What's next: COVID-19, science and the public health

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What I'll discuss today

- The emergence and early spread of SARS-CoV-2
- Worldwide, national, statewide and local epidemiology of COVID-19 and SARS-Co—2
- Status of immunizations
- What can still go wrong?
- What could we have done differently and how do we respond next time?

Emergence and early spread of SARS-CoV-2

Coronaviruses

- Large enveloped family of RNA viruses with a mucoid coating
- Before SARS (2002), coronaviruses were considered relatively inconsequential pathogens that caused common colds
  - Four human coronaviruses are endemic globally and cause 10-30% of upper respiratory tract infections in adults (alpha coronaviruses HCoV 2229E, NL 63,and betacoronaviruses OC 43, HKU 1)
- Widely distributed in mammals and birds
- Since 2002 we've recognized two highly pathogenic strains that causes severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS)

SARS and MERS

- As opposed to the human coronaviruses that are associated with upper respiratory tract infections, SARS and MERS are caused by beta coronaviruses
- Primarily cause lower respiratory tract infection (pneumonia)
- Relatively high case fatality rates

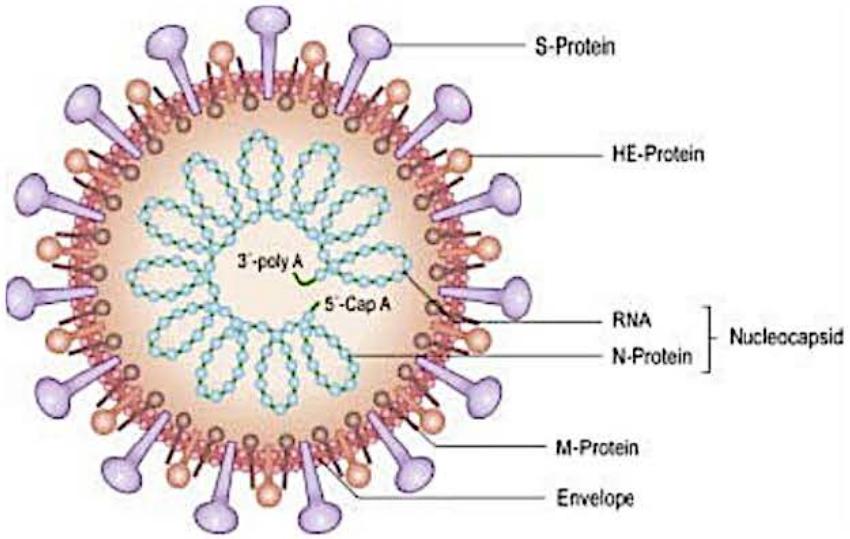
	SARS	MERS
Cases	8098	2494
Deaths	774	858
Case fatality rate	9.5%	34.4%
Controlled	Yes after reached pandemic	No, continued transmission
Other features	58% from nosocomial transmission	70% of cases from nosocomial transmission

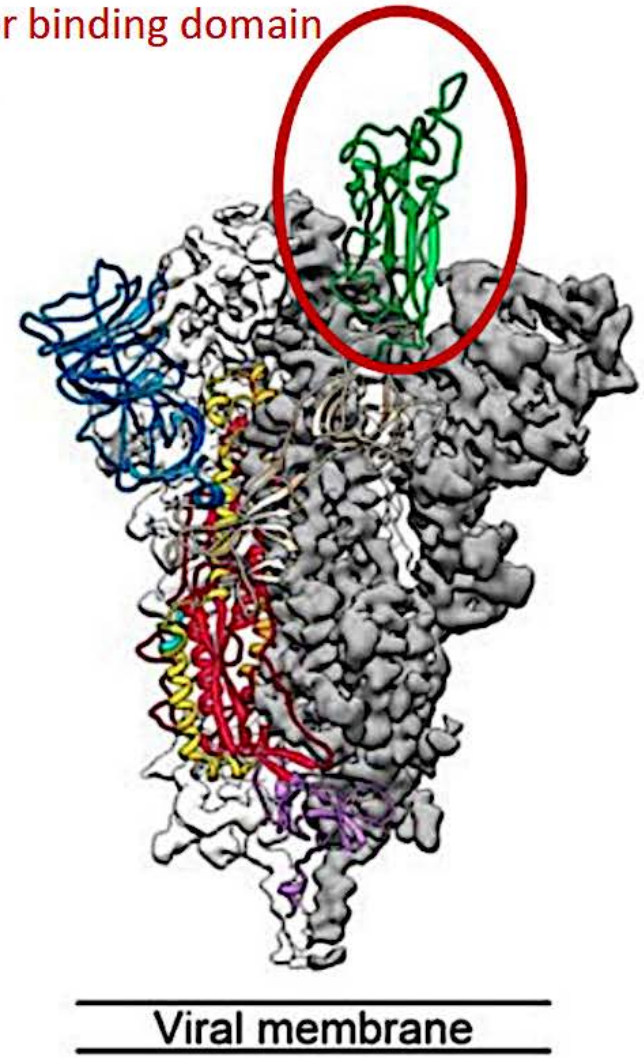
Emergence of the 2019 novel coronavirus (SARS-CoV-2)

- First recognized case (COVID-19) hospitalized 17 December 2019
- Cluster reported on 30 December
- Huanan Wholesale Seafood Market closed 1 January
- SARS-CoV-2 isolated 7 January
- SARS-CoV-2 sequenced 10 January
- Rapid diagnostic tests developed and distributed
- Cordon sanitaire implemented in Wuhan and surrounding cities on 23 January – 59 million people quarantined
- WHO declared Public Health Emergency of International Concern 30 January
- Outbreak grew from a handful of cases exposed at Huanan wholesale seafood market to more than 150 million cases and 3.2 million deaths in less than 16 months with ongoing person-to-person transmission primarily via respiratory droplet

SARS-CoV-2

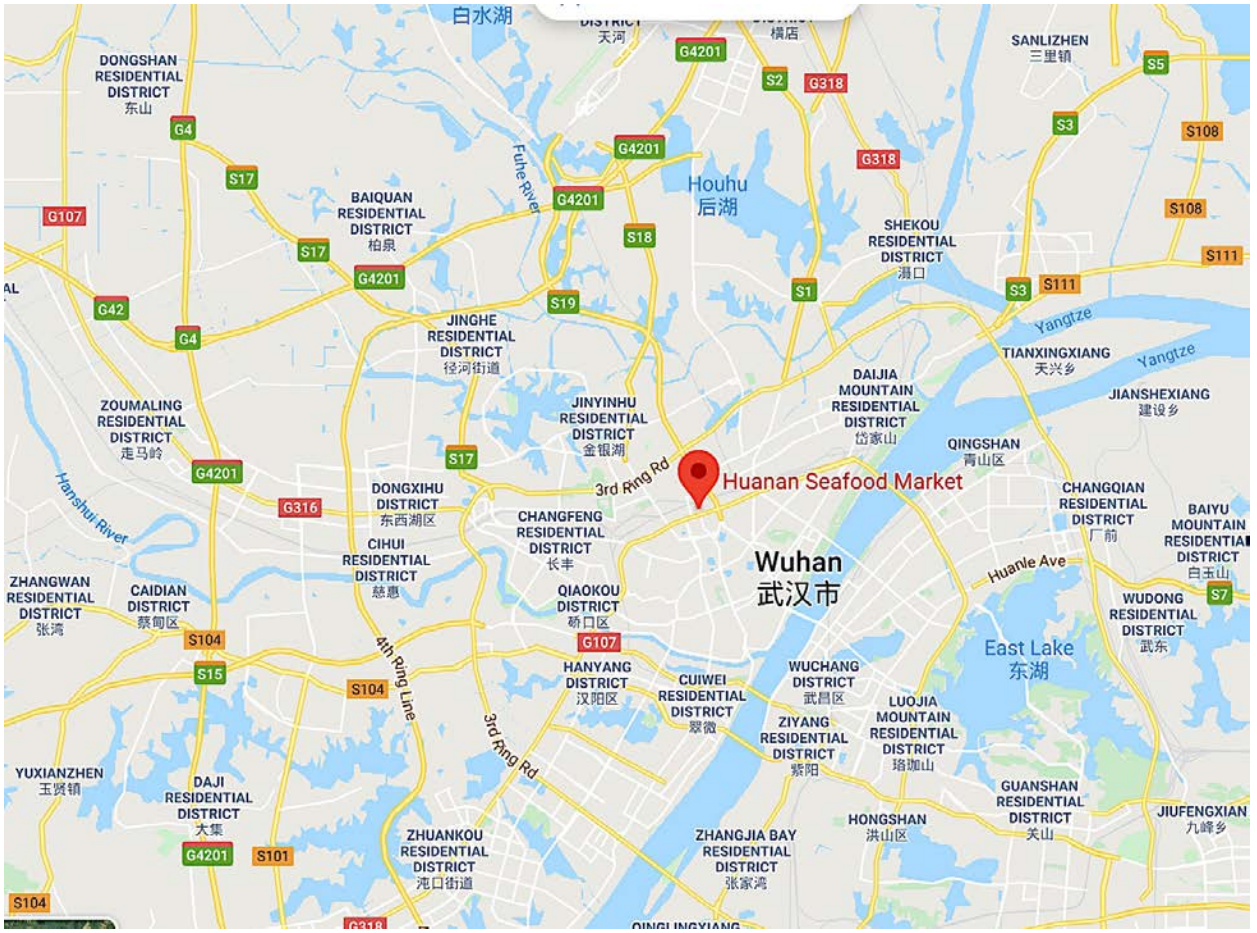
- Spike (S) protein binds to angiotensin-converting enzyme 2 (ACE2) on the membranes of lung alveolar cells, upper airway epithelial cells and glandular cells of the GI tract





The story starts in Wuhan in Hubei Province, China

- A major commercial city in central China on the Yangtze River
- Capitol of Hubei Province
- Population 11 million




武汉华南海鲜批发市场
WUHAN HUANAN HAIXIAN PIFA SHICHANG
永红特菜商行
杨智辉大闸蟹
孙氏泥鳅鳝鱼
金祥龙虾螃蟹
舒氏水产商行

SARS and MERS

- Both closely related to bat strains of coronavirus
- Transmitted through other secondarily infected species
  - SARS Himalayan palm civets
  - MERS dromedaries
- Epizoology of SARS-CoV-2 is unclear

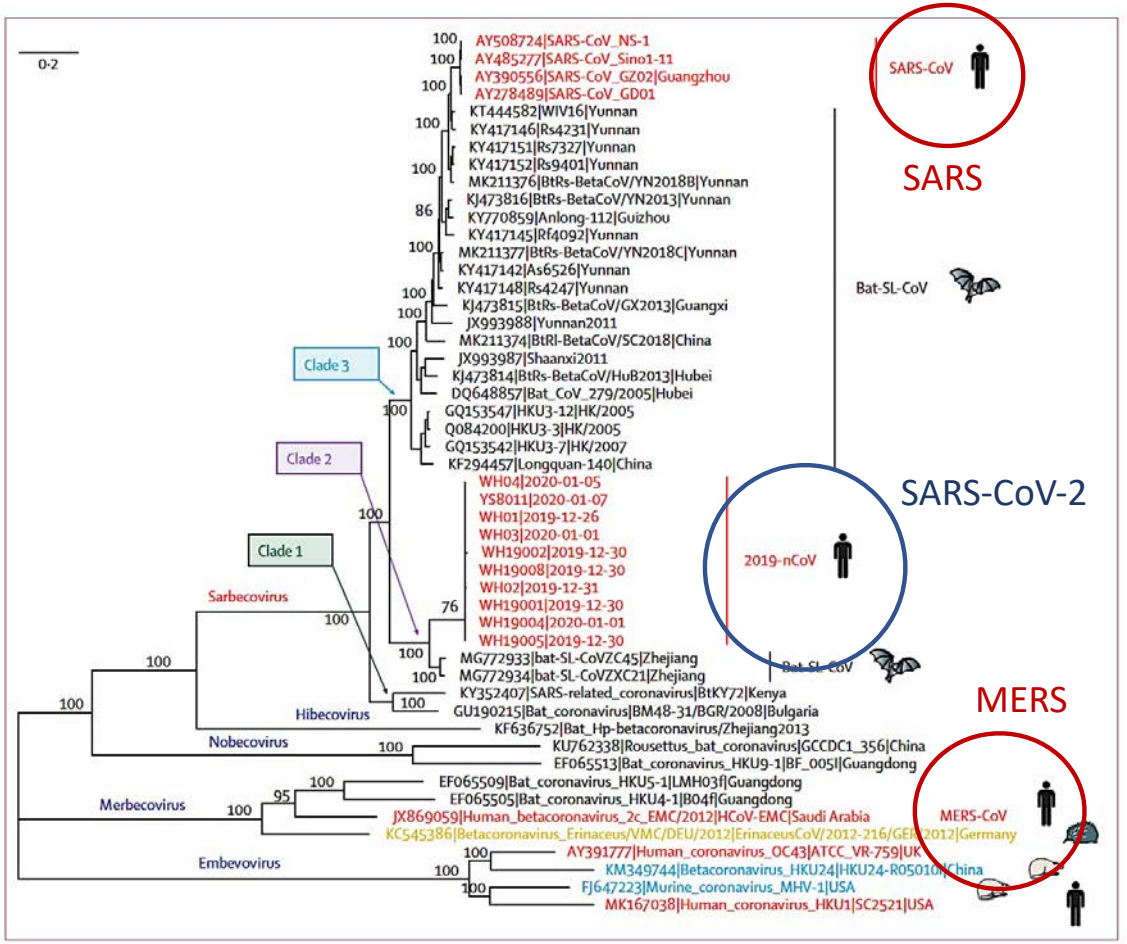


Figure 3: **Phylogenetic analysis of full-length genomes of 2019-nCoV and representative viruses of the genus Betacoronavirus**
2019-nCoV=2019 novel coronavirus. MERS-CoV=Middle East respiratory syndrome coronavirus. SARS-CoV=severe acute respiratory syndrome coronavirus.

From: Lu R, Li J, N P, et al. Genomic characterisation of and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet 2020 Jan 29 [Epub ahead of print].

Epizoology of COVID-19

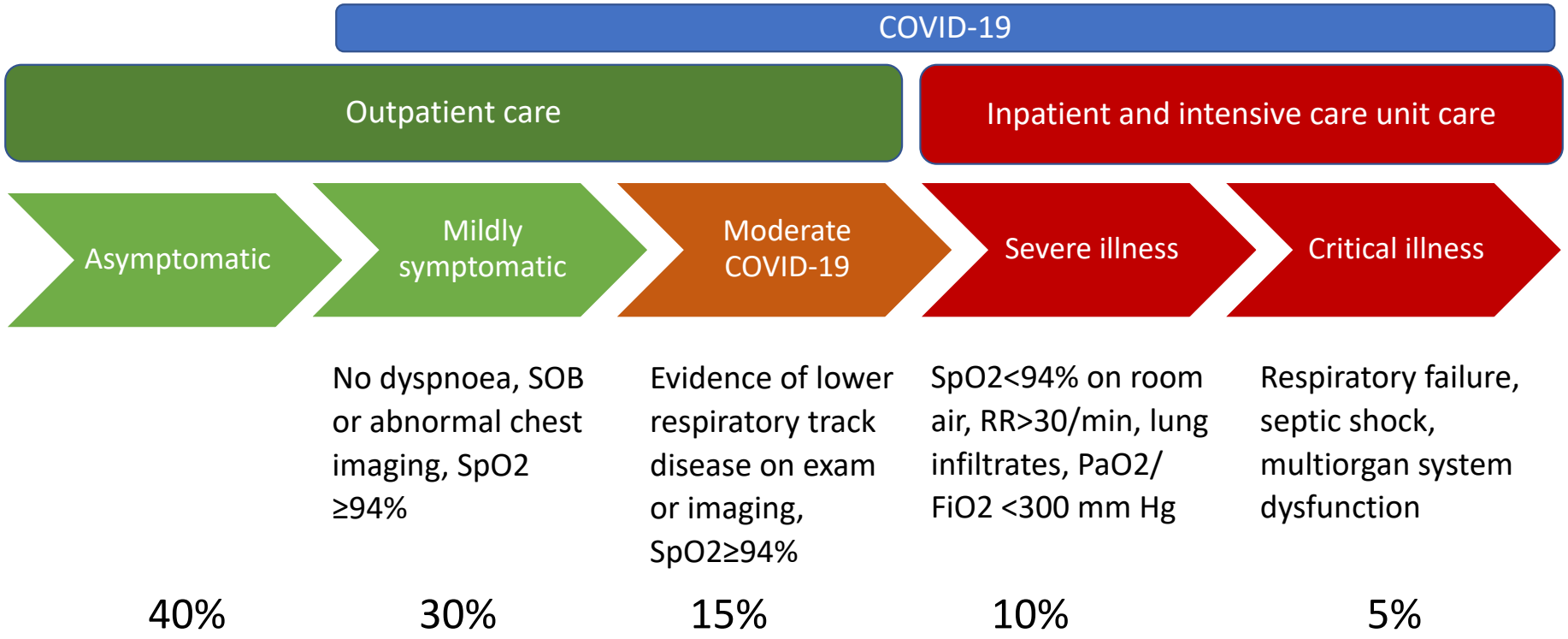
- Genetic sequence close to bat strains of coronavirus
- Suggestion of a secondary host, which acquired COVID-19 from bats and transmitted it to humans at Huanan Wholesale Seafood Market
- Possible candidate is the pangolin, a mammal whose scales used in traditional medicine
  - Most illegally trafficked animal in the world

Routes of transmission

SARS-CoV-2 infection causes the clinical disease COVID-19
Primary clinical manifestation is pneumonia

- SARS-CoV-2 spread by two routes:
  - Respiratory droplets spread (≥5μ)
  - Aerosol (airborne) spread (<5μ)
- No evidence for fomite (surface transmission)
- Droplet spread is far more common
- Target = respiratory epithelial cells with ACE2 receptor (including conjunctivae)
- Number of droplets exhaled depends on force of exhalation
  - Breathing 50-5,000 droplets (=200-1000 viral particles/min for influenza)
  - 10x increase when speaking
  - 30,000 droplets when sneezing (=2M viral particles)
- Masks are highly effective in preventing transmission and acquisition of SARS-CoV-2 infection

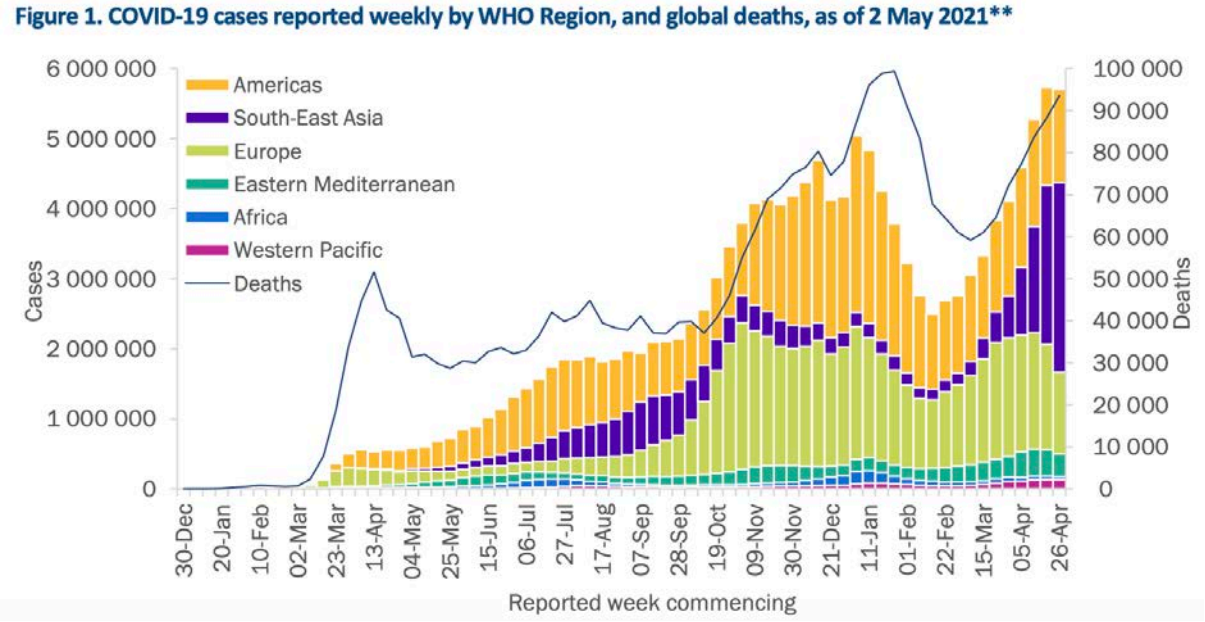
Spectrum of severity of illness from SARS-CoV-2 infection

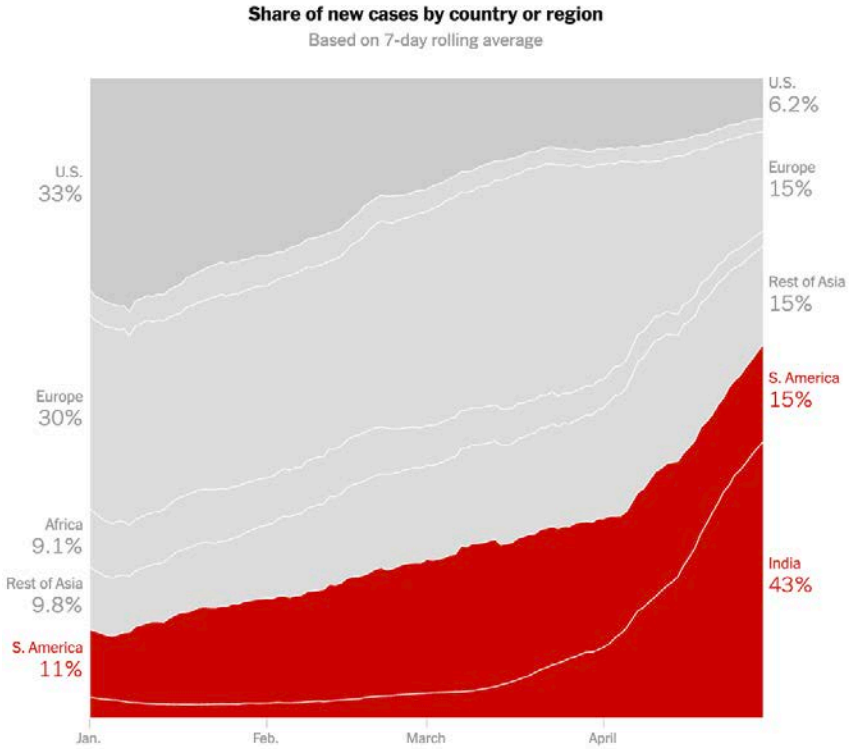


Worldwide, national, statewide and local epidemiology of COVID-19 and SARS-Co-2

COVID-19 cases world by day and country, 2020-2021

Worldwide:
151 812 556 total cases
+5 705 981 new cases last week (no change)
3 186 817 total deaths
+93 523 last week (+6%)



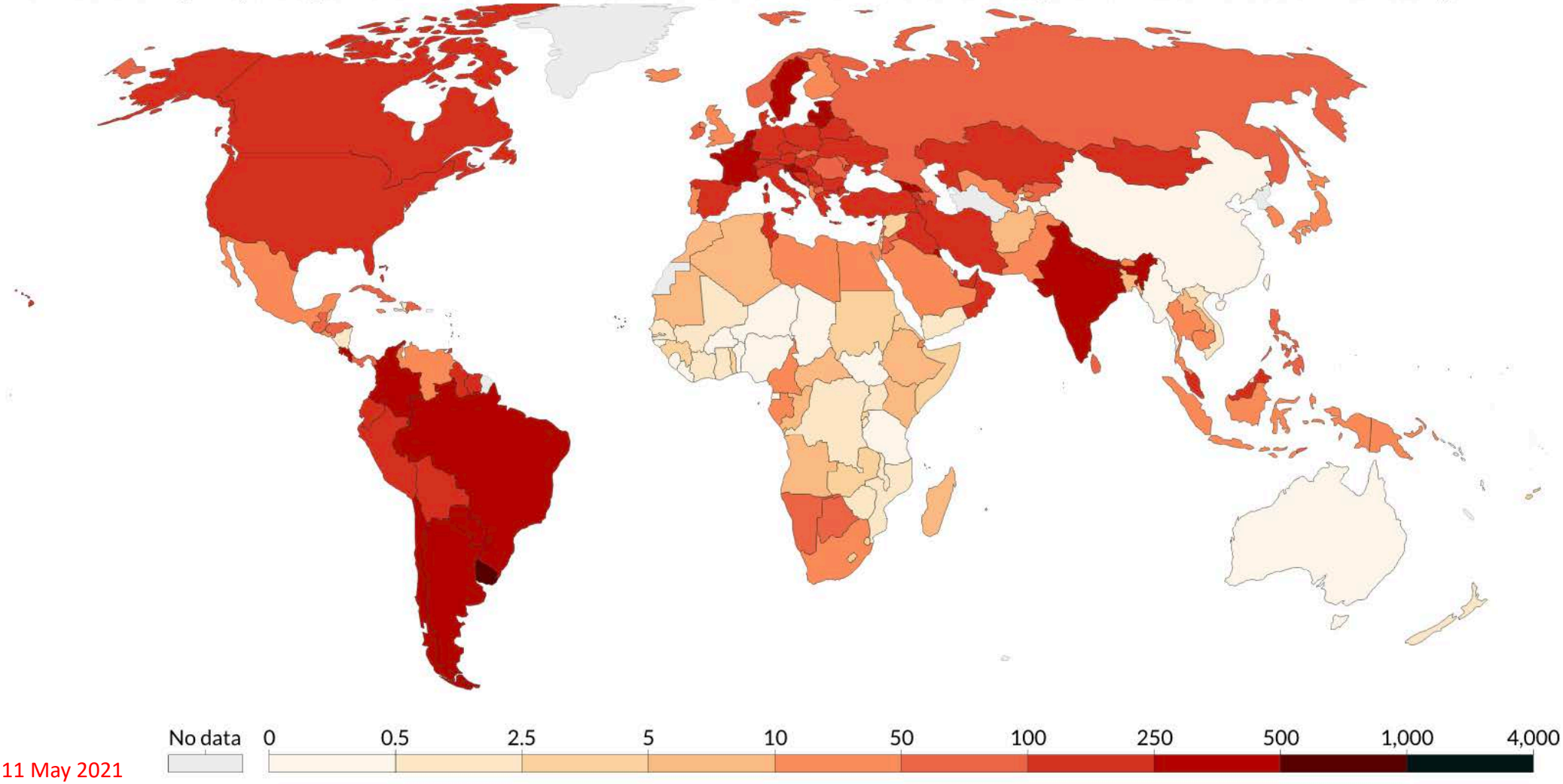


Cases in last week	
India	2 597 285
Brazil	421 933
United States	345 692
Turkey	257 992
France	163 666

2 May 2021

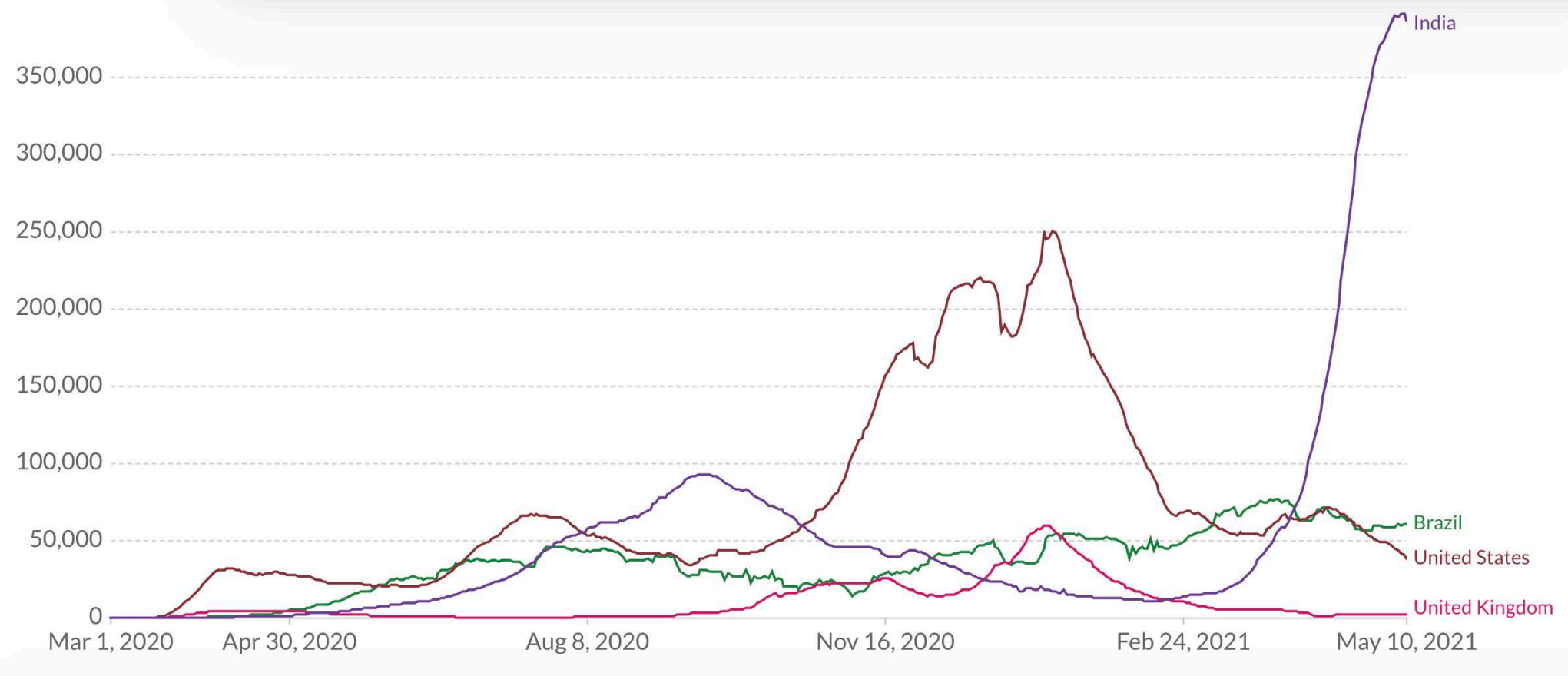
Daily new confirmed COVID-19 cases per million people, May 10, 2021

Shown is the rolling 7-day average. The number of confirmed cases is lower than the number of actual cases; the main reason for that is limited testing.



11 May 2021

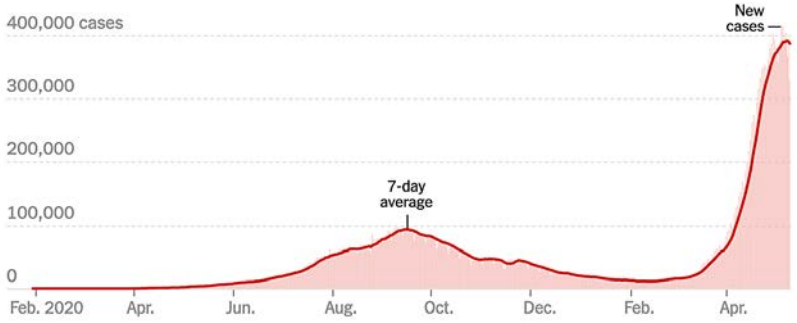
COVID-19 cases per 100,000 population by day, Brazil, India, UK and US, 2020-2021



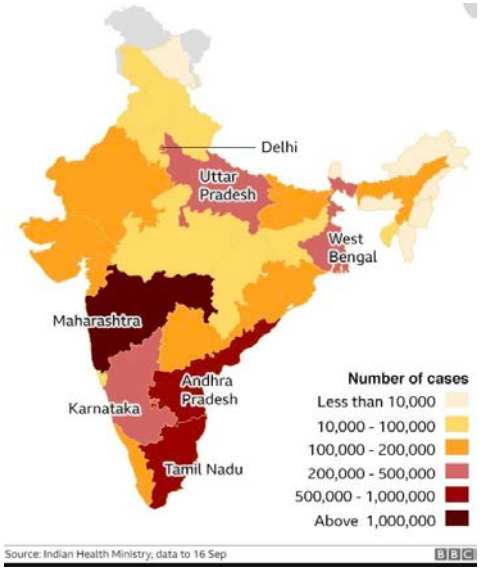
Our World in Data COVID-19 data tracker, 11 May 2021.

COVID-19 cases by day, India, 2020-2021

- Shortages of beds and oxygen
  - All industrial oxygen has been commandeered for health care
- Role of variants – B.1.1.7 and B.1.617 variant (E484Q and L452R)
  - 70.4% of isolates in India are B.1.617
  - Up to 40% of isolates in Australia
  - Controllable by current vaccines
- Only 5.5% of Indian adults have been fully vaccinated
- India has stopped exporting vaccines, diverting them for domestic use
- Lockdown in several states – air pollution has dropped



	TOTAL REPORTED	ON MAY 10	14-DAY CHANGE
Cases	22.9 million+	329,861	+17%
Deaths	249,992	3,876	+59%



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U.S. will support compulsory licensing of of COVID vaccines

- Waiver of intellectual property for public health emergencies
- WTO allows under TRIPS
- Countries who apply for waiver can manufacture their own vaccines or biologics without IP infringement

Los Angeles Times

$2.75 DESIGNATED AREAS HIGHER © 2021 THURSDAY, MAY 6, 2021 latimes.com

FELIPE DANA Associated Press

A KEY STEP FOR GLOBAL VACCINE ACCESS

The U.S. says it will support waiving patent protections on COVID-19 vaccines, a shift that could hasten inoculations in developing countries. Above, a COVID-19 patient in a Ukraine conflict zone. NATION, A4

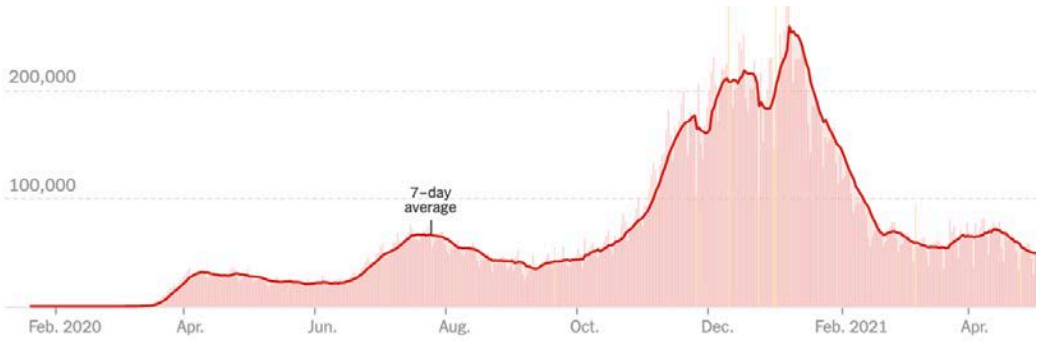
U.S. will support vaccine patent waiver

By Emily Baumgaertner

The Biden administration will support a waiver for intellectual property protections on COVID-19 vaccines, the U.S. trade representative said Wednesday, a long-awaited step that could help developing countries speed up vaccinations against the disease.

COVID-19 cases and deaths are falling, United States and California, 2020-2021

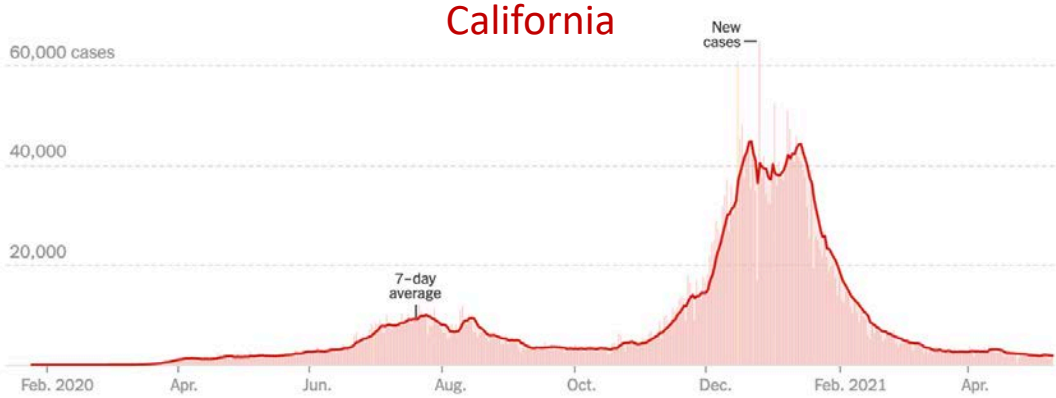
United States



These are days with a reporting anomaly. Read more here.

	AVG. ON MAY 10	14-DAY CHANGE	TOTAL REPORTED
Cases	39,124	-29%	32,772,514
Tests	932,457	—	—
Hospitalized	37,850	-15%	—
Deaths	650	-8%	581,669

California



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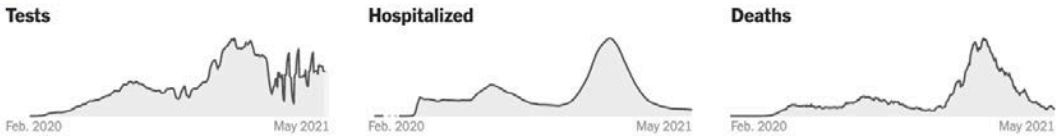

	AVG. ON MAY 10	14-DAY CHANGE	TOTAL REPORTED
Cases	1,857	-16%	3,760,124
Tests	166,917	-1%	—
Hospitalized	1,869	-11%	—
Deaths	53	-18%	62,331

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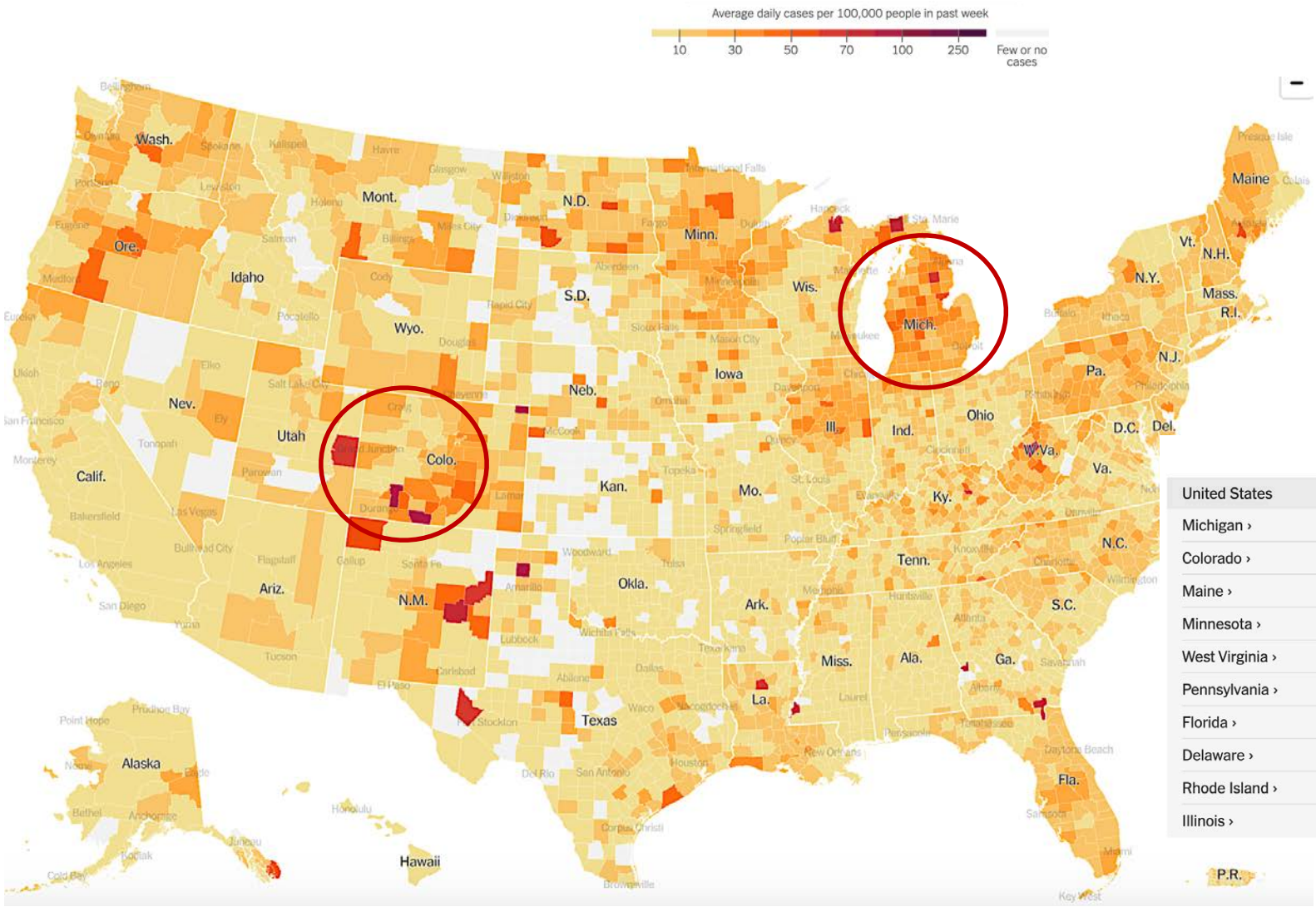

	CASES DAILY AVG.	PER 100,000	14-DAY CHANGE	FULLY VACCINATED
United States	39,124	12	-29%	35%
Michigan ›	2,737	27	-47%	36%
Colorado ›	1,392	24	-16%	38%
Maine ›	302	22	-14%	45%
Minnesota ›	1,230	22	-27%	39%
West Virginia ›	344	19	-5%	32%
Pennsylvania ›	2,299	18	-40%	36%
Florida ›	3,750	17	-33%	33%
Delaware ›	169	17	-38%	37%
Rhode Island ›	183	17	-36%	42%
Illinois ›	2,109	17	-23%	34%

30 April 2021

COVID-19 cases per 100,000 by state, last 7 days, United States, May 2021

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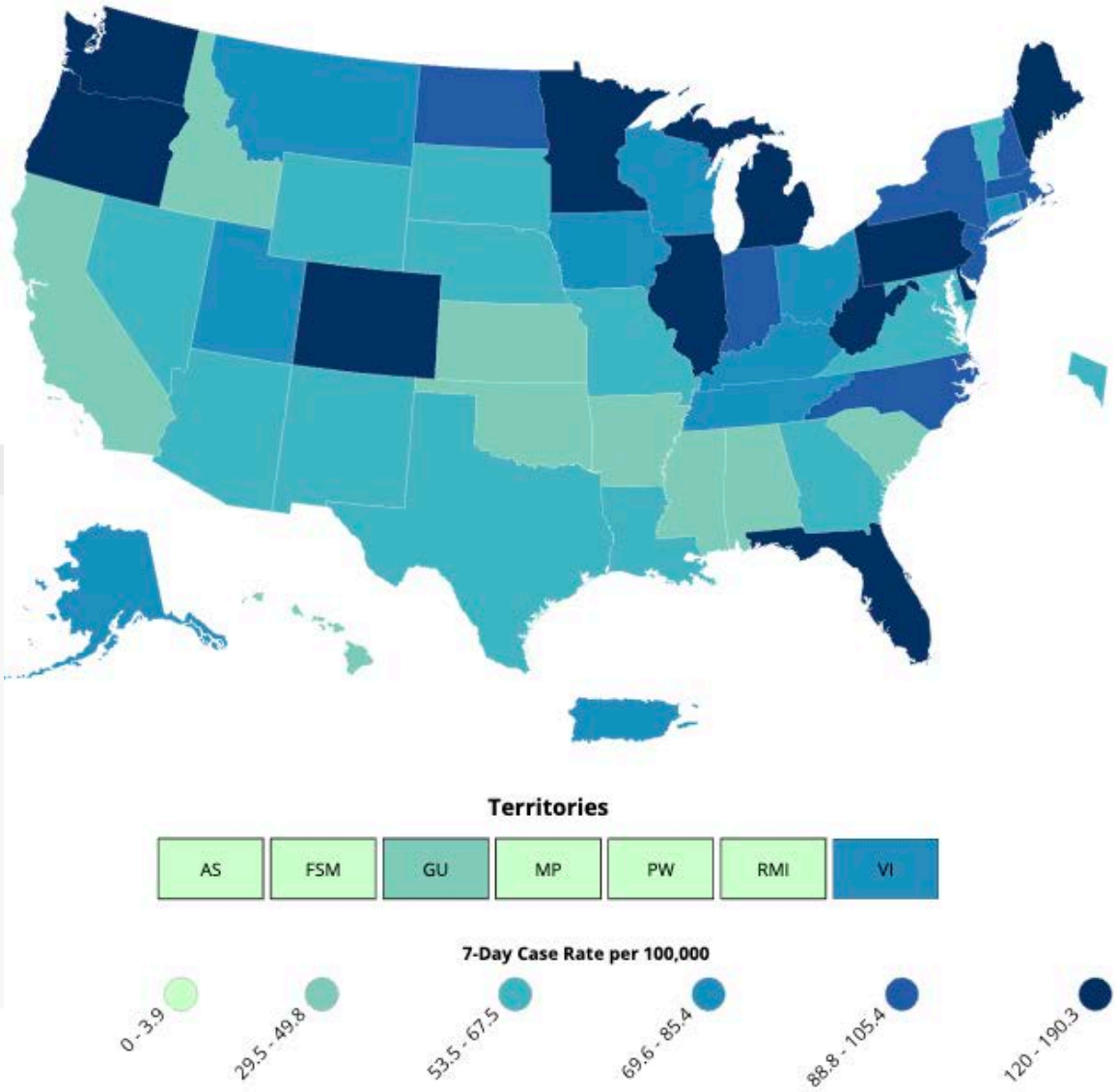

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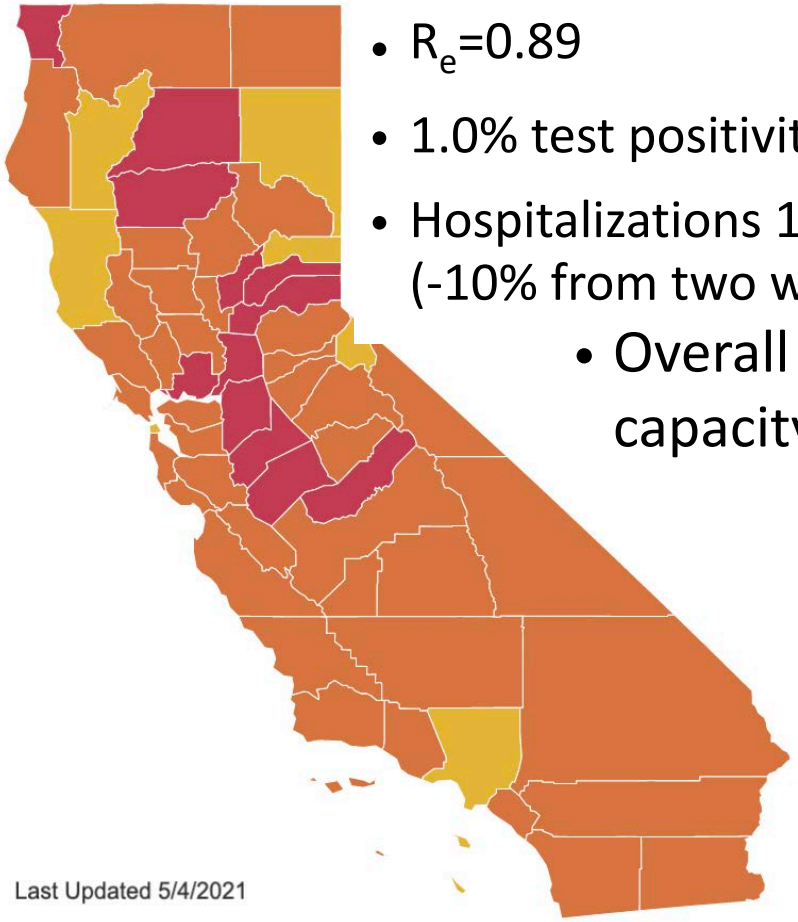
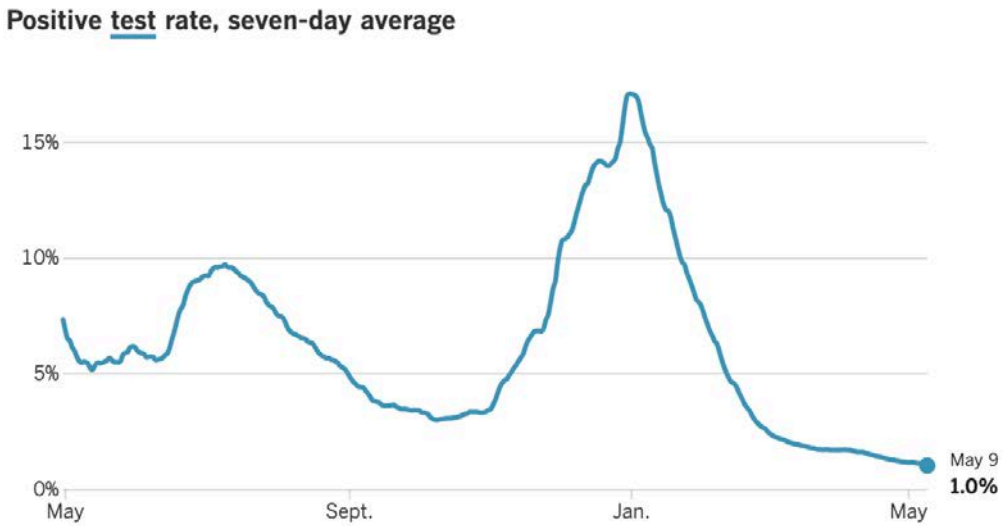
Statewide indicators, SARS-CoV-2 infection, California, 2021



- R_e=0.89
- 1.0% test positivity
- Hospitalizations 1 546 (-10% from two weeks ago)
  - Overall ICU capacity 32.8%



Beyond the Blueprint for a Safer Economy

On June 15, all sectors can return to normal

Two criteria:

- Equitable vaccine availability for ≥16 years old
- Consistently low burden of disease

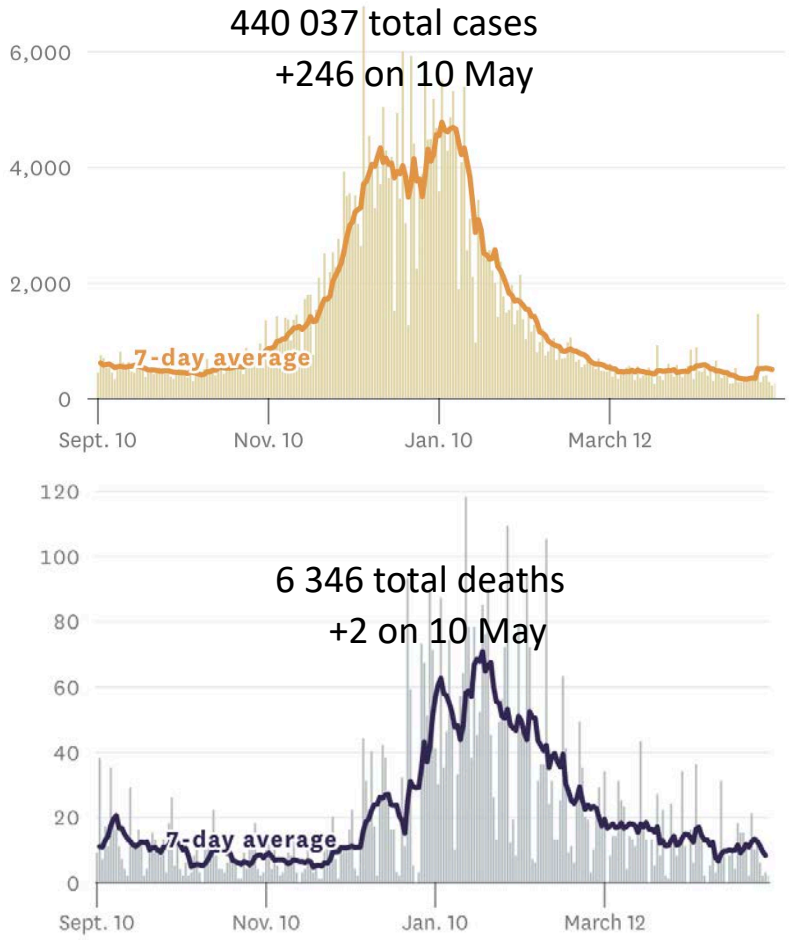
Continued mandate for masking and testing or vaccination requirements for large-scale higher-risk events

11 May 2021

San Francisco Bay Area

County	Total deaths	Total cases	New cases curve	Weekly change in new cases	Cases/ 10^5/ d*	R_e.	%+
Santa Clara	2,086	118,932	68 (Sept. 9 – May 10)	▼87 -15%	2.3	0.87	0.9%
Alameda	1,546	87,637	223	▲1158 +287%	3.7	0.89	1.3%
Contra Costa	792	68,638	67	▼61 -12%	5.1	0.86	1.7%
San Mateo	568	41,747	39	▲85 +46%	1.7	0.82	0.6%
San Francisco	538	36,320	26	▲24 +15%	1.8	0.86	0.6%
Solano	216	32,864	39	▼76 -22%	8.3	0.99	2.7%
Sonoma	312	30,002	14	▼10 -9%	1.9	0.72	0.9%
Marin	210	14,040	8	▼23 -29%	2.5	0.73	0.9%
Napa	78	9,857	8	▲19 +48%	4.3	0.80	1.4%

*Adjusted for testing rate, 7-day lag



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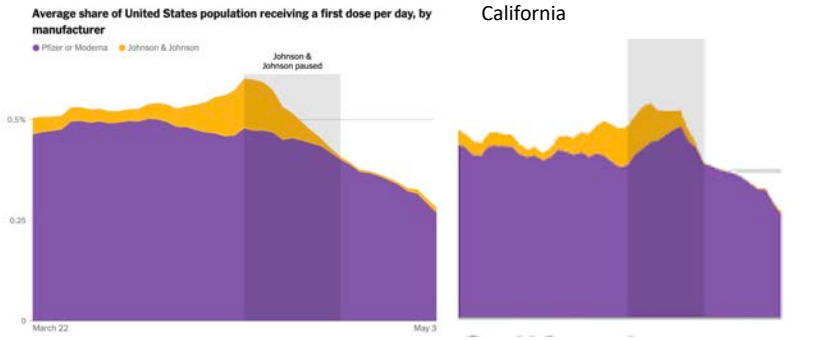
Status of immunizations

COVID-19 vaccine doses administered, California, 2021

- All Californians ≥16 years old

- All Californians ≥12 years old



- 31 869 478 doses administered
- 235 653 average per day for the last 7 days
- 49.1% of Californians have received ≥1 dose
- 35.7% have been fully vaccinated
- San Francisco: 64.4% with ≥1 dose, 44.6% fully vaccinated

County	▼ Doses administered	At least 1 dose	Fully vaccinated
Los Angeles »	8,191,091	48.7%	35.4%
San Diego »	2,936,043	60.2%	38.7%
Orange »	2,714,025	50.6%	37.6%
Santa Clara »	1,929,068	61.4%	42.8%
Alameda »	1,623,602	59.6%	44.4%
Riverside »	1,604,160	39.5%	29.7%
San Bernardino »	1,289,735	35.8%	26.5%
Contra Costa »	1,163,922	58.5%	47.4%
Sacramento »	1,117,134	43.7%	32.1%
San Francisco »	957,635	65.8%	48.7%

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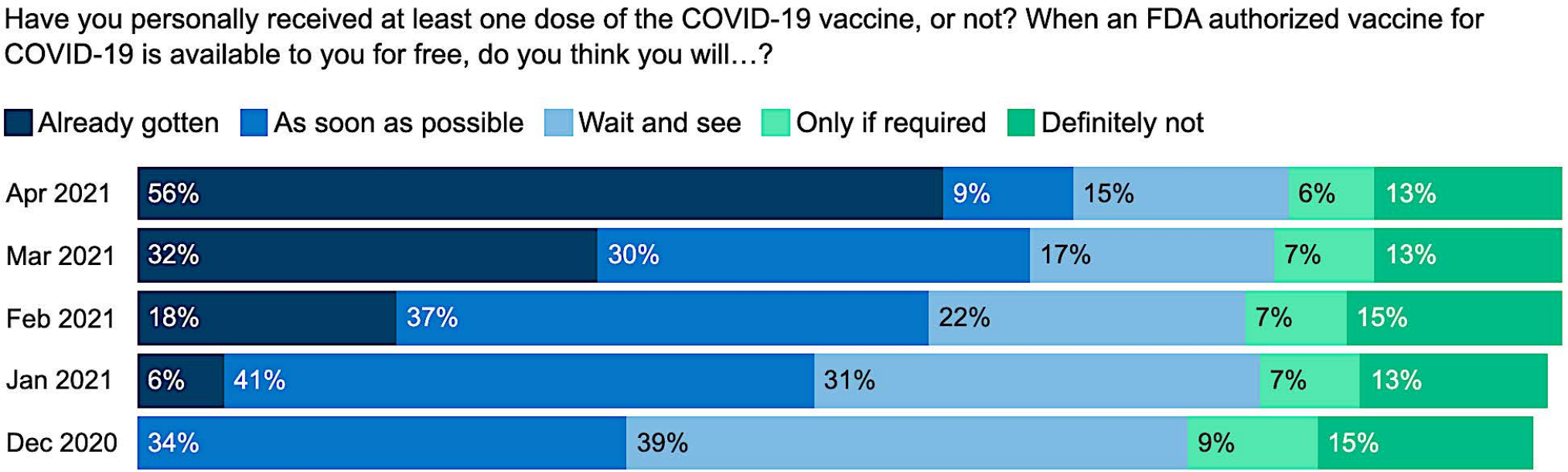
Share of completed vaccinations by Pfizer, Moderna or Johnson & Johnson

COVID-19 vaccination intentions, United States, December 2020-April 2021



Vaccination breakthroughs, United States

- 5 800 cases of vaccine breakthrough have been reported
- 66M people have been completely vaccinated
- Rate = 8.8 per 100,000 vaccinees (1 in 11 364 vaccinees)
  - 40% in people ≥65 years old
  - 65% in women
  - 29% asymptomatic, 7% hospitalized, 1% died

- Vaccine breakthroughs in trials
  - Moderna
    11 of 14 134 (77.8 per 100 00)
    1 per 1 285 vaccinees
  - Pfizer
    8 of 21 720 (36.8 per 100 000)
    1 in 2 717 vaccinees
  - Johnson & Johnson
    66 of 19 306 (342 per 100 000)
    1 in 292 vaccinees

Personal communication, Martha Sharan, CDC

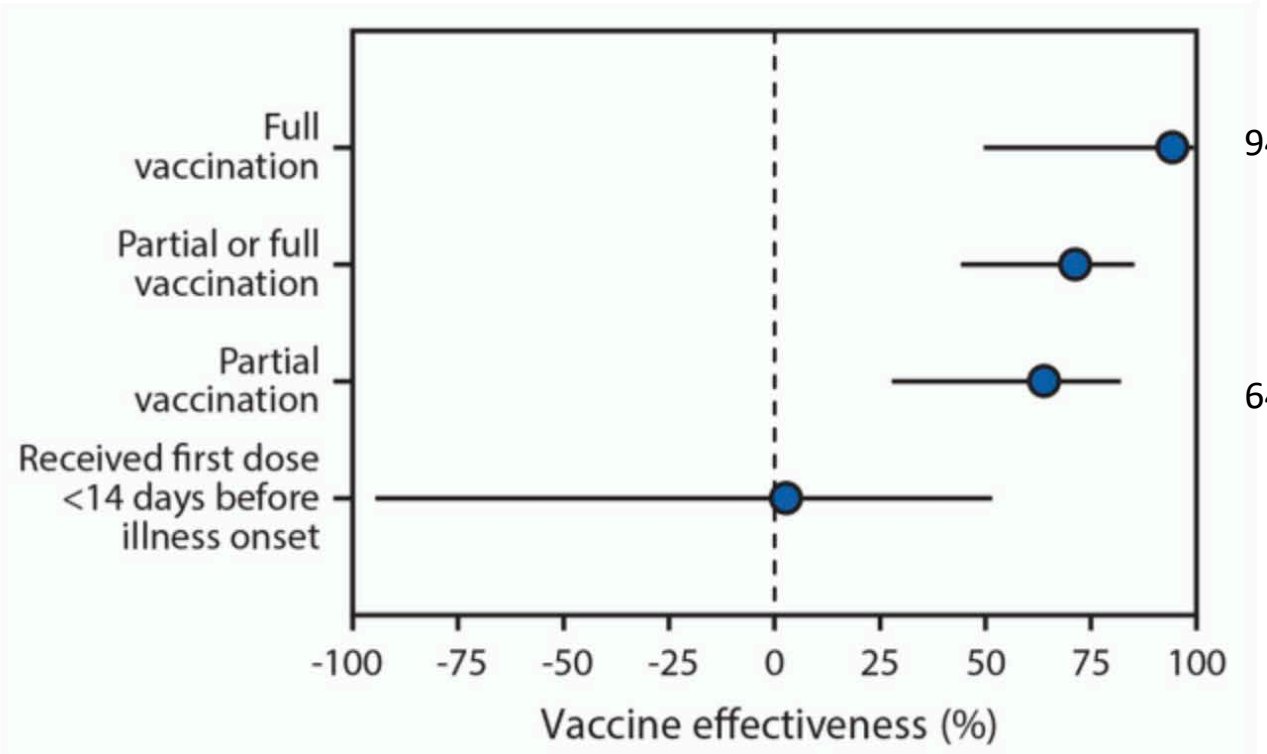
Vaccination breakthroughs, California

- Surveillance for post-vaccination breakthroughs
- Matched immunization registry with case registry for cases with positive PCR (confirmed cases) ≥14 days after completion of both doses

- ≥10.7 million fully vaccinated
- 1,379 reported cases matched with immunization registry
- 0.013% or 1 in 7,760 vaccinees

Office of Communication, California Department of Public Health, April 27, 2021

FIGURE. Adjusted* vaccine effectiveness (with 95% confidence intervals) against COVID-19 among hospitalized† adults aged ≥65 years, by vaccination status§ — 24 medical centers in 14 states,¶ January–March 2021



94%, 95% CI 49-99%

64%, 95% CI 28-82%

Tenforde MW, Olson SM, Self WH, et al. Effectiveness of Pfizer-BioNTech and Moderna vaccines against COVID-19 among hospitalized adults aged 65 years – United States, January-March 2021. MMWR 2021 Apr 28 [Early release].

Evidence for vaccine effectiveness for hospital admission after single dose, Scotland

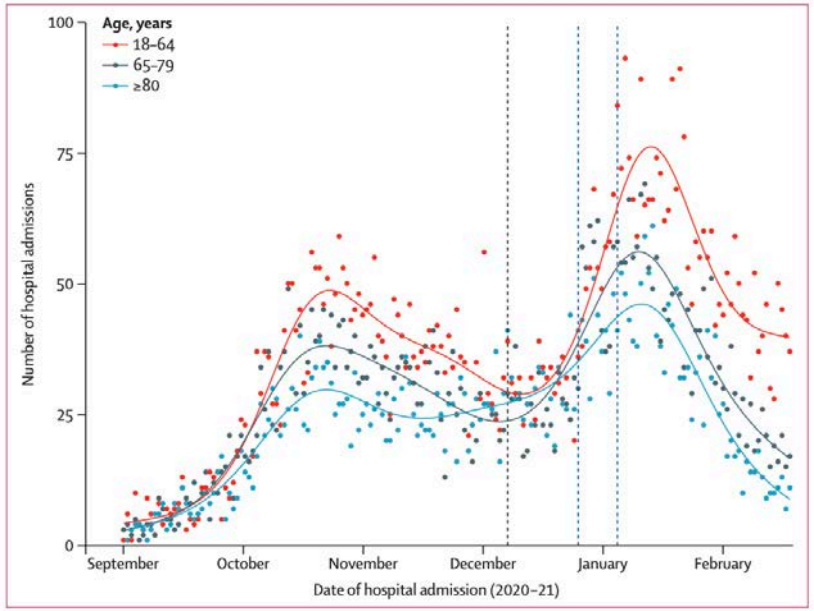
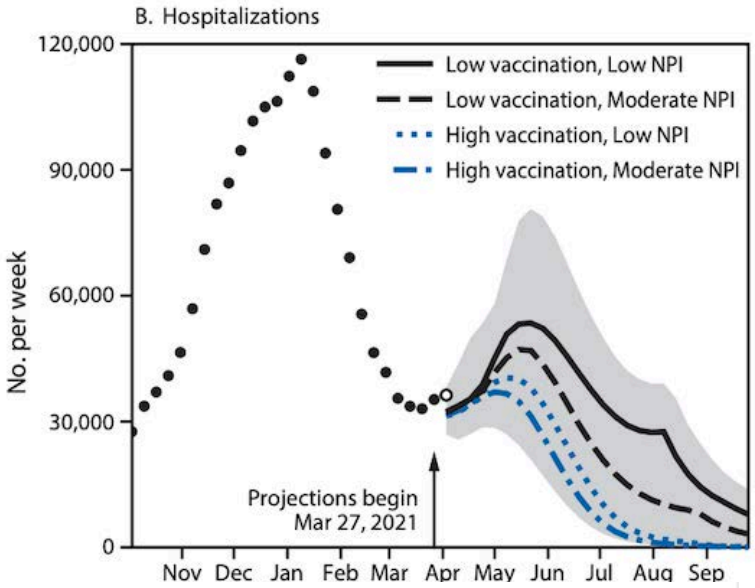


***Figure 3*: COVID-19 hospital admissions by age group from September, 2020, to February, 2021**
The black dotted vertical line represents the start of vaccination (Dec 8, 2020) and the blue dotted lines represent the two lockdowns on Dec 26, 2020, and Jan 5, 2021. The smooth lines are obtained from fitting a generalised additive Poisson model to the admissions.

BNT162b2 (Pfizer–BioNTech)						
Unvaccinated	734 031	6671	1 (ref)	1 (ref)	1 (ref)	0
Vaccine dose 1 (0–6 days)§	10 517	34	0·18 (0·13 to 0·25)	0·15 (0·10 to 0·21)	0·14 (0·10 to 0·19)	86% (81 to 90)
Vaccine dose 1 (7–13 days)§	10 991	119	0·57 (0·48 to 0·69)	0·42 (0·35 to 0·51)	0·47 (0·41 to 0·55)	53% (45 to 59)
Vaccine dose 1 (14–20 days)	7684	71	0·51 (0·40 to 0·64)	0·31 (0·24 to 0·39)	0·31 (0·25 to 0·38)	69% (62 to 75)
Vaccine dose 1 (21–27 days)	5672	38	0·41 (0·30 to 0·57)	0·21 (0·15 to 0·29)	0·22 (0·17 to 0·29)	78% (71 to 83)
Vaccine dose 1 (28–34 days)	4585	19	0·26 (0·16 to 0·40)	0·13 (0·08 to 0·21)	0·09 (0·06 to 0·15)	91% (85 to 94)
Vaccine dose 1 (35–41 days)	3292	20	0·40 (0·26 to 0·62)	0·18 (0·11 to 0·28)	0·22 (0·15 to 0·31)	78% (69 to 85)
Vaccine dose 1 (42+ days)	5996	31	0·38 (0·26 to 0·54)	0·20 (0·14 to 0·28)	0·23 (0·17 to 0·32)	77% (68 to 83)
ChAdOx1 (Oxford–AstraZeneca)						
Unvaccinated	743 142	7252	1 (ref)	1 (ref)	1 (ref)	0
Vaccine dose 1 (0–6 days)§	9222	122	0·46 (0·38 to 0·55)	0·43 (0·35 to 0·51)	0·28 (0·23 to 0·34)	72% (66 to 77)
Vaccine dose 1 (7–13 days)§	8699	139	0·48 (0·41 to 0·57)	0·53 (0·44 to 0·63)	0·32 (0·27 to 0·39)	68% (61 to 73)
Vaccine dose 1 (14–20 days)	5742	83	0·38 (0·30 to 0·47)	0·47 (0·37 to 0·58)	0·27 (0·21 to 0·34)	73% (66 to 79)
Vaccine dose 1 (21–27 days)	3447	34	0·23 (0·16 to 0·32)	0·31 (0·22 to 0·44)	0·19 (0·13 to 0·28)	81% (72 to 87)
Vaccine dose 1 (28–34 days)	1666	11	0·15 (0·08 to 0·26)	0·21 (0·12 to 0·39)	0·12 (0·06 to 0·25)	88% (75 to 94)
Vaccine dose 1 (35–41 days)	530	≤5	0·04 (0·01 to 0·29)	0·06 (0·01 to 0·44)	0·03 (0·00 to 0·37)	97% (63 to 100)
Vaccine dose 1 (42+ days)	51	≤5	0·44 (0·06 to 3·10)	0·68 (0·10 to 4·87)	0·41 (0·04 to 3·96)	59% (–296 to 96)

Vasileiou E, Simpson CR, Shi T, et al. Interim findings from first-dose mass COVID-19 vaccination roll-out and COVID-19 hospital admissions in Scotland: a national prospective cohort study. Lancet Lancet 2021 Apr 23 [Epub ahead of print].

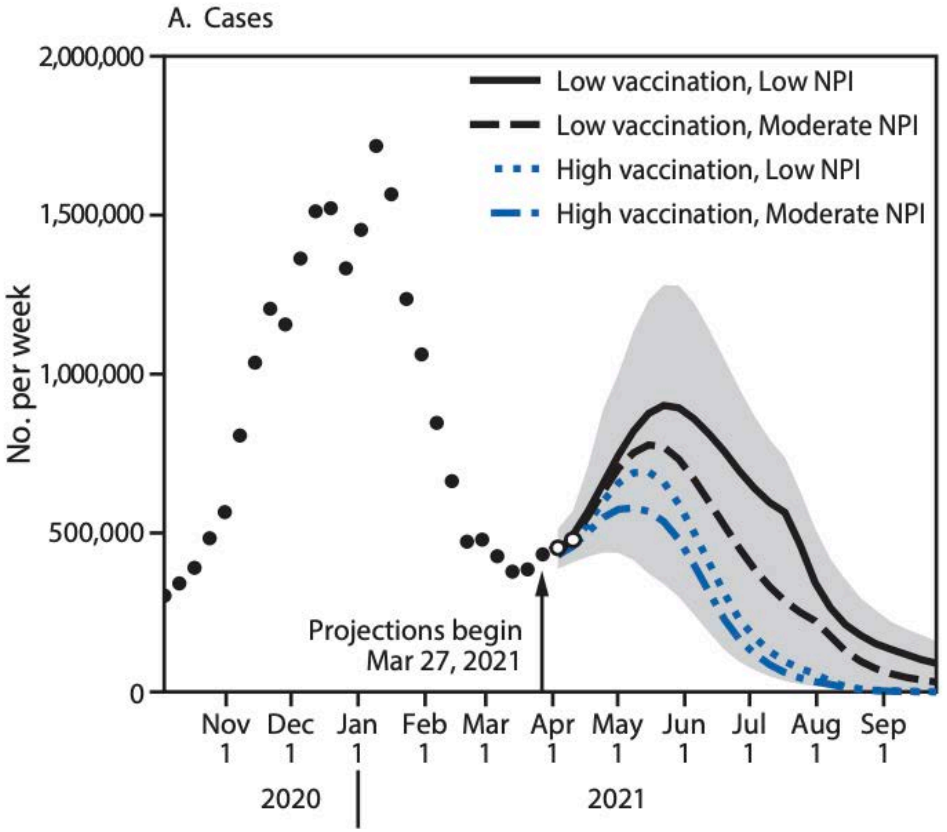
Projected COVID-19 cases under four scenarios, United States, 2021



Abbreviation: NPI = nonpharmaceutical intervention.

* Historical data are shown as filled points, curves represent ensemble projections based on six models, and the grey area represents the maximum and minimum of the 50% projection intervals among all four scenarios. Vertical arrows represent the last date of observations used in the projections. Observations available after projections were made are shown as open points. Projection intervals are based on the 25th percentile of the more optimistic scenario (high vaccination and moderate NPI use) and the 75th percentile of the more pessimistic scenario (low vaccination and low NPI use). Ensemble projection curves represent the median of six median model projections, so they might not always appear smooth; the discontinuity in low vaccination scenario ensembles arises as two models project a late summer resurgence.

FIGURE 1. Weekly projections of reported numbers of cases (A), hospitalizations (B), and deaths (C)* under four scenarios representing different levels of vaccination and nonpharmaceutical intervention adherence — United States, March 27–September 25, 2021



Borchering RK, Viboud C, Howerton E, et al. Modeling of future COVID-19 cases, hospitalizations, and deaths, by vaccination rates and nonpharmaceutical intervention scenarios – United States, April-September 2021. MMWR 2021 May 5 [Early release].

What can still go wrong?

1. Mask fatigue and breakdown of non-pharmaceutical interventions
2. Maldistribution of vaccine with substantial pockets of immunologic inequity that can sustain epidemic transmission
3. Emergence of more transmissible and less immunologically susceptible variants
4. Ignoring international spread
5. Loss of confidence in vaccines and more vaccine hesitancy
6. Decreased vaccine supply

San Francisco and the 1918-19 influenza epidemic

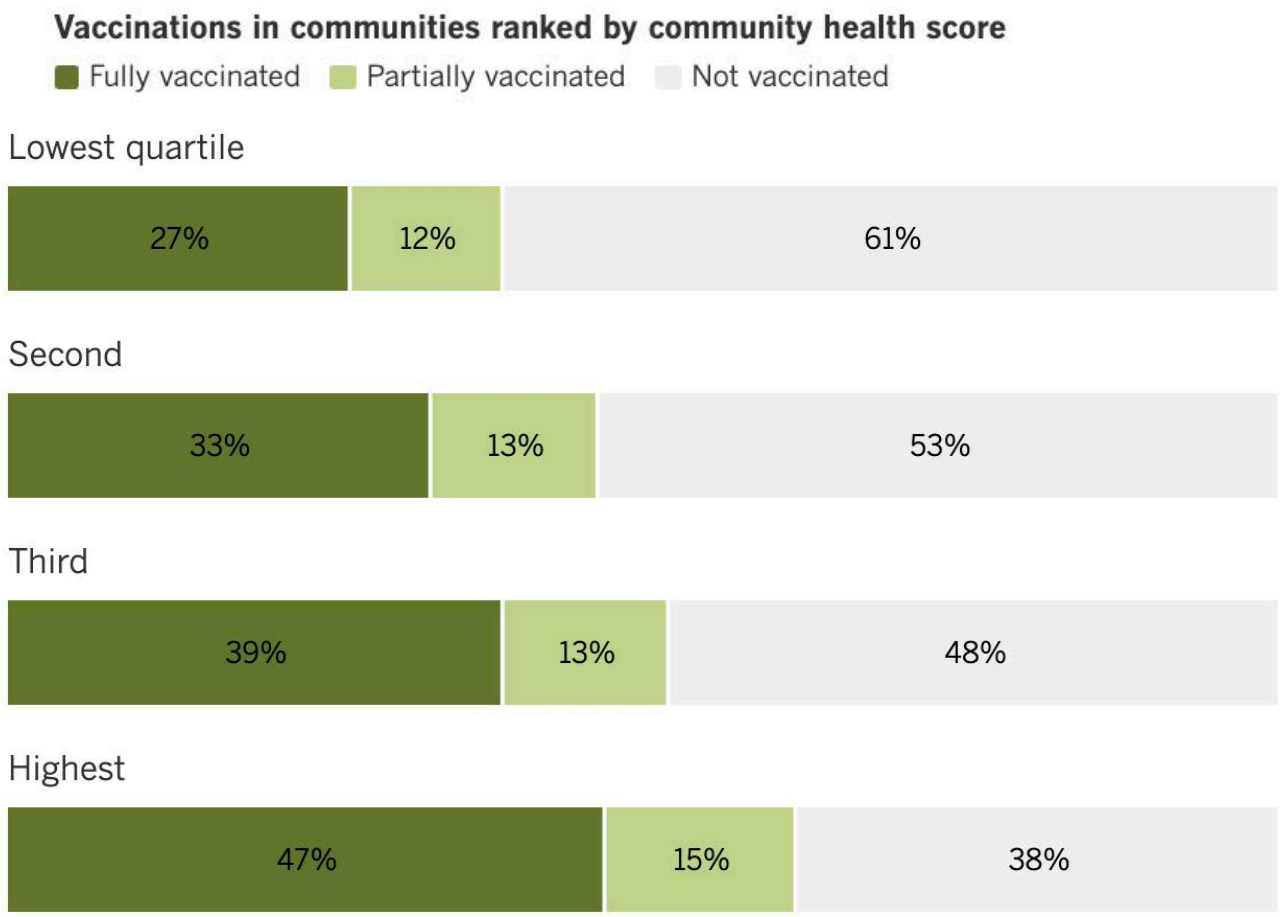
A family wearing masks in San Francisco on November 21, 1918. San Francisco History Center, San Francisco Public Library

A family with their masks off in San Francisco on November 21, 1918. San Francisco History Center, San Francisco Public Library

Masking recommendations for fully vaccinated people

- CDC issued new guidelines on 27 April 2021
- Governor Newsom announces on the same day that California will adopt these new guidelines

COVID-19 vaccine equity, California, 2021



11 May 2021

Risk of variants by time and COVID-19 incidence

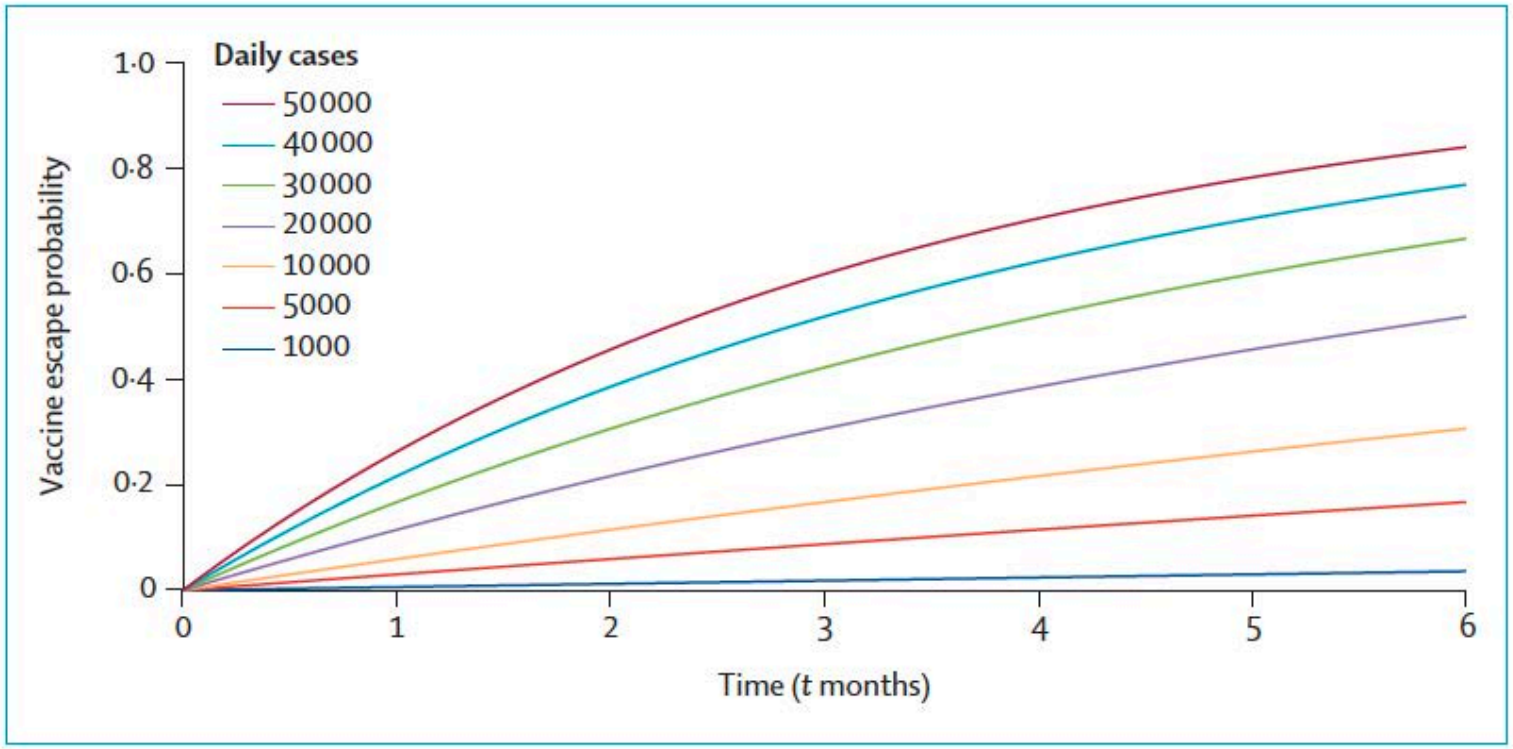


Figure: **Risk that at least one vaccine escape variant arises in a time period of length *t*, for different daily numbers of cases**

The per-infection probability of vaccine escape is $p = 2 \times 10^{-7}$ (for details, see the appendix).

Thompson RN, Hill EM, Gag JR. SARS-CoV-2 incidence and vaccine escape [Letter]. Lancet Infect Dis 2021 Apr 13 [Epub ahead of print].

SARS-CoV-2 variants of concern, United States, California and Arizona, 2021

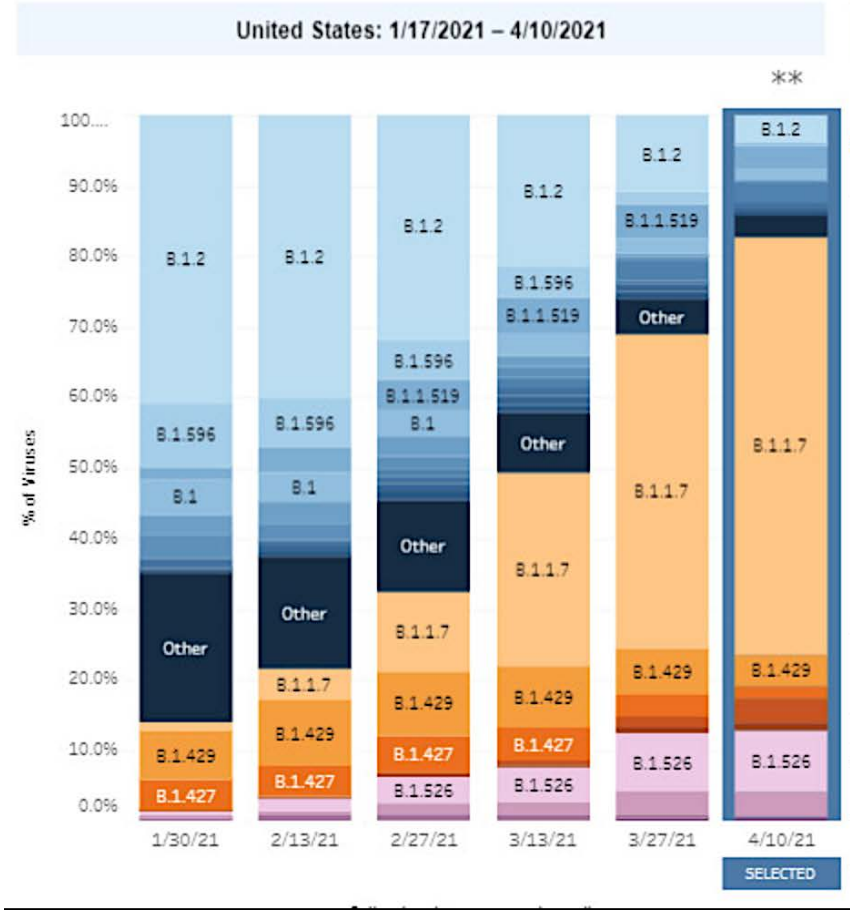
California (N=7 663)

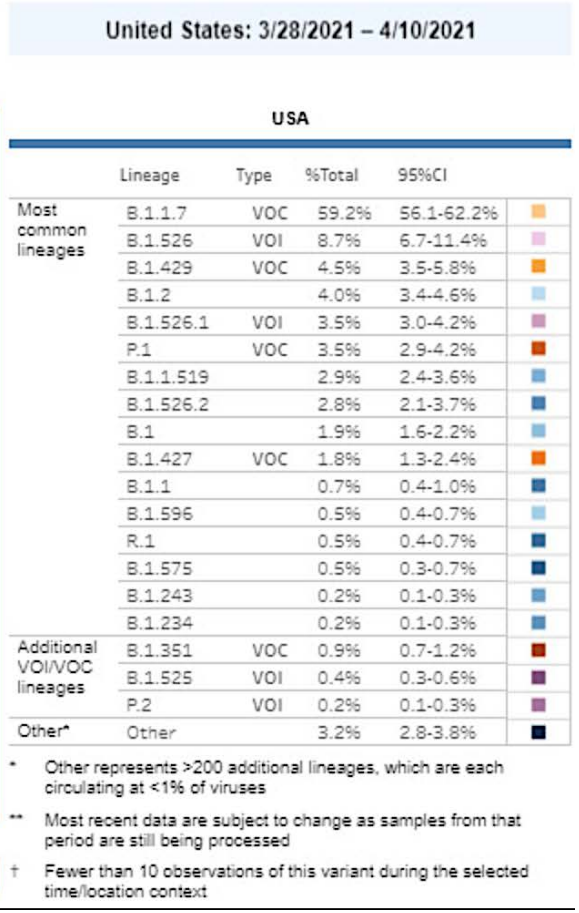
B.1.1.7	30.6%
P.1	4.0%
B.1.351	0.6%
B.1.427/ B.1.429	38.4%

Arizona (N=487)

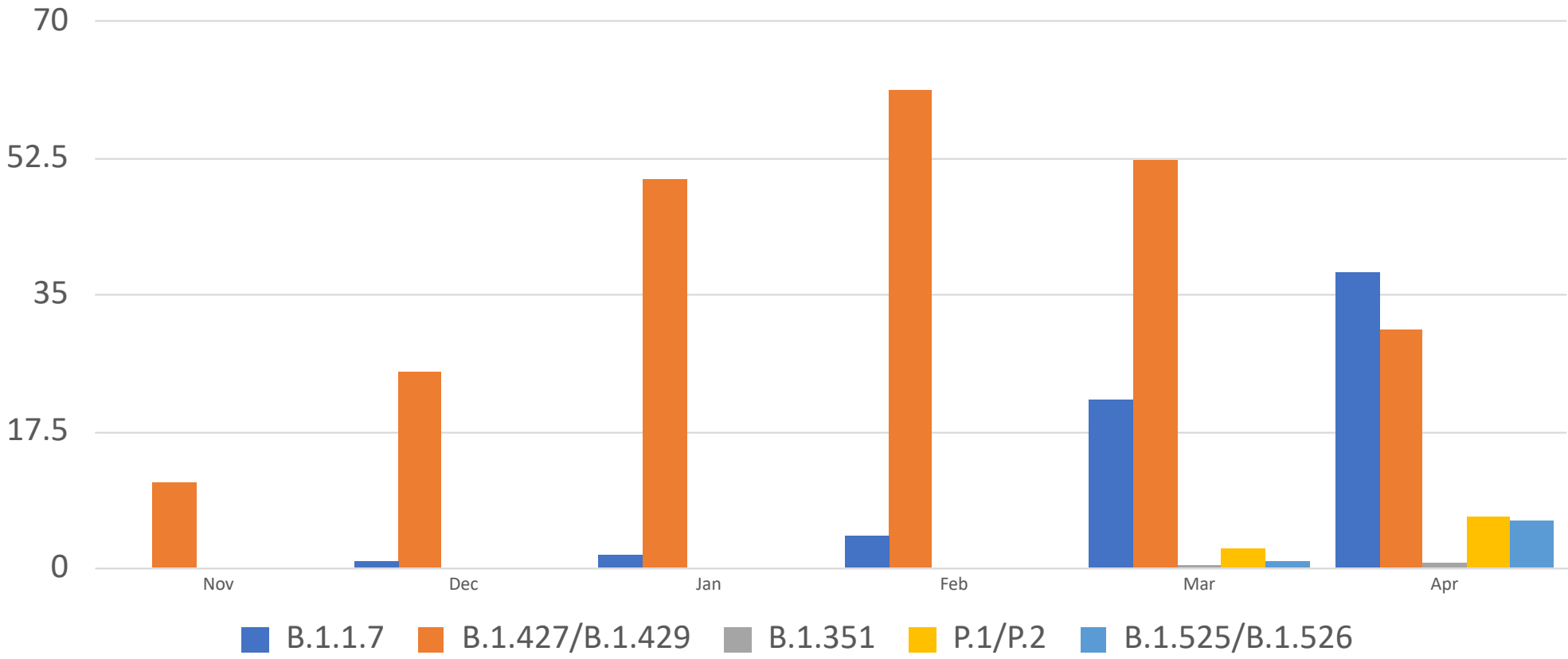
B.1.1.7	32.0%
P.1	3.5%
B.1.351	0.6%
B.1.427/ B.1.429	27.7%

11 May2021





Proportion of SARS-CoV-2 variants by month, California, 2020-2021



California Department of Public Health, 1 May 2021

U.S. Calls for Pause on Johnson & Johnson Vaccine After Clotting Cases

New York Times, April 13, 2021, updated Reuters April 28, 2021

- CDC and FDA have called for immediate pause in administration of J&J vaccine
- 17 recipients in the U.S. have developed cerebral sinus vein thromboses (CSVT) and other deep thromboses with thrombocytopenia following vaccination out of 8 M doses administered (1.4 M to women 20-50 years old) – overall rate $2.1/10^6$ or 1/471 000 doses
- All but one were women between <60 years old, one died

April 28, 2021

The NEW ENGLAND JOURNAL of MEDICINE

BRIEF REPORT

Thrombosis and Thrombocytopenia after ChAdOx1 nCoV-19 Vaccination

- Possibly similar mechanism to AstraZeneca vaccine-associated antibodies (against platelet factor 4)
  - 169 cases of CSVT and 53 cases of abdominal thrombotic thrombocytopenia following 34 million doses in the European Economic Area and the UK <14 days post vaccination
  - Mostly in women <60 years old

Greinacher A, Thiele T, Warkentin TE, Weisser K, Kyrie PA, Eichinger S. Thrombotic thrombocytopenia after ChAd Ox1 nCov-19 vaccination. N Engl J Med 2021 Apr 9 [Epub ahead of print].

Schultz NH, Sørvoli IH, Michelsen AE et al. Thrombosis and thrombocytopenia after ChAdOx1 nCoV-19 vaccination. N Engl J Med 2021 Apr 9 [Epub ahead of print].

Q: Have thromboses with thrombocytopenia been seen with other Adenovirus-vectored vaccines? A: Not reported

- Gameleya (Sputnik V)
  - Adenovirus 5 and 26
  - VE 91.6%

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

VACCINE NAME: Sputnik V (also known as Gam-Covid-Vac)
EFFICACY: 91.6%
DOSE: 2 doses, 3 weeks apart
TYPE: Muscle injection
STORAGE: Freezer storage. Developing an alternative formulation that can be refrigerated.

Logunov DY, Dolzhiova IV, Shcheblyakov DV, et al. Safety and efficacy of an rAd26 and rAd5 vector-based heterologous prime-boost COVID-19 vaccine: an interim analysis of a randmomised controlled phase 3 trial in Russia. Lancet 2021; 397:671-81.

- CanSino BIO (Convidecia)
  - Adenovirus 5
  - VE 65.3%

PHASE 3
APPROVED IN CHINA | EMERGENCY USE IN OTHER COUNTRIES

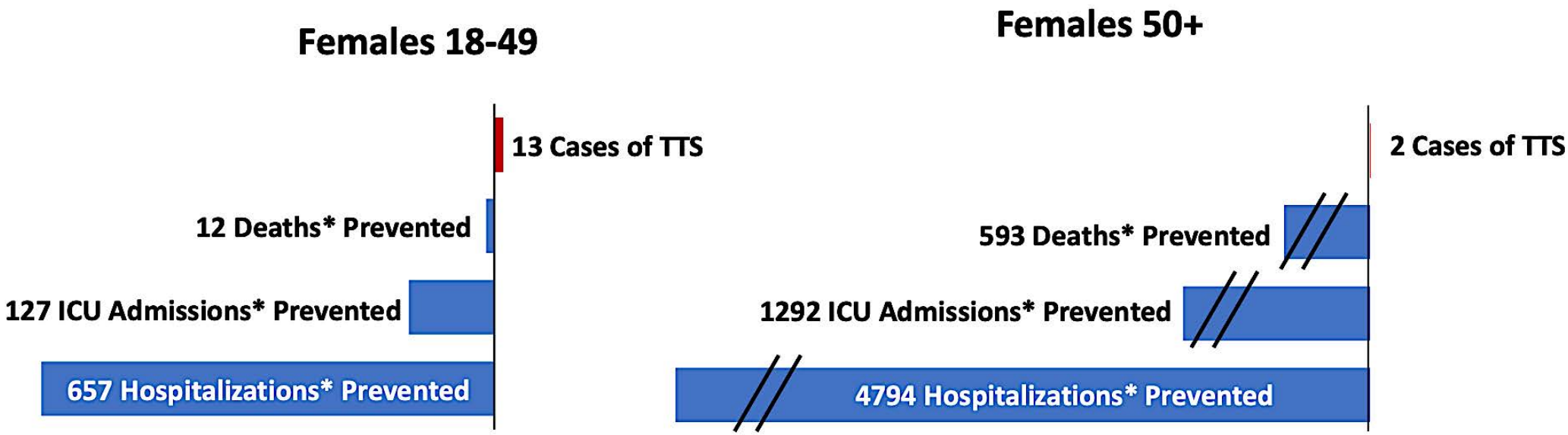
CanSinoBIO

VACCINE NAME: Convidecia (also known as Ad5-nCoV)
EFFICACY: 65.28%
DOSE: Single dose
TYPE: Muscle injection
STORAGE: Refrigerated

Zhu F-C, Guan X-H, Li Y-H, et al. Immunogenicity and safety of a recombinant adenovirus type-5-vectored COVID-19 vaccine in healthy adults aged 18 years or older: a randomised, double-blind, placebo-controlled, phase 2 trials. Lancet 202; 396:479-88.

Risks and benefits females, by age group

For every **1 million** doses of vaccine given with current US exposure risk[1]

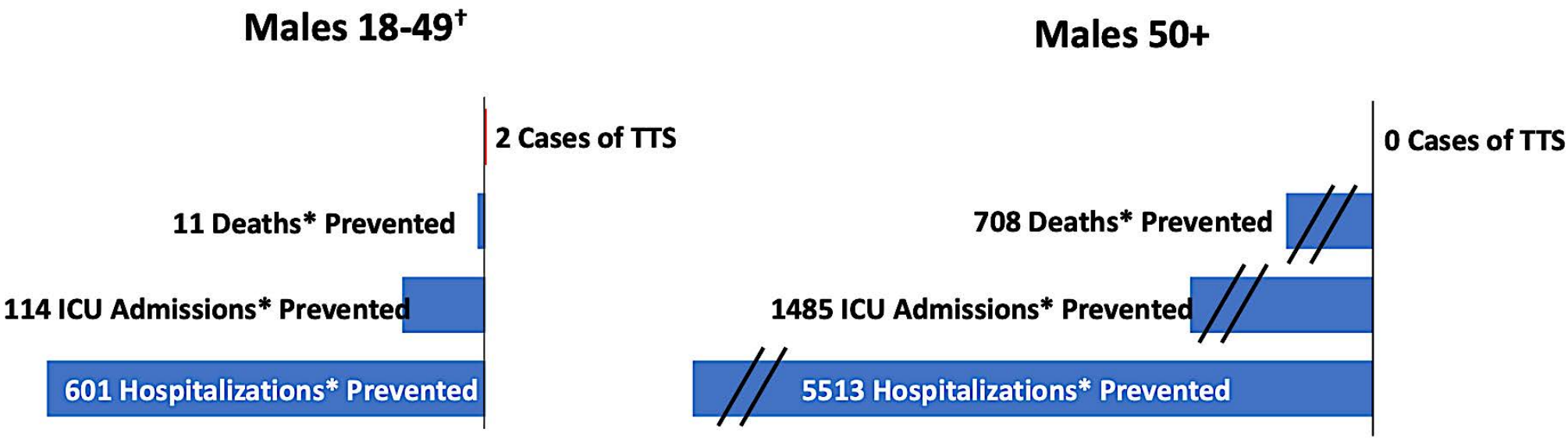


* Deaths, ICU admissions, and deaths due to COVID-19
Acronyms: Thrombosis with Thrombocytopenia Syndrome (TTS)

Oliver S. Risk/benefit assessment of thrombotic thrombocytopenic events after Janssen COVID-19 vaccines: applying evidence to recommendation framework. ACIP 2021 Apr 23.

Risks and benefits males, by age group

For every **1 million** doses of vaccine given with current US exposure risk[1]



†Analyses incorporated one TTS case that occurred in the Phase 3 trial in a male aged 18-49 years.
*Deaths, ICU admissions, and deaths due to COVID-19
Acronyms: Thrombosis with Thrombocytopenia Syndrome (TTS)

Oliver S. Risk/benefit assessment of thrombotic thrombocytopenic events after Janssen COVID-19 vaccines: applying evidence to recommendation framework. ACIP 2021 Apr 23.

The US pre-paid for 1.2 billion vaccines

Table 2: COVID-19 Vaccine Doses Owned by the U.S.		
Vaccine	**Number of doses owned**	**Number of people that could be vaccinated**
Pfizer	300 million	150 million
Moderna	300 million	150 million
Johnson & Johnson	200 million	200 million
AstraZeneca*	300 million	150 million
Novavax*	100 million	50 million
Total	1.2 billion	700 million
U.S. Population	—	331 million
Potential "Surplus"	—	369 million

NOTES: * Not yet authorized by the FDA for use in the U.S.
SOURCE: KFF analysis of Operation Warp Speed contracts and US government announcements.

Courtesy of Peter Chin-Hong, M.D., UCSF

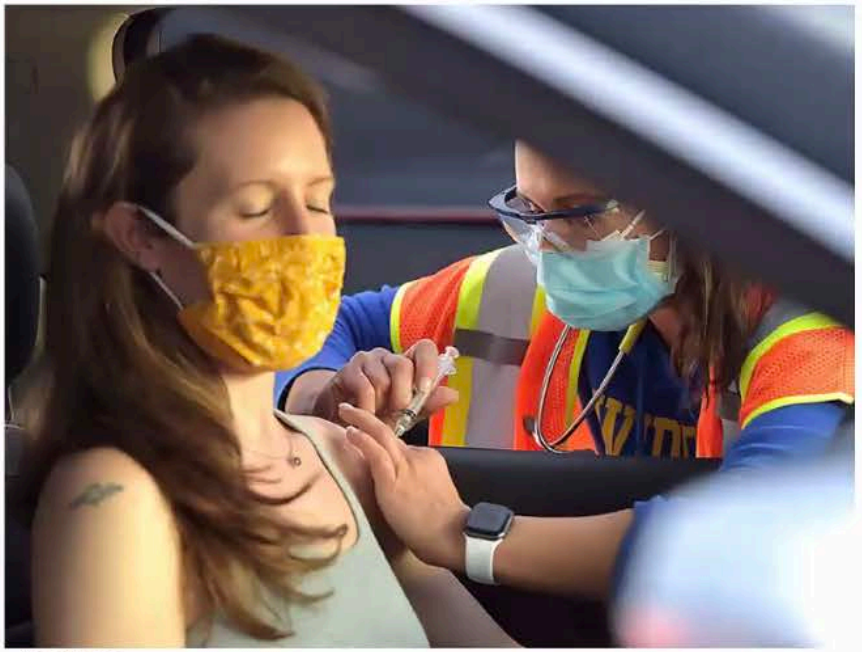
What can the US (and others) do?

Strategy	What done?	Can still do
Donate vaccines	4 million AZ to Mexico, Canada 60 million AZ promised to India	Give more and to more countries
Fund global vaccine efforts	$4 billion to COVAX	Give more $ Give others (eg World Bank)
Expand manufacturing	Enacted Defense Production Act Gave raw materials	More incentives
Patents	Support waive IP	Support WTO, WHO efforts

NEWS · 06 MAY 2021

In shock move, US backs waiving patents on COVID vaccines

The development from the Biden administration draws cheers from public-health researchers and ire from drugmakers



Nature

Courtesy of Peter Chin-Hong, M.D., UCSF

POLITICS

As US stocks up on COVID-19 vaccines, Biden pledges $4 billion to global COVAX campaign

Deirdre Shesgreen and **Courtney Subramanian** USA TODAY

Published 5:05 p.m. ET Feb. 18, 2021 | **Updated 5:23 p.m. ET Feb. 18, 2021**

Biden announces more vaccine supply on the way

President Joe Biden said Thursday that the U.S. will have enough supply of the COVID-19 vaccine by the end of the summer to inoculate 300 million Americans. (Feb. 11) *AP*

Photo credit: WHO Sudan Country Office

Photo caption: Boxes of vaccine doses at the Phnom Penh International Airport on 2 March 2021. Photo credit: ©WHO

U.S. to Send Mexico, Canada Shots

The Biden administration plans to send a total of four million doses of AstraZeneca's Covid-19 vaccine to Mexico and Canada, White House press secretary Jen Psaki said.

By Tarini Parti in Washington and Santiago Pérez in Mexico City

The administration is assessing how it can loan those doses to the countries, Ms. Psaki said on Thursday, with the expectation that the nations would send doses to the U.S. later. Of the four million, 2.5 million doses would be sent to Mexico and 1.5 million to Canada. She added the plans haven't yet been finalized.

The AstraZeneca vaccine isn't approved for use in the U.S.

"Our first priority remains vaccinating the U.S. population," Ms. Psaki said. "But the reality is...the pandemic knows no borders, and ensuring our neighbors can contain the virus is a mission-critical step."

A Canadian official said talks with the U.S. are in an

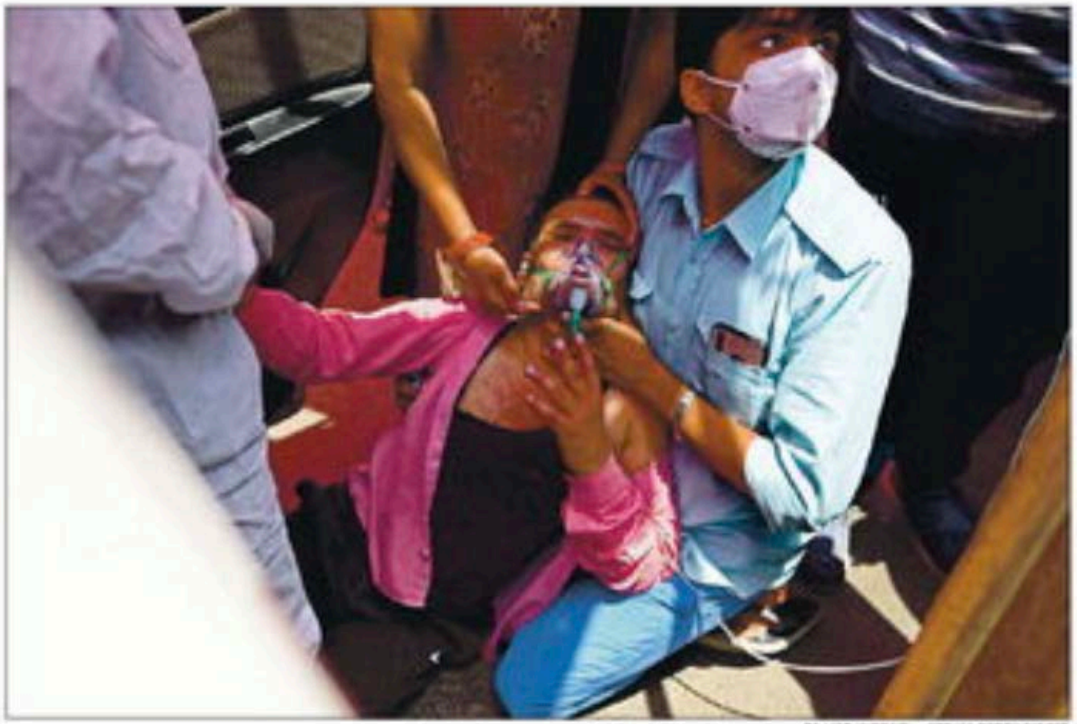
A healthcare worker speaks with a patient before administering a dose of the AstraZeneca Covid-19 vaccine in Mexico City.

Vaccine supplies

- U.S. has up to 300 million doses of AstraZeneca vaccine on order
- Has not received EUA from FDA
- 4 millions doses already provided to Canada and Mexico
- Administration announced yesterday that U.S. will provide up to 60 million doses to India after safety determination by FDA

COVID-19 VACCINES

U.S. will share AstraZeneca shots with rest of the world



SAJJAD HUSSAIN — AFP VIA GETTY IMAGES

A patient breathes with the help of oxygen provided by a gurdwara, a place of worship for Sikhs, outside a parked car along the roadside amid the COVID-19 pandemic in Ghaziabad, India, on Monday.

What could we have done differently and how do we respond next time?

Lessons learned for future pandemics

- Early warning systems are key with focus on human-animal interfaces (OneHealth approach)
- Internationalism is essential
- Employ private sector solutions for manufacturing and distributing early prototype diagnostic and screening tests
- Strengthen domestic and global health architecture for pandemic preparedness and response
- Invest in public health