CORONAVIRUSES: UNDERSTANDING THE SPREAD OF INFECTIOUS DISEASES AND MOBILIZING INNOVATIVE SOLUTIONS

HEARING

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

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Appendix II: Additional Material for the Record

CORONAVIRUSES: UNDERSTANDING THE SPREAD OF INFECTIOUS DISEASES AND MOBILIZING INNOVATIVE SOLUTIONS

THURSDAY, MARCH 5, 2020

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to notice, at 9:03 a.m., in room 2318 of the Rayburn House Office Building, Hon. Ami Bera [Chairman of the Committee] presiding.

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions

March 5, 2020
9:00 a.m.
2318 Rayburn House Office Building

PURPOSE

The purpose of the hearing is to discuss emerging infectious diseases, in light of the recent coronavirus outbreak, and the modeling tools used to detect, predict, and understand the spread of such diseases. The Committee will discuss how some infectious agents spread from animals to humans and how predictive modeling can help control and mitigate the effects of emerging diseases. The Committee will also explore how investments in U.S. research may help combat epidemics and pandemics.

Given that COVID-19 is an emerging, rapidly evolving situation, please note that some information is subject to change.

WITNESSES

- **Dr. Suzan Murray**, Program Director, Smithsonian Global Health Program, Smithsonian's National Zoo & Conservation Biology Institute.
- **Dr. John Brownstein**, Chief Innovation Officer, Boston Children's Hospital; Professor, Harvard Medical School.
- **Dr. Peter Hotez**, Professor and Dean, National School of Tropical Medicine, Baylor College of Medicine; Co-Director, Texas Children's Hospital Center for Vaccine Development.
- **Dr. Tara Kirk Sell**, Senior Scholar, Johns Hopkins Center for Health Security; Assistant Professor, Johns Hopkins Bloomberg School of Public Health.

KEY QUESTIONS

- What factors contribute to the emergence of new infectious diseases, and how can we learn from past outbreaks to inform next steps?
- How can we apply predictive modeling to anticipate present day and future geographic distributions of infectious diseases?
- What are cutting-edge tools that can help decision-makers understand and manage the effects of emerging infectious diseases?
- How can investments in U.S. research contribute to global preparedness and response to emerging infectious diseases?
- What steps can we take to mitigate harmful social stigmas surrounding infectious diseases?

Background

Since 1980, outbreaks of emerging infectious diseases have been occurring with greater frequency and have been causing higher numbers of human infections.[1] Nearly 75% of all emerging infectious diseases identified in humans during the 21st century have been caused by zoonotic pathogens,[2] meaning the pathogen spreads from animals to humans, often through a vector (e.g., a mosquito).[3] Each year, zoonotic pathogens cause an estimated one billion cases of human illness, including 15 million deaths.[4]

An epidemic is an unusual, often sudden, increase in the number of cases of a disease above what is normally expected. An outbreak carries the same definition but is typically used for a more limited geographic area. A pandemic refers to an epidemic that has spread over several countries or continents, usually affecting many people. Changing ecosystems, economic development and land use, climate and weather, and international travel and commerce are all examples of ecological, environmental, and social factors that will increase the emergence and spread of infectious diseases in the future.[5]

Coronaviruses are a large family of zoonotic viruses that cause respiratory illness ranging from the common cold to more severe diseases like MERS (Middle East respiratory syndrome) and SARS (severe acute respiratory syndrome).[6] There are seven coronaviruses known to infect humans, including the novel coronavirus (COVID-19) first identified in Wuhan City, Hubei Province, China in December 2019.[7] The most common symptoms among confirmed COVID-19 patients include high fever, cough, and shortness of breath.[8]

Global Effects of COVID-19

The size of the COVID-19 outbreak has created a public health crisis with significant international dimensions. As of March 2, 2020, COVID-19 has been detected in 60 locations internationally, including in the United States.[9] While the overwhelming number of cases and deaths have occurred in China, significant outbreaks are now arising in other countries such as

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[1] Katherine Smith et al., "Global Rise in Human Infectious Disease Outbreaks," *Journal of the Royal Society Interface*, volume 11 (August 2014); Stephen Morse et al., "Prediction and Prevention of the Next Panemic Zoonosis," *The Lancet*, vol. 380 (December 1, 2012), pp. 1956-1965; and A. Marm Kilpatrick and Sarah Randolph, "Drivers, Dynamics, and Control of Emerging Vector-Borne Zoonotic Diseases," *The Lancet*, vol. 380 (December 1, 2012), pp. 1946-1955.

[2] Smithsonian's National Zoo & Conservation Biology Institute, Global Health Program.

[3] Katherine Smith et al., "Global Rise in Human Infectious Disease Outbreaks," *Journal of the Royal Society Interface*, volume 11 (August 2014); and Stephen Morse et al., "Prediction and Prevention of the Next Pandemic Zoonosis," *The Lancet*, vol. 380 (December 1, 2012), pp. 1956-1965.

[4] William Karesh et al., "Ecology of Zoonoses: Natural and Unnatural Histories," *The Lancet*, vol. 380 (December 1, 2012), pp. 1936-1945; Barbara Han et al., "Rodent Reservoirs of Future Zoonotic Diseases," *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, vol. 112, no. 22 (June 2, 2015), pp. 7039-7044; and Wu XiaoXu et al., "Impact of Global Change on Transmission of Human Infectious Diseases," *Science China*, (April 19, 2013).

[5] Institute of Medicine. 2014. The Influence of Global Environmental Change on Infectious Disease Dynamics: Workshop Summary. Washington, DC: The National Academies Press.

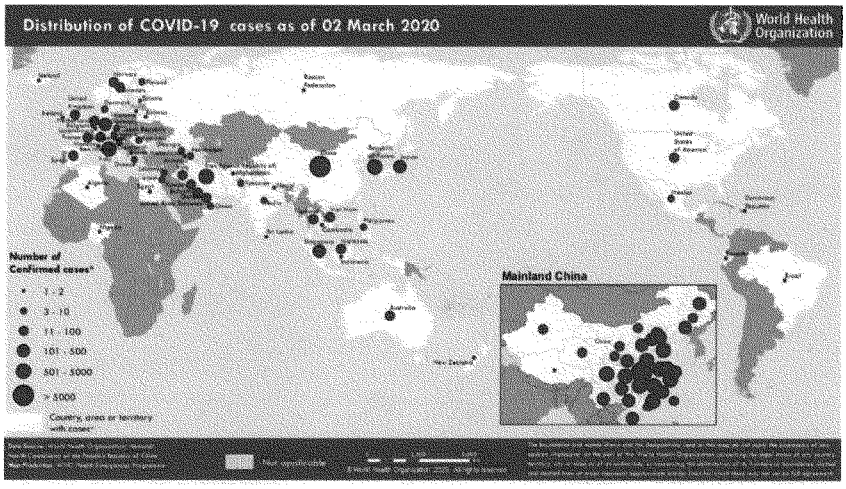
[6] Johns Hopkins Center for Health Security, Coronaviruses: SARS, MERS, and 2019-nCoV, January 21, 2020.

[7] Centers for Disease Control and Prevention. Human coronavirus types. January 10, 2020. The virus has been named "SARS-CoV-2" and the disease it causes has been named "coronavirus disease 2019" (abbreviated "COVID-19").

[8] Chaolin Huang, Yeming Wang, and Xingwang Li, et al., "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China," *The Lancet*, January 24, 2020.

[9] Centers for Disease Control and Prevention, "Coronavirus Disease 2019 (COVID-19)," COVID-19 Situation Summary.

South Korea, Italy, and Iran. The global spread of the COVID-19 virus prompted the World Health Organization (WHO) to take action by declaring a "public health emergency of international concern" on January 30, 2020, only the sixth time in the organization's history that it has declared a public health emergency since it gained the authority to do so in 2005.[10] The WHO's declaration is advisory in nature and cannot compel any nation to undertake any specific policy or action. Nevertheless, it is viewed as an important signal of severe concern from the world's leading international public health organization, and it may galvanize further responses to the outbreak at the national and sub-national level.



The impacts of COVID-19 will extend broadly throughout the U.S. and global economies. Depending on the size of the eventual outbreak and the length of time that it persists, the U.S. economy could suffer significant disruption due to a decline in tourism from China and elsewhere, decreased demand for American exports, the disruption of global supply chains for American companies, and disruptions to daily life in the United States.[11] The financial sector has taken note of these concerns, as the S&P 500 index experienced its worst week since the 2008 financial crisis last week, although it rebounded somewhat on March 2, 2020.[12] The technology and automotive sectors could be particularly vulnerable due to the potential for shortages to occur among critical parts for their production lines.[13]

The U.S. international public health response to COVID-19 has centered around the goal of overseas containment through the imposition of severe travel restrictions on foreign nationals

[10] Sui-Lee Wee, Donald G. McNeil Jr., and Javier C. Hernandez, "W.H.O. Declares Global Emergency as Wuhan Coronavirus Spreads," *New York Times*, January 30, 2020.
[11] Paul Davidson, "How is the coronavirus in China casting a widening shadow across the US economy," *USA Today*, February 20, 2020.
[12] New York Times, "Asian Markets Seesaw, Bonds Rise as Coronavirus Fears Linger," March 1, 2020.
[13] *Id.*

from China and Iran, the issuance of heightened warnings for U.S. citizens traveling to South Korea and Italy, and the use of mandatory quarantines for American citizens returning from some affected areas.[14] The United States has also sent two public health experts to China as part of a WHO team of international disease experts deployed to assist the Chinese government's response.[15] Finally, the United States has offered an additional $100 million in support of the WHO's international response efforts to study the virus and contain the outbreak.[16] Due to the outbreak of the virus within the country, the United States is increasingly shifting its focus to confronting the effects of COVID-19 domestically.

On February 26, 2020, President Trump named Vice President Pence to coordinate the government's response to COVID-19. The White House submitted a $2.5 billion plan to Congress to address the outbreak. Senate Minority Leader Chuck Schumer proposed to increase the President's emergency request substantially, to $8.5 billion in new funds, including $3 billion for a public health emergency fund, $1.5 billion for the Centers for Disease Control and Prevention (CDC), $1 billion for vaccine development, and $2 billion for reimbursing states and cities for efforts they have so far made to monitor and prepare for potential cases of the virus.[17]

COVID-19: A Rapidly Evolving Situation

In an effort to contextualize COVID-19 as the outbreak is rapidly evolving, attempts have been made to explain the threat through comparisons to other well-known outbreaks, like the seasonal flu, SARS, and H1N1. For example, the CDC has confirmed two COVID-19-related deaths as of March 2, 2020,[18] while this year's seasonal flu has killed more than 18,000.[19] However, it is important to note that such comparisons are complicated while the virus continues to spread. Not all those who have contracted the virus have been diagnosed, and most of those who have been diagnosed have neither died nor recovered yet. When the H1N1 influenza pandemic broke out in the spring of 2009, the mortality rate appeared to be 10%. However, as time progressed, it became clear that there were many cases of people whose infections were so mild that they didn't seek medical help. Ultimately, the death rate of H1N1 was below 0.1%.[20]

Like with any other outbreak, outcomes of COVID-19 cases will vary based on the resources available to the impacted communities. H1N1, for example, had a death rate over four times higher for American Indians and Alaska Natives than for all other racial and ethnic groups combined. Reasons for this include a high prevalence of chronic health conditions, poverty, and delayed access to healthcare.[21] In the Hubei province, medical resources are stretched very thin, exacerbated by a lockdown that is slowing the delivery of protective wear for hospital staff.[22]

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[14] Rob Stein, "U.S. Coronavirus Quarantine and Travel Limits: Needed Protection or Overreaction?" *NPR*, February 3, 2020.
[15] Steven Lee Myers and Edward Wong, "Coronavirus Worsens U.S.-China Ties and Bolsters Hawks in Washington," *New York Times*, February 19, 2020.
[16] Reuters, "U.S. announces aid for China, other countries impacted by coronavirus," February 7, 2020.
[17] Jordain Carney, "Schumer requesting $8.5 billion in emergency funding on coronavirus," February 26, 2020.
[18] "Coronavirus Disease 2019 (COVID-19)," Centers for Disease Control and Prevention, March 2, 2020.
[19] "Weekly U.S. Influenza Surveillance Report (FluView)," Centers for Disease Control and Prevention, February 15, 2020.
[20] Emily Baumgaertner, "How deadly is the new coronavirus? Scientists race to find the answer," *LA Times*, February 12, 2020.
[21] "Deaths Related to 2009 Pandemic Influenza A (H1N1) Among American Indian/Alaska Natives – 12 States, 2009," Center for Disease Control *MMWR Weekly*, December 11, 2009.
[22] Chris Buckley, Sui-Lee Wee, Amy Qin, "China's Doctors, Fighting the Coronavirus, Beg for Masks," *New York Times*, February 14, 2020.

Over 3,000 medical workers have now been infected with COVID-19 in China, largely in the Hubei province.[23] Meanwhile, according to the CDC, there have been 43 cases of COVID-19 confirmed in the United States as of March 2, 2020 including 26 cases of transmission to people who had not recently been to China or had known contact with someone who had. There have been 48 confirmed cases among individuals repatriated to the United States from Asia, including three from Wuhan and 45 from the Diamond Princess, a cruise ship on which 695 people were infected.[24]

Epidemiologists believe that, despite the Chinese government's lockdown of areas surrounding Wuhan, COVID-19 will infect more people in the United States and around the world.[25] Like SARS and MERS, it will be more dangerous for elderly patients and those with existing cardiovascular disorders.[26] Beyond that, it is difficult at the moment to make predictions about how contagious or deadly COVID-19 will be outside China.

Using Technology to Detect, Predict, and Understand the Spread of Infectious Diseases

During outbreaks of novel viruses—especially ones with pandemic potential—public health leaders use epidemiological models to detect, predict, and control the spread and impact of disease.[27] These models can assist in answering critical questions, such as: '*When will the disease reach its peak?*' or '*How transmissible is the disease*?' or '*Who in the population should be prioritized for vaccination or treatment?*'.[28] The researchers using such models require quality data but are limited by time; as time passes and the outbreak progresses, more data become available to analyze.[29]

Traditional models or techniques that track outbreaks often use manually coded data, like confirmed infections and hospitalizations. However, it can take a long time to collect and verify this data. For example, a physician might identify a cluster of patients with a new set of similar symptoms and contact the CDC for further follow-up and testing. The CDC (or one of its designated laboratories) would then analyze and verify patient specimens before making recommendations and issuing an official alert. While necessary, this process can delay critical policies and interventions during the early stages of an outbreak.

One of the key differences between the SARS outbreak in 2003 and COVID-19 is the greater availability and amount of non-traditional data like social media posts, Google Search queries, and online news reports. Researchers are now using artificial intelligence (AI) applications to identify and track outbreaks faster and more precisely. HealthMap, for example, is a tool that collects and analyzes online informal sources to generate visualizations that show how and

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[23] "China says more than 3,000 medical staff infected by COVID-19," *Channel News Asia*, February 24, 2020.
[24] Coronavirus Disease 2019 (COVID-19), Centers for Disease Control and Prevention.
[25] James Hamblin, "You're Likely to Get the Coronavirus," *The Atlantic*, February 24, 2020.
[26] Katarina Zimmer, "Why Some COVID-19 Cases Are Worse than Others," *The Scientist*, February 24, 2020.
[27] Manoj Gambhir, et al., "Infectious Disease Modeling Methods as Tools for Informing Response to Novel Influenza Viruses of Unknown Pandemic Potential," *Clinical Infectious Diseases*, 2015;60(S1):S11-9.
[28] Typically, descriptive modeling tries to estimate what probably occurred or is occurring now, while predictive modeling predicts cases in the future. Government Accountability Office, "Emerging Infectious Diseases: Actions Needed to Address the Challenges of Responding to Zika Virus Disease Outbreaks," May 23, 2017.
[29] Manoj Gambhir, et al., "Infectious Disease Modeling Methods as Tools for Informing Response to Novel Influenza Viruses of Unknown Pandemic Potential," *Clinical Infectious Diseases*, 2015;60(S1):S11-9.

where communicable diseases like COVID-19 are spreading.[30] The WHO uses HealthMap as part of its Epidemic Intelligence from Open Sources initiative, facilitating early detection of global public health threats.[31]

While advancements in AI could help predict infectious disease outbreaks before they happen, these methods are considered a supplement to, and not a replacement for, traditional surveillance and diagnostic processes. Decision-makers could use a hybrid approach to allocate resources faster and contain the spread of an outbreak more effectively.

Halting the Spread of Misinformation around Infectious Disease Outbreaks

Researchers generally define misinformation as information that is false or misleading but promulgated with sincerity by a person who believes it is true. Disinformation, on the other hand, is shared with the deliberate intent to deceive. The Subcommittee on Investigations & Oversight of the House Committee on Science, Space, and Technology held a hearing on this important topic on September 26, 2019, particularly focusing on the tools needed to combat these threats.[32]

The outbreak of global viruses is often followed by the spread of misinformation about the virus, such as its origins, causes, and government response. The WHO has even labeled this outbreak an "infodemic," meaning there is "an over-abundance of information – some accurate and some not – that makes it hard for people to find trustworthy sources and reliable guidance when they need it."[33] There have been multiple reports documenting the international spread of public health disinformation on COVID-19.[34,35,36]

Stigma is a central theme of public health misinformation. Johns Hopkins' Center for Health Security describes stigma as something that comes from an impulse to assign blame during an outbreak of infectious disease. People are often trying to answer basic questions, such as: '*Where did this come from?*' and '*How is it spreading?*'. To understand and avoid illness, people often create a mental distinction between "us" (the uninfected) and "them" (the infected). According to Johns Hopkins, this phenomenon can contribute to an inaccurate picture of health risk and reflect preexisting social differences and prejudices. A whole country or group of people may be singled out as the source of the problem—rather than the pathogen.

Misinformation about infectious diseases is hardly a new phenomenon, but the spread of misinformation is accelerated by social media. Several social media companies have taken steps to mitigate misinformation around COVID-19. In late January, Facebook released a statement saying that their "third-party fact-checkers are continuing their work reviewing content and

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[30] Will Knight, "How AI is Tracking the Coronavirus Outbreak," *WIRED*, February 8, 2020.
[31] Alejandro De La Garza, "Coronavirus Researchers Are Using High-Tech Methods to Predict Where the Virus Might Go Next," *TIME*, February 11, 2020.
[32] "Online Imposters and Disinformation," hearing before the Subcommittee on Investigations and Oversight, H. Comm. On Sci., Space, and Tech. (September 26, 2019).
[33] World Health Organization, "Novel Coronavirus (2019-nCoV) Situation Report -13," February 2, 2020.
[34] Malaka Gharib, "Fake Facts Are Flying About Coronavirus. Not There's a Plan To Debunk Them," *NPR*, February 21, 2020.
[35] Beatrice Dupuy and Arijeta Lajka, "Not Real News: An outbreak of virus-related misinformation," *AP News*, February 28, 2020.
[36] Makena Kelly, "The World Health Organization has joined TikTok to fight coronavirus misinformation," *The Verge*, February 28, 2020.

debunking false claims" related to COVID-19.[37] Around the same time, Twitter launched a prompt for individuals searching *#coronavirus* to receive credible information from the CDC.[38] Similarly, users searching "coronavirus" on YouTube are met with a link to the WHO guidance on COVID-19.[39] Unfortunately, despite these efforts, misinformation surrounding the virus persists.[40,41]

Investments in Research and Development to Prevent and Respond to Outbreaks

Recent infectious disease outbreaks have highlighted certain strengths and weaknesses of the international research and development (R&D) response. For example, there is broad consensus that global research efforts were hampered by insufficient collaboration and transparency during the Ebola epidemic in 2014-2015, which led to a slow and uncoordinated response.[42] According to the National Academies of Science, Engineering, and Medicine, the mobilization of a rapid and robust research response during the next epidemic will depend not just on what happens during the epidemic, but on what happens before or between epidemics.[43]

There are numerous ways the United States can work with its international partners on priority research that can curtail ongoing outbreaks and prepare for future ones. For example, the WHO R&D Blueprint is a global strategy and preparedness plan that outlines research actions which can help identify key knowledge gaps and accelerate the development of critical scientific information.[44] The WHO activated its R&D Blueprint in early January 2020 in response to the COVID-19 outbreak. Some of the Blueprint's recommended actions include:

- **R&D for Emerging Pathogens:** Understanding where zoonotic viruses originate and how they are transmitted from animals to humans is a key research priority identified by the WHO. U.S. research on the human and ecological drivers of disease spillover could help detect novel pathogens likely to cause severe outbreaks and facilitate faster and more effective responses to public health emergencies across the globe.

- **R&D for Diagnostics, Therapeutics, and Vaccines:** The WHO suggests taking advantage of all available technological innovations to improve survival and recovery. Further, the WHO recommends close collaboration among researchers to expedite the development of tests that quickly identify sick people, but also to optimize the use of currently available treatments and evaluate candidates for new drugs and vaccines. U.S. research in this area could help develop health technologies that would control the effects of disease and increase global preparedness between crises. The House Committee on

[37] Kang-Xing Jin, "Keeping People Safe and Informed About the Coronavirus," *Facebook*, January 30, 2020.
[38] Jun Chu and Jennifer McDonald, "Helping the world find credible information about novel #coronavirus," *Twitter*, January 29, 2020.
[39] Ryan Broderick, "YouTube Has Been Cracking Down on Coronavirus Hoaxes, But They Are Still Going Viral," *BuzzFeed News*, February 12, 2020.
[40] Tony Romm, "Fake cures and other coronavirus conspiracies are flooding WhatsApp, leaving governments and users with a 'sense of panic'," *Washington Post*, March 2, 2020.
[41] Tony Romm, "Millions of tweets peddled conspiracy theories about coronavirus in other countries, an unpublished U.S. report says," *Washington Post*, February 29, 2020.
[42] World Health Organization, "An R&D Blueprint for Action to Prevent Epidemics," Plan of Action, May 2016.
[43] National Academies of Sciences, Engineering, and Medicine 2017, "Integrating Clinical Research into Epidemic Response: The Ebola Experience," Washington, DC: The National Academies Press.
[44] World Health Organization, "A research and development Blueprint for action to prevent epidemics."

Science, Space, and Technology held a hearing on vaccine innovation on November 20, 2019.[45]

- **R&D for Social Science:** According to the WHO, integrating social scientists into outbreak responses helps communities accept and adhere to public health measures aimed at limiting disease transmission.[46] Fear, anxiety, and stigma can drive sick people to hide their symptoms to avoid discrimination, prevent some individuals from seeking health care immediately, and discourage others from adopting healthy behaviors.[47] U.S. research on how to combat misinformation during outbreaks could improve prevention and control measures and strengthen global public health communication.

[45] "Fighting Flu, Saving Lives: Vaccine Science and Innovation," hearing before the H. Comm. On Sci., Space, and Tech. (November 20, 2019).
[46] World Health Organization and Global Research Collaboration for Infectious Disease Preparedness, "2019 Novel Coronavirus Global Research and Innovation Forum: Towards a Research Roadmap," February 2020.
[47] World Health Organization, "Coronavirus disease 2019 (COVID-19) Situation Report – 35."

Chairman BERA. This hearing will come to order. Without objection, the Chair is authorized to declare recess at any time. Good morning, and welcome today's hearing on "Coronavirus: Understanding the Spread of the Infectious Disease, and Mobilizing Innovative Solutions". I'll recognize myself for an opening statement, and then I'll recognize the Ranking Member for his opening statement, then we'll introduce the witnesses.

Again, thank you for being here. Obviously, this is an incredibly timely topic. COVID–19 is not the first pandemic we're going to ever deal with, and it certainly is not going to be the last one, but it is incredibly important that we come together as a nation, and as a planet, to get ahead of this, address it, and, you know, come up with the treatment for it. If we think about, you know, the basis of global health security, it's a three-pronged approach, containment, mitigation, and then treatment.

This is the third hearing that I'm chairing on this subject, and the first hearing focused on the containment strategy. That was actually the first hearing that Congress held. Conclusion of that was the initial strategy of trying to contain this disease with travel bans, et cetera, was likely not going to be successful, very difficult. You know, I think what China did was ambitious, it bought us some time but most of us in the public health world—and I'm a physician by background, and ran a large public health system—recognize that we would likely see community cases. It would be very difficult to stop the spread of this disease.

The second hearing we had, which was last Thursday, was on mitigation, largely looking at testing. And this was last Thursday, after the first community spread case hit my home county of Sacramento, where a patient was hospitalized at the University of California Davis Health System, where I used to practice. What we discovered was, you know, the testing criteria were probably too rigid, that we were missing a lot of community tests, and we also started to discover the ability to test folks, the availability of test kits, et cetera, was largely not there. I'm pleased, you know, to hear the Vice President yesterday. Things are ramping up, but we probably did lose quite a bit of time, and we are likely going to see many more community cases, probably in all of our congressional districts. So we still, you know, there's a lot to be learned from kind of the bureaucratic breakdown that prevented us from rapidly getting those tests out there.

Today's hearing is focused on treatment based on science, and what we can learn from how this virus initially developed, what we can learn from looking at the Chinese response. We now have a big data set. How did they manage folks? You know, China is a communist country, so they were able to do things that we can't do as a democratic nation. You know, we respect individual rights and individual freedoms here, but there's still a lot that we can learn from how they did surveillance, et cetera, especially given the breadth of contact tracing that we likely are going to have to do based on the community cases that we're going to see all across the United States. We won't have enough epidemiologists, the CDC (Centers for Disease Control and Prevention) won't have enough personnel, so what can we learn in how China and Korea—and if you're looking at the data that's coming out of Korea now, their ag-

gressive approach to testing, and community-based testing. They were doing 15,000 tests a day, may have actually mitigated and reduced how bad the response could've been. So I think that's going to be incredibly important.

We're also going to look at the science of, you know, how is it spread? How efficiently is it spread? You know, how long can this virus live as a fomite on inanimate objects? So, you know, I think this is an incredibly timely hearing. I think this is, you know, this is the Science Committee, so I'm glad that we're looking at the science of this, and the science basis of treatment, and, again, I appreciate the witnesses that are here that are bringing their scientific expertise to help us better understand this disease.

[The prepared statement of Chairman Bera follows:]

Good morning and welcome to today's hearing on Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions. I want to thank Ranking Member Lucas, the Members of this Committee, and our witnesses for joining us today to discuss the scientific tools and research investments we need to better detect, predict, and understand the spread of emerging diseases. While the Chairwoman is not able to join today, I'm proud to hold the gavel and appreciate her strong commitment to public health.

As a doctor, the former Chief Medical Officer of Sacramento County, and a member of the CSIS Commission on Strengthening America's Health Security, I have been a strong advocate of American leadership in global health. Congress' job is to exercise oversight over the federal government's response to COVID-19. That is precisely what I have been doing, both as the Vice Chair of the Science, Space, and Technology Committee and as the Chairman of the Foreign Affairs Subcommittee on Asia, the Pacific, and Nonproliferation. In addition to this hearing, I have chaired two other Congressional hearings on the coronavirus outbreak, sounded the alarm when the White House disbanded the office in charge of preparing for pandemics, and sought to include funds to combat coronavirus over a month ago through other legislation.

Viruses have caused some of the most dramatic and deadly disease outbreaks in human history. Novel viruses of animal origin-like SARS and MERS-have been emerging at an alarming rate over the last two decades. People are traveling more internationally and living in more densely populated areas. We are expanding into new geographic areas through deforestation, mining, and agricultural land use. Humans are coming into closer contact with animal species that are the perfect hosts of infectious agents, making it easier for viruses to jump from animals to humans.

Disease outbreaks caused by new viral infections are a growing public health concern for the global community, as viruses show no respect for national boundaries. The effect of COVID-19 on our communities will depend on how the virus spreads, the severity with which people get sick, and the measures we have available to control its impact. I'd like to drive home the point that these questions can all be answered by a rapid and robust research response.

Yet recent outbreaks have highlighted the strengths and weaknesses of our research and development response, both domestically and internationally. We need additional research to expedite the development of diagnostic tests to quickly identify those that are sick and push those testing capabilities to every state. Not only will this protect our public health personnel on the front lines, but it will also give them the tools to combat the disease head on.

Thanks to my role with the Foreign Affairs Committee, I am also aware of the importance of social science in guiding our response and actively combating the spread of misinformation around infectious disease outbreaks. Fear, anxiety, and stigma can drive sick people to hide their symptoms to avoid discrimination, prevent some individuals from seeking health care immediately, and discourage others from adopting healthy behaviors. Integrating social scientists into our outbreak response helps communities accept and adhere to public health measures aimed at limiting the spread of disease.

Research and development actions are an integral part of the response to an outbreak. Scientists are using innovative technologies like artificial intelligence to detect and predict the spread of disease more effectively. Others are conducting research to optimize the use of currently available treatments and evaluate candidates for new drugs and vaccines. It is apparent now more than ever that our best scientists should be leading our response.

For the last 14 months, this Committee has worked tirelessly to ensure that decision-making is driven by science. Now is the time to listen and trust science and use it to react calmly and smartly to COVID-19. It is critical that we are not swayed by misinformation and avoid the stigmatization of vulnerable groups.

This issue has hit close to home. The first reported death from COVID-19 in California occurred in Roseville, California, which borders my district. Sacramento County is now monitoring several potential cases of COVID-19 transmission. The hospital where I used to attend in and teach medical students is treating a patient with the disease. My heart is with those who are currently suffering.

I continue to believe that the risk to the American people is low at this time. But this disease is global in scope and it is impacting our communities and our economy. Tackling it will require our communities, our government, and our international partners working together. With American leadership, we can do it. But it will require proper planning, coordination, and resourcing. It's not too late.

I look forward to hearing from our witnesses today on how we can best support our nation's scientists as they deploy new health technologies and develop scientific information critical to controlling and mitigating the effects of emerging infectious diseases.

With that, I will turn it over to the ranking member, Mr. Lucas.

Chairman BERA. With that, the Chair now recognizes the Ranking Member, Mr. Lucas, for his opening statement.

Mr. LUCAS. Good morning, and thank you, Dr. Bera, for holding this important hearing as we deal with an emerging and rapidly evolving situation with the spread of coronavirus, COVID–19. According to the Centers for Disease Control at this time, most people in the United States have little immediate risk of exposure to the virus, however, public health experts also advise us a pandemic is likely, so we must gather the facts and be prepared. Today I hope our expert witnesses can provide important information we can share with our constituents. I also hope we can learn what tools are needed to detect, predict, and prevent the next pandemic.

COVID–19 was first identified in Wuhan, China in December of 2019. Since then the World Health Organization has reported over 90,000 confirmed cases, and over 3,000 deaths spread throughout 76 countries. In the United States, the CDC has reported at least 152 confirmed cases and 11 deaths. We know that for most individuals the illness is not serious, but we're still getting information on the death rate. The impact on vulnerable populations is particularly concerning, though, and my thoughts are with the individuals and families that have been affected.

This is not the first global pandemic in modern times, and I'm quite certain it won't be the last. Just over 100 years ago the world faced one of the deadliest pandemics in history, the 1918 avian flu pandemic, also known as the Spanish flu. It killed an estimated 50 million people worldwide, including over 600,000 people in the United States. Since 1980, outbreaks of emerging infectious diseases have been occurring with greater frequency and have been causing higher numbers of human infections than in the past. The vast majority of these infections are initially caused by the spread of the disease from animals to humans. A SARS (Severe Acute Respiratory Syndrome) outbreak in 2003 and an avian flu outbreak in 2006 were wakeup calls for the American public health system, and Congress made considerable investments in improving our Nation's capacity to detect and respond to pandemics. We would be in a much worse position today without those investments.

I'm confident that the U.S. Government has the tools necessary to deal with this. We have the best scientists in the world with

NIH (National Institutes of Health), CDC, and in our universities. Their work has yielded considerable advancements in health technology, disease surveillance, and predictive modeling, as well as medicine, drugs, and vaccine development. With the integration of technology like artificial intelligence (AI), and the greater availability of data, researchers are now able to identify and track outbreaks faster. Last Congress, we also modernized the *Pandemic All-Hazards Preparedness Act* to set up a framework to deal with precisely this type of outbreak. While significant progress has been made, gaps remain, and a severe pandemic like the novel coronavirus could be devastating to the global population.

As the human population has grown, so has the livestock, swine, and poultry populations needed to feed us. This expanded number of hosts provides increased opportunities for viruses from birds, cattle, and pigs to spread, evolve, and infect people. To better understand how zoonotic diseases like avian flu, swine flu, Ebola, Zika, SARS, and now coronavirus spread and operate, we must invest in basic research to learn more about the interconnection between people, animals, and plants in shared environments. Yesterday the House passed a supplemental appropriations bill to address the response to COVID–19 and the development of a vaccine. I supported the bipartisan bill, and I hope my colleagues and I can work together on a long-term strategy to prepare for any global pandemic we may face in the future. Our top priority is the health and welfare of the American people.

I'm pleased the President has created the Coronavirus Task Force. This interagency group is working to monitor, contain, and mitigate the spread of the novel coronavirus, while ensuring the American people have access to accurate and up-to-date health and travel information. The best thing Americans can do right now is to follow the guidance of CDC. Many of their recommendations are simple ones you learned from your mother. Wash your hands, wash your hands, do it thoroughly and frequently, cover your mouth to cough or sneeze, avoid touching your face, stay home if you are sick.

I want to thank the witnesses for taking the time to come here to share their expertise and insights with us during this crucial time to help keep Americans safe, healthy, and secure. And, with that, I yield back the balance of my time, Mr. Chairman.

[The prepared statement of Mr. Lucas follows:]

Good morning and thank you Chairwoman Johnson for holding this important hearing as we deal with an emerging and rapidly evolving situation with the spread of the coronavirus COVID-19.

According to the Centers for Disease Control (CDC), at this time most people in the United States have little immediate risk of exposure to the virus. However, public health experts also advise us a pandemic is likely, so we must gather the facts and be prepared.

Today I hope our expert witnesses can provide important information we can share with our constituents. I also hope we can learn what tools are needed to detect, predict, and prevent the next pandemic.

Covid-19 was first identified in Wuhan, China in December 2019. Since then the World Health Organization has reported nearly 90,000 confirmed cases and over 3,000 deaths spread throughout 76 countries. In the United States, the CDC has reported 152 confirmed cases and 11 deaths. We know that for most individuals the illness is not serious, but we are still getting information on the death rate. The impact on vulnerable populations is particularly concerning though, and my thoughts are with the individuals and families that have been affected.

This is not the first global pandemic in modern times, and I am certain it won't be the last. Just over a hundred years ago the world faced one of the deadliest pandemics in history - the 1918 avian flu pandemic, also known as the ″Spanish flu.″ It killed an estimated 50 million people worldwide, including over 600,000 people in the United States.

Since 1980, outbreaks of emerging infectious diseases have been occurring with greater frequency and have been causing higher numbers of human infections that inthe past. The vast majority of these infections are initially caused by the spread of disease from animals to humans.

A SARS outbreak in 2003 and an Avian flu outbreak in 2006 were wake-up calls for the American public health system, and Congress made considerable investments to improve our nation's capabilities to detect and respond to pandemics. We would be in a much worse position today without those investments.

I am confident the U.S. government has the tools necessary to deal with this. We have the best scientists in the world at NIH, CDC, and in our universities. Their work has yielded considerable advancements in health technology, disease surveillance and predictive modeling, as well as medicine, drugs, and vaccine development.

With the integration of technology like artificial intelligence and the greater availability of data, researchers are now able to identify and track outbreaks faster. Last Congress, we also modernized the *Pandemic All-Hazards Preparedness Act* to set up a framework to deal precisely with this type of an outbreak. But while significant progress has been made, gaps remain, and a severe pandemic like the novel coronavirus could be devastating to the global population.

As the human population has grown, so has the livestock, swine and poultry populations needed to feed us. This expanded number of hosts provides increased opportunities for viruses from birds, cattle and pigs to spread, evolve, and infect people.

To better understand how zoonotic diseases like avian and swine flu, Ebola, Zika, SARS, and now COVID-19 spread and operate, we must invest in basic research to learn more about the interconnection between people, animals, and plants in shared environments.

Yesterday the House passed a supplemental appropriations bill to fund the response to COVID-19 and the development of a vaccine. I supported the bipartisan bill. But I hope my colleagues and I can work together on a long-term strategy to prepare for any global pandemic we may face in the future.

Our top priority is the health and welfare of the American people. I am pleased the President has created the Coronavirus Task Force. This interagency group is working to monitor, contain, and mitigate the spread of the novel coronavirus while ensuring the American people have access to accurate and up-to-date health and travel information. The best thing Americans can do right now is follow the guidance of the CDC. Many of their recommendations are simple ones you learned from your mother, wash your hands thoroughly and frequently, cover your cough or sneeze, avoid touching your face, and stay home if you are sick. I want to thank the witnesses for taking the time to be here to share your expertise and insights with us during this crucial time to help keep Americans safe, healthy, and secure. I yield back the balance of my time.

Chairman BERA. Thank you, Mr. Lucas. If there are members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time I'd like to introduce our witnesses. First we have Dr. Suzan Murray. Dr. Murray is the Program Director of the—for the Global Health Program at the Smithsonian's National Zoo and Conservation Biology Institute. Next is Dr. John Brownstein. Dr. Brownstein is the Chief Innovation Officer at Boston Children's Hospital, and a Professor at Harvard Medical School. Third I welcome Dr. Peter Hotez, who will be introduced by the Chair for the Subcommittee on Energy, Lizzie Fletcher of Texas.

Mrs. FLETCHER. Thank you very much, Mr. Chairman. It's truly a privilege and a pleasure to introduce an internationally recognized physician/scientist in global health, neglected tropical diseases, and vaccine development who is also my neighbor, and a true leader in our community in Houston, Dr. Peter Hotez.

Dr. Hotez is Professor and Dean at Baylor College of Medicine, and Co-Director of Texas Children's Hospital Center for Vaccine

Development. As head of Texas Children's Center for Vaccine Development, he leads a team of product development partnership for developing new vaccines for a variety of diseases, including other human coronaviruses, like SARS and MERS (Middle East Respiratory Syndrome), diseases affecting hundreds of millions of children and adults worldwide, while championing access to vaccines globally and in the United States. Dr. Hotez, welcome. We are glad to have you here today.

Chairman BERA. And lastly we have Dr. Tara Kirk Sell. Dr. Sell is a Senior Scholar at Johns Hopkins Center of Health Security, and is an Assistant Professor at Johns Hopkins Bloomberg School of Public Health.

You will each have 5 minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When you have completed your spoken testimony, we'll begin with questions. Each member will have 5 minutes for questioning. Dr. Murray, you may proceed.

TESTIMONY OF SUZAN MURRAY, PROGRAM DIRECTOR, SMITHSONIAN GLOBAL HEALTH PROGRAM, SMITHSONIAN'S NATIONAL ZOO AND CONSERVATION BIOLOGY INSTITUTE

Dr. MURRAY. Thank you very much. Congressman Bera, Ranking Member Lucas, and all Members of the esteemed Committee, thank you for calling this hearing, and inviting me to participate. My name is Dr. Suzan Murray, and I'm the Director of Smithsonian's Global Health Program, based out of the National Zoological Park and Conservation Biology Institute. Our program utilizes experts in wildlife medicine, human medicine, public health, conservation, biology, and epidemiology to study and respond to health issues at the human/animal interface. We utilize a multidisciplinary approach to investigate emerging infectious diseases that threaten both human and animal life, and we build in-country capacity to train the next generations of health specialists. In short, this is the reason right now that our program was created.

Human health, wildlife, and environmental health are inextricably linked, and closely depend upon each other. In order to safeguard the survival of all species, it's critical that we examine health across a continuum of species, and have research and decisions firmly rooted in scientific knowledge. Understanding the current viral threats, the patterns and drivers of disease emergence, and the human behaviors that contribute to such emergence, will best allow us to not only respond to this outbreak, but the next one, and the one after that, because we do know they're coming. Already we have identified many of the drivers of disease emergence and spread, including land use change, increased human/wildlife interaction, and the globalization of travel and markets.

Time and history have repeatedly shown us that it is much more humane, efficient, and economical to prevent disease rather than to identify, respond, diagnose, treat, and attempt to contain an outbreak. Through increased understanding of the as-yet undiagnosed viruses, the drivers of emergence, and the risk factors associated with various behaviors, we can develop the early warning systems,

prepare for—prepare rapid response teams, and provide critical data and information to the vaccine industry to better prepare for the next outbreak. Just as critical, we must educate local medical professionals, and the people living in the communities at the greatest risk of outbreaks. By preventing the spread of pathogens at the source, we can avoid the global consequences that we are experiencing now.

For example, over the last 10 years, and working with partner agencies, our team has collectively identified over 1,200 novel mammalian viruses. So that's, you know, 1,200 is a lot of viruses. It's only a small amount of the ones that are out there. One hundred sixty-one of these belong to the same family as COVID–19. In this time we also strengthened the capability for virus detection and characterization in 60 labs, and—in which pandemics are most likely to originate. We've also trained over 6,000 people in more than 30 countries at the frontline of defense against emerging diseases. At this moment, the world is focused on the novel coronavirus, COVID–19, as it should be. While it's essential that we do everything we can to respond to this global crisis, it's also the time we need to be thinking of emerging viruses. The next global pandemic is not a matter of if, but when and where. To quickly identify and contain such infections, health and disease must be evaluated across species, and on a global scale.

While he might not have imagined it in this context, Ben Franklin was right when he said an ounce of prevention is worth a pound of cure. When it comes to outbreaks, the costs of responding to a crisis can dwarf the up front investment in research and education. Beyond a clear moral obligation to protect human life, there are staggering financial benefits from focusing on preventative measures. For example, the human and economic toll from the West African Ebola outbreak was massive. More than 11,000 people lost their lives, and well over $4 billion was spent globally. In case of the SARS epidemic of 2004, the estimated global financial impact was between $30 and $50 U.S. billion dollars, and the current COVID impact, while still evolving, and a dynamic situation, is expected to be on orders of magnitude higher.

Advancements in the detection of novel pathogens show that the most efficient way to respond to and contain an outbreak is through the coordinated wildlife and human surveillance. While we estimate there are 1.7 as yet unknown viruses, about half of which can affect human people, and some lead to new pandemics. As of now, there are no coordinated programs to work in high risk regions to identify these unknown viruses, get their genetic sequences into labs, and identify ways to reduce risk of them emerging. Our best defense against spreading diseases that make their way into the human population is through research and education. While we cannot stop every disease outbreak, we can reduce their frequency, and build the capacity for a rapid global response when they do occur.

Thank you once again for this hearing, and your interest in this pressing and important topic. I look forward to answering any questions you might have.

[The prepared statement of Dr. Murray follows:]

Smithsonian Institution

Written Testimony of
Dr. Suzan Murray, D.V.M., D.A.C.Z.M., Director, Smithsonian Global Health Program
Smithsonian National Zoological Park and Conservation Biology Institute

Beyond Coronavirus:
Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions

House Committee on Science, Space, and Technology
U.S. House of Representatives
March 5, 2020

Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, thank you for calling this hearing, and inviting me to participate. My name is Suzan Murray, and I am the Director of Smithsonian's Global Health Program, based out of the National Zoological Park and Conservation Biology Institute. This program utilizes experts in wildlife medicine, human medicine, public health, conservation biology, epidemiology, virology and molecular biology to study and respond to issues emerging at the human/animal interface. We utilize a multidisciplinary approach to investigate emerging infection diseases that threaten both human and animal life, and we build in country capacity and train the next generation of health specialists.

Human health, wildlife health, and environmental health are often described as inextricably linked and closely dependent upon one another. In order to safeguard the survival of all species, it is critical that we examine health across a continuum of species and have research and decisions firmly rooted in scientific knowledge. Understanding the current viral threats, the patterns and drivers of disease emergence, and the human behaviors that contribute to such emergence will best allow us to not only respond to this outbreak, but the next one and the one following that because we know this is coming. Already we have identified many of the drivers of disease emergence and spread, including land use change, increased human/wildlife interaction, and globalization of travel and markets.

Time and history have repeatedly shown us it is much more humane, efficient, and economical to prevent disease, rather than identify, respond to, diagnose, treat, and attempt to contain an outbreak. Through increased understanding of the as-of-yet undiscovered viruses, the drivers of emergence, and the risk factors associated with various behaviors we can develop early warning systems, prepare rapid response teams, and provide critical data and information to the vaccine industry to better prepare for the next outbreak.

Just as critical, we must educate local medical professionals and the people living in communities with the greatest risk of outbreaks. By preventing the spread of pathogens at the source, we can avoid the global consequences we are seeing now.

For example, over the last 10 years, working with partner agencies, we have identified more than 1,200 novel wildlife-borne viruses, 161 of which belong to the same family as the COVID-19 virus. In that time, we strengthened the capability for virus detection and characterization in 60 labs in regions where

pandemics are most likely to originate, and trained over 6,600 people in more than 30 countries to be our front line of defense against emerging diseases.

At this moment, the world is focused on the novel coronavirus, COVID-19. While it's essential that we do everything we can to respond to the emerging global crisis, now is also a time when we should be thinking about future emerging viruses.

Research published in the Proceedings of the National Academy of Sciences has found that spillover of new viral infections from animals to humans is occurring with increased frequency, a direct result of the increased interaction people now have with wildlife and their products. The next global pandemic is not a matter of if, but when and where. To quickly identify and contain such infections, health and disease must be evaluated across species on a global scale.

While he might not have imagined it in this context, Ben Franklin was right when he said "An ounce of prevention is worth a pound of cure." When it comes to outbreaks, the costs of responding to a crisis can dwarf the up-front investment in research and education. Beyond the clear moral obligation to protect human life, there are staggering financial benefits from focusing on preventative measures. For example, the human and economic toll from the West African Ebola epidemic was massive—more than 11,000 people lost their lives and over $3.6 billion dollars was spent globally, with nearly $2.4 billion spent by the U.S., in response. A global economy compounds the economic impacts of disease through travel, trade, and financial networks. In the case of the SARS epidemic of 2004, the estimated global financial impact was between $30 and $50 billion, Ebola was $10 billion, and the current COVID-19 impact, while still an evolving and dynamic situation, is expected to be even higher. It is obvious through market reaction by now that this outbreak has already created an international financial impact.

Advancements in the detection of novel pathogens show the most efficient way to identify, respond to, and contain an outbreak is through coordinated wildlife and human surveillance. We estimate there are 1.7 million unknown viruses, around half of which could infect people, and some lead to new pandemics. As of now, there are no coordinated programs to work in high risk regions to identify these unknown viruses, get their genetic sequences into our labs, and identify ways to reduce risk of them emerging. Our best defense against spreading diseases that make their way into human populations is through research and education. While we cannot stop every disease outbreak, we can reduce their frequency and build the capacity for a rapid global response when they occur.

Thank you once again for having this hearing and for your interest in this pressing and important topic. I look forward to answering any questions you may have.

SMITHSONIAN'S NATIONAL ZOO & CONSERVATION BIOLOGY INSTITUTE

Suzan Murray, D.V.M., D.A.C.Z.M.

Director, Smithsonian Global Health Program

B.S., Amherst College; DVM, Tufts University; Board-Certified Diplomate, American College of Zoological Medicine (DACZM)

Dr. Suzan Murray is a board-certified zoo veterinarian at the Smithsonian Conservation Biology Institute and serves as both the program director of the Global Health Program and as the SCBI's chief wildlife veterinary medical officer. She leads an interdisciplinary team engaged in worldwide efforts to address health issues in endangered wildlife and combat emerging infectious diseases of global significance, including zoonotic diseases. Dr. Murray also acts as the Smithsonian liaison to the Foreign Animal Disease Threat and Pandemic Preparedness subcommittees of the White House's Office of Science and Technology. Dr. Murray's work focuses on providing clinical care to free-ranging wildlife, pathogen detection, advanced diagnostics, training of international veterinarians and other health professionals, capacity building, and collaboration in infectious disease research at the human-wildlife-domestic animal interface. She previously served as chief veterinarian for the Smithsonian's National Zoo and has a wealth of clinical knowledge and experience with wildlife and zoo animals both free-ranging and in human care.

Dr. Murray earned a bachelor's degree from Amherst College in 1984 and completed her veterinary degree in 1991 from Tufts University. After a surgical internship, she completed a residency in zoological medicine at the Smithsonian's National Zoo in 1995 and became a Diplomate of the American College of Zoological Medicine (DACZM) in 2000. Dr. Murray has been either the principle investigator or co-principle investigator on several research grants including Morris Animal Foundation, Smithsonian Endowment, Smithsonian Women's Committee, and James Bond Funds.

TESTIMONY OF JOHN BROWNSTEIN,
CHIEF INNOVATION OFFICER,
BOSTON CHILDREN'S HOSPITAL
AND PROFESSOR, HARVARD MEDICAL SCHOOL

Dr. BROWNSTEIN. Congressman Bera, Ranking Member Lucas, and distinguished Members of the U.S.——

Chairman BERA. Dr. Brownstein, could you turn your mic on?

Dr. BROWNSTEIN. That would help. Congressman Bera, Ranking Member Lucas, and distinguished Members of the U.S. House of Representatives Committee on Science, Space, and Technology, thank you for inviting me today to speak with you. Today I'll describe ways that novel technologies like artificial intelligence can help detect, monitor, and predict emerging infectious diseases. I'll also discuss how non-traditional sources can supplement existing epidemiological techniques. But as I describe the good news about such advances, I don't want to sugarcoat the bad, for the current Federal investments in disease surveillance are inadequate and transient. We urgently need Federal and local investment in new technologies for public health surveillance and response. Such investment will augment the capacity of public health to implement new ways to monitor the health of populations. It will deepen our understanding of community-based morbidity and mortality. It will also save lives.

This is the goal of my team at Boston Children's Hospital, where we develop innovative surveillance technology, where we use freely online information to provide insights for both public health agencies and the general public. We did this for the H1N1 influenza pandemic, H7N9, avian influenza, Ebola in West Africa, and now COVID–19. These platforms, and our research, have ultimately played a critical role in that innovative surveillance technologies can help detect, monitor, and ultimately mitigate the impact of these diseases.

Our inaugural project, HealthMap, which is available to the public, brings together disparate sources from a variety of data streams to help provide a unified view of the world of infectious diseases. To do that we use AI, machine learning, natural language processing, all to organize that information and make it available. Here's an example. On December 30, 2019 the platform alerted us to an unknown viral pneumonia. That turned out to be one of the earliest signals of the current COVID–19 outbreak.

Using AI in modeling of epidemics is one of the areas of research offering vast insights into the potential burden of disease, and where it spreads. Machine learning models can predict where a given virus may arrive next. That lets us inform public health organizations about how to respond. Predictive modeling can also be used with data like prior disease history, weather, travel patterns, laboratory data, symptom surveillance. All, together through AI, help us exchange information, conduct surveillance, and measure public response to the events and response.

It is also critical to support sentinel surveillance of disease. Sentinel surveillance allows public health officials to identify signals early, impacts, and disease burden in the community. One such example is Flu Near You, which is a crowdsourcing platform for symptom surveillance in the U.S. It offers two advantages. One, it

identifies individuals who may be ill, but not seeking medical attention, and it's in real time. Our team has now augmented this tool to improve with COVID–19 surveillance.

To date, there is no evidence supporting widespread transmission of COVID–19 in the U.S., but does suggest that sustained transmission in the community level will be occurring. Current global situation suggests that this outbreak will become a pandemic. It threatens the people—the health of the people of the United States and globally. The COVID–19 outbreak also demonstrates some reasons for optimism. It demonstrates what we can accomplish when the scientific and humanitarian disciplines unite around a common goal. We understand that each outbreak might require a slightly different approach to monitoring response, but there are key updates and metrics that we need in every single outbreak. There are questions that we must ask, how many new cases are there? What is the geographic spread? Are healthcare workers infected? We can help answer these questions by using both digital disease platforms, along with traditional surveillance. We aggregate data from a variety of these sources in real time.

There's an epidemiological expression that expresses what we want, prioritizing sensitivity over specificity. In English this means that—risking some false positives to uncover more of those who are sick. These platforms do that. They aggregate everything available to provide stakeholders with a snapshot of the current view of the situation. Those within the realm of infectious diseases often say it is not a matter of if, it's a matter of when. We continually need support for initiatives to make an impact both domestically and globally through infectious disease monitoring and surveillance. By investing in our neighbors, and promoting health initiatives outside of our borders, we help reduce the threat of an outbreak reaching the United States.

There's another essential step to being prepared, long term support of the Centers for Disease Control and Prevention, and for local Departments of Public Health. The CDC's Influenza Surveillance Systems are the backbone of flu surveillance for this country. Augmenting this surveillance system with novel programs like HealthMap provides us with additional information. It allows the public health authorities, clinicians, researchers, and the general public to stay alert of what's happening. And this is why I urge this Committee to make sure the United States provides sustained investment in the fundamental needs of disease detection and surveillance. That means investments domestically and around the world. Non-traditional data sources and enhanced data processing through AI and machine learning have proven their worth. They support traditional surveillance, they aid in the developing of a clear path, and a picture of an existing or potential infectious disease threat to human health.

You have shown through your thoughtful leadership on these issues in the past, and now we need your help again, for with your continued support, we cannot only strengthen the public health community, we will protect the lives that we serve. Thank you again, and I look forward to your questions.

[The prepared statement of Dr. Brownstein follows:]

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL | Boston Children's Hospital Until every child is well | HealthMap

Written Testimony before The U.S. House Of Representatives Committee on Science, Space and Technology

HEARING ENTITLED:
"Beyond Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions."

Dr. John Brownstein, PhD
Chief Innovation Officer, Boston Children's Hospital
Professor, Harvard Medical School

Thursday, March 5, 2020

Chairwoman Johnson, Ranking Member Lucas and distinguished members of the U.S. House of Representatives Committee on Science, Space and Technology, thank you for inviting me to speak with you today. I will be addressing the topic of "Beyond Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions" and sharing with you how novel technologies, like Artificial Intelligence (AI), can help predict, detect and monitor emerging infectious diseases while also discussing how nontraditional data sources can supplement existing epidemiological techniques. It is my goal to share how these technologies have changed the ways we manage public health crises or potential crises and what the future can hold, with proper investments and planning.

I am a Professor at Harvard Medical School and the Chief Innovation Officer at Boston Children's Hospital. I also direct the Computational Epidemiology Lab at the Boston Children's Hospital's Computational Health Informatics Program. My research aims to have translational impact on the surveillance, control and prevention of disease. My team develops innovative infectious disease surveillance platforms that use freely available online data to provide real-time insights for both public health officials and the general public. Throughout the 2009 H1N1 influenza pandemic, H7N9 Avian Influenza, Ebola in West Africa, Zika in the Americas and now COVID-19, these platforms, and our research, have highlighted the critical role that innovative surveillance can have on outbreak detection, monitoring, and mitigation.

Our inaugural project, developed in 2006, is called HealthMap. It is a publicly available platform, which brings together disparate data sources, including online news aggregators, eyewitness reports, expert-curated discussions and validated official reports, to achieve a unified and comprehensive view of the current global state of infectious diseases. The system automates data acquisition, filtering and characterization of information, using machine learning algorithms and natural language processing. The system ingests and classifies its data independently, without human intervention. However, we choose to keep a human in the loop - having infectious disease analysts review the content to correct and refine the automated classifications. The analysts ensure that subtle signals of an outbreak are captured. For example, on March 14th 2014 the HealthMap system brought in a French alert reporting cases of "mystery hemorrhagic fever" that had killed eight in Guinea. This was the earliest signal in West Africa of what would become the largest Ebola outbreak in history. On December 30, 2019, we were alerted to an unknown viral pneumonia, which was one of the earliest signals in the current COVID-19 outbreak. The HealthMap platform has been integrated into the Epidemic Intelligence from Open Sources (EIOS) platform developed and maintained by

the World Health Organization. This system supports efforts for event-based surveillance globally, and has proven to be a valuable resource during emerging disease outbreaks.

The HealthMap platform is just one of many that highlight the utility and need for timely, sentinel outbreak signals. Artificial Intelligence (AI) can be used for public health preparedness measures to control the spread of disease, particularly during an emerging disease outbreak. Earlier disease detection provides health leaders with the tools to adequately prevent or prepare against the threat of an emerging disease.

The use of AI in modelling epidemics is one area of research that can provide vast insight into the potential burden of disease, and where it spreads. For example, machine learning models can predict where a given virus may arrive next, and inform public health organizations how to prepare in response. Predictive modelling techniques can utilize information like prior disease history, weather and travel patterns, laboratory testing, symptom surveillance and more. These forecasting tools have the power to provide insights on health outcomes and disease progression.

AI use in healthcare systems can provide novel insights on an emerging outbreak, as well. AI has been used to identify patterns in images, scans or records that emulate the disease of interest, providing earlier signs of infection. Increased use of AI for disease surveillance measures can hopefully provide a more rapid response between countries to control epidemics. AI technologies provide value in information exchange, surveillance measure, public response to emerging and seasonal outbreaks, and education on disease threats, all of which are critical needs to prevent or contain an outbreak.

It is also critical to support sentinel surveillance measures of disease. Sentinel surveillance allows public health officials an ability to identify signal trends, and impacts to disease burden in a community. One such example of this is Flu Near You[1], a crowdsourced symptom surveillance tool in the U.S. where users submit health reports weekly. The project, created in partnership with my research lab at Boston Children's Hospital, Ending Pandemics and the American Public Health Association, allows researchers, and local, state and federal public health agencies to access the submitted symptom data to understand disease patterns at the community level. This system captures individuals who may not be seeking medical attention, and is updated in real time. In response to the ongoing novel coronavirus outbreak, our team has added additional questions that may pick up early signals of this virus here in the US, including questions on diagnosis and travel history. As we collect reports in the Flu Near You system, we are able to detect spikes in symptoms over a set amount of time. We can also retroactively look back at symptom reports to learn about potential community spread after a case is confirmed. Systems like Flu Near You are extremely valuable tools to fill in gaps of information, and provide early signals of disease impacts at a community level.

With each outbreak comes its own difficulties. We experienced the lack of online local news media during the West African Ebola outbreak, we have built platforms to allow field epidemiologists on the ground confirm or deny rumored outbreaks.

We understand that each outbreak might require a slightly different approach to monitoring or response. However, there are key updates and metrics, which every outbreak could benefit from: how many new cases, is there geographical spread, are healthcare workers infected, and/or are there new testing or treatment methods available.

[1] https://flunearyou.org/#!/

The use of digital disease detection platforms is complementary to traditional surveillance - aggregating data from a variety of sources in real-time. Prioritizing sensitivity over specificity, these platforms provide stakeholders with a snapshot view of the current situation - aggregating everything that's available.

On December 31, 2019, the World Health Organization (WHO) China Country office was informed of cases of pneumonia of unknown etiology located in Wuhan City, Hubei Province of China[2]. Within 4 days, 44 cases of disease were identified, though no infectious agent or cause was known. At the time, the only link between cases was a seafood market that all cases reportedly visited. On January 7, 2020, Chinese scientists released sequencing that determined that the cause of illness was a novel coronavirus, later named COVID-19[3]. Since the first alert of COVID-19, the number of confirmed cases in China and globally expanded quickly, leading to WHO holding three emergency meetings of the International Health Regulations Emergency Committee (IHR) on January 22, 23 and 30, 2020[3]. IHR, led by WHO Director General Dr. Tedros Adhanom Ghebreyesus, determined that the COVID-19 outbreak is a Public Health Emergency of International Concern (PHEIC) on January 30, 2020 due to the threat of disease globally[3].

As of 10am CET on March 2, 2020, 78,811 confirmed cases of COVID-19 have been reported to WHO globally, including 2,462 deaths related to the disease[4]. The number of cases reported daily in China have continued to decrease, showing promising results in an effort to contain the disease within the country[5]. Based on evidence provided by the WHO-China joint mission, WHO reports that the epidemic peaked and plateaued between January 23 and February 2, 2020 in China and has been steadily declining since that time[5].

WHO currently has the global risk level for COVID-19 as very high. Outside of China, 8,774 cases have been confirmed in 64 countries[4]. In the United States, 62 cases of COVID-19 have been confirmed, including 2 deaths[4]. To date, there is evidence supporting local transmission of COVID-19 in the United States, but does not suggest sustained transmission at the community-level at this time. Additionally, the epidemiologic curve for the outbreak is showing an increase in case reports outside of China over time (fig. 3)[4]. This suggests that COVID-19 has expanded beyond imported cases associated with travel to Hubei, China and has sustained transmission in new regions. Sudden increases in cases since February 21, 2020 in Italy, the Republic of Korea and the Islamic Republic of Iran are deeply concerning for human health and signal that a continued global response is necessary[4].

Great strides have been taken to understand COVID-19 since its discovery. The public health community has united to work quickly to understand the virus and its impact. WHO has been able to determine that the fatality rate is between 2% and 4% in Wuhan, China and 0.7% outside of Wuhan[5]. In most cases of mild disease, recovery time is approximately two weeks and in cases of severe disease, recovery takes three to six weeks[5].

While COVID-19 is not currently circulating in the United States, the risk of sustained transmission is still high. The current global situation suggests that this COVID-19 outbreak has the potential to cause a pandemic, threatening the health of people in the United States and globally[6]. The continued COVID-19 response has demonstrated what can be accomplished as scientific and humanitarian disciplines unite for a common goal. In order to stay persistent in

[2] https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn=20a99c10_4

[3] http://www.diseasedaily.org/diseasedaily/article/world-health-organization-covid-19-outbreak-public-health-emergency

[4] https://www.who.int/docs/default-source/coronaviruse/20200302-sitrep-42-covid-19.pdf?sfvrsn=d863e045_2

[5] https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---24-february-2020

combating COVID-19 and future outbreaks, we need more continuous support for public health initiatives and investment in programs aiding in the detection and monitoring of infectious diseases.

Within the realm of infectious diseases, we often say, "it is not a matter 'if' the next pandemic occurs, but a matter of 'when'". Global emerging and re-emerging infectious diseases are a constant threat to human health. Infectious disease monitoring and surveillance are critical for preventing the spread of disease. We need continual support for initiatives that strive to make an impact both domestically and globally. We live in an interconnected world and it is our duty to protect human health. By investing in our neighbors and promoting health initiatives outside our borders, we are also helping reduce the threat of an outbreak within the United States.

It is critical that, as a nation, we take a stance in promoting global health and health security. We have already seen the impacts that COVID-19 has had, in two months time, on travel, trade, and economies. It highlights the need to support and empower local health departments in preparedness. Long term support for the Centers for Disease Control and Prevention and for local health departments are critical to preparedness efforts. This support should not only include funding, but also oversight and direction to ensure that systems employed utilize the most effective tracking tools, such as AI and other data driven methods and that the findings of publicly funded surveillance translate into action and tools to combat these global challenges. We need to be diligent in our continual response to infectious diseases. The CDC's Influenza surveillance systems are the backbone of flu surveillance in this country. Augmenting the current system with novel programs like HealthMap provides additional information that can help public health authorities, clinicians, researchers and decision makers learn more and react faster to seasonal and novel outbreaks.

With every outbreak, whether it is Ebola, Zika or even influenza, we have a dangerous cycle that exists. The outbreak is announced and captures the attention of politicians and media, where all the alarms are raised. The entire world becomes united with concern and amazing strides are taken, but only for a relatively short period of time. Eventually, we become complacent and as the headlines fade, so does the investment in infectious disease response, both in time and financially. But this cycle needs to change and that can start with you today. If we, the United States, are proactive instead of reactive in the investment of public health and surveillance initiatives, we can hopefully prevent the next COVID-19, or at the very least, reduce its global scale. It is time that we make a continued effort to ensure all public health systems are prepared and equipped to handle any infectious disease threat it may encounter.

Federal government investments have already shown to be successful in protecting human health. Among them, USAID has proven this success through the PREDICT project, which has prepared us for the next pandemic through its wildlife sampling. Through this work, we are able to detect potential zoonotic diseases before humans are infected. But with this achievement, we are clear that we need more support from our federal government to keep innovating and creating novel technologies for the surveillance and detection of infectious diseases globally. Amidst this crisis, we are starkly aware of the need for continual investment so that in the times of peace, we can be preparing for the next event.

In short, it is my recommendation that the United States continues to invest in the fundamental needs of disease detection and surveillance domestically and internationally. Nontraditional data sources and crowdsourcing tools have proven to give support to traditional surveillance activities and can aid in developing a clearer picture of any existing or potential infectious diseases that threaten human health. By leveraging these tools and resources, we can

identify transmission patterns of disease within a community near-real time in order to directly allocate where support is needed to prevent diseases from spreading further. Additionally, the data collected by these tools can allow us to learn about different models of transmission in order to predict the spread of disease in the future.

The COVID-19 outbreak reminds us that while we have made incredible advances in preparedness and response activities, there is still a huge amount of work to be done. Investing in novel technologies that support disease detection and existing epidemiological techniques will provide a new era for handling infectious disease outbreaks. It is only with your continued support that the momentum we have gained as a public health community is maintained.

Thank you for your thoughtful leadership on these issues. I look forward to your questions and wish to continue to be a resource in your important work.

***Please note, the COVID-19 outbreak is rapidly changing both in the United States and globally. All relevant COVID-19 case information provided in this testimony reflects the outbreak situation as of Monday, March 2, 2020.*

Charts and Figures

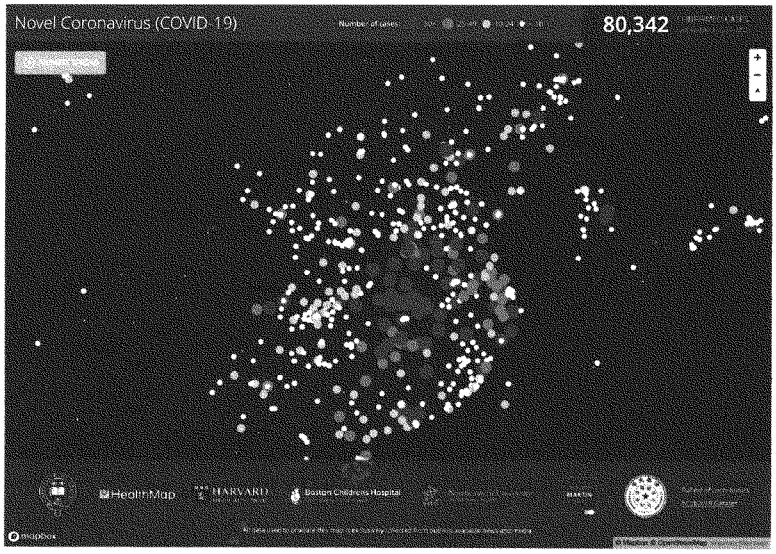


Figure 1: HealthMap COVID-19 map shows confirmed cases of coronavirus globally[6].

[6] https://www.healthmap.org/covid-19/

HARVARD MEDICAL SCHOOL TEACHING HOSPITAL | Boston Children's Hospital Until every child is well | HealthMap

Figure 2: HealthMap shows media reports of COVID-19 globally[7].

Figure 2. Epidemic curve of confirmed COVID-19 cases reported outside of China, by date of report and WHO region with complete days of reporting through 01 March 2020

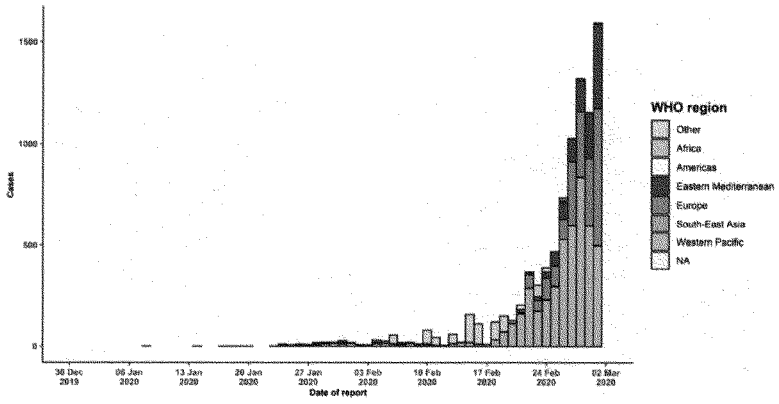
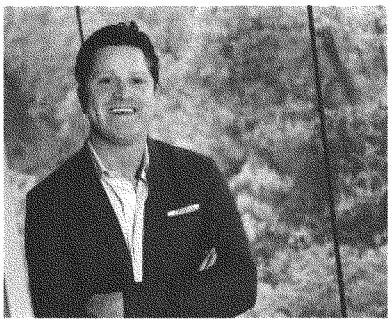


Figure 3: WHO situation report from March 2, 2020 shows epidemic curve of coronavirus cases detected outside of China as increasing over time[4].

[7] https://www.healthmap.org/wuhan/



John S. Brownstein, Ph.D.
Chief Innovation Officer, Boston Children' Hospital
Professor, Harvard Medical School

John Brownstein, Ph.D is Professor of Biomedical Informatics at Harvard Medical School and is the Chief Innovation Officer of Boston Children's Hospital. He also directs the Computational Epidemiology Lab and the Innovation and Digital Health Accelerator both at Boston Children's. He was trained as an epidemiologist at Yale University. Overall, his work aims to have translation impact on the surveillance, control and prevention of disease. He has been at the forefront of the development and application of data mining and citizen science to public health. His efforts are in use by millions each year including the CDC, WHO, DHS, DOD, HHS, and EU, and has been recognized by the National Library of Congress and the Smithsonian. In addition to research achievements, this translational impact comes from playing an advisory role to numerous agencies on real-time public health surveillance including HHS, DHS, CDC, IOM, WHO and the White House. He was awarded the Presidential Early Career Award for Scientists and Engineers, the highest honor bestowed by the United States government to outstanding scientists and the Lagrange Prize for international achievements in complexity sciences. Dr. Brownstein is also Uber's healthcare advisor and co-founder of digital health companies Epidemico and Circulation. He has authored over 200 peer-reviewed articles on epidemiology and public health. This work has been reported on widely including pieces in the New England Journal of Medicine, Science, Nature, New York Times, The Wall Street Journal, CNN, National Public Radio and the BBC.

Short bio

John Brownstein, PhD is Professor of Biomedical Informatics at Harvard Medical School and is the Chief Innovation Officer of Boston Children's Hospital. He directs the Computational Epidemiology Lab and the Innovation and Digital Health Accelerator both at Boston Children's. He was trained as an epidemiologist at Yale University. Dr. Brownstein is also Uber's healthcare advisor and co-founder of digital health companies Epidemico and Circulation.

Chairman BERA. Dr. Hotez?

TESTIMONY OF PETER HOTEZ, PROFESSOR AND DEAN, NATIONAL SCHOOL OF TROPICAL MEDICINE, BAYLOR COLLEGE OF MEDICINE, AND CO-DIRECTOR, TEXAS CHILDREN'S HOSPITAL CENTER FOR VACCINE DEVELOPMENT

Dr. HOTEZ. Thank you very much. Dr. Bera, Congress—Chairman Bera, Ranking Member Lucas, Congresswoman Lizzie Fletcher, thank you for that very generous introduction. I'd also like to acknowledge my fellow Texan, Congressman Pete Olson. It's an honor to be here. I always get thrilled when I have the opportunity—I've been doing this for 20 years—to address Committees in Congress, and it's still a special thrill for me.

I'm a vaccine scientist, and a pediatric scientist. I was previously Chair of Microbiology at George Washington University, just down the road, and then a decade ago we moved to Texas to create a new—a unique school for emerging and neglected tropical diseases, and also to create a unique center for vaccine development, and the need was this. There is an urgency to create vaccines for diseases which don't make money. So we took this on in—with the idea of pioneering not only the interesting science, but also a new business model, and the business model part we haven't quite figured out yet, because we're trying to make diseases—vaccines for diseases no one else will make.

So we have a schistosomiasis vaccine now in clinical trials, a leishmaniasis vaccine that we hope will advance to the clinic soon, a hookworm vaccine in clinical trials, a new Chagas disease vaccine that's moving into the clinic. I like to say these are the most important diseases you've never heard of. These are some of the most common afflictions of the world's population, but they mostly occur among people who live in extreme poverty, and so there's no model to figure out who's going to pay for them, so, as a consequence, neither the biotechs, nor the big pharmaceutical companies, make those vaccines. And, for reasons that we'll explore this morning, we also took on, a decade ago, the interesting problem of making coronavirus vaccines, because we recognize these as enormous public health threats, and yet we have not seen the Big Pharma guys and the biotechs rushing into this space.

So we partnered with a group at the New York Blood Center and the Galveston National Laboratory to take on the big scientific challenge of coronavirus vaccines. And I say a scientific challenge because one of the things that we're not hearing a lot about is the unique potential safety problem of coronavirus vaccines. This was first found in the early 1960s, with the respiratory syncytial virus (RSV) vaccines that—and it was done here in Washington with the NIH and Children's National Medical Center, that some of those kids who got the vaccine, actually did worse, and I believe there were two deaths as—in the consequence of that study.

Because what happens with certain types of respiratory virus vaccines, you get immunized, and then, when you get actually exposed to the virus, you get this kind of paradoxical immune enhancement phenomenon. And what—how—and we don't entirely understand the basis of it, but we recognize that it's a real problem

for certain respiratory virus vaccines. That killed the RSV program for decades. Now the Gates Foundation is taking it up again, but when we started developing coronavirus vaccines, and our colleagues, we noticed in laboratory animals that they started to show some of the same immune pathology that resembled what had happened 50 years earlier, so we said, oh, my God, this is going to be problematic.

But we collaborated with a unique group that figured out how to solve the problem, that if you narrow it down to the smallest subunit, the piece that—of—what's called the receptor binding domain, that docks with the receptor, you get protection, and you don't get that immune enhancement phenomena. So we were really excited about that, and we proposed this to the National Institute of Allergy and Infectious Diseases (NIAID). They funded it, and we wound up actually making and manufacturing, in collaboration with Walter Reed Army Institute of Research, a first generation SARS vaccine. So SARS was the one that emerged in 2003, and then this new one, of course, we call the SARS–2 coronavirus.

We had it manufactured, but then we could never get the investment to take it beyond that. And then—so that was really unfortunate, because we had the vaccine ready to go, but we couldn't move it into the clinic because of lack of funding, because by then nobody was interested in coronavirus vaccines. When the Chinese started putting up the data on bioarchive in January/February, we saw very close homology between the two, and realized that we may be sitting on a very attractive coronavirus vaccine. Now we're working with—again with NIH, and we'll work with BARDA (Biomedical Advanced Research and Development Authority) and others, to get the funding, but now we'll have that lag. And these clinical trials are not going to go quickly because of that immune enhancement. It's going to take time.

And so, you know, all—unfortunately, some of my colleagues in the biotech industry are making these inflated claims, you know, you've seen this in the newspapers, we're going to have this vaccine in weeks, or—in this and that. What they're really saying is they could move a vaccine to clinical trials, but this will not go quickly because, as we start vaccinating human volunteers, especially in areas where we have community transmission, we're going to have to proceed very slowly, very cautiously. The FDA (Food and Drug Administration) is on top of that. They have a great team in place at the Center for Biologics Evaluation Research (CBER). They're aware of the problem, but it's not going to go quickly. We are going to have to follow this very slowly, cautiously, to make certain we're not seeing that immune enhancement.

So, you know, now we're hearing projections, a year, 18 months, who knows? This is not going to go quickly. The bottom line is, had we had those investments early on to carry this all the way through clinical trials years ago, we could've had a vaccine ready to go. So we've got to figure out what the ecosystem is going to be to develop vaccines that are not going to make money. The Big Pharma companies are still not going in, some of the biotechs are starting to, because they're trying to really accelerate their technology, and use it—and hopefully to flip it around for something else that will make money. We need a new system in place, and

I'm happy to explore that with you more during the questions and answers.

Chairman BERA. Right.

Dr. HOTEZ. Thank you.

[The prepared statement of Dr. Hotez follows:]

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Testimony of Peter Hotez, M.D., Ph.D.
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Co-Director, Texas Children's Hospital for Vaccine Development
Texas Children's Hospital Endowed Chair in Tropical Pediatrics

before the Committee on Science, Space, and Technology
of the United States House of Representatives
March 5, 2020

Beyond Coronaviruses:
Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions

Chairwoman Johnson, Ranking Member Lucas, and Distinguished Members of the Committee:

Thank you for the opportunity to make remarks before the committee. Over the years, I've testified numerous times to both House and Senate Committees, and it's still a special thrill for me to be here in Washington DC in order to discuss how science can help shape national policies. I'm a vaccine and pediatric-scientist, and for the last decade I've served as Professor of Pediatrics and Dean of the National School of Tropical Medicine, where I'm also Co-Director (together with my 20 year science partner, Dr. Maria Elena Bottazzi) of the Texas Children's Hospital Center for Vaccine Development. At Baylor College of Medicine and Texas Children's we develop vaccines for neglected tropical diseases and emerging infections.

I sometimes say we make the vaccines no one else will make because they're intended either for diseases of extreme poverty - such as schistosomiasis, Chagas disease, or leishmaniasis - or for pandemic threats and stockpiling. In addition, in 2015-16 I served as US Science Envoy for the State Department and White House focusing on vaccine development capacity building in the Middle East and North Africa. I also write books, and as a parent of an adult daughter with autism I'm both a vaccine and autism advocate, and the author of Vaccines Did Not Cause Rachel's Autism (Johns Hopkins Univ Press).

Relevant to today's hearing, I want to emphasize how investments in US research and development can contribute to global preparedness and our nation's response to infectious disease. One of our signature programs at Baylor College of Medicine and Texas Children's is a coronavirus vaccine program. Through support of NIAID, NIH and in collaboration with Walter

Reed Army Institute of Research and the Galveston National Laboratory, we developed, tested, and manufactured a very promising recombinant protein vaccine antigen to prevent SARS (severe acute respiratory syndrome), which emerged in Southern China and caused a pandemic in 2003. We also developed a recombinant protein vaccine antigen for MERS (Middle East respiratory syndrome). And now, we're developing a new recombinant protein vaccine for the new COVID-19 also known as SARS CoV2, or just SARS-2. In addition, we're conducting studies to see if our initial vaccine that we developed and manufactured for SARS could be repurposed for this new SARS-2 epidemic/pandemic.

Our experience developing coronavirus vaccines has provided some insights on where the gaps are in terms of our nation's emergency preparedness. I have 5 brief observations I would like to share:

1. We must recognize that pandemic threats such as SARS 2 go way beyond public health. As has been reported in multiple news outlets, the epidemic in Central China has severely damaged the Chinese economy, Asian markets overall, and has even promoted political unrest. The point is we're looking at tens of billions of dollars in losses to the Chinese economy because there was not adequate investment or interest in coronavirus vaccines. In the US, we have a similar vulnerability.

2. Let me provide an example. Through NIAID NIH support, we developed and manufactured a promising SARS vaccine. It used standard recombinant protein technology, similar to the technology used to license the current hepatitis B and HPV vaccines. The vaccine was protective against SARS challenge infections in lab animals, work done at the GNL, and appeared to maximize safety by minimizing what's known as immunopotentiation, a problem that sometimes plagues coronavirus and other respiratory virus vaccines.

The problem was this: By the time we completed manufacturing the SARS vaccine there was no longer interest in SARS as a public health threat. There was no transmission of SARS anywhere and we could not attract further public and private investments to carry this through clinical trials and licensure. In the end, industry is not interested in investing in a vaccine, which they would have to stockpile. No one wants to invest in a product designed NOT to be used. However, as the information in January 2020 showed that SARS and SARS 2 were about 80% similar and the two viruses bound to the same human receptor in the lungs, it became clear that there was a possibility that we could repurpose our SARS 1 vaccine to fight SARS 2. NIAID NIH is now helping us with some funds to advance this concept, and we are applying to other organizations such as CEPI and even the British Medical Research Council (MRC). But the point is that if that had investments been made previously, we potentially could have a vaccine ready to go now. Potentially it could have rescued the Chinese economy saving billions of dollars, or even the US economy should SARS 2 gain a foothold in the US as predicted by Dr. Redfield the CDC Director. An investment of a few million dollars for clinical trials and stockpiling of this vaccine, could have saved ten billion or even maybe one hundred billion dollars – a 10,000 to 100,000 to 1 rate of return, and in so doing stabilize our global economy.

3. We must recognize that vaccines for neglected and emerging infections fall through the cracks because they are not a priority for pharma and biotechs. We need investments in non-profit and academic based product development partnerships such as our center at our National School of Tropical Medicine at Baylor College of Medicine and Texas Children's or a handful of others such as PATH in Seattle, the University of Maryland CVD to name a few. Those funds would be used to support what we call a "warm base" of scientists at centers of excellence to produce vaccines needed for the health and global security of our nation.

4. I don't think all of the funds for this should come from the US Government. In my 2016 book entitled Blue Marble Health: An Innovative Plan to Fight Diseases of Poverty amid Wealth (Johns Hopkins Press) I made the observation that to the surprise of many, most of the global health threats from emerging and neglected diseases actually occurs within the G20 nations, especially the poor living in the G20 nations. However, overwhelmingly the public support for global health innovations, including vaccines, comes from just three sources, the US and UK Governments and to some extent the European Union. Currently these three entities provide 86% of public funding according to Policy Cures G-FINDER Report.[1] Somehow, we need to get the other G20 nations involved, particularly the BRICS nations, such as China, Russia, Brazil, and India, as well as Japan and others. We need them to step up, and this needs to be prioritized at a future G20 Summit. This issue has not been on the radar screen of the G20 leaders and sherpas, but after what we've seen occur in China, I believe our President and the Department of State should make this a priority.

5. Finally, in regards to SARS 2 in America, I'm worried. Without a vaccine in-hand, it will be tough to fight this virus. It's a fight with one hand tied behind our back. We also the have the problem that it looks increasingly likely that we may need to combat both flu and SARS-2 simultaneously. This has been a bad flu season in America, and according to the CDC it will likely continue to last for weeks or months. Tragically, more than 14,000 Americans, including 100 children, have died so far of flu this season, and while we don't yet have the final data, it appears that many if not most of those adults and children were not vaccinated despite recommendations by the CDC. We have a problem in this country with an aggressive, organized and well-funded antivaccine movement spreading misinformation about the flu vaccine. I'm also worried about measles. Because of the antivaccine movement last year measles returned to the US after it was eliminated in the year 2000. For instance, the epidemic in NY resulted in more than 50 hospitalizations, including 18 admissions to intensive care units (ICUs). Historically measles peaks in late winter and early spring, in other words around this time. As I wrote recently in a Fox News op-ed[2], if our local and state health agencies have to simultaneously fight SARS 2, flu, and measles, we'll simply lose, and this will have a terrible impact on our nation's economy.

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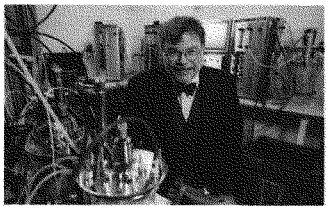
[1] https://s3-ap-southeast-2.amazonaws.com/policy-cures-website-assets/app/uploads/2020/02/07161934/GF-6pSummary2019.pdf

[2] https://www.foxnews.com/opinion/peter-hotez-infectious-epidemics-near-you

Therefore, I would be happy to discuss at your convenience ways this Committee could take an even greater role in combating antiscience movements.

America faces a number of challenges in the coming weeks. We're now seeing the start of community spread in pockets across the country. It's tragic that we won't have a vaccine ready for this epidemic – and practically speaking, we'll be fighting these outbreaks with one hand tied behind our backs. The good news is that we have the best research universities and institutions the world has ever seen, and optimistic that we'll eventually regroup to solve important problems. Thank you for the opportunity to share some thoughts with you today.

Professor Peter J. Hotez M.D. Ph.D. FAAP FASTMH



Peter J. Hotez, M.D., Ph.D. is Dean of the National School of Tropical Medicine and Professor of Pediatrics and Molecular Virology & Microbiology at Baylor College of Medicine where he is also the Director of the Texas Children's Center for Vaccine Development (CVD) and Texas Children's Hospital Endowed Chair of Tropical Pediatrics. He is also University Professor at Baylor University, Fellow in Disease and Poverty at the James A Baker III Institute for Public Policy, Senior Fellow at the Scowcroft Institute of International Affairs at Texas A&M University, Faculty Fellow with the Hagler Institute for Advanced Studies at Texas A&M University, and Health Policy Scholar in the Baylor Center for Medical Ethics and Health Policy.

Dr. Hotez is an internationally recognized physician-scientist in neglected tropical diseases and vaccine development. As head of the Texas Children's CVD, he leads a team and product development partnership for developing new vaccines for hookworm infection, schistosomiasis, leishmaniasis, Chagas disease, and SARS/MERS/SARS-2 coronavirus, diseases affecting hundreds of millions of children and adults worldwide, while championing access to vaccines globally and in the United States. In 2006 at the Clinton Global Initiative he co-founded the Global Network for Neglected Tropical Diseases to provide access to essential medicines for hundreds of millions of people

He obtained his undergraduate degree in molecular biophysics from Yale University in 1980 (*phi beta kappa*), followed by a Ph.D. degree in biochemistry from Rockefeller University in 1986, and an M.D. from Weil Cornell Medical College in 1987. Dr. Hotez has authored more than 500 original papers and is the author of four single-author books, including *Forgotten People, Forgotten Diseases* (ASM Press); *Blue Marble Health: An Innovative Plan to Fight Diseases of the Poor amid Wealth* (Johns Hopkins University Press); *Vaccines Did Not Cause Rachel's Autism* (Johns Hopkins University Press); and a forthcoming 2020 book on vaccine diplomacy in an age of war, political collapse, climate change and antiscience (Johns Hopkins University Press).

Dr. Hotez served previously as President of the American Society of Tropical Medicine and Hygiene and he is founding Editor-in-Chief of *PLoS Neglected Tropical Diseases.* He is an elected member of the National Academy of Medicine (Public Health Section) and the American Academy of Arts & Sciences (Public Policy Section). In 2011, he was awarded the Abraham Horwitz Award for Excellence in Leadership in Inter-American Health by the Pan American Health Organization of the WHO. In 2014-16, he served the U.S. State Department as US Envoy, focusing on vaccine diplomacy initiatives between the US Government and countries in the Middle East and North Africa. In 2018, he was appointed by the US State Department to serve on the Board of Governors for the US Israel Binational Science Foundation, and is frequently called upon frequently to testify before US Congress. He has served on infectious disease task forces for two consecutive Texas Governors. In 2017, he was named by FORTUNE Magazine as one of the 34 most influential people in health care, while in 2018 he received the Sustained Leadership Award from Research!America. In 2019 he received the Ronald McDonald House Charities Award for Medical Excellence.

Most recently as both a vaccine scientist and autism parent, he has led national efforts to defend vaccines and to serve as an ardent champion of vaccines going up against a growing national "antivax" threat. In 2019, he received the Award for Leadership in Advocacy for Vaccines from the American Society of Tropical Medicine and Hygiene. Dr. Hotez appears frequently on television (including BBC, CNN, Fox News, and MSNBC), radio, and in newspaper interviews (including the New York Times, USA Today, Washington Post, and Wall Street Journal).

Chairman BERA. Thanks, Dr. Hotez. Dr. Sell?

TESTIMONY OF TARA KIRK SELL, SENIOR SCHOLAR, JOHNS HOPKINS CENTER FOR HEALTH SECURITY, AND ASSISTANT PROFESSOR, JOHNS HOPKINS BLOOMBERG SCHOOL OF PUBLIC HEALTH

Dr. SELL. Good morning, Vice Chairman Bera, Ranking Member Lucas, and members of the Committee. Thank you for inviting me to speak about my research on crowd forecasting and misinformation, this research, in context of COVID–19, and ways to support research that improve outbreak response.

Traditional disease surveillance is critical during infectious disease outbreaks, however, this information can be supported with tools to help support decisionmaking. One such tool is crowd forecasting. Crowd forecasting consolidates the diverse opinions of many into hard probabilities for future outcomes. This is helpful in engaging the most likely outcome, but also for understanding the uncertainty about that outcome.

Over the past year my research team, in partnership with a group called Hypermind, developed a crowdsourced disease prediction platform, and asked forecasters to make predictions about outbreaks. For instance, we asked about the growth of Ebola in the DRC (Democratic Republic of Congo), the spread of measles in the United States, and how many U.S. counties might see cases of Eastern Equine Encephalitis. On most occasions, forecasters provided accurate predictions about 3 weeks ahead of time. Recently we focused our forecasting platform on COVID–19. We asked about the number of countries that would have cases of COVID–19, and the number of cases that would be seen around the world, and in the U.S. For global cases, forecasts showed high confidence that there would be a rapid and explosive spread.

On a few occasions our predictions were incorrect. We think this is probably because forecasters didn't have enough information to make accurate forecasts. Essentially, there's no magic here. If disease surveillance information is lacking, or is delayed, forecasters don't have any information to go on. This underscores an essential research need for the current COVID–19 outbreak, that surveillance, both within the U.S. and globally, is essential.

Another area of my research, misinformation during disease outbreaks has emerged as a challenge during the COVID–19 outbreak, and highlights the need to transparently and rapidly share information. Health misinformation can be defined as false health-related information, and can range from the promotion of fake cures to rumors about the origin of the outbreak. Misinformation can substantially impede the effectiveness of public health response measures, increase societal discord, reduce trust in governments, leaders, and responders, and increase stigmatization.

My team and I analyzed misinformation during the 2014 West African Ebola outbreak, one of the most recent examples of a fear inducing disease event for the U.S. public. Our—in our analysis, we found that about 10 percent of the Ebola related tweets had false or half true information. We also saw that more tweets with misinformation were political, and seemed designed to promote discord. Another finding with parallels to COVID–19 was the infection—or

the identification of rumors, often focused on government conspiracies. Although we have been—not been able to do a systematic analysis of COVID–19 misinformation, we have seen the spread of rapid—of false information, including recommendations for false cures that could be harmful, like drinking chlorine dioxide, blaming specific ethnic groups, and conspiracy theories about various governments creating the virus as a bioweapon.

Response to misinformation requires a nuanced approach, and further research to best determine the ways forward. While the solutions will be complex, one thing that is critical is the prevention of an information void that can be filled with false information. Members of the public need accurate and timely information to help them make sense of what is happening in the outbreak. As I advocated for improved disease surveillance earlier, this shows the need for a better collection and communication of disease information in a transparent and rapid manner.

From my experience in conducting research in response to emergent disease outbreaks, I believe that we need to reduce the impediments and disincentives to doing rapid and timely research during these events. One hurdle to overcoming—to overcome is the slow response—or slow process to establish Federal funding streams for research during a response. My research was funded by awards from private groups prior to the outbreak, which provided the flexibility to shift gears toward COVID–19. And while the development of vaccines and countermeasures are critical, social, behavioral, and epidemiological research are also important. The best treatment cannot be effective without knowing where the disease is, and who it is affecting. The best vaccine cannot change the course of an outbreak if people refuse to take it. And the best public health response cannot be implemented if members of the public don't cooperate.

My bottom line message is this, we need to support the systematic collection and rapid dissemination of information about outbreaks. The—as the issue of misinformation grows, a dedicated effort to understanding the best ways to combat it will be needed. Even after the COVID–19 outbreak is over, emerging outbreaks will still be a continuing concern. The Federal research space needs to evolve toward a more rapid approach to meet this threat. Thank you.

[The prepared statement of Dr. Sell follows:]

United States House of Representatives
Committee on Science, Space, and Technology

Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions

Testimony of Tara Kirk Sell, PhD
Senior Scholar, Center for Health Security
Johns Hopkins Bloomberg School of Public Health

March 5, 2020

Good morning Chairwoman Johnson, Ranking Member Lucas, and members of the committee.

Thank you for inviting me to speak at this hearing and for your interest in supporting research. Although preparedness and response activities garner much of the attention in outbreaks such as COVID-19, research plays a critical role in developing the evidence base for the most effective and useful interventions. My focus in this testimony will be several areas of my research that relate to emerging infectious disease outbreaks—crowd forecasting and misinformation—as well as the ways to support important research to improve responses to diseases like COVID-19.

I am an Assistant Professor in the Department of Environmental Health and Engineering at the Johns Hopkins Bloomberg School of Public Health. I am also a Senior Scholar at the Johns Hopkins Center for Health Security. *The opinions expressed herein are my own and do not necessarily reflect the views of the Johns Hopkins University*. The Center for Health Security's mission is to protect people's health from major epidemics and disasters and build resilience. We study the organizations, systems, and tools needed to prepare and respond to these events. At the Center, I direct research on crowd forecasting through our disease prediction platform and communication, including misinformation, during infectious disease outbreaks.

My testimony is founded on expertise gained through my research and over a decade of work on pandemic preparedness but not specific epidemiological modeling of the COVID-19 outbreak. Additionally, my testimony is based on the situation as it stands today and my analysis of publicly shared information. I am not a part of the on-the-ground public health or clinical response to COVID-19. There is still a great amount of information to be learned that will shape our understanding of COVID-19 in the weeks and months to come.

Crowd forecasting using the Disease Prediction Platform

Traditional disease surveillance—the collection of information about the numbers of cases and deaths, their locations, and other health-related information—is a critical component of preparedness and response to infectious disease outbreaks. However, these data can be enhanced with additional sources of information about the projected course of disease outbreaks to help support decision making. One potential tool to help support decision making is crowd forecasting, which my team and I have used to establish a prediction platform that provides forecasts focused on infectious disease outcomes.

Early crowd forecasting efforts, such as the Iowa Electronic Markets, were started in the late 1980s and were often focused on political outcomes. Essentially, crowd forecasting consolidates diverse opinions, expertise, and informed guesswork of many into hard probabilities for future outcomes or events. This is helpful in gauging the most likely outcome but also for understanding uncertainty about that outcome. For instance, although crowd forecasting might predict the outcome of a political race, perhaps saying that one candidate is more likely to win than the other, it will also provide a probability of that outcome. If the probability that one candidate will win is a 51% probability and the other has a 49% probability of winning, then that outcome is very uncertain. Overall, the results of crowd forecasting should allow people to question or confirm basic assumptions and help raise new questions that should be considered.

One of the better-known uses of crowd forecasting is the Good Judgement Project, which was supported by the Intelligence Advanced Research Projects Activity (IARPA). This project highlighted the ability of so-called super forecasters, using open source information, to outperform intelligence analysts with access to classified data. The best forecasters were skilled in assimilating information and tapping into multiple sources to understand a range of outcomes.

We wanted to test this type of method for infectious disease. With the help of Hypermind, a company that is involved in the IARPA work, we developed the Johns Hopkins Disease Prediction Platform. Using this platform, we asked forecasters recruited from all over the world, including super forecasters from Hypermind's other forecasting efforts, more than 50 questions about ongoing disease outbreaks. At last count, we had more than 1,000 registered users from 88 countries and more than 500 active forecasters, although not every forecaster answers every question, and some attrition occurred over the course of the project. Forecasters were from a number of different fields; the most common were public health, medicine, and academia, but there were also participants from vector control, the pharmaceutical industry, biotechnology, veterinary medicine, and policy. We considered this range of geographic location and expertise an advantage in potentially developing real-time on-the-ground, crowdsourced prediction data from individuals with high awareness of the health issues in their local communities around the globe.

We asked forecasters to make predictions about a range of outbreaks and locations. For instance, we asked about the growth of the Ebola outbreak in the Democratic Republic of Congo, the spread of measles in the United States , how many US counties might see cases of Eastern Equine Encephalitis, and what the most prevalent influenza virus type at the end of 2019 would be. In order to make these questions work on the platform, we needed to have some way to determine the final correct answer once the time period for the question was over. This limited our questions to diseases that had active traditional disease surveillance efforts around them. On most occasions, forecasters accurately

predicted the infectious disease outcome we asked about—on average about 3 weeks ahead of the outcome in question.

Recently, we have focused our forecasting platform on COVID-19. This was possible only because we had previously received the resources and had time to build our forecasting platform and our forecaster pool before the emergence of COVID-19. When the epidemic started, we were ready to ask forecasters about this emerging disease. Early in the outbreak, we asked about the number of countries that would have cases of COVID-19 by the end of February and the number of cases that would be seen around the world and the US. For global case counts, forecasts showed high confidence that there would be rapid and explosive spread, which we eventually saw. We also asked questions that compared reported numbers of countries with COVID-19 to forecasters' estimates of actual on-the-ground numbers of countries with COVID-19. Although reported case counts are the only official count, our platform showed that the potential lack of reporting, possibly due to poor disease surveillance, was a significant area of uncertainty.

This project also underscores an essential research need for the current COVID-19 outbreak—that surveillance both within the US and globally is essential to understanding what is going on with the disease, planning necessary responses, and thinking ahead to what will happen. It is important to note that on a few occasions, we found that our predictions did not match up with the right answers or were very delayed in identifying the correct outcome. We think that this is probably because forecasters still need reliable information about what is going on in the outbreak in order to make accurate forecasts. Essentially, there is no magic here. If disease surveillance information is lacking or is delayed, forecasters don't have any information to go on.

Misinformation during infectious disease outbreaks

Another area of my research, misinformation during disease outbreaks, has emerged as an important challenge during the COVID-19 outbreak. Health misinformation can be defined as false health-related information and can encompass a wide range of messages—from the promotion of fake cures to spreading rumors about the origin of the outbreak. Some false information may also be defined as disinformation if it is intentionally false and created to mislead receivers of these messages. Although the existence of misinformation and disinformation is not a new problem, the emergence of new communication platforms and access-enabling technology, such as social media and cell phone apps, that connect networks of people who often share similar opinions and beliefs, has exacerbated and amplified this problem.

Misinformation and disinformation can substantially impede the effectiveness of public health response measures, reduce trust in public health leaders and responders, and increase stigmatization or scapegoating of affected communities. A number of researchers have been working in the field of health misinformation. Some have identified health issues, such as vaccines, as areas susceptible to the promotion of public discord. Misinformation spread during the Ebola outbreaks in West Africa and the Democratic Republic of Congo has contributed to violence against healthcare workers, social instability, and increased community transmission. Rumors and conspiracy theories have also fueled distrust of governments during outbreaks at a time when collaboration and cooperation are critical.

My research focuses on health misinformation during outbreaks. Specifically, I have led a team analyzing misinformation during the 2014 West African Ebola outbreak, one of the most recent examples of a

fear-inducing disease event for the US public. We chose this outbreak because of the potential lessons it could teach for future fear-inducing outbreaks, including the current COVID-19 outbreak.

In our analysis, we found that about 10% of the Ebola-related tweets we looked at had false or half-true information. For example, this tweet with false information focuses on a debunked rumor: "Renown #NSA #Whistleblower: #Ebola Could Be Staged Event To Pillage Africa's Natural Resources | EPIC @Infowars #News." Half-true tweets generally included some true information but also suggested something that was not true. For instance, the following tweet correctly notes that a patient was being tested for Ebola but suggests that there was an actual case: "THERE IS AN EBOLA PATIENT IN A FAIRFAX COUNTY HOSPITAL I'M GOING TO CANADA."

We also saw that more tweets with misinformation were political and seemed designed to promote discord among readers. Discord-promoting tweets were those that aimed to generate a response from and conflict with other Twitter users. Another important finding, and one with parallels to COVID-19, was the identification of several specific types of false rumors. Most often rumors focused on government conspiracies, but they also included mention of rumors that Ebola was airborne—a transmission feature it did not possess. However, we did see an effort on the part of Twitter users to refute this rumor.

Although we have not been able to do a systematic analysis of misinformation during the current COVID-19 outbreak, we have seen evidence of a range of different types of false information. These include recommendations for false cures that could be harmful, like drinking chlorine dioxide, and scapegoating and blaming of specific ethnic groups, such as those with Chinese heritage. Other misinformation includes accusations of conspiracies that various governments created the virus as a bioweapon.

This outbreak has also highlighted another emergent theme from our research with Ebola: the idea that not all misinformation is the same. As I noted earlier, some health-related information may be completely false or even deliberately false, but there are many cases in which information is partially true or a misinterpretation of facts. This is a misinformation gray area. In the case of COVID-19, early erroneous reports of SARS cases in Wuhan were technically incorrect, but in hindsight, they had an element of truth in them that would have been helpful to understand earlier. In considering this, my team and I have come to believe that the response to misinformation requires a nuanced approach, one that we have yet to find the best formula for.

In an effort to chart that course, one of my team members, Divya Hosangadi, is currently cataloguing global misinformation management efforts—from rumor correction programs to criminalization of the publication of health misinformation—and she is reviewing the use of these actions in the context of the COVID-19 outbreak. We hope that this research will help us better understand the best interventions for managing misinformation so that policymakers can be ready for the next epidemic.

While the solutions to the problem of misinformation are complex and still to be determined, we know one thing that is critical in communication is the prevention of an information void that can be filled with false information. When people are faced with an uncertain situation, they engage in sense-making—that is, pulling in and testing information in order to develop an explanation for what they are seeing. Members of the public need accurate and timely information to help them make sense of what is happening in an outbreak. Just as I advocated for improved disease surveillance earlier, this is another

case that shows the need for better collection of information about the disease in a transparent and rapid manner. This information should be provided to both the public and to policymakers—the latter, so that they can use the information to make smart policies and to use their position as influencers to spread true information.

Supporting research

From my experience in conducting research in response to emerging disease outbreaks, I believe that one potential area of improvement in the support of research is to reduce the impediments or disincentives to doing rapid and timely research during these events. For instance, one potential hurdle to overcome is the slow process to establish federal funding streams for research during a response. The research I have described today is funded by grants or gifts from private groups—Open Philanthropy and Founders Pledge—which were put in place prior to the outbreak and provided the flexibility to investigate how existing research streams intersected with COVID-19. Although the federal research space is not devoid of rapid research funding, in my experience, this process takes time. In a rapidly evolving world with fast-moving outbreaks, we need a more nimble and agile research support system implemented by the federal government.

These impediments are particularly applicable to social and behavioral research, which can often require data collection in the form of interviews, focus groups, and surveys. Several of my past research efforts have taken the form of research contracts. While these provide the opportunity to work closely with excellent technical staff at federal agencies, they also come with a number of hurdles to overcome. One particularly vexing difficulty is managing Paperwork Reduction Act (PRA) requirements, which measurably slow the process of doing research, increase costs in researcher time, and disincentivize research that would require PRA approvals.

During this response there has been an emphasis on reducing barriers and speeding the development of vaccines and countermeasures. While this is a critical area for research, the research I have discussed today highlights the need for reducing impediments to social, behavioral, and epidemiological research as well. The best treatment cannot be effective without an understanding of where the disease is and who it is affecting. The best vaccine cannot change the course of an outbreak if people refuse to take it. And the best public health response plan cannot be implemented if members of the public refuse to cooperate.

Recommendations

1) *Fund and support the collection of disease surveillance information.* Disease surveillance information underpins cutting-edge forecasting efforts that may help predict disease outcomes. This information is critical to understanding the disease, establishing the most appropriate responses, and planning for a range of potential scenarios.
2) *Transparently and rapidly share information about disease outbreaks.* Misinformation and disinformation breed in an information void. Timely and accurate information should be provided to both the public and to policymakers. Further research on misinformation and disinformation is needed to help develop an appropriate response strategy.

3) *Improve the speed and agility of federal research funding during outbreaks.* Outbreaks currently move more quickly than most federal research dollars. Improvements in this area will allow researchers to contribute their expertise to developing effective outbreak response strategies while they are ongoing, rather than after the event has subsided.
4) *Remove impediments that disincentivize rapid research during outbreaks.* Overwhelming approval requirements can prevent necessary research from occurring in the timeframe necessary to make an impact on an evolving outbreak and may disincentivize research altogether.

Conclusion

My bottom-line message is this: The federal research space needs to support the systematic collection and rapid dissemination of information about outbreaks, including case counts and epidemiological information, as an essential component to both outbreak response and research. Transparency in the ways that data are collected, the protocols for diagnostic testing, and potential data gaps is critical to ensure that researchers and practitioners can interpret data correctly. Information voids lead to uncertainty and suspicion, where misinformation can breed. As the issue of misinformation grows, a dedicated effort to understanding the best ways to combat it will be needed. Even after the COVID-19 outbreak is over, emerging outbreaks and associated misinformation will still be a continuing concern. The federal research space needs to evolve to meet this threat.

Thank you for your time and attention.

Biography for Tara Kirk Sell, PhD

Dr. Sell is a Senior Scholar at the Johns Hopkins Center for Health Security and an Assistant Professor in the Department of Environmental Health and Engineering at the Johns Hopkins Bloomberg School of Public Health. At the Center, she conducts, manages, and leads research projects to develop a greater understanding of potentially large-scale health events. She also serves as an Associate Editor of the peer-reviewed journal Health Security.

Dr. Sell's work focuses on improving public health policy and practice in order to reduce the health impacts of disasters and terrorism. Her primary research interests focus on health security: the broad intersection of public health and national security. She studies past responses to public health emergencies to discover ways to improve future preparedness and response. From terrorism to pandemics and natural disasters, she employs mixed methods and multidisciplinary approaches to examine how the public, practitioners, and policymakers prepare for and respond to public health emergencies. In turn, she works to build the evidence base to advance policies and practices to minimize impacts of emergent threats. Though seemingly distinct, these topics are all linked by crosscutting preparedness and response needs critical to the improvement of the field of health security.

A hallmark of her work is the discovery of scientifically rigorous results while simultaneously interfacing with policymakers, public health practitioners, and the general public to translate research findings into actionable and evidence-based practices. She works collaboratively and purposefully to translate and disseminate findings and recommendations to target audiences in meaningful ways, such as engaging in collaborative work with the CDC to improve public communication or co-developing Event 201, an immersive pandemic scenario to engage new stakeholders such as the private sector in pandemic preparedness.

Dr. Sell joined the Center in 2009 as an Analyst and subsequently served as Senior Analyst and Associate. Prior to joining the Center, she maintained a career as a professional athlete. She was a member of the USA national swim team for 8 years, and she served as captain for 6 USA national swim teams. In 2004 she broke the world record in the 100 breaststroke (Short Course Meters), and she earned a silver medal at the 2004 Olympics in Athens.

Dr. Sell completed her PhD at the Johns Hopkins Bloomberg School of Public Health in the Department of Health Policy and Management, where she was a Sommer Scholar. Her dissertation work focused on public policy responses to emerging epidemics and specifically how the media and policy intertwine in the case of Ebola and the health consequences of these policy actions. She received a BA in human biology and an MA in anthropological sciences from Stanford University. In 2005 she was a Rhodes Scholar finalist.

Chairman BERA. Thank you, Dr. Sell. Before we proceed, I'd like to bring the Committee's attention to a letter that Chairwoman Johnson received in preparation for today's hearing, letters from Johnson & Johnson (J&J) that highlights their global response to the COVID–19 virus. Without objection, I'm placing this document, and Chairwoman Johnson's opening statement, in the record.

[The prepared statement of Chairwoman Johnson follows:]

Good morning and welcome to today's hearing. We have an excellent panel of witnesses today, all experts in their field. I look forward to a robust discussion of how science can help control and mitigate the effects of emerging infectious diseases, especially in light of this recent coronavirus outbreak.

Unfortunately, outbreaks of new infectious diseases are happening more often and infecting more people. Changing ecosystems, economic development and land use, climate and weather, and international travel and commerce are all examples of ecological, environmental, and social factors that are increasing the emergence and spread of disease. The size of the current COVID-19 outbreak has created a public health crisis with significant international dimensions. A successful public health response relies on science- not only through rapid and robust research during an outbreak, but through sustained investments in research and development between epidemics.

As more people interact with technology in their day-to-day lives, we have new ways of harnessing data. Scientists are developing modeling techniques that use artificial intelligence to predict where viruses may emerge and how far they'll spread. Policymakers use these programs to inform efforts that seek to prevent and control the spread and impact of disease. We also rely on scientists to develop diagnostic tests and treatment options and evaluate new drugs and vaccines. It is clear how our research and development investments directly impact our ability to prepare and respond to global emergencies. Every decision we make must be rooted in science.

The outbreak of global viruses is often followed by the spread of misinformation, especially about how or where the virus originated and the government's response to control it. A whole country or group of people may be singled out as the source of the problem-rather than the pathogen. This is hardly a new phenomenon, but the spread of misinformation during this current outbreak has been accelerated by social media. The World Health Organization has even labeled this outbreak an ″infodemic,″ meaning there is so much information out there that it is hard for people to find trustworthy sources and reliable guidance when they need it.

Given that COVID-19 is a new disease, it is understandable that its emergence and spread may cause confusion, anxiety, and fear. But if we let these emotions guide us, instead of science, we will see the rise of harmful stereotypes that will prevent people from accessing the health care they need. We have already seen reports of public stigmatization against people from areas affected by the COVID-19 outbreak. Coupled with the health impacts of the virus itself, this is of grave concern.

According to the World Health Organization, recent disease outbreaks like SARS, MERS, Ebola, and Zika have highlighted the need to use social science to fight deadly disease outbreaks and epidemics. Additional investments in social science research on combatting misinformation during outbreaks could improve prevention and control efforts and strengthen global public health communication. We need a holistic research and development response now more than ever.

As the first nurse elected to Congress, I have been dedicated to public health my entire career. Our Committee may not have jurisdiction over the Health and Human Services agencies, but we have long had a role in amplifying the voices of our nation's best scientists and bringing them to the forefront on an issue. Thousands have been affected by COVID-19. We do not know how many more will be. We must do everything in our power to ensure that science guides our response to this outbreak and prepares us for the future.

Thank you all for being here this morning. And I thank Vice-Chair Bera for his leadership on this issue.

Chairman BERA. At this point we'll begin our first round of questions. The Chair recognizes himself for 5 minutes.

Dr. Hotez, you touched on some of your research into developing a coronavirus vaccine and, you know, a SARS vaccine. I think it's incredibly important since, you know, Dr. Sell just talked about in-

formation and misinformation, we've heard quite a bit about how quick we're going to get a vaccine, how quickly that'll be available to the public. And I think just, you know, this morning I woke up to a news alert that said a Cambridge, Massachusetts biotech company had come up with a vaccine that they've sent to Dr. Fauci to start looking at testing and so forth. But I think we've got to be honest with the public so we don't give them false hope. And, you know, perhaps—if you could just go through a timeline on what vaccine development is going to look like in the best case scenario, then to clinical trials, and then to potential public availability?

Dr. HOTEZ. Sure. Thank you for that question. So I think what we're going to see over the next few weeks to months is several vaccines will enter into a pipeline of clinical trials. Hopefully ours will be one of them. You mentioned the Moderna vaccine out of MIT (Massachusetts Institute of Technology). Theirs will—certainly will be in there. Probably Inovio's another one. There's about five or six—J&J may have one as well. About five or six, maybe a couple more. But then it's going to go into a bottleneck, and that bottleneck are the clinical trials, phase one, phase two, phase three trials.

You know, in spite of what the anti-vaccine lobby likes to claim, that vaccines are not adequately tested for safety, in fact, among the pharmaceuticals, vaccines are the single most tested pharmaceuticals we have for safety, and it takes time. And because you have to initially do an injection in normal human volunteers, show that it's safe, and then you proceed, step-wise, to show that it actually works. And now, because of this immune enhancement phenomena, you have the added complexity because you want to make certain that those volunteers, when they're immunized in an area of community transmission, don't actually get worse.

And so the FDA and CBER—which, again, you know, I can't emphasize enough how lucky America is to have that group, some of the best public health vaccine scientists in the world—are going to follow this very closely, step-wise. And that——

Chairman BERA. The best case scenario——

Dr. HOTEZ [continuing]. And that's not quick, right? That's going to take——

Chairman BERA. Best case scenario, Dr.—and Dr. Fauci said at least 12 months.

Dr. HOTEZ. And he's definitely right, at least 12 months, but whether that means another year after that, maybe 2 years, it really depends on the safety signals that we're seeing with these vaccines.

Chairman BERA. OK. And the ability of our commercial pharmaceutical sector to quickly ramp up and develop that—the vaccine, and make it commercially available, is that going to be an issue, or do we have that——

Dr. HOTEZ. Yeah, I mean, there's a lot being—there's a lot of press releases from the biotechs, and some of them I'm not very happy about, frankly, because I think it's telling only half the message. You know, there's—so it took us years to develop our recombinant protein vaccines. It's an old method, but we know it works, because we've had a Hepatitis B vaccine licensed with this technology, the HPV (human papillomavirus) vaccine licensed with this

technology. Now you're seeing next generation platform vaccines, like DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) vaccines. It's a very exciting technology because you can move very quickly into clinical trials. The problem is we don't have a single licensed vaccine with that technology. So the idea that all of a sudden this is going to work, you know, historically, these have worked very well in mice and laboratory animals, but they haven't been reproduceable in people. Organizations like Moderna and Inovia say they've gotten around it now, they've fixed the—they've fixed this——

Chairman BERA. Right.

Dr. HOTEZ [continuing]. So maybe they have, but, you know, it's——

Chairman BERA. Right.

Dr. HOTEZ [continuing]. Still we don't have——

Chairman BERA. So we're——

Dr. HOTEZ [continuing]. A lot of experience.

Chairman BERA. We're moving at an incredibly rapid pace right now, but the public needs to understand that, at best, there may be a vaccine in 12 months, it'll be longer——

Dr. HOTEZ. Yeah. I mean——

Chairman BERA [continuing]. Potentially longer than that.

Dr. HOTEZ. I mean, look at what happened with——

Chairman BERA. Yeah.

Dr. HOTEZ. [continuing]. Ebola, right? We had, you know, our first Ebola vaccines started being rolled out in 2015 in the epidemic in West Africa. It's not really until 2019 that we really got it rolling, which, by the way, is one of the most extraordinary public health stories ever told.

Chairman BERA. It absolutely——

Dr. HOTEZ [continuing]. And, you know, thanks to BARDA, and all these——

Chairman BERA. Exactly. Let me ask Dr. Sell a question. You talked about information and misinformation. Based on your research as you're observing this, what are some of the common misinformation that is out there on COVID–19?

Dr. SELL. Yeah, so I think that there's a range of different misinformation. So there's misinformation about false cures, and there aren't any cures right now, so all that is false. There's misinformation about sort of government conspiracies, that someone else started the disease, and I think there's also misinformation about the disease, you know, what characteristics it has. I think there's a lot that we don't know, and so there's that information void that people are just filling with their ideas.

Chairman BERA. So it is—it behooves this institution, and each—vested Members of Congress to make sure we're in tight communication with our constituents back home. With that, let me recognize the Ranking Member, Mr. Lucas, for 5 minutes.

Mr. LUCAS. Thank you, Mr. Chairman. And, Dr. Hotez, thinking about Dr. Sell's comments, let's begin from the parochial perspective, being your neighbor up north in Oklahoma. As of last night the State Department of Health reports there are no confirmed positive cases of coronavirus in Oklahoma, as of yesterday evening, although one Oklahoman showing symptoms is waiting on the test

results from CDC. Can you discuss for a moment what we can share with our constituents back home to not instill panic, and how to stress the importance of reasonable steps, prevent spread? Yes, doctor?

Dr. HOTEZ. Peter Hotez. Yeah, I—we—I know Oklahoma pretty well. My son graduated from OU, so—just last year as a petroleum engineer, so he's—it was a great place. We love Norman.

Mr. LUCAS. Absolutely.

Dr. HOTEZ. The issue is this, you know, I think, in an attempt to calm public fears, you're hearing things like it's a mild illness, this is like flu. It's not really the case, because this is an unusual virus. For many young people especially it is a mild illness, but we're seeing some devastating things, and we got a heads up about this from the Chinese. They actually informed us, and we knew it was coming. Nursing homes, look what this virus did in that nursing home in Kirkland, Washington. It rolled through it like a train, right? It's at least seven deaths so far in a nursing home of about 100 people, so this is like the angel of death for older individuals.

We need to go back and support all of our nursing homes—I don't know what we're doing wrong, but clearly that nursing home was not prepared for this, and I'm going to guess nursing home in—across Oklahoma are not prepared as well. Also our healthcare providers. We saw in Wuhan 1,000 healthcare providers got sick, and we had at least 15 percent severely ill and in ICUs (intensive care units), and that is very dangerous because not only do you subtract those people out of the healthcare workforce, but the demoralizing effect of colleagues taking care of colleagues is going to be—I mean, the whole thing can fall apart if that starts to happen.

We saw this with Dallas. So I was on Governor Perry's task force for infectious disease, and those two ICU nurses, when they got sick, it was really devastating. And finally the Governor had to call the Health and Human Services Secretary, CDC Director, and said, look, I—normal ICUs can't take care of these patients, we've got to get them out of here. So you don't want to see those kinds of situations. I'm worried about our first responders. We're already seeing in Washington State how they're already in quarantine. So does that mean we're going to have to bring in the National Guard? I think that's going to be another big issue as well. So those are the three vulnerabilities that I see right now in a place like Oklahoma.

Mr. LUCAS. And how should our constituents back home react to that, the average J.Q. Public out there?

Dr. HOTEZ. Well, I think the average J.Q. Public needs to hear from its elected leaders, from the Governor, from the public health authorities, on what the plan is. I mean, don't just get up there and say, this is a flu, this is a mild illness. One, it's not true, and people in Oklahoma are pretty smart, and they'll figure that out pretty quickly, and second, explain what the risks are, these are the three vulnerable populations that we have to worry about, and here are the steps that we're doing to mitigate that. That's what people will appreciate.

Mr. LUCAS. Dr. Murray, as you mentioned in your opening statement, approximately 75 percent of emerging infectious diseases originate in zoonotic pathogens. You estimate that 1.7 million unknown viruses yet to be discovered, around half of which are capa-

ble of infecting people. Could you elaborate on the current state of research to improve surveillance in these diseases, and where gaps may exist now as we look toward the future, about addressing future challenges?

Dr. MURRAY. Yes, thank you very much, and I also appreciate that, while we're trying our best to address the topic at hand of a lot of ill people, we do need to be thinking of the next virus, and the next virus. I also think that the CDC has done a wonderful job of looking at and studying human health, and, if we're going to do our best job to prevent future viruses from jumping, I think one of the missing components is indeed wildlife health. If 75 percent of the viruses come from wildlife, it makes sense that we look at that juncture of both wildlife and human health.

We also—this virus is termed a novel virus, it's new. It's new to the people. I don't think it's new to the bats, and that's—right? That's an important point. And then some of our other colleagues here have been talking about modeling, and how important that is. Modeling gives us greater information now as to what COVID will be doing within the U.S. and within other countries.

We also have groups of modelers who look at the forefront stages, before emergence, and look at the data that we have to try and determine where are the hot zones, what are the risk factors, and, behaviorally, what are people doing to put themselves in danger? Those are really, really important ways for us to get ahead of the curve and catch the viruses before they come out.

As part of the team that we've been on, which is a USAID (United States Agency for International Development) program called Predict, we have a team of modelers who look at viral emergence, and they're able to determine for each different virus how—as we collect more and more data, what percentage of the viruses that we know are characterized, and how many more are likely to be out there? Latest estimates are less than 1 percent—well, the viruses we know are less than 1 percent of the viruses that are out there, meaning there's over 99 percent viruses in wildlife waiting to jump into humans. That's staggering, and that's really one of the things that we need to look at.

Mr. LUCAS. Thank you, Mr. Chairman. My time's expired.

Chairman BERA. The gentlelady from Oregon, Ms. Bonamici, is recognized for——

Ms. BONAMICI. Thank you——

Chairman BERA. [continuing]. 5 minutes.

Ms. BONAMICI. [continuing]. Dr. Bera, and Ranking Member Lucas. This emergent coronavirus epidemic is a top concern for Oregonians, and I'm glad we're having this hearing today. In Oregon we currently have three individuals who have tested positive, two of whom are in the district I represent, plus I have an additional couple of constituents still in Japan who had been on the cruise ship there. We know further community transmission is likely. It's clear, from the tragic deaths in Washington, how this virus can spread quickly, and cause serious harm, and so let's take a moment to reflect on those who have lost their lives in our neighboring States of Washington, and now we understand there's a reported death in California as well, all the affected friends and family of those people. We need to take this seriously.

I also want to recognize the tireless efforts of our public health officials in Oregon, and the Pacific Northwest, and across the country. I know they've been working around the clock to coordinate a response. For the past several days I've spoken with our Governor, Kate Brown, and many State and county public health officials, and school superintendents—we had a school closed in Oregon for a couple of days—healthcare providers. And everyone has emphasized the need for robust funding, and I'm glad we passed a bill with strong bipartisan support in the House here yesterday. I hope they get it over the finish line soon in the Senate.

But I've also heard numerous concerns about the availability of protective equipment, particularly masks. Also staffing challenges, and testing capability. And we know those infected with COVID–19 can remain asymptomatic for several weeks, so healthcare professionals, as Dr. Hotez was talking about, are at even greater risk. There are furloughed healthcare workers in my district.

The CDC just expanded its guidance for testing, but there's still a significant amount of confusion about who should get tested, and how those increasing testing capabilities can best be used to inform and improve our response efforts. And we heard this morning South Korea's testing 15,000 people a day. Dr. Brownstein and Dr. Hotez, we can't get an accurate picture of the infection if we're not testing, but until recently, the testing was limited to those who had recently traveled to places with high rates, or those showing symptoms after close contact.

So I understand the process of getting the tests out into the field is slow. We had the test sent to the CDC the—on Friday, and then it didn't come back until Tuesday, and that's really hard for a community that's wondering what's happening. So can you explain whether the scope of the CDC's guidance—was that based on best practices, or was it inappropriately limited because—a lack of capacity to test, and who should be tested? Dr. Brownstein and Dr. Hotez?

Dr. BROWNSTEIN. Of course, it's hard to delve too deep into what was happening at the CDC at the time, but, of course, increasing testing is incredibly important. We know that this is a mild condition. Oftentimes people might be feeling symptoms, they may not even be interacting with a healthcare provider, and so we don't actually know the full scope of numbers of cases that are out there. And I think you mentioned a really great point about the impact on the health system. We are really advocating for opportunities to bring concepts like telemedicine, and tools that help at the front line, beyond the point where someone actually has to come in and end up in an emergency department. There's opportunities to think about tools that actually provide symptom checkers that integrate data from the CDC, but also have virtual visits with providers. This is a real important component, because——

Ms. BONAMICI. Absolutely.

Dr. BROWNSTEIN [continuing]. What we expect is an influx of people coming into our health system. I work in a health system. We are very nervous about the flooding of our emergency departments with potential cases, so the opportunities to bring digital tools and innovative solutions, along with the ability to integrate with testing—so home based testing, other opportunities—are real-

ly things that we advocate for because of the fact that, again, mild illness, lack of opportunities for someone to come and meet with someone live, and for the fact that we can actually begin to understand the depth of what's happening in the population, again, those kind of data points are so critical now to understanding——

Ms. BONAMICI. Absolutely.

Dr. BROWNSTEIN [continuing]. The features of this epidemic, and to understand more broadly what's happening in the community.

Ms. BONAMICI. Thank you. Dr. Hotez, as I mentioned, the test was presumptive on Friday, sent to the CDC, it didn't come back until Tuesday. Can you elaborate on some ideas why we've seen such delays in testing? Do you think this recent emergency use authorization will expedite things, and what else can we do to increase the availability and accelerate the testing?

Dr. HOTEZ. So four brief points are around that, and thank you for that question. I think the first is testing for respiratory viruses is not trivial, because you get a—oftentimes, and we've been seeing this in China, and this is actually not unusual, if you look at the literature on testing for respiratory viruses, you get a negative result, a negative result, a negative result, you put the person on a quarantine, all of a sudden they're positive. What does that mean? Is it a true false negative, or is it because the test isn't sensitive enough? So it takes time to really fine tune these diagnostic tests for respiratory viruses.

And, in fairness to the CDC, testing—developing a new diagnostic test, just like developing a vaccine in the middle of a public health crisis, developing new technologies for a new agent in a public health crisis, one of the hardest things that we do as a nation. So this—so—and it' s hard to make that go quickly. I understand we could've—we should've done better as a country of getting those kits out there.

I think we will get up to a million eventually, as I believe the Vice President mentioned, but until we do that, I think we've got to prioritize who gets tested, and my recommendation would be that we focus the testing strategically around our protecting our three most vulnerable populations that I mentioned. Our older residents in nursing homes and places of assisted living, they're highly vulnerable. The mortality among them is——

Ms. BONAMICI. Right.

Dr. HOTEZ. [continuing]. 10 to 15 percent. The healthcare providers, those who interact with the healthcare providers, and protecting our first responders, because if they go down, then, again, everything collapses.

Ms. BONAMICI. OK.

Dr. HOTEZ. But then, even after that, I think the other thing that not a lot of people are talking about, even then, this is not adequate, right? If we have to wait hours, or days, for the test result, it's of limited use to us. What we need is like what we have now for a rapid flu test. We need to get a rapid test for that.

Ms. BONAMICI. Thank you. My time's long expired. I yield back.

Chairman BERA. Thank you. Let me recognize the gentleman from Florida, Mr. Posey, for 5 minutes.

Mr. POSEY. Thank you, Mr. Chair, for calling this important hearing. I only regret that it conflicts with a Member's only brief-

ing on almost the exact same topic taking place simultaneously. And thank you, witnesses, for the important work that you do every day, thinking about ways to combat public health threats. There's a common theme across your testimony, and that's pretty much when there's a crisis all eyes turn to you, but when the disease or the crisis moves off the front pages, the public loses interest, then the funding goes away.

And you didn't say this part, but I'll say this also, that when Washington sees a problem, the habit is to throw billions of dollars at it and say, look, now we've done our job, and hope for a good result, and move on to the next issue. And, of course, there's always the finger pointing and blaming, based on, as you well pointed out earlier, much information and disinformation. That's really regrettable, and I think the American people are getting a little tired of that, but Dr. Murray, working with partner agencies you state you've successfully identified over 1,200 novel wild-born illnesses, including 161 of which belong to the same family as COVID–19. I think most of us in the room are wondering what the risk to humans is from those viruses as well? I have four related questions that I'll ask you after——

Dr. MURRAY. Thank you very much. I'll try to be quick in my response. So in addition to identifying the viruses, we also have a team of modelers who helps us identify where to look in the world. We also have a team of phylogenists and virology experts who then rank all these viruses. If we had enough money to look at every country, every species, every animal, we would, but we don't, so we really try and use funds effectively, so we identify the countries in which—are most likely to be a problem, the species that are most likely to transmit lethal diseases to humans, primates, bats, and rodents, and then, of those 1,200 viruses, they're ranked according to the families that are most likely to cause a problem for human health, and that's where we spend the majority of our time and resources. Influenzas, coronaviruses, filoviruses, and paramyxoviruses are some of the most important families.

Just to add on to what my colleagues here have said, it is the time from—funds are an issue, and the program that I'm describing is just in the process of being closed down. We're actually holding our closeout session on March 17 at the Museum of American Indian, in case anybody would like to join us, because we'll be reporting on a lot of what we've done over the last 10 years. My suggestion would be this is not the time to lean out, but it'd be the time that we need to be leaning in.

Mr. POSEY. What percentage of the viruses have the potential to jump to humans? Just swag it, I mean.

Dr. MURRAY. So of the 1.7 as yet unidentified viruses, about 50 percent of those have the potential to jump to humans, and that's based on the receptor sites, and where they can attach to the trachea. Of those—but not all of those are going to spread rapidly, and not all of those are going to cause severe disease. So we look at—there's 50 percent that could jump to humans, and probably only 10 percent or 15 that can cause rapid disease and a pandemic. But until we identify those viruses, the species in which they occur, the reservoir species, and the mode of transmission to humans, we're really still at a tremendous risk.

And then we—the research has shown that these outbreaks are coming more and more frequently, so while everybody—a lot of us have felt like, this is a surprise, the folks in the health community have felt like this isn't a surprise. We've been saying it collectively for the last several years, these pandemics are coming. We can tell you in general the countries or the areas, some of the risk factors, and some of the viral families.

Mr. POSEY. Well, you answered my next two questions about the percentages already, so, for the final question, how do you think we best prioritize research? You know, is there a good process to set research priorities in place?

Dr. MURRAY. I think a lot of what we're doing right here—and thank you for this hearing. It does bring everybody—a lot of the same folks into the room to help identify some of the issues. From my perspective, the more that we can look at bringing experts from many different fields, from the government, from NGOs (non-governmental organizations), and universities together, then that—and the confluence of human physicians—well, most physicians are human, right? So human physicians, veterinarians, nurse—and nursing staff researchers, I think that's really what we need to be doing, and looking at not only in the U.S., but in countries—in other countries as well, because—we look at the economy globally. It's really time for us to look at health globally. So that's how I would go about establishing research priorities.

Mr. POSEY. Thank you. That beats crisis du jour.

Dr. MURRAY. Thank you for your questions.

Chairman BERA. Thank you, Mr. Posey. The gentlelady from Texas, Mrs. Fletcher, is recognized for 5 minutes.

Mrs. FLETCHER. Thank you, Chairman Bera. I want to get right to the questions. I thank all of you for being here, for your testimony. It's very important. I want to follow up with you, Dr. Hotez, on your opening comments with a question, and then open it up to the panel to weigh in with your thoughts. But, kind of following up on what Mr. Posey asked as well, in your opening comments, or your statement, you mentioned your work developing a vaccine for SARS, and you asked the question what will the ecosystem be for vaccines that don't make money?

And that seems to be an appropriate question for this Committee, and for the Congress of the United States to be tackling. So I would like to ask you what you think that ecosystem should look like, and then get others on the panel to weigh in on that question, and also touch a little bit on what Dr. Murray said about kind of the global nature, and something we have discussed before as well, where can we partner with other countries in doing this work, and where can we have a national response and a global response? I'd love to get your thoughts, and then open it up to the panel.

Dr. HOTEZ. Well, thank you very much for that question. I mean, there is some good news to this. You know, we—we're very blessed to have the National Institute of Allergy and Infectious Diseases, headed by Dr. Fauci, who's been very committed to this problem. And, you know, if it wasn't for NIAID and NIH, I wouldn't be—even be here, right? They've, you know, really worked hard around trying to fix this problem. The issue is it's not enough, and it

doesn't—and the problem is, you know, if you talk to Tony—if you talk to Dr. Fauci, he'll say, look, Peter, I'm not a venture capitalist. I can't just hand over money. It's got to go through study sections.

And the issue is the study sections—some—oftentimes will get dinged and get turn down from an NIH grant because what we're—they'll claim what we're doing is not innovative, and they're often right. It's not innovative. We're trying to make a recombinant protein vaccine. It's boring, but it's absolutely essential. So we have to figure out a way to—for a funding mechanism to be created that will provide steady funding for a base of scientists who are ready and able to develop a vaccine, because this—we're over-relying on the big pharmaceutical companies. They're not coming into this space in a big way, with a couple of exceptions. The biotechs, some of them are in it. Most of them are in it not so much for the specific vaccine, but it's a device to accelerate their technologies. So we've got to figure out a mechanism to create a—fund a group of scientists working in an area where they'll develop vaccines in the non-profit sector.

We've had Walter Reed Army Institute of Research for years. They've been hit very hard. We could restore that. That would be one way. We have this great VRC, Vaccine Research Center, at the NIH, and there's a couple of others, like ours, the University of Maryland Center for Vaccine Development, our Baylor College of Medicine, one at Texas Children's, but we need—each one has to be bigger, and each one has to be—and we need more of them as well.

Dr. BROWNSTEIN. I'll just add also my thanks to the NIH, because I also wouldn't be here without support from specifically the National Laboratory of Medicine, and their efforts to really train the next generation of data scientists in health.

Specifically around—your question around vaccines, I think it's really important to think about the comments of Dr. Murray and think about the next event, right? Of course we need to be focused on the current coronavirus, but we're going to see likely another event, another likely coronavirus event. We saw SARS, MERS. It's likely that we should be thinking about universal vaccines around coronaviruses, as opposed to maybe something very specific around this event, that ultimately will prepare us for the next pandemic that we'll see in the future. I think the more that we can be thinking about those next events, and they will occur, the better off we'll be for the next one.

Mrs. FLETCHER. Thank you, Dr. Brownstein——

Dr. SELL. One——

Mrs. FLETCHER. Dr. Sell, you had a——

Dr. SELL. Yeah, I have one thing to add. So you'd asked about the ecosystem for vaccines that don't make money, right? We have the difficulties with developing those vaccines, and then testing them, but we also—a project at our center led by Nancy Connell, we also have a problem with manufacturing those vaccines at scale, right? So we might be able to have a vaccine, but we can't make, you know, half a billion doses, or whatever we need, quickly, in enough time to make a difference. And so I think that's another thing, you know, we can't just swap over the products in a manu-

facturing plant. That's another area that really needs a lot of attention.

Mrs. FLETCHER. Thank you. Dr. Murray, I have a few—30 seconds left. I'd love to hear your thoughts.

Dr. MURRAY. I agree, again, with my colleagues, in particular with Dr. Brownstein, who was saying about the universal vaccine. I think it's very well—a very good idea to invest in that. And, again, part of the information we would collect in the field about what types of vaccines, or what type of viruses are out there, will hopefully help inform that. I also wanted to add on just—I thought a little bit more about the question from Mr. Posey, and I do think that if we're going to be looking at research, creating a one health program somewhere that we're—because we don't currently have a program that works in high risk areas that incorporates both human expertise and wildlife expertise, and ideally has one foot in the Federal Government, and one foot outside of the Federal Government. It would be great if such an institution were here somewhere in D.C., and perhaps a parastatal institution that's—already exists.

Mrs. FLETCHER. Thank you very much. I have gone over my time, so I will yield back.

Chairman BERA. Thank you——

Mrs. FLETCHER. Thank you all.

Chairman BERA. [continuing]. Mrs. Fletcher. The gentleman from Texas, Mr. Cloud, is recognized for 5 minutes.

Mr. CLOUD. Thank you, Chairman, and thank you all for being here to help us address this very important topic. I appreciate the healthy discussion over some of the misinformation that's come out sometimes with, you know, political goals in the dispersion of it. I also appreciate you educating us just really on some of the real scientific challenges in addressing a situation like this.

I wanted to see, Dr. Murray, in the effort of giving good communication on this, if you can give us, kind of backtracking, it was kind of an understanding of why are doing this, where did this coronavirus come from, how is it unique, how is it spreading?

Dr. MURRAY. Thank you very much. I'd be happy to do—and I think I could probably share the answer to that question as well. In terms of what we know, or—that bats, primates, and rodents are the species that are most likely to carry these viruses that transmit to humans, and—the coronas in particular, and our team has already discovered a—several other coronaviruses in China, with 98—97 and 98 percent homology to this virus, meaning—so they're very closely related. And we also developed these trees so you can determine how closely this virus is related to the other coronas. We found some in Myanmar that are not closely related, and not likely to cause disease.

So—and we also have behaviorists looking at what are the risks associated with bats? In a lot of countries bats provide a lot of protein, and people do eat bats. But, if you think through it, the risk might not be the person in a restaurant eating a fully cooked bat. Perhaps the risk is the women in the back who are preparing the bat without the gloves, and without the masks, that are—along with children, and then take it home. So trying to understand the

cultural norms and human behavior patterns that give—that contribute to these sorts of things.

A quick shoutout to OSTP (Office of Science and Technology Policy) from—because we also have a pandemic preparedness forecasting science and technology panel that looks at these sorts of things, and collectively this past year we—at Smithsonian we housed a—or a we hosted a 2 day workshop looking at the—bringing together the soft sciences and the hard sciences, the modelers who look at human behavior, and also the hard scientists that look at what the virus does.

So we believe that these—that markets—wildlife markets and the wildlife trade are a really huge risk in general, and the risks are different whether you're in Africa or Asia. Africa, animals tend to come to the market. The risk is more in bush meat trade for the folks who are there in the forests that are killing the animals, and the meat tends to come to the market already dead, whereas in Asia it's often live animals that are at the market. So those are—to answer some of your questions about the virus, we believe that it's a bat related virus, and that it's—it came in close contact through this—the markets.

We still have so much more to learn about this virus in particular, and these—with epidemiologists, and our human health folks as well, and so—there's still so much we don't know, but that's what we know so far. I'd like to yield to any of our M.D. colleagues to see if they have something to add.

Mr. CLOUD. Well, if I may, I only have two minutes left. Dr.——

Dr. MURRAY. Sorry.

Mr. CLOUD. [continuing]. Hotez, if you can tell us what's some of the challenges in addressing these treatments and vaccine, also, I'm just going to get all the questions out here. Based on your experience working with SARS, and Ebola, and Zika, what are some of the challenges that you've seen governments face in the past, what are some of the best practices we've learned, and what's some of the things that we can use toward addressing this? And then if you can answer that, and if any of you want to jump in and finish the time out?

Dr. HOTEZ. Yeah, two points. We need more vaccines, and trying to do this in the middle of a crisis is very difficult, right? I mean, we have one—N of one, the—what—the story with Ebola, maybe cholera vaccines in Yemen, so we want to start doing this now. And one of the other problems that I'm seeing is, you know, through NIAID and BARDA, we have incredible mechanism for supporting vaccines, so clearly the U.S. is the global leader in this. We need some of the other countries to start pitching in and help supporting global health technologies.

If you look at the funding—public funding globally, you know, the U.S. is by far the No. 1, UK maybe second, the European Union, and then the bottom falls out, so we see a lot of underachievement among the G20 countries. China's doing very little. Japan, not much, a little bit. Korea's starting now. I'm on a board called the Korean Right Fund with the Gates Foundation. Brazil needs to step up. You know, all the BRICS (Brazil, Russia, India, China and South Africa) countries need to step up. So the—we really need to put this on the agenda of a G20 summit to say, look,

the U.S., you know, has, you know, globally taken the lead on recognizing this is a huge problem through NAID and BARDA, the other countries need to step up. This needs to be on the topic of a G20 summit.

I have a book—I like to write books, so one of the books I wrote is called *Blue Marble Health*, which actually finds this quite interesting finding. Overwhelmingly, most of the world's emerging and poverty-related neglected diseases are not necessarily in the poorest, most devastated countries of Africa. It's the G20 countries. It's the poor living among the wealthy, including 12 million Americans that suffer from neglected tropical diseases. So we need the other G20 to show some leadership, and work with State Department and others on this.

Chairman BERA. Thank you, Dr. Hotez. The gentleman from California, Mr. McNerney, is recognized for 5 minutes.

Mr. MCNERNEY. Well, I thank the Chairman, and I thank the witnesses this morning. Very useful, informative. Dr. Sell, how can social science aid us in understanding how to stop misinformation during outbreaks?

Dr. SELL. So misinformation during outbreaks is a big problem, and I think it's a very complex problem. So social science could help us understand what the best messages are to help people understand when the rumors they're seeing are false. So, to improve our messaging, the type of ways we're trying to communicate with people, how to convince them of, you know, the facts, rather than to believe in these rumors.

But I also think that there's a—we need to actually develop an entire strategy here. We need to think about all the different stakeholders, right? We have tech companies, they need to be doing work. We have the public. The public—we can't just say the public—the public should—we think the public should figure out how to determine truth from falsehoods. But we also have government, we have news media, and we have public health. We all need to think about those stakeholders, and everything they can do to deal with this problem.

Mr. MCNERNEY. Is there a specific area of research that would help develop those tools?

Dr. SELL. I mean, I think that looking into seeing what misinformation is out there, and then also the communications research that I do. I think that it's looking at what kind of ways we can solve that, and the messages that are necessary, so that's social science research.

Mr. MCNERNEY. OK. Thank you. Dr. Hotez, I'm going to follow up on Ms. Fletcher's question. How do we incentivize pharma and biotechs to prioritize vaccine development?

Dr. HOTEZ. Well, it's tough, and, you know, I know I've been critical of the big pharmaceutical companies today, but I also have some great—some support as well. I mean, you know, what Merck did—Merck and Company did for the Ebola vaccine is an extraordinary story, right? I mean, this—that vaccine ultimately—giving it to 200,000 people in DR Congo in the middle of a war and conflict prevented a catastrophic epidemic that would've dwarfed the one in West Africa, and would've destabilized the entire African

continent. So we owe a real debt of gratitude to Merck, and BARDA, and the supporters that made that happen.

But if you talk to some of the people at Merck offline, one of the things they'll tell me is, look we didn't make—Peter, we didn't make money on this thing, we actually—in some—depending on how you crunch the numbers, we actually might have lost money because we had to pull people from moneymaking projects in order to put them on this, so it's really a problem. You know, vaccines are expensive, and they're expensive because of all the quality control and quality assurance that you have to put in, and all the belts and suspenders you put in to ensure safety.

So I, you know, and I'm, you know, and that's maybe one of the reasons why we're not seeing the big pharmaceutical companies jump in this time around, because they saw, my God, look what Merck had to do in order to make this happen. So I think we have to look at creating a new type of organization, and maybe working this out in the nonprofit sector here in the United States.

Mr. MCNERNEY. Thank you. Dr. Brownstein, I'm pretty excited about the HealthMap platform that you discussed. How is artificial intelligence used in public health preparedness——

Dr. BROWNSTEIN. Yeah. So——

Mr. MCNERNEY [continuing]. To prevent spreads?

Dr. BROWNSTEIN. So AI is seeing a real explosion in use in healthcare. Of course we've seen advancements in other domains, financial services, entertainment, but of—what we see is there's opportunities in leveraging AI with large datasets. When we're dealing with an important event like a public health crisis, there's a huge amount of data, a lot of information about cases, a lot of misinformation, and being able to sort through all that critical data to get important insights that we can feed to our modelers, our policymakers, even the public, that's where this kind of—these kind of methodologies come into play.

So, if you think about the earliest signs of the COVID–19 event, they are actually through this epidemic intelligence collecting tools, actually some that support the technologies that Dr. Murray was talking about. Combing through the web, looking for signs of mysterious illnesses that we could utilize to then pinpoint, and then communicate those to the World Health Organization, and CDC, and other organizations. But more importantly, there's a vast amount of information globally now being transmitted about cases confirmed, suspected, on trying to understand the response, the recovery, the demographic data of these patients. That is well more capacity than the existing workforce of epidemiologists that exist on this planet, and so what we're trying to do is augment the work of these public health practitioners through the opportunities that AI brings. So the opportunity to mine that information, organize it, and bring the situational awareness data to the forefront so it can be used effectively.

Mr. MCNERNEY. OK. I'm running out of time, so I'm going to ask you for the record, not a verbal response, what the challenges are in expanding AI into this field. So I yield back.

Chairman BERA. Thanks. The gentleman from Texas, Mr. Olson, is recognized for 5 minutes.

Mr. OLSON. I thank the Chair, and welcome to our four expert witnesses. A special welcome to Dr. Peter Hotez. I'd like to join my Texas colleague, Mrs. Fletcher, in bragging about Dr. Hotez. My colleagues need to know this is not just a man who's an expert in Texas. He's a recognized expert in all of America, and globally on pandemic viruses. And that's why you saw him all day yesterday on national cable, explaining the challenges with the COVID–19 virus. You also saw him doing that with the Ebola, with SARS, with H1N1, and also with Zika. H1N1 was very special back home. That broke out in 2009, and your institution, Texas Children's Hospital, set up a drive-through vaccine in a parking garage almost overnight to have those vaccines deployed. So, again, thank you for being here. As Bum Phillips would say, you may not be in a class by yourself, but every class you're in, it don't take long to call the roll. I want to talk about——

Dr. HOTEZ. Thank you, Congressman.

Mr. OLSON [continuing]. Quality treatments and future responses. First, quality treatments. Yesterday it was announced that my home county of Fort Bend was the first site in Texas to have a confirmed case of the COVID–19 virus. Don't know too much. The man was 70 years old, he had traveled overseas, no confirmation if he went to China, Iran, or Italy, and he's now quarantined in the local hospital. As Dr. Sell mentioned, a lot of people right now are living in fear that this disease is among the people of my hometown, and those fears may cause people to do something that's not very wise, and sometimes very foolish.

We've seen photos all across this country of towns reacting to this influenza. We've seen empty shelves of grocery stores. We've seen empty shelves of bleach. As you said, Dr. Sell, people think drinking bleach can somehow help control this virus, which is just crazy. We've seen empty shelves of canned foods. We see at the Home Depots, the Lowe's, all the masks and stuff needed to protect people are getting swarmed up by people who don't need them. And, Dr. Hotez, you brought this up yesterday on national TV, how can we make sure the required resources we have to fight back are given to the top priorities, which I think as you mentioned, are probably, first all, the families, the victim, their neighbors, the first responders, the EMS (emergency medical services) vehicles, the cops, the firefighters, and also the doctors and nurses—how can we make sure those people have the first priority to get these scarce resources?

Dr. HOTEZ. So you've hit on it, right? I mean, that's exactly right, and thank you for those really generous comments. We need to give our one, two, three, four top priorities of the groups that we're going to insure, because if they go down, then everything falls apart, and things go badly very quickly. And I don't know that we've really done that yet, so, I think, you know protecting our older individuals in nursing homes, because if—because we're—we now know, from Kirkland, anytime a virus hits a community, those are the ones who are going to get hit the hardest, and the healthcare providers, and others.

The other thing I've been saying is—regarding panic has been, look, you will have time. It's not like you're going to wake up tomorrow morning and find that the entire Eastern half of the

United States is infected. What we're going to see is multiple communities being affected, and that will cause a lot of concern, but you will have time in order to prepare and figure out what's happening. And we don't exactly know. It may stop there. You know, there are some who believe there may be seasonality to this virus. We don't know that at all, because it's a new agent. So I think it's—the key is to stay in—our leaders need to stay in contact with the people, hold those White House briefings on a pretty regular basis, but also try not to sugarcoat, right? To be—it's a real art to be able to give difficult information, but to do it in a way to say, we're aware of it, here's what we're doing about it. And I think, you know, we've been through this before.

You know, one of the things that I've noticed in the 20 years that I've been following pandemics, it started with anthrax in 2001, and then SARS in 2003, H1N1 2009, as you pointed out, Ebola 2014, and then we go to Zika, and now this, the same thing happens every time. It takes us a little bit of time to get our arms around it. There are always stumbles in the beginning, and a lot of that has to do with the Federal Government and the State governments have to figure out all over again how to work together, so there always seems to be that new relationship building that has to happen. And then eventually we get it right, and this will happen again.

So—and that's, I think, the other thing that we want to see is the press not piling on too much when these things happen.

Mr. OLSON. Good luck with that.

Dr. HOTEZ. Yeah, and—well, especially it's occurring right during the Democratic—it's, you know, it's happening in the worst time possible from that sense. And to have that perspective of time, saying, look, this always happens, I mean, it's the hardest——

Chairman BERA. Thank you, Doctor.

Dr. HOTEZ [continuing]. Thing our country does.

Chairman BERA. Thank you, Doctor.

Mr. OLSON. Yeah, I hear the gavel banging. I have some questions for the record on stockpiling vaccines. Thank you very much.

Chairman BERA. Let me recognize the gentleman from Illinois, Mr. Casten.

Mr. CASTEN. Thank you, and thank you all for coming. I want to follow, if I could, a little bit on the questions Dr. Bera asked at the start about vaccine development. Dr. Hotez, thank you for clarifying that we're not going to have this vaccine for a year or so. Can you just share a little bit some of the risks of bringing the vaccine to market too early?

Dr. HOTEZ. Thank you for that. Yes, well, the risk is compromising safety. This, you know, the—remember what we're doing, we're going to be doing. We're going to be immunizing healthy people, right, so vaccines always have a higher safety bar because you're injecting well people. These are often not individuals who are ill, and you're trying to accelerate some technology for compassionate use. So—and our FDA, our CBER, has one of the best track records in the world in ensuring safety, and we have one of the best monitoring systems in the world ensuring safety. I mean, we have these four systems in place, the vaccine events, adverse reporting system, we have—but—and many times people think that's

the only thing we have. We have a redundant system of four tracks that follow this. So we know how to do this.

We know how to ensure that vaccines could be developed and tested safely. Don't try to pressure FDA, CBER, into doing something that breaks with that, because, you know, if we start rolling out a vaccine too quickly, and it's shown that a number of those individuals are getting worse because of this vaccine, which we know can happen with certain respiratory virus vaccines. We've seen it with RSV, we've seen it with—in laboratory animals with other coronavirus vaccines, then people will lose confidence, and not only confidence in coronavirus vaccines, but our whole vaccines——

Mr. CASTEN. Sure.

Dr. HOTEZ [continuing]. And safety network——

Mr. CASTEN. So——

Dr. HOTEZ [continuing]. So——

Mr. CASTEN. So with a, you know, with an unvaccinated population, given that some of the early data, you know, is—seems to suggest that those who are most at risk are those—the elderly, immunocompromised, we're not going to have a——

Dr. HOTEZ. And healthcare workers.

Mr. CASTEN. Yeah. So we're not going to have a vaccinated population. Presumably other complications that people have may be at risk. As you look through sort of our broader healthcare ecosystem, do you see other medications that we may be where, you know, where increasing focus on some of these non-coronavirus drugs may be the thing that is ultimately going to hurt people? Are there other places we should be looking in the ecosystem right now?

Dr. HOTEZ. Well, remember, vaccines are the highest bar there is, so even though that's going to take, you know, whatever time it is, there are other technologies out there that we could be—that'll get deployed more quickly. I think we'll probably have antiviral——

Mr. CASTEN. Just——

Dr. HOTEZ [continuing]. Drugs a little——

Mr. CASTEN. Sorry, I don't—I'm asking a sort of different question, and maybe it's my own lack of knowledge. If I already—let's say, as an example, I'm taking immunosuppressants because I just had a liver transplant——

Dr. HOTEZ. Um-hum.

Mr. CASTEN [continuing]. The—and all of a sudden I come down with coronavirus, I may not—coronavirus may not be the thing that does me in, but this other thing does. So if we look at the populations that are most at risk from getting a bad flu, are there other sort of drugs and pharmacologicals that that community is disproportionately taking that we should be concerned about, or maybe a little focus there might protect some of these folks?

Dr. HOTEZ. I don't know—I'll have to think about that a little bit more, but you're right. I mean, I think, you know, we don't have—remember, this is a new virus agent, and there are differences in the U.S. and the Chinese population. We haven't seen a lot of data of people with immunosuppressive drugs, so——

Mr. CASTEN. OK.

Dr. HOTEZ [continuing]. I don't think we really know what that——

Mr. CASTEN. Yeah, I just used that as an example. I——

Dr. HOTEZ. So people on Humira, and—I don't——

Mr. CASTEN. Yeah. My concern is just all these people who might be needing insulin, might be needing statins, other things. Shifting with the little bit of time I have left, Dr. Sell, I appreciate your comments on not spreading misinformation, and just, with the little time we have left, all of us going to be back in our districts next week. We all have, you know, certain platforms that we can speak to. Given what you researched on Ebola, and without, you know, making this a political conversation, as you look at what's going on right now, are there specific pieces of misinformation that trouble you, and if you were in our shoes, what would you love to see us saying to the country this weekend?

Dr. SELL. You bring up something that's very important, because influencers, like you, have the—one of the biggest roles in spreading the truth about the disease. That's actually borne out by the research. So I think, when you go home to your constituents this weekend, I think people might be afraid, and I think this is a concerning disease. We can't sugarcoat it. We have to say, this is serious, we need to think of it, and think about the ways that we can prepare.

People—research has shown that people really want to know more about the actions that they can take, rather than the risks that they have to worry about. So, you know, the CDC has a lot of advice out there, wash your hands, use respiratory etiquette. I think people also want to think about how they can be prepared, how they might take care of a loved one, if a loved one is sick, but not serious enough to be in the hospital, to—and we're limiting how many people we're trying to take care of in hospitals, to how we might care for sick people at home, and think about, you know, stockpiling prescription meds, and things that you might need, and you don't want to be at the store when there's, you know, a lot of sick people or whatever. I think that actions are really what people need to hear right now.

Mr. CASTEN. Thank you. I yield back.

Chairman BERA. The gentleman from Ohio, Mr. Gonzalez, is recognized for 5 minutes.

Mr. GONZALEZ. Thank you, Mr. Chairman, and thank you, for our witnesses. Dr. Hotez, you have a great background. I'm going to sing Dr. Sell's praises for a moment. It's not every day that we get an Olympic athlete in our midst, especially one that had a world record at one point. Do you still have it, by the way?

Dr. SELL. No. Someone took it a——

Mr. GONZALEZ. Someone—OK.

Dr. SELL [continuing]. Years ago.

Mr. GONZALEZ. Still unbelievably impressive. I don't think any of us have world records in our history. Could be wrong. Certainly for nothing as impressive as what you did. But of all the accomplishments and things I respect most about Dr. Sell, it's the fact that she has my wife's unyielding admiration and appreciation, that means the most to me, as a college teammate of yours.

So I want to start by asking about the role that diagnostics play in forecasting accuracy. I just left a briefing, where it's very obvious that we did not, and still probably do not, have the number of diagnostics available, with respect to coronavirus today. So, when it comes to your forecasting accuracy, what role does having robust diagnostics play in the process?

Dr. SELL. Well, that's a great question—and thank you very much for the introduction. Diagnostics have an incredible role to play because the way that you look for information out there about the disease determines what you'll find, right? So if you're only looking for people who have a travel history, you're never going to say, we have community transmission, because every case you find will have a travel history. And so I think that being able to use rapid diagnostics, like the flu test, or these other things, is really important so that we can note those more mild cases, and we know the range of disease, and where it is.

Mr. GONZALEZ. Great.

Dr. BROWNSTEIN. From a modeling perspective——

Mr. GONZALEZ. Yeah.

Dr. BROWNSTEIN [continuing]. Having an accurate understanding of what's happening in the community is incredibly important, right? Because we're essentially seeing some of the more severe cases. It might lead to overestimates of case fatality. We don't actually know what's happening at the community level because we don't have the testing. So we're going to essentially be biased in our understanding of disease, and not actually have a direct understanding of things like household transmission, what we're seeing in terms of the level of spread that's happening. So this is why having enough diagnostic capacity to do it at a population scale is so critical, and why we see incredible advances in Korea and other places.

Mr. GONZALEZ. Yeah. And I think that, you know, one of the things that is troubling for a lot of folks, certainly for me, is you see different case fatality rates depending on the country, right? And my estimation of that is because we don't know the N, and everybody's using a disparate, you know, South Korea they're testing all the time. It seems almost like drive-through test kits, whereas here it's unclear to me how many people we've actually tested. I don't think it's north of 1,000. I could be wrong on that. So that's been a little troubling.

I guess follow up question on the model piece, if we had been testing on the order of, say, South Korea, how much further along do you think we would be, and how much closer to being able to more effectively prepare and prevent a major outbreak would we be if we had the better testing capabilities? I'll start with Dr. Sell.

Dr. SELL. I'll be quick, so the others can answer, but I think if we had better testing capabilities, I think we would have had the motivation to get moving a little bit quicker.

Mr. GONZALEZ. Yeah.

Dr. SELL. And—especially in places where we might see disease so that we could keep it out of those nursing homes and hospitals. So I think that's—would've been helpful.

Mr. GONZALEZ. Great. Dr. Brownstein.

Dr. BROWNSTEIN. Yeah, exactly the same thing. The more detailed information we have on the ground, the better off we are to respond. Models are only as good as the data that we feed them, of course, and so, if we have richer information about what's happening, we have that testing, we can understand what is happening at the community level, and think about things like social isolation, and other mitigation efforts that could slow the spread of the coronavirus.

Mr. GONZALEZ. Thank you. And then, with my final minute, Dr. Sell, I want to go back to the question that Mr. Casten was asking, with respect to false information. Obviously, since 2014 and Ebola, the platforms that we use, the way we communicate, has changed quite a bit. Have you noticed a stark difference of any kind between how misinformation was spread in 2014 versus how it's spread today? What sort of lessons can we learn from that?

Dr. SELL. This is an opinion without an analysis behind it, but I think that the spread of misinformation has been much more rapid. We know that in some cases it's been coordinated, and I think that it spreads across multiple platforms very quickly. We have these echo chambers, and we had echo chambers in 2014, but this information just bounces within people who have the same belief systems, and so it's very hard to change that.

Mr. GONZALEZ. OK. Thank you, and I yield back.

Chairman BERA. The gentleman from Illinois, Mr. Foster, is recognized for 5 minutes.

Mr. FOSTER. Thank you, Mr. Chairman, and to our witnesses. I've been sitting here trying to synthesize from your testimony what a coherent plan to actually, you know, do something over the next decades that would really move the ball on this, and so the first step, it seems to me, is to actually characterize the up to 1.7 million potentially transmissionable viruses, and I think there may be hope for developing technology so we can see the sort of, you know, 1.7 million sounds like a big number, but with technology development you might be able to bring the cost down. And then to potentially do things to mitigate transmission from the animal reservoirs. And, you know, there are things like gene drives, and other things. They just did—they're talking about releasing mosquitoes that can't transmit certain—that sort of approach might be important.

And secondly, to simply identify the concerned sequences across broad classes of these. There was an example of this, actually, in my district, Argonne National Labs, where they recently solved a protein called NSP–15, which is conservative on coronaviruses. It is apparently involved in the replication of the virus as a very attractive drug target that—actually do something that would sort of persist over a time longer than Congress's Attention Deficit Disorder to actually, you know, stay focused on a handful of attractive targets, or a large number of attractive targets, and develop these for drugs, you know, both as treatments and vaccines.

And here I perceive there's a real difference, that you can potentially do things quickly for treatments, but the vaccine problem is much tougher because of the clinical trial bottleneck. I don't know if there are any great breakthrough ideas to—so that if you have thousands of potential viruses, and everything about them under-

stood, but you haven't done the clinical trials on—and you identified targets, but you still need clinical trials, are there any ways to accelerate that, or any potential technologies out there? I—that seems like an unsolved problem, from your testimonies.

And then, fourth, developing high volume, general purpose manufacturing that's on standby, which is something Dr. Sell mentioned. This seems like it's something where you can throw money at the problem. You know, if there are really general purpose technologies out there, and we, you know, there's a lot of overlap with this—frankly, with money we're spending on bioterror defense, and it may be that it's the exact same equipment that you need.

And so I'd be interested in—well, first off, have I missed any big parts of this? Are there significant things—I think the rapid detection is something you mentioned that's sort of a parallel track from this.

Dr. BROWNSTEIN. If I may add just one other component to this, which is this idea of a national or international service around disease forecasting, right? We've done this for the weather, right, like a national service for weather, where we collect data from NOAA and make predictions. That does not exist today in disease forecasting, and if there was investments to be made in addition to important pipelines around manufacturing, it would be developing a way to predict the—sort of the next coronavirus-like pandemic.

Mr. FOSTER. Yes, Dr. Hotez?

Dr. HOTEZ. Yeah. I think you pointed out a very good bottleneck, that, you know, that clinical testing does take time. There has been a lot of effort to apply innovation toward streamlining clinical safety testing. Sometimes we call it systems vaccinology. The idea is we can do more things in parallel, rather than sequentially. And, in fact, that was already started with the Ebola vaccine in DR Congo. We did a lot of things in parallel, so it really went through and got—we got information on its efficacy and its safety in record time.

And I think, if it wasn't for this particular safety signal around this immune enhancement problem, we may—we might have broken a record, because there is an appetite to figure out how to streamline vaccine safety testing, it's just that there's just—unique, quirky feature about coronavirus vaccines, and some other respiratory virus vaccines. So I think you will see innovation and streamlining clinical trials, I'm just not sure this is the one to do it with.

Dr. SELL. I had one other addition. I think that, you know, we—when we come up with these tools, they're interesting, and the exist out there, but we really need a way to sort of integrate them into practice, and that—so I think practice-focused research at public health agencies and the CDC is really important to making sure that we actually move research into actually making a difference on the ground.

Mr. FOSTER. And have there been, you know, big studies that actually come up with, here's the holistic plan, here's rough budgets? You know, are—is this something where it was done 15 years ago by the National Academies, and ignored by Congress, or is that—there actually the need for, OK, let's just sit down and, in an inter-

national context, come up with a plan that has those elements that I mentioned and others? Dr. Murray?

Dr. MURRAY. Yes, if I can answer part of that? The—to answer the first part of your question, there is a group that is newly formed, the Global Virome Project, that is looking at the 1.7 million as yet unknown viruses. Their goal is to identify and characterize all of that in—much in the same way as the Human Genome Project started out, and provided a wealth of information. We have had, for the last 10 years, a global program looking at human and animal health, as well as syndromic surveillance in country, laboratory building. That's the one I was describing that's just in the process of shutting down now.

I would suggest that this is not the time for the U.S. to be pulling out, but, if we have a program that's doing it, if anything else, we need to continue and expand, and incorporate more of the type of folks we have here. And part of that program also had what Dr. Sell was working on——

Mr. FOSTER. I'm sorry, I guess I'm——

Chairman BERA. Yeah. We're——

Mr. FOSTER [continuing]. Exceeding time here.

Chairman BERA. We're going to try to get one last question in, since they called votes on us. The gentleman from Virginia, Mr. Beyer, is recognized for five——

Mr. BEYER. Mr. Chairman, thank you very much, and thank you all so much for being here. This—incredibly important topic. And, Dr. Hotez, it's nice to see you again, 30 years after first coming across your incredible landmark work on the hookworm vaccine, so, good luck. I want to start by submitting a letter I—yesterday supported by 60 Members of Congress sharing my concern about the ineffective White House response, the lack of a chain of command, sharing conflicting information, et cetera, so—and how we stand ready to improve it. So, if there's no objection, Mr. Chairman?

And, Dr. Sell, first, with apologies, I hate asking yes or no questions because they tend to be gotcha questions here, so please know that, time allowing, there will be time for paragraph questions later, but I'd like to make just some—a quick point, so five yes or no questions would be helpful——

Dr. SELL. OK.

Mr. BEYER [continuing]. And then we'll move. First, the World Health Organization says that the death rate from coronavirus is over 3 percent of those infected. Do you have any reason to believe that the actual figure is a fraction of 1 percent?

Dr. SELL. A fraction of 1 percent?

Mr. BEYER. Yeah.

Dr. SELL. Yes.

Mr. BEYER. OK. Thank you. Would you say that the World Health Organization statistics on the spread of the novel coronavirus are false?

Dr. SELL. No.

Mr. BEYER. Will we have a vaccine soon, or within a few months?

Dr. SELL. No.

Mr. BEYER. Are we likely to get a quick cure?

Dr. SELL. By cure do you mean a treatment?

Mr. BEYER. Well——

Dr. SELL. I have to say possibly, because there's drug trials.

Mr. BEYER. OK, great. And should Americans who have the coronavirus symptoms, or believe themselves to be sick, go to work and risk spreading the disease?

Dr. SELL. No.

Mr. BEYER. Would you generally agree that all those statements are false? The panel. Let me go on—the—Dr. Sell, one last question, would you say that it would endanger American lives to spread disinformation that would cause people to go to work, and potentially spread the coronavirus because the public was misled about the dangers of this deadly disease?

Dr. SELL. Misleading the public about a disease is wrong.

Mr. BEYER. And so the sad part here is that these statements, which most scientists—well, every scientist testifying today, would agree endanger American lives were actually made by our President to large audiences in the last 3 days. Scientists just told me that Trump's coronavirus statements about a soon—quick vaccine, a quick cure, it's OK to go to work, that all these things are endangering American lives. And, to be clear, the CDC advises anyone exhibiting symptoms of coronavirus, such as a fever, coughing, or shortness of breath, stay home from work, avoid public areas as much as possible, and seek medical attention.

The Tuesday briefing from Vice President—was not televised. He came here and talked I think four different times. On Monday we heard reports that the CDC stopped disclosing the stats on how many Americans are being tested. At a time of high uncertainty in the face of a likely pandemic, should the American administration more transparent or less? Maybe Dr. Hotez? Or Dr. Sell?

Dr. SELL. I'll just be quick. The administration should be transparent. They should be clear about what they know. They should tell the truth, be clear about what they don't know, what they're doing to try to find out those missing pieces of information, and be clear about what the course is, and what information might change that course.

Mr. BEYER. Great. Thank you. Dr. Brownstein, we've heard a claim that focusing on testing is no longer needed once the disease has spread, you know, that it's in the community, that testing is moot. We've also heard the test—sentiment from many that they'd rather over-test folks than under-test folks. Do you think that testing will still be valuable when it starts to spread into a community?

Dr. BROWNSTEIN. Yeah. I think it's important to actually have an accurate picture, because the dynamic of this virus is going to change as it moves from community to community, and understanding the impact that it's having at scale is going to be critical. And so, just like we do this for the influenza on a seasonal basis, where we test for flu to understand what the underlying illness is, the idea of doing this at scale for coronavirus makes a lot of sense.

Mr. BEYER. Dr. Hotez, you've done so much work on vaccines over the decades, and you testified earlier quite well about it. What's the best the American people can hope for, in terms of a quick vaccine, or a soon vaccine, or——

Dr. HOTEZ. Well, you know, I think it's really important to remember that vaccines are not quick, and that has a lot to do with

vaccine confidence in the United States, because, as you know, we have a very aggressive anti-vaccine movement here in this country, and, as of the last couple of years, it's affecting public health, right? Measles came back in 2019 because of the anti-vaccine movement. Historically, when we've had measles epidemics, it peaks now, late winter, early spring, so we may be battling two epidemics. We still have 16,000 Americans who've died of flu, including 100 kids most who were not vaccinated. So I think it's really important not to tell the American public that we will have a quick vaccine, because that's not how it works. We have to reassure the public that we don't give out vaccines unless they're thoroughly tested, and they are the most thoroughly tested pharmaceuticals we have for safety.

Mr. BEYER. And, Mr. Chairman, as I yield back, I just want to thank Dr. Hotez too for leading the fight against the anti-vaxxers, and that misinformation.

Chairman BERA. Thank you, Mr. Beyer. Before we bring this hearing to a close, I want to thank all of our witnesses for testifying before the Committee today. The record will remain open for 2 weeks for additional statements from Members, and for any additional questions the Committee may ask of the witnesses. With that, the witnesses are excused, and this hearing is now adjourned.

[Whereupon, at 10:45 a.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

Answers to Post-Hearing Questions

Responses by Dr. Suzan Murray

Questions submitted for the record by Members of the Committee on Science, Space, and Technology.
Answers requested no later than Monday, April 6, 2020.

Questions for the Record "Beyond Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions"

To: Eddie Bernice Johnson, Chairwoman
Attn: Jane Eyre
Committee on Science, Space, and Technology

Dear Congresswoman Johnson,

Thank you for the opportunity to respond to the below questions from members of the Committee on Science, Space, and Technology as a follow-on to testimony I provided during the March 5, 2020 hearing entitled "Beyond Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions".

It is my distinct honor to submit the responses below for the congressional record.

Sincerely,

Submitted by: Representative Ami Bera (CA-07)
Dr. Murray, based on your expertise, can you comment on how, if at all, ecological, environmental, and social factors may have led to the outbreak of COV1D-19?

1) What is the possibility that COVID-19 will become endemic, meaning that it will always be present in a certain population or region?
2) How can we learn from past outbreaks to inform current response efforts and next steps in research and development?

Response: Emerging pandemic threats, including zoonotic viral diseases like COVID-19, are inextricably linked with how human beings, animals and our shared environment coexist here on planet Earth. As mentioned during my testimony, science has identified many of the drivers of disease emergence and spread, including land use and climate change, and human behaviors such as increased human/wildlife interaction, and globalization of travel and markets. Science shows us that as the global population of human beings increases, so too do opportunities for what we refer to as "spillover" events where a virus or disease circulating in a wildlife or animal population infects a human being. Once such spillover occurs a virus or disease can then quickly amplify and infect other humans, what we term disease emergence. Given our collective global interconnection and interdependence today, this means the possibility of next outbreak or pandemic is less than 24 hours away at any given time.

For those of us who study and work to prevent disease emergence, the current COVID-19 pandemic was not unexpected, and we knew it was not a question of if, but when and where the next pandemic threat would emerge. We also know that as a new virus or disease emerges into a completely naïve global human population, meaning that it is present on several continents, it is here to stay. Circulation in human populations may decrease over time as the previously naïve population develops herd immunity,

either through natural infection and recovery or human intervention such as vaccination. In the case of COVID-19, now that it has reached a pandemic level, it is certainly here to stay. Coronaviruses like SARS-CoV-2 have genomes that are subject to genetic mutation, both prior to and during disease emergence, which is why this viral family currently is and has been under intense study as a pandemic threat.

The concept of One Health recognizes the interconnection and interdependence between human, animal and environmental health. In the Unites States and globally, health professions, scientific disciplines, sectors and countries working together in collaboration to implement this One Health concept is recognized as critical to address complex global challenges. The interconnections between human, animal and wildlife populations are complex and dynamic. We know if that it takes an equally complex collaborative approach across health disciplines, soft and hard sciences, sectors and governments to address disease outbreaks as they occur, and preferentially identify them in wildlife species to prevent spillover events from occurring. Early detection before a spillover event occurs is the ideal, and helps local health, animal and wildlife authorities mitigate the factors and risks that lead to disease emergence in human populations. Globalization of trade and travel, interdependence of humans on each other for information, goods, food and resources, increasing urbanization, climate change and many other factors are known to directly contribute to disease outbreaks like COVID-19.

There is much we have learned from previous outbreaks that is already being applied in response to the COVID-19 pandemic and just as importantly, to future epidemics and pandemics we know are coming. We know that prevention is more economically feasible, efficient, and a shared ethical imperative versus the horrific costs to life, liberty and economies that we've already seen with COVID-19. Advancements in the detection of novel pathogens show the most efficient way to identify, respond to, and contain an outbreak is through coordinated wildlife and human surveillance. Our best statistical models estimate there are 1.7 million unknown viruses across all species globally, roughly half of which may have the potential to infect people. These numbers give us pause, as we know that even a small percentage of these viruses will lead to new pandemics. While many agencies work on pandemic prevention as of now, there are no coordinated programs to work in high risk regions to identify these unknown viruses, get their genetic sequences into our labs, and identify ways to reduce risk of them emerging. Our best defense against disease emergence and spread is investment and coordination of a One Health approach to research and education.

Submitted by: Representative Bill Foster (IL-11)

1) Is there a correlation between the death rate of COVID-19 and the percentage of the population with existing pulmonary and respiratory issues? I say this because I assume that the percentage of the population in China with these issues is far less than the United States, and the death rate in the U.S would potentially be far-greater based on this premise.

Response: This is an important question, and while I would defer more specific guidance on this question to my human physician counterparts, we do know that people who are immunocompromised, those with pre-existing respiratory disease, and / or chronic diseases are at increased risk of more serious illness and death. Epidemiological information available to date shows that the effective death rate is much higher in older individuals due in part to higher rates of chronic diseases (including pulmonary and respiratory diseases and symptoms) in older populations, both here in the United States and around the world.

Submitted by: Representative Paul Tonko (NY-20)

Dr. Murray, climate change presents a clear and present danger to human health. Human activities are driving unprecedented changes in the Earth's climate and causing the emergence of novel viruses that spread from animals to humans in regions where dense human populations and biodiversity interact. Land use change, for example, is one of the leading causes of disease emergence.

1) Can you elaborate on how current and future land use, like deforestation, mining, and oil extraction, are fundamentally changing our environment and facilitating increased contact between animals and humans?
2) What research and development actions are needed to better detect pathogens and prevent the transmission of diseases from animals to humans?
3) Analyzing the effects of climate change on the emergence of infectious diseases will require collaboration between physicians, climatologists, biologists, and social scientists. Are we prepared to do that?

Response: Prospective extraction of natural resources, such as oil, minerals and timber, leads to the expansion of human activities into ecologically intact natural habitats. In the tropics, where these habitats are characterized by an abundance of wildlife, people who work in extractive industries often reply on wild animals and livestock as sources of protein, creating interfaces at which novel pathogens can pass between wildlife, livestock and humans. Supply chains associated with extractive industries link these communities to larger urban areas, providing a route by which a novel pathogen that has already infected people, or is present in wildlife and livestock products, can enter the broader human population. By these mechanisms, human activities in previously pristine environments can bring people into contact with microbial diversity harbored in wildlife, for which humans are naïve.

Through expanding existing efforts, scientists and policymakers can be successful at identifying high-risk interfaces at which pathogens are more likely to cross from animals into humans. Priority research focus areas should remain on increased understanding of the processes by which pathogens spillover from wildlife into livestock and humans at these interfaces, the risk factors for this occurring, and how these risks can be mitigated. Another priority area is understanding the natural history of zoonotic pathogens in wildlife – particularly how perturbations to wildlife populations as a result of human exploitation, land-use and climate change could alter the dynamics of pathogen transmission between wildlife hosts, and facilitate cross-species transmission. Engaging extractive industries in partnering in and investing in both human and animal surveillance programs may provide an interesting option

Development actions of highest priority are to

1. enhance capacity for cost-effective surveillance activities targeting high risk pathogens, in at-risk human and animal populations;
2. improve integration and sharing of data between state-run animal and human health agencies;
3. improve dynamic forecasting of disease outbreaks, so that surveillance activities are responsive to changing climatic, environmental and demographic conditions. This will require more accurate forecasting of the future state of ecological, epidemiological and economic systems within which diseases are emerging.

Within the framework of One Health, some progress has been made towards mobilizing the transdisciplinary research required to study climate change and health. However, more can and should be done. Of particular importance is support at state and federal levels to establish a One Health research center or institution, a physical manifestation that brings together health disciplines, along with other hard and soft sciences and directly applies scientific research and knowledge to the prevention of and response to disease epidemics. Such an institution would ensure research

infrastructure is in place which encourages human and animal health professionals, biologists, climatologists and social scientists to work together and share ideas and solutions within the same research environment. Of equal importance is establishing funding mechanisms for One Health research to ensure availability of dedicated large-scale funding for projects that seek to apply a systems approach to studying the impact of climate change on disease transmission at local and regional scales. Such grants would provide the framework for the formation of successful interdisciplinary research groups, and the outputs needed to address this important issue.

Submitted by: Representative Troy Balderson (OH-12)

1) I would like each of you to weigh in on this if you could. One of my biggest concerns is the person-to-person transmission and community spread of these types of viruses. As we see COVID-19 cases arise in different parts of the country, what can be done at the community level to prevent a city or county-wide outbreak from occurring, beyond the standard personal hygiene recommendations from the CDC?
2) I am sure you are all aware of some of the abnormalities that surround the virus' original outbreak in China, for example the possible downplaying of the numbers by the Chinese government. How would you say the lack of transparency about COVID-19 by China and others like Iran has impacted the CDC's and the WHO's abilities to respond to the heath emergency at hand?

Response: We know that when a new disease emerges in a human population one of the most difficult and important roles of human physicians and pathologists is to recognize the clinical signs and symptoms in their patients as being different from a known disease presentation. Through careful and purposeful tracking of clinical signs and symptoms health care professionals around the world utilize case definitions to track disease across individuals and populations. Many respiratory diseases, like influenza and COVID-19, have similar signs and symptoms in individual patients which complicates identification of a new disease, or different presentation in an individual patient of a known disease. The World Health Organization has established International Health Regulations where-by countries that sign on agree to report epidemiological data based on known case definitions for particular diseases of concern, along with syndromic data that may include broader clinical signs and symptoms of disease, as well as events of unknown sources or causes that may constitute public health emergencies of international concern. Given such complexity of what diseases are known and that they often have different presentations in individuals, across geographies, and across health care systems it is very challenging for even the most advanced health systems in the world to reach 100% accuracy in disease status and reporting. As a recognized global leader, the United States plays a critical role in encouraging sharing of accurate and timely information on health and disease. Creating, implementing and facilitating working examples to disseminate scientific knowledge, developing platforms for sharing factual and timely information, and critically evaluating information sourced across a broad and complex information networks are some important areas for focus and leadership on a global stage.

Responses by Dr. John Brownstein

HOUSE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

Beyond Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions

Questions for the Record to:

Dr. John Brownstein, PhD
Chief Innovation Officer, Boston Children's Hospital
Professor, Harvard Medical School
Boston Children's Hospital

Submitted by Representative Ami Bera (CA-07)

Dr. Brownstein, a successful public health response to an outbreak of a new infection requires high-quality data to detect the pathogen, characterize the risk, project the outbreak trajectory, and stop it. Leveraging existing technology and supporting research and development of new technology can help the United States better address today's pandemic and future outbreaks.

On the technology

1. How can advanced analytics be used to characterize the risk of an outbreak and project the likely trajectory of an outbreak? What kind of data would be needed to use these analytics in order to effectively support response activities by public health agencies?

2. How can we best combine new technologies with tried-and-true disease surveillance techniques to detect and predict the spread of infectious diseases?

New technologies should be used in partnership with traditional disease surveillance. The use of AI and crowdsourcing in this field provides ample opportunities for early detection of disease or quickly identifying changes in patterns. The benefit to new technology is it's speed. Traditional disease surveillance is very thorough, but because of this, it can be quite time consuming and burdensome if there are not enough resources to support traditional efforts. By using new technologies as a first line of action, you are able to be alerted sooner, and therefore you can be pointed to where traditional surveillance activities could be most beneficial. Early detection on our tools can help concentrate activities or give pinpoints to where we can start. Innovative disease surveillance tools are seen as complementary to traditional surveillance by highlighting sensitivity over specificity whereas traditional surveillance is more specific. Additionally, new technologies can shed light on areas with decreased access to care, highlighting the potential for hot-spots during outbreaks

On the implementation

3. What kind of legal barriers prohibit technology companies' use of regularly collected data to help public health agencies track transmission data from individuals with confirmed or suspected COVID-19?

One of the largest legal barriers we face is related to privacy and confidentiality concerns. Personal health information is protected in this country, so it can be difficult to get details at the individual level that are vital for understanding transmission dynamics. For example, aggregated forms of demographic information (e,g. age, sex, race, location) is shared, however, we are often unable to make a connection between them. Individually each factor is important, but knowing their interconnectedness would make our work even more comprehensive.

4. How should the U.S. government navigate those legal barriers in partnership with the information technology industry, while ensuring the patient's data is properly safeguarded??

5. How can the Federal government support technology and innovation in the public health surveillance sector?

The Federal government can support technology and innovation in public health surveillance through sustained investment of personnel, funding and acceptance of new technology. We need this support even when there are no major outbreaks so that we are able to prepare for when we face a new emerging infectious disease threat. There is a need for a new discipline in disease forecasting akin to weather. The US government could invest in an agency that would provide foundational support for this effort.

Submitted by Representative Bill Foster (IL-11)

1. Is there a correlation between the death rate of COVID-19 and the percentage of the population with existing pulmonary and respiratory issues? I say this because I assume that the percentage of the population in China with these issues is far less than the United States, and the death rate in the U.S. would potentially be far-greater based on this premise.

People with pre-existing pulmonary and respiratory diseases have an increased risk of severe infection if they contract COVID-19. However, there are many other aspects that contribute to death rates, including (but not limited to) other health conditions, access to care and age that also would contribute to death rate. So we can't make any assumptions based on pre-existing lung disease alone.

One of the most important factors in disease modeling is determining how contagious a disease is. Put simply, the R0 [R-nought] is the average number of people in a population that a single infected person will spread the disease to over the course of their infection. However this is a complex and constantly changing factor.

2. Can you tell us the current R0 for COVID-19 and how that number may change as time passes?

As of April, the most commonly accepted estimate for the R0 of COVID-19 is between 2-3. This number may change over time as we grow in our understanding of transmission dynamics, factors that may increase or decrease susceptibility and immunity.

3. Can you elaborate on certain factors that increase the effectiveness and usefulness of infectious disease modeling as well as areas that present challenges for modeling efforts?

Infectious disease modeling can only be as good as the data that is available. Having quality data, both in completeness and detail, increases the effectiveness and usefulness of infectious disease modeling. However, the biggest burden for innovative infectious disease modelling is access to reliable data, whether it be granular line-list data or information on population mobility. More sustained funding of these efforts would allow for collaborations between data sources, modellers, and health officials to be established and maintained. Additionally, health officials and policymakers need to know about the available tools ahead of crises. Sustained funding would allow for greater collaboration and marketing of these tools.

4. In your opinion, what are the key research and development gaps for infectious disease modeling, and how can those gaps be addressed?

The biggest gap is the ability to maintain these efforts outside of outbreaks, in a sustainable way. So much of this work is done via grant or philanthropic funding, which has been generally only released during crises. Sustainable funding would make these initiatives time to grow and prepare stakeholders, via training and preparedness.

Submitted by: Representative Jerry McNerney (CA-09)

1. What are some of the challenges of expanding AI in this area?

Official buy-in and acceptance of this kind of data is critical to be able to expand AI in infectious disease research. Also AI depends on the quality of the data. As they say garbage in is garbage out, we need improved surveillance information (high quality clinical data streams) to improve our forecasting efforts.

2. You've noticed the success that the Flu Near You crowdsourcing tool, which you helped create, has had as a symptom surveillance tool. Can you speak more to how systems like these may serve to fill in gaps of information and provide early signals of disease impacts at a community level

Crowdsourcing tools, like Flu Near You (FNY), connect with users more frequently than someone may visit a physician. With regular check-ins, you are able to detect even the slightest changes in reporting patterns because people might not always seek care depending on factors

like healthcare access and illness severity. With this kind of tool, we are able to capture mild illnesses that do not require hospitalizations, which fills in gaps of understanding. For example, a person may report having a cough on the first day of experiencing a cough, but might not seek professional care for over a week if the cough persists. When reported into a crowdsourced tool like FNY, we capture that data sooner, which allows for an earlier signal that disease may be occurring.

Submitted by Representative Haley Stevens (MI-11)
Dr. Brownstein, much of your research focuses on using innovative disease surveillance platforms for detecting and monitoring outbreaks and mitigating their spread. HealthMap, a project you and your colleagues at Boston Children's Hospital founded in 2006, is a freely available, automated website that delivers data and alerts on emerging infectious diseases. HealthMap is used by major public health organizations including WHO, CDC, and HHS, to facilitate real-time surveillance.

1. Can you elaborate on both HealthMap and other cutting-edge tools can help us understand and manage diseases?

HealthMap allows us to understand and manage diseases by capturing disease signals that might not be as quickly recognized as more traditional methods. It taps into data that is not traditionally used for surveillance (for example, news and social media) to enhance our understanding of diseases. With AI tools we are able to monitor every disease that poses a potential threat in a unified way. The speed of the tools can help direct official containment efforts to the areas most critically in need.

2. How could innovative tools increase collaboration between decision-makers during an outbreak?

Aggregating data from a variety of different sources can provide visibility into information otherwise siloed within different organizations or working groups. Innovative tools can increase collaboration between decision-makers during an outbreak by providing data as supplementary sentinel signals to traditional surveillance efforts. These tools provide a data landscape of the current situation, which would promote preemptive collaboration ahead of an outbreak, which would build buy-in across groups.

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Professor, Harvard Medical School
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3. How can the Federal government support research and development into new modeling technologies?

The Federal government can reiterate the need for sustained, rather than acute, support for these endeavors. The more funding spent on these tools will mean less funding that would be needed acutely during a public health response and public health officials will be better prepared. Additionally, funding spent on detecting the next outbreak and keeping outbreaks controlled will mean less impact on the global and domestic economy.

Submitted by Representative Troy Balderson (OH-12)

1. I would like each of you to weigh in on this if you could. One of my biggest concerns is the person-to-person transmission and community spread of these types of viruses. As we see COVID-19 cases arise in different parts of the country, what can be done at the community level to prevent a city or county-wide outbreak from occurring, beyond the standard personal hygiene recommendations from the CDC?

There are 3 critical pieces at the city and county level that can help minimize the spread of infectious diseases:

1. Have ample testing abilities:You need to be able to test people for COVID-19 in order to estimate and understand the spread within a community. Without sufficient testing, there is a higher probability that a virus will circulate. This means having enough tests to be able to test seemingly healthy individuals in addition to those presenting with symptoms.

2. Contact tracing: When you have a confirmed case of a disease like COVID-19, it is critical to identify all of the potential people that the single case may have infected. Contact tracing allows all potential new cases to be aware of their exposure as well as giving them the opportunity to self-isolate and be tested to help reduce spread in a community.

3. Enforcing social distancing procedures: Social distancing procedures are very important when dealing with preventing community-level transmission. Reduced contact with other people is the key to minimizing risk within a community. At the city or county level, this could include, reduced business hours, reduced occupancy and stay-at-home orders.

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2. I am sure you are all aware of some of the abnormalities that surround the virus' original outbreak in China, for example the possible downplaying of the numbers by the Chinese government. How would you say that the lack of transparency about COVID-19 by China and others like Iran has impacted the CDC's and WHO's abilities to respond to the health emergency at hand.

Especially when dealing with a novel outbreak, such as COVID-19, where we have not seen human infection before, having as much information as quickly as possible is vital to accurately prepare and understand risk. In order to predict transmission rates, we need to understand (1) how many people have been infected, (2) how cases are connected and (3) how long after potential exposure did they become ill. Without this understanding, we cannot accurately determine global risk and prepare for widespread outbreaks.

Responses by Dr. Peter Hotez

Hotez Answers to QUESTIONS

1. Dr. Hotez, much focus has been on the rapid development and deployment of a COVID-19 diagnostic test and vaccine. What can Congress do now to support research and development for treatment options for COVID-19?

ANSWER: The current approach to vaccines relies too heavily on pharma and biotechs, but the lessons learned from COVID19 is that there are some key academic labs, such as those at Baylor College of Medicine (National School of Tropical Medicine), Harvard Medical School/Beth Israel Deaconess, Duke, Emory, which are contributing much of the intellectual content to make these vaccines possible. There needs to be funding streams that support translational research on vaccines, which includes the transition between discovery, and process development/manufacture leading to an IND submission. Currently NIAID NIH funds this largely through SBIR or specific contracts but the most important academic institutions fall through the cracks for investigative research directly leading to vaccines. Therefore I recommend a specific NIH support for non-hypothesis driven initiatives by academic vaccine centers to advance vaccine concepts into new technologies. Possibly create a network of federally funded vaccine laboratories based at academic health centers.

1. Is there a correlation between the death rate of COVID-19 and the percentage of the population with existing pulmonary and respiratory issues? I say this because I assume that the percentage of the population in China with these issues is far less than the United States, and the death rate in the U.S would potentially be far-greater based on this premise.

ANSWER: I think one of the big surprises so far in this COVID-19 epidemic in the US is the high rates of clotting disorders leading to deep venous thromobotic events and pulmonary emboli, heart disease, and strokes. This needs to be investigated.

Dr. Hotez, in November of last year, this Committee held a hearing that focused on vaccine innovation using the influenza vaccine as a case study. During that hearing, one of the things we discussed was the 2009 H1N1 influenza pandemic and the lessons we learned from it.

1. How would you assess the progress we have made and our application of the lessons we have learned from that pandemic and other instances of disease outbreak such as the MERS outbreak in 2012 and the Ebola outbreak in 2014?

2. From a vaccine development standpoint, how would you assess our progress since the 2009 H1N1 pandemic?

3. What more is needed to better prepare the United States for a disease outbreak with the potential to cause a pandemic?

ANSWER: It is clear that there were many deficiencies in our national response to COVID-19, and we were not prepared. Areas that still require improvement include 1) how we communicate regularly to the US public, 2) granular epidemiologic models for every major metropolitan areas, 3) a plan for diagnostic testing and syndromic surveillance, 4) guidance to local public health departments, and 5) even now how new vaccines will be accelerated in a way that will be safe and effective. As a result, multiple antiscience groups have worked to undermine government effectiveness. I have now written about this last point https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7235572/

We clearly need an analysis on how we might improve our national response in anticipation that COVID19 will not be our last serious epidemic. Possibly this is something that could be led by the US National Academies.

1. I would like each of you to weigh in on this if you could. One of my biggest concerns is the person-to-person transmission and community spread of these types of viruses. As we see COVID-19 cases arise in different parts of the country, what can be done at the community level to prevent a city or county-wide outbreak from occurring, beyond the standard personal hygiene recommendations from the CDC?

2. I am sure you are all aware of some of the abnormalities that surround the virus' original outbreak in China, for example the possible downplaying of the numbers by the Chinese government. How would you say the lack of transparency about COVID-19 by China and others like Iran has impacted the CDC's and the WHO's abilities to respond to the heath emergency at hand?

ANSWER: Beyond what everyone discusses in terms of standard personal hygiene, we must expand diagnostic testing and contact tracing, which is not currently being conducted at an adequate scale. I'm disappointed that even this late in the US epidemic we still do not have granular epidemiologic models for every major US city in order to have a roadmap to follow, also we lack well-engineered systems of syndromic surveillance tied to an alert system. These deficiencies are holding back our efforts to reopen our economy safely. I have no particular insights into what transpired in China, but regarding WHO, I am concerned that they are being singled out. My worry is that as COVID19 now races through Latin America, South Asia, and possibly Sub-Saharan Africa, we need a strong WHO to help fight this pandemic. As terrible as the epidemic has been in the US, I believe things could go much worse in the "Global South".

1. Dr. Hotez, you mentioned that by the time you completed manufacturing the SARS vaccine, the virus was no longer a public health threat and in the end was never produced. It could have gone to the stockpile, but industry was not interested in investing in the vaccine if there were no customers. How do we incentivize investment and stockpiling of vaccines for such diseases?

ANSWER: The current approach to vaccines relies too heavily on pharma and biotechs, but the lessons learned from COVID19 is that there are some key academic labs, such as those at Baylor College of Medicine (National School of Tropical Medicine), Harvard Medical School/Beth Israel Deaconess, Duke, Emory, which are contributing much of the intellectual content to make these vaccines possible. There needs to be funding streams that support translational research on vaccines, which includes the transition between discovery, and process development/manufacture leading to an IND submission. Currently NIAID NIH funds this largely through SBIR or specific contracts but the most important academic institutions fall through the cracks for investigative research directly leading to vaccines. Therefore I recommend a specific NIH support for non-hypothesis driven initiatives by academic vaccine centers to advance vaccine concepts into new technologies. Possibly create a network of federally funded vaccine laboratories based at academic health centers.

Questions for the Record to:
Dr. Peter Hotez, MD, PhD
Professor and Dean, National School of Tropical Medicine
Co-Director, Texas Children's Hospital Center for Vaccine Development
Baylor College of Medicine
Submitted by: Representative Randy Weber (TX-14)

In your testimony you highlight previous work your team has completed on the development of a SARS vaccine antigen with the support of the National Institute of Health (NIH), Walter Reed Army Institute of Research, and Galveston National Lab, a high security National Biocontainment Lab that is home to several Biosafety level 4 research laboratories which also happens to be located in the district I am proud to represent. Your team has also developed a vaccine for MERS and is now working on a COVID-19 vaccine after discovering an 80-percent similarity between the 2003 SARS virus.

1. With continued support from NIH, what is the potential that you may be able to repurpose the 2003 SARS-CoV vaccine to combat the current coronavirus outbreak and what type of timeline would we be looking at until a deliverable vaccine is available for deployment?

Dr. Hotez, you spent time as the U.S. Science Envoy to the State Department and the White House from 2015 to 2016 where you focused on vaccine development capacity building in the Middle East and North Africa.

2. Dr. Murray stated in her testimony that "as of now, there are no coordinated programs to work in high risk regions to identify these unknown viruses, get their genetic sequences into our labs, and identify ways to reduce risk of them emerging." Can you speak a little about this issue and what you experienced during your time as U.S. Science Envoy?

3. Is there work to set up these coordinated programs to work in high risk regions? What steps are we taking to improve coordination?

ANSWER: The US Science Envoy has not been set up to address these issues specifically, but there are opportunities to expand the program. Our nation's academic scientists are respected all over the world. Having an expanded cadre of US Science Envoys in this area could help in information sharing around new pathogens. The current reliance on US Government scientists has generally worked well but it has some limitations. From my time as US Science Envoy I have learned how our nation underestimates the power and reach of its research institutions and universities, our academic scientists represent some of our best ambassadors.

Dr. Hotez, the National Institute of Allergy and Infectious Diseases funds research through the Center for Structural Genomics of Infectious Diseases, which is housed at Northwestern University in Illinois. The Center is an ongoing infectious disease research effort able to quickly mobilize as a "rapid response research operation" to address emerging health threats in real time. Recently, the group has focused on the current COVID-19 outbreak and has already identified a potential drug target.

1. What is the value of funding ongoing research efforts like the Center for Structural Genomics of Infectious Diseases?
2. Even in between outbreaks, does laying a foundation of knowledge better enable us to respond more quickly when a threat does emerge?

Dr. Hotez, can you please describe some of the major barriers that exist to developing vaccines or treatments for emerging infectious diseases, like COVID-19? I appreciate ongoing research efforts to address outstanding scientific knowledge gaps. However, I am interested in learning more about how we can better facilitate transition of those research findings into vaccines and treatments to combat this disease.

ANSWER: I do not have a specific relationship with the center at Northwestern Univ, but it looks really exciting and I plan to follow up with them. If you have a contact, I would appreciate it! I have outlined this above, there is a specific gap in funding for academic based vaccine research centers

Questions

Responses by Dr. Tara Kirk Sell

House Committee on Science, Space and Technology
Coronaviruses: Understanding the Spread of Infectious Diseases and Mobilizing Innovative Solutions

Response to Questions for the Record:

Question submitted by Representative Jerry McNerney

1. Dr. Brownstein noted the success that the Flu Near You crowdsourcing tool, which he helped create, has had as a symptom surveillance tool. Can you speak more to how systems like this may serve to fill gaps in information and provide early signals of disease impacts at a community level?

   Answer: The increasing availability of large datasets that can signal events occurring in the community may facilitate a number of advances in public health practice. Syndromic surveillance tools, such as the one mentioned above, have the potential to provide early signals of disease outbreak and spread. However, these tools cannot change on-the-ground realities without the people and systems in place to leverage these insights. This is why support for state and local public health departments is critical. While a syndromic surveillance system may signal an event, public health practitioners need to be able to quickly investigate these signals to determine if action is called for.

2. You've noted the need for improving the speed and agility of federal research funding during outbreaks. What improvements would you like to see in order to better enable researchers to contribute their expertise during an outbreak, as opposed to after it has subsided?

   Answer: While some rapid funding mechanisms exist, I would like to see the US Centers for Disease Control be able to rapidly fund researchers and collaborative research projects in areas that may require additional expertise. This would require an existing funding source that could be tapped in the event of an emergency and quickly linked to researchers. In this case, I think it is important that research can quickly be utilized in practice for an ongoing outbreak. In the case of a rapidly emerging outbreak this sort of engagement should be completed in the course of weeks rather than months.

Questions submitted by Representative Ed Perlmutter

1. Dr. Sell, beyond the health impacts of the virus itself, we have seen reports of public stigmatization against people from areas affected by the COVID-19 outbreak. In some cases, this has been made worse by the spread of misinformation and disinformation on social media platforms.
   a. What are the effects of misinformation, both on individuals and, more widely, on the geographic spread of infectious diseases?

Answer: Misinformation and disinformation during the COVID-19 outbreak has been a significant problem. The WHO has declared an "infodemic" and has highlighted serious concerns about the spread of false information. From my research, misinformation and disinformation have the potential to severely erode trust and the ability of public health responders to engage the public in necessary response activities. Without this trust and cooperation, there is a greater risk of spread of the disease both within communities, making the outbreak more intense and possibly overwhelming health systems, and to different communities, increasing the geographic spread of the disease. Additionally, misinformation may cause individuals to take actions that are harmful to themselves or others.

b. How have past outbreaks and history influenced our understanding of public behavior during this current outbreak?

Answer: Research in the field of pandemic preparedness, which I have been a part of for the past decade, has been based on previous disease outbreaks as well as extrapolation from those outbreaks to larger threats. For instance, a project I co-led, Event 201, was a pandemic scenario designed to galvanize preparedness activities for the future. This exercise, occurring in October 2019, was focused on an outbreak of a novel coronavirus and was based on past pandemics as well as consideration of what might occur if disease spread was more severe than in the past.

Much of our early response to COVID-19 was based on our understanding of influenza or the actions of countries who were hit with the disease first. However, understanding of public behavior during the COVID-19 response is somewhat uncharted territory, because no recent disease outbreak is comparable in size and scope. As we learn more about the COVID-19 virus and our society's ability to respond, public health efforts to control the disease will likely evolve.

c. How can social science research prepare us for future public health emergencies?

Answer: Thank you for this question. Social science research is critical in preparations for future public health emergencies. For instance, the topic I study, misinformation, has a powerful role in influencing public trust and receptiveness to outbreak response activities. While researchers may develop effective vaccines, responders may outline public health response plans, and policymakers may establish laws and orders to stop disease spread – none of these matters if people do not trust and refuse to comply. Social science research is often neglected in favor of more tangible research deliverables like vaccines and treatments, yet it is critical in understanding critical aspects an outbreak and the responses necessary to bring it under control by helping us understand *why* different individual and social responses occur and *how* to move forward in ways most likely to produce hoped for results in the control of the disease.

Questions submitted by Representative Tory Balderson

1. I would like each of you to weigh in on this if you could. One of my biggest concerns is the person-to-person transmission and community spread of these types of viruses. As we see COVID-19 cases arise in different parts of the country, what can be done at the community level to prevent a city or county-wide outbreak from occurring, beyond the standard personal hygiene recommendations from the CDC?

   Answer: The most important thing that can be done at a community level is to facilitate appropriate protective actions, such as staying home when ill, physical distancing, avoiding crowded indoor locations, wearing face coverings when distancing is not possible and thinking through activities to reduce transmission risks. Effective public health communication is critical in this space – policymakers such as yourself play an important role in providing accurate public health messages to help keep your constituents safe. Maintaining trust is also critical in controlling the disease, which means being up front about knowns and unknowns and letting people know that advice might change as we learn more. Beyond education and behavior change, widely available testing and contact tracing is important to alert those who might have the disease to stay home and avoid activities that could lead to disease transmission.

2. I am sure you are all aware of some of the abnormalities that surround the virus' original outbreak in China, for example the possible downplaying of the numbers by the Chinese government. How would you say the lack of transparency about COVID-19 by China and other like Iran has impacted the CDC's and the WHO's abilities to respond to the health emergency at hand?

   Answer: Data sharing and transparency are critical components of global public health response. While we've seen for ourselves the difficulties of conducting COVID-19 testing and surveillance, the more information that can be shared will only increase the ability of the rest of the world to learn important lessons that can help initiate and improve response activities.

Appendix II

Additional Material for the Record

LETTER SUBMITTED BY REPRESENTATIVE AMI BERA

Johnson & Johnson WORLDWIDE GOVERNMENT AFFAIRS & POLICY

March 5, 2020

The Honorable Eddie Bernice Johnson
2306 Rayburn House Office Building
Washington, DC 20515

The Honorable Frank Lucas
2405 Rayburn House Office Building
Washington, DC 20515

Chairwoman Johnson, Ranking Member Lucas and Members of the Committee:

On behalf of Johnson & Johnson, I am pleased to share information regarding the company's response to the threat of the novel coronavirus (COVID-19) outbreak. Throughout our more than 130-year history, Johnson & Johnson has had a legacy of coming to the aid of local and global communities during times of crisis, from natural disasters to health outbreaks. We believe we have a responsibility to step in and invest in solutions for global public health crises and are proud to be contributing to the global response to COVID-19.

In early January 2020, when the viral sequence became available, Johnson & Johnson began to rapidly mobilize our resources in response to the virus. As part of this work, we have initiated efforts to develop a vaccine candidate against COVID-19, which we hope can ultimately be deployed quickly and extensively to help combat this outbreak. Earlier this month, J&J announced a collaboration with the Biomedical Advanced Research and Development Authority (BARDA), part of the Office of the Assistant Secretary for Preparedness and Response (ASPR) at the U.S. Department of Health & Human Services, to further expedite our investigational coronavirus vaccine program as well as to accelerate the discovery of potential treatments for the virus. We remain open to collaborating with governments, healthcare professionals and others to ensure rigorous collection of data that will allow evidence generation to guide the use of effective medicines and support the best outcomes for patients affected by the outbreak.

The company has also mobilized quickly to provide crucial donations from across its businesses, as well as other support, to help those impacted. To date, J&J has made available 1 million surgical masks, 50,000 bottles of BAND-AID® Brand Isopropyl Alcohol, and 1 Million Renminbi to the Chinese Red Cross Foundation. Johnson & Johnson Medical Devices Companies China is also providing an electrosurgical generator and other devices to the Red Cross Society of China Wuhan Branch to help supply new isolation hospitals that were constructed quickly to address the growing outbreak.

We believe that global health security is everyone's responsibility and requires coordinated effort from governments, civil society and healthcare companies. We are proud to contribute to global efforts to combat the novel coronavirus through both humanitarian donations and the development of a vaccine and treatment for COVID-19.

Thank you for your attention to this critically important issue. If you have any questions, please e-mail Meghan Stone at mdstone@its.jnj.com or call 202-589-1425.

Sincerely,

Jane M. Adams
Vice President, Federal Affairs

1350 I Street NW, Suite 1210, Washington DC, 20005 T: +1 202 589 1000 www.jnj.com

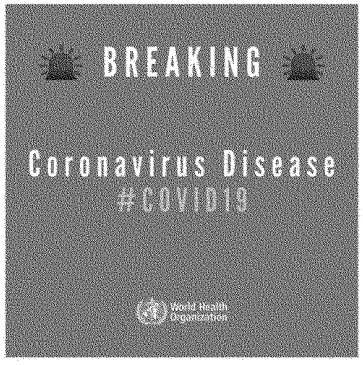
Goats and Soda

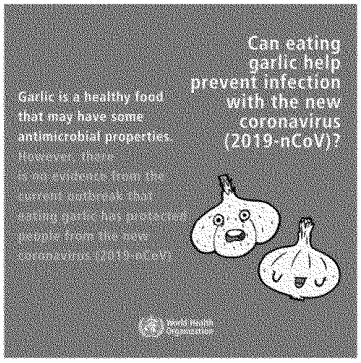
THE CORONAVIRUS CRISIS

Fake Facts Are Flying About Coronavirus. Now There's A Plan To Debunk Them

February 21, 2020 · 11:33 AM ET

MALAKA GHARIB





The World Health Organization is sharing social media posts to debunk widely circulated rumors about coronavirus cures.
Facebook/ Screengrab by NPR

Updated on Feb. 24 at 5:54 p.m. ET to include comments from Twitter and Facebook.

The coronavirus outbreak has sparked what the World Health Organization is calling an "infodemic" — an overwhelming amount of information on social media and

websites. Some of it's accurate. And some is downright untrue.

The false statements range from a conspiracy theory that the virus is a man-made bioweapon to the claim that more than 100,000 have died from the disease (as of this week, the number of reported fatalities is reported at 2,200-plus).

WHO is fighting back. In early January, a few weeks after China reported the first cases, the U.N. agency launched a pilot program to make sure the facts about the newly identified virus are communicated to the public. The project is called EPI-WIN — short for WHO Information Network for Epidemics.

"We need a vaccine against misinformation," said Dr. Mike Ryan, head of WHO's health emergencies program, at a WHO briefing on the virus earlier this month.

The Coronavirus Outbreak

What you should know

- **Where the virus has spread**
- **Coronavirus 101**
- **Coronavirus FAQs**
- **NPR's ongoing coverage**

Subscribe to Goats and Soda's newsletter for a weekly update on the outbreak.

While this is not the first health crisis that has been characterized by online misinformation — it happened with Ebola, for example — researchers are especially concerned because this outbreak is centered in China. The world's most populous country has the largest market of Internet users globally: 21% of the world's 3.8 billion Internet users are in China.

And fake news can spread quickly online. A 2018 study from Massachusetts Institute of Technology found that "false news spreads more rapidly on the social network Twitter than real news does." The reason, say the researchers, may be that the untrue statements inspire strong feelings such as fear, disgust and surprise.

This dynamic could cause fake coronavirus cures and treatments to fan out widely on social media — and as a result, worsen the impact of the outbreak, says Bhaskar Chakravorti, dean of global business at the Fletcher School at Tufts University. Over the past decade, he has been tracking the effect of digital technology on issues such as global health and economic development.

The rumors offer remedies that have no basis in science. One untrue statement suggests that rubbing sesame oil on the skin will block the coronavirus.

If segments of the public turn to false treatments rather than follow the advice of trusted sources for avoiding illness (like frequent hand-washing with soap and water), it could cause "the disease to travel further and faster than it ordinarily would have," says Chakravorti.

There could be a political agenda behind the fake coronavirus news as well. Countries that are antagonistic toward China could try to hijack the conversation in hopes of creating chaos and eroding trust in the authorities, says Dr. Margaret Bourdeaux, research director for Harvard Belfer Center's Security and Global Health Project.

"Disinformation that specifically targets your health system or your leaders who are trying to manage an emergency is a way of destroying, undermining, disrupting your health system," she says.

In the instance of vaccines, Russian bots have been identified as fueling skepticism about the effectiveness of vaccination for childhood diseases in the U.S.

The World Health Organization's EPI-WIN team believes that the countermeasure for misinformation and disinformation is simply to tell the truth.

It works rapidly to debunk unjustified medical claims on social media. In a series of bright blue graphics posted on Instagram, EPI-WIN states categorically that neither sesame oil nor breathing in the smoke of fire or fireworks will kill the new coronavirus.

Part of this truth-telling strategy involves enlisting large-scale employers.

The approach, says Melinda Frost, an officer on the EPI-WIN team, is based on the idea that employers are the most trusted institution in society, a finding reflected in a 2020 study on global trust from the public relations firm Edelman: "People tend to trust their employers more than they trust several other sources of information."

Over the past few weeks, Frost and her team have been organizing rounds of conference calls with representatives from Fortune 500 companies and other multinational corporations in sectors such as health, travel and tourism, food and agriculture, and business.

The company representatives share questions that their employees might have about the coronavirus outbreak — for example, is it safe to go to conferences? The EPI-WIN team gathers the frequently asked questions, has their experts answer them within a few days, and then sends the responses back to the companies to distribute in internal newsletters and other communication.

Because the information is coming from their employer, says Frost, the hope is that people will be more likely to believe what they hear and pass the information on to their family and community.

Bourdeaux at Harvard calls this approach a "smart move."

It borrows from "advertising techniques from the 1950s," she adds. "They're establishing the narrative before anybody else can. They are going on offense, saying,

'Here are the facts.' "

WHO is also collaborating with tech giants like Google, Twitter, Facebook, Pinterest and TikTok to limit the spread of harmful rumors. It's pursuing a similar tactic with Chinese digital companies such as Baidu, Tencent and Weibo.

"We are asking them to filter out false information and promote accurate information from credible sources like WHO, CDC [the U.S. Centers for Disease Control and Prevention] and others. And we thank them for their efforts so far," said Dr. Tedros Adhanom Ghebreyesus, director-general of WHO, in a briefing earlier this month.

Twitter, for example, now actively bumps up credible sources such as WHO and the CDC in search results for the term "coronavirus."

"We're also taking proactive action on any coordinated attempts to undermine the public conversation on this critical issue," wrote a Twitter spokesperson in a statement to NPR.

Facebook (which is one of NPR's financial sponsors) is implementing similar strategies. "When people search for information related to the virus on Facebook, we will surface an educational pop-up with credible information in multiple languages and countries," wrote a Facebook spokesperson in a statement to NPR. "We've connected people to regional health ministries in several countries, for example: The Center for Health Protection in Hong Kong, Taiwan Center for Disease Control in Taiwan, the Republic of the Philippines Department of Health in the Philippines, the Ministry of Health in Italy."

Facebook has taken the extra step of deploying fact-checkers to remove content with false claims or conspiracy theories about the outbreak. Kang-Xing Jin, head of health at Facebook, wrote in a statement about one such rumor that it has eliminated from its platform: that drinking bleach cures coronavirus.

Chakravorti applauds WHO's coordination with the digital companies — but says he's particularly impressed with Facebook's efforts. "This is a radical departure from

Facebook's past record, including its controversial insistence on permitting false political ads," he wrote in an op-ed in Bloomberg News.

Still, there is no silver bullet to fighting health misinformation. It has become "very, very difficult to fight effectively," says Chakravorti of Tufts University.

A post making a false claim about coronavirus can just "jump platforms," he says. "So you might have Facebook taking down a post, but then the post finds its way on Twitter, then it jumps from Twitter to YouTube."

LIFE KIT

Fake News: How To Spot Misinformation

In addition to efforts by WHO and other organizations, individuals are doing their part.

On Wednesday, *The Lancet* published a statement from 27 public health scientists addressing rumors that the coronavirus had been engineered in a Wuhan lab: "We stand together to strongly condemn conspiracy theories suggesting that COVID-19 does not have a natural origin .... Conspiracy theories do nothing but create fear, rumors and prejudice that jeopardize our global collaboration in the fight against this virus."

Dr. Deliang Tang, a molecular epidemiologist at Columbia University's Mailman School of Public Health, says his friends from medical school and his research colleagues in China find it difficult to trust Chinese health authorities, especially after police reprimanded the eight Chinese doctors who warned others about a pneumonialike disease in December.

As a result, Tang's network in China has been looking to him and others in the scientific community to share information.

Since the outbreak began, Tang says he has been answering "30 to 50 questions a night." Many want to fact-check rumors or learn about clinical trials for a potential

cure.

"My real work starts at 7 p.m.," he says — morning in China.

covid-19 wuhan coronavirus coronavirus facebook who social media

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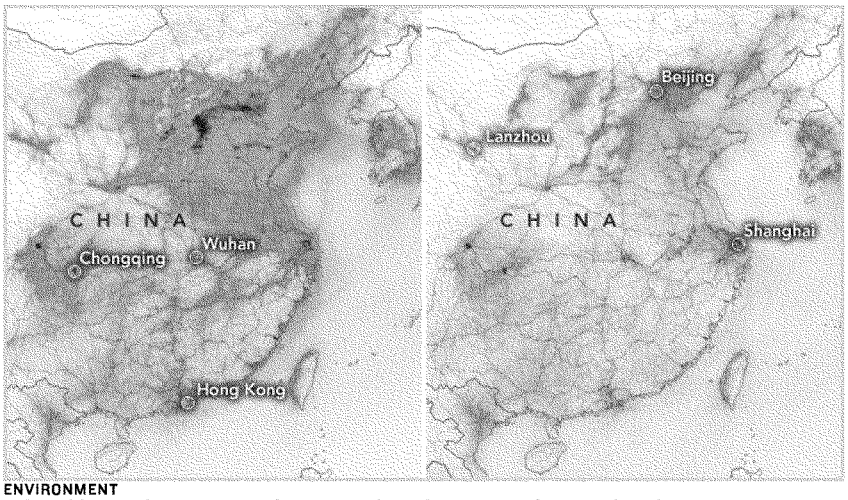
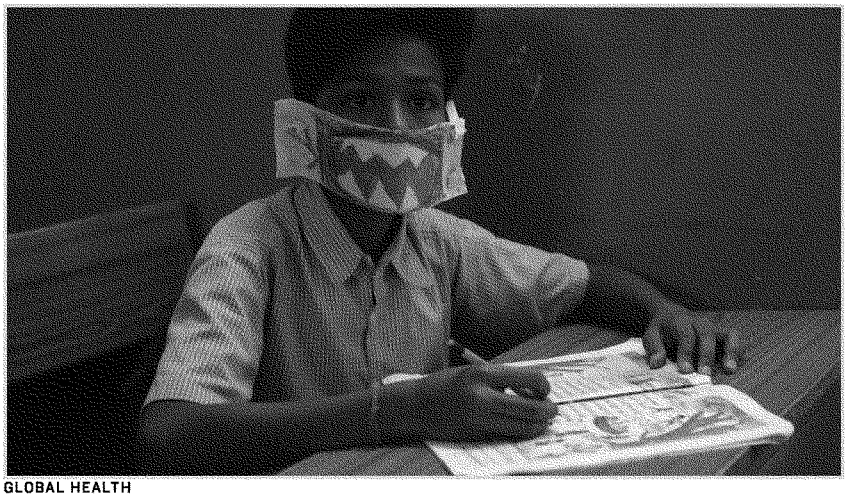


ENVIRONMENT

Why China's Air Has Been Cleaner During The Coronavirus Outbreak

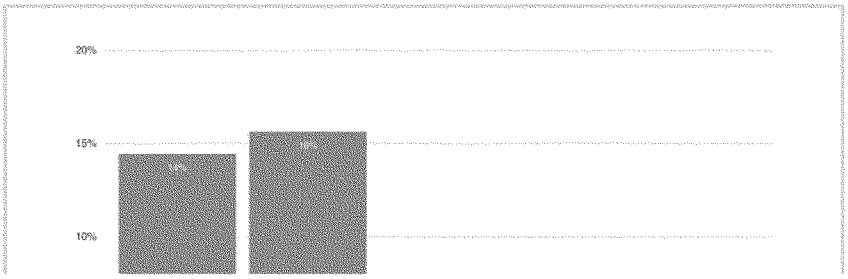
GLOBAL HEALTH

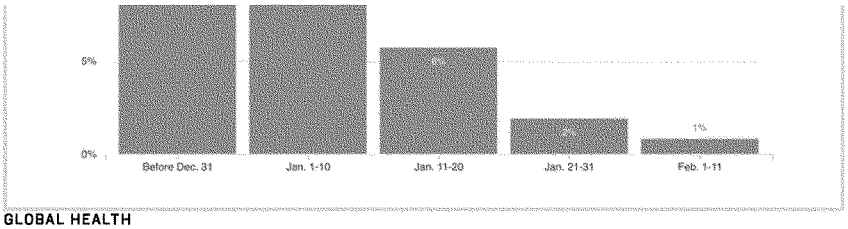
Who Faces The Greatest Risk Of Severe Illness From Coronavirus?



GLOBAL HEALTH

COVID-19: 'We Can Push This Virus Back,' WHO Leader Says Of Coronavirus



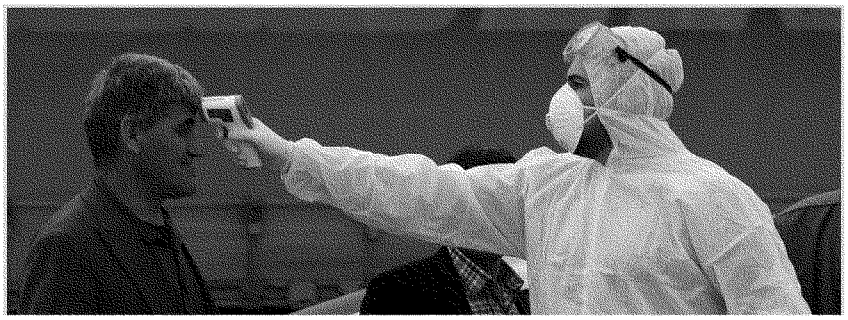


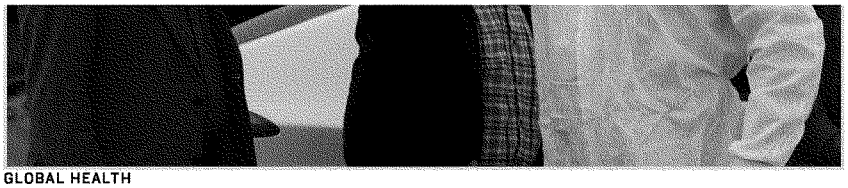
GLOBAL HEALTH

Why The Death Rate From Coronavirus Is Plunging In China

OPINION

Personal Essay: Coronavirus Lockdown Is A 'Living Hell'





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Coronavirus Update: Containment Is Possible, WHO Says

Popular on NPR.org

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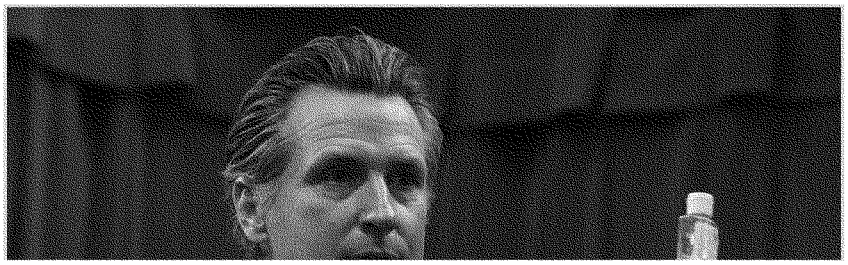

NATIONAL

Coronavirus Deaths In Washington State And California, Where Gov. Declares Emergency

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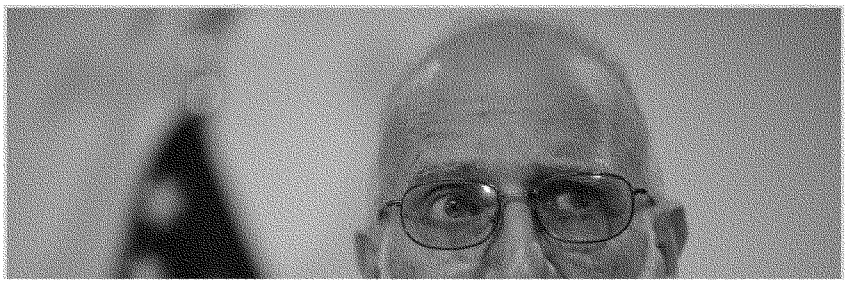
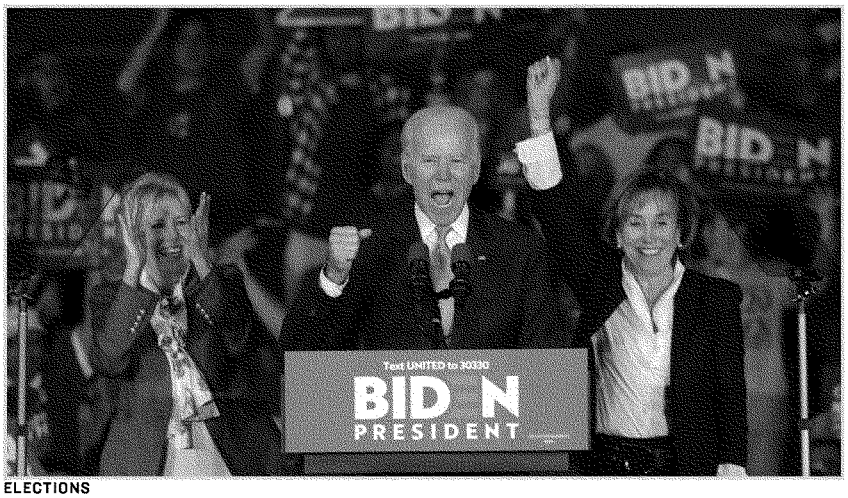
Dixie Chicks Announce First Album In 14 Years, 'Gaslighter,' Share Title Track



POLITICS

Former Prisoner Recalls Sanders Saying, 'I Don't Know What's So Wrong' With Cuba



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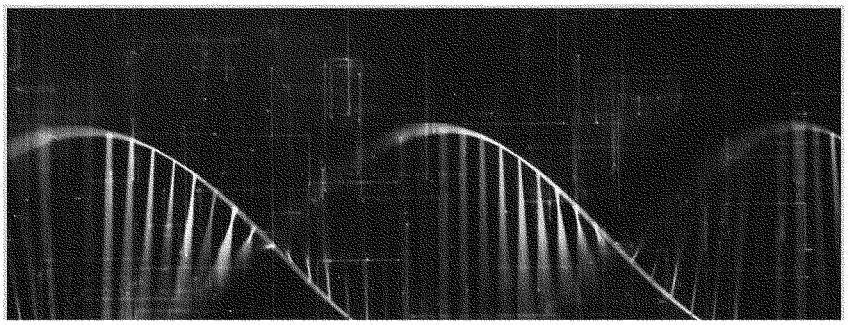
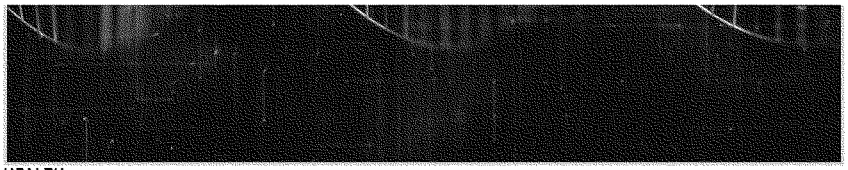
5 Takeaways From Super Tuesday And Joe Biden's Big Night





HEALTH

In A 1st, Scientists Use Revolutionary Gene-Editing Tool To Edit Inside A Patient

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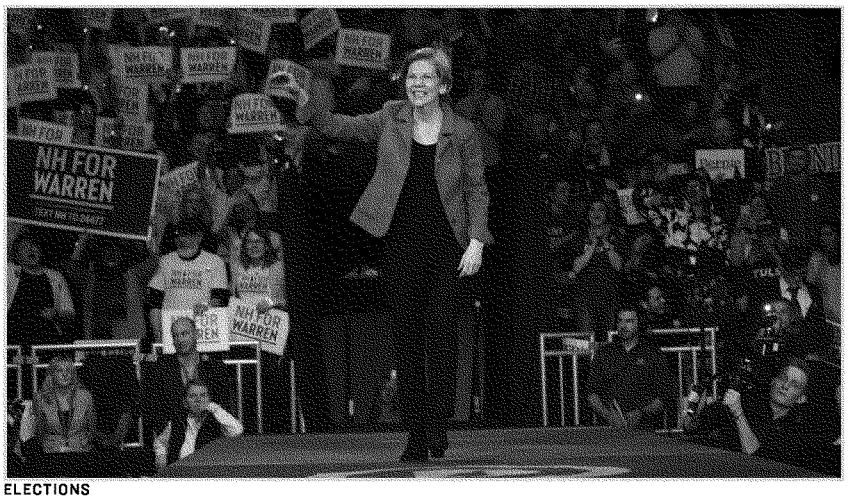
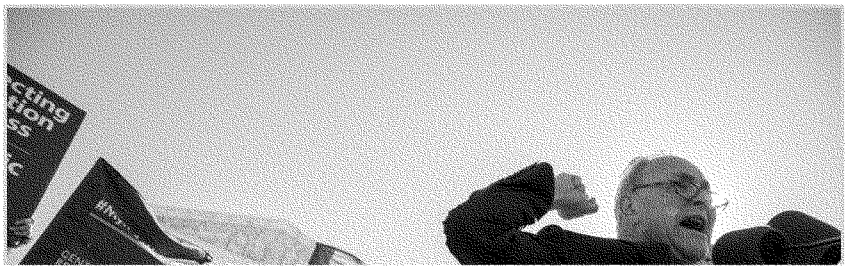


ELECTIONS

Sen. Elizabeth Warren Drops Out Of The 2020 Presidential Race



POLITICS

McConnell Condemns Schumer's Comments Targeting Supreme Court Justices

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10 Census Facts That Bust Common Myths About The 2020 U.S. Head Count

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What To Know About The Election Security Situation After Super Tuesday

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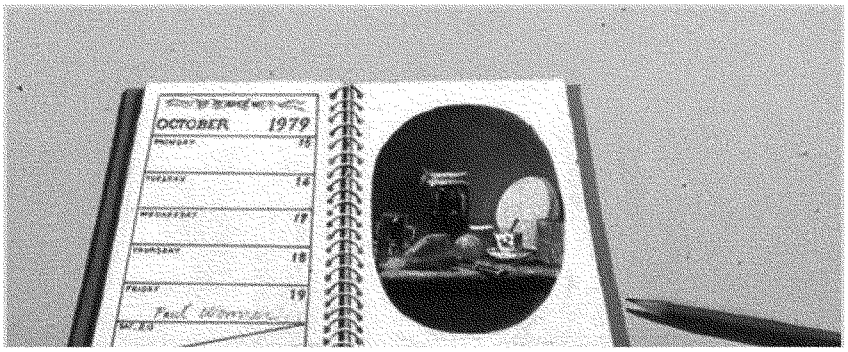

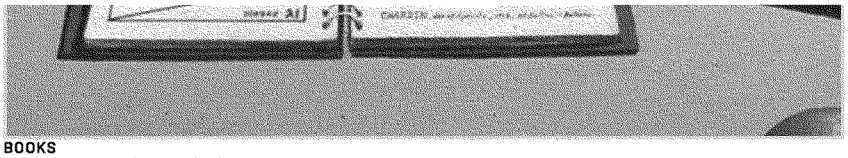

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Democracy Dies in Darkness

Coronavirus rumors and chaos in Alabama point to big problems as U.S. seeks to contain virus

Rumor mill, lack of communication by federal officials undermines trust in plan to relocate quarantined patients

By **Todd C. Frankel**

March 1, 2020 at 10:45 a.m. EST

ANNISTON, Ala. — Not long before local leaders decided, in the words of one of them, that federal health officials "didn't know what they were doing" with their plan to quarantine novel coronavirus patients in town, a doctor here set out in a biohazard suit to stage a one-man protest along the highway with a sign. "The virus has arrived. Are you ready?" it asked.

The town didn't think it was. Residents already were unnerved by strange stories posted on Facebook and shared via text messages about helicopters secretly flying in sick patients, that the virus was grown in a Chinese lab, that someone — either the media or the government — was lying to them about what was really going on.

The quarantine plan hastily hatched by the federal Department of Health and Human Services was soon scrapped by President Trump, who faced intense pushback from Alabama's congressional delegation, led by Republican Rep. Mike D. Rogers. Americans evacuated after falling ill aboard the Diamond Princess cruise ship in Japan would not be coming to Anniston, a town of 22,000 people in north-central Alabama, after all. They would remain in the same Texas and California sites where they were taken after leaving the cruise ship.

What happened here over the past week illustrates how poor planning by federal health officials and a rumor mill fueled by social media, polarized politics and a lack of clear communication can undermine public confidence in the response to the novel coronavirus, which causes the disease named covid-19. The rapidly spreading virus has rattled economies worldwide in recent weeks and caused the deaths of more than 2,900 people, mostly in China.

The panic and problems that burned through Anniston also provided a preview of what could unfold in other communities, as the spread of the virus is considered by health experts to be inevitable.

"Their little plan sketched out in D.C. was not thought out," said Michael Barton, director of the emergency management agency in Calhoun County, where Anniston is located.

As local officials learned more, Barton added, "We knew then —"

"We were in trouble," said Tim Hodges, chairman of the county commission.

In Anniston, local leaders were stunned to discover serious problems with the federal government's plan for dealing with patients infected with the virus — starting with how the patients would get to Alabama, according to interviews with county and city officials, along with business leaders who dealt with the federal response.

"I was shocked," Anniston Mayor Jack Draper said. "I was shocked by the lack of planning. I was shocked by the manner in which it was presented to us."

Two HHS officials — Darcie Johnston, director of intergovernmental affairs, and

Kevin Yeskey, principal deputy assistant secretary for preparedness and response — said in a Feb. 23 meeting with local officials that the patients would be flown from California to the Fort McClellan Army Airfield in Anniston, according to multiple local officials.

The airfield was closed when the Army base was shuttered in 1999. Local officials said they told the HHS officials during the meeting the runway was in bad shape.

"The more we talked," Hodges said, "the more holes we found."

The HHS plan also called for housing coronavirus patients at the Center for Domestic Preparedness, a FEMA facility on the old Army base and one of several redevelopment projects at the sprawling outpost.

The center has several brick dormitory buildings — behind tall black fencing — where federal officials planned for the patients to live. Federal officials even picked out the building they wanted to use for the first arrivals: Dorm No. 28, local officials said. A team of federal health workers would care for the patients and U.S. marshals would keep them from leaving the quarantine, local officials said they were told.

The dorms normally house emergency responders from around the country.

But the center doesn't have any special capabilities for handling infectious diseases, local officials said. The center is used for training. It has isolation hospital rooms — located in a former Army hospital building — but they are mostly just props, with fake equipment and light switches that exist only as paint on walls.

Meanwhile, federal officials never contacted the town's hospital, Regional Medical Center, about handling covid-19 patients, said Louis Bass, the hospital's chief executive.

Yet HHS officials said in a statement released to the public Feb. 22 that patients who become seriously ill would be sent to "pre-identified hospitals for medical care."

"We were surprised," Bass said.

The hospital does have eight negative-pressure isolation rooms, but patients with serious complications would need to be sent to a larger institution, such as Emory University Hospital in Atlanta, 90 miles away, Bass said.

Emory University Hospital did not respond to a question about whether it was told

about the HHS plan.

A federal contract for a local ambulance service was secured at the last moment, after HHS had already issued a statement about its plan for Anniston. Details on how to handle other tasks — including patients' laundry and food — seemed unfinished.

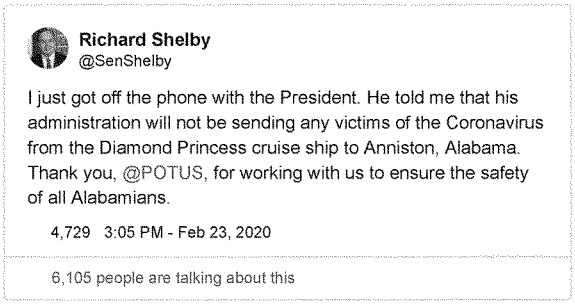
The preparations for bringing patients to Anniston were handled partly by Caliburn International, a government contractor that previously provided emergency medical services to federal agencies, according to interviews and documents reviewed by The Washington Post.

Former Trump chief of staff John F. Kelly joined the firm based in Reston, Va., as a board member last year. Caliburn is the parent company of Comprehensive Health Services, which has come under scrutiny for its operation of medical services at a detention site for migrant children.

A Caliburn spokeswoman referred questions about the Anniston operations to the Centers for Disease Control and Prevention, which did not immediately respond to a request for comment.

HHS, through its Office of the Assistant Secretary for Preparedness and Response, responded to The Post's questions about its Anniston operations with a statement noting the office's staff members "have a long-standing relationship" with the disaster preparedness center and were familiar with its capabilities. The statement also said the federal agency "was considering the facility as a contingency location" and decided during discussions with local officials that "the site would not actually be needed."

It was Trump who finally canceled the planned quarantine in Anniston on Feb. 23, according to tweets from Rogers and Sen. Richard C. Shelby (R-Ala.) that referred to their conversations with the president.



The news arrived as people attended an emergency meeting of the Calhoun County Commission. Cheers broke out.

"I guess in our culture today a tweet is considered official," Barton said.

Anniston has plenty of experience dealing with unwelcome threats — and learning to live with them.

It was for years home to the nation's chemical weapons stockpile, including sarin and mustard gas. Later, it was the location of a chemical weapons incinerator, where those munitions were carefully destroyed.

The town also deals with the toxic legacy of a former Monsanto plant that for decades polluted the soil and water with PCBs, which were banned in the 1970s amid health concerns. The pollution resulted in a $700 million settlement for 20,000 residents in 2003.

But the novel coronavirus posed a different kind of challenge.

Fear that the HHS plan was flawed gave new energy to already circulating rumors and wild theories about the virus.

Residents didn't know whom to believe. Trump had said without evidence that CNN

and MSNBC were exaggerating the threat. Rush Limbaugh was on the radio saying it was no worse than the regular flu. Facebook posts claimed the outbreak had been foreshadowed by a 1981 Dean Koontz book. And the idea the virus could have been created in a Chinese biochemical lab was floated widely, including by Sen. Tom Cotton (R-Ark.).

The whirlwind caught the attention of Michael Kline, a urologist in Anniston.

"I don't think anyone knows what's going on," he said.

So on the weekend of Feb. 22-23, Kline dressed up in a blue biohazard suit with his "the virus has arrived" sign. He stood along the highway and waved to passing vehicles. He wanted to drum up opposition to allowing infected patients in Anniston. But even after the plan was abandoned, Kline said he still wasn't certain patients weren't being housed at the old Army base.

Rumors of black helicopters ferrying infected patients to the training center at night were rampant. The local Home Depot sold out of painting and sanding face masks. Hodges, the commissioner, said he heard often from worried residents. But helicopters were common in the area because of a nearby Army depot and National Guard training center. Only now they were nefarious. Other people talked about mysterious vans driving along county roads.

Hodges and Draper held emergency news conferences and meetings to try to lessen the panic. But those meetings also allowed for additional rumors to flourish during public comment periods. A commission meeting included one resident tying the coronavirus to a 1992 United Nations document about climate change.

"That's how long this has been going on," he said.

"The public is going crazy," said Bobby Foster, a business owner who spoke at the

meeting and asked the commissioners to try harder to distribute accurate information.

Glen Ray, president of the local NAACP, talked about the virus at a Sunday service at Rising Star United Methodist Church on Feb. 23 to try to calm people's worries. But he was also dismayed that one of the county commissioners wore a red "Make America Great Again" hat to an emergency meeting about the virus.

"It's not about Donald Trump," Ray said later. "A virus is not going to just jump on a Democrat. So at times like this, we need to be coming together. No time for politics."

Anniston's flirtation with the dreaded virus did have one positive effect, officials said. It made them realize they need to prepare — that the virus could come without warning and they shouldn't rely on outsiders alone for expertise.

Barton, the emergency management director, helped create a county infectious disease task force. It has already had its first meeting. The focus is not solely on the coronavirus. It will handle the flu and whatever other viruses pop up in the future.

The public's interest in the virus hasn't faded, either.

Barton gave a talk Thursday to a lunchtime meeting of a civic organization, the Exchange Club. It had been planned months ago but he decided to talk about the aborted plan to bring infected patients to town.

People peppered Barton with questions about why federal health officials had ever considered the disaster training facility and how much emergency food they should keep at home. They wanted to know how to avoid getting sick.

Barton suggested hand-washing and keeping a safe distance from sick people.

As he talked, a lady reached into her purse, squeezed some alcohol sanitizer on her

hands and passed the bottle around the table.

Emma Brown and Beth Reinhard contributed.

Coronavirus: What you need to read

Updated March 4, 2020

The latest: California announced its first coronavirus-linked death Wednesday, bringing the death toll in the United States to 11.

Sign up for our Coronavirus Updates newsletter: Get the latest news straight to your inbox as we track the spread of the virus in the United States and around the world. **All stories linked the newsletter are free to access.**

What you need to know about coronavirus: What is it? How deadly is it? How does it spread?

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What do you want to know about coronavirus? **Let us know here.**

EDITORS' PICK | 12,823 views | Mar 1, 2020, 11:22 pm EST

Fears Of The COVID-19 Coronavirus Provide More Opportunity For Misinformation About 'Miracle Cures'

Nina Shapiro Contributor ⓘ
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Dispelling health myths, fads, exaggerations and misconceptions.

Herbal remedies GETTY

Unless you live in a cave or have literally had your head in the sand these past few weeks, you are well aware that fears about the novel coronavirus, or COVID-19, are rampant. While the earliest cases of the illness originated in Wuhan, China, it has since spread to six continents, fifty countries, and is now a bi-coastal disease in the United States. The first U.S. death due to COVID-19 infection occurred in the state of

New York. While most physicians and health organizations, including the Centers for Disease Control (CDC), have been advising to be cautious but not to panic, many find that panic is the only option, as it seems every time one refreshes a browser, reports of new states, new countries, and new deaths pop up. Both brick and mortar as well as online stores have run out of water, masks (despite the fact that the CDC does not recommend use of masks for protection, unless you're a healthcare worker caring for a infected individual), and apparently ramen noodles. Perhaps we're all headed back to the college dorms to perfect our ramen noodle cooking skills?

Much worse than panicking over COVID-19 is taking the alternative medicine/herbal remedy route. The National Institutes of Health (NIH) has a subsection entitled the National Center for Complementary and Integrative Health. Even this subsection state (in bold): **There is no scientific evidence that any of these alternative remedies can prevent or cure the illness caused by this virus**. It follows with: "In fact, some of them may not be safe to consume." The latter statement refers in particular to herbs found in traditional Chinese medicine (TCM). A toxicology study published in 2015 found some of these herbs to contain pharmaceutical agents includi warfarin (a blood thinner commonly known as coumadin), dexamethasone (steroids), and paracetamol (pain killers). In addition, heavy metals such as arsenic, lead, and cadmium were found. Some remedies even contained DNA of a snow leopard. Cute.

Snow Leopard GETTY

False claims abound regarding prevention and treatment of COVID-19 infections, and seem to spread nearly as fast as the disease itself.

Just a few that have been circulating include:

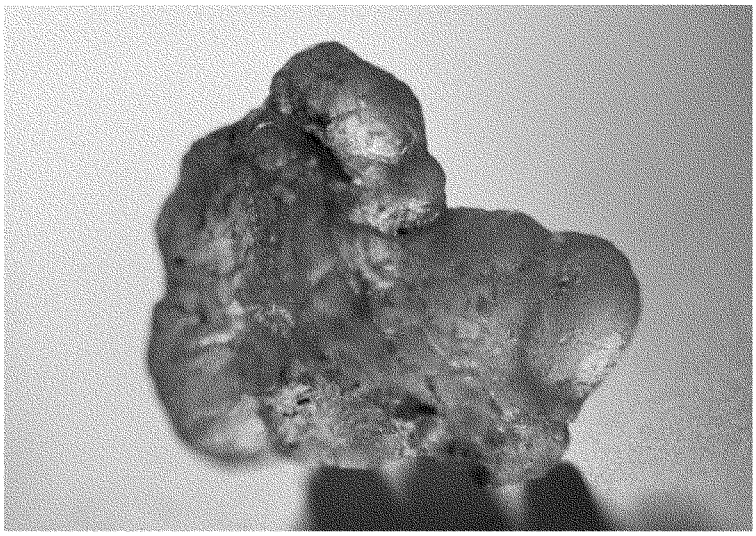
"Immune boosters will ward off COVID-19 infections"

"High dose Vitamin C will prevent it"

"Diet modification, including avoiding spicy foods, cold drinks, milkshakes, or ice crea will prevent the infection."

"Drinking hydrogen peroxide will kill the virus"

A big fat "no" to all of the above, especially the bit about the ice cream. Sadly, even som physicians are sharing inaccurate recommendations regarding COVID-19. One pediatrician begins by providing sound information and recommendations on her site regarding incidence of the illness, methods of prevention, and signs to look for that should trigger concern. She then goes on to recommend elderberry, vitamin C, frankincense, and bone broth. Yes, there are disclosures that there is no hard data on any of this, but these remedies, especially when there are none to date that are availabl will draw in any captive audience. While most of this stuff is harmless, it's a waste of money and it will not treat or prevent any viral infection, let alone one caused by COVID-19.



Wellness influencers are recommending high-dose vitamin infusions, including vitami A, C, and D, to prevent and treat coronavirus. There is no evidence that these can help. In fact, using extremely high doses of vitamins can lead to kidney and liver problems. Using too much vitamin A during pregnancy can lead to fetal abnormalities.

Besides it being wise to avoid claims for herbal remedies, steer clear of any scams that appear on social media, an email, a website link offering a "miracle cure," claiming testimonials about conspiracy theories, offering "secret vaccines not released by the government," or asking for money for fake fundraising efforts. And remember, "all natural" has nothing to do with being safe or effective. It's a marketing term, and a poo one at that.

The CDC is continually updating its site regarding information about COVID-19. This will provide you the most accurate information, including information regarding travel advisories, risk assessment, prevention strategies, updates on testing, and treatments. Frankincense somehow didn't make it to their site.

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New coronavirus protein reveals drug target

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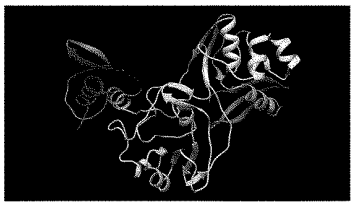
BY NORTHWESTERN UNIVERSITY | MARCH 2, 2020

A potential drug target has been identified in a newly mapped protein of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19).



Structure of the Nsp 15 hexamer. (Image by Northwestern University.)

A potential drug target has been identified in a newly mapped protein of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19). The structure was solved by a team including the University of Chicago (U of C), the U.S. Department of Energy's (DOE) Argonne National Laboratory, Northwestern University Feinberg School of Medicine and the University of California, Riverside School of Medicine (UCR).

The scientists said their findings suggest drugs that had previously been in development to treat the earlier SARS outbreak could now be developed as effective drugs against COVID-19.

The protein Nsp15 from Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is 89% identical to the protein from the earlier outbreak of SARS-CoV. Studies published in 2010 on SARS-CoV revealed that inhibition of Nsp15 can slow viral replication. This suggests drugs designed to target Nsp15 could be developed as effective drugs against COVID-19.

"The newly mapped protein, called Nsp15, is conserved among coronaviruses and is essential in their lifecycle and virulence. Initially, Nsp15 was thought to directly participate in viral replication, but more recently, it was proposed to help the virus replicate possibly by interfering with the host's immune response." — Andrzej Joachimiak

The structure of Nsp15 will be released to the scientific community on March 4 on the RSCB Protein Data Bank.

This new structure was solved by the group of Andrzej Joachimiak, Distinguished Fellow of Argonne, the University of Chicago professor and director of the Structural Biology Center at Argonne's Advanced Photon Source (APS), a DOE Office of Science user facility in conjunction with the Center for Structural Genomics of Infectious Diseases. Dr. Joachimiak is a co-director of the center.

Karla Satchell, principal investigator for the Center for Structural Genomics of Infectious Diseases and professor of microbiology-immunology at Northwestern, leads this international team of scientists investigating the structure of the SARS CoV-2 virus to understand how to stop it from replicating.

The initial genome analysis and design of constructs for protein synthesis were performed by the bioinformatic group of Adam Godzik, a professor of biomedical sciences in the UCR.

"The newly mapped protein, called Nsp15, is conserved among coronaviruses and is essential in their lifecycle and virulence. Initially, Nsp15 was thought to directly participate in viral replication, but more recently, it was proposed to help the virus replicate possibly by interfering with the host's immune response," said Joachimiak.

Mapping a 3D protein structure of the virus, also called solving the structure, allows scientists to figure out how to interfere in the pathogen's replication in human cells.

Satchell said, "The Nsp15 protein has been investigated in SARS as a novel target for new drug development, but that never went very far because the SARS epidemic went away, and all new drug development ended. Some inhibitors were identified but never developed into drugs. The inhibitors that were developed for SARS now could be tested against this protein."

Rapid upsurge and proliferation of SARS-CoV-2 raised questions about how this virus could became so much more transmissible as compared to the SARS and MERS coronaviruses. The scientists are mapping the proteins to address this issue.

"While the SARS-CoV-2 is very similar to the SARS virus that caused epidemics in 2003, new structures shed light on the small, but potentially important differences between the two viruses that contribute to the different patterns in the spread and severity of the diseases they cause," Godzik said.

Northwestern is the lead site for the international center that comprises eight institutions, including U of C and UCR. The center has committed resources across all eight sites since the news of the new

coronavirus was made public in January. The structure of Nsp15 is the first structure solved by the center.

The Center for Structural Genomics of Infectious Diseases is funded as a contract from the National Institute of Allergy and Infectious Diseases, part of the National Institutes of Health (NIH), in part to serve as a response site for structure biology in the event of an unexpected infectious disease outbreak.

SARS-CoV-2 is responsible for the current outbreak of COVID-19. Over the past two months, the pathogen infected more than 80,000 people and caused at least 2,700 deaths. Although currently mainly concentrated in China, the virus is spreading worldwide and has been found in 46 countries (www.trackcorona.live). Millions of people are being quarantined, and the epidemic has impacted the world economy. There is no existing drug for this disease, but various treatment options, for example utilizing medicines effective in other viral ailments, are being attempted.

Satchell, Joachimiak and Godzik — along with the entire center team — will map the structure of some of the 28 proteins in the virus in order to see where drugs can throw a chemical monkey wrench into its machinery. The proteins are folded globular structures with precisely defined function and their "active sites" can be targeted with chemical compounds.

The first step is to clone and express the genes of the virus proteins and grow them as protein crystals in miniature ice cube-like trays. The consortium includes nine labs across eight institutions that will participate in this effort.

Viewing these proteins down to the arrangement of their atoms requires an intense X-ray beam. Thus, once the crystals are grown, the center scientists image them using the APS' extremely bright light source in a process called X-ray crystallography. Data for structure determination were collected at Structural Biology Beamlines funded by DOE Office of Biological and Environmental Research.

Satchell and her team are well prepared for the challenges that come with developing drugs to fight the virus. The Center for Structural Genomics of Infectious Diseases, established in 2007, has mapped more than a thousand parts of lethal bacteria and viruses in three dimensions, exposing an intimate chemical portrait of diseases. This view offers scientists a window into the bacteria or virus' vulnerabilities enables them to create drugs to disable it or vaccines to prevent it.

This study has been funded by contract HHSN272201700060C from the National Institute of Allergy and Infectious Diseases of NIH.

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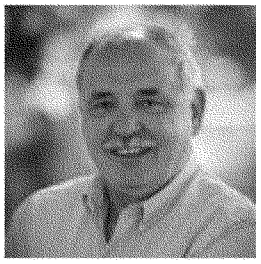
Andrzej Joachimiak

Argonne Distinguished Fellow
Andrzej's current research focuses on proteins and protein-nucleic acid interactions and includes enzymes, transcription factors and molecular chaperones.



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LETTER SUBMITTED BY REPRESENTATIVE DON BEYER

Congress of the United States
Washington, DC 20515

March 4, 2020

President Donald J. Trump
The White House
1600 Pennsylvania Avenue
Washington, DC 20500

Dear President Trump:

We write regarding the risk of the 2019 Novel Coronavirus (COVID-19) spreading within the United States[1] and your administration's handling of this potential public health crisis. The American people need strong, organized leadership at this moment, but the response to date has been dangerously inadequate.

The death toll from the coronavirus is now more than 3,200 worldwide and there have been 93,000 global cases since the outbreak originated in Wuhan, China in December of 2019. As it becomes clear that efforts to contain the virus to mainland China have failed, current and former public health officials have increasingly warned that the spread of the virus to the United States is increasingly likely and a pandemic may be "inevitable."[2]

In the face of such a threat, the American people need to know that there is a strategy being executed by competent leadership with adequate resources. The growing evidence that such a strategy is absent is deeply concerning to us.

Recent statements by top administration officials have given wildly conflicting answers to critical questions, including the prospect of the virus spreading within the United States[3] and the potential timeline for the development of a vaccine.[4][5] The obvious and inescapable fact is that if multiple Cabinet-level officials give different answers on these topics, at least one of the most important public officials responsible for handling this crisis is ignorant of key facts. Such

[1] ABC, "CDC warns Americans of 'significant disruption' from coronavirus," Morgan Winsor, Erin Schumaker, Marc Nathanson, Feb. 25, 2020 https://abcnews.go.com/International/coronavirus-live-updates-cdc-warns-americans-significant-disruption/story?id=69190968
[2] CNN, "Former CDC director: A coronavirus pandemic is inevitable. What now?" Dr. Tom Frieden, Feb. 25, 2020 https://www.cnn.com/2020/02/25/health/coronavirus-pandemic-frieden/index.html
[3] Politico, "Kudlow breaks with CDC on coronavirus: 'We have contained this,'" Eli Okun, Feb. 25, 2020 https://www.politico.com/news/2020/02/25/kudlow-white-house-coronavirus-117402
[4] The Hill, "Top health official warns coronavirus spread appears inevitable in US," Nathaniel Weixel, Feb. 25, 2020 https://thehill.com/policy/healthcare/484530-top-health-official-warns-coronavirus-spread-in-us-inevitable-its-not-a
[5] NBC, "Fact checking Trump's comments on coronavirus," Jane C. Timm, Feb. 26, 2020 https://www.nbcnews.com/politics/donald-trump/fact-checking-trump-s-comments-coronavirus-n1143856

discrepancies reveal a startling lack of information-sharing, which also suggests the absence of interagency coordination, planning, and strategic focus.

On February 26, 2020, you appointed Vice President Pence to take charge of the administration's response to the coronavirus. However, the following day, Ambassador Debbie Birx was appointed as the "White House Coronavirus Response Coordinator," reporting under Pence. Additionally, she will be joining the White House's task force, which is still led by HHS Secretary Azar. It is apparent there is chaos and a lack of clarity among the top levels of leadership regarding who is overseeing not only the dissemination of accurate information, but also the execution of an effective strategy. We believe that a clear chain of command is required for your administration's pandemic response, not just for the public, but across government agencies and leadership, in order to allow the full force of the bureaucracy to efficiently quell the outbreak.

Such a response must also have the resources necessary to succeed. We note that Appropriations leaders from both parties in both chambers of Congress found the administration's funding request unserious.[6] We further note your history of requesting enormous funding cuts to the CDC and NIH, particularly in the area of global health.[7] Protecting the American people will require funding for research and medical supplies than administration officials have sought, and we are committed to making sure such funding is provided, without pulling from important existing programs.

Relatedly, the teams within the White House National Security Council (NSC) and the Department of Homeland Security (DHS) responsible for responding to global health threats were disbanded nearly two years ago, since which time the office of the head of global health security on the NSC has remained vacant.[8] These teams were permanently established following the 2014 Ebola outbreak in order to rapidly and efficiently respond to global health threats, such as the coronavirus. We believe it is essential to restore this permanent infrastructure within the administration immediately.

The potential of a pandemic is not a matter of economic or political benefit, it is a matter of life and death. We urge you to immediately establish a strong chain of command for the U.S. government's pandemic response with clearly identified authority to coordinate an administration-wide response. We urge you to reestablish the NSC and DHS offices of global health security and appoint qualified experts to lead them. We urge you to abandon planned cuts

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[6] The Hill, "GOP chairman of Appropriations panel worries Trump 'lowballing' coronavirus funding request," Jessie Hellmann, Feb. 25, 2020 https://thehill.com/policy/healthcare/484515-gop-senator-worries-trump-administration-is-lowballing-coronavirus-funding

[7] Foreign Policy, "Trump Has Sabotaged America's Coronavirus Response," Laurie Garrett, Jan. 31, 2020 https://foreignpolicy.com/2020/01/31/coronavirus-china-trump-united-states-public-health-emergency-response/

[8] Washington Post, "Top White House official in charge of pandemic response exits abruptly," Lena H. Sun, May 10, 2018 https://www.washingtonpost.com/news/to-your-health/wp/2018/05/10/top-white-house-official-in-charge-of-pandemic-response-exits-abruptly/

to public health agencies and global health initiatives immediately. We urge you to utilize all available resources to prevent the spread of the coronavirus.

The level of chaos with which the administration has greeted the spread of coronavirus is unacceptable and frankly frightening. Our constituents are not interested in credit or partisan battles, they just want to know that this problem will be solved.

They are counting on you to solve it. We stand ready and willing to help.

Sincerely,

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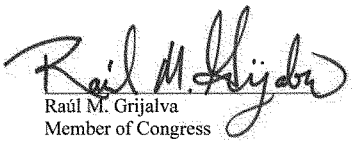

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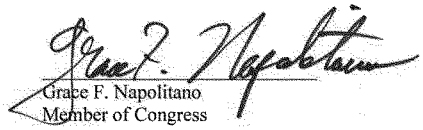

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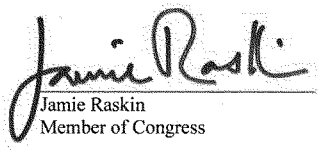

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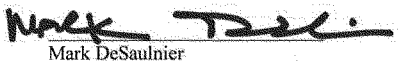

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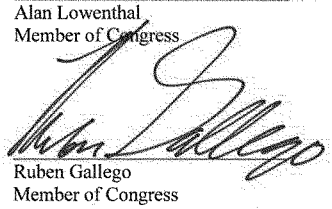

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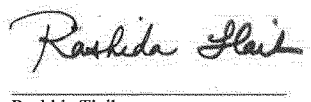

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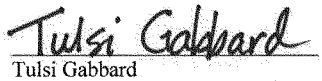

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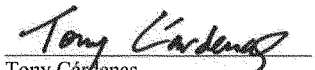

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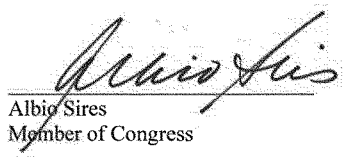

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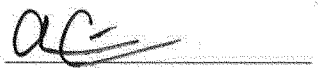

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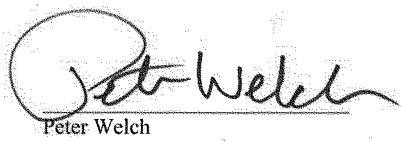

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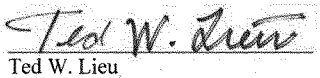

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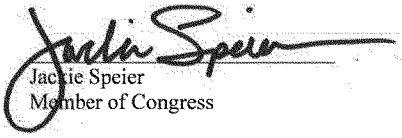

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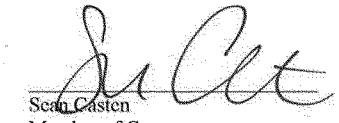

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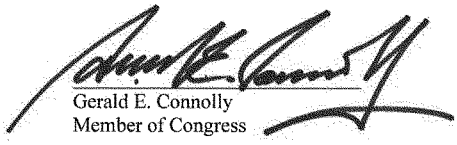

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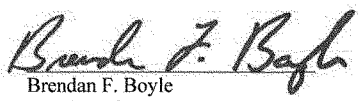

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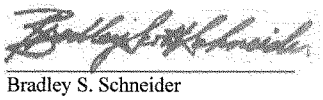

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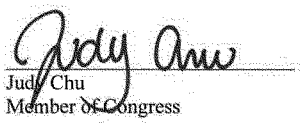

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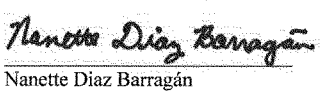

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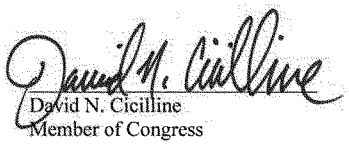

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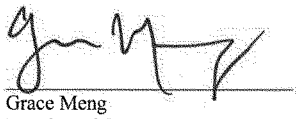

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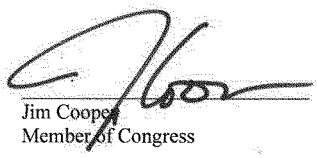
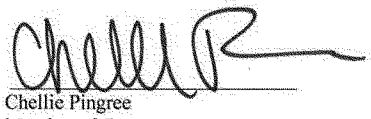


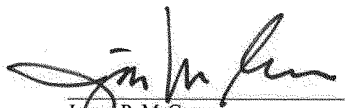
Jim Cooper
Member of Congress

Danny K. Davis
Member of Congress

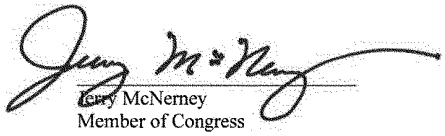


Chellie Pingree
Member of Congress

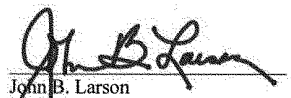
Daniel T. Kildee
Member of Congress



James P. McGovern
Member of Congress



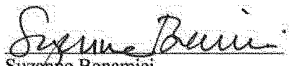
Jerry McNerney
Member of Congress



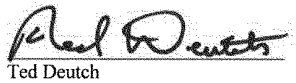
John B. Larson
Member of Congress

Al Lawson, Jr.
Member of Congress

Chrissy Houlahan
Member of Congress



Suzanne Bonamici
Member of Congress



Ted Deutch
Member of Congress