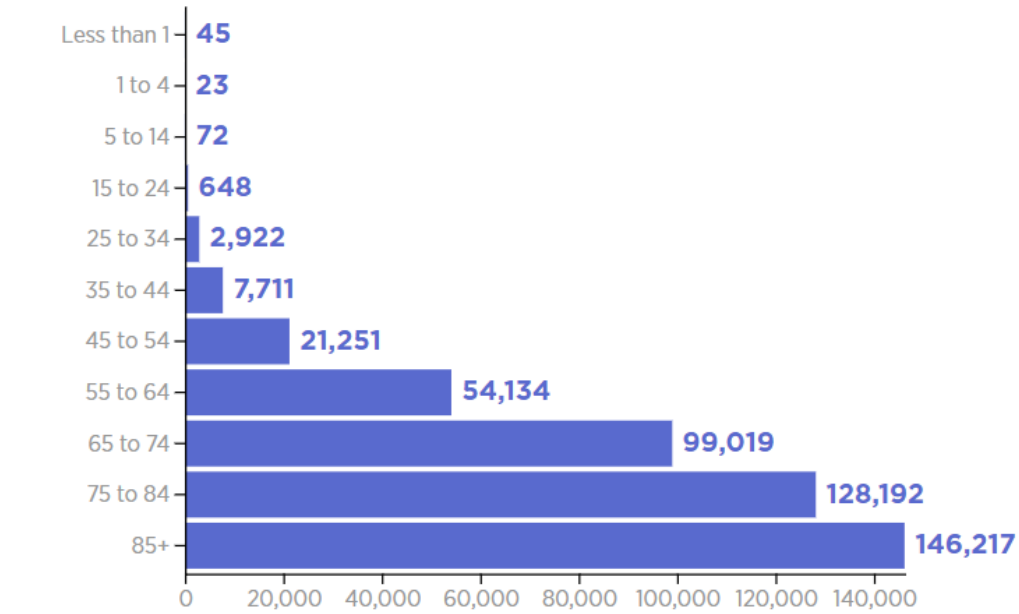
COVID-19 Deaths by Age

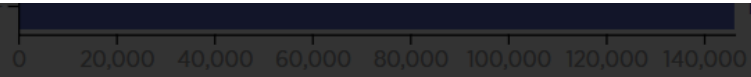
Updated February 17, 2021

According to data from the Centers for Disease Control and Prevention, COVID-19 is deadliest among older populations. In fact, through February 17, 93 percent of COVID-19 deaths nationwide have occurred among those ages 55 or older. Only 0.2 percent were younger than 25. This trend can also be found on the state level.

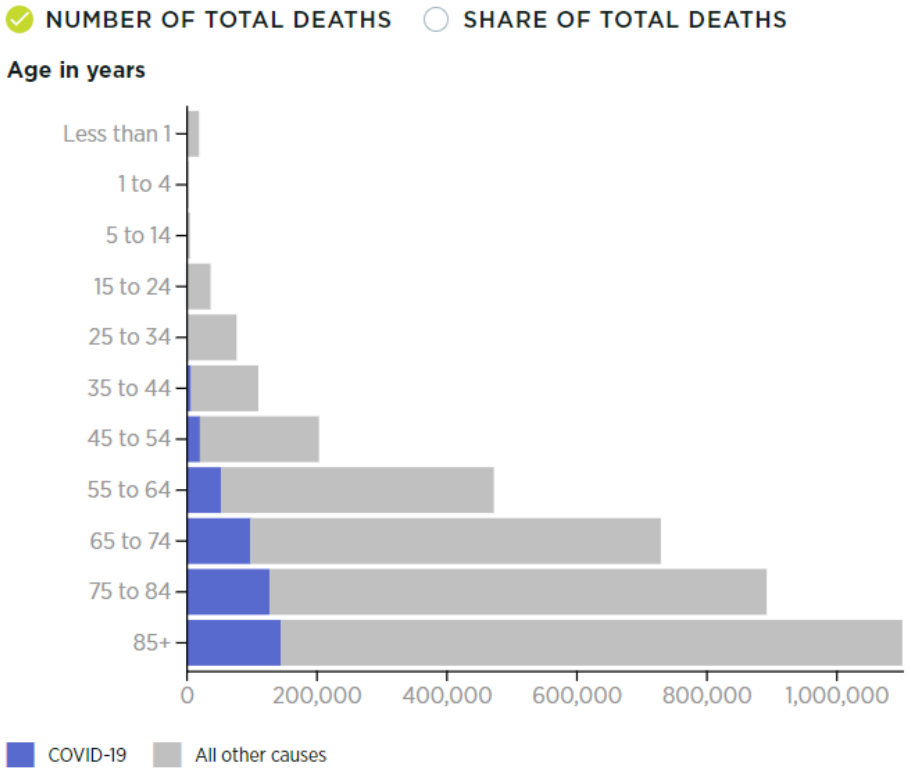
Select state

United States





CDC data also show that Americans, regardless of age group, are far more likely to die of something other than COVID-19. Even among those in the most heavily impacted age group (85 and older), only 13.3 percent of all deaths since February 2020 were due to COVID-19.



* Not included is a value between 1 and 9 that has been suppressed by the CDC in accordance with NCHS confidentiality standards.

SOURCES: Centers for Disease Control and Prevention, "Provisional COVID-19 Death Counts by Sex, Age, and State".

DESIGN AND DEVELOPMENT: Graphic produced by John W. Fleming and Jay Simon.

Centers for Disease Control and Prevention

COVID-19

Risk for COVID-19 Infection, Hospitalization, and Death By Age Group

Updated July 19, 2021 Print

Rate ratios compared to 18- to 29-year-olds[1]

	0-4 years old	5-17 years old	18-29 years old	30-39 years old	40-49 years old	50-64 years old	65-74 years old	75-84 years old	85+ years old
Cases[2]	<1x	1x	Reference group	1x	1x	1x	1x	1x	1x
Hospitalization[3]	<1x	<1x	Reference group	2x	2x	4x	6x	9x	15x
Death[4]	<1x	<1x	Reference group	4x	10x	35x	95x	230x	600x

All rates are relative to the 18- to 29-year-old age category. This group was selected as the reference group because it has accounted for the largest cumulative number of COVID-19 cases compared to other age groups. Sample interpretation: Compared with 18- to 29-year-olds, the rate of death is four times higher in 30- to 39-year-olds, and 600 times higher in those who are 85 years and older. (In the table, a rate of 1x indicates no difference compared to the 18- to 29-year-old age category.)

References

[1] Rates are expressed as whole numbers, with values less than 10 rounded to the nearest integer, two-digit numbers rounded to nearest multiple of five, and numbers greater than 100 rounded to two significant digits.

[2] Includes all cases reported by state and territorial jurisdictions (accessed on July 12, 2021). The denominators used to calculate rates were based on the 2019 Vintage population .

[3] Includes all hospitalizations reported through COVID-NET (from March 1, 2020 through July 3, 2021, accessed on July 12, 2021). Rates were standardized to the 2020 US standard COVID-NET catchment population.

[4] Includes all deaths in National Center for Health Statistics (NCHS) provisional death counts (accessed on July 12, 2021). The denominators used to calculate rates were based on the 2019 Vintage population.

Last Updated July 19, 2021

Blood Pressure Medicines for Five Years to Prevent Death, Heart Attacks, and Strokes

125 for prevented death

In Summary, for those who took anti-hypertensives:

Benefits in NNT

- 1 in 125 were helped (prevented death)
- 1 in 67 were helped (prevented stroke)
- 1 in 100 were helped (prevented heart attack*)

Harms in NNT

- 1 in 10 were harmed (medication side effects, stopping the drug)

*fatal and non-fatal myocardial infarction and sudden or rapid cardiac death

View As: NNT %

Details for this Review | Further References

Source:

- Wright JM, Musini VM. First-line drugs for hypertension. Cochrane Database Syst Rev. 2009 Jul 8;(3):CD001841. doi: 10.1002/14651858.CD001841.pub2.
- ACCORD Study Group. Effects of intensive blood-pressure control in type 2 diabetes mellitus. N Engl J Med. 2010 Apr 29;362(17):1575-85.
- Diao D, Wright JM, Cundiff DK, Gueyffier F. Pharmacotherapy for mild hypertension. Cochrane Database of Syst Rev. 2012, Issue 8. Art. No.: CD006742. DOI: 10.1002/14651858.CD006742.pub2.
- Yusuf S, Lessem J, Jha P, et al. Primary and secondary prevention of myocardial infarction and strokes: an update of randomly allocated controlled trials. J Hypertens Suppl; 1993 Jun;11(4):S61-73.
- Carlberg B, Samuelsson O, Lindholm LH. Atenolol in hypertension: is it a wise choice? Lancet. 2004 Nov 6-12;364(9446):1684-9.
- Snow V, et al. The evidence base for tight blood pressure control in the management of type 2 diabetes mellitus. Ann Intern Med 2003 Apr 1; 138:587-92
- Arguedas JA, Perez MI, Wright JM. Treatment blood pressure targets for hypertension. Cochrane Data-base Syst Rev. 2009 Jul 8;(3):CD004349.
- Major cardiovascular events in hypertensive patients randomized to doxazosin vs chlorthalidone: the anti-hypertensive and lipid-lowering treatment to prevent heart attack trial (ALLHAT). ALLHAT Collaborative Re-search Group. JAMA. 2000 Apr 19;283(15):1967-75.
- Parving HH, Brenner BM, McMurray JJ, et al. ALTITUDE Investigators. Cardiorenal end points in a trial of aliskiren for type 2 diabetes. N Engl J Med. 2012 Dec 6;367(23):2204-13.
- Effects of treatment on morbidity in hypertension. II. Results in patients with diastolic blood pressure av-eraging 90 through 114 mm Hg. JAMA. 1970 Aug 17;213(7):1143-52.
- Effects of treatment on morbidity in hypertension. Results in patients with diastolic blood pressures av-eraging 115 through 129 mm Hg. JAMA. 1967 Dec 11;202(11):1028-34.
- Tinetti ME, Han L, Lee DS, et al. Antihypertensive medications and serious fall injuries in a nationally representative sample of older adults. JAMA Intern Med. 2014 Apr;174(4):588-95.

Efficacy Endpoints: Mortality, heart attack, stroke

Harm Endpoints: Adverse medication effects leading to drug stoppage

Narrative: Hypertension (elevated blood pressure) is associated with an increased risk of cardiovascular events and mortality. However, numerous studies have shown a number of medications when given to reduce BP can reduce the risk of developing cardiovascular problems like heart attacks

and strokes.

The data reviewed here are partially based on a Cochrane review, a meta-analysis of trials comparing antihypertensive medicines to placebo.1 The NNTs listed above assume that the patient is an average person enrolled in trials of thiazide diuretic medicines, a common first line drug class.

This is important because while the relative impact of different drug classes was similar, there were differences. For instance thiazide diuretics and 'ACE inhibitors' (ACEI) demonstrated a statistically significant reduction in overall mortality, total stroke, and most other cardiovascular outcomes, whereas calcium channel blockers (CCBs) and beta-blockers only showed a statistically significant reduction in total stroke and a limited number of cardiovascular outcomes. Neither CCBs nor beta-blockers statistically reduced deaths.(see Table 2 below) These differences may reflect, at least for the CCBs, the smaller numbers of research subjects evaluated in the meta-analysis.

What these differences suggest is that antihypertensive medicines are effective for reducing the risk of cardiovascular problems, but possibly to varying degrees. Their impact is therefore complex and multifaceted, and distilling this into a single number is not as valuable as individualizing. Therefore we are including Table 1 that offers NNTs based on demographic variations. We suggest using a calculator to customize even further, like this one. As always for NNTs, these numbers are rough estimates.

Table 1. **Numbers-needed-to-treat to avoid the listed cardiovascular outcomes**

5 years, systolic BP 170*	Heart attacks (fatal and nonfatal)	Strokes
Male 50 y/o	238	227
Female 50 y/o	568	310
Male 65 y/o	101	88
Female 65 y/o	294	120

Data use the Framingham calculator to estimate baseline risks of heart attack and stroke, and apply relative reductions from trials.(3-7, see Table 2) Calculator inputs for base-case data: *Non smoker, no diabetes, total cholesterol 200mg/dl, HDL 50 mg/dl

Caveats: These are data estimates from randomized trials, which tend to represent a best case scenario for a drug's benefits. In addition, the Framingham database over-estimates CVD risk for some populations so these benefits are, if anything, a further overestimate. However, these estimates are based on five years of treatment, and the number of heart attacks and strokes often increases linearly over time. If true for any given individual this would mean that after ten years of treatment each of the NNT numbers would be halved, and halved again after 15 years, and so on.

It is also notable that not all drugs that lower BP lead to benefits. Atenolol,2 doxazosin,3 and aliskiren4 all lower blood pressure but large RCTs have

shown no heart attack, stroke, or death benefit from these agents when used to lower blood pressure. Moreover, evidence for lowering BP below 150 (systolic) with any agent has not been beneficial in trials, but does increase harms (see our other hypertension NNT review).

Importantly, the two earliest trials of blood pressure management[5] [6] treated patients whose average blood pressures were ~190/120 and 164/105 respectively, and demonstrated impressive and important benefits. These findings support data suggesting that the higher the blood pressure and the higher the risk, the better the NNT. This is evident in our numbers. Note, for instance, that our estimated overall NNTs (top of the page) are more favorable than the NNTs in Table 1. This is likely because patients in early thiazide trials were at higher risk, often due to existing heart disease. The Framingham calculator, which we used for calculations in Table 1, was developed for relatively healthy people and therefore assumes that patients have a lower risk at baseline than those in the thiazide trials.

Harms of BP medications are very real, but not as well documented in trials as benefits. Roughly 10% stop a drug due to intolerability (NNH* 10) and types of side effects vary between antihypertensive classes, including some that can be severe (angioedema, syncope, arrhythmias, electrolyte disturbances, etc.). Many of these side effects are dose related. Moreover, there is increasing documentation of a long held suspicion, namely that antihypertensives may increase fall risk and therefore risk of major injury, particularly for elderly patients.[7] As always, in addition to side effects there is the inconvenience of, among many other issues, blood pressure measurement, dose and drug alterations, cost, and pill burden. These concerns are not addressed in trials but may impact quality of life in various ways and degrees.

Author: James McCormack, MD; Peer-Reviewed by Rita Redburg, MD and Barbara Roberts, MD

Published/Updated: July 21, 2014

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Thrombolytics Given for Major Heart Attack (STEMI)

43 for mortality

In Summary, for those who took the thrombolytics:

Benefits in NNT

- 1 in 43 were helped (life saved, given within 6 hours)
- 1 in 63 were helped (life saved, given between 6-12 hours)
- 1 in 200 were helped (life saved, given between 12-24 hours)

Harms in NNT

- 1 in 143 were harmed (major bleeding episode)
- 1 in 250 were harmed (hemorrhagic stroke)

View As: NNT %

Details for this Review

Source: Indications for fibrinolytic therapy in suspected acute myocardial infarction: collaborative overview of early mortality and major morbidity results from all randomized trials of more than 1000 patients. Lancet 1994; 343:311-22.

Efficacy Endpoints: Death at 1 month following acute heart attack (STEMI)

Harm Endpoints: Major bleeding (brain bleeding or bleeding requiring transfusion).

Narrative: This systematic review includes 9 trials and 58600 patients randomized to receive a fibrinolytic drug or placebo for suspected heart attack. Patients were enrolled based on strong suspicion of heart attack by the treating doctor. Most (76%) were men, and most had ST-elevations on their EKG (68%). There was an overall mortality benefit of 1.9% (9.6 vs. 11.5) in favor of fibrinolytics. There was also a 0.4% increase in hemorrhagic stroke (1.2 vs. 0.8). Benefit was demonstrably greater with earlier treatment, with the most benefit apparent for treatment given within a few hours of symptom onset. Benefits were smaller and less statistically robust in the 12 to 24 hour period. Patients with ST-depressions were harmed rather than helped.

Caveats: There was no gold standard to prove STEMI (e.g. catheterization or biomarkers) and some patients had normal EKG's (5%). There is heterogeneity between trials, including inconsistency in the use of aspirin. However, groups appear to have been randomized well and treated equally with respect to other interventions.

Author: Joshua Quaas, MD

Published/Updated: January 19, 2010

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Past vaccine disasters show why rushing a coronavirus vaccine now would be 'colossally stupid'

By Jen Christensen, CNN
Updated 11:34 AM ET, Tue September 1, 2020

(CNN) Vaccine experts are warning the federal government against rushing out a coronavirus vaccine before testing has shown it's both safe and effective. Decades of history show why they're right.

FDA signals vaccine could green light early

Their concern that the FDA may be moving too quickly heightened when FDA Commissioner Dr. Steven Hahn told the Financial Times that his agency could consider an emergency use authorization (EUA) for a Covid-19 vaccine before late stage clinical trials are complete if the data show strong enough evidence it would protect people.

Covid-19 vaccine will likely require 2 doses 02:16

The commissioner has the authority to allow unapproved medical products to be used in an emergency when there are no adequate or approved alternatives. An EUA is not the same as full approval and it can be withdrawn.

That's what happened with hydroxychloroquine and chloroquine. The FDA granted an EUA to the drugs -- much praised by President Donald Trump -- on March 28. It subsequently revoked its EUA in June after studies showed they were not effective and could also potentially cause serious heart problems.

Vaccine approval

For a vaccine to be FDA approved, scientists must gather enough data through clinical trials in large numbers of volunteers to prove it is safe and effective at protecting people against a disease. Once the data is collected, FDA advisers usually spend months considering it.

Optimism grows for emergency coronavirus vaccine use in 2020 02:14

An EUA is much quicker. Only once before has the FDA given a vaccine this lesser standard approval of an EUA, but it was in an unusual circumstance. Soldiers had sued, claiming a mandatory anthrax vaccine made them sick, and a judge put a hold on the program. The Department of Defense asked for an EUA that then overrode the court ruling in 2005, so it could continue vaccinating military personnel -- this time on a voluntary basis.

Otherwise, vaccines have had to go through the entire clinical trial process and FDA approval process, which can take months or years.

When the vaccine making process has been rushed, there have been bad outcomes.

The Cutter incident

On April 12, 1955 the government announced the first vaccine to protect kids against polio. Within days, labs had made thousands of lots of the vaccine. Batches made by one company, Cutter Labs, accidentally contained live polio virus and it caused an outbreak.

More than 200,000 children got the polio vaccine, but within days the government had to abandon the program.

The US just topped 6 million coronavirus cases in about 7 months. What happens next is up to you, Birx says

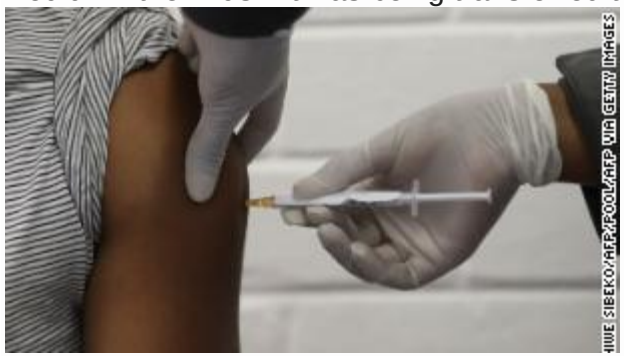
"Forty thousand kids got polio. Some had low levels, a couple hundred were left with paralysis, and about 10 died," said Dr. Howard Markel, a pediatrician, distinguished professor, and director of the Center for the History of Medicine at the University of Michigan. The government suspended the vaccination program until it could determine what went wrong.

Monkey trouble

However, increased oversight failed to discover another problem with the polio vaccine.

From 1955 to 1963, between 10% and 30% of polio vaccines were contaminated with simian virus 40 (SV40).

"The way they would grow the virus was on monkey tissues. These rhesus macaques were imported from India, tens of thousands of them," medical anthropologist S. Lochlann Jain said. "They were gang caged and in those conditions, the ones that didn't die on the journey, many got sick, and the viruses spread quickly," added Jain, who taught a history of vaccines course at Stanford and is working on a publication about the incident. Scientists wrongly thought the formaldehyde they used would kill the virus. "It was being transferred to millions of Americans," Jain said.

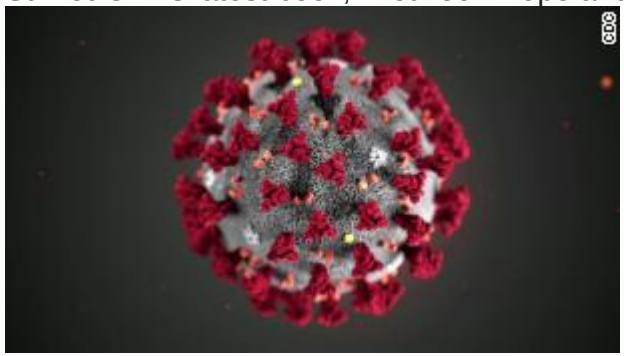


Experts call for independent commission separate from FDA to review Covid-19 vaccines

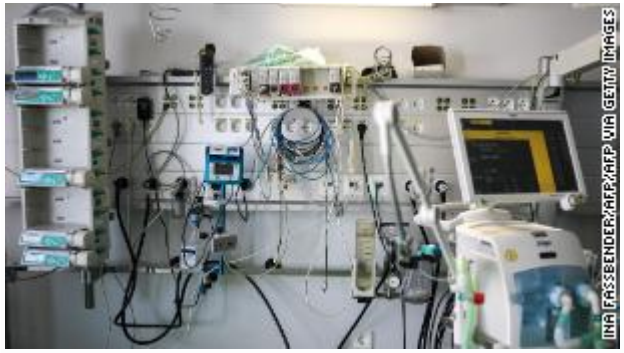
"Many believe this issue wasn't adequately pursued," Jain said. Some studies showed a possible link between the virus and cancer. The US Centers for Disease Control website, however, said most studies are "reassuring" and find no link.
No current vaccines contain SV40 virus, the CDC says, and there's no evidence the contamination harmed anyone.

The epidemic that never was

In 1976, scientists predicted a pandemic of a new strain of influenza called swine flu. More than 40 years later, some historians call it "flu epidemic that never was."
"President Ford was basically told by his advisers, that look, we have a pandemic flu coming called swine flu that may be as bad as Spanish flu," said Michael Kinch, a professor of radiation oncology in the school of medicine at Washington University in St. Louis. His latest book, "Between Hope and Fear," explores the history of vaccines.



What you need to know about coronavirus on Monday, August 31
"Ford was being cajoled to put forward a vaccine that was hastily put together. When you have a brand new strain situation like that, they had to do it on the fly," Kinch said.
Ford made the decision to make the immunization compulsory.
The government launched the program in about seven months and 40 million people got vaccinated against swine flu, according to the CDC. That vaccination campaign was later linked to cases of a neurological disorder called Guillain-Barre syndrome, which can develop after an infection or, rarely, after vaccination with a live vaccine.
"Unfortunately, due to that vaccine, and the fact that it was done so hastily, there were a few hundred cases of Guillain-Barre, although it's not definitive that they were linked," Kinch said.



We're only just beginning to learn how Covid-19 affects the brain

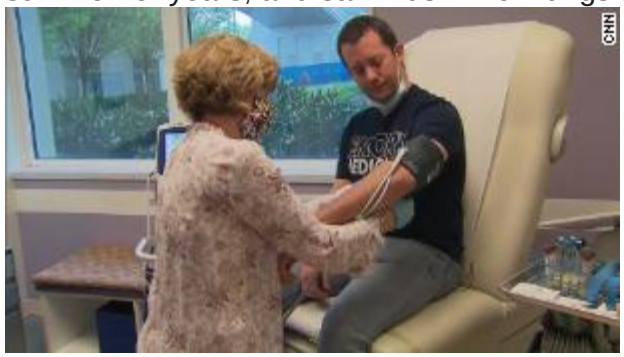
The CDC said the increased risk was about 1 additional case of Gullain-Barre for every 100,000 people who got the swine flu vaccine. Due to this small association, the government stopped the program to investigate.

"It was kind of a fiasco," Markel said. "The good news is that there never was an epidemic of swine flu. So we were safe, but that shows you what could happen."

Growing distrust in the US

It took several incidents for people to start distrusting vaccines. Even after thousands of kids got sick from the first polio vaccine in 1955, when the program restarted, parents made sure their children got vaccinated. They had clear memories of epidemics that paralyzed between 13,000 and 20,000 children every year. Some were so profoundly paralyzed that they could not even breathe easily on their own, and relied on machines called iron lungs to help them breathe.

"Parents were pushing their kids to get to the head of the line to get the polio vaccine, because they had seen epidemics every summer for years, and saw kids in iron lungs and they were terrified," Markel said.



He signed up for a coronavirus vaccine trial using a method that's never been used in humans. Here's why.

Markel said people's attitudes started to change between 1955 and the problematic 1976 swine flu vaccination project.
"You've got civil rights, when people see the cops beating the hell out of people on TV. You've got the Vietnam War where people start to get disgusted with the killing. You've got Watergate when the president is literally lying through his teeth," Markel said. "That led to a real distrust of authorities and federal government, and it extended to doctors and scientists. And, that's only progressed as time has gone along."

A 'colossally stupid' move

Trump claims 'political reasons' held up convalescent plasma emergency authorization

Markel said people's mistrust of the system makes the idea that the FDA would rush this process before late stage clinical trials are complete "colossally stupid."
"This is one of the most ridiculous things I've heard this administration say," Markel said. "All it takes is one bad side effect to basically botch a vaccine program that we desperately need against this virus. It's a prescription for disaster."
FDA Commissioner Hahn said that the vaccine decision will be based on data, not politics, but Kinch shares Markel's concern.

"This could do substantial damage," Kinch said. Kinch, who is a patient in one of the vaccine trials himself, said the clinical trial process needs to be followed to the end. A too-early EUA for a vaccine could cause a "nightmare scenario," for a few reasons. One, the vaccine may not be safe. Two, if it is not safe, people will lose faith in vaccines. Three, if a vaccine doesn't offer complete protection, people will have a false sense of security and increase their risk. Four, if a substandard vaccine gets an EUA, a better vaccine may never get approval, because people would be reluctant to enroll in trials and risk getting a placebo instead of a vaccine.
"People are going to die unnecessarily if we take chances with this," Kinch said. "We've got to get this right."
CNN Health's Jamie Gumbrecht contributed to this story

MEDPAGE TODAY®

Scrap the Old COVID Script for Act Four

— The lack of narrative from our leaders is creating public confusion

by Randy Olson, PhD
August 8, 2021

"Everyone is confused." That was part of the headline in a July 23 article in *Reuters* about new mask rules for the vaccinated amid escalating COVID-19 cases. You might think that a year and a half into such an enormous public health crisis, all sources of confusion would be gone, but sadly it's the opposite. Why?

Science consists of two parts: 1) research and 2) communication.

On the research side, at the start of the pandemic, there was an outcry during the Trump administration to throw everything possible into developing a vaccine. And later for deployment, the Biden administration laid out plan after plan to get the country vaccinated as efficiently as possible. However, a key ingredient has been missing all along: a communications plan.

Michael Osterholm, PhD, MPH, director of the University of Minnesota's Center for Infectious Disease Research and Policy, identified the seriousness of the communication problem last October on *NBC*'s "Meet the Press" when he said, "we don't have one consolidated voice." He also noted the failure to draw on the power of story.

We're still paying dearly for the failure to establish effective communications today.

Simultaneous with the lack of focus on effective mass communication was the emergence of an anti-science voice at a level never before seen. It produced a resistance to everything from masks to vaccines, complicated by advocates of unproven treatments like hydroxychloroquine and ivermectin. All of which has led to headlines like, "Everyone is

confused."

Communications Lessons from Professional Storytellers

There are many aspects to the communications challenge, but there is one specific new tool that addresses Osterholm's plea for a singular voice. The problem is based in narrative dynamics.

For over a century, Hollywood has focused its efforts on how to use the power of narrative to connect with audiences. The result has been a great deal of knowledge of the practical side of narrative that has only sparingly been shared with the general public.

One of the simplest and most important observations came from legendary screenwriting instructor Frank Daniel in a 1986 speech about the shaping of material from a first draft to a final draft. He boiled basic narrative structure down to two paragraphs, saying:

"Monotony is a problem in first drafts. One reason for it is that the scenes follow in the forbidden pattern: and then, and then, and then."

"In a dramatic story the pattern is: 'and then,' 'but,' 'therefore.' If you don't have this 'but' and 'therefore' connection between the parts, the story becomes linear, monotonous. Diaries and chronicles are written that way, but not scripts."

He was talking about screenwriting, but the principle applies just as well to the communication of science to the public. That last line could be rewritten as, "Laboratory notebooks and journals are written that way, but not public communication."

It is this transition from pure information into the narrative structure that Osterholm was pleading for. In simple terms, "Narrative is leadership." People don't follow leaders who are boring or confusing. They follow leaders who are able to wield the power of narrative structure to deliver information that is concise and compelling to a broad audience.

The secret to accomplishing this lies in what Daniel identified: The three key words of *and*, *but*, *therefore*, and the powers they embody -- agreement, contradiction, consequence. The words come together in a simple tool called the ABT Narrative Template, which is this single sentence: "__ **and** __ **but** __ **therefore** __."

Applying the Narrative Model to COVID Communications

This is the tool that every COVID-19 communicator needs to be working with every day in all communication. It is the tool that distills down the central message to the three basic elements of setup (the context), problem, and solution.

For example: The public is not crazy in feeling confused by contradictory messages **and** there are multiple perspectives on what do to, **but** right now daily COVID-19 cases are again topping 100,000, **therefore** what is needed is ...

"What is our ABT?" needs to be the central question for all communications teams.

We are now training thousands of scientists and communicators from government agencies (National Park Service, U.S. Forest Service, U.S. Geological Survey, Federal Aviation Administration, Army Corps of Engineers, and many others) in the ABT Framework. Last year, I published a short article in *Scientific American* explaining the relevance of the ABT to medical training. Now, the ABT Framework is desperately needed to help combat the cloud of confusion plaguing COVID-19 communication.

It's not the singular solution to the problem, but it is a solid resource that is needed everywhere in the communication of the pandemic to put an end to headlines that say, "Everyone is confused."

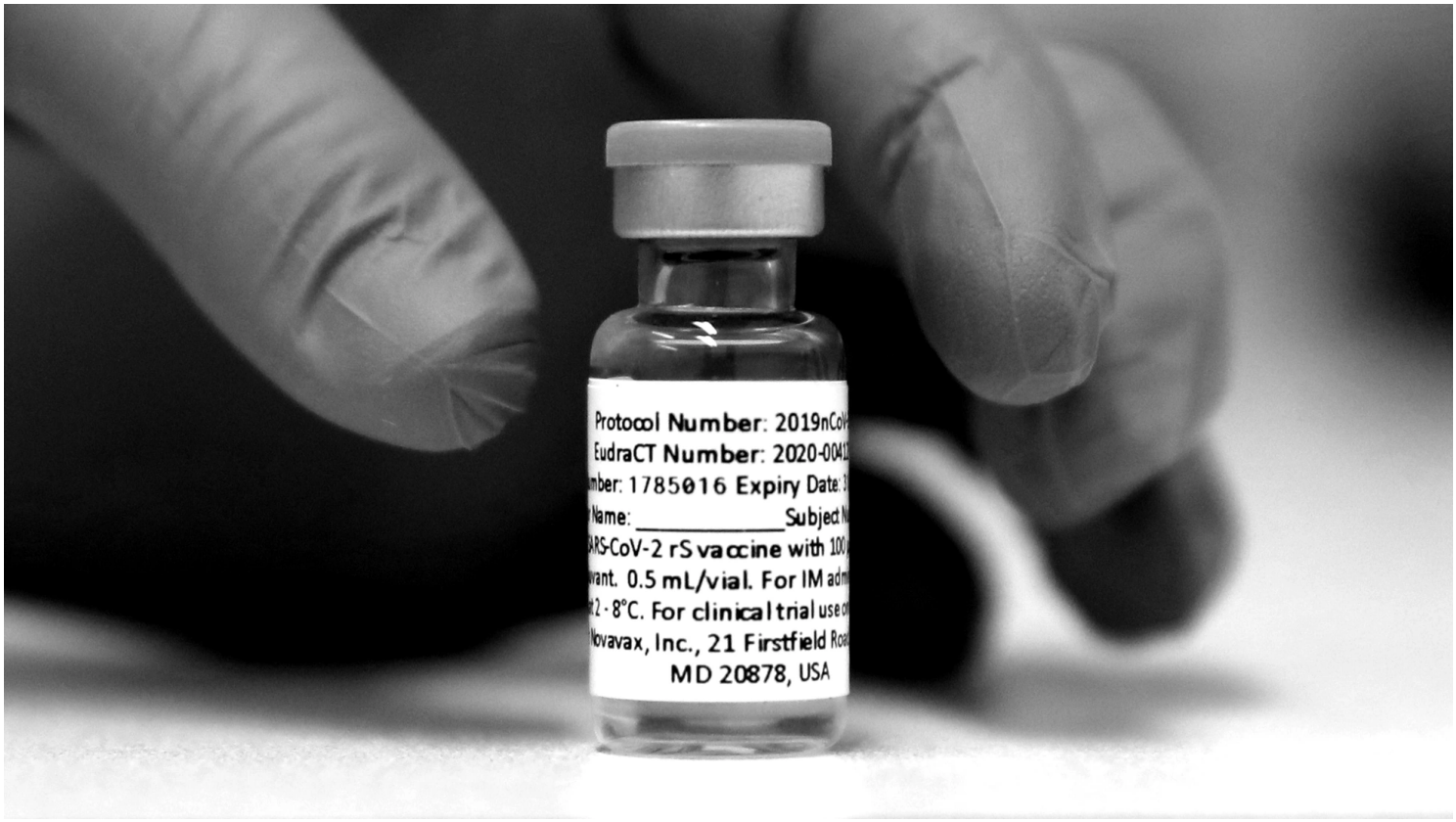
Randy Olson, PhD, is a scientist-turned-filmmaker. He is the author of "Houston, We Have A Narrative" and 2020 recipient of the John P. McGovern Award for Excellence in Biomedical Communication from the American Medical Writers Association.

HEALTH

The mRNA Vaccines Are Extraordinary, but Novavax Is Even Better

Persistent hype around mRNA vaccine technology is now distracting us from other ways to end the pandemic.

By Hilda Bastian



Alastair Grant / AP

JUNE 24, 2021 SHARE

At the end of January, reports that yet another COVID-19 vaccine had succeeded in its clinical trials—this one offering about 70 percent protection—were front-page news in the United States, and occasioned push alerts on millions of phones. But when the Maryland-based biotech firm Novavax announced its latest stunning trial results last week, and an efficacy rate of more than 90 percent even against coronavirus variants, the response from the same media outlets was muted in comparison. The difference, of course, was the timing: With three vaccines already authorized for emergency use by the U.S. Food and Drug Administration, the nation is "awash in other shots" already, as the *The New York Times* put it.

Practically speaking, this is true. If the FDA sees no urgency, the Novavax vaccine might not be available in the U.S. for months, and in the meantime the national supply of other doses exceeds demand. But the asymmetry in coverage also hints at how the hype around the early-bird vaccines from Pfizer and Moderna has distorted perception. Their rapid arrival has been described in this magazine as "the triumph of mRNA"—a brand-new vaccine technology whose "potential stretches far beyond this pandemic." Other outlets gushed about "a turning point in the long history of vaccines," one that "changed biotech forever." It was easy to assume, based on all this reporting, that mRNA vaccines had already proved to be the most effective ones you could get—that they were better, sleeker, even *cooler* than any other vaccines could ever be.

But the fascination with the newest, shiniest options obscured some basic facts. These two particular mRNA vaccines may have been the first to get results from Phase 3 clinical trials, but that's because of superior trial management, not secret vaccine sauce. For now, they are harder and more expensive to manufacture and distribute than traditional types of vaccines, and their side effects are more common and more severe. The latest Novavax data confirm that it's possible to achieve the same efficacy against COVID-19 with a more familiar technology that more people may be inclined to trust. (The mRNA vaccines delivered efficacy rates of 95 and 94 percent against the original coronavirus strain in Phase 3 trials, as compared with 96 percent for Novavax in its first trial, and now 90 percent against a mixture of variants.

Read: The differences between the vaccines matter

Pandemic-vaccine success, as I wrote last year, was never just about the technology. You needed a good vaccine, sure—but to get it out the door quickly, you also had to have a massive clinical-trial operation goin, and had to be situated in places where the virus would be spreading widely at just the right time. Even if your candidate worked amazingly well, if you weren't

testing it in the middle of a huge outbreak, you'd have to wait a very long time for the evidence to build.

The precise timing of these studies mattered a great deal in practice. The Phase 3 clinical trials for Pfizer and Moderna, for example, were up and running in the U.S. by late summer 2020, and so they caught the nation's giant wave of infections in the fall. By the time Novavax had finished recruiting in the U.S. and Mexico, in February, case rates had been dropping precipitously. This fact alone, independent of any aspect of vaccine technology, did a lot to shape the outcome.

Corporate strategy was another crucial factor. To "win" the vaccine race, a company would need to be able to produce high-quality vaccine doses reliably and quickly, and in vast numbers. It would also need to field the challenges of working with multiple regulatory agencies around the world. And it would need to do all of this *at the same time*.

BioNTech, the German company that developed the Pfizer mRNA vaccine, could not have accomplished so much, so quickly by itself. Last October, the company's CEO, Uğur Şahin, told German interviewers that BioNTech had sought out Pfizer for help because of the scale of the clinical-trial program necessary for drug approvals. That strategic partnership, and not simply the "triumph of mRNA," was what propelled them past the post. (Moderna had the advantage of its partnership with the National Institutes of Health.) Consider this: The BioNTech-Pfizer first-in-human vaccine study appeared on the U.S. government's registry of clinical trials on April 30, 2020—the same day as the first-in-human vaccine study for Novavax, which would be going it alone. In a parallel universe where Novavax had paired up with, say, Merck, this story could have come out very differently.

In the meantime, the early success of two mRNA vaccines pulled attention away from the slower progress of other candidates based on the same technology. Just two days after last week's Novavax announcement came the news that an mRNA vaccine developed by the German company CureVac had delivered a weak early efficacy rate in a Phase 3 trial, landing below even the 50 percent minimum level set by the World Health Organization and the FDA. "The results caught scientists by surprise," *The New York Times* reported. CureVac is the company that President Donald Trump reportedly tried to lure to the U.S. early in the pandemic, and the one that Elon Musk said he would supply with automated "RNA microfactories" for vaccine production. In the end, none of this mattered. CureVac's mRNA vaccine just doesn't seem to be good enough.

The "sobering" struggles of CureVac perfectly illustrate what epidemiologists call "survivor bias"—a tendency to look only at positive examples and draw sweeping conclusions on their basis. When the Pfizer and Moderna vaccines triumphed, *The Washington Post* suggested that a bet on "speedy but risky" mRNA technology had paid off with a paradigm-shifting breakthrough. Anthony Fauci called the gamble "a spectacular success." Such analyses usually had less to say about the non-mRNA vaccines that had gotten into clinical trials just as quickly—and about the other mRNA vaccines that were hitting snags along the way.

Now we've seen what happened to CureVac, and that some mRNA formulations clearly work much better than others. By one count, nine groups were testing mRNA COVID-19 vaccines in animal studies as of May 2020, and six were expected to be in clinical trials a few months later. By the end of the year, only BioNTech-Pfizer, Moderna, and CureVac had reached Phase 3 testing, compared with 13 non-mRNA vaccines. Of the nine mRNA-vaccine candidates that were already testing in animals in mid-2020, just two have proved efficacy at this point, while no fewer than nine vaccines based on more traditional technologies have reached the same mark.

These other, non-mRNA vaccines have been widely used throughout the world—and some could still make an important difference in the U.S. Although the U.S. has plenty of doses of the Pfizer and Moderna vaccines available right now, demand for them has cratered. *The Washington Post* reports that in 10 states, fewer than 35 percent of American adults have been vaccinated. An international study of COVID-19 vaccine misinformation, published in May, found that among the most common online rumors were those alleging particular dangers of mRNA technology—that it leads, for example, to the creation of "genetically modified human beings." The CDC has also made a point of debunking the circulating falsehood that COVID-19 vaccines can change your DNA. For a time, it looked as though the Johnson & Johnson vaccine would help address this worry. It's based on a fairly new technology, but not as new as mRNA. However, concerns about tainted doses made at a Baltimore factory and the emergence of a very rare but serious side effect have pretty much dashed that hope. The Johnson & Johnson single-dose vaccine has reportedly accounted for fewer than 4 percent of doses administered in the country.

Read: Microchipped vaccines, a 15-minute investigation

In this context, the success of the Novavax vaccine should be A1 news. The recent results confirm that it has roughly the same efficacy as the two authorized mRNA vaccines, with the added benefit of being based on an older, more familiar science. The protein-subunit approach used by Novavax was first implemented for the hepatitis B vaccine, which has been used in the U.S. since 1986. The pertussis vaccine, which is required for almost all children in U.S. public schools, is also made this way. Some of those people who have been wary of getting the mRNA vaccines may find Novavax more appealing.

The Novavax vaccine also has a substantially lower rate of side effects than the authorized mRNA vaccines. Last week's data showed that about 40 percent of people who receive Novavax report fatigue after the second dose, as compared with 65 percent for Moderna and more than 55 percent for Pfizer. Based on the results of Novavax's first efficacy trial in the U.K., side effects (including but not limited to fatigue) aren't just less frequent; they're milder too. That's a very big deal for people on hourly wages, who already bear a disproportionate risk of getting COVID-19, and who have been less likely to get vaccinated in part because of the risk of losing days of work to post-vaccine fever, pain, or malaise. Side effects are a big barrier for COVID-vaccine acceptance. The CDC reported on Monday that, according to a survey conducted in the spring, only about half of adults under the age of 40 have gotten the vaccine or definitely intend to do so, and that, among the rest, 56 percent say they are concerned about side effects. Lower rates of adverse events are likely to be a bigger issue still for parents, when considering vaccination for their children.

Don't get me wrong—the Pfizer and Moderna vaccines have been extraordinary lifesavers in this pandemic, and we may well be heading into a new golden age of vaccine development. (This week, BioNTech started injections in an early trial for an mRNA vaccine for melanoma.) But even the best experts at predicting which drugs are going to be important get things wrong quite a bit, overestimating some treatments and underestimating others. Pharmaceuticals are generally a gamble.

But here's what we know today, based on information that we have right now: Among several wonderful options, the more old-school vaccine from Novavax combines ease of manufacture with high efficacy and lower side effects. For the moment, it's the best COVID-19 vaccine we have.