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The U.S. Is Getting a Crash Course in Scientific Uncertainty

As the pandemic takes an unexpected direction, Americans again must reckon with twists in scientific understanding of the virus.

By Apoorva Mandavilli

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When the coronavirus surfaced last year, no one was prepared for it to invade every aspect of daily life for so long, so insidiously. The pandemic has forced Americans to wrestle with life-or-death choices every day of the past 18 months — and there's no end in sight.

Scientific understanding of the virus changes by the hour, it seems. The virus spreads only by close contact or on contaminated surfaces, then turns out to be airborne. The virus mutates slowly, but then emerges in a series of dangerous new forms. Americans don't need to wear masks. Wait, they do.

At no point in this ordeal has the ground beneath our feet seemed so uncertain. In just the past week, federal health officials said they would begin offering booster shots to all Americans in the coming months. Days earlier, those officials had assured the public that the vaccines were holding strong against the Delta variant of the virus, and that boosters would not be necessary.

As early as Monday, the Food and Drug Administration is expected to formally approve the Pfizer-BioNTech vaccine, which has already been given to scores of millions of Americans. Some holdouts found it suspicious that the vaccine was not formally approved yet somehow widely dispensed. For them, "emergency authorization" has never seemed quite enough.

Americans are living with science as it unfolds in real time. The process has always been fluid, unpredictable. But rarely has it moved at this speed, leaving citizens to confront research findings as soon as they land at the front door, a stream of deliveries that no one ordered and no one wants.

Is a visit to my ailing parent too dangerous? Do the benefits of in-person schooling outweigh the possibility of physical harm to my child? Will our family gathering turn into a superspreader event?

Living with a capricious enemy has been unsettling even for researchers, public health officials and journalists who are used to the mutable nature of science. They, too, have frequently agonized over the best way to keep themselves and their loved ones safe.

But to frustrated Americans unfamiliar with the circuitous and often contentious path to scientific discovery, public health officials have seemed at times to be moving the goal posts and flip-flopping, or misleading, even lying to, the country.

Most of the time, scientists are “edging forward in a very incremental way,” said Richard Sever, assistant director of Cold Spring Harbor Laboratory Press and a co-founder of two popular websites, bioRxiv and medRxiv, where scientists post new research.

“There are blind alleys that people go down, and a lot of the time you kind of don’t know what you don’t know.”

Biology and medicine are particularly demanding fields. Ideas are evaluated for years, sometimes decades, before they are accepted.

Researchers first frame the hypothesis, then design experiments to test it. Data from hundreds of studies, often by competing teams, are analyzed before the community of experts comes to a conclusion.

In the interim, scientists present the findings to their peers, often at niche conferences that are off-limits to journalists and the general public, and hone their ideas based on the feedback they receive. It’s not unusual to see attendees at these meetings point out — sometimes harshly — every flaw in a study’s methods or conclusions, sending the author back to the lab for more experiments.

Fifteen years elapsed from the description of the first cases of H.I.V. to the identification of two proteins the virus needs to infect cells, a finding crucial to research for a cure. Even after a study has reached a satisfying conclusion, it must be submitted for rigorous review at a scientific journal, which can add another year or more before the results become public.

Measured on that scale, scientists have familiarized themselves with the coronavirus at lightning speed, partly by accelerating changes to this process that were already underway.

Treatment results, epidemiological models, virological discoveries — research into all aspects of the pandemic turns up online almost as quickly as authors can finish their manuscripts. “Preprint” studies are dissected online, particularly on Twitter, or in emails between experts.

What researchers have not done is explain, in ways that the average person can understand, that this is how science has always worked.

The public disagreements and debates played out in public, instead of at obscure conferences, give the false impression that science is arbitrary or that scientists are making things up as they go along.

“What a non-scientist or the layperson doesn’t realize is that there is a huge bolus of information and consensus that the two people who are arguing will agree upon,” Dr. Sever said.

Is it really so surprising, then, that Americans feel bewildered and bamboozled, even enraged, by rapidly changing rules that have profound implications for their lives?

Federal agencies have an unenviable task: Creating guidelines needed to live with an unfamiliar and rapidly spreading virus. But health officials have not acknowledged clearly or often enough that their recommendations may — and very probably would — change as the virus, and their knowledge of it, evolved.

“Since the beginning of this pandemic, it’s been a piss-poor job, to say it in the nicest way,” said Dr. Syra Madad, an infectious disease epidemiologist at the Belfer Center for Science and International Affairs at Harvard.

Leaders in the United States and Britain have promised too much too soon, and have had to backtrack. Health officials have failed to frame changing advice as necessary when scientists learn more about the virus.

The Coronavirus Pandemic >

And the officials have not really defined the pandemic’s end — for example, that the virus will finally loosen its stranglehold once the infections drop below a certain mark. Without a clearly delineated goal, it can seem as if officials are asking people to give up their freedoms indefinitely. One jarring backtrack was the mask guidance by the Centers for Disease Control and Prevention. The agency said in May that vaccinated people could drop their masks, advice that helped set the stage for a national reopening. Officials did not emphasize, or at least not enough, that the masks could be needed again. Now, with a new surge in infections, they are.

“It can be really difficult for public perception and public understanding when these big organizations seem to reverse course in a way that is really not clear,” said Ellie Murray, a science communicator and public health expert at Boston University.

It does not help that the C.D.C. and the World Health Organization, the two leading public health agencies, have disagreed as frequently as they have in the past 18 months — on the [definition](#) of a [pandemic](#), on the [frequency](#) of [asymptomatic infections](#), on the safety of [Covid-19 vaccines for pregnant women](#).

Most Americans have a decent grasp of basic health concepts — exercise is good, junk food is bad. But many are never taught how science progresses.

In 2018, 15-year-olds in the United States ranked 18th in their ability to explain scientific concepts, [lagging behind](#) their peers in not just China, Singapore and the United Kingdom, but also Poland and Slovenia.

In a [2019 survey](#) by the Pew Research Center, many Americans correctly identified fossil fuels and the rising threat of antibiotic resistance, but they were less knowledgeable about the scientific process.

Understand Vaccine and Mask Mandates in the U.S.

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- **Vaccine rules.** On Aug. 23, the Food and Drug Administration [granted full approval to Pfizer-BioNTech's coronavirus vaccine](#) for people 16 and up, paving the way for an increase in mandates in both the public and private sectors. Private companies have been [increasingly mandating vaccines](#) for employees. Such mandates are [legally allowed](#) and have been upheld in court challenges.
- **Mask rules.** The Centers for Disease Control and Prevention in July [recommended](#) that all Americans, regardless of vaccination status, wear masks in indoor public places within areas experiencing outbreaks, a reversal of the guidance it offered in May. [See where the C.D.C. guidance would apply](#), and where [states have instituted their own mask policies](#). The battle over masks has become contentious in some states, with some [local leaders defying state bans](#).
- **College and universities.** More than 400 colleges and universities are requiring students to be vaccinated against Covid-19. [Almost all are in states that voted for President Biden](#).
- **Schools.** Both [California](#) and [New York City](#) have introduced vaccine mandates for education staff. A survey released in August found that many American parents of school-age children [are opposed to mandated vaccines for students, but were more supportive of mask mandates for students, teachers and staff members who do not have their shots](#).
- **Hospitals and medical centers.** [Many hospitals and major health systems are requiring employees to get a Covid-19 vaccine](#), citing rising caseloads fueled by the Delta variant and stubbornly low vaccination rates in their communities, even within their work force.
- **New York City.** Proof of vaccination is required of workers and customers for [indoor dining, gyms, performances and other indoor situations, although enforcement does not begin until Sept. 13](#). [Teachers and other education workers](#) in the city's vast school system will need to have at least one vaccine dose by Sept. 27, without the option of weekly testing. [City hospital workers](#) must also get a vaccine or be subjected to weekly testing. Similar rules are in place for New York State employees.
- **At the federal level.** The Pentagon announced that it would seek to make coronavirus vaccinations mandatory for the country's [1.3 million active-duty troops](#) "no later" than the middle of September. President Biden announced

that [all civilian federal employees](#) would have to [be vaccinated against the coronavirus](#) or submit to regular testing, social distancing, mask requirements and restrictions on most travel.

And basic tenets of public health often are even more of a mystery: How does my behavior affect others' health? Why should I be vaccinated if I consider myself low-risk?

"People weren't primed before to understand a lot of these concepts," Dr. Madad said. "We should have known that we couldn't expect the public to change their behaviors on a dime."

Both information and disinformation about Covid-19 surface online, especially on social media, much more now than in previous public health crises. This represents a powerful opportunity to fill in the knowledge gaps for many Americans.

But health officials have not taken full advantage. The C.D.C.'s Twitter feed is a robotic stream of announcements. Agency experts need not just to deliver messages, but also to answer questions about how the evolving facts apply to American lives.

And health officials need to be more nimble, so that bad actors don't define the narrative while real advice is delayed by a traditionally cumbersome bureaucracy.

"They're not moving at the speed that this pandemic is moving," Dr. Murray said. "That obviously creates a perception in the public that you can't just rely on those more official sources of news."

In the middle of a pandemic, health officials have some responsibility to counter the many spurious voices on Twitter and Facebook spreading everything from pseudoscience to lies. Risk communication during a public health crisis is a particular skill, and right now Americans need the balm.

"There are some people whose confidence outweighs their knowledge, and they're happy to say things which are wrong," said Helen Jenkins, an infectious disease expert at Boston University.

"And then there are other people who probably have all the knowledge but keep quiet because they're scared of saying things, which is a shame as well, or just aren't good communicators."

Health officials could begin even now with two-minute videos to explain basic concepts; information hotlines and public forums at the local, state and federal levels; and a responsive social media presence to counter disinformation.

The road ahead will be difficult. The virus has more surprises in store, and the myths that have already become entrenched will be hard to erase.

But it's not too much to hope that the lessons learned in this pandemic will help experts explain future disease outbreaks, as well as other urgent problems, like climate change, in which individual actions contribute to the whole.

The first step toward educating the public and winning their trust is to make plans, and then communicate them honestly — flaws, uncertainty and all.