

COVID-19 vaccines

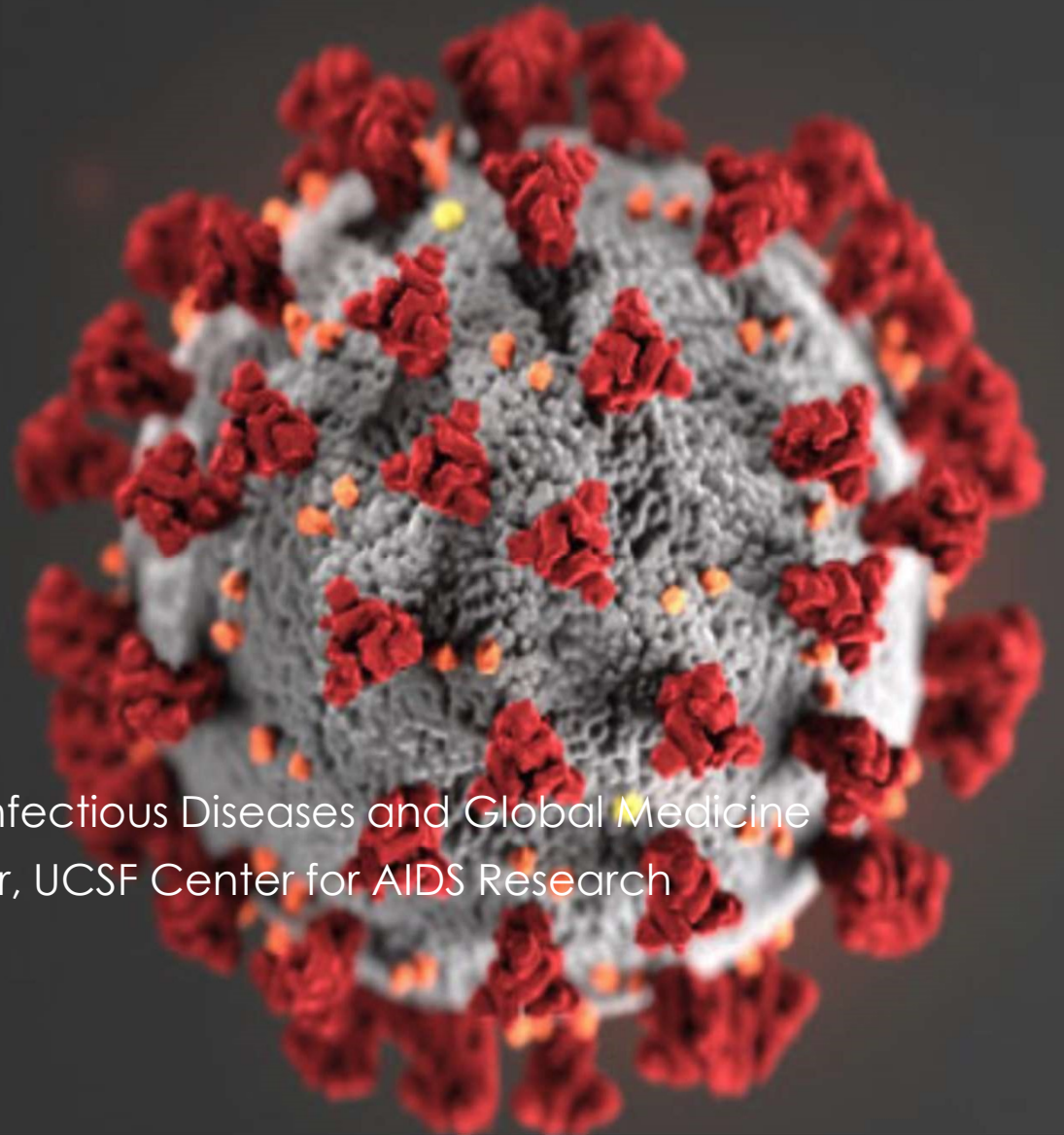
Monica Gandhi MD, MPH

Professor of Medicine, Division of HIV, Infectious Diseases and Global Medicine

Medical Director, Ward 86 and Director, UCSF Center for AIDS Research

Osher Mini Medical School

June 15, 2021



Have we ever seen coronavirus cause more than the “common cold” before?



- This new coronavirus is causing more severe symptoms than “upper respiratory infection” symptoms, like fever, cough, shortness of breath, sometimes even pneumonia
- We had another coronavirus which came out in the world like this in 2002 and yet another in 2012 so this is the 3rd time

Another coronavirus named SARS came out in 2002-3: Didn't just cause cold but worse symptoms

- In 2002, there was another virus that came out of China called “SARS” - Severe Acute Respiratory Syndrome (SARS-CoV-1)
- Lasted about 9 months in the world until 2003; 8098 cases, 29 countries, 774 deaths
- 29 cases in U.S. but 0 deaths, more in Canada
- Horseshoe bat, then cat-like mammal called palm civet → human → human to human



Middle East respiratory syndrome coronavirus in 2012 (MERS-CoV)










- First came out in Saudi Arabia in 2012; all cases linked to Middle East
- Went around world from 2012-2019: 27 countries, 2494 cases, 858 deaths
- United States: 2 cases in May 2014 (Indiana, Florida) – both health care workers from Saudi Arabia
- Was originally in camel and then went to humans then human to human



What about this new coronavirus?

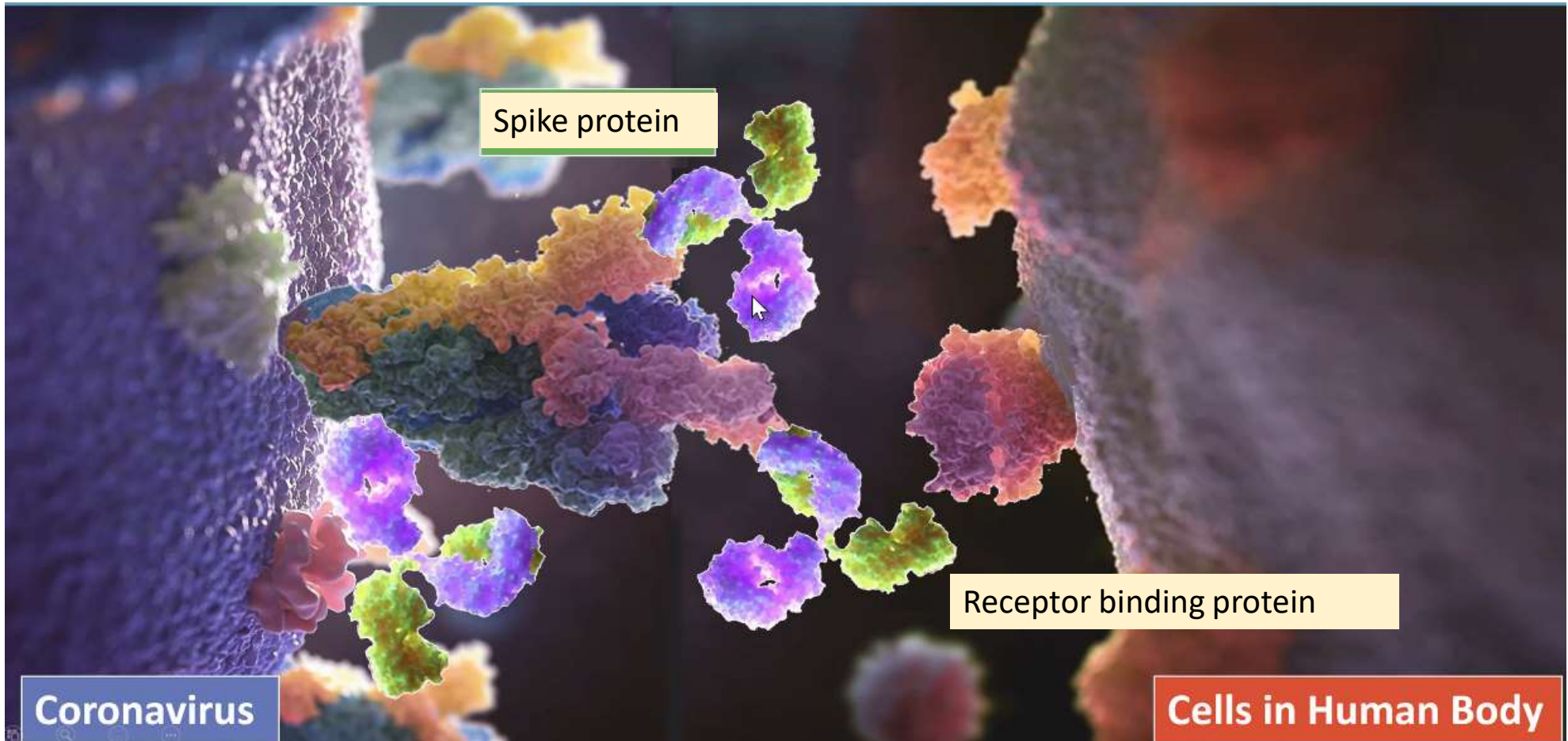
- Illness with fever, cough, pneumonia reported in Wuhan, China on New Years' Eve (December 31, 2019) after “whistleblower event”
- January 7, 2020: Identified etiology a new coronavirus
- Has been spreading around world since then
- January 30, 2020: WHO - “global health emergency”
- March 11, 2020: WHO – “Pandemic”
- March 26, 2020: US became epicenter of pandemic and then
- March 5, 2021: Cases started rising in India



Company or name	Form of publication for phase 3 data/ type of vaccine	Reference
	Peer reviewed publication/ mRNA	Baden NEJM , Feb 4, 2021
	Peer reviewed publication/ mRNA	Polack NEJM , December 31, 2020
	Press release only/ adenovirus + DNA	J&J press release January 29, 2021; FDA document Feb 24
	Two peer-reviewed publications but ongoing (adenovirus + DNA)	Voysey Lancet December 8, 2020; Preprint Feb 1, 2021
	Press release, abstract, press release (phase 3 UK; phase 2b S. Africa; phase 3 US/Mexico)	Novavax press release 1/28 and NYAS abstract 2/2/21; press release June 14
	Peer-reviewed publication (DNA plus adenovirus)	Logunov Lancet , February 2, 2021
	Publication (whole inactivated)	Sinopharm , JAMA, May 28, 2021
	Publication (whole inactivated)	Sinovac , JAMA May 28, 2021
	Press release (whole inactivated)	Bharat Covaxin , April 21, 2021

There are actually 9 vaccines out there for COVID-19, three authorized in U.S.

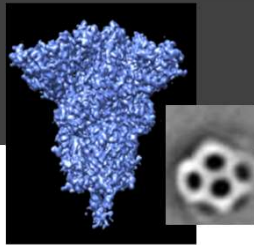
6 vaccine candidates to date involve spike protein and receptor binding domain of SARS-CoV-2 - either mRNA or adenoviral-vector DNA vaccines or protein adjuvant itself; 3 inactivated virus



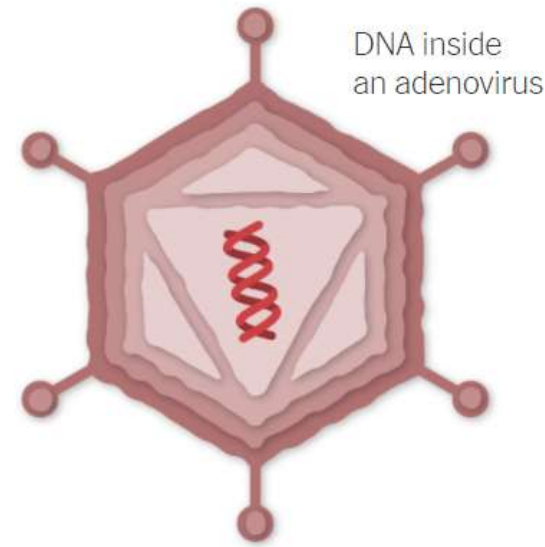
Three types of vaccines involving spike protein

- mRNA vaccines (2)
- Adenoviral vector DNA vaccines (3)
- Spike protein + M-adjuvant vaccine (1)

Three vaccines whole inactivated virions



NOVAVAX
Creating Tomorrow's Vaccines Today



Johnson & Johnson

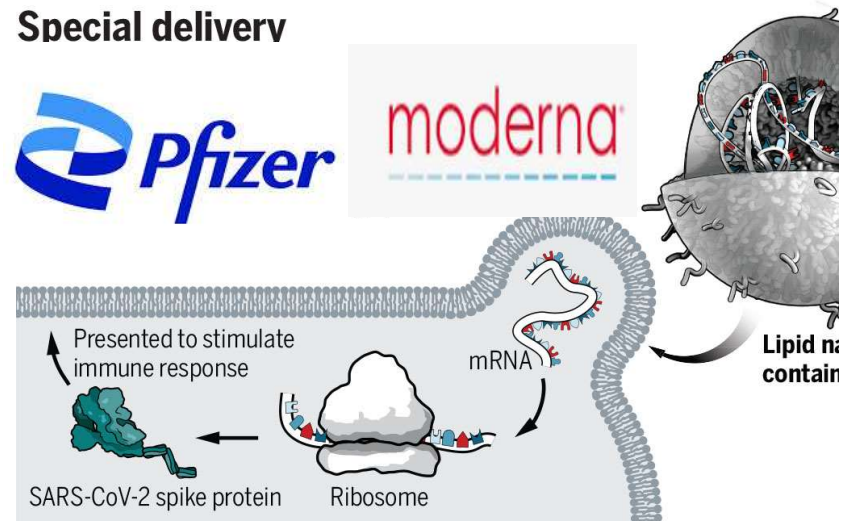
AstraZeneca

Sputnik V

Special delivery

Pfizer

moderna

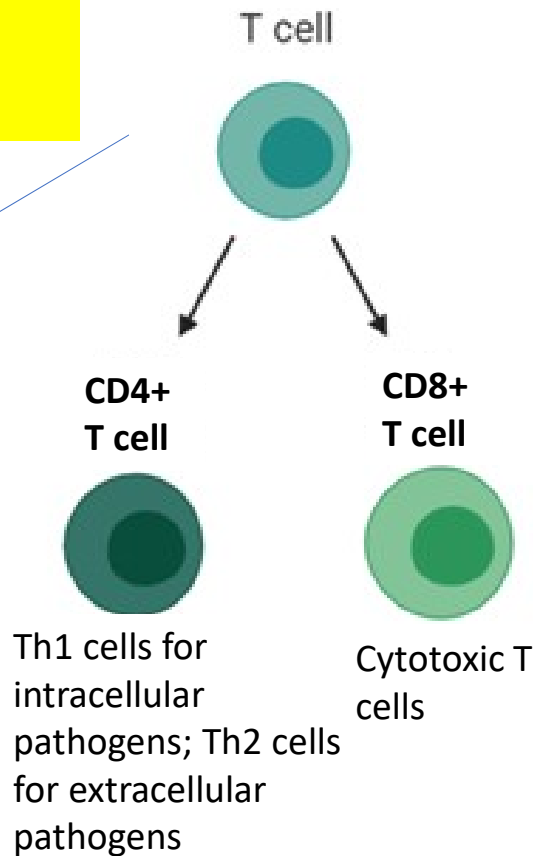


Remember immunity -antibodies and cell-mediated

T cells are the major immune defense against viruses

Memory T cells

Of note, want Th1:Th2 ratio $\gg 1$ for viruses; Th2 CD4s block antiviral Th1-CD4s and CD8s



B cell

Memory B cells



Most vaccine trials measured antibodies and T cell responses

LETTERS

Neutralizing antibodies derived from the B cells of 1918 influenza pandemic survivors

Xiaocong Yu^{1*}, Tshidi Tsibane^{2*}, Patricia A. McGraw¹, Frances S. House¹, Christopher J. Keefer¹, Mark D. Hicar¹, Terrence M. Tumpey³, Claudia Pappas^{2,3}, Lucy A. Perrone³, Osvaldo Martinez², James Stevens^{1,2}, Ian A. Wilson⁴, Patricia V. Aguilar⁵, Eric L. Altschuler⁶, Christopher F. Basler² & James E. Crowe Jr¹

nature

Article

SARS-CoV-2-specific T cell immunity in cases of COVID-19 and SARS, and uninfected controls

nature reviews immunology

Biochemical and Biophysical Research Communications

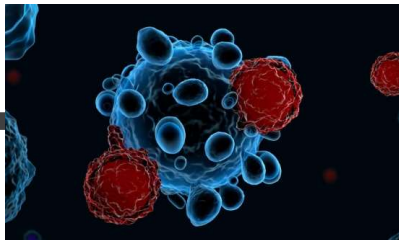
T cell immunity to SARS-CoV-2 following natural infection and vaccination

JEM
Journal of Experimental Medicine

ARTICLE

Highly functional virus-specific cellular immune response in asymptomatic SARS-CoV-2 infectionMiao Li¹, Dongliang Chen², Huihui Chen², Anshu T. Todi³, Min Ai⁴, Chaojie Yi⁵, Tianyi Li⁶, Jun M. Liu⁷, Kwok-Kwan Lam⁸

nature reviews immunology

T cell responses in patients with COVID-19

CellPress







Trends in Immunology




Opinion

T Cells: Warriors of SARS-CoV-2 Infection

How does functional T-cell response modulate severity of disease?

- T cell responses modulate the severity of disease
- Strong T cell responses in all of these trials seem to have led to prevention of severe disease
- JEM study shows us that those with asymptomatic infection mounted good T cell responses to COVID-19
- If you get re-infected after natural infection or vaccine (rare), should be mild if mounted good T-cell response
- Fun fact: Study from 1918 survivors of influenza pandemic show durable B cell immunity (memory B- Ab) 90 years later!

Company	Platform	Doses	Non-clinical results	# with vaccine (same placebo)	Protection from COVID-19 hospitalization	Protection from COVID severe dz (some at home)	Efficacy against milder COVID
 Moderna	mRNA-1273 mRNA in lipid nanoparticle	2	Neutralizing Abs; Strong Th1 CD4+ protection from challenge (macaques)	~15,000	90% (1 in vaccine arm after 2nd dose hospitalized)	97% (30 cases in placebo arm; 0 in vaccine reported but 1 severe per FDA)	94.1%
 Pfizer	BNT162b2 mRNA in lipid nanoparticle	2	Neutralizing Abs; Strong Th1 CD4+, CD8+; protection from challenge (macaques)	~18,600	100%	100% (9 cases in placebo arm; 0 in vaccine- 1 initially severe but not)	95%
 Johnson & Johnson	JNJ-78436725 Non-replicating human adenovirus/DNA	1	Neutralizing Abs; Strong Th1 CD4+ > Th2; CD8+; challenge protection (macaque)	~22,000 US, Latin America, S. Africa	100%	85.4% across 3 sites (7 deaths, 16 hospitalizations, all in placebo arm)	72% US; 61% Latin America; 64% S. Africa (95% B.1.351)
 AstraZeneca	AZD 1222 Non-replicating Chimp Adenovirus-DNA	2	Neutralizing Abs; Strong Th1 CD4+ > Th2; CD8+; protection from challenge (macaques)	~28,588 (UK, SA, US/Peru/Chili)	100%	100% (UK, 15 placebo arm hospitalized, 0 in vaccine; US, 8 severe in placebo, 0 vaccine)	76% US (85% in >65 yrs); 70% UK; S. Africa halted for mild
 NOVAVAX <small>Creating Tomorrow's Vaccines Today</small>	NVX-CoV2373 Spike protein/RBD + Matrix M adjuvant	2	Neutralizing Abs; Strong Th1 CD4 > Th2; macaque challenge protection	8833 (Phase 3 UK; 2b SA); 12.5K (Φ 3)	100%	100% (24 severe placebo in UK/SA/US/MX; 0 vaccine)	90.4% US/MX; 100% severe; 93.2% variants
 Sputnik V	Ad26 and Ad5 adenovirus/DNA	2	NAbs; IFN-γ secretion PMBCs, cellular response	~14964	100%	100% (20 in placebo; 0 vaccine)	91.6%

Company	Platform	Doses	Non-clinical results	# with vaccine (same placebo)	Protection from COVID-19 hospitalization	Efficacy against milder COVID
 BHARAT	Inactivated whole virus	2	Neutralizing Abs; Strong Th1 CD4 responses in phase II trial (Lancet)	11,000 (press release 4/21)	100%	78%
 sinovac	Whole inactivated virion	2	Neutralizing Abs; IFN-gamma assays T cell responses	13,068	100%	72.8%
 SINOPHARM	Whole inactivated virion	2	Neutralizing Abs; IFN-gamma assays T cell responses	13,068	100%	78.1%

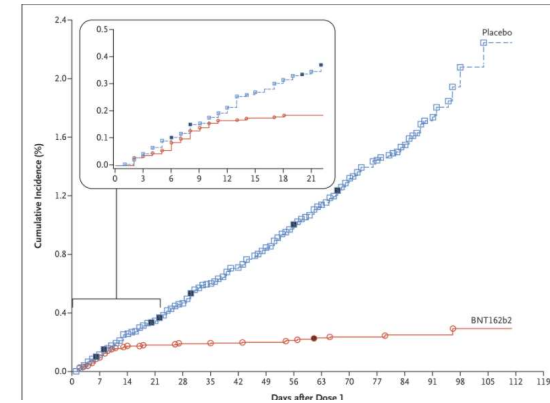
Two mRNA vaccines clinical trials



- 2 shots, 3 weeks apart
- Trial participants: half female, 83% White; 9.9% African America; 28% Hispanic/Latino
- 21% >65 years
- Some risk factors for severe illness: obesity (35%), diabetes 8%; pulmonary disease 8%
- 170 symptomatic COVID-19, 162 in placebo arm and 8 in vaccine arm so 95% effective
- 9 cases of severe disease all in placebo

moderna

- 2 shots, 4 weeks apart
- ~half female, 36.5% of participants communities of color
- 25%, ≥ 65 years of age
- Some risk factors for severe illness, including obesity (mean BMI 29.3)
- 196 symptomatic COVID-19, 185 in placebo arm and 11 in vaccine arm so 94.1% effective
- 30 cases of severe disease in placebo; 1 in vaccine arm



NEJM 2020

Johnson and Johnson 1-dose phase 3 trial

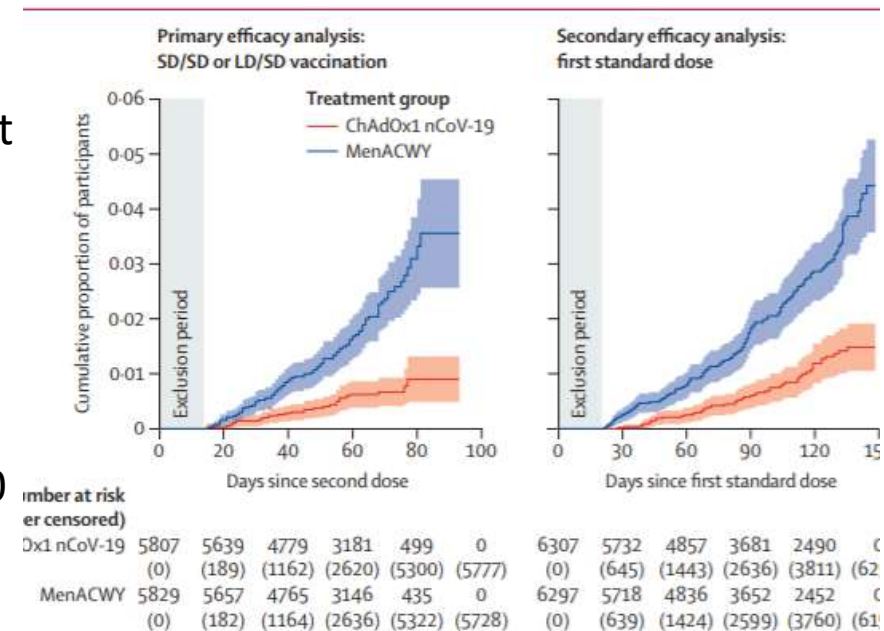
- 43,783 participants, 44% from US, 41% Central and South America, 15% South Africa
- 59% White; 45% Hispanic and/or Latinx; 17.2% AA or African; 9% Native American, 3% Asian
- 41% risk factors for severe illness, e.g. obesity or diabetes
- 486 cases symptomatic COVID-19
- **All hospitalizations (16) and deaths (9) from COVID-19 in placebo arm**
- **High efficacy against variants (95% B.1.351 S. Africa; 69% P1 Brazil) and 85% effective against all severe disease**
- Variable against mild disease (72% U.S., 64% in South Africa, 61% Latin America)

Press release: [Phase 3 ENSEMBLE trial](#); [FDA document](#) February 24, 2021

The Johnson & Johnson logo is displayed within a white circle that has a red border. The logo itself consists of the words "Johnson & Johnson" in a red, cursive script font, set against a solid red rectangular background.

AstraZeneca two Lancet paper results together

- Between April 23 and Nov 4, 2020, 17,177 enrolled
- 619 PCR+ COVID-19 infections, of which 332 met the primary endpoint of symptomatic infection >14 days post dose .
- Primary analysis of overall vaccine efficacy >14 days after the second dose including LD/SD and SD/SD groups 66.7% (57.4%, 74.0%)
- Efficacy after a single dose of vaccine days 22-90 76% (59%, 86%),
- **Severe outcome- 15 severe cases of COVID-19 - all in the placebo group, none in vaccine group**



Will vaccines work against
variants and all against
severe disease?
Short answer: yes

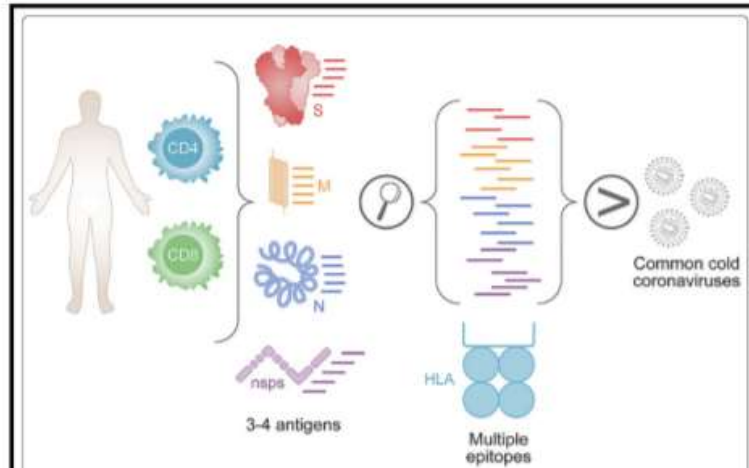
Why T cell response will work against variants? First look at natural infection

Cell Reports
Medicine

Article

Comprehensive analysis of T cell immunodominance and immunoprevalence of SARS-CoV-2 epitopes in COVID-19 cases

Graphical Abstract



Authors

Alison Tarke, John Sidney, Conner K. Kidd, ..., Daniela Weiskopf, Alba Grifoni, Alessandro Sette

Correspondence

agrifoni@lji.org (A.G.), alex@lji.org (A.S.)

In Brief

Tarke et al. show a broad T cell repertoire, suggesting that viral escape of T cell immunity is unlikely. CD4 immunodominant regions correlate with

Broad T cell repertoire (100s of T cells across spike protein) after infection. Means viral escape of T cell-immunity (from both natural infection and vaccination) unlikely, re-infection if happens mild

Then look at T-cell response to variants after vaccines- still intact

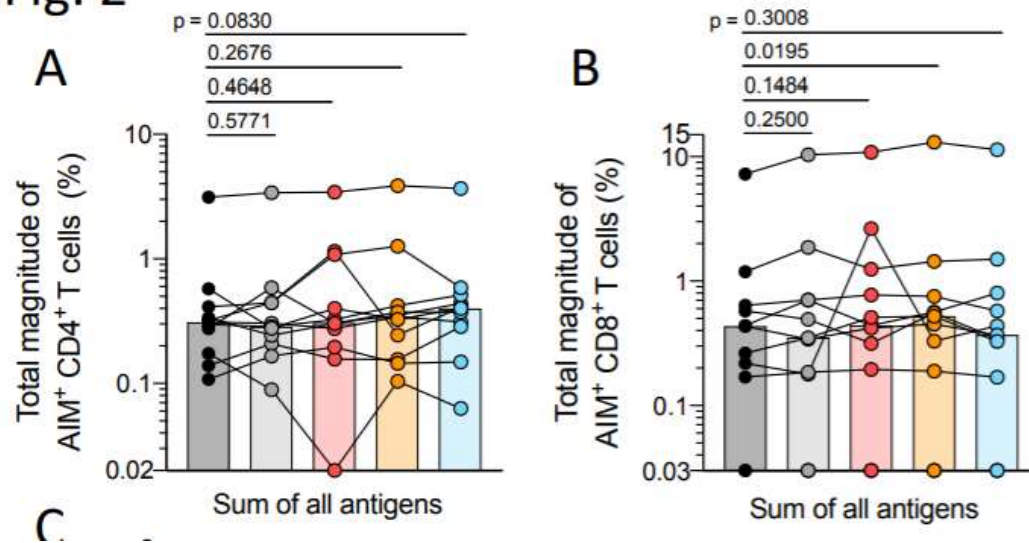
bioRxiv

THE PREPRINT SERVER FOR BIOLOGY

Negligible impact of SARS-CoV-2 variants on CD4+ and CD8+ T cell reactivity in COVID-19 exposed donors and vaccinees.

Alison Tarke, John Sidney, Nils Methot,  Yun Zhang,  Jennifer M Dan, Benjamin Goodwin, Paul Rubiro,

Fig. 2



¹Madhi. NEJM. March 16, 2021

- Looked at SARS-CoV-2-specific CD4+ & CD8+ T cell responses from those with natural infection with non-variant & examined activity against alpha, beta, gamma variants
- T cell reactivity against those variants remained intact if you had natural infection or mRNA vaccination (Pfizer/Moderna)
- **CD4/CD8 responses in South Africa AztraZeneca trial¹ showed 75 out of 87 T cell epitopes in the spike protein remained unaffected by beta variant**

AstraZeneca induces robust T cell responses against serious illness and death

Single vaccination with BNT162b2 or ChAdOx1 in older people induces equivalent antibody generation but enhanced cellular responses after ChAdOx1

Parry H¹, Bruton R¹, Tut G¹, Ali M¹, Stephens C¹, Faustini S¹, Hughes S², Huissoon A^{1,2}, Meade R³

9:10 PM Wed May 5 poseidon01.ssrn.com 82% P1

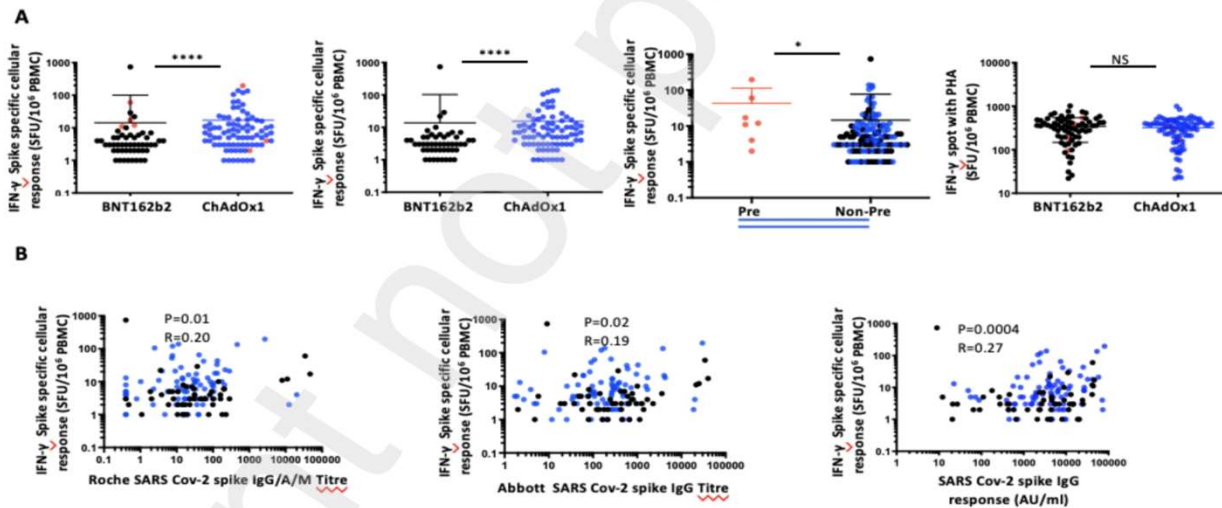


Figure 2: ChAdOx1 induces stronger spike-specific cellular responses after single vaccination in older people

SARS-CoV-2 spike-specific cellular responses after single vaccination with BNT162b2 or ChAdOx1. Assessment is by IFN-γ ELISpot. The total cohort

THE LANCET

Interim findings from first-dose mass COVID-19 vaccination roll-out and COVID-19 hospital admissions in Scotland: a national prospective cohort study

Eleftheria Vasileiou^{}, Colin R Simpson^{*}, Ting Shi^{*}, Steven Kerr^{*}, Utkarsh Agrawal, Ashley Akbari, Stuart Bedston, Jillian Beggs, Declan Bradley, Antony Chuter, Simon de Lusignan, Annamaria P Docherty, David Ford, E D Richard Habbu, Mark Jay, Sriyani Vittal Katikireddi, James Marmot*

- 90% reduction in hospital admissions after just one dose of **AztraZeneca** vaccine in UK
- Same findings as in India in recent wave – just 1 dose protected from severe disease (two doses better)



The NEW ENGLAND
JOURNAL of MEDICINE

Thrombosis and Thrombocytopenia after ChAdOx1 nCoV-19 Vaccination

Nina H. Schultz, M.D., Ph.D., Ingvild H. Sørvoll, M.D.,
Annika E. Michelsen, Ph.D., Ludvig A. Munthe, M.D., Ph.D.,
Fridtjof Lund-Johansen, M.D., Ph.D., Maria T. Ahlen, Ph.D.,
Markus Wiedmann, M.D., Ph.D., Anne-Hege Aamodt, M.D., Ph.D.,
Thor H. Skattør, M.D., Geir E. Tjønnfjord, M.D., Ph.D.,
and Pål A. Holme, M.D., Ph.D.

Thrombotic Thrombocytopenia after ChAdOx1 nCov-19 Vaccination

Andreas Greinacher, M.D., Thomas Thiele, M.D., Theodore E. Warkentin, M.D.,
Karin Weisser, Ph.D., Paul A. Kyrle, M.D., and Sabine Eichinger, M.D.

Pathologic Antibodies to Platelet Factor 4 after ChAdOx1 nCoV-19 Vaccination

Marie Scully, M.D., Deepak Singh, B.Sc., Robert Lown, M.D.,
Anthony Poles, M.D., Tom Solomon, M.D., Marcel Levi, M.D.,
David Goldblatt, M.D., Ph.D., Pavel Kotoucek, M.D., William Thomas, M.D.,
and William Lester, M.D.

SARS-CoV-2 Vaccine–Induced Immune Thrombotic Thrombocytopenia

Douglas B. Cines, M.D., and James B. Bussel, M.D.

- **VERY RARE clotting disorder** after AZ or J&J vaccine, 1-7 in 1 million
- 5-24 days after initial vaccine
- Primarily women < 50
- **About 1 in 1 million incidence**
- Median platelet counts: 20,000-30,000
- Improvement with IVIG, steroids

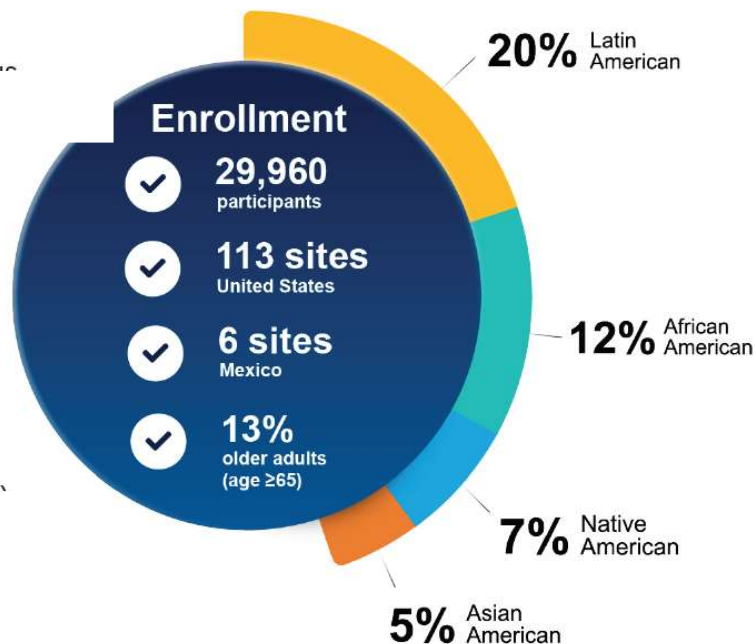
90.4%
 overall efficacy
 (primary endpoint)

100%
 protection against moderate
 & severe disease

93.2%
 efficacy against Variants
 of Interest/Concern

91%
 efficacy in "high-risk"
 populations

Two doses of NVX-CoV2373 vaccine are well-tolerated and show high levels of efficacy



June 14 press release
 Sequenced variants in
 54 out of 77 failures
 Fridge 6 months, room
 temperature during
 transport for 24 hours

	FINAL ANALYSIS	
	NVX-CoV2373 n=17,315	Placebo n=8,142
Total	14	63
Mild	14	49
Moderate	0	10
Severe	0	4
Vaccine Efficacy	90.4% 95% CI: 82.9, 94.6	

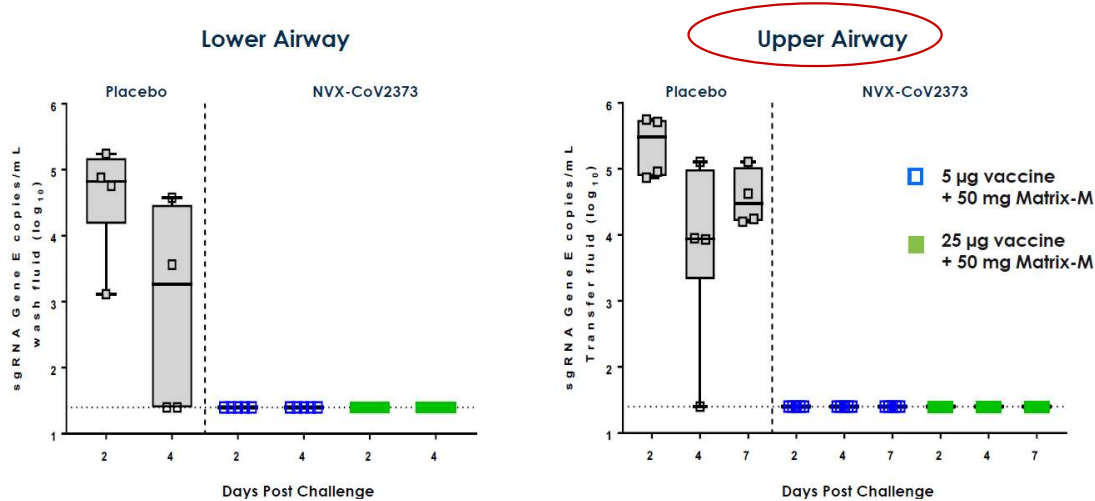
Table 1. Final analysis of PREVENT-19 Phase 3 Trial.

Do vaccines reduce
transmission?

Short answer: yes

Will vaccines halt transmission? Biological plausibility (4 main reasons)

NVX-CoV2373 Protected Lower & Upper Airways in Rhesus Macaques No viral replication observed following Day 38 challenge with WT SARS-CoV-2



4. Challenge experiments with macaques in pre-clinical trials show blocking of viral replication (or no/low viral RNA) in BAL and nasal swabs (Mercado Nature J&J vax, 2020; Guebre-Xabier Vaccine Novavax 2020)

1. IgG antibodies measured in trials found in high levels in nasal mucosa

frontiers in
IMMUNOLOGY

REVIEW ARTICLE
published: 16 July 2013
doi: 10.3389/fimmu.2013.00200

Antibodies and their receptors: different potential roles in mucosal defense

2. Systemic vaccines induce IgA (mucosal immunoglobulin) and recent study shows mRNA COVID-19 vaccines induce IgA



Clinical and Vaccine
Immunology

Parenteral Vaccination Can Be an Effective Means of Inducing Protective Mucosal Responses

BIOLOGICAL SCIENCES - ARTICLE

SARS-CoV-2 mRNA vaccines induce a robust germinal centre reaction in humans

3. Monoclonal antibodies hasten viral clearance from airways

ORIGINAL ARTICLE

SARS-CoV-2 Neutralizing Antibody
LY-CoV555 in Outpatients with Covid-19

Studies to date that showed COVID-19 vaccines reduce asymptomatic infection (transmission)

Setting	% reduction in asymptomatic infection or transmission	Reference
Healthcare workers in England	85%	Hall Lancet , April 23, 2021
Healthcare workers in Israel	75% and 86%	Amit, Lancet , March 6; Angel JAMA May 6
Patients in Mayo Clinic health system	88.7%	Pawlowski medRxiv , February 27, 2021
Israel Ministry of Health (nationwide)	94% (largest study)	Pfizer press release , March 11, 2021 (and Goldberg Medrxiv , April 24, 2021)
Israel general population (Pfizer)	90%	Dagan NEJM , February 24, 2021
Pre-surgical patients in Mayo Clinic system swabbed asymptotically	80%	Tande Clin Inf Dis , March 10, 2021
Healthcare workers in Cambridge University Hospitals	75%	Weekes Authorea , February 24, 2021
First-line responders and HCWs in US	90%	Thompson A. MMWR , March 30, 2021
Israel population (>16) with children unvaccinated	For every 20-point increase in adult vaccination, rates of kids testing positive halves	Milman O. Medrxiv . March 31, 2021
Long-term care facility, Spain	90%	Salazar P. Medrxiv . April 13, 2021
Nursing homes, U.S. (two studies)	100%	Cavanaugh MMWR , April 21 and Terran MMWR , April 30

Nasal viral load values most important determinant of transmissibility ([Lancet study](#), Spain); Viral loads from post-vaccination exposures are low and likely noninfectious per CT values (use [rapid antigen tests](#) after vaccination if test symptomatic or incorporate CT)

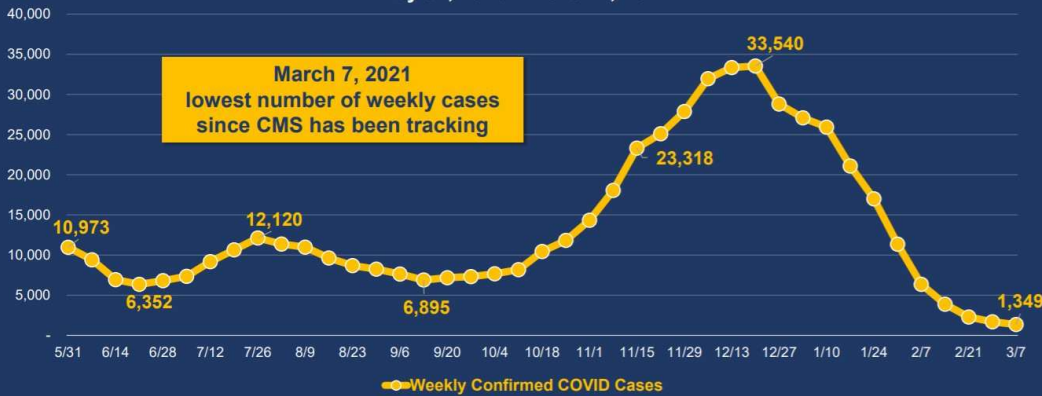
How are vaccines working
in real-world setting?

This is what mass vaccinated settings look like in the U.S.

Nursing homes

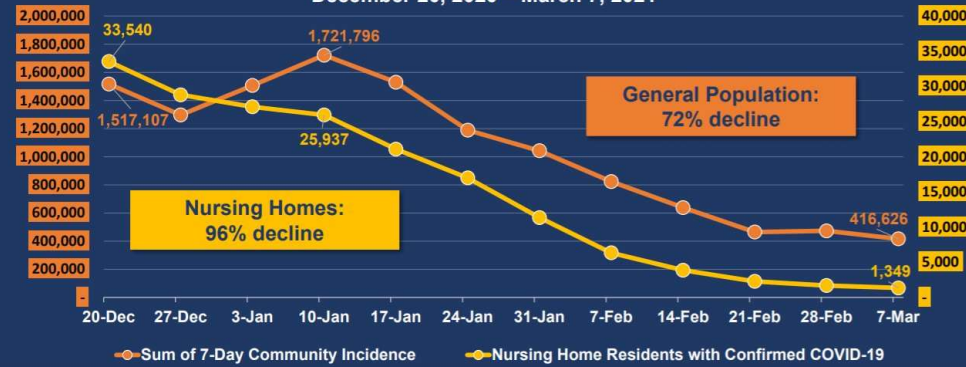
NEW COVID CASES AMONG NURSING HOME RESIDENTS

May 31, 2020 – March 7, 2021



NURSING HOME CASES DECLINING AT FASTER RATE THAN COMMUNITY CASES

December 20, 2020 – March 7, 2021



March 30, CMA data



March 23, 2021

CORRESPONDENCE

SARS-CoV-2 Infection after Vaccination in Health Care Workers in California

UCSD and UCLA began vaccinating HCWs December 16, 2020
Weekly asymptomatic testing at UCSD
Optional asymptomatic testing program at UCLA

379 Vaccinated HCWs tested positive between Dec 16 – Feb 9

- 71% tested positive within the first 2 weeks after 1st dose
7 out of 14,990 HCWs who were > 2 weeks after 2nd dose tested positive (0.05%)

Keehner et al, NEJM 2021; Daniel et al, NEJM 2021

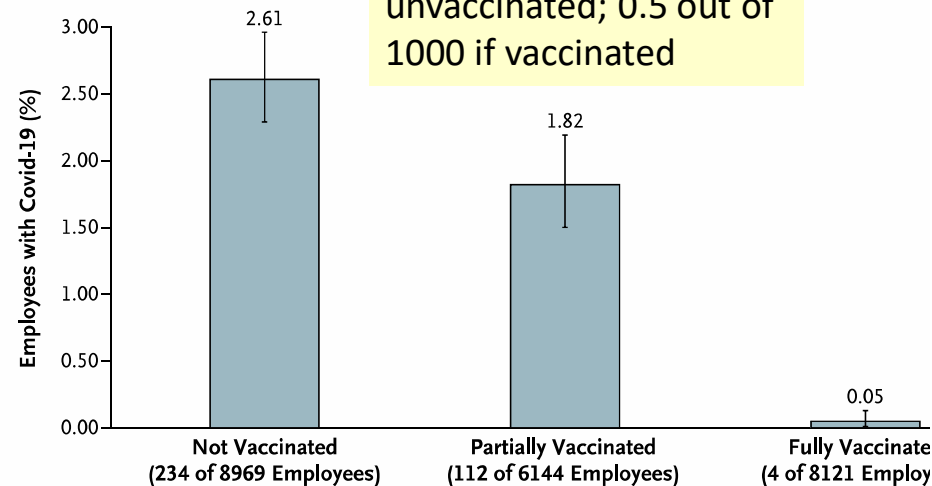
CORRESPONDENCE

Early Evidence of the Effect of SARS-CoV-2 Vaccine at One Medical Center

Evaluation of SARS-CoV-2 infections at UT Southwestern December 15 – January 28 by vaccination status

- 4/8121 fully vaccinated employees (0.05%)

New SARS-CoV-2 Infections



To put simply, 26 out of 1000 infections if unvaccinated; 0.5 out of 1000 if vaccinated



Morbidity and Mortality Weekly Report (*MMWR*)

CDC



Interim Estimates of Vaccine Effectiveness of BNT162b2 and mRNA-1273 COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Health Care Personnel, First Responders, and Other Essential and Frontline Workers — Eight U.S. Locations, December 2020–March 2021

Early Release / March 29, 2021 / 70

To put simply, 161 COVID infections out of 1000 unvaccinated; 1 out of 1000 if vaccinated



April 1 press release, 100% effectiveness in real-world against severe disease even against B.1.351

Pfizer and BioNTech Confirm High Efficacy and No Serious Safety Concerns Through Up to Six Months Following Second Dose in Updated Topline Analysis of Landmark COVID-19 Vaccine Study

- *Analysis of 927 confirmed symptomatic cases of COVID-19 demonstrates BNT162b2 is highly effective with 91.3% vaccine efficacy observed against COVID-19, measured seven days through up to six months after the second dose*
- *Vaccine was 100% effective in preventing severe disease as defined by the U.S. Centers for Disease Control and Prevention and 95.3% effective in preventing severe disease as defined by the U.S. Food and Drug Administration*
- *Vaccine was 100% effective in preventing COVID-19 cases in South Africa, where the B.1.351 lineage is prevalent*
- *Vaccine safety now evaluated in more than 44,000 participants 16 years of age and older, with more than 12,000 vaccinated participants having at least six months follow-up after their second dose*

Mayo
Clinic
HCWs
Florida,
Minnesota,
AZ

ACCEPTED MANUSCRIPT

Effectiveness of mRNA COVID-19 vaccines against SARS-CoV-2 infection in a cohort of healthcare personnel

Melanie D Swift , Laura E Breeher, Aaron J Tande, Christopher P Tommas
Caitlin M Hainy, Haitao Chu, PhD, MD, M Hassan Murad, Elie F Berbari,
Abinash Virk

Clinical Infectious Diseases, ciab361, <https://doi.org/10.1093/cid/ciab361>

Published: 26 April 2021 **Article history** ▼

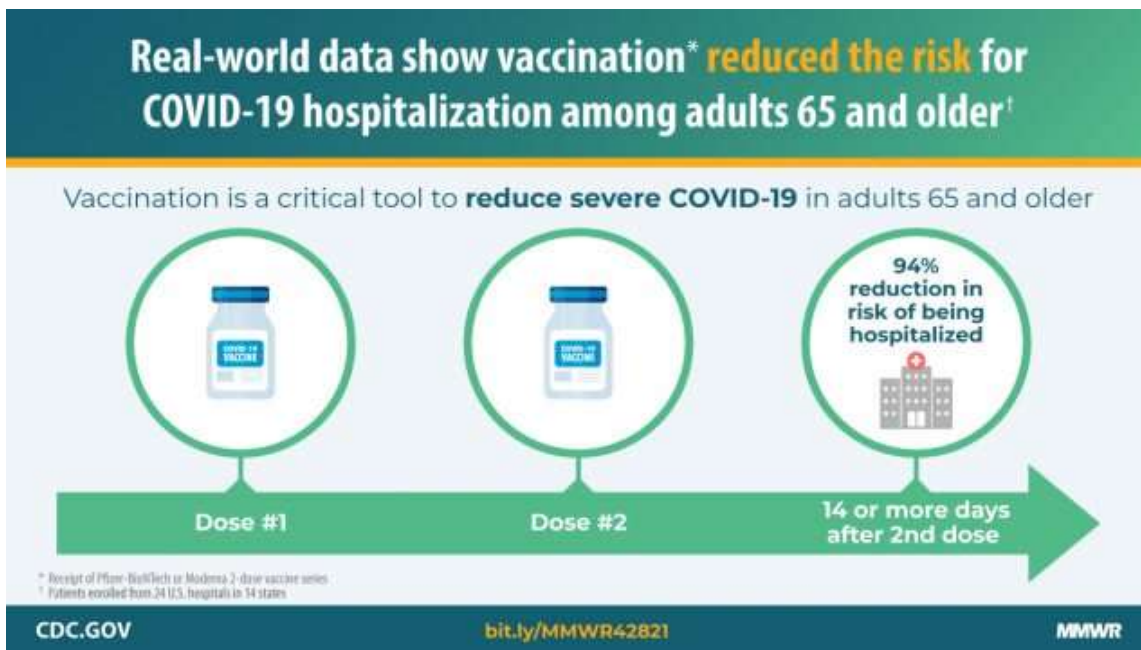
Unvaccinated cohort
23,931
2-dose vax cohort
44,011
(Moderna/Pfizer)

- 96.8% effectiveness for Pfizer vaccine; 98.6% effectiveness for Moderna in real-world cohort (for both disease & asymptomatic infection)

To put simply, 36 symptomatic COVID infections out of 1000 unvaccinated; 0.4 out of 1000 if vaccinated (42 symptomatic+ asymptomatic out of 1000 unvaccinated; 0.7 all infections out of 1000 if vaccinated)

Effectiveness of Pfizer-BioNTech and Moderna Vaccines Against COVID-19 Among Hospitalized Adults Aged ≥ 65 Years — United States, January–March 2021

Early Release / April 28, 2021 / 70



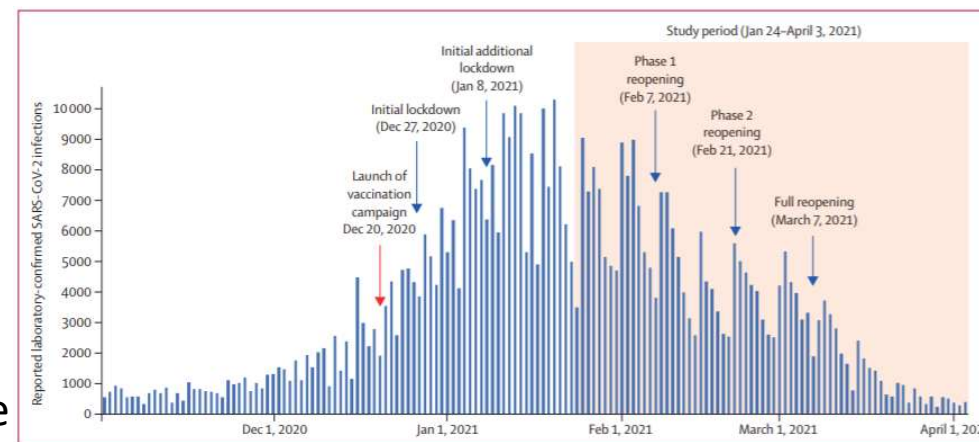
- Examined respiratory illness admissions among adults >65 from January 1, 2021–March 26, 2021 in 24 hospitals across 14 states as vaccines rolled out in this population
- Knew vaccine status and admissions for COVID-19 dropped by 64% after 1st dose and 94% after 2nd dose within this vulnerable group of older patients
- Defanging the virus in the population most at risk of severe illness in real-time during times of high circulating virus in the US (January-March 2021)

Cases continue to decline in Israel with mass vax despite opening

- More data on the real-world effectiveness of the vaccine despite B117 being 95% of SARS-CoV-2 infections during Israel roll-out Jan 24-April 3, 2021
- Pfizer vaccine 95% effective overall against symptomatic COVID-19
- 92% effective in preventing asymptomatic infection
- 98% effective against hospitalizations, 97% effective against death across all age groups even ≥ 85 yrs
- Despite full opening March 2, 2021, cases continue to decline with fastest mass vaccination campaign on planet (and only >16 years vaccinated)

Impact and effectiveness of mRNA BNT162b2 vaccine against SARS-CoV-2 infections and COVID-19 cases, hospitalisations, and deaths following a nationwide vaccination campaign in Israel: an observational study using national surveillance data

THE LANCET

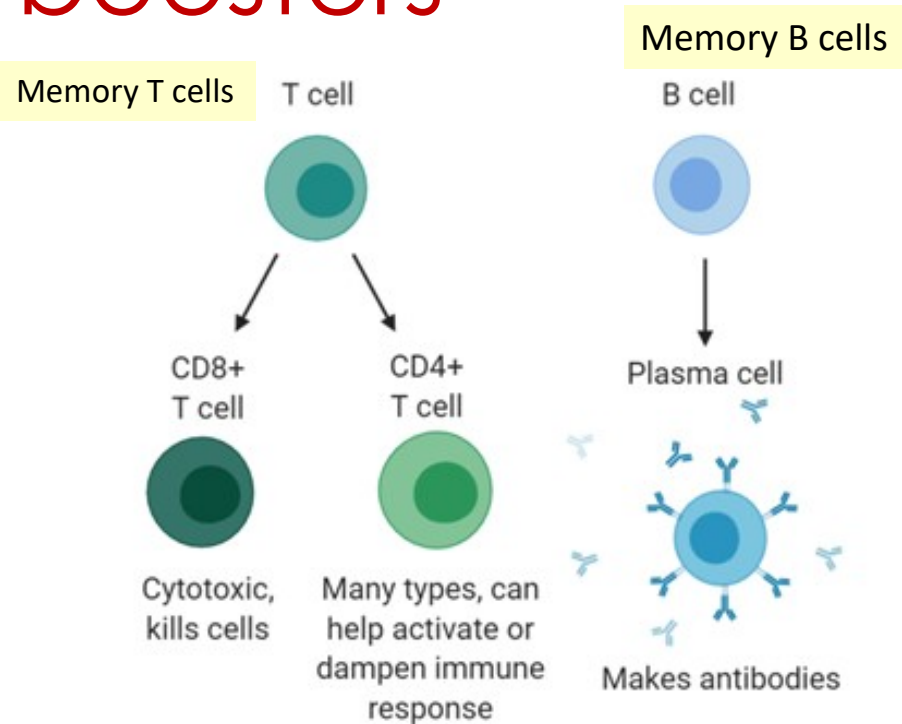


CDC breakthrough data



- CDC keeping track of [breakthrough infections](#) in U.S
- Out of >135 million Americans who are fully vaccinated against COVID-19
 - 2473 hospitalized breakthroughs (0.001%)
 - Deaths 0.0001% for COVID-19
- Not a single breakthrough infection has been reported to have transmitted

7 reasons don't think we will need boosters

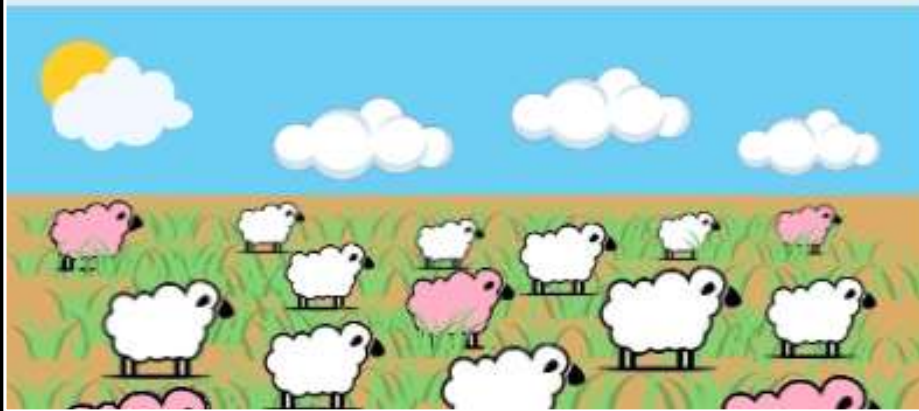


In the bank!

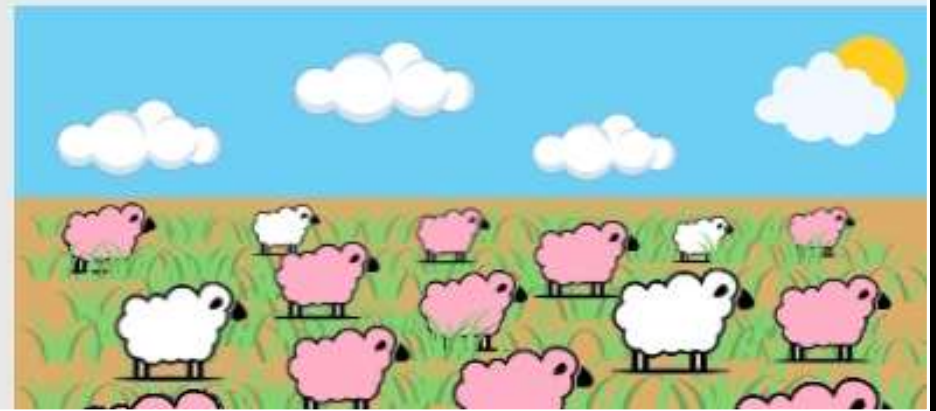
- 1. Memory B cells can be triggered to produce neutralizing antibodies against an [infection 90 years later!](#)
- 2. Memory B cells generated by the COVID-19 mRNA vaccines (study did [lymph node biopsies](#)) and [natural infection](#)
- 3. Memory T cells generated by [natural infections](#)
- 4. T cell immunity [long-lasting](#) (measles vaccine 34 years & counting)
- 5. T cells work against variants
- 6. SARS-CoV (first SARS) – T cell immunity [17 years later](#) (pandemic 2003)
- 7. Coronaviruses don't mutate that fast (unlike HIV, influenza), [strong proofreading mechanism](#), only when transmission high

HERD IMMUNITY

BEFORE







AFTER

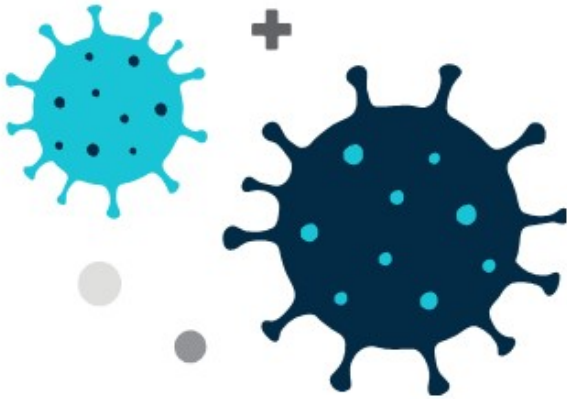


Herd immunity: Form of indirect protection from an infection that occurs when a significant % of population has become immune (through vaccine or previous infection), so children, unvaccinated protected (does not mean eradication)

✕ New names proposed for Covid variants < >

Country/region	Scientific name	WHO name
 Kent, UK	B.1.1.7	Alpha
 South Africa	B.1.351	Beta
 Brazil	P.1	Gamma
 India	B.1.617.2	Delta

Summary



- Vaccine trials show amazing efficacy and safety
- All vaccines reduce severe disease significantly, likely due to T-cell response
- Vaccines decrease transmission
- Real world effectiveness even better than efficacy
- Variants can be managed
- 1st dose FIRST of AZ and J&J effective
- Rare safety concerns – much more rare than COVID itself