

COVID-19: *Prevention and Vaccines*

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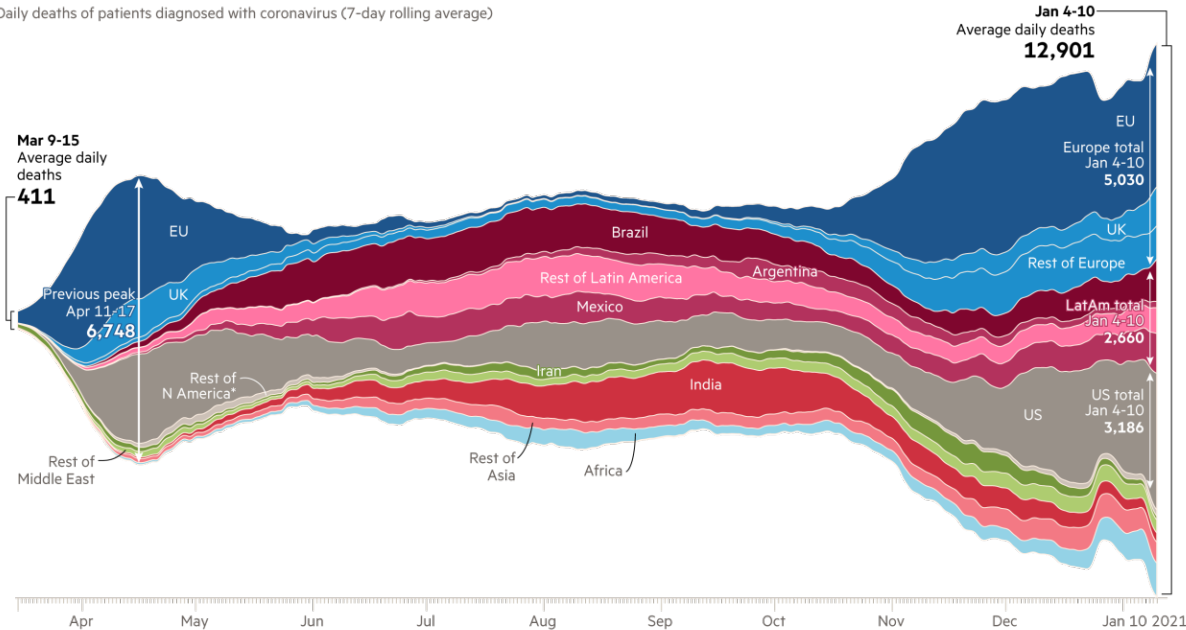
Northwestern University Feinberg School of Medicine

Disclosures

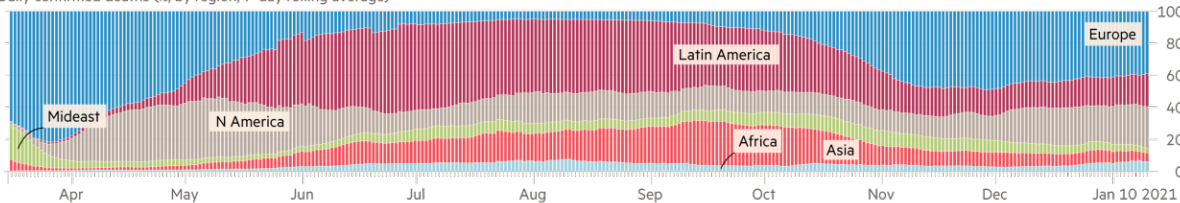
- Research Support^o
 - AiCuris, Janssen, Shire
- Paid Consultation
 - Adagio, AlloVir, Celltrion, Cidara, Genentech/Roche, Janssen, Shionogi, Viracor Eurofins
- Unpaid Consultation
 - Romark
- Data & Safety Monitoring Board Participation
 - NIH, Janssen, Merck, SAB Biotherapeutics, Sequiris, Takeda, Vitaeris

COVID-19: Current Global Situation

Daily deaths of patients diagnosed with coronavirus (7-day rolling average)



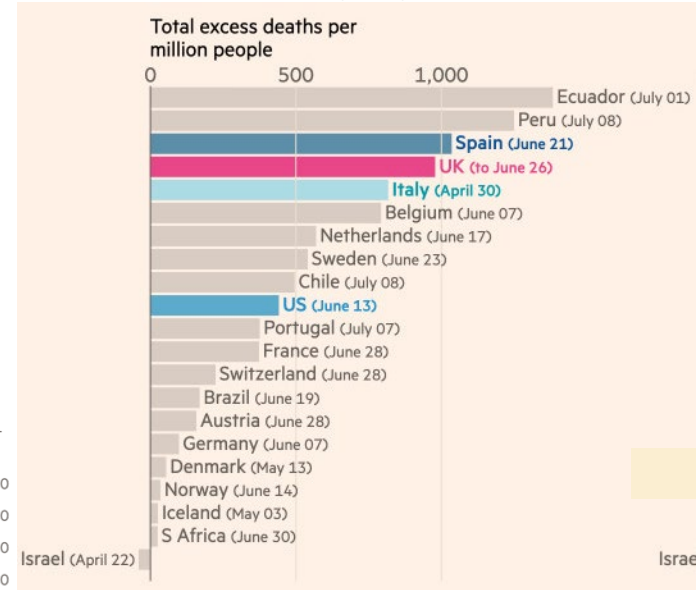
Daily confirmed deaths (% by region, 7-day rolling average)



* Canada, Bermuda, Greenland and St Pierre and Miquelon

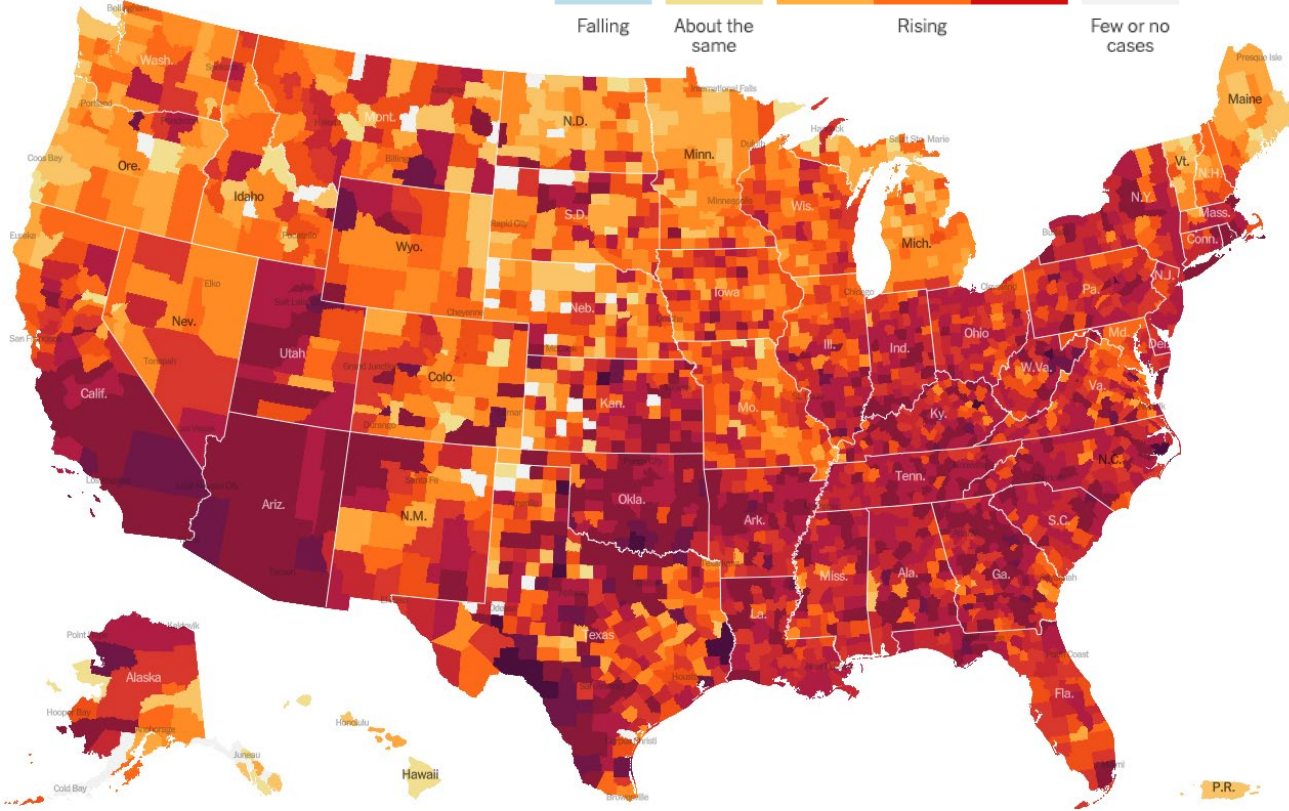
Global Data on 12 January 2021

- COVID-19 Cases: 90,404,579
- COVID-19 Deaths: 1,930,972



COVID-19: Current Situation in the United States

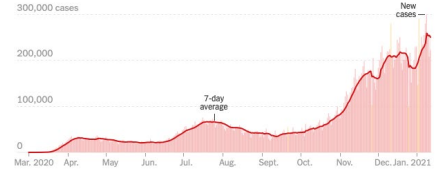
How the number of new cases has changed in the last two weeks



US Data on 19 December 2020

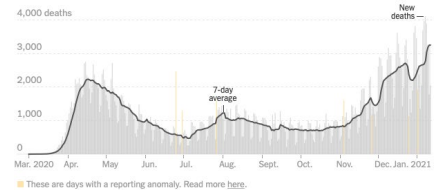
- COVID-19 Cases: 122,797,700 (23.5%)
- COVID-19 Deaths: 379,020 (19.0%)
- COVID-19 Hospitalized: 129,748

New reported cases by day

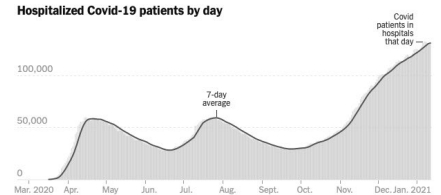


These are days with a reporting anomaly. Read more [here](#).
Note: The seven-day average is the average of a day and the previous six days of data.

New reported deaths by day

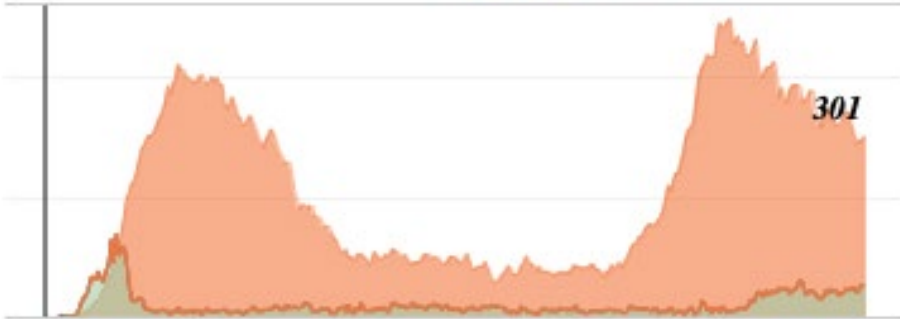


Hospitalized Covid-19 patients by day

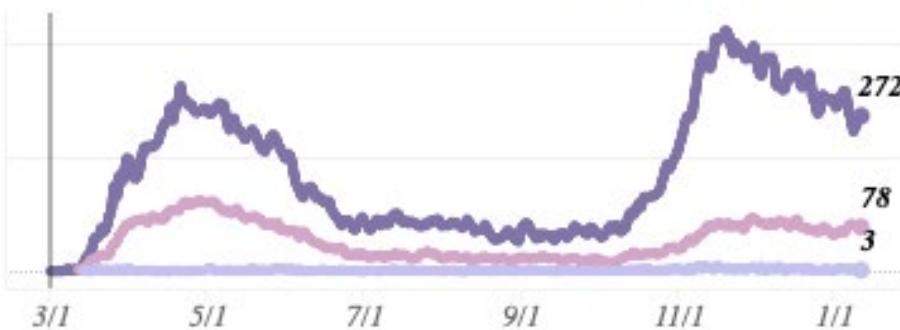


Local Epidemiology: NM SARS-CoV-2 Hospitalizations

IN HOUSE BY STATUS (DAY): COVID+/RULE-OUT



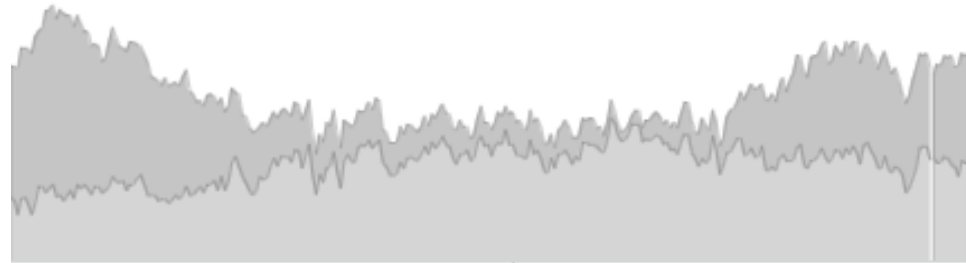
DEPARTMENT COUNTS (DAY): NON-ICU | ICU | ED



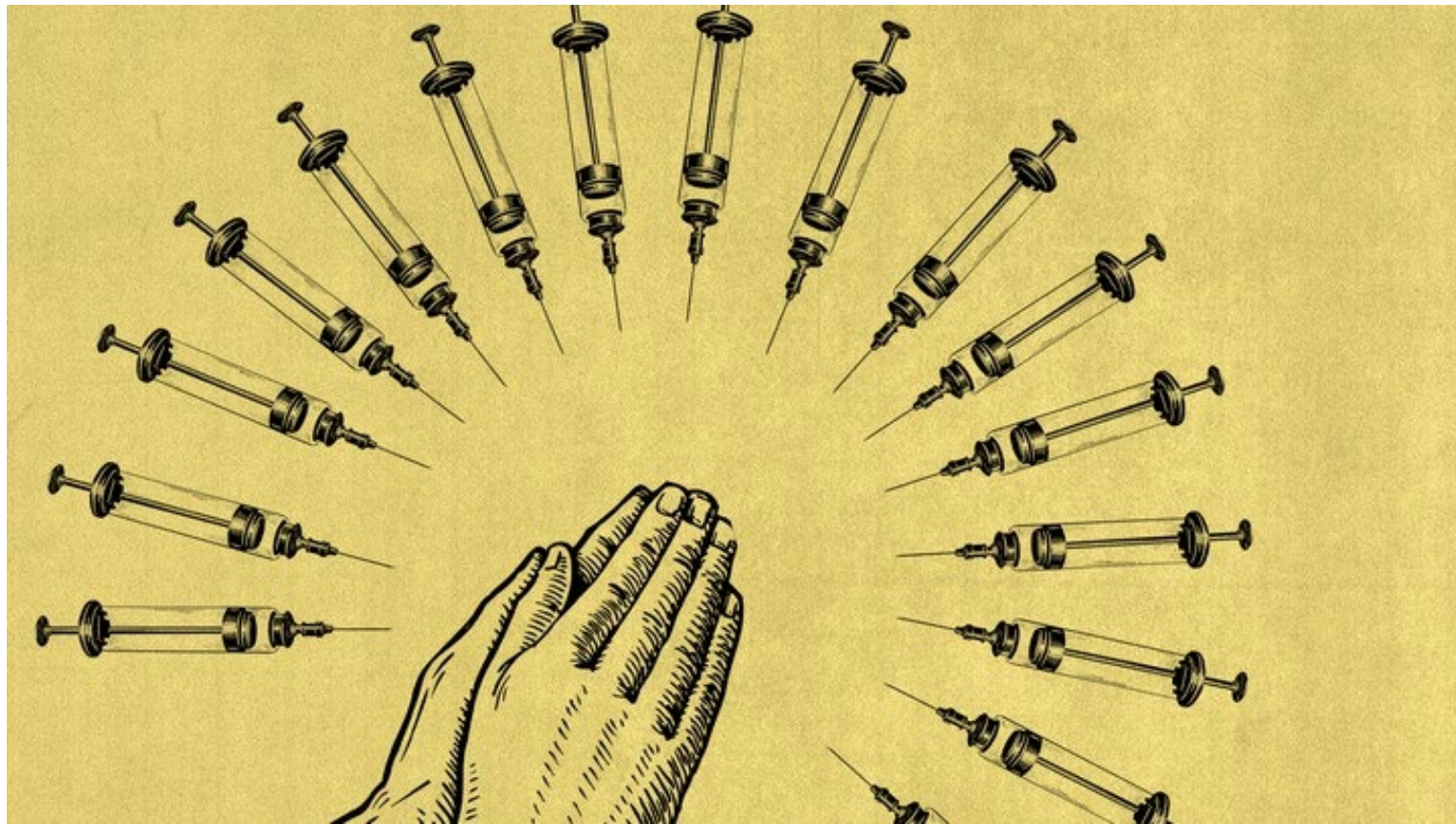
Ventilator Use

COVID VENTS IN USE
(COUNT)
54

NON-COVID VENTS IN USE
(COUNT)
50



SARS-CoV-2 Vaccines: *Current Status*



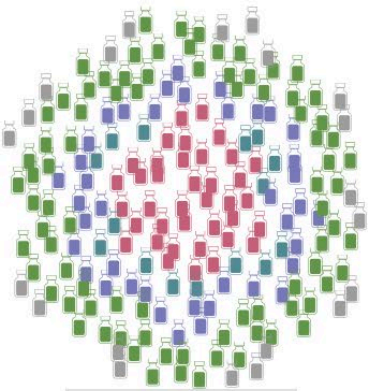
SARS-CoV-2 Vaccines: *Rapid Development*

Date	Milestone
Dec 1	Covid-19 illness documented (unpublicized Nov 17 th)
Jan 10	SARS-CoV-2 virus sequenced
Jan 15	NIH designs mRNA vaccine in collaboration with Moderna
Mar 16	Moderna Phase 1/2 trial begins
May 2	Pfizer/BioNTech Phase 1/2 trial begins
July 14	Moderna Phase 1/2 trial published in NEJM
July 27, 28	Moderna and Pfizer/BioNTech Phase 3 trial begins
Aug 12	Pfizer/BioNTech Phase 1/2 published in Nature
October 22,27	Enrollment in both Phase 3 trials complete; >74,000 participants
Nov 9	Pfizer/BioNTech announces interim analysis efficacy > 90%
Nov 16	Moderna announces interim analysis efficacy 94.5%
Nov 18	Pfizer/BioNTech announces 95% efficacy as final result
Nov 20	1 st EUA submitted by Pfizer/BioNTech
Nov 27	Distribution of vaccine by UAL charter flights throughout US
Dec 10	FDA External review of Pfizer/BioNTech EUA
Dec 11	Phase 1a Vaccination begins for health care professionals*

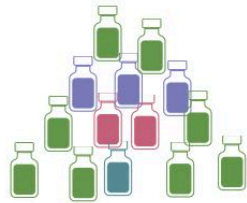
*Provisional on positive external review

COVID-19: Prevention - Vaccines

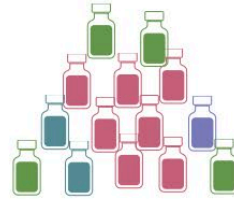
Technology used:  Nucleic acid  Viral-vectored  Subunit  Virus  Other



Pre-clinical



Phase 1



Phase 2

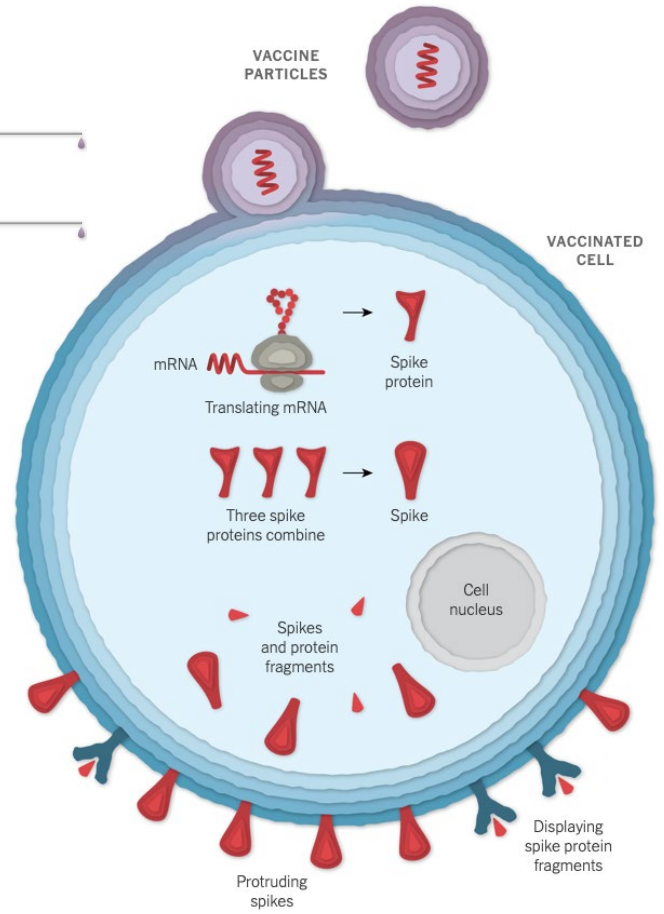
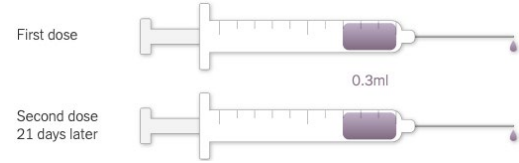
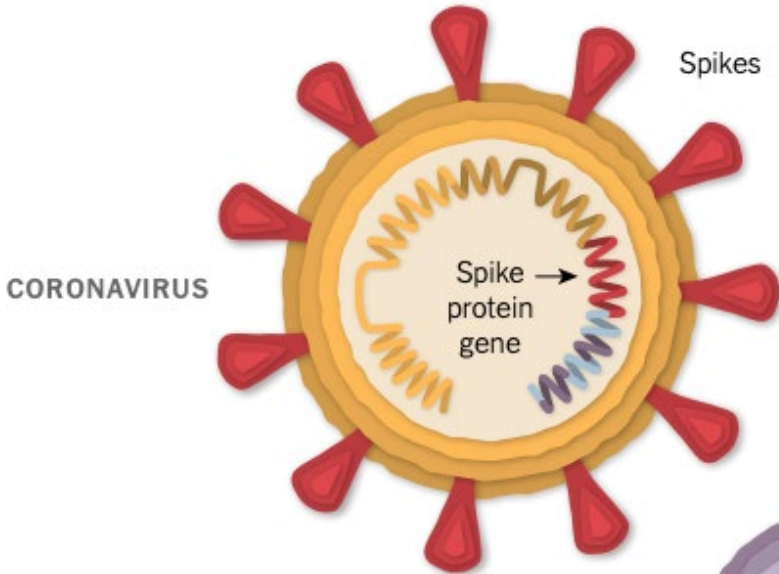


Phase 3



Authorized

SARS-CoV-2 Vaccines : mRNA Vaccines



COVID-19: RNA/DNA and Viral Vaccines

DNA vaccine

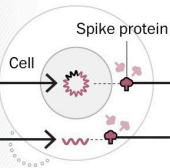
Spike gene on DNA



mRNA in lipid shell

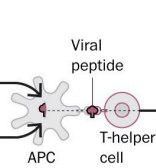
RNA vaccine

An electric pulse allows DNA into the cell's nucleus where it forms mRNA, then creates spike proteins

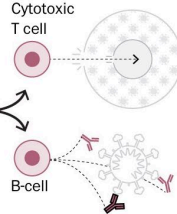


A lipid shell delivers mRNA into the cell, where it is used to produce proteins

Antigen-presenting cells (APCs) consume the viral proteins and pass viral peptides to T-helper cells



Cytotoxic T cells may eliminate virus-infected cells



Antibodies from B-cells may block the virus

Replicating viral vector

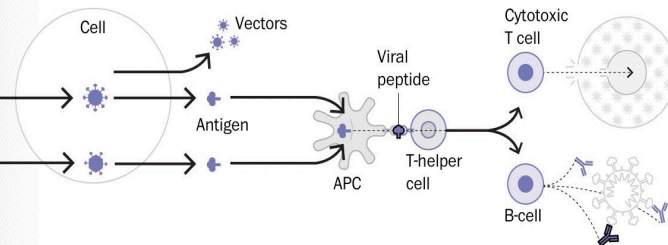
SARS-CoV-2 gene in a different virus



SARS-CoV-2 gene in a different virus

Non-replicating viral vector

Replicating viral vector infects cell, produces SARS-CoV-2 antigen and additional vectors



Non-replicating viral vector infects cells, produces SARS-CoV-2 antigen

Nucleic acid vaccines, developed by...

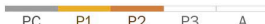
Moderna; National Institutes of Health



Pfizer; BioNTech; Fosun Pharma



AnGes; Osaka University; Takara Bio



Arcturus Therapeutics; Duke-NUS



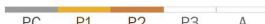
CureVac



Genexine



Imperial College London; VacEquity Global Health



Inovio Pharmaceuticals



Viral-vectored vaccines, developed by...

AstraZeneca; University of Oxford



CanSino Biologics; Beijing Institute of Biotechnology*



Gamaleya Research Institute*



Johnson & Johnson, Beth Israel Deaconess Medical Center



Institut Pasteur; Themis; University of Pittsburgh CVR; Merck Sharp & Dohme

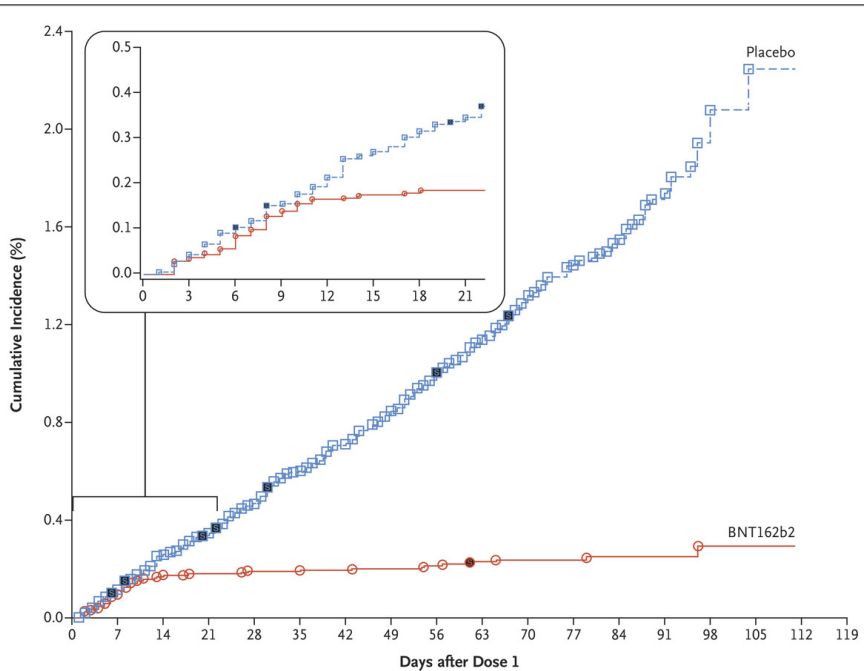


"These are the Top Coronavirus Vaccines to Watch." *Washington Post*. 18 December 2020.

SARS-CoV-2 Vaccine: mRNA Pfizer Vaccine

Table 1. Demographic Characteristics of the Participants in the Main Safety Population.*

Characteristic	BNT162b2 (N=18,860)	Placebo (N=18,846)	Total (N=37,706)
Sex — no. (%)			
Male	9,639 (51.1)	9,436 (50.1)	19,075 (50.6)
Female	9,221 (48.9)	9,410 (49.9)	18,631 (49.4)
Race or ethnic group — no. (%)†			
White	15,636 (82.9)	15,630 (82.9)	31,266 (82.9)
Black or African American	1,729 (9.2)	1,763 (9.4)	3,492 (9.3)
Asian	801 (4.2)	807 (4.3)	1,608 (4.3)
Native American or Alaska Native	102 (0.5)	99 (0.5)	201 (0.5)
Native Hawaiian or other Pacific Islander	50 (0.3)	26 (0.1)	76 (0.2)
Multiracial	449 (2.4)	406 (2.2)	855 (2.3)
Not reported	93 (0.5)	115 (0.6)	208 (0.6)
Hispanic or Latinx	5,266 (27.9)	5,277 (28.0)	10,543 (28.0)
Country — no. (%)			
Argentina	2,883 (15.3)	2,881 (15.3)	5,764 (15.3)
Brazil	1,145 (6.1)	1,139 (6.0)	2,284 (6.1)
South Africa	372 (2.0)	372 (2.0)	744 (2.0)
United States	14,460 (76.7)	14,454 (76.7)	28,914 (76.7)
Age group — no. (%)			
16–55 yr	10,889 (57.7)	10,896 (57.8)	21,785 (57.8)
>55 yr	7,971 (42.3)	7,950 (42.2)	15,921 (42.2)
Age at vaccination — yr			
Median	52.0	52.0	52.0
Range	16–89	16–91	16–91
Body-mass index‡			
≥30.0: obese	6,556 (34.8)	6,662 (35.3)	13,218 (35.1)

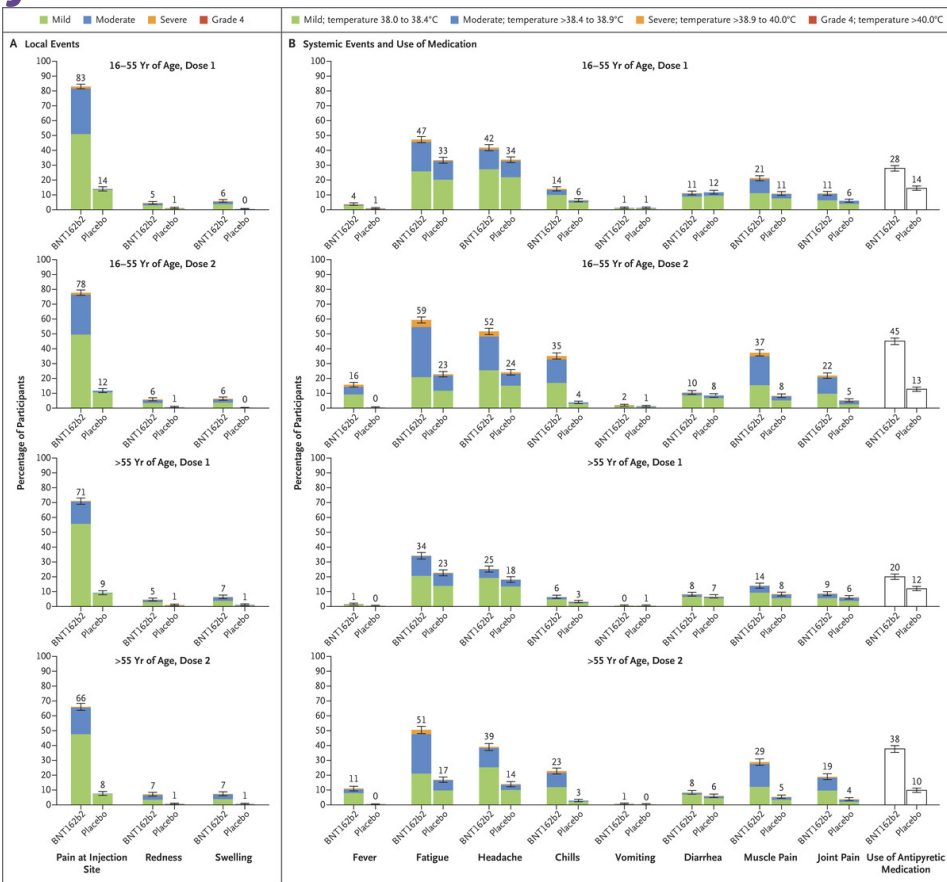


Efficacy End-Point Subgroup	BNT162b2, 30 µg (N=21,669)		Placebo (N=21,686)		VE (95% CI) percent
	No. of participants	Surveillance time person-yr (no. at risk)	No. of participants	Surveillance time person-yr (no. at risk)	
Covid-19 occurrence					
After dose 1	50	4.015 (21,314)	275	3.982 (21,258)	82.0 (75.6–86.9)
After dose 1 to before dose 2	39		82		52.4 (29.5–68.4)
Dose 2 to 7 days after dose 2	2		21		90.5 (61.0–98.9)
≥7 Days after dose 2	9		172		94.8 (89.8–97.6)

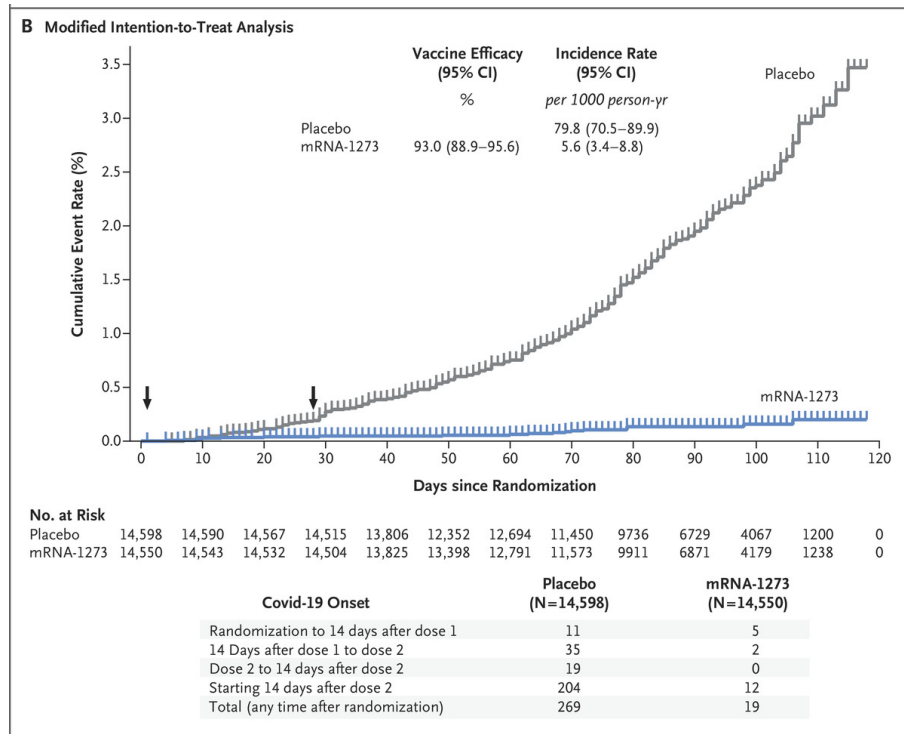
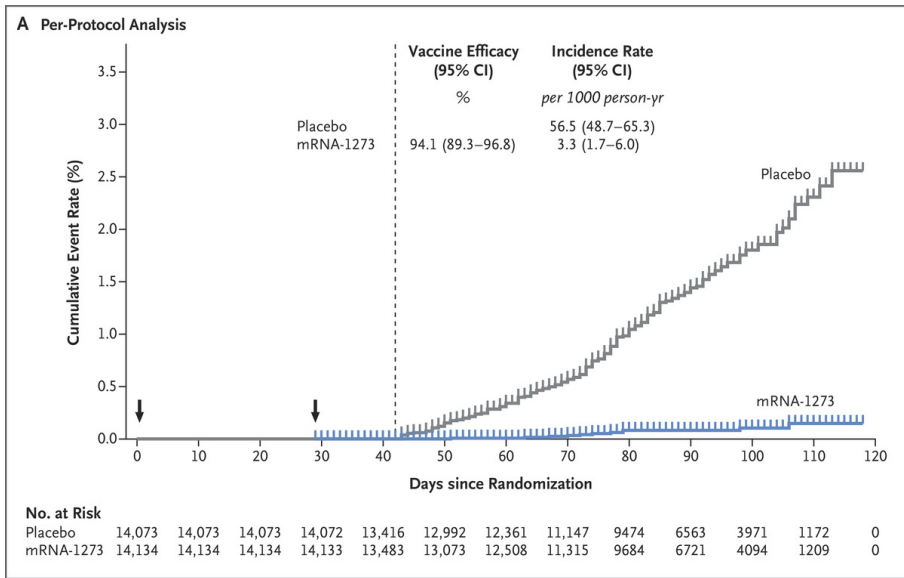
SARS-CoV-2 Vaccine: mRNA Pfizer Vaccine

Table 3. Vaccine Efficacy Overall and by Subgroup in Participants without Evidence of Infection before 7 Days after Dose 2.

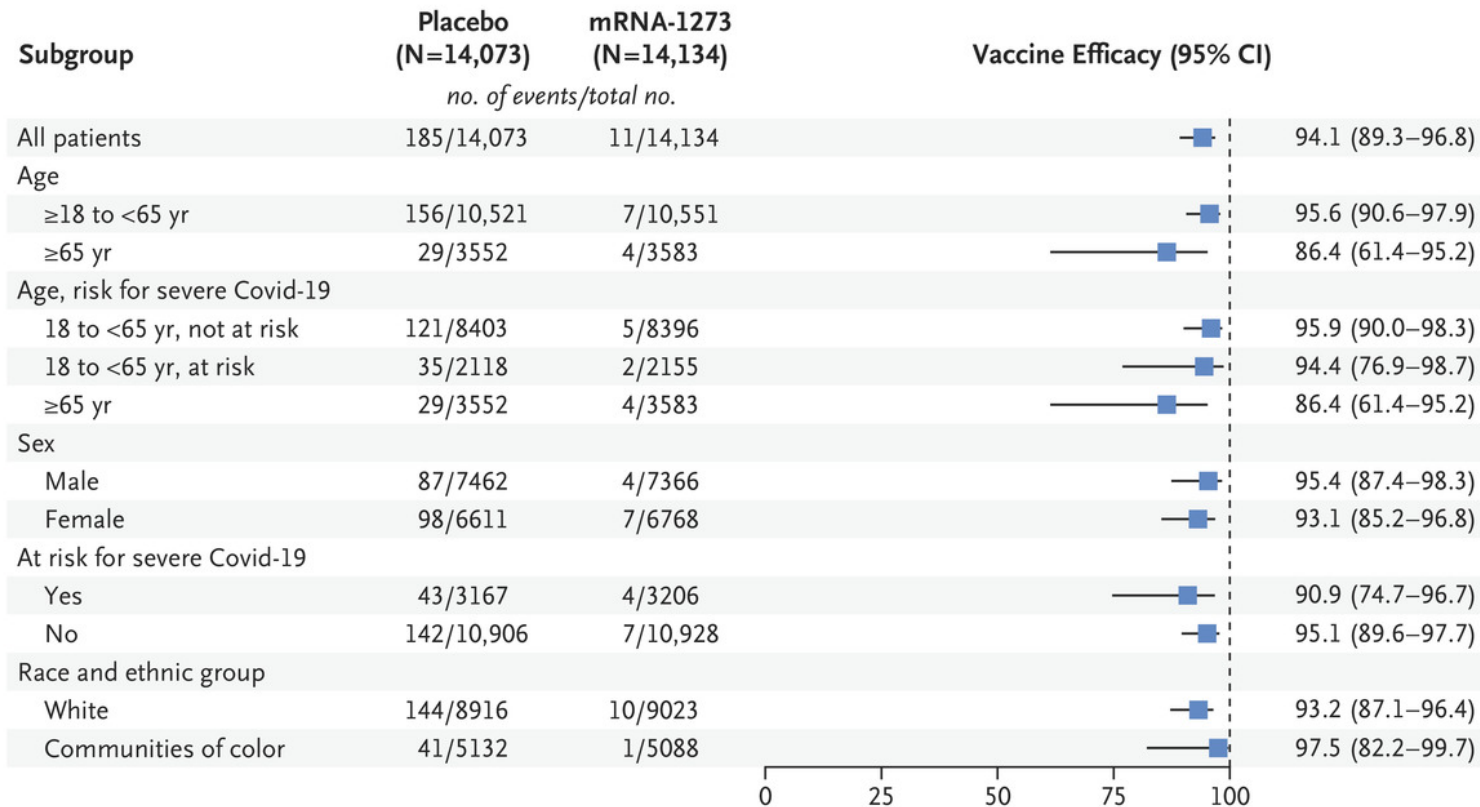
Efficacy End-Point Subgroup	BNT162b2 (N=18,198)		Placebo (N=18,325)		Vaccine Efficacy, % (95% CI) [†]
	No. of Cases	Surveillance Time (No. at Risk)*	No. of Cases	Surveillance Time (No. at Risk)*	
Overall	8	2,214 (17,411)	162	2,222 (17,511)	95.0 (90.0–97.9)
Age group					
16 to 55 yr	5	1,234 (9,897)	114	1,239 (9,955)	95.6 (89.4–98.6)
>55 yr	3	0.980 (7,500)	48	0.983 (7,543)	93.7 (80.6–98.8)
≥65 yr	1	0.508 (3,848)	19	0.511 (3,880)	94.7 (66.7–99.9)
≥75 yr	0	0.102 (774)	5	0.106 (785)	100.0 (–13.1–100.0)
Sex					
Male	3	1,124 (8,875)	81	1,108 (8,762)	96.4 (88.9–99.3)
Female	5	1,090 (8,536)	81	1,114 (8,749)	93.7 (84.7–98.0)
Race or ethnic group [‡]					
White	7	1,889 (14,504)	146	1,903 (14,670)	95.2 (89.8–98.1)
Black or African American	0	0.165 (1,502)	7	0.164 (1,486)	100.0 (31.2–100.0)
All others	1	0.160 (1,405)	9	0.155 (1,355)	89.3 (22.6–99.8)
Hispanic or Latinx	3	0.605 (4,764)	53	0.600 (4,746)	94.4 (82.7–98.9)
Non-Hispanic, non-Latinx	5	1,596 (12,548)	109	1,608 (12,661)	95.4 (88.9–98.5)
Country					
Argentina	1	0.351 (2,545)	35	0.346 (2,521)	97.2 (83.3–99.9)
Brazil	1	0.119 (1,129)	8	0.117 (1,121)	87.7 (8.1–99.7)
United States	6	1,732 (13,359)	119	1,747 (13,506)	94.9 (88.6–98.2)



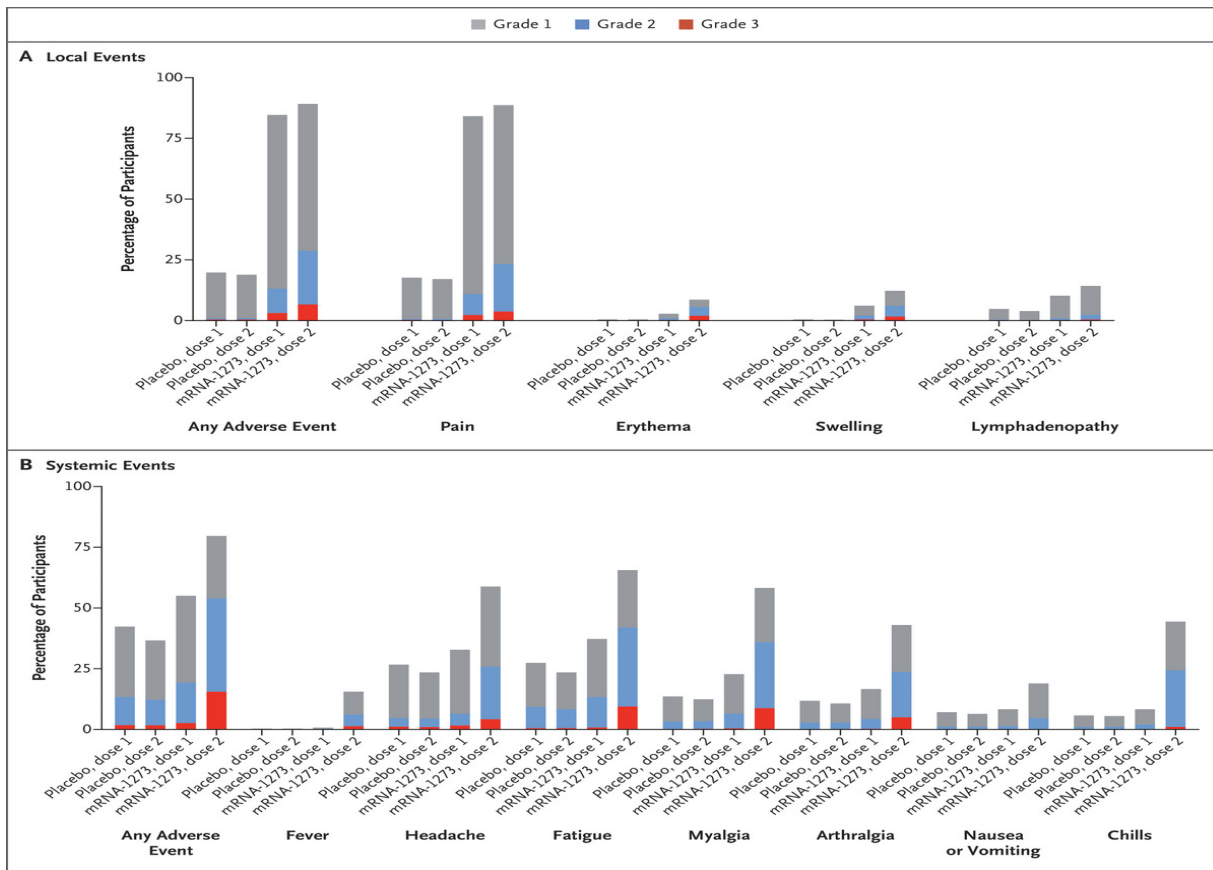
SARS-CoV-2 Vaccine: mRNA Moderna Vaccine



SARS-CoV-2 Vaccine: mRNA Moderna Vaccine

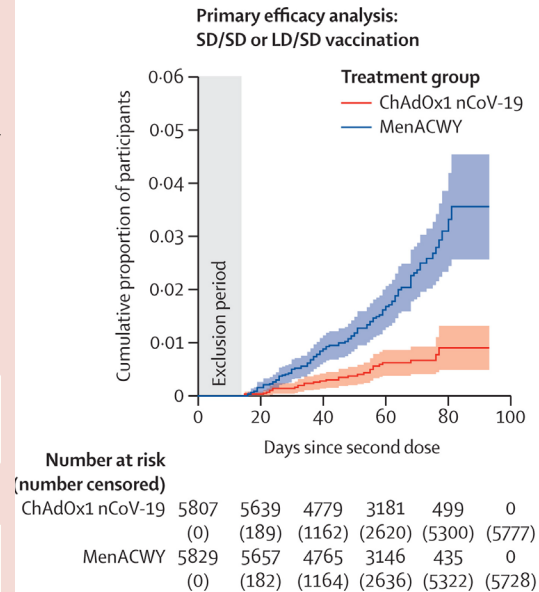


SARS-CoV-2 Vaccine: mRNA Moderna Vaccine

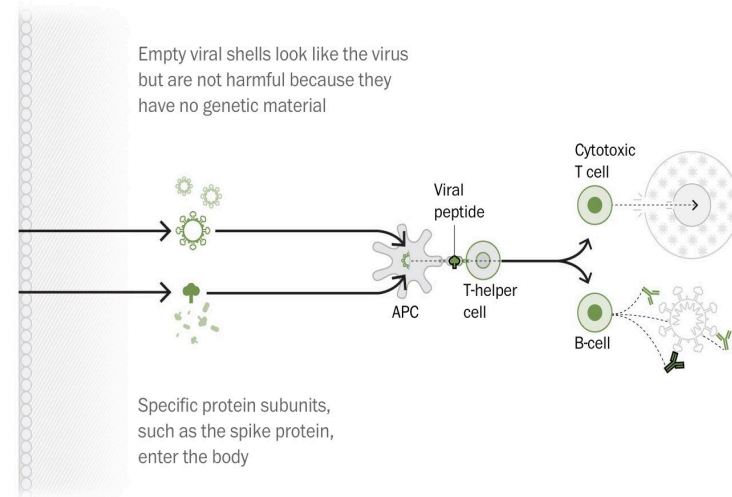
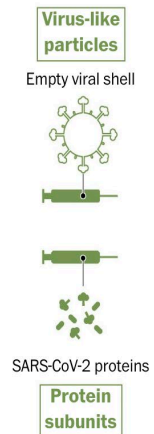
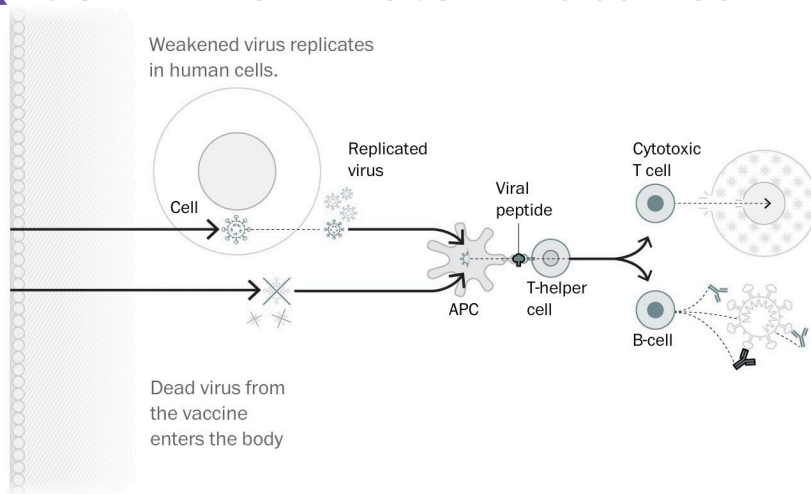
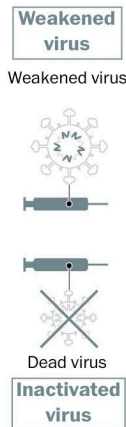


SARS-CoV-2 Vaccine: Adenovirus Vector – AstraZeneca/Oxford

	Total number of cases	ChAdOx1 nCoV-19		Control		Vaccine efficacy (CI*)
		n/N (%)	Incidence rate per 1000 person-years (person-days of follow-up)	n/N (%)	Incidence rate per 1000 person-years (person-days of follow-up)	
All LD/SD and SD/SD recipients	131	30/5807 (0.5%)	44.1 (248 299)	101/5829 (1.7%)	149.2 (247 228)	70.4% (54.8 to 80.6)†
COV002 (UK)	86	18/3744 (0.5%)	38.6 (170 369)	68/3804 (1.8%)	145.7 (170 448)	73.5% (55.5 to 84.2)
LD/SD recipients	33	3/1367 (0.2%)	14.9 (73 313)	30/1374 (2.2%)	150.2 (72 949)	90.0% (67.4 to 97.0)‡§
SD/SD recipients	53	15/2377 (0.6%)	56.4 (97 056)	38/2430 (1.6%)	142.4 (97 499)	60.3% (28.0 to 78.2)
COV003 (Brazil; all SD/SD)	45	12/2063 (0.6%)	56.2 (77 930)	33/2025 (1.6%)	157.0 (76 780)	64.2% (30.7 to 81.5)‡
All SD/SD recipients	98	27/4440 (0.6%)	56.4 (174 986)	71/4455 (1.6%)	148.8 (174 279)	62.1% (41.0 to 75.7)
Other non-primary symptomatic COVID-19 disease¶	18	7/5807 (0.1%)	10.3 (248 299)	11/5829 (0.2%)	16.3 (247 228)	36.4% (-63.8 to 75.3)‡
Any symptomatic COVID-19 disease	149	37/5807 (0.6%)	54.4 (248 299)	112/5829 (1.9%)	165.5 (247 228)	67.1% (52.3 to 77.3)
Asymptomatic or symptoms unknown (COV002)	69	29/3288 (0.9%)	69.8 (151 673)	40/3350 (1.2%)	96.0 (152 138)	27.3% (-17.2 to 54.9)
LD/SD recipients	24	7/1120 (0.6%)	41.4 (61 782)	17/1127 (1.5%)	100.6 (61 730)	58.9% (1.0 to 82.9)‡
SD/SD recipients	45	22/2168 (1.0%)	89.4 (89 891)	23/2223 (1.0%)	92.9 (90 408)	3.8% (-72.4 to 46.3)
Any NAAT-positive swab	221	68/5807 (1.2%)	100.0 (248 299)	153/5829 (2.6%)	226.0 (247 228)	55.7% (41.1 to 66.7)



COVID-19: Protein Vaccines



Weakened and inactivated virus vaccines, developed by...

Beijing Institute of Biological Products; Sinopharm	PC	P1	P2	P3	A
Bharat Biotech	PC	P1	P2	P3	A
Sinopharm	PC	P1	P2	P3	A
Sinovac	PC	P1	P2	P3	A
Chinese Academy of Medical Sciences	PC	P1	P2	P3	A
Research Institute for Biological Safety Problems, Republic of Kazakhstan	PC	P1	P2	P3	A

Subunit vaccines, developed by...

Novavax	PC	P1	P2	P3	A
Anhui Zhifei Longcom; Chinese Academy of Sciences	PC	P1	P2	P3	A
Federal Budgetary Research Institution (FBRI) State Research Center of Virology and Biotechnology "VECTOR"	PC	P1	P2	P3	A
Instituto Finlay de Vacunas	PC	P1	P2	P3	A
SpyBiotech; Serum Institute of India	PC	P1	P2	P3	A



"These are the Top Coronavirus Vaccines to Watch." *Washington Post*. 19 December 2020.

SARS-CoV-2 Vaccines: *Time to Vaccination*

Phase 1c
Adults with high -risk medical conditions
Adults 65+

Phase 1b
Essential workers
(examples: Education Sector, Food & Agriculture, Utilities,
Police, Firefighters, Corrections Officers, Transportation)

Phase 1a
Health care personnel
LTCF residents

Time

SARS-CoV-2 Vaccines: *Time to Vaccination*

Proposed Phase 1 & 2 allocation, December 2020

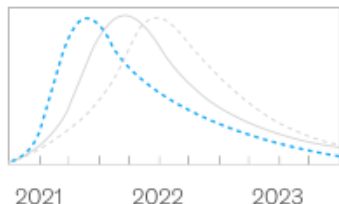
Phase	Groups recommended for vaccination	Number of persons in each group (millions)	Number of unique* persons in each group (millions)	Total* (millions)
1a	Health care personnel	21	21	24
	Long-term care facility residents	3	3	
1b	Frontline essential workers	30	30	49
	Persons aged 75 years and older	21	19	
1c	Persons aged 65-74 years	32	28	129
	Persons aged 16-64 years with high-risk conditions	110	81	
	Essential workers not recommended in Phase 1b	57	20	
2	All people aged 16 years and older not in Phase 1, who are recommended for vaccination			

SARS-CoV-2 Vaccines: *Time to Herd Immunity*

The probability of reaching COVID-19 herd immunity in the United States is highest in the third or fourth quarter of 2021 but could shift.

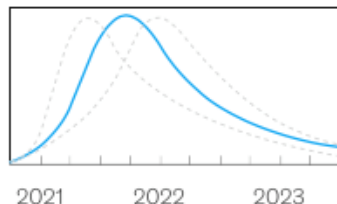
Probability of functional end¹ to COVID-19 pandemic in US by quarter (illustrative)

Early (Q2 2021)



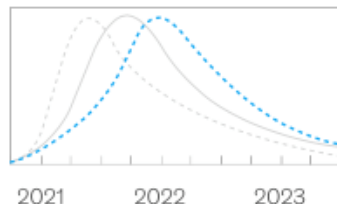
- COVID-19 vaccine with high efficacy arrives sooner than expected
- Timeline of manufacturing, distribution, and administration of COVID-19 vaccine is shorter than expected
- Cross-immunity from other coronaviruses proves significant
- There is broad-based willingness to be vaccinated

Most likely (Q3/Q4 2021)



- ≥ 1 COVID-19 vaccine is authorized by end of 2020 or early 2021
- COVID-19 vaccine is distributed to a sufficient portion of population in ~6 months
- There is broad-based willingness to be vaccinated

Late (2022 or later)



- Early COVID-19-vaccine candidates have low efficacy or low coverage (eg, side effects, slow adoption)
- Timeline of manufacturing, distribution, and administration of COVID-19 vaccine is longer than expected
- Immunity duration is very short

Are you a registered organ donor?

I am!



Questions?

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