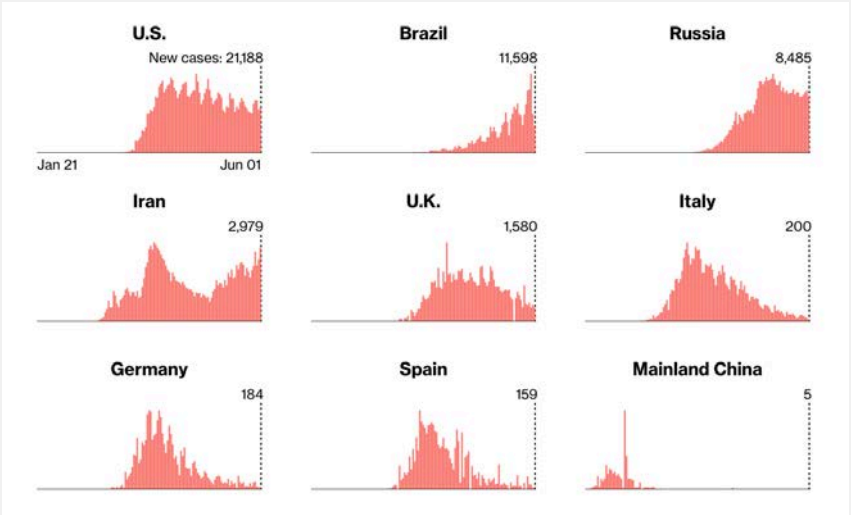
COVID-19 Barometer | Visualization and Visual Analytics Laboratory, PKU (China)

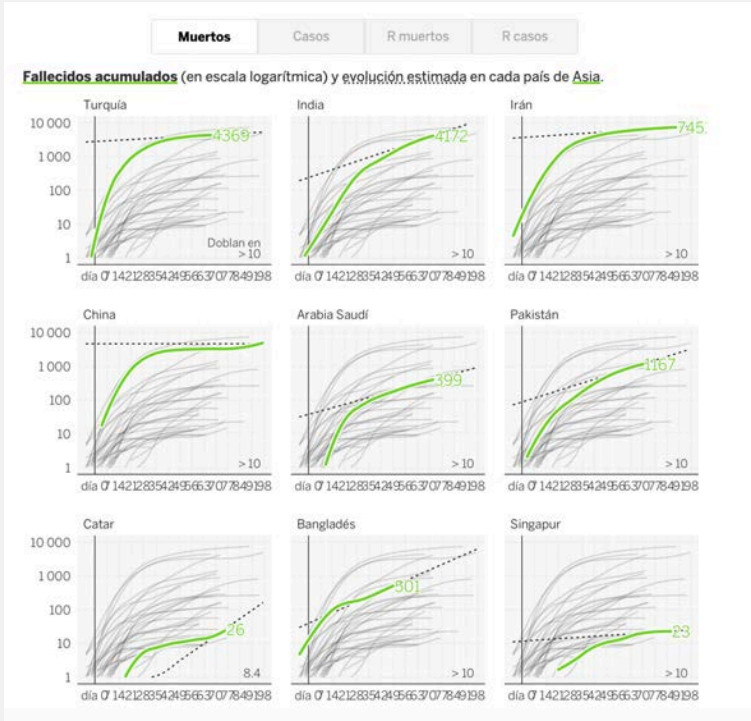
晴雨记录表

代号 月 \ 日	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
5月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
6月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
7月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
8月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
9月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
10月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
11月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
12月	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
图例	晴 ●				雨 ●								阴 ●											半阴半晴 ◐							

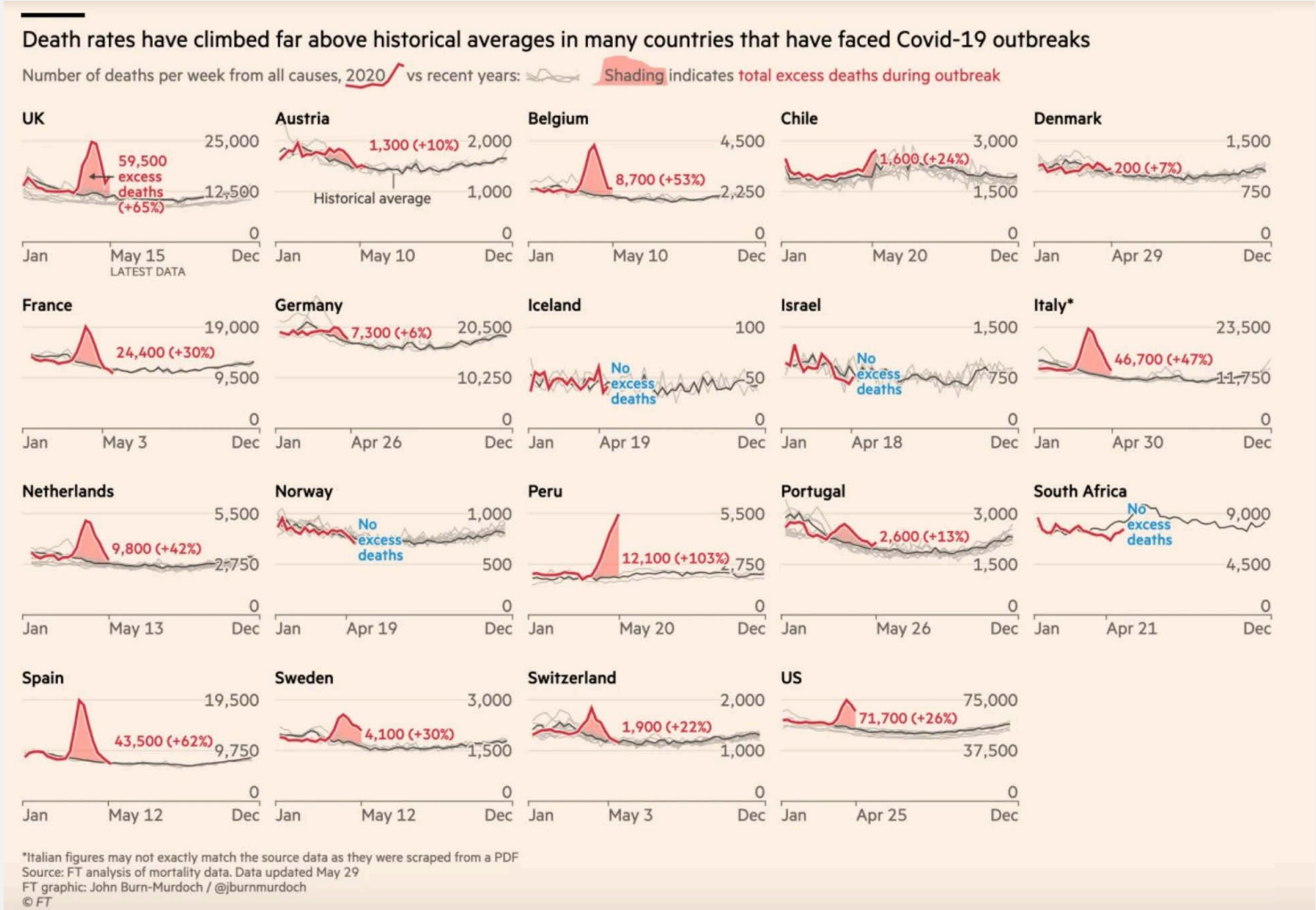
Proliferation of Small Multiples



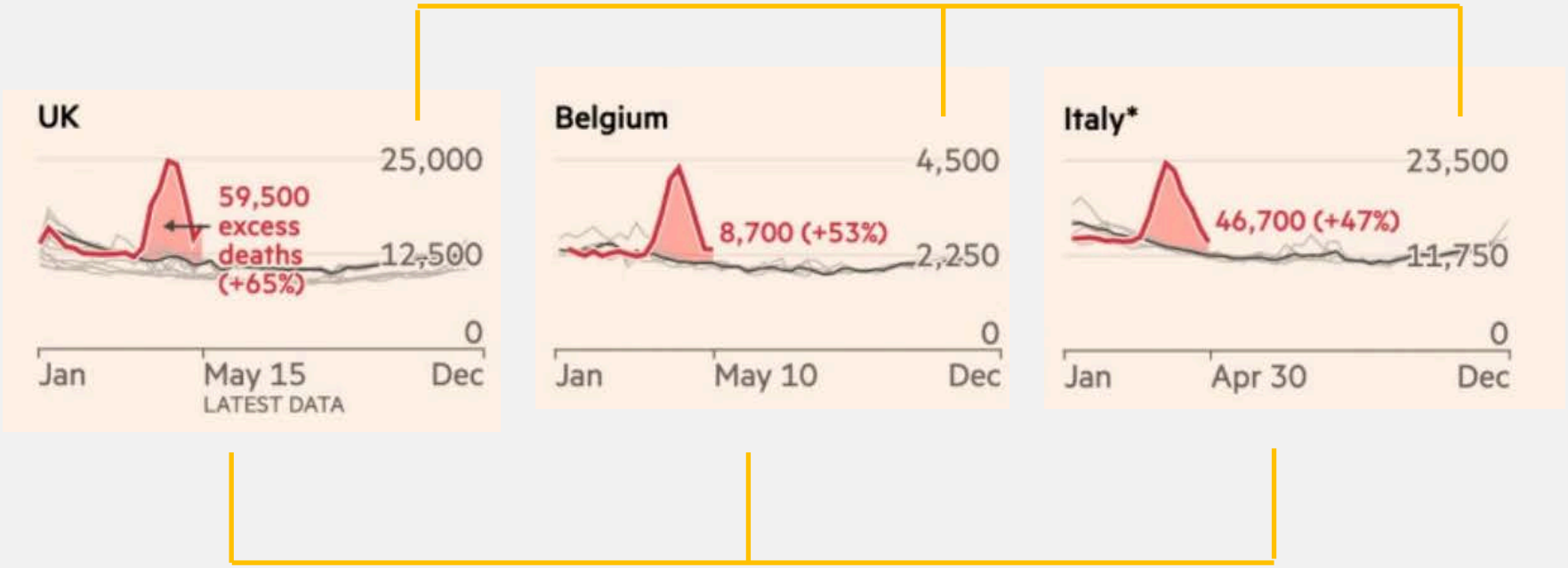




Coronavirus tracked: the latest figures as countries fight to contain the pandemic | Financial Times



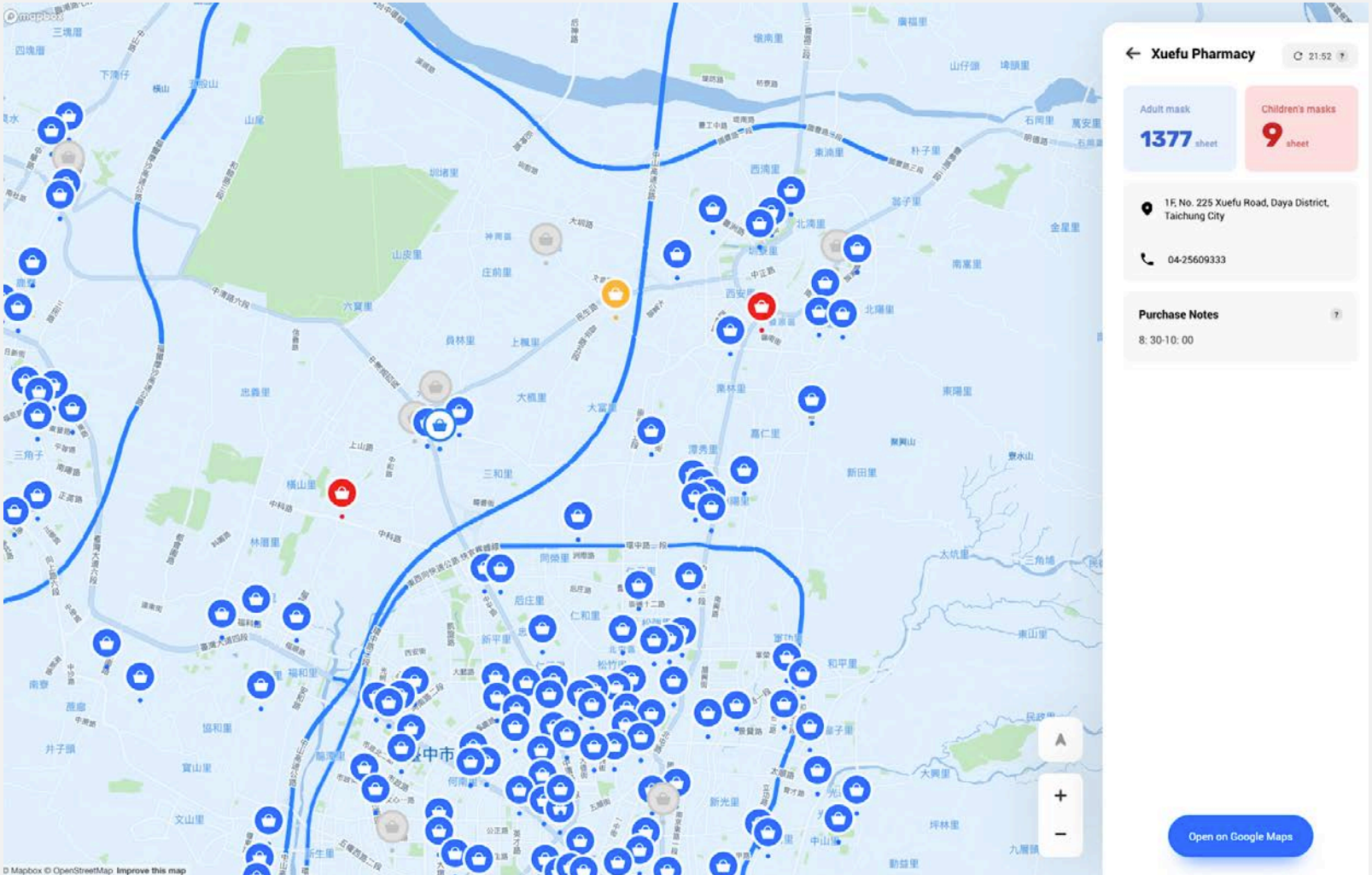
Coronavirus tracked: the latest figures as countries fight to contain the pandemic | Financial Times



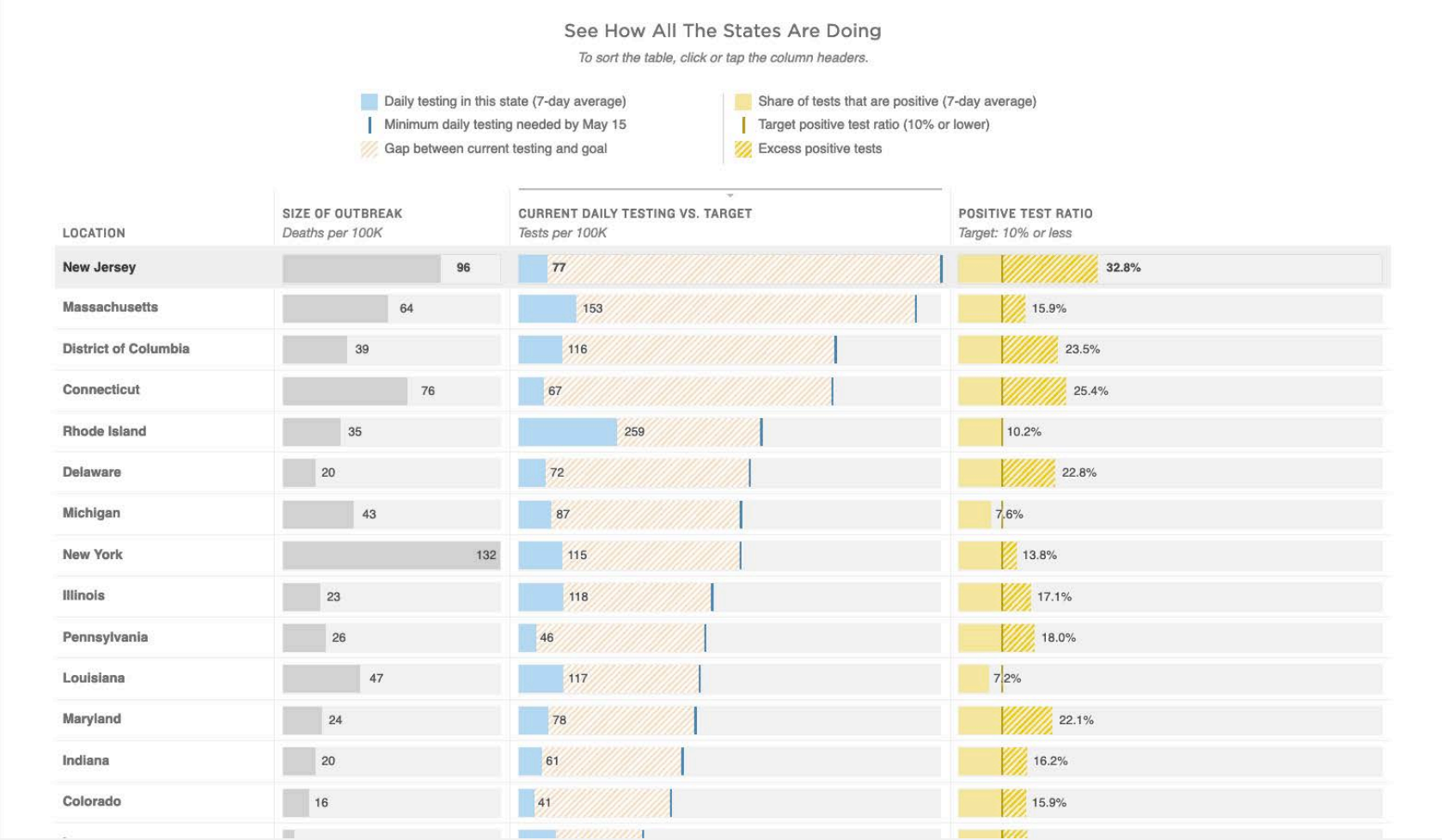
COMMUNICATING THE CURRENT MEDICAL STATE, SUPPLIES

Intended Message #2

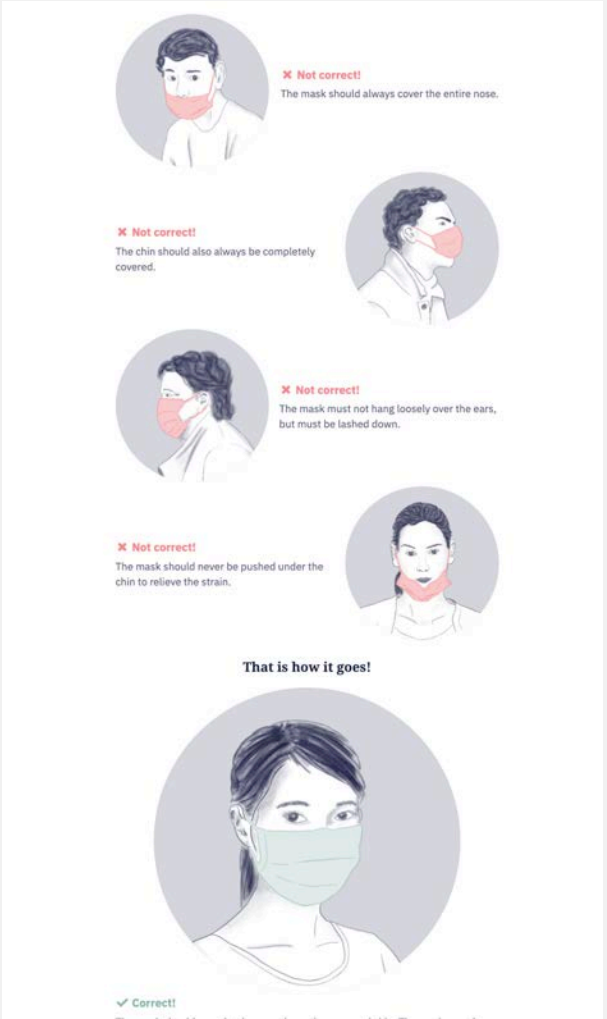
Mask Guide (Taiwan)



U.S. Coronavirus Testing Still Falls Short. How's Your State Doing? | NPR



Welche Masken schützen und wie man sie richtig trägt | Tages-Anzeige (Zurich)



✖ Not correct!
The mask should always cover the entire nose.

✖ Not correct!
The chin should also always be completely covered.

✖ Not correct!
The mask must not hang loosely over the ears, but must be lashed down.

✖ Not correct!
The mask should never be pushed under the chin to relieve the strain.

That is how it goes!

✓ Correct!

2nd What types of masks are there?

Respirators (with and without valve)

FFP1, FFP2, FFP3

- FFP stands for Filtering Face Piece. FFP1, FFP2 and FFP3 provide 80, 94 and 99 percent protection against viruses - but they are not completely dense. FFP1 masks do not protect against aerosols and are unsuitable for self-protection in the medical field.
- FFP2 / 3 masks protect the wearer, e.g. nurse or doctor, from infections, since the air we breathe is filtered from the outside when inhaled.
- Particle filters also collect dust, vapors or some microorganisms.
- Should be strictly reserved for medical personnel.
- Warning: some of these masks have a valve for easier exhalation. Infected people with or without symptoms of illness should not use these masks because they contribute to the spread of viruses.
- The protection values only apply if the mask fits perfectly, so "beard hair in the area of the sealing line between the respirator and facial skin can impair the protective effect", as the Robert Koch Institute emphasizes.

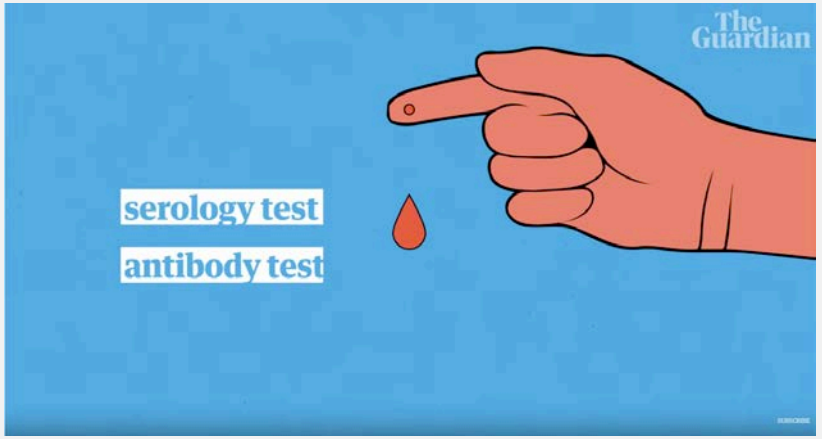
Hygiene masks or surgical mask

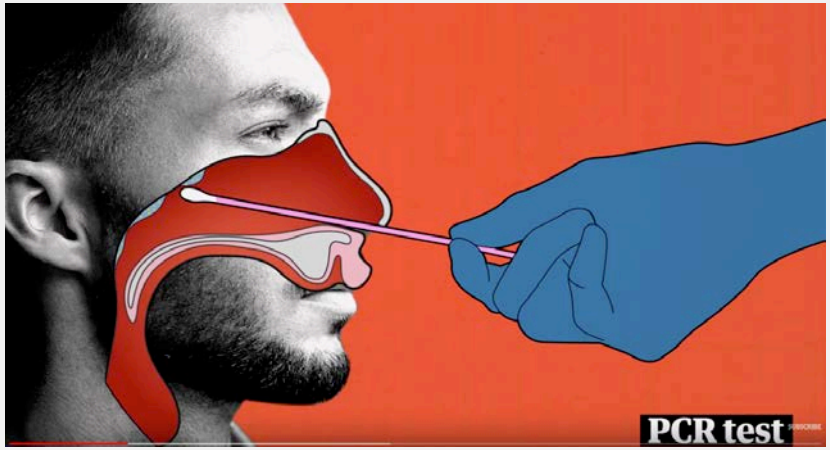
Type II or IIR

- The inside of most medical masks are white, while the outside is of any other color.
- Intended for people with symptoms of illness. They protect the environment from infectious agents from the nose and mouth of the mask wearer. So can reduce the risk of infection in older and chronically ill people.
- They do not offer reliable protection against infection because they do not have a filter and a lot of air is sucked in at the edges.
- Prevent mucous membranes from being touched by the mouth and nose with any contaminated hands.
- Press the metal piece over the nose firmly at the beginning so that the mask fits tightly.
- Throw away immediately after one use and then wash your hands with soap and water.

Fabric masks

Coronavirus tests: how they work and what they show | The Guardian (UK)





COMMUNICATING TRANSMISSION AND INFECTION

Intended Message #3

Transition from Data Visualization to Concept Visualization

Hidden Outbreaks Spread Through U.S. | New York Times

Hidden Outbreaks Spread Through U.S. Cities Far Earlier Than Americans Knew, Estimates Say

By Benedict Carey and James Glanz

Published April 23, 2020 Updated May 14, 2020

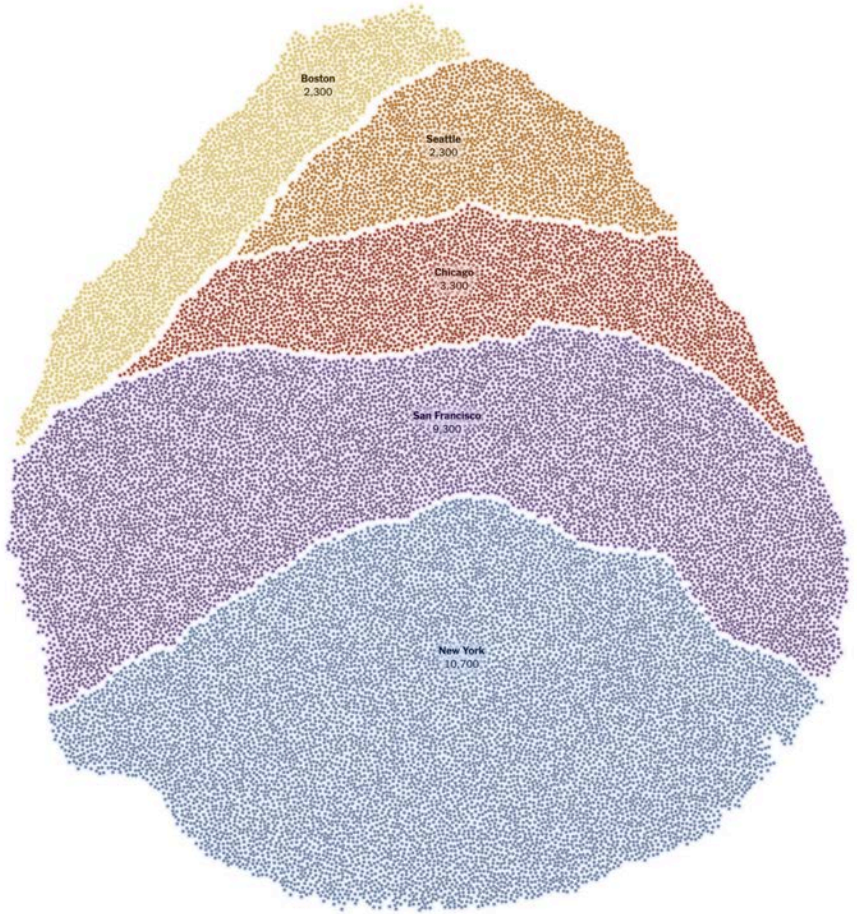
By the time New York City confirmed its first case of the coronavirus on March 1, thousands of infections were already silently spreading through the city, a hidden explosion of a disease that many still viewed as a remote threat as the city awaited the first signs of spring.

Hidden outbreaks were also spreading almost completely undetected in Boston, San Francisco, Chicago and Seattle, long before testing showed that each city had a major problem, according to a model of the spread of the disease by researchers at Northeastern University who shared their results with The New York Times.

Even in early February — while the world focused on China — the virus was not only likely to be spreading in multiple American cities, but also seeding blooms of infection elsewhere in the United States, the researchers found.

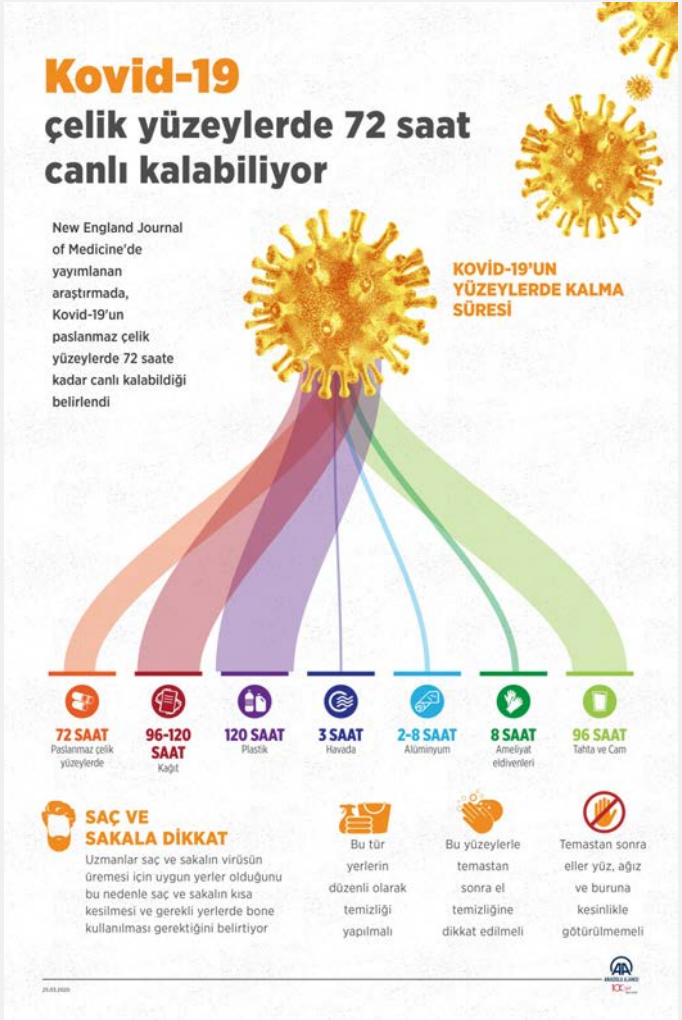
In five major U.S. cities, as of March 1
there were only **23 confirmed cases** of coronavirus.

But according to the Northeastern model, there could have actually been about **28,000 infections** in those cities by then.

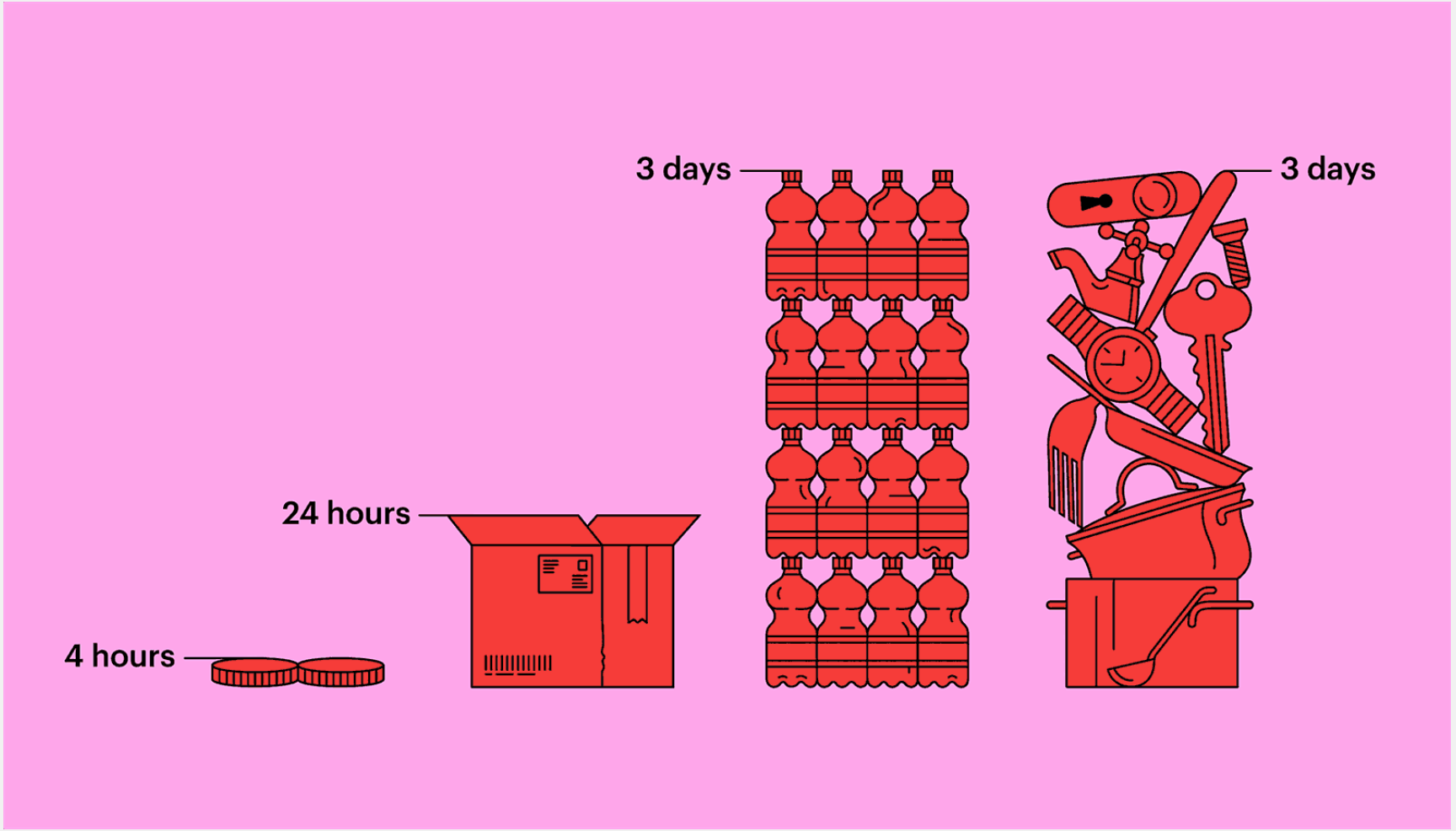


Note: Numbers are median estimates that the Northeastern model calculated for each city. The true number of infections could have been substantially higher or lower than shown here. By Derek Watkins

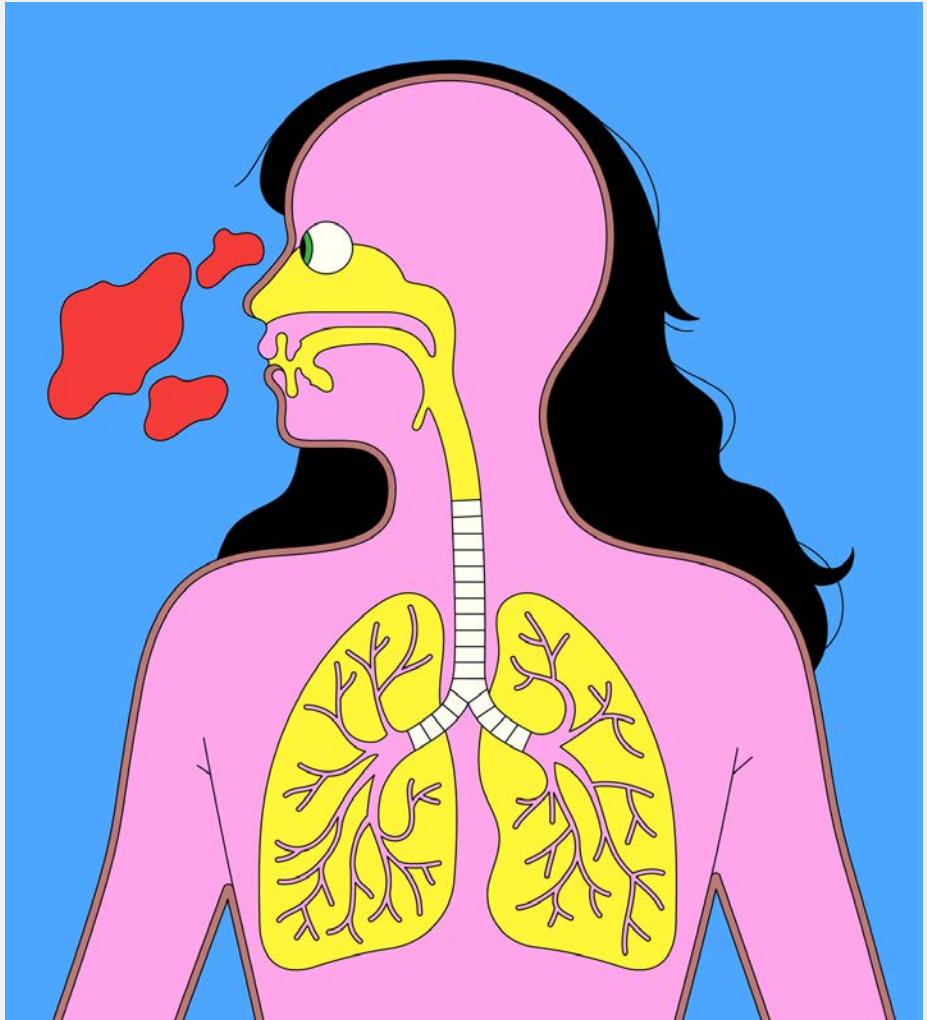
COVID-19 can stay alive on metal for 72 hours

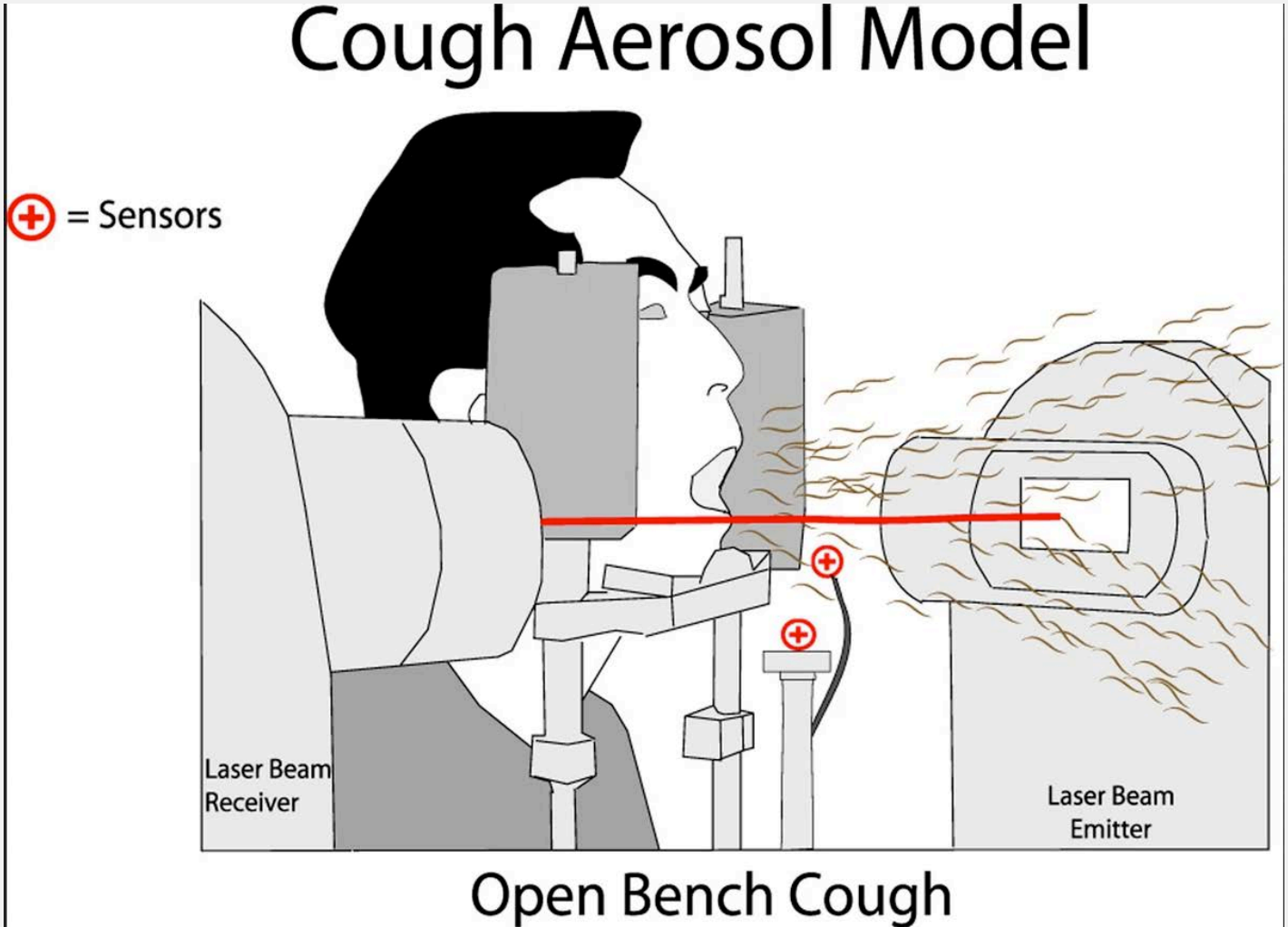


From Bats to Human Lungs, the Evolution of a Coronavirus | The New Yorker

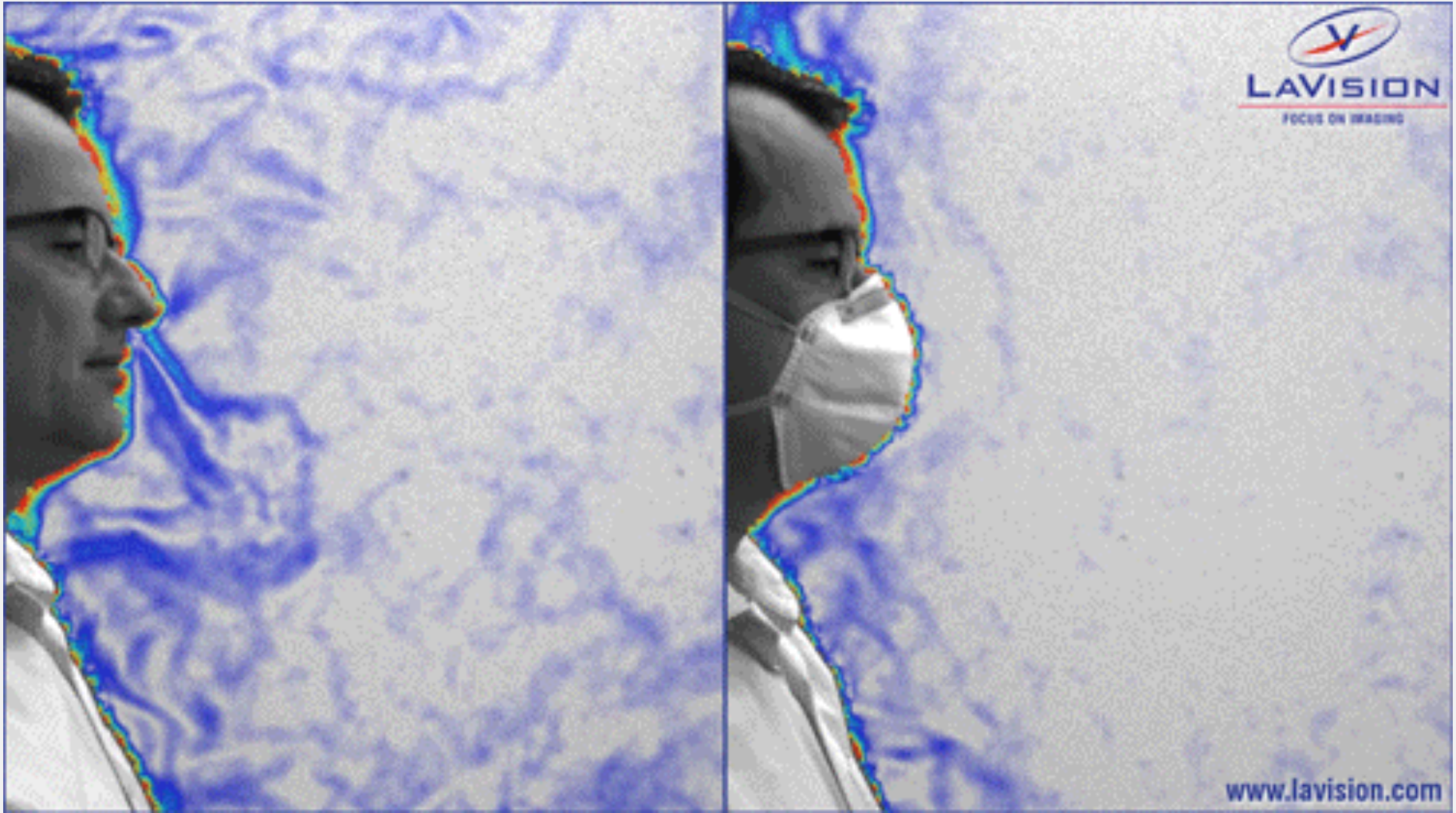


From Bats to Human Lungs, the Evolution of a Coronavirus | The New Yorker

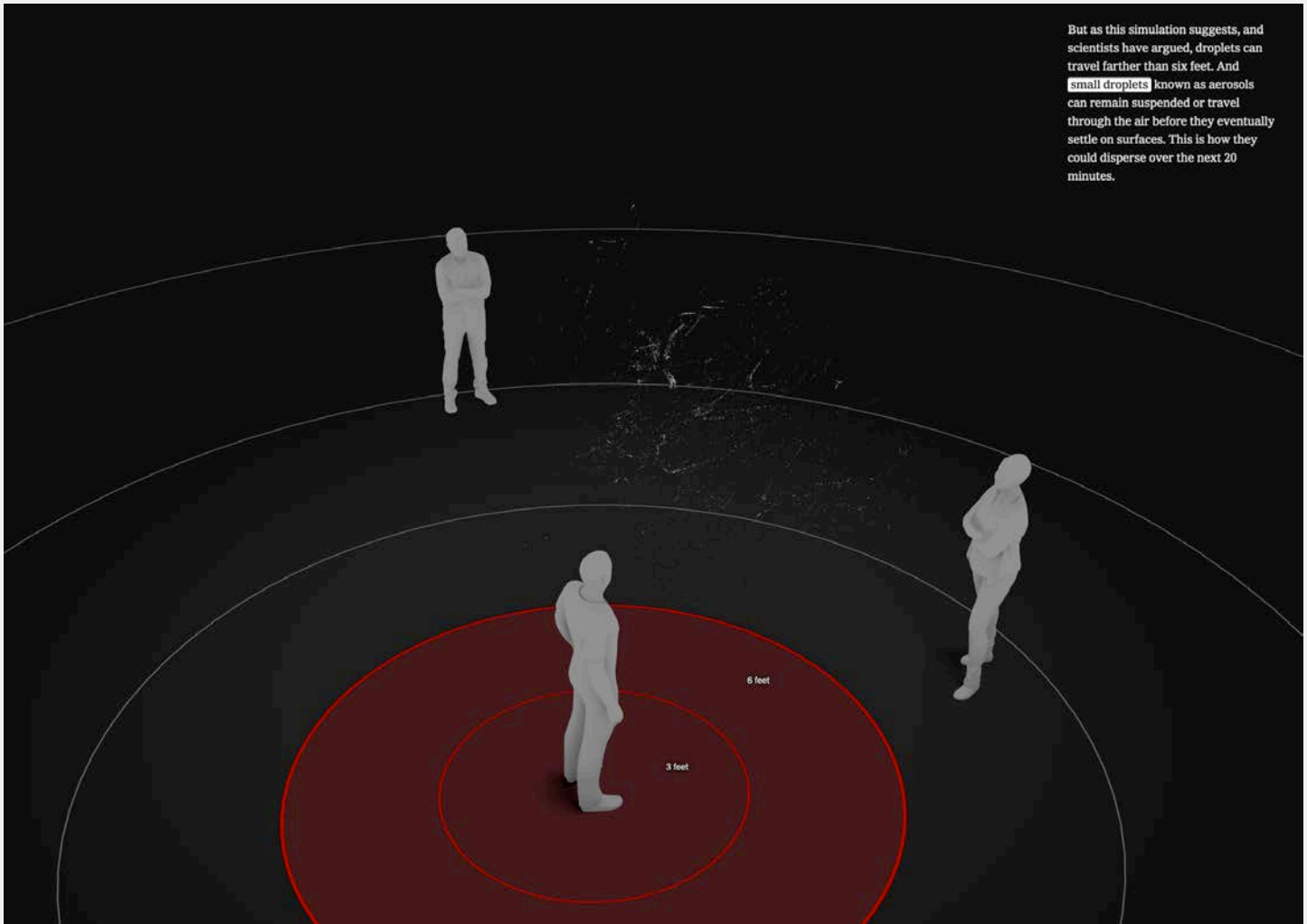



Cough Aerosol Model
= Sensors
Laser Beam
Receiver
Laser Beam
Emitter
Open Bench Cough

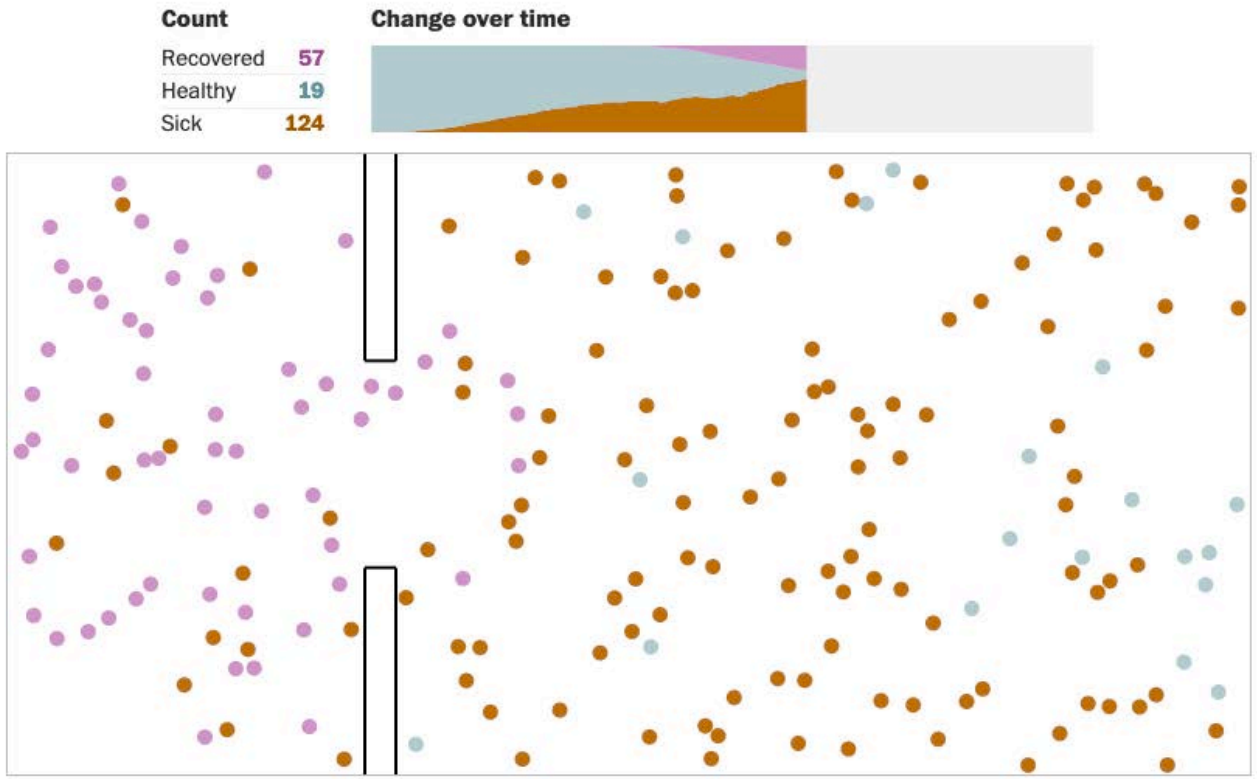
LaVision imaging technique shows how masks restrict the spread of exhaled air



This 3-D Simulation Shows Why Social Distancing Is So Important | New York Times

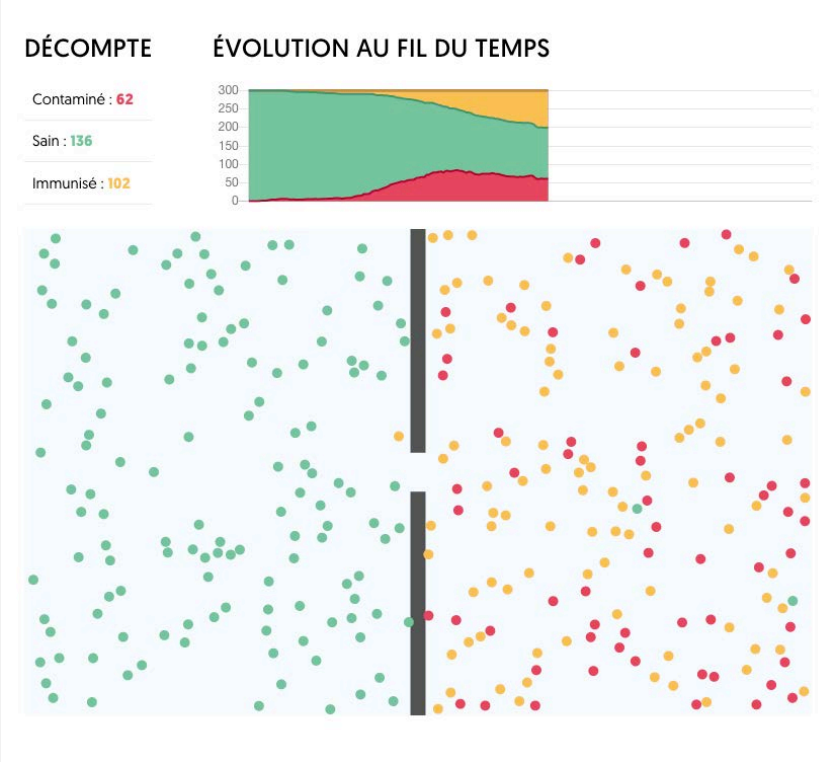


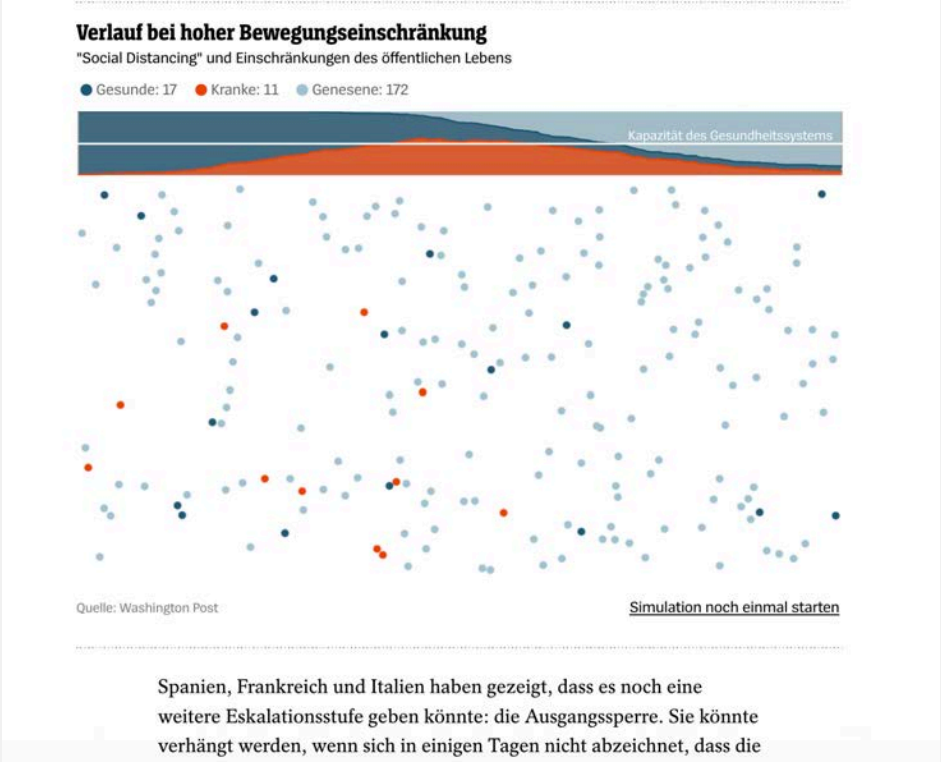
Why outbreaks like coronavirus spread exponentially, and how to “flatten the curve” | Washington Post



Whoops! As health experts would expect, it proved impossible to completely seal off the sick population from the healthy.

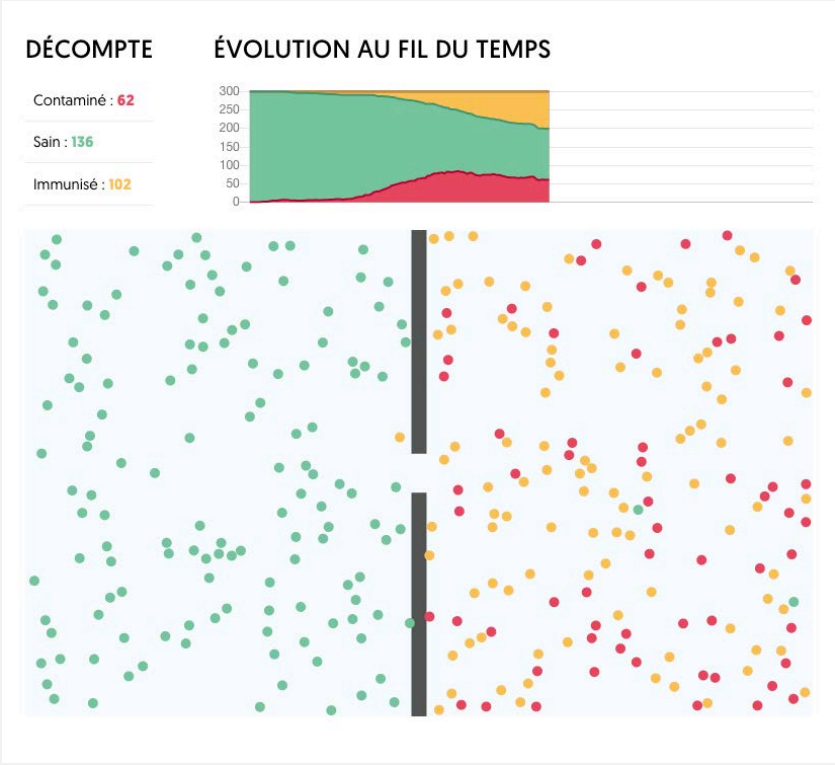
Face au coronavirus, le pari mortel de l'immunité collective | Le Media; So verbreitet sich ein Virus | Spiegel Wissenschaft





Spanien, Frankreich und Italien haben gezeigt, dass es noch eine weitere Eskalationsstufe geben könnte: die Ausgangssperre. Sie könnte verhängt werden, wenn sich in einigen Tagen nicht abzeichnet, dass die

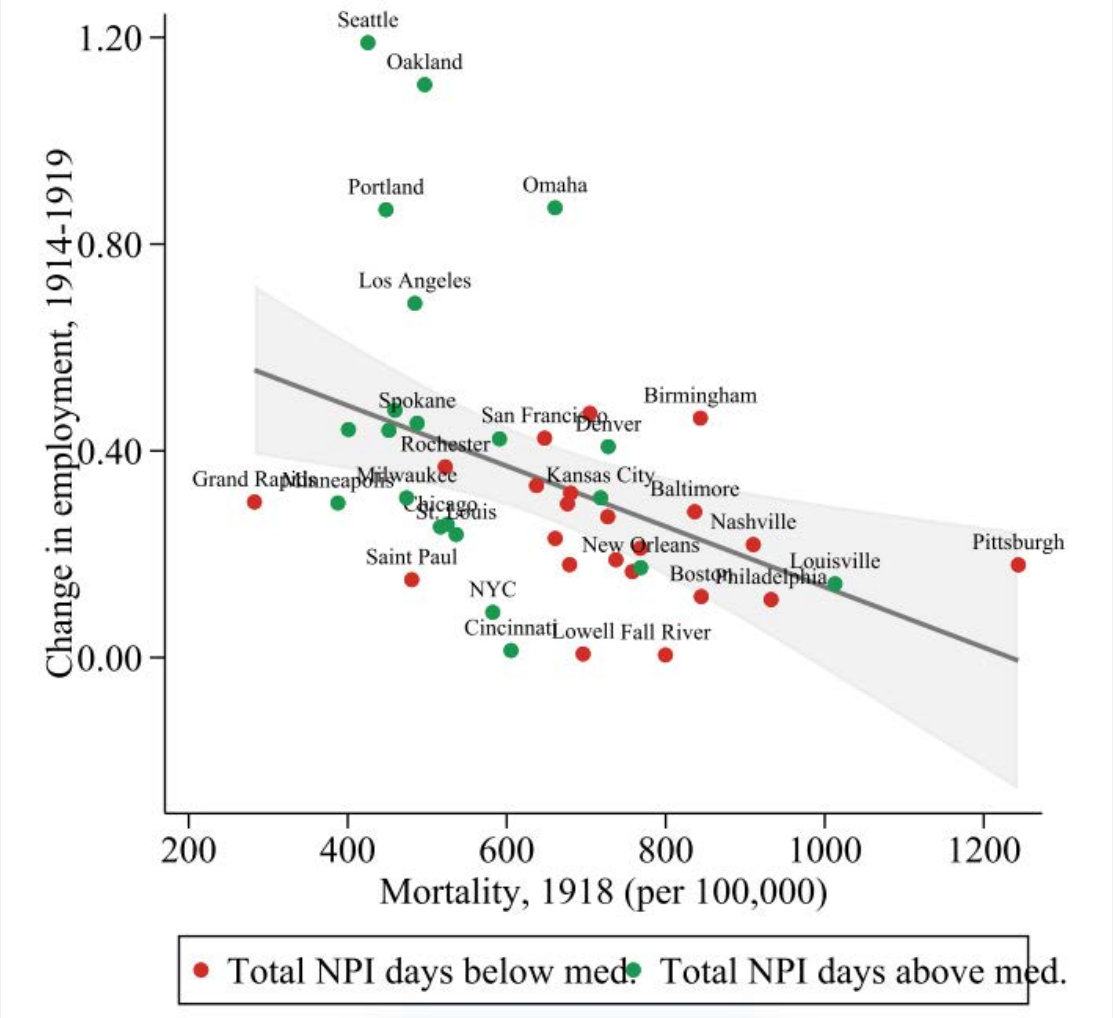
Face au coronavirus, le pari mortel de l'immunité collective | Le Media; So verbreitet sich ein Virus | Spiegel Wissenschaft



ВИДЕО: Хөл хорио, хөдөлгөөний хязгаарлалт | medee.mn

Translation from Academic Figures to News Stories

Pandemics Depress the Economy, Public Health Interventions Do Not: Evidence from the 1918 Flu



By Sergio Correia, Stephan Luck and Emil Verner, published in SSRN 3/26/20

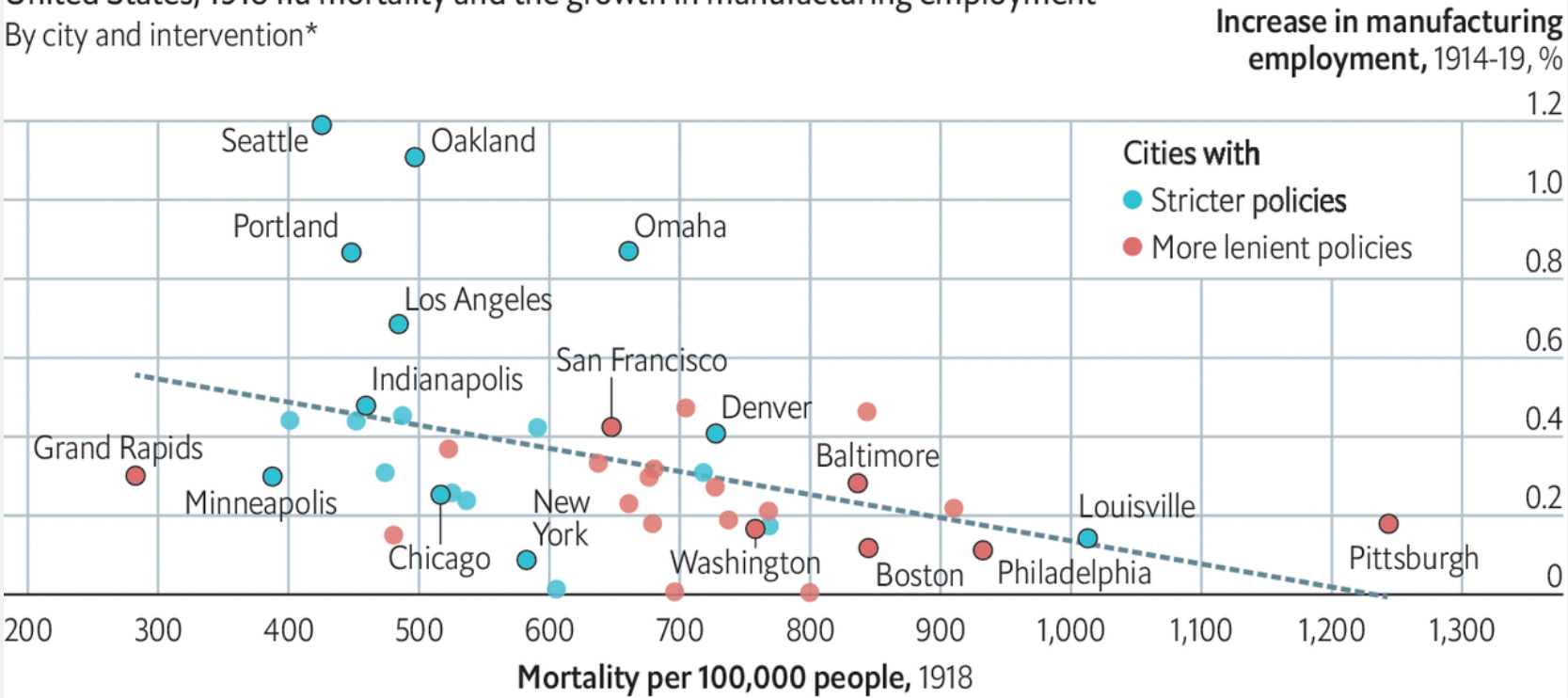
- NPI = Non-Pharmaceutical Interventions
- RED DOT = cities with below median days of NPI
- GREEN DOT = cities with above median days of NPI
- X = Influenza deaths per 100K population
- Y = Change in employment rate from 1914-1919

Lessons from the Spanish flu: social distancing can be good for the economy | The Economist

Necessary precautions

United States, 1918 flu mortality and the growth in manufacturing employment

By city and intervention*

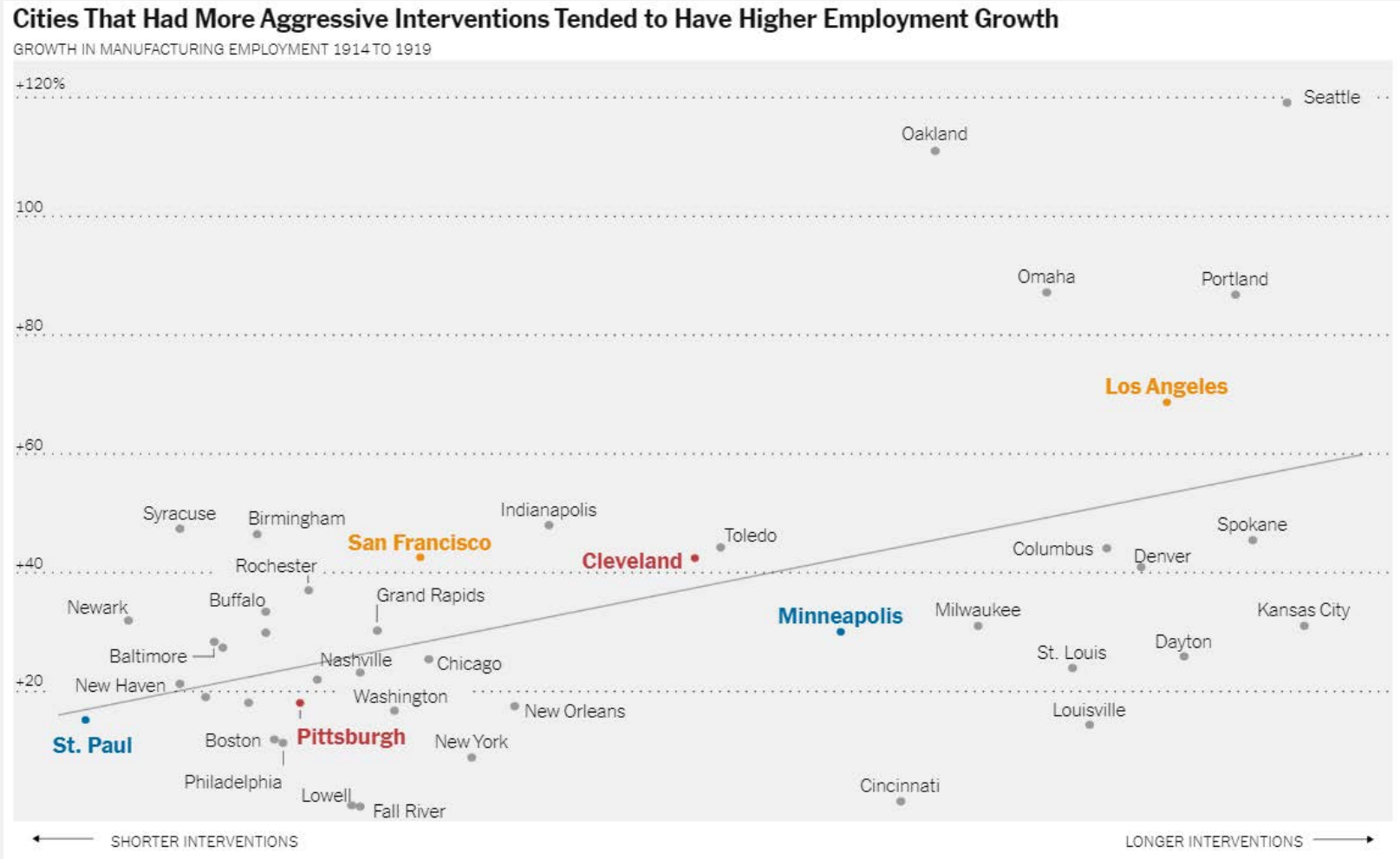


Source: "Pandemics depress the economy, public health interventions do not: evidence from the 1918 flu" by S. Correia, S. Luck and E. Verner, 2020

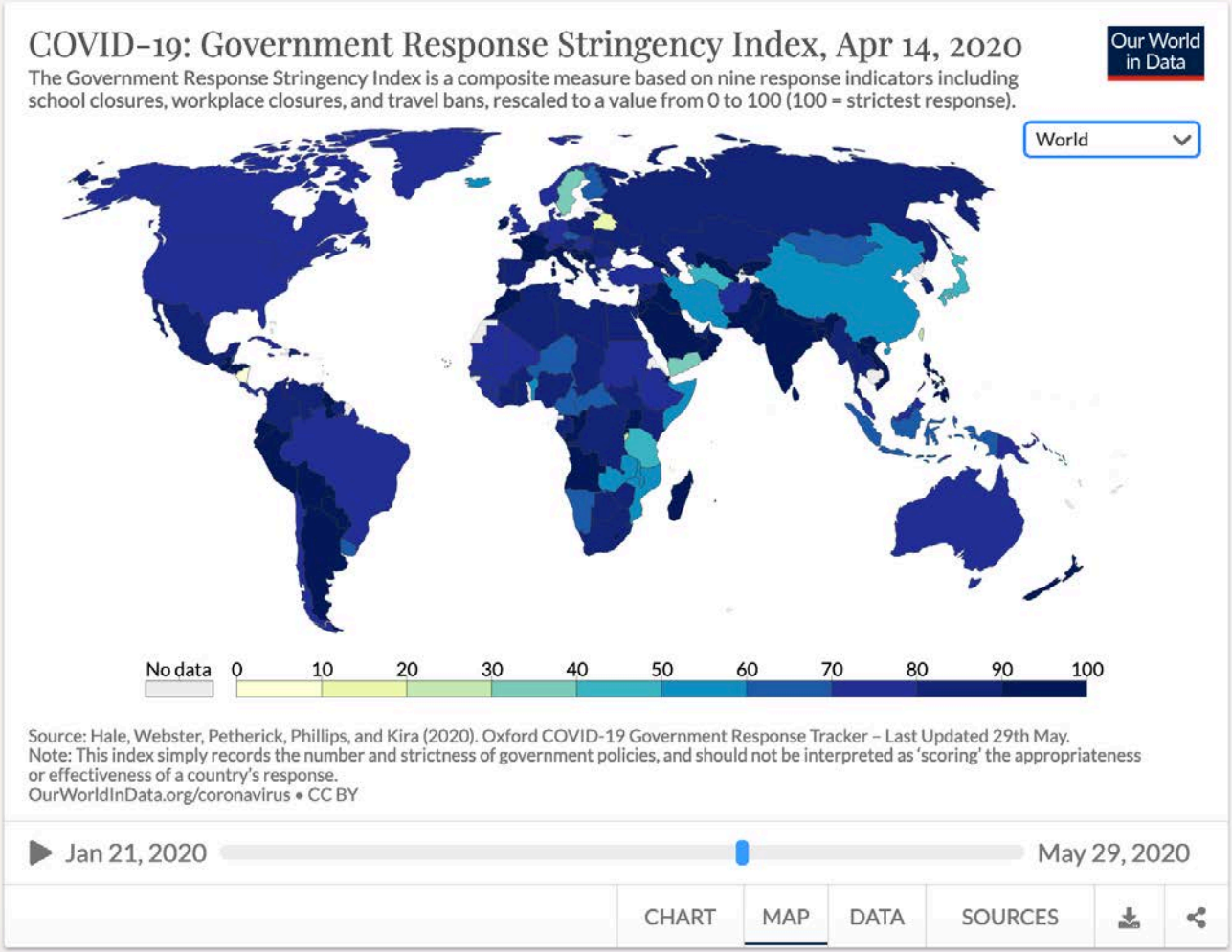
*Non-pharmaceutical measures, e.g. social distancing, closing schools and churches, mandatory face masks

The Economist

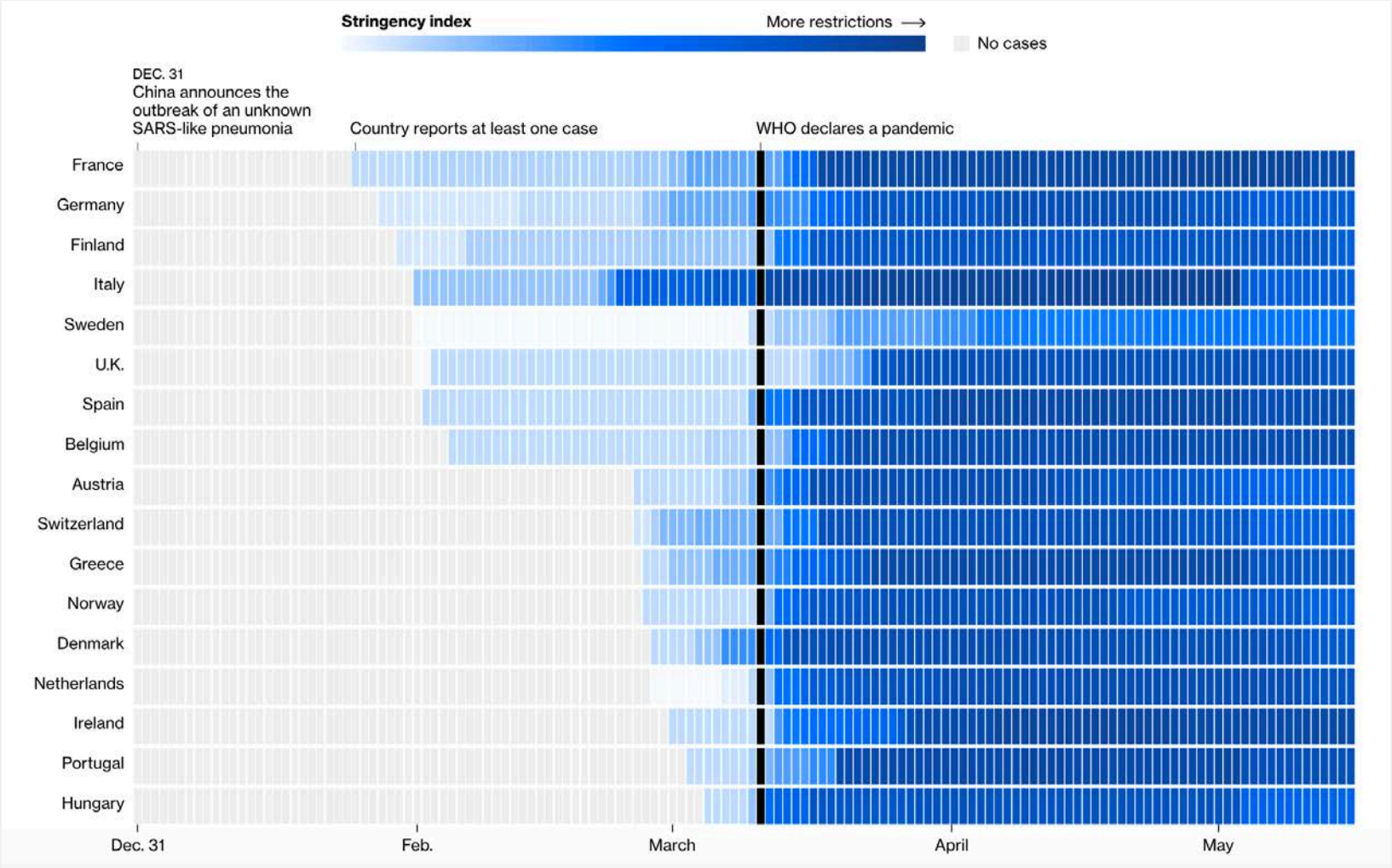
Cities That Went All In on Social Distancing in 1918 Emerged Stronger for it | New York Times



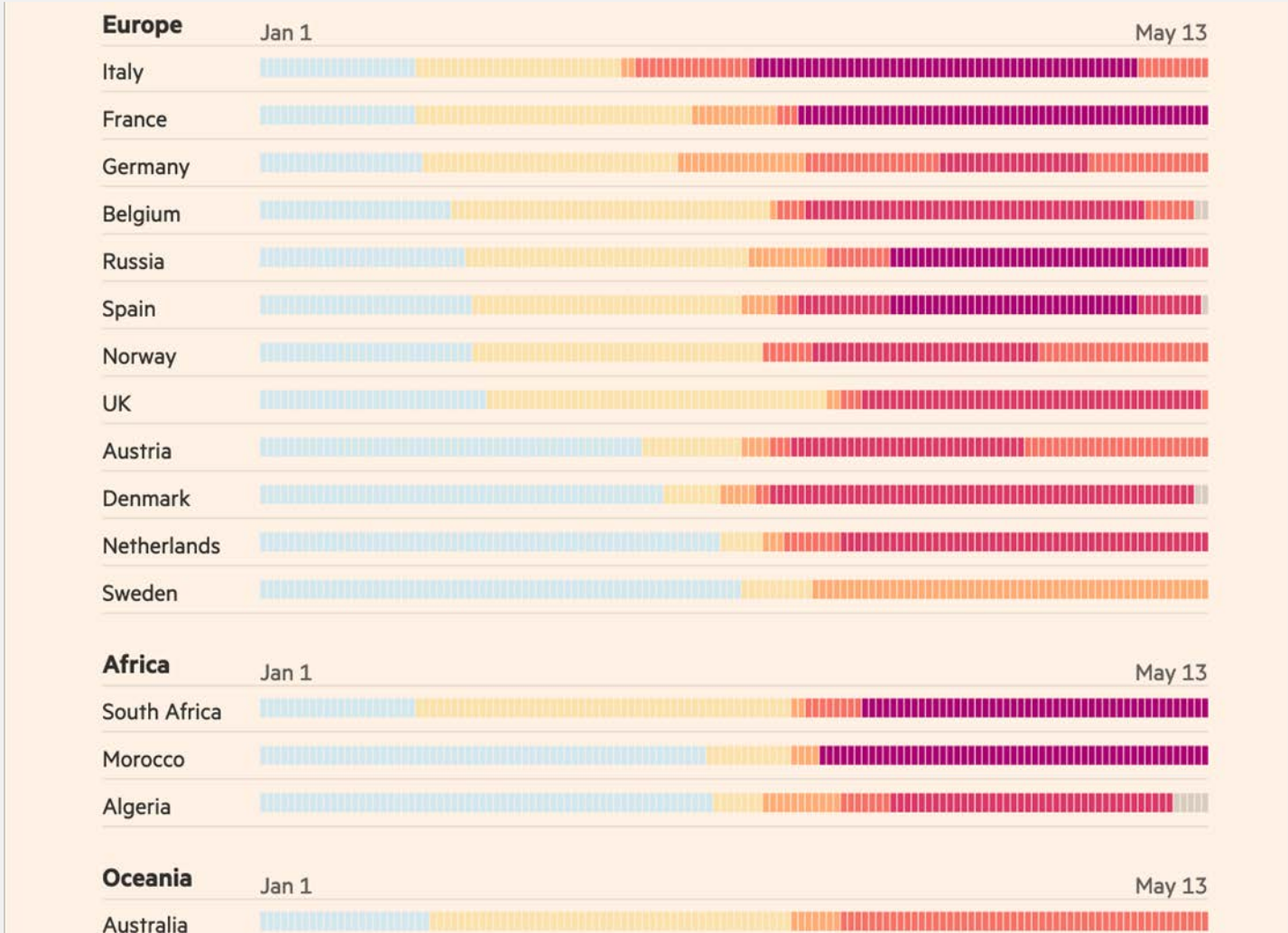
COVID-19: Government Response Stringency Index | Our World in Data (Oxford UK)



The Results of Europe’s Lockdown Experiment Are In | Bloomberg News



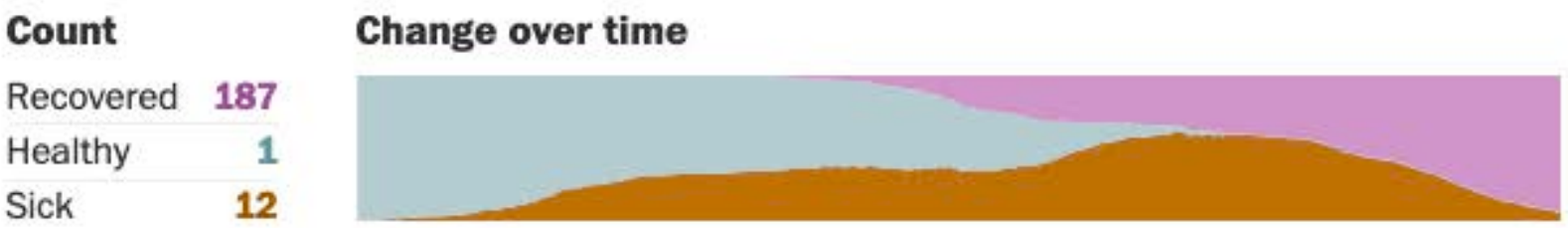
Exiting lockdowns: tracking governments' changing coronavirus responses | Financial Times



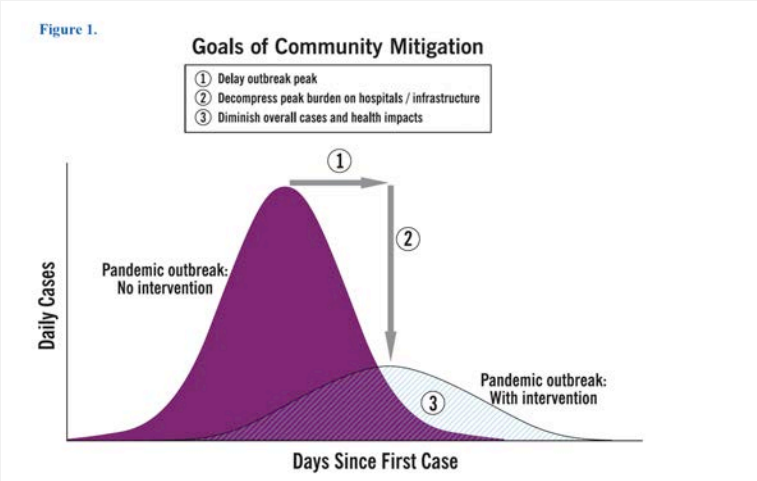
COMMUNICATE RISK
FLATTEN THE CURVE

Intended Message #4

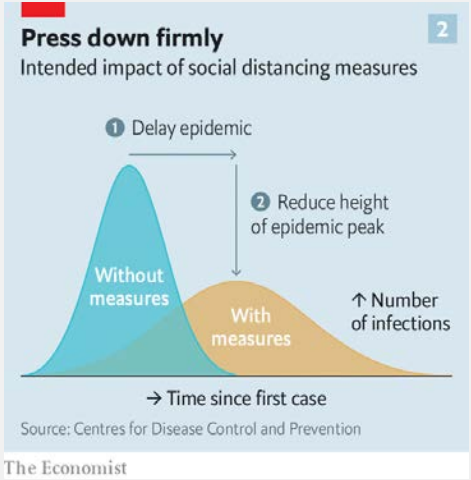
Why outbreaks like coronavirus spread exponentially, and how to “flatten the curve” (Washington Post)

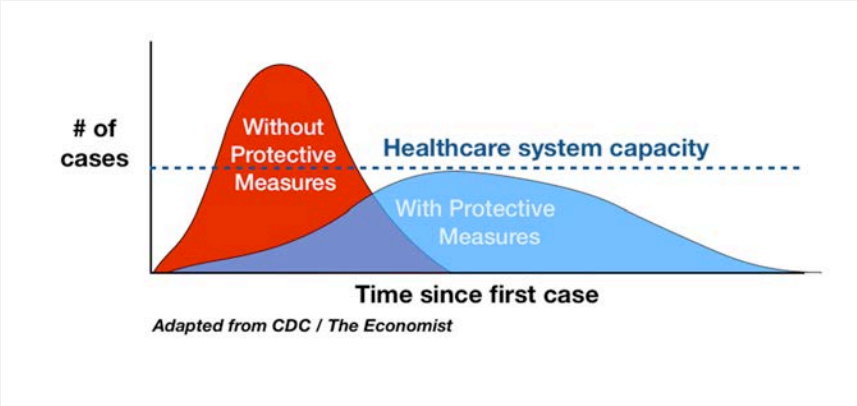


Community Strategy for Pandemic Influenza Mitigation in the United States | CDC, 2007



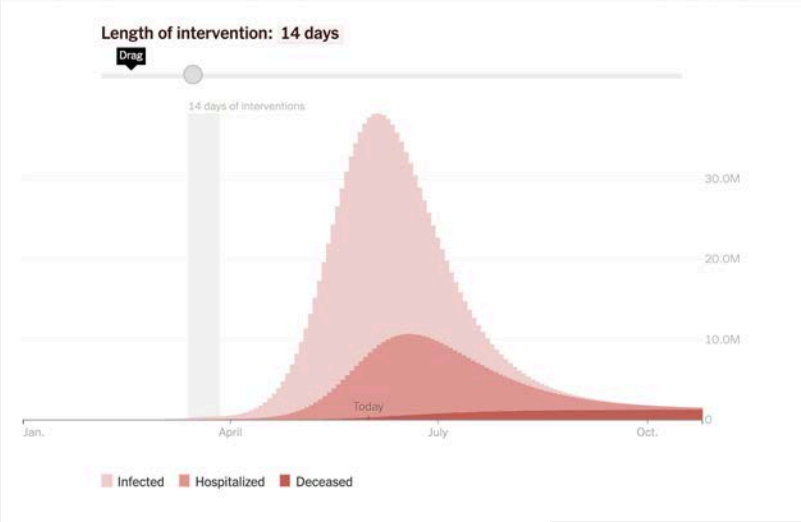
Covid-19 is now in 50 countries, and things will get worse | The Economist (2/29/20)

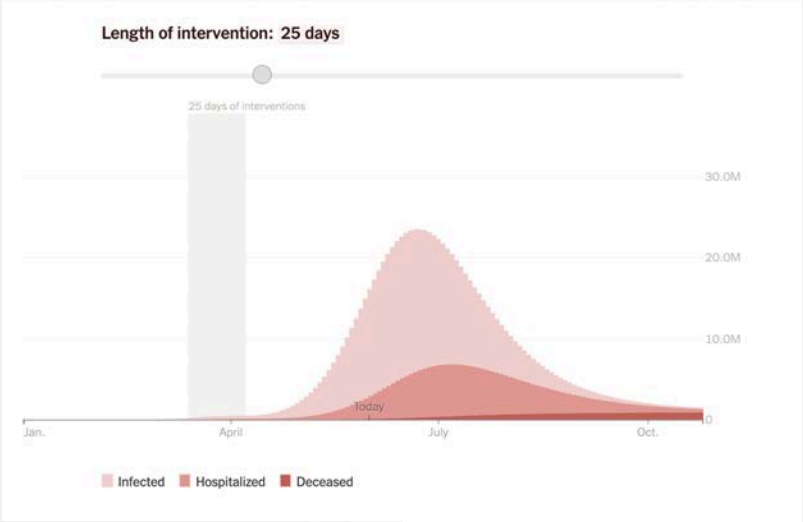


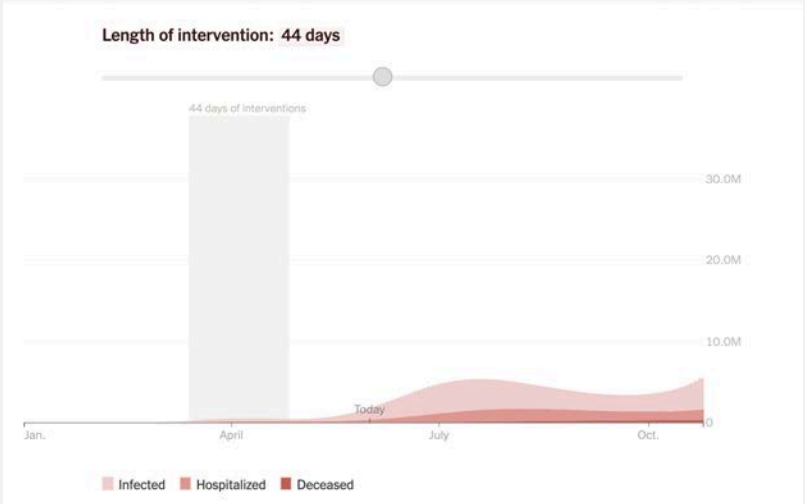


Redrawn by Drew Harris, professor of Population Health and published on Twitter

Trump Wants to ‘Reopen America.’ Here’s What Happens if We Do. | New York Times (3/25/20)



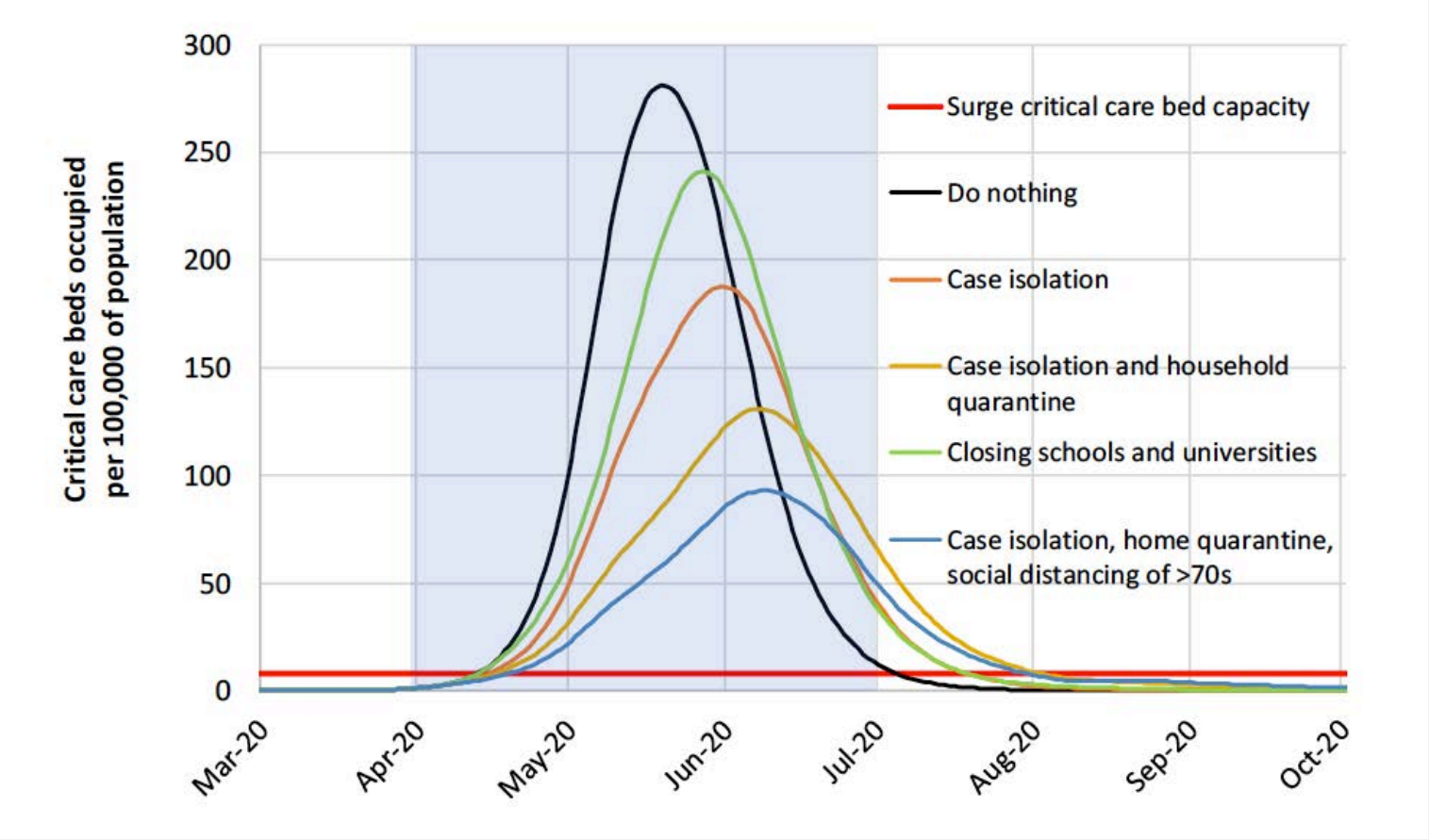




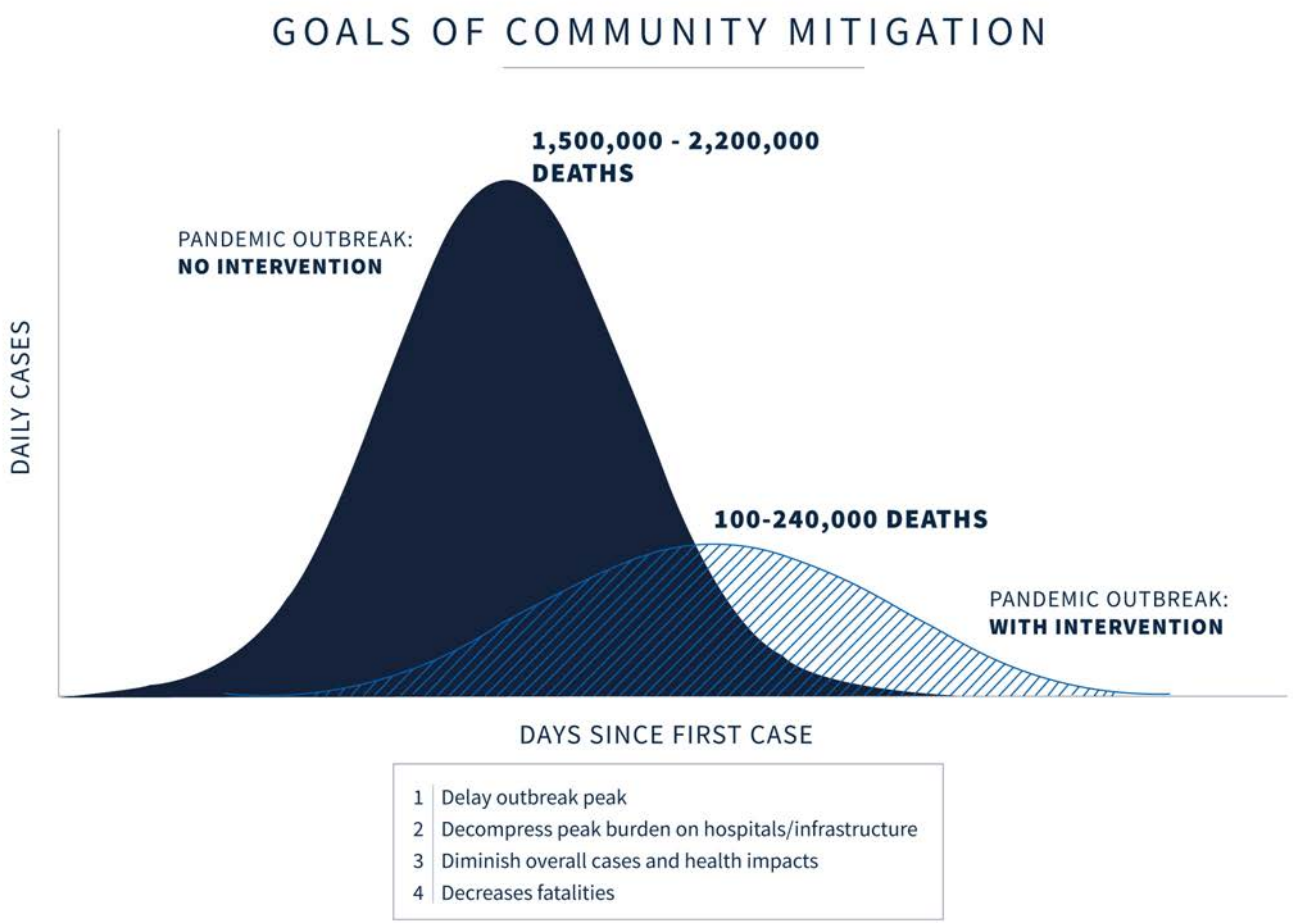
COMMUNICATE RISK FUTURE MODELS

Intended Message #5

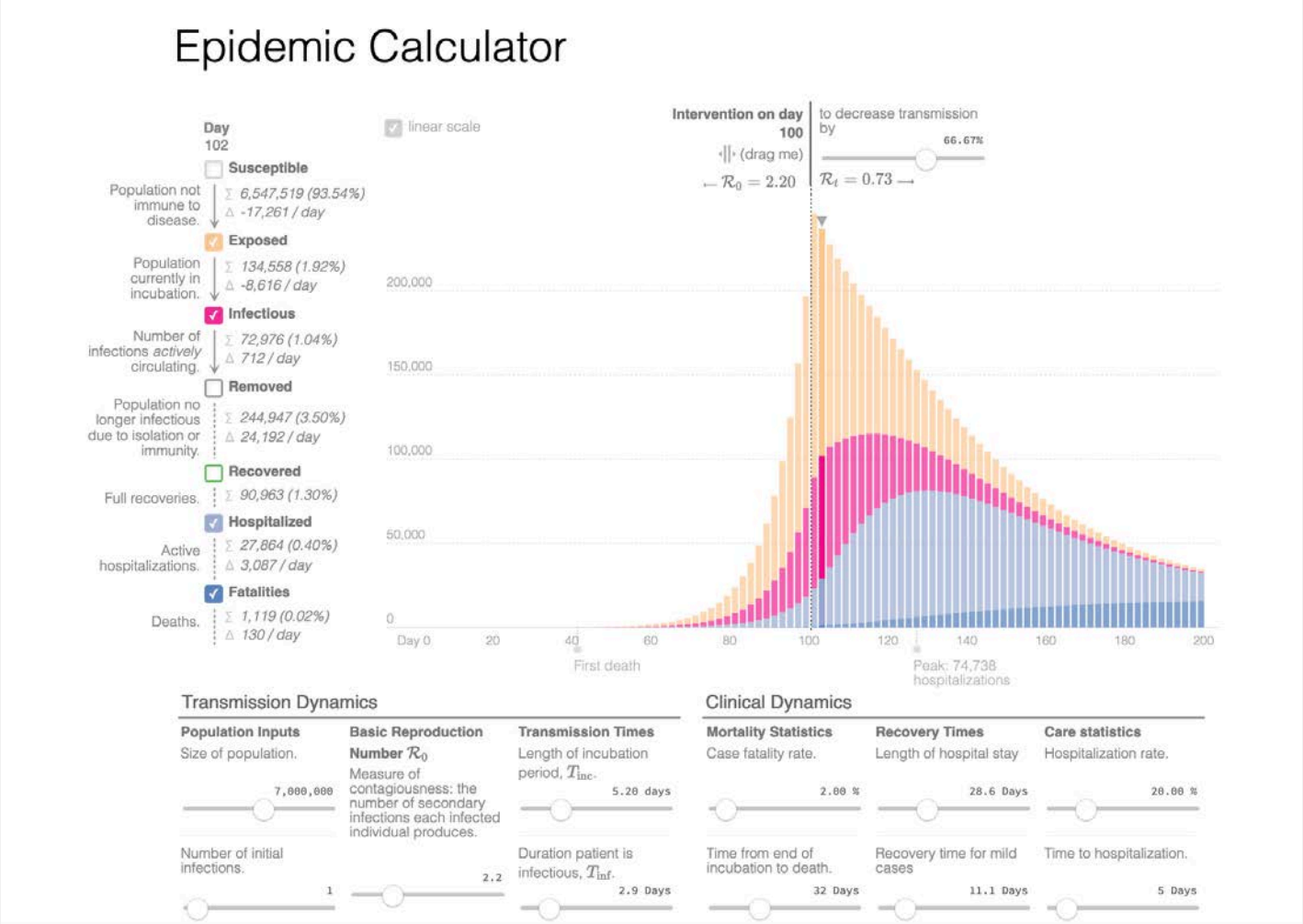
Imperial College COVID-19 Response Curves (3/16/20)



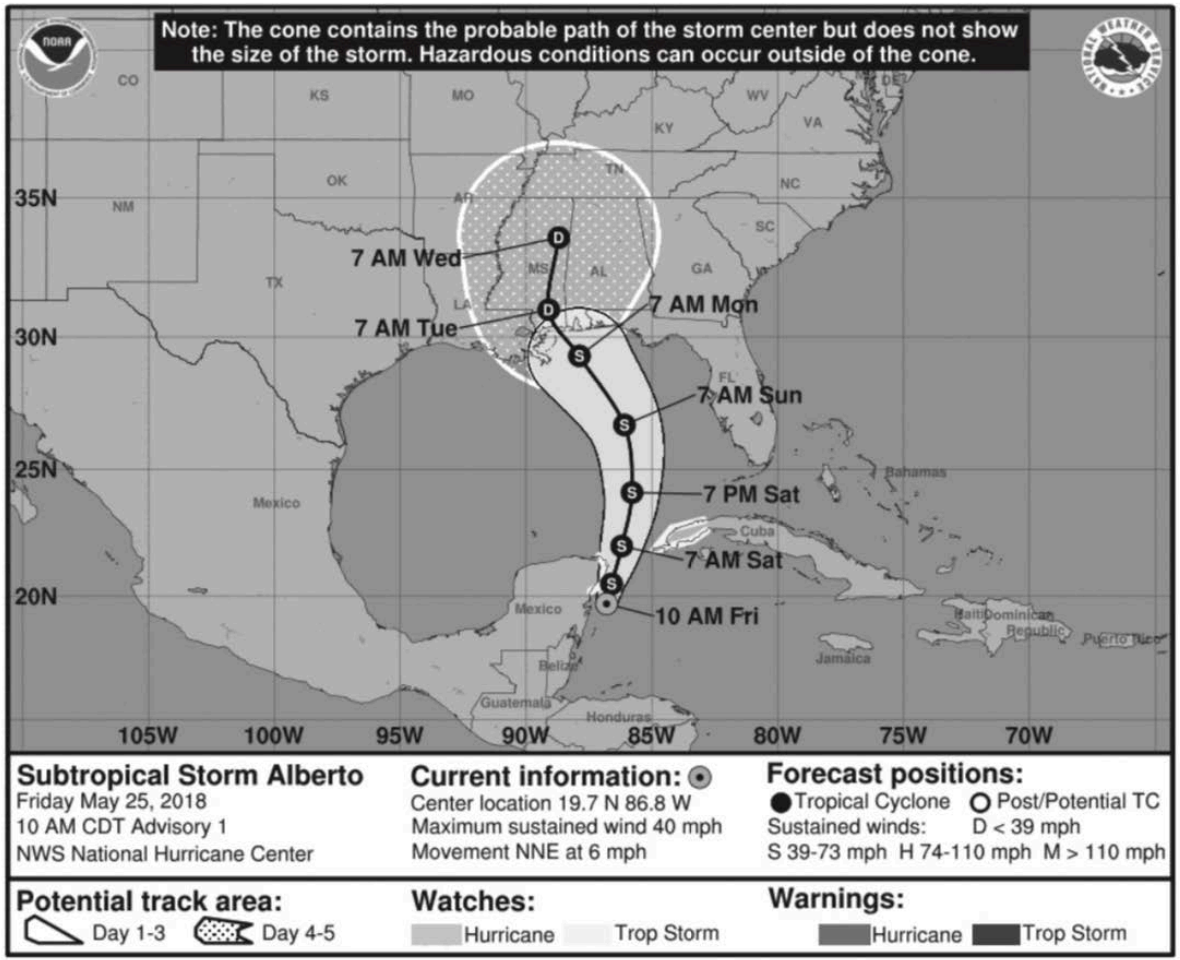
White House Briefing Presentation (3/31/20)



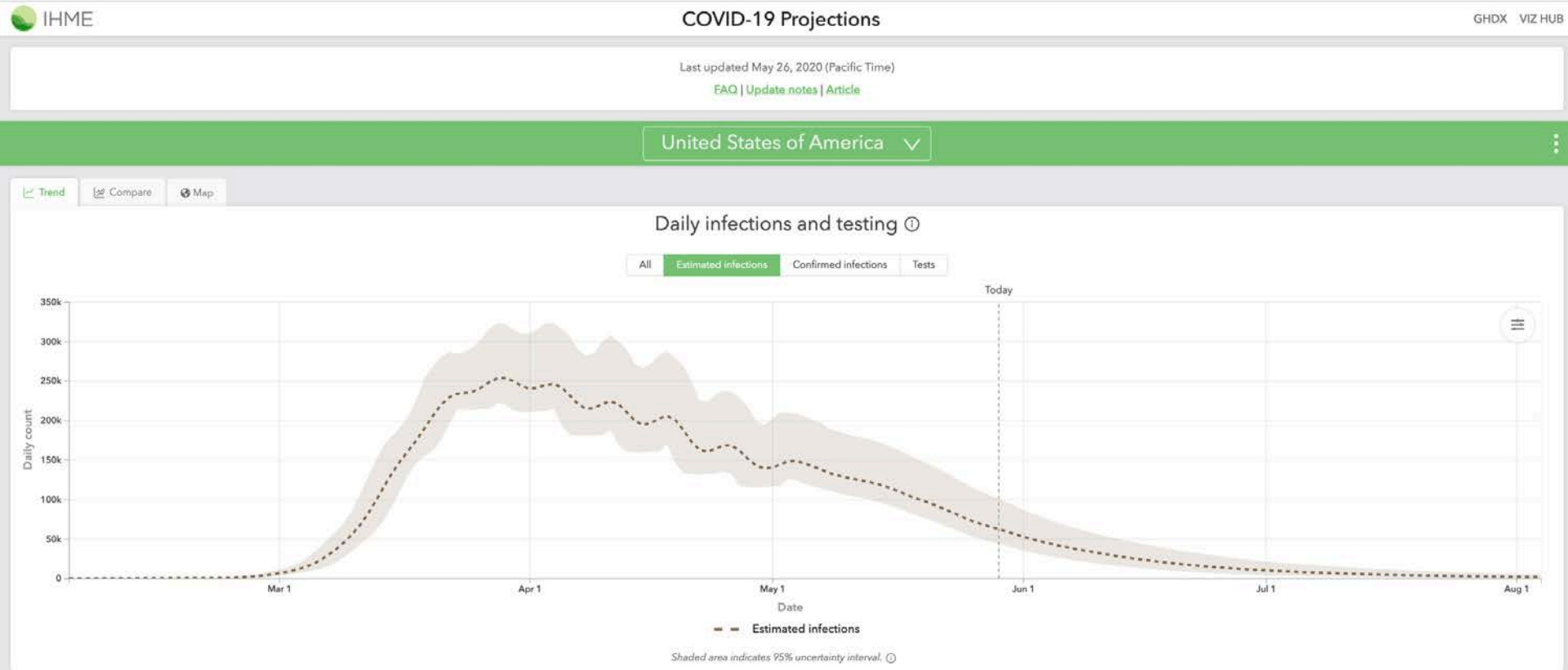
Epidemic Calculator (Gabriel Goh, OpenAI)



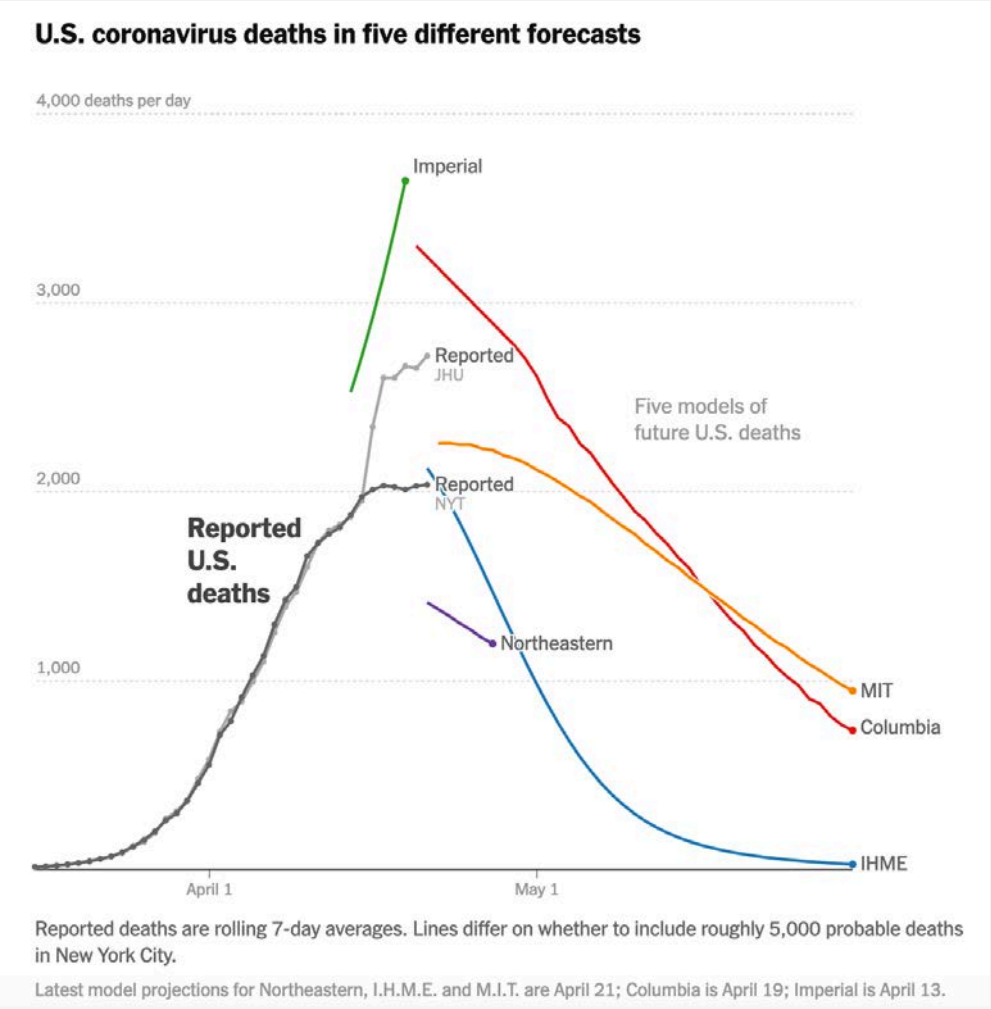
The Cone of Uncertainty in the Hurricane Chart

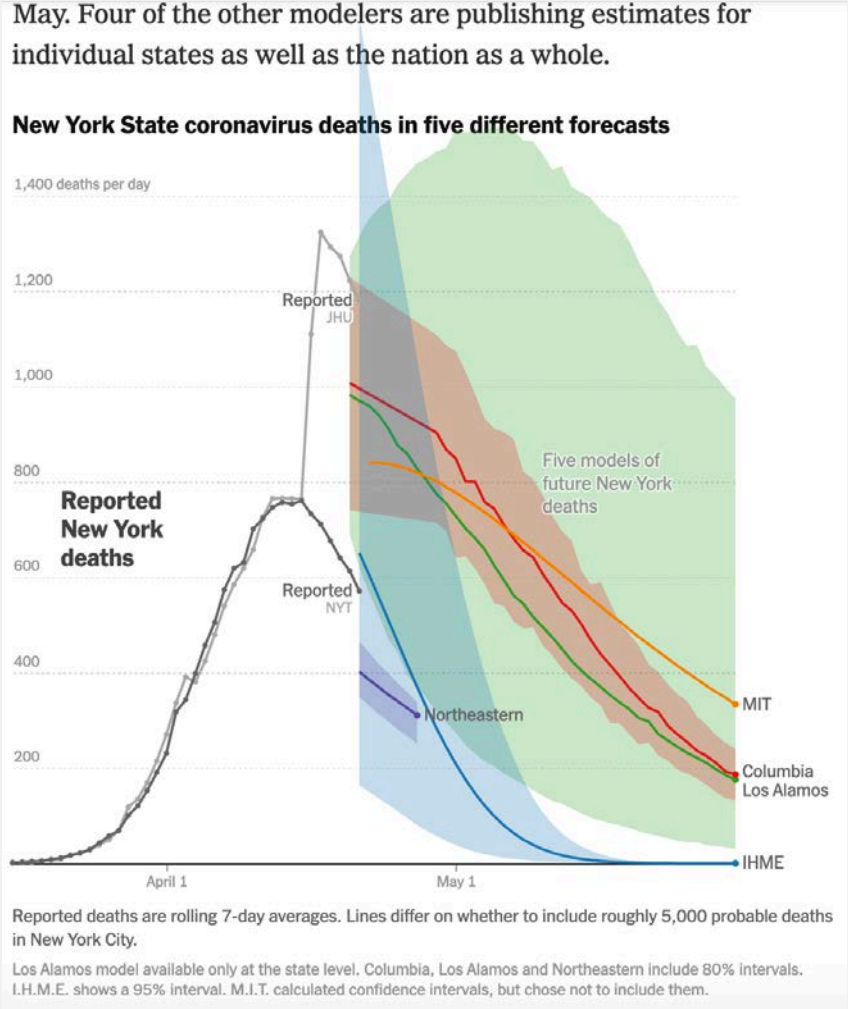


COVID-19 Projections | Institute for Health Metrics and Evaluation (University of Washington)

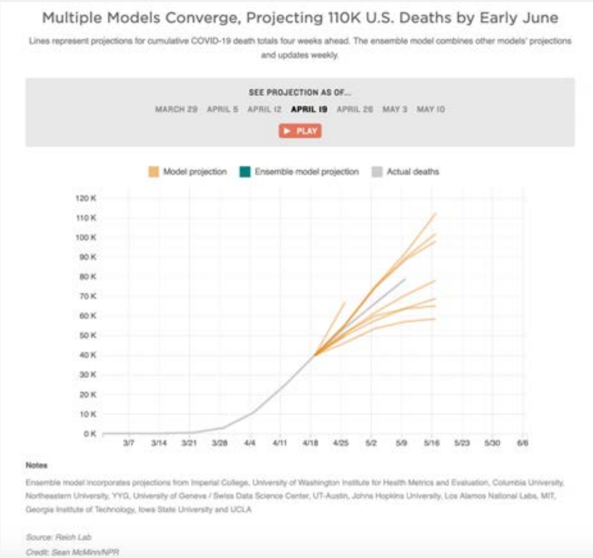


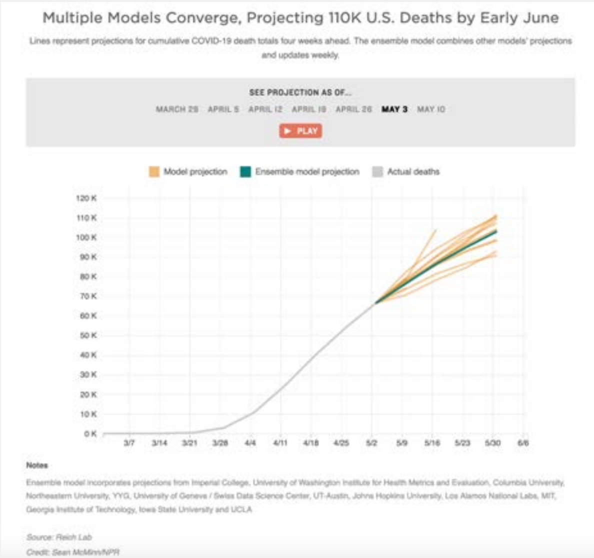
What 5 Coronavirus Models Say the Next Month Will Look Like | New York Times

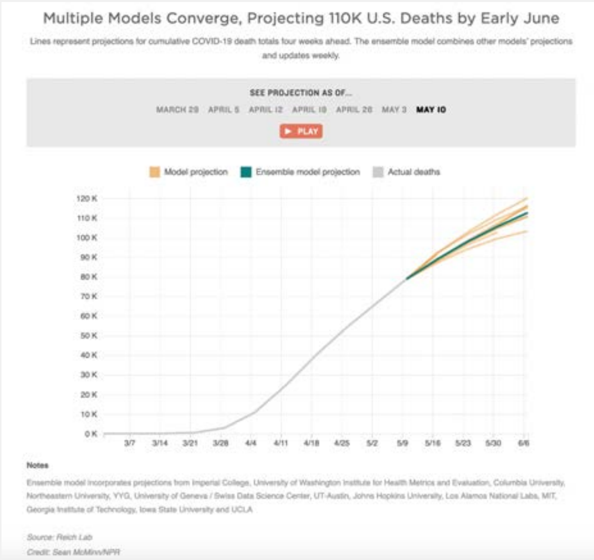




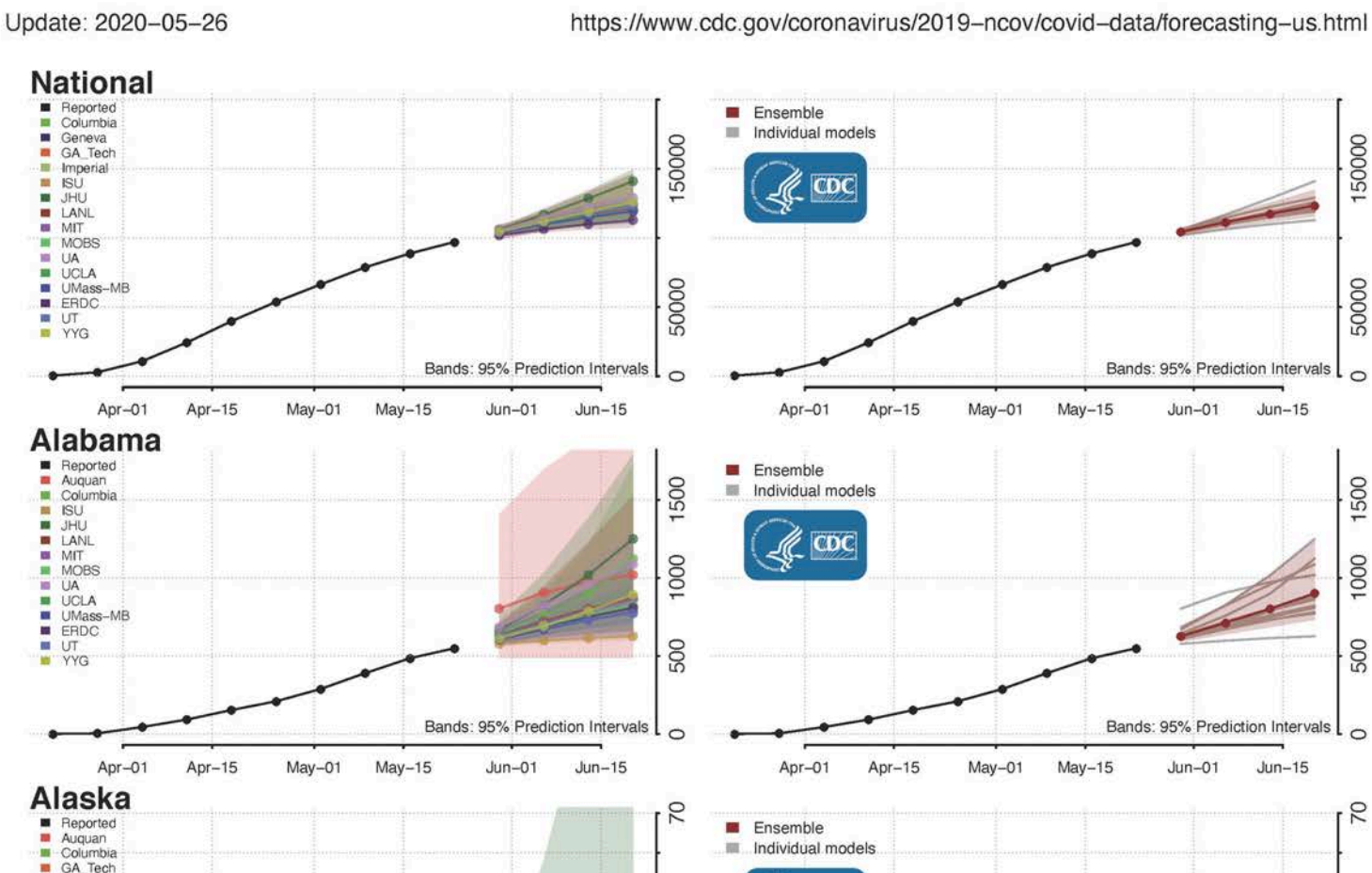
How To Make Sense of All The COVID-19 Projections? A New Model Combines Them | NPR







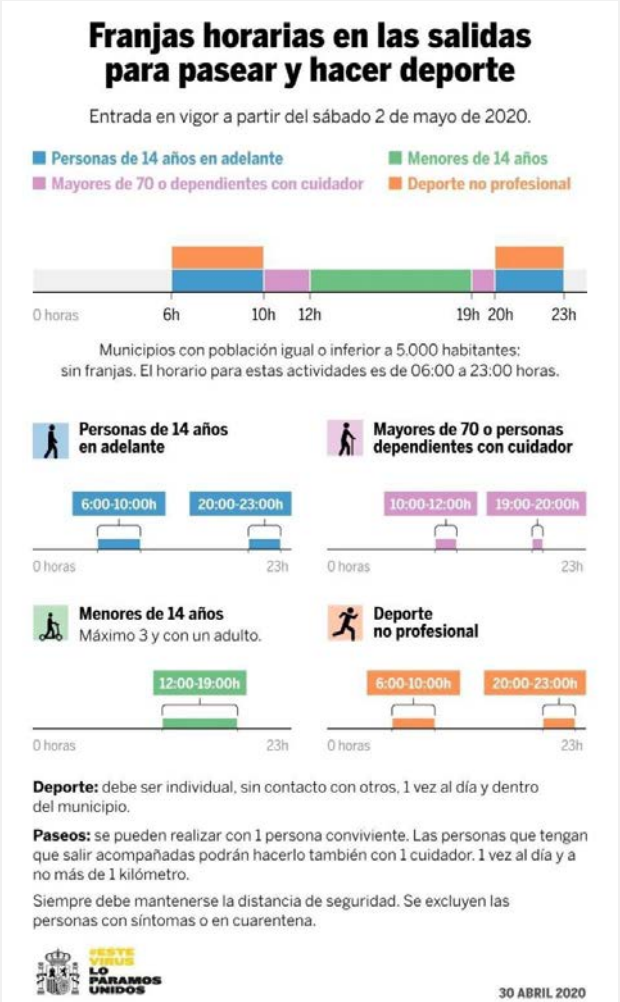
COVID-19 Forecasts: Cumulative Deaths | CDC



COMMUNICATE RISK FUTURE MODELS / RE-OPENING PLANS

Intended Message #6

Re-Opening Plan: Spain (4/30/20), Massachusetts (5/18/20)



Franjas horarias en las salidas para pasear y hacer deporte

Entrada en vigor a partir del sábado 2 de mayo de 2020.

- Personas de 14 años en adelante
- Menores de 14 años
- Mayores de 70 o dependientes con cuidador
- Deporte no profesional

Municipios con población igual o inferior a 5.000 habitantes: sin franjas. El horario para estas actividades es de 06:00 a 23:00 horas.

Personas de 14 años en adelante

Mayores de 70 o personas dependientes con cuidador

Menores de 14 años
Máximo 3 y con un adulto.

Deporte no profesional

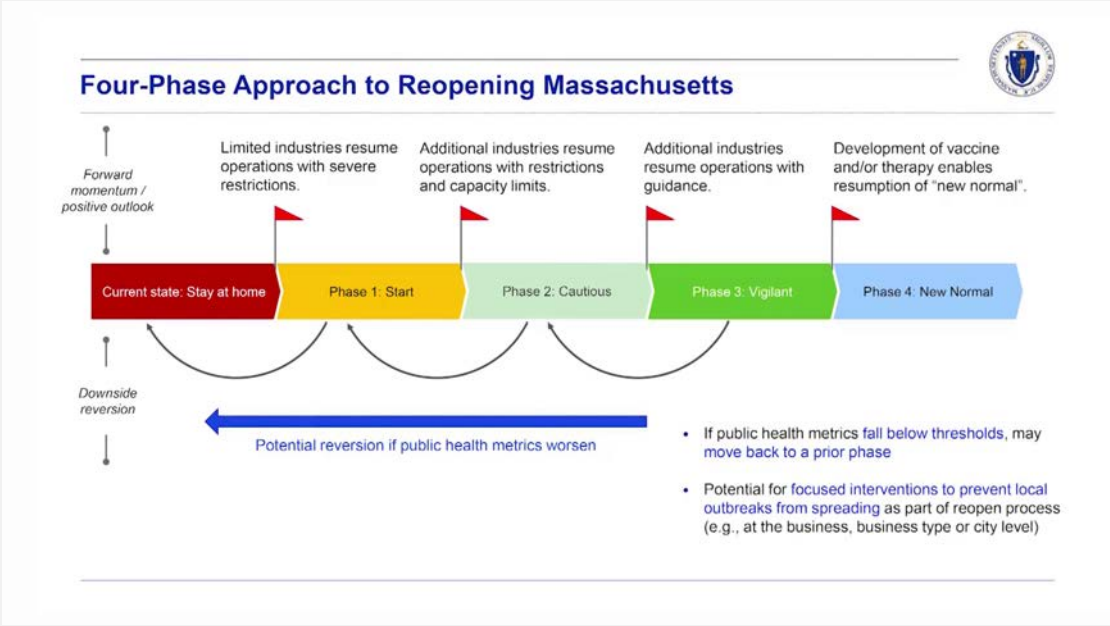
Deporte: debe ser individual, sin contacto con otros, 1 vez al día y dentro del municipio.

Paseos: se pueden realizar con 1 persona conviviente. Las personas que tengan que salir acompañadas podrán hacerlo también con 1 cuidador. 1 vez al día y a no más de 1 kilómetro.

Siempre debe mantenerse la distancia de seguridad. Se excluyen las personas con síntomas o en cuarentena.

#ESTE VIRUS LO PARAMOS UNIDOS

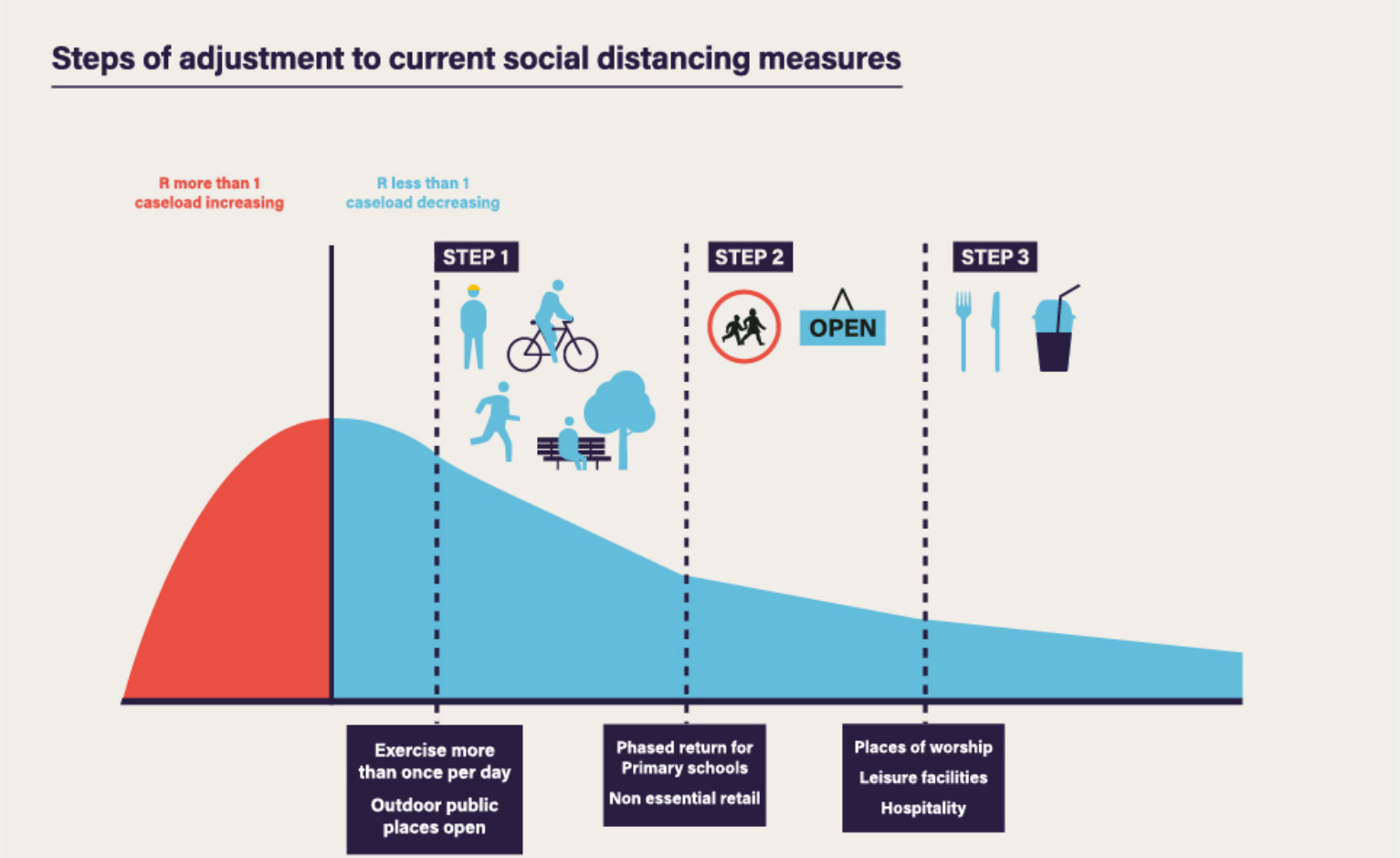
30 ABRIL 2020



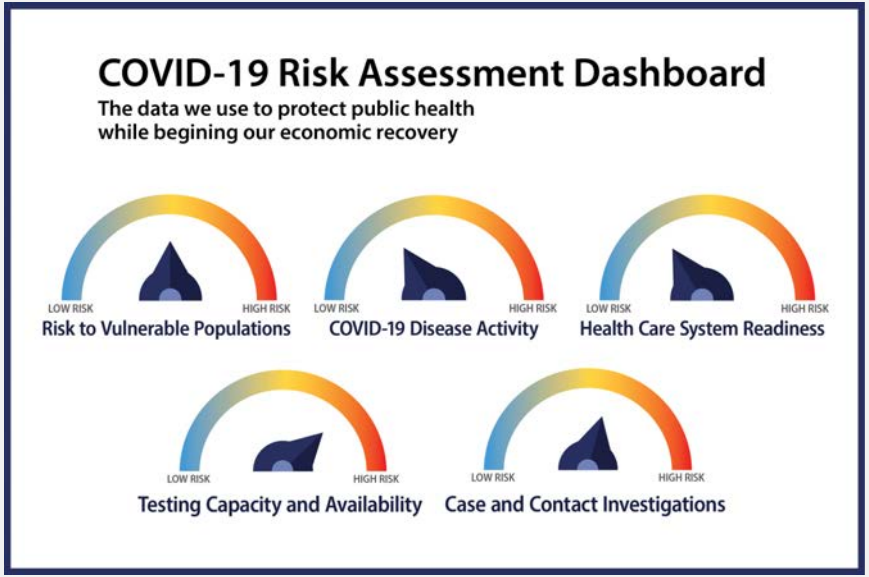
Four-Phase Approach to Reopening Massachusetts

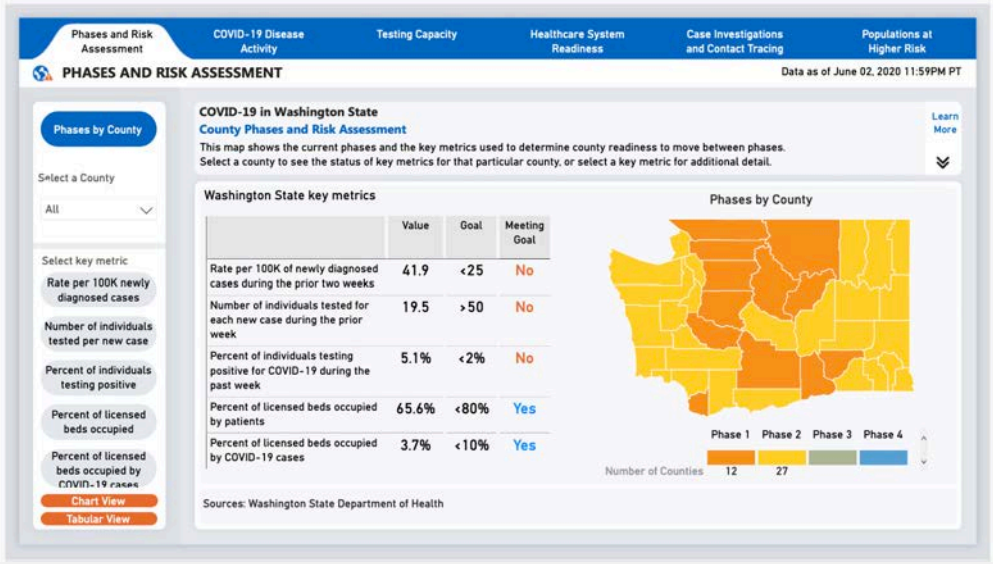
- If public health metrics fall below thresholds, may move back to a prior phase
- Potential for focused interventions to prevent local outbreaks from spreading as part of reopen process (e.g., at the business, business type or city level)

UK: Steps of adjustment to current social distancing measures - As the caseload falls, different steps can be taken to adjust social distancing measures. | Her Majesty's Government (5/11/20)



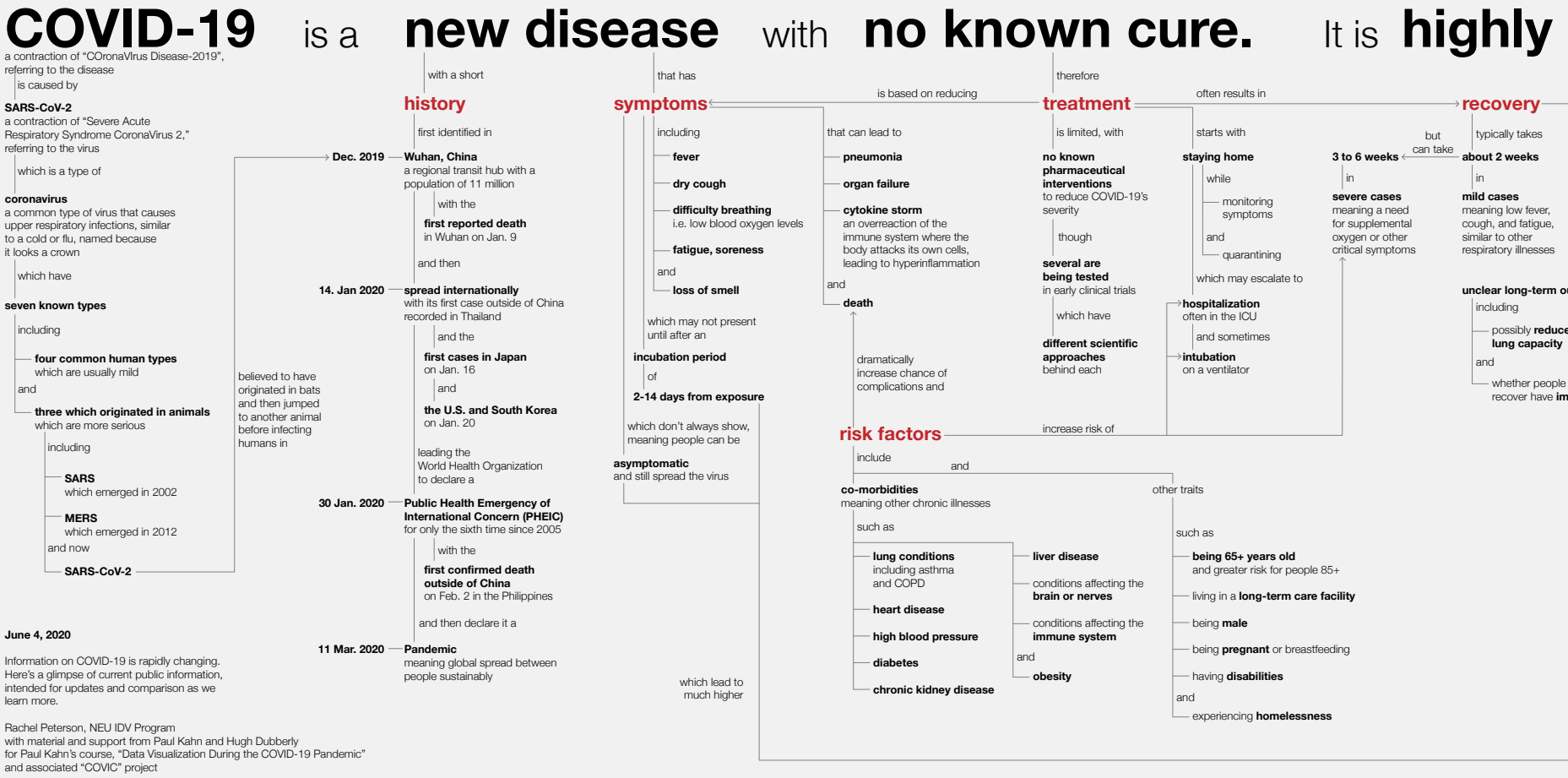
COVID-19 - Risk Assessment Dashboard | Washington State



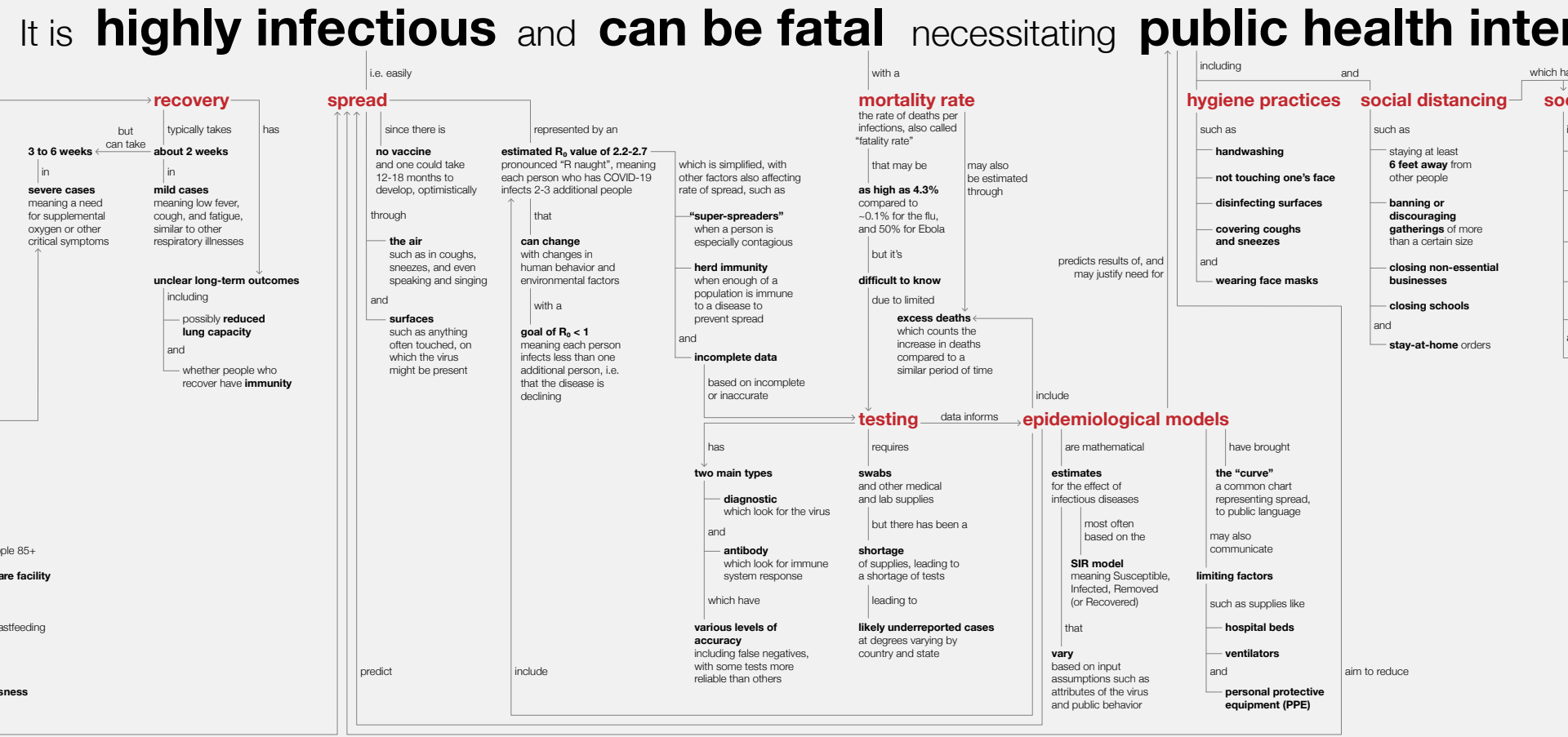


COVID-19 CONCEPT MAP

COVID-19 Concept map by Rachel Peterson, work in progress

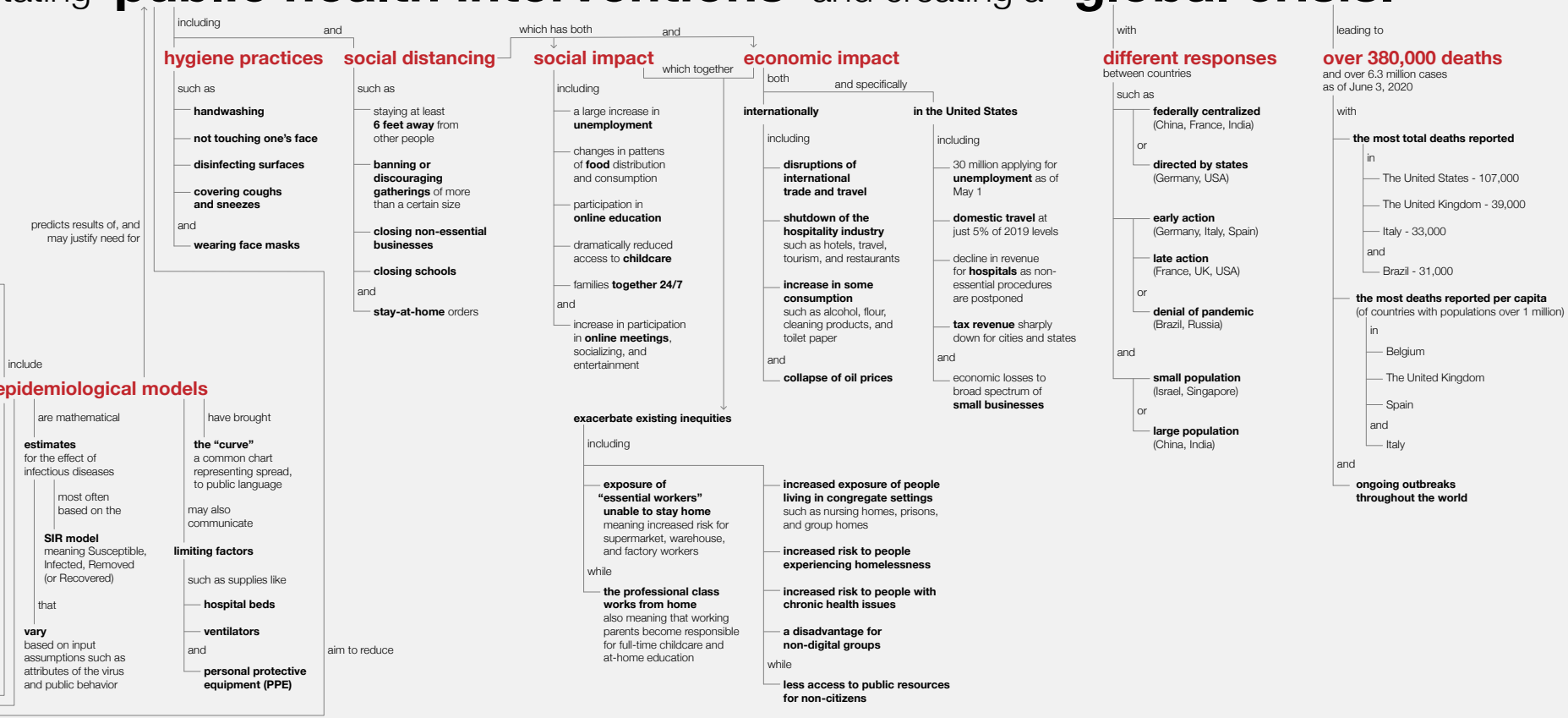


Concept map by Rachel Peterson, work in progress



Concept map by Rachel Peterson, work in progress

tating **public health interventions** and creating a **global crisis.**



Concept map by Rachel Peterson, work in progress

ventions and creating a global crisis.

oth
and

al impact

which together

luding

a large increase in **unemployment**

changes in pattens of **food** distribution and consumption

participation in **online education**

dramatically reduced access to **childcare**

families **together 24/7**

d

increase in participation in **online meetings**, socializing, and entertainment

exacerbate existing inequities

including

- **exposure of "essential workers" unable to stay home** meaning increased risk for supermarket, warehouse,
- **increased exposure of people living in congregate settings** such as nursing homes, prisons, and group homes

economic impact

both

and specifically

internationally

including

- **disruptions of international trade and travel**
- **shutdown of the hospitality industry** such as hotels, travel, tourism, and restaurants
- **increase in some consumption** such as alcohol, flour, cleaning products, and toilet paper

and

- **collapse of oil prices**

in the United States

including

- 30 million applying for **unemployment** as of May 1
- **domestic travel** at just 5% of 2019 levels
- decline in revenue for **hospitals** as non-essential procedures are postponed
- **tax revenue** sharply down for cities and states

and

- economic losses to broad spectrum of **small businesses**

with

different responses

between countries

such as

- **federally centralized** (China, France, India)

or

- **directed by states** (Germany, USA)

- **early action** (Germany, Italy, Spain)

or

- **late action** (France, UK, USA)

or

- **denial of pandemic** (Brazil, Russia)

and

- **small population** (Israel, Singapore)

or

- **large population** (China, India)

leading to

over 380,000 deaths

and over 6.3 million cases as of June 3, 2020

with

- **the most total deaths reported**
  - in
    - The United States - 107,000
    - The United Kingdom - 39,000
    - Italy - 33,000
    - and
    - Brazil - 31,000
- **the most deaths reported per capita** (of countries with populations over 1 million)
  - in
    - Belgium
    - The United Kingdom
    - Spain
    - and
    - Italy

and

- **ongoing outbreaks throughout the world**

COVIC thanks the people who helped make this possible

Our International Contributors

Arushi Singh, Andreas Schneider, Andrew Tang, Andy Krackov, Antonio Solano, Aprisa Chrysantina, Attila Bátorfy, Bassel Abu Fakher, Ben Shneiderman, Catherine Plaisant, Chihiro Hosoe, David Bumbeishvili, David Serrault, Eric Reiss, Ewa Lenk, Hannes van Zyl, Irene Rietschel, Jack Lenk, Joep Paemen, Karim Chaibi, Kita Kaczmarek, Lewis Chou, Lilly Diaz, Liuhuaying Yang, Lorenzo Scarpelli, M. Natsagbadam, Magga Dora Ragnarsdottir, Matteo Riva, Matthew Siu, Matthias Mueller-Prove, Max Spielmann, Megan Danielson, Nuno Correia, Rupesh Vyas, Sarah Callaghan, Sergelen Tsogt-Ochir, Susan Hazan, Tarun Deep Chhabra, Zeynep Ozturk, Zhengyan Yu

Northeastern Faculty and Students

Alison Booth, Christian Dicker, Elizabeth Cory, Ha Ta, Hugh Dubberly, Jayden Khatib, Nik Brown, Ning Wang, Pedro Cruz, Rachel Peterson, Siyue Tan, Yinan Dong, Yuke Li, YuQing Liu, Zixuan Yang

Thank You

Contact Information

Paul Kahn

Lecturer
Information Design & Visualization
Northeastern University, Boston

pauldavidkahn@gmail.com

p.kahn@neu.edu