



COVID-19: SCIENCE AND SOCIETY

A Summary of the Proceedings of the 14th Annual Symposium

Washington State Academy of Sciences
September 23, 2021

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The Washington State Academy of Sciences (WSAS) is a not-for-profit organization of more than 300 elected members who are nationally recognized for their scientific and technical expertise. All members of the National Academies of Sciences, Engineering and Medicine who reside in Washington State are invited to join; others are elected in recognition of their scientific and technical contributions to our nation and their desire to contribute their expertise to inform issues in Washington State.

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WSAS provides expert scientific and engineering assessments to inform public policy making and works to increase the impact of research in Washington State.

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WSAS mobilizes the expertise of our members, plus our network of partners, to provide independent, unbiased, evidence-based scientific and engineering assessments of issues that impact the citizens, government and businesses of Washington State.

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We accomplish our mission by drawing on our statewide pool of distinguished members, state government officials, and other key stakeholders and experts to address critical issues facing Washington State. We organize and conduct multi-disciplinary roundtable discussions, workshops, and symposia to assess risks, identify technological opportunities, and define critical research gaps. Our use of peer review ensures the studies we conduct, programs and projects we evaluate, and reports we provide are scientifically and technically sound and unbiased resources for informing the development of Washington State policy.

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Forward

The COVID-19 pandemic has affected everyone in many different ways. These effects range well beyond the biomedical and public health aspects of the pandemic. They include economic, social, and political impacts that have already had and will continue to have far-reaching consequences.

The 14th annual symposium of the Washington State Academy of Sciences, which was held virtually on September 23, 2021, highlighted the many links between science and larger societal issues that affect our lives every day. Occurring roughly 20 months into the pandemic, it examined how scientific insights can help crystallize the lessons learned, inform the recovery process, and build resilience against future disasters, with particular attention to the pandemic's implications for Washington State. The Symposium sought to identify patterns and connections across multiple domains to understand the course of the pandemic, the pandemic's consequences, and ways to build future resilience.

Symposium organizer Howard Frumkin, professor emeritus of environmental and occupational health sciences at the University of Washington, worked for months with the panel moderators, the panelists, and Washington State Academy of Sciences staff and members to pull together the program. He organized the symposium into three panels, all of them based on the concept of unity. The immunity session addressed biomedical, public health, and epidemiologic aspects of the pandemic (Chapter 2). The community session examined the impacts of the pandemic on people, including the groups hit especially hard by the virus (Chapter 3). The opportunity session looked at the economic aspects of the pandemic, both past and future (Chapter 4). After each of these sessions, symposium participants divided into virtual breakout groups to extend the conversation with individual panelists. At the end of the day, a final set of breakout groups discussed some of the broader messages to be drawn from the symposium (Chapter 5).

We were extremely fortunate to have two esteemed, experienced, and knowledgeable keynote presenters (Chapter 1). Apoorva Mandavilli, health and science journalist for The New York Times, had perhaps the most challenging job in science reporting at the most difficult time in history and rose to the occasion marvelously. Lisa Brown, director of the Washington State Department of Commerce, took time from her extremely busy schedule to describe the actions that her department and state government in general have taken to protect

and strengthen the state's business, institutions, and communities. Together, they provided a solid base of information on which the rest of the symposium could build.

For the second year in a row, the symposium was held virtually because of the pandemic, which represented both challenges and opportunities. Compensating for our inability to gather in one place, people throughout the state were able to participate in the symposium, including high school students and teachers state-wide through a collaboration with the Washington Science Teachers Association. The event was also telecast on TVW, reaching an even broader audience both on the day of the event and in subsequent rebroadcasts. A video recording of the event can be found on the website of the Washington State Academy of Sciences at <https://washacad.org/2021-symposium>.

We would like to thank the wonderful staff of the Washington State Academy of Sciences, program officer Yasmee Hussain, consultant Bridget Kelly, and operations leads Devon Emily Thorsell and Elizabeth Jarowey, who did the hard work of preparing and running the symposium. Seattle-based writer Steve Olson put together this summary of the symposium.

Throughout the day we heard that having good evidence alone cannot carry the day. Evidence needs to be translated into policy and practice through good communication and respectful interactions among parties with competing interests. The Washington State Academy of Sciences is committed to this process, from support for research to the incorporation of scientific findings into policy. As just one example of our activities, we have established a Community Dialogue Series where we bring together scientist and local decision makers in a public forum to discuss the latest science and impacts on a local level. All these efforts will result in a state that is better prepared to meet the challenges that the future is sure to hold.

Roger Myers, President

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Preface

For anyone interested in the many links between science and larger social issues such as economic activity, political discourse, and social justice, it's hard to imagine a more compelling, powerful, and timely example than the COVID-19 pandemic.

When the staff and board of directors of the Washington State Academy of Sciences, the COVID-19 Steering Committee, and I began planning the symposium toward the end of 2020, we thought we would be talking about the pandemic in the past tense on September 23, 2021. It didn't work out that way. The symposium was held as the Delta variant of the virus was spreading rapidly through the state. More than a year and a half into the pandemic, many questions at the interface of science and society remained largely unanswered.

Some of these questions were immediate and practical: How can more people be convinced to be vaccinated? How can we deal with the disinformation that is causing many people to avoid vaccination? How can injustices that have become apparent during the pandemic be reduced? Other questions are more general and long term: What is the nature of evidence, including evidence on social, economic, and political impacts? How do we reckon with uncertainty and communicate about it? How do we combine evidence with uncertainty to make good decisions now and in the future?

As a preview of what you're about to read, I drew four general conclusions from the symposium. The first involves the need for good data, both to understand the past and to predict the future. Good data become evidence, evidence becomes information, and information guides us in making wise decisions. However, some data that would be very valuable to both understanding and prediction have been missing, such as data on domestic violence, poverty, the extent to which people are accessing services, and other social factors. If things are important to us, we need to measure them, which is an important lesson of the pandemic.

The second conclusion I drew is that data are necessary but not sufficient. As several speakers observed, stories move people in ways that numbers simply cannot. Numbers numb while stories stir. At the same time, science communication is a two-way process that requires listening as well as talking. This calls for meeting individuals and communities where they are and enlisting trusted messengers to communicate science. It also requires combating disinformation, which implies a role for advocacy. Researchers need to go beyond the production

of data, and even beyond the communication of data, toward advocacy for the honest and faithful translation of data into policy and practice.

My third point concerns inequities. Nothing has become clearer in this pandemic than the devastating consequences on some populations of the racism and historical inequities that have marked the history of the United States. Those inequities have played out in the experiences of communities during the pandemic, with people of color, women, and people who are poor all suffering disproportionately. Addressing inequities requires new ways of thinking. A good example is the definition of infrastructure. Usually conceived as highways and bridges, the symposium made clear that services such as childcare also are essential. Addressing inequities also requires system thinking. Who would have thought when the pandemic began that a phenomenon that was virologic would become so completely and inextricably tied up with economic development, racial equity, urban planning, property values, and academic performance? We all need to be systems thinkers.

My fourth and final point is how best to move forward. How do we build back better and recover from the pandemic? How do we as scientists, how do we at the Washington State Academy of Sciences, how do we as citizens of this state support recovery? Building back better involves infrastructure, including everything from streets and green spaces to childcare and the public health system. It includes addressing inequities and racism. It requires building economic, institutional, and social resilience—not only for the next pandemic but for threats such as earthquakes and climate change. Though predictions are difficult, the more we can build robust systems that deliver all-hazards preparedness, the better the recovery will be.

The 2021 Washington State Academy of Sciences symposium "COVID-19: Science and Society" was an invaluable reminder that science and society can no longer be separated. Each depends on the other for both to advance.



Howard Frumkin, Symposium Organizer; Professor Emeritus, University of Washington; and Senior Vice President, Trust for Public Land

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1. The Pandemic

The two keynote speakers at the symposium placed the COVID-19 pandemic within the broader context of how people learn about, assess, and act on scientific information. First, a prominent science journalist described some of the major issues involved in communicating scientific evidence, conclusions, and recommendations to the public. Then the director of the Washington State Department of Commerce discussed some of the many social, behavioral, and economic issues that arose during the pandemic.

COMMUNICATING SCIENTIFIC INFORMATION

The COVID-19 pandemic has made extraordinary demands on science communication, said Apoorva Mandavilli, a health and science journalist for The New York Times. The general public has been asked to understand complex scientific concepts as a matter of life and death. Scientists have had to work as hard as possible and share information in unprecedented ways and at an unprecedented pace. And public health officials have had to communicate information, including its nuances, without losing the public's trust as the pandemic has continually changed.

In addition, magazines and newspapers have had to communicate science despite having far fewer science journalists than in the past. As a result, when the pandemic was at its height, reporters from many other beats were writing about the virus. "Kudos to them," said Mandavilli, "because it's hard enough to write about this when you have a background in science, but to have to jump in and write about these things without having had a ton of experience or knowledge about this must have been incredibly intimidating. They worked very hard to get things right, and when they did get things wrong, it was unintentionally, despite their best efforts."

Relatively few scientists were experts on coronaviruses at the beginning of the epidemic. As a result, journalists not experienced in science sometime ended up interviewing scientists about subjects in fields where those scientists had not worked—"nutritionists talking about infectious disease epidemiology, toxicologists talking about virology, chemists talking about immunology." The resulting "inaccurate takes on a finding" complicated the task of getting accurate information to readers.

With so much information coming at journalists so rapidly—sometimes several major new pieces of

information a day—the science reporters and editors at The New York Times had to ask themselves a "big question": Do people need to know this? If the answer to this question was yes, several questions followed: What do people need to know about this? Is this information important for them to protect themselves or their loved ones from the virus? Is the information scientifically plausible?

The first story Mandavilli wrote about the pandemic, early in 2020, was about how the virus was largely sparing children under the age of 15. This was a tentative conclusion at the time, since not much was then known about transmission and virulence. But it was known to be a coronavirus, previous coronaviruses that had infected humans were not very harmful for children, and "viruses rarely do something new," Mandavilli knew. This became a theme of her reporting. "How is this [virus] different? Is this like all other viruses, or is this new?"

Since that first story, Mandavilli has written about subjects that "I never thought I would put in an article in The New York Times": cytokine storms, the difference between humoral and cellular immunity, viral evolution. But understanding these subjects became important to the public, "especially to stem panic." For example, when news articles emerged saying that people might get reinfected with the virus every few weeks, Mandavilli wrote an article about how this was unlikely, based on previous experiences with viral infections. But this would not have been an easy conclusion to draw for someone who had never before written about science, she observed. "If you don't know what you don't know, how do you ask questions?"

Spending less time teaching about specific scientific facts and more time talking about general principles could help people understand that disagreements arise "not because one side is lying to me, and not because one side is completely wrong and the other is right, but because this kind of disagreement is how science moves forward."

-Apoorva Mandavilli

Reporters also could have difficulties if they had never dealt with agencies like the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), the Department of Health and Human Services

(HHS), or the Food and Drug Administration (FDA). These agencies do their jobs in particular and convoluted ways, Mandavilli observed, and some of them were under political pressures that distorted the messages they were trying to convey. Because of political pressures, for instance, Mandavilli had to rely on sources within the CDC to tell her what was really going on inside the agency.

A particular example involved guidance on wearing masks. Early in the pandemic, journalists were hearing that mask wearing was widespread in other countries, yet the WHO and other public health agencies were recommending against wearing masks. “Because we journalists are used to trusting information from public health agencies and experts, it took us a while to realize that what we were hearing was not reality and that there were political and social considerations that had nothing to do with the science.” For example, Mandavilli later wrote that discussions of mask wearing at the WHO were dominated by a few people who were focused on hand hygiene. “Their perspective was that people cannot handle both pieces of information at once, so they decided to emphasize hand washing over wearing masks.” Shortly after her article appeared, the WHO said it would review its guidance on airborne transmission, and a few days later the guidance was changed.

A particular problem for scientists was learning how to communicate with reporters and the public without using the jargon that they use with their own colleagues. In part, the CDC and WHO were reluctant to say that the virus is airborne indoors because the word “airborne” has a specific meaning to hospitals involving how ventilation systems remove infectious agents from the air. At the same time, experts were pointing out that the virus is “airborne” in that it can be transmitted through the air. “People needed to know that,” Mandavilli said. It became “absolutely essential that the public know that it’s not surfaces that are the big problem. It’s indoor air. I still to this day don’t understand why it took that long to change guidance on something that was literally taking lives every day.”

But science communicators—including federal agencies, public health experts, and medical professionals—may fail to explain that vaccines protect not just the health of people who are getting them but also the health of other people, including older people and children.

For many aspects of the pandemic, not enough was known about the virus to make good predictions. Understanding of how the virus would infect people in

waves, or how the emergence of variants works, or how people would behave was lacking. In some cases, such as people’s behavior, predictions were difficult because of the large number of variables involved. In such cases, said Mandavilli, the best option was to talk with experts about what might happen given particular antecedent events. “Scenarios based on how things might go [was] really the best you can do. Certainty was just not an option.”

Sometimes, science communicators focus on some, but not all, of the important issues. For example, when people are asked their reasons for not getting a flu vaccine, the 50 percent or so of people who do not get vaccinated each year provide lots of reasons for their inaction—for example, “I’m healthy, why do I need a vaccine?” But science communicators—including federal agencies, public health experts, and medical professionals—may fail to explain that vaccines protect not just the health of people who are getting them but also the health of other people, including older people and children. “We have not done a great job as a society of conveying what infectious diseases really do and what it means to protect your community and not just yourself.” Such messages need to be delivered all along, not just after a pandemic starts, said Mandavilli. If people understood more about the public health benefits of vaccination, there could have been less polarization around masks and vaccines. “These are lessons learned for the next pandemic.”

People can be very resistant to scientific information, Mandavilli pointed out. Before working at the Times she ran a magazine about autism for 13 years and became very familiar with the anti-vax community. “These people are incredibly organized and incredibly good at what they do, because their messages are simple and take root, whereas science, as we know, is complicated and nuanced.” The political divide in the country further increased resistance to scientific information, and science and science communicators did not do enough to address the problem early. “By the time people started talking about the safety of vaccines, that ship had sailed already.”

Finally, the public has well-known difficulties understanding science, Mandavilli observed, though that is not necessarily their fault. In school, students learn about specific scientific topics, such as climate change or aspects of biology. But they do not learn how scientists develop and test hypotheses, arrive at conclusions, get feedback from other people, and revise their hypotheses, experiments, and conclusions. The education system does not provide students with an understanding that uncertainty is the norm for scientists. As a result, “for the average person who doesn’t understand how science works, it can be very confusing and disorienting to hear about things changing all the time.” Spending less time

teaching about specific scientific facts and more time talking about general principles could help people understand that disagreements arise “not because one side is lying to me, and not because one side is completely wrong and the other is right, but because this kind of disagreement is how science moves forward.”

SUPPORTING WASHINGTON STATE’S BUSINESSES, COMMUNITIES, AND PEOPLE

The Washington State Department of Commerce has a very broad mission, from strengthening businesses to supporting international trade to administering the state’s housing trust fund, observed the department’s director, Lisa Brown. That diverse portfolio “has given us a unique perspective as we’ve moved through this challenging time.”

Because of her training as an economist, Brown tends to think in terms of the costs and benefits of taking an action. Those tradeoffs have been important during the pandemic as people have made decisions about when to go back to work, what to do with their children, and whether to get vaccinated. Even if the public sector creates a mandate to do something, people still weigh costs and benefits before taking action.

Washington State consists of a multiplicity of communities, said Brown, and inappropriate aggregation can leave out important parts of the story. For example, Washington State as a whole may have strong economic growth, but that observation masks the fact that northeastern Washington, for example, had not yet recovered from the last recession when the pandemic began. Even dividing the state into eastern and western portions can be misleading if it overlooks the differences between smaller regions, such as urban and rural areas. “The unit of analysis we use is very significant, and that’s an important lesson.”

One important role the Department of Commerce played during the pandemic was tracking the state’s economic recovery. Brown and her colleagues knew, from previous experience, that recovery from the downturn caused by the loss of economic activity would be uneven. Commerce therefore tracked the recovery by economic sector and subsector—for example, manufacturing, hospitality, and restaurants, all of which were hit hard by the pandemic. The department also tracked changes in economic activity by county, though the dramatic differences in population among counties could make comparisons difficult.

A particular need was for data on not only economic activity but also on need. For example, besides tracking unemployment at the county level, the department gathered data on the percentage of people in a county who were accessing basic food assistance. These data showed a dramatic increase, from about 800,000 individuals accessing food assistance in Washington State in January 2020 to 984,000 in January 2021. Again, these numbers varied geographically, with 8 percent of people accessing food assistance in King County to 16 percent in Spokane County to 23 percent in Yakima County.

One data gap highlighted during the pandemic was a limited ability to track equity, said Brown. For example, the state “has a long way to go” in collecting information about businesses owned by members of historically underserved or marginalized communities. National data show that Black-owned businesses were much more likely to fail during the pandemic, and baseline information is needed about those businesses to provide support for entrepreneurs in underserved communities.

The Department of Commerce was also engaged in providing pandemic relief. It relayed billions of dollars in COVID-19 relief funds from the federal government and the state to counties, tribes, businesses, and nonprofit organizations in the form of rental assistance, housing assistance, and small business assistance. Because it was much larger than what the state was able to provide, federal unemployment and business assistance were critical and remain critical, said Brown. For example, the childcare tax credit and support for infrastructure “will have a big impact on our lives far beyond what we do at the state level.”

In many cases, people and businesses found it difficult to access resources that are available to them because of language issues, a lack of technical assistance on applications, or other obstacles. With a newly granted ability to contract more freely, the Commerce Department helped pull together a group of organizations around the state that worked as a peer network in particular communities to support entrepreneurs and small businesses. “Having entities that can be navigators, trusted messengers, and authentic voices in communities is really significant, and it’s going to change the way that Commerce does its work across a whole spectrum of programs as we move into the future.”

Another lesson from the pandemic was that infrastructure matters—not just traditional infrastructure like clean water, waste disposal systems, road networks, and electricity grids but other supports for daily life. One is high-speed broadband connectivity, access to which varies dramatically in Washington State. For example, the

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Commerce Department has undertaken a major initiative to use new technologies to reach people in rural and underserved communities to meet their health care needs.

Another form of infrastructure is the availability of safe and affordable childcare. During the pandemic, many adults throughout the state were working from home while their children were doing school virtually. Quality, affordable childcare as a form of support for families, particularly women, is a “fundamental issue,” said Brown, and “I’m happy that the legislature is taking it on and that the feds are thinking about it.”

Brown challenged the group to examine the issue of community resilience. How can communities be prepared for public health or climate-related disasters? “We need cross-disciplinary thinking to understand how to better prepare and prevent all communities from suffering these major disasters and then how to recover.”

She also noted that science is not enough. Science “gets translated through a lens of public perception and political will and interest group dynamics to become public policy,” she said. “We’ve got to work a lot harder on that whole spectrum if we want our public policy to reflect the best of our evidence and facts.”

In particular, Brown pointed to the need for civics education and engagement. “Civic engagement is the way that history is made and social change happens. It’s an exciting and honorable endeavor.”

Brown concluded by observing that a long-lasting positive change from the pandemic could be that communities in the state learn how to work in teams to accomplish major initiatives. With the appropriate infrastructure and supports, people can live in all parts of the state and interact with people they would not have otherwise. “The rural-urban divide and political polarity is something we have to take on,” she said. Besides helping to address high housing and transportation costs in urban centers, a more distributed population could show people what they have in common and how they can work together. “We’ve got to figure this out, because the bipolarity of our current political system is very damaging and potentially getting worse.”

Science “gets translated through a lens of public perception and political will and interest group dynamics to become public policy,” she said. “We’ve got to work a lot harder on that whole spectrum if we want our public policy to reflect the best of our evidence and facts.”

-Lisa Brown

2. Immunity

The first panel of the symposium focused on the biomedical and public health aspects of the pandemic. The panel presentations and discussions in subsequent breakout sessions ranged from the biological properties of the virus to modeling viral transmission to the public health measures needed to contain the pandemic.

FROM THE FLU TO COVID-19

SARS-CoV-2, the formal name of the coronavirus responsible for the COVID-19 pandemic, is one of several coronaviruses that have circulated in human populations, explained Helen Chu, associate professor of medicine, epidemiology, and public health at the University of Washington. In the Seattle region, human coronaviruses have accounted for 15 to 30 percent of the colds seen in emergency rooms and clinics in recent years. Some of these coronaviruses made the leap from nonhuman animals to humans hundreds of years ago, while others may have entered human populations in the past couple of centuries. “It remains to be determined what will happen with SARS-CoV-2,” said Chu, “but the history of human coronaviruses is that they enter into humans and then they become seasonal viruses.”

The coronavirus attacks human cells using a surface protein called the spike protein, which attaches to a protein on human cells called the ACE2 receptor. Vaccines work by eliciting an antibody response against the spike protein, preventing it from fusing with human cells. Though parts of this process have been studied just since the pandemic started, this research has built on previous

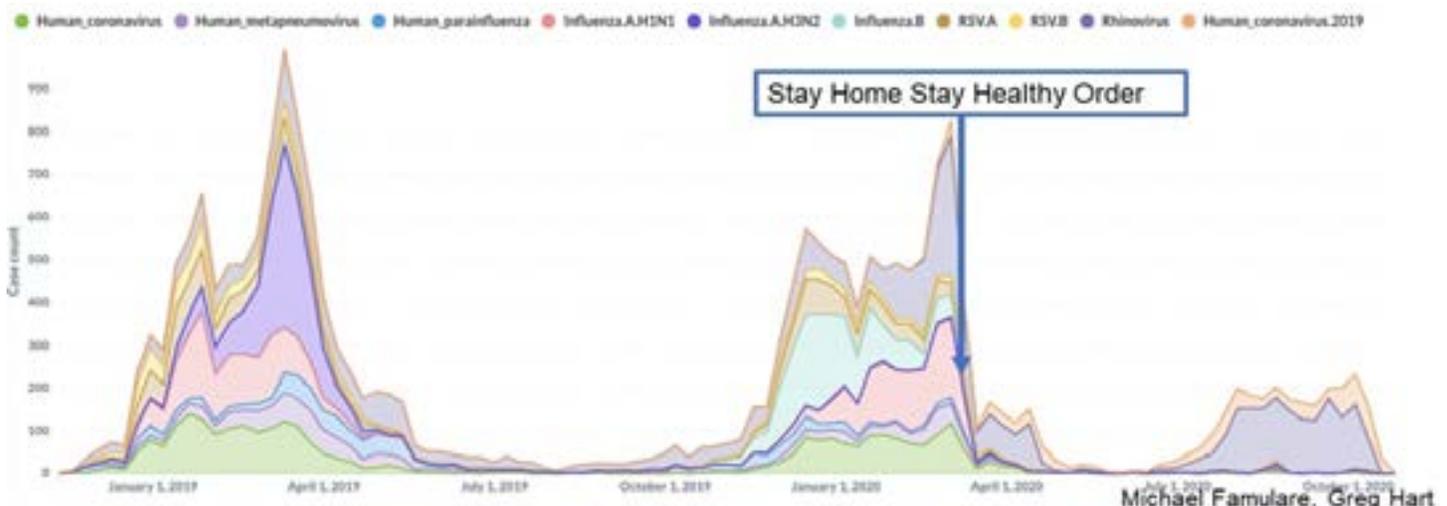
work done with coronaviruses and other viruses over the past several decades, Chu noted.

Coincidentally, when the pandemic began, Chu was leading a project called the Seattle Flu Study, which had been working to understand how pandemics emerge in cities and how to prevent their spread. She and her colleagues had set up kiosks around the city of Seattle and a website where people could report that they were sick, sign a consent form, and have a mucosal sample collected from their nose, either by themselves or by a trained staff member at a kiosk. The swabs were tested for 27 different pathogens, including flu and human coronaviruses, with the results returned to the participants.

After the first cases of COVID-19 surfaced in the Seattle area in February 2020, samples from the Seattle Flu Study were tested for SARS-CoV-2, and viral genomes were sequenced from the positive tests. These sequences demonstrated that the virus had been circulating in the community for at least several weeks. The Seattle Flu Study was then expanded, with a particular focus on vulnerable populations, such as people living in congregate settings like dorms and homeless shelters. These studies produced some of the public health information that was critical in the early stages of the pandemic, Chu observed. For example, they showed that containment strategies were effective at containing outbreaks so that the virus “wouldn’t spill over into places like nursing homes or hospitals.” They also revealed that containment measures such as Washington State’s “Stay Home, Stay Healthy” order virtually eliminated the spread of all the other viruses that normally circulate in the region.

Studies are ongoing (see Figure 2-1), said Chu, with

Figure 2-1. Imposition of the “Stay Home, Stay Healthy” order in Washington State drastically curtailed the transmission of many viruses that cause colds and the flu.



an emphasis on not only the pandemic but other public health issues. What will happen as containment strategies are relaxed? Will viruses that cause the flu, colds, and other sickness resume their normal levels of transmission? “That’s something that we will see over time.”

COVID-19 IN CHILDREN

Early in the pandemic, evidence suggested that children were not driving the pandemic, but those findings have been modified over time, Chu pointed out. While children are less likely to be symptomatic and less likely to be hospitalized than adults, recent evidence shows that they can have viral loads comparable with those of adults and can play a role in transmission to the community, though a smaller role than adults. Children also can develop a serious condition called multisystem inflammatory syndrome that is not seen in adults.

As with adults, COVID-19 has disproportionately affected Black and Latino children. Children also can develop long COVID, in which symptoms persist much longer than in normal cases.

Early in the pandemic, the closure of schools and childcare centers reduced exposures and led to very low reported cases in children. More recently, school transmission rates have tended to reflect what is going on in the community. If community transmission is low or high, school transmission tends likewise to be low or high. Mitigation measures, such as the weekly screening protocols used in some schools, can “really help protect children in schools,” said Chu, “particularly in places with high community transmission.” For example, a study in Snohomish County of children from kindergarten to second grade showed that weekly testing was both feasible and effective. Furthermore, “parents really liked it because it started to remove the burden on parents of figuring out what was going on with their kids.”

LONG COVID-19

Studies in adults have shown that people who are hospitalized tend to have higher proportions of symptoms 6 and 12 months later than people with COVID-19 who do not enter the hospital, though outpatients are not as well characterized. Symptoms include fatigue, dyspnea, joint pain, chest pain, insomnia, anxiety, and depression. In a Seattle study of people treated mostly as outpatients, 30 percent still had symptoms six months after getting sick. “This is concerning and has also been shown in several other outpatient populations,” said Chu.

The NIH has put together a consortium of sites across

the United States, including the University of Washington, aimed at understanding the immunologic underpinnings of long COVID. The consortium is studying several thousand individuals with and without symptoms who are being followed over time, including before and after they are vaccinated. Their immune systems and other health indicators are being monitored to help understand why some do and others do not develop lingering symptoms. “Hopefully soon we’ll have more information about the drivers of long COVID and whether or not we can identify people at risk early on.”

VACCINES

The development of vaccines to prevent COVID-19 “has shown the extraordinary power of science in terms of being able to help us end pandemics quickly,” said Chu. The vaccines were developed to prevent symptomatic disease and hospitalization, but they also protect against asymptomatic disease. The first round of vaccines has also been effective against the Delta variant of SARS-CoV-2, and breakthrough infections in vaccinated individuals are much less likely to result in hospitalization than in unvaccinated individuals with infections.

The vaccines demonstrated that science can move very quickly to develop ways of protecting society as a whole. What moved more slowly, Chu observed, were regulatory actions such as allowing clinical laboratories or major academic medical centers to develop diagnostic tests and use them.

At the time of the symposium, controversy was ongoing about who should receive booster shots for the vaccine. Chu pointed out that the basic scientific question is how much the vaccines protect against variants and the durability of vaccine-induced immunity. The original mRNA vaccines produce a broad antibody repertoire that responds not only to the original strains but also to the Delta strain. However, it still was not known, because of a lack of data, whether waning immunity or lack of coverage by the original vaccine had been leading to breakthrough infections.

In recent decades, the public health infrastructure in the United States has been so underfunded that the nation was not able to respond effectively in many key areas.

THE NEED FOR INTEGRATION

Chu called for the integration of academic research and public health frameworks to develop better pandemic responses in the future. For example, the sampling for the flu study was designed to determine what was happening in the community, but how best to monitor viral transmission in the larger community remains an unanswered question. Could public health surveillance systems be established that will allow for community-wide sampling, especially in populations of interest like travelers, young children, older adults, and healthy working adults?

In recent decades, the public health infrastructure in the United States has been so underfunded that the nation was not able to respond effectively in many key areas, Chu observed. One way to address these deficiencies in Washington State, she added, is to work with private companies like Amazon and Microsoft to build data integration and management systems. Having information that is directly useful in the public health response “will really help next time.”

MODELING

In the context of COVID-19, the purpose of models is to predict the future, and “that’s quite a complicated task,” said Ruanne Barnabas, associate professor of global health and medicine at the University of Washington. For example, models to predict the number of new cases must take into account the biology of the virus, human biology, human behavior, and the impact of prevention and treatment interventions. Successfully achieving this goal requires strengthening the modeling approaches used today.

Mathematical modeling is not new in the social and life sciences, Barnabas pointed out. It is used for estimating the impacts of climate change, predicting stock market fluctuations, projecting election results, forecasting electricity demand, and many other purposes. In infectious disease epidemiology, mathematical models are used for both endemic and pandemic predictions for influenza, AIDS, malaria, tuberculosis, and many other diseases, including COVID-19.

One way to model SARS-CoV-2 transmission is to focus on households within a community (Figure 2-2). Infectious, susceptible, exposed, and recovering people within a household can be connected through probabilities of transmission given particular behaviors. For example, within households, the likelihood of transmission is “quite high,” said Barnabas—between 15 and 35 percent, and up to 50 percent with the Delta variant. This description of disease transmission can then be translated into

mathematical equations, and solving these equations can yield a predicted number of new cases.

Models also can incorporate interventions to stop transmission. For example, masks can decrease the acquisition of SARS-CoV-2 by 70 percent, movement restrictions can lower the number of cases, and vaccines can prevent about 90 percent of hospitalizations, even from the Delta variant. Incorporating these data enables models to predict numbers of new cases.

Sometimes a model’s output does not fit what has been observed in the past, which is an indication that something important is missing from the model. “A key insight for modeling,” said Barnabas, “is to look at other models and see if they perform better, why that is, and learn from that.”

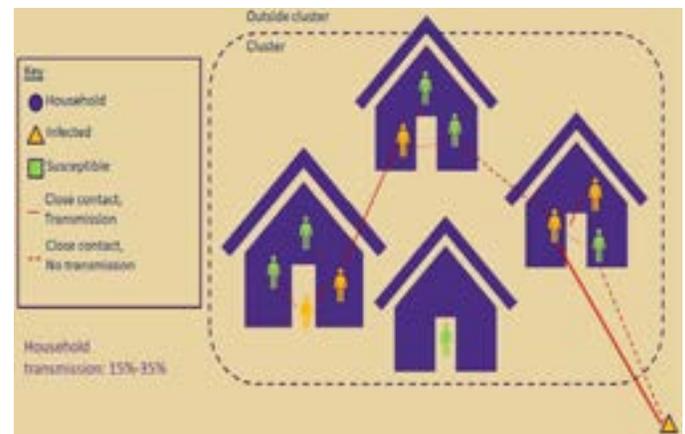


FIGURE 2-2. Models of transmission within and among households can yield infection rates within communities.

THE LIMITS OF MODELS

Though conceptually straightforward, this approach to modeling is still “quite challenging,” according to Barnabas. New data are emerging even as the models are being built, and limited and uncertain data produce uncertainty in how to interpret model results. More complex models are more realistic, but they require more information to produce estimates of results and associated uncertainties. Variants of the virus change over time, resulting in different rates of transmission. Parameters such as behaviors can change over time, as when the “Stay Home, Stay Safe” order produced a decrease in transmission.

Other kinds of models use approaches such as machine learning and statistical methods to estimate transmission. Such models are typically run under scenarios that examine such questions as where boosters will be needed as vaccine immunity wanes. But each model is only as good as the uncertain and evolving data that it incorporates

and analyzes.

In response to a question, Barnabas pointed out that a model can answer questions about the unit of analysis on which it was built—but not on a smaller or larger unit of analysis. The smaller the unit of analysis, the more individual data are needed. Each individual's behavior then becomes more important than at a population level where averages can be used to predict the future.

But each model is only as good as the uncertain and evolving data that it incorporates and analyzes.

In April 2020, the CDC partnered with the University of Massachusetts at Amherst to launch the COVID-19 forecasting hub. Research teams from around the world have submitted models, including at the time of the symposium 52 models for weekly deaths in the United States and 40 models for weekly cases in the United States. Results from the eligible models are then aggregated into an “ensemble” model, which has proven to be the best way to model U.S. mortality. According to an analysis of the ensemble model, the ensemble forecast “provided the most consistently accurate probabilistic forecasts of incident mortality due to COVID-19 at the state and national level.”¹ However, the ensemble model made the single best forecast less frequently than did some other models, and the true number of deaths has fallen within the model's 95 percent credibility interval only “most” of the time.

Barnabas's main message was that “team science is the way forward, not only for this pandemic but for public health” in general. Access to and sharing of real-time data, the use of multiple approaches, and comparative modeling can leverage expertise about infectious diseases to anticipate challenges and work toward more equitable health outcomes. But communities need to be at the table for team science to succeed. Sharing and interpreting data “is a shared process,” she said. “It's two ways. It's not just us taking the data and analyzing but that those answers go back.” As just one example, Barnabas agreed with a symposium participant that a choir might be an excellent place to engage with a community in collecting good data. Where everyone is wearing a mask and singing together, “it would be super to do testing and evaluate what the transmission is.”

1 Estee Y. Cramer, et al. 2021. Evaluation of individual and ensemble probabilistic forecasts of COVID-19 mortality in the U.S. Available at <https://www.medrxiv.org/content/10.1101/2021.02.03.21250974v2>.

RESPONDING TO THE PANDEMIC

As the Institute of Medicine has pointed out, public health is “what we as a society do collectively to assure the conditions in which people can be healthy.”² The key word in this definition is “collectively,” said Umair Shah, the Washington State Secretary of Health. “It's about what we do together, and I think that's been a key problem or challenge that we've had throughout this pandemic.”

When Shah moved to Washington State from Texas in 2020, he had six priorities: equity, innovation, engagement, partnership, building capacity, and the intersection of global and domestic health. These priorities were not based on particular program areas, such as climate health or chronic disease prevention. But as COVID-19 came to dominate the public health agenda, these priorities became pivotal in responding to the pandemic.

Washington State had the first case of COVID-19 in the continental United States, the first outbreak in the continental United States, and the first death in the continental United States. As a result, the state was an important source of information on which policy decisions were based. The relatively low death rate per capita across the state is “a testament to the difficult decisions that our leadership and all of our community members and all of you together have been working on so that we can fight this pandemic.” The state sought to leverage the private sector, including major companies like Starbucks, Amazon, Microsoft, Google, and Costco, to work collaboratively and not leave groups behind. It created mass vaccination sites and then mobile outreach to get vaccines to more people—“the first time we've had that capability as a state health agency.” It worked with health care providers to get the word out that the vaccines are safe and effective.

Washington State's response required new policies involving such issues as face covering, business practices, and social gatherings. Public health officials around the country learned from these early decisions. For example, enforcement of public health policies proved to be a major challenge, said Shah, which became even greater as the issue became politicized. Enforcement usually depends on local practitioners, whether restaurants, stores, or law enforcement, which means that it is inevitably uneven. Shah urged people to contact the local health jurisdiction to report a lack of enforcement and let them know that the issue is important. “People who want to see others protect not just themselves but others around them are often silent.” Advocacy for taking action has also become

2 Institute of Medicine. 2003. *The Future of the Public's Health in the 21st Century*. Washington, DC: The National Academies Press.

an issue with vaccination. “The rights of people who did the right thing and got vaccinated are being infringed by people who have not gotten vaccinated and are forcing others to constrain their own actions.

As the Institute of Medicine has pointed out, public health is “what we as a society do collectively to assure the conditions in which people can be healthy.”

GUIDANCE FOR THE RESPONSE

The state’s response was based on three themes, said Shah: communication, coordination, and collaboration. Guided by these themes, key efforts included:

1. Data monitoring
2. Timely testing
3. Epidemiologic investigation
4. Contact tracing
5. Expedient quarantine and isolation
6. Healthcare/hospital support and therapeutics
7. Communications/community engagement
8. 4Ws (wear mask, wash hands, watch distance, Washington Notify)
9. Financial and social supports
10. Vaccines and the process of assuring vaccinations

These efforts reinforce each other, but they also represent a tremendous amount of work. “That’s why you’ve seen public health and the health sector in general being so taxed,” said Shah. “It’s not that one of these activities goes away. [Rather], it loses focus in the headlines while we continue to add on additional activities.” For example, the need for booster vaccine shots will add to the activities already going on in the state.

“Testing is the cornerstone building block of everything we’re doing in public health,” said Shah. “If you don’t know who is positive with a disease, you simply cannot act.” But a major problem with testing has been supply constraints. A lack of materials to test people makes it hard to have policies in place, because the policies require access to testing materials. Even at the school level, where federal dollars have been used to help with testing, accessing materials has sometimes been difficult, resulting in a patchwork system.

Shah also pointed to the importance of tracking mutations in the virus. In part because of its strong research and health care institutions, Washington has been one of the top states in tracking viral sequences. The state also has focused attention on contact tracing as an indispensable aid to case investigation and follow-up. For example, 40 percent of smartphone users in the state have enabled Washington Notify, which is a free tool that uses Bluetooth technology to alert users that they may have been exposed to COVID-19 without sharing any personal

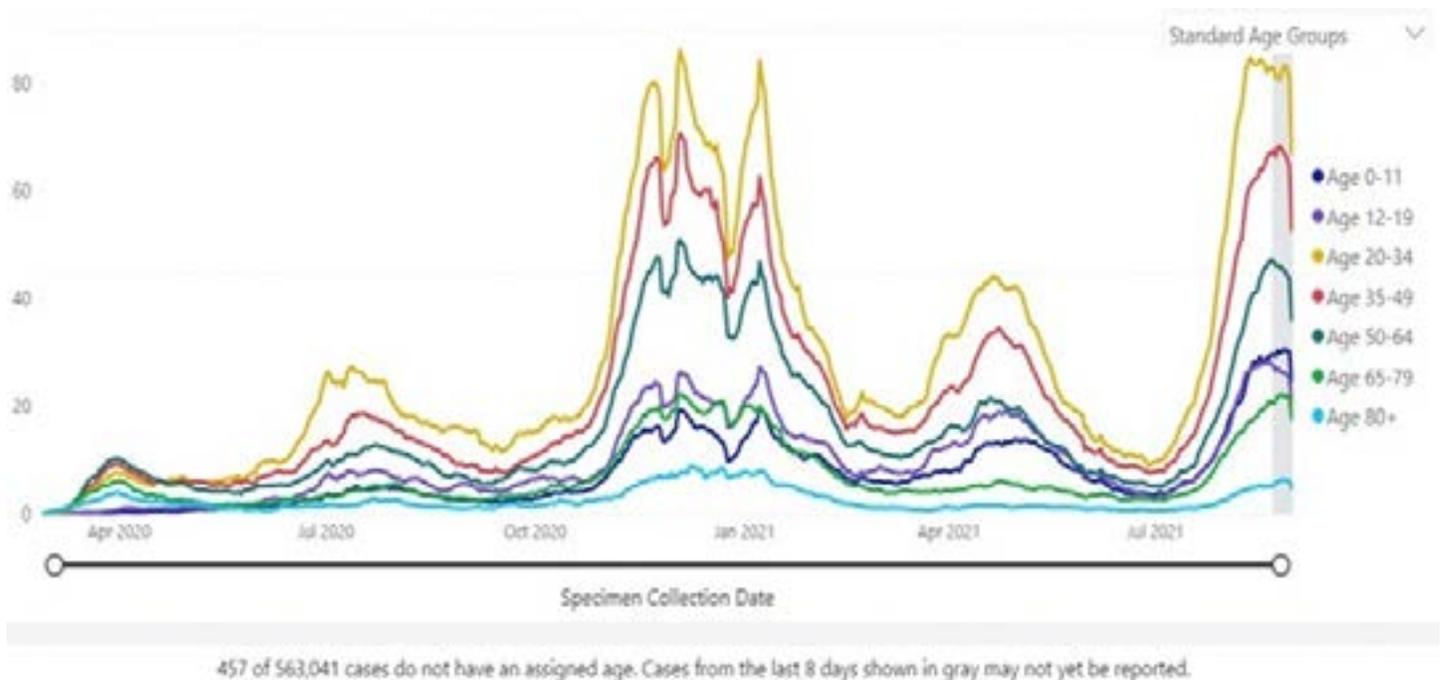


FIGURE 2-3. Trends in the seven-day rate of new COVID-19 cases per 100,000 population show the age groups most affected by the pandemic.

information.

Epidemiologic surveillance has been another key part of the response. Epidemiological data have revealed the waves of the pandemic, the age and population groups affected, and other key aspects of the pandemic. They also document the effects of public health measures such as vaccination, mask covering, and the closing and opening of workplaces, schools, and other institutions, providing information that can be used to shape the ongoing response.

THE CONTINUING CHALLENGE

Like other public health officials, Shah had assumed that the pandemic would subside in 2021, but “that’s not been the case.” The symposium was held during the fifth wave of the pandemic, which produced a bed occupancy challenge for almost every hospital in the state and new mandates for vaccination and masking (Figure 2-3). Urban areas and critical access hospitals, including those in rural areas, were particularly stressed, both in terms of beds and the staff needed to operate intensive care units. “Our health care providers are human beings, and there is a limit to what they can sustain over time.”

At the time of the symposium, 76 percent of the state’s population 12 years of age and older had received at least one dose of a vaccine, and close to 70 percent were fully vaccinated. That proportion was one of the highest in the country, but it was not uniform across the state, Shah observed. Some communities had 80 to 90 percent proportions, while others had 30 to 40 percent proportions. “That’s the biggest challenge that we have, because we know vaccines are safe, they’re effective, they work, but they’re only safe, effective, and work if people take them.”

Laboratory science has been absolutely essential for policy and population health activities, Shah said, but science is not sufficient. Scientists, policymakers, and health care providers all have to be engaged with communities and equipped with the tools needed for that engagement. For example, Washington State provides COVID-19 information in 36 languages to make sure that people have the resources to respond and be protected. It has a “Care-a-Van” to work with hard-to-reach populations, such as refugees who have recently arrived in the state. The Power of Providers initiative works with health care providers to champion education, vaccination, and empowerment. “It’s not just about science. It’s also about making sure people have the tools and the resources to be able to respond and also be protected.”

Public health is inherently political, Shah said in

closing. Health care providers, state officials, researchers, and many others will need to continue to fight misinformation and mistrust. Society as a whole will also need to strengthen its public health infrastructure. “The key message for all of us is that it took a pandemic to show how vital it is to invest in prevention and public health infrastructure,” he said. “Public health makes common sense, but we can’t do it unless we are in it together.”

Laboratory science has been absolutely essential for policy and population health activities, Shah said, but science is not sufficient. Scientists, policymakers, and health care providers all have to be engaged with communities and equipped with the tools needed for that engagement.

3. Community

The COVID-19 pandemic has had enormous impacts on communities, societal institutions, families, and public discourse. The symposium's second panel examined these impacts with a continued emphasis on the disproportionate ways in which some communities have been affected.

DISPROPORTIONATE IMPACTS

"As a person who acquired the virus myself at the end of last year and spent the first quarter of this year recovering, suffering from it, and then recuperating from it, I know personally how disruptive it is to children, families, and communities," said Stephan Blanford, executive director of the Children's Alliance. "That experience undergirds my urgency about this issue, and I hope that it does yours as well."

The COVID-19 pandemic has had disproportionate impacts on communities in Washington State, and those impacts have been further amplified by another "long-lived virus in our society—that of racism," said Blanford. The uprising after the murder of George Floyd laid bare how these two viruses have decimated communities of color. "So much work that's been done by leaders and followers and people of goodwill to try to create a more egalitarian society is being undone by what we're seeing."

The Children's Alliance does much of its work on community engagement, trying to learn from communities and then advocating with those communities in the state legislature. Blanford identified five themes that have emerged from this work on community engagement and advocacy.

The first is the disparate health impacts of the pandemic. Native Hawaiian and other Pacific Islander populations in Washington State have rates of infection three times as high as other racial groups, and African Americans are two times more likely to acquire the virus. Health insurance coverage and rates also disproportionately disadvantage people of color, and vaccination rates have a "huge disparity" as well, said Blanford.

The second issue is the expiration of the eviction moratorium, which will have "tremendous impacts on communities of color." About 15 percent of Washington families report that they have little or no confidence that they could make their next month's mortgage payment. That number is twice as high for Latinx families across

Washington State and 35 percent higher for African American families in the state.

The third issue is the impacts on women. Even before the pandemic began, the unemployment rate for Latinx women was 1.5 times as high as for white women, and for African American women the number was two times as high. "We expect that that number has increased substantially as a result of the pandemic."

The fourth issue is access to childcare, which is crucial to reviving the economy. Half of existing childcare providers reported in 2020 that they would not make it to the end of the year because of the decrease in funding available to them. The resulting inaccessibility of high-quality childcare has lifelong implications for children and families. "It is an issue that we have been working tirelessly on," said Blanford.

Researchers can empower communities to act on research findings. "We don't advocate for community, we advocate with community."

-Stephan Blanford

The fifth is the restart of schools. If the disparities seen in vaccination rates persist, outbreaks will likely occur among children in schools, with negative effects on their education. In addition, when schools shut down, many children did not have access to behavioral, emotional, and mental health services that are primarily provided inside of schools, representing yet another disproportionate impact. "Educators tell me that there is a tsunami—and I use that word very carefully—a tsunami of kids who are arriving at school doors now that have had a year and a half with no engagement with professionals around those issues. And that's having a huge impact on schools, from early learning all the way through higher education," he said. "It will have long-term implications for economic recovery as well as for the life choices and life chances of a whole generation of kids."

THE NEED FOR COMMUNITY ENGAGEMENT

Blanford observed that scientists are traditionally taught to be disinterested observers, people who create

their hypotheses and test them without extensive engagement with their research subjects. “That is not the right strategy, particularly for an issue as deeply pernicious as this one,” he said. He encouraged researchers to engage with the communities that have been ravaged by the twin viruses of COVID-19 and racism. Researchers need to “figure out ways to engage with trusted advocates to ensure that the interventions that you design very carefully and closely actually get to the people who need them the most.”

Many promising practices can help researchers engage people of color. For example, useful, research results can be brought to communities that have typically assumed that the results of research have no implications or effects on them. Researchers can receive training around critically important “soft skills” such as building long-term relationships with communities. They can make sure that the results of research done in partnership with a community are always returned to that community. “If we ask a community a question, then we always report back to that community what we find. That’s something that doesn’t happen frequently.” Researchers can empower communities to act on research findings. “We don’t advocate for community, we advocate with community,” Blanford said. “And the reason that we say that—and we are very explicit about this—is because there is a phenomenon of white saviorism that is prevalent, where people believe that they can come in and save the community through their preferred intervention, and more frequently than not, when they don’t see immediate results, they leave and the community is left high and dry, frequently worse off than before the intervention started.” If these and other promising practices could be evaluated and the results of those evaluations disseminated, “we might start to crack the nut of distrust in communities of color,” Blanford concluded.

THE DISPROPORTIONATE IMPACT ON CAREGIVERS

In March 2021, Phumzile Mlambo-Ngcuka, Under-Secretary-General of the United Nations and executive director of UN Women, said that the COVID-19 pandemic “is the most discriminatory crisis [women and girls] have ever experienced.” Celestina Barbosa-Leiker, associate professor in the College of Nursing and vice chancellor for research at Washington State University Health Sciences in Spokane, explored this crisis among three groups of women: caregivers, researchers, and perinatal women.

Care jobs are jobs that support the ability of other

people to work, Barbosa-Leiker observed. They tend to be seen as simultaneously essential and lacking in inherent value. Caregiving labor is often done by women, and disproportionately by women of color, with a median annual income of less than \$25,000.

The caregiving sector has been profoundly affected by the 3 million U.S. women who have left the workforce during the pandemic, either through choice or loss of a job. One consequence has been \$64.5 billion per year in lost wages among mothers. Though the federal government has made short-term relief packages available, long-term relief is not guaranteed.

As workplace expectations and COVID-19 rates have evolved, concerns about childcare and distance learning requirements have come to the fore. Even before the pandemic, more than half of Americans lived in “childcare deserts” where access to childcare is limited. Then, when the pandemic hit, many more parents suddenly became teachers and childcare providers. With nearly half of childcare facilities expected to close permanently because of the pandemic, childcare became an even more serious issue for parents.

Much of the additional caregiving burden fell on mothers, and the burden was especially great on single mothers, who make up approximately 70 percent of single-parent households nationwide. For women in the workforce, stress was exacerbated by their less secure employment and the wage gap compared with their male counterparts, and women of color endured even more economic hardships. In addition, the prevalence of domestic violence in some cities increased substantially during the pandemic, though state-specific data are not available. All these factors have exacerbated disparities that were already severe before the pandemic.

WOMEN SCIENTISTS AND PERINATAL WOMEN

As a particular example of working mothers, Barbosa-Leiker focused on women scientists with children. “I know there’s a lot of scientists who are watching today, and future scientists, as well and those who are educating future scientists.” Females with young children lost more research time than did other researchers.³ Comparing March and April 2019 with the same two months in 2020, the number of male authors on preprints posted to bioRxiv

³ Kyle R. Myers, Wei Yang Tham, Yian Yin, Nina Cohodes, Jerry G. Thursby, Marie C. Thursby, Peter Schiffer, Joseph T. Walsh, Karim R. Lakhani, and Dashun Wang. 2020. Unequal effects of the COVID-19 pandemic on scientists. *Nature Human Behavior* 4:880–883.

and arXiv grew faster than the number of female authors.⁴ Tenure clocks were lengthened during the pandemic by a year and potentially up to two years, “but we know that that is not going to be enough,” said Barbosa-Leiker. “We may be facing a large brain drain as women researchers leave academia because of the consequences during the pandemic and the loss of research productivity when children were home.”

Finally, Barbosa-Leiker described research her group has done on perinatal women.⁵ Since the COVID-19 pandemic, perinatal women have experienced psychological stress due to changes in labor and delivery hospital policies, possible perinatal COVID-19 transmission, and COVID-19-related maternal and infant outcomes. People were not able to bring their partners into the delivery room. Mothers worried about what would happen to their children if they contracted COVID-19 or if they gave it to their babies. The lack of information created extreme stress for many pregnant mothers, and psychological stress experienced during pregnancy can have harmful effects on maternal and infant health.

Barbosa-Leiker and her colleagues surveyed 162 pregnant and postpartum women in the United States using open-ended questions regarding stress and resources needed during the COVID-19 pandemic. “We wanted to hear in their own words what they needed and how they were feeling.” They collected demographic data on age, race, ethnicity, health insurance, employment, income, and education and performed quantitative and qualitative analyses of the information. One thing they found is that 25 percent missed prenatal appointments, which “is startling, because we know that the main thing that you can do to have a positive birth outcome is to attend those prenatal appointments.” A positive result was that 36 percent reported using telemedicine for prenatal appointments, though access to telemedicine is not equitable; rural pregnant mothers, for example, have less access to telemedicine. Pregnant women were less likely to engage in stress coping behaviors than postpartum women, possibly because they were afraid that they were going to contract COVID while delivering. Women of color and women with lower incomes were more likely to report serious financial problems due to the pandemic compared with non-Hispanic white women and women with higher

income. Women with higher incomes not on Medicaid and non Hispanic white women reported more support while women with lower incomes, women on Medicaid, and women of color had not only less financial support but less social support.

Women reported a variety of stressors, including their baby contracting COVID-19, their self or their partner contracting COVID-19, and the possibility of being isolated from their baby should they or their infant test positive for the virus. As one woman said, “I was afraid to die and leave my baby behind.” Another woman said, “I’m worried that my husband and I won’t have enough money to support our baby,” while another said, “I’m most worried about the world around us changing so drastically that I can’t give my baby the life I had planned on.” They did not know when they could let friends and family see their babies, and they cited the lack of public understanding of the severity of the pandemic. Mothers also had trouble getting diapers, formula, wipes, and other nursing and pumping supplies, and they cited a lack of support groups, financial resources, work support to care for their children at home, safe childcare options, or longer times to stay home with a child.

Addressing these issues requires advocacy, Barbosa-Leiker said—advocacy for childcare, for facilities for working parents, and for workplace childcare policies, including university policies. Resources may be available, but they are not well integrated or immediately available. For perinatal women, health care providers need to continue to assess perinatal stress during pregnancy and postpartum. Researchers need to be able to track infants over the course of their child development to understand cohort effects that are likely to occur with this generation. “What is this going to look like for the next generation? How do we make sure that they grow up to be safe and healthy and have a great shot at life? How do we protect vulnerable populations knowing about disparities across economic groups and families of color?”

UNDERSTANDING MISINFORMATION AND DISINFORMATION

The Center for an Informed Public was launched at the University of Washington in December 2019 to resist strategic misinformation, promote an informed society, and strengthen democratic discourse. The center was formed just before the pandemic gripped the world, and the pandemic has been a focus of the center’s activities ever since. In less than two years, the center has collected more than 4 billion tweets about COVID-19, 400 million tweets about vaccines, and billions of other tweets on the

4 Giuliana Viglione G. 2020. Are women publishing less during the pandemic? Here’s what the data say. *Nature* 581:365–366.

5 Celestina Barbosa-Leiker, Crystal Lederhos Smith, Erica J Crespi, Olivia Brooks, Ekaterina Burduli, Samantha Ranjo, Cara L. Carty, Luciana E. Hebert, Sara F. Waters, Maria A. Gartstein. 2021. Stress, coping, and resources needed during the COVID-19 pandemic in a sample of perinatal women. *BMC Pregnancy and Childbirth* 21(1):171.

U.S. elections, the Black Lives Matter movement, and even K-pop fandom. “We collect these at a very large scale and look at trends and the ways in which misinformation and disinformation is amplified,” said the center’s director Jevin West, associate professor in the Information School at the University of Washington. “We also dig down to the individual tweets, the individual posts, and conversations that they’re having.”

One interesting feature of the discourse on Twitter has been that both sides of a debate can cite and draw radically different conclusions from the same scientific paper, West said. The authors and editors of scientific papers have also issued additional comments on previously published papers in light of the pandemic, introducing “something relatively new in the history of science communication.” That proponents on both sides of a debate cite science “is a good thing,” West observed. “But when they cite science, they’re citing for different reasons, [which] plays into the way in which we talk about these things collectively online.”

In a perfect world, experts would be moderating online discussions, but that is not the case when anyone can open an account and create content. Nevertheless, West and his colleague Carl Bergstrom have found that experts still have “more traction” in online discussions than non-experts.⁶ However, experts can be cited in content available online that is extremely misleading—for example, on the wearing of face masks, which is the single most politicized public health issue based on an analysis of the tweets collected by the center. Scientists need to engage with the public and platforms that are governing online conversations to minimize this kind of misuse, said West.

Another issue with social media companies is the way they create echo chambers so that people are exposed only to content that accords with their own narrative about the world. The algorithms and other systems set up to generate ever more attention to social media “really does create more polarization and less diversified ideas, and certainly less common understanding of even just basic facts,” said West. People who absorb contrasting narratives don’t even know that contrasting worlds exist. “In a world where we didn’t have social media, you had to bump into your neighbor more, or you had more of the Walter Cronkite opportunity at the end of the day where you’re on some common ground about what might be true and not about the world.”

Framing makes a big difference, said West. For example, misinformation about election fraud was already

being circulated online before the election of 2020. As a result, a base of activity already existed before the topic exploded after the election. Similarly, with vaccinations, anti-vaccination forces were already disseminating disinformation in a way that allowed for amplification after the vaccine became available. “These frames can be used in negative ways and are highly effective at amplification down the line.”

A recent innovation in the life sciences has been the use of preprints to communicate information before peer review, though preprint archives have long been used in other areas of science. A problem with this approach is that most of the public is not aware that preprint archive papers have not been peer reviewed, which has led to papers that have gone viral before publication and then have been withdrawn because of problems revealed during review. With “new forms of communication like the preprint archive, we have to be talking to the public more . . . to slow some of the spread of misinformation and disinformation,” said West.

One interesting feature of the discourse on Twitter has been that both sides of a debate can cite and draw radically different conclusions from the same scientific paper.

Finally, West described the ways in which data can be used to mislead. For example, invidious comparisons made early in the pandemic argued that COVID-19 is not as serious as other diseases such as tuberculosis, malaria, and even rabies, whereas fair comparisons made later in the pandemic revealed that it has in fact been much more deadly than other diseases. As another example, comparison of case rates in Georgia counties were used by some to argue that masks made little difference in controlling transmission, but the comparisons used different baselines to present misleading conclusions. “Be looking out for those unfair comparisons,” warned West. A useful guide is to ask, who is telling me this, how do they know it, and what’s in it for them?

REFORMING SOCIAL MEDIA

Conversations about how to control social media are making progress, said West. Discussions are under way about whether it would be better to treat social media as a utility that simply conveys information produced by others or as a publisher that exerts control over that information. Social media companies have demonstrated their ability and skill at deleting certain types of information, such as child pornography. “There’s no reason that they couldn’t

⁶ Jevin D. West and Carl T. Bergstrom. 2021. Misinformation in and about science. Proceedings of the National Academy of Sciences 118(15)e1912444117.

be that good and effective at removing other kinds of misinformation,” said West. “The challenge of course is that one person’s information might be another person’s misinformation.” The center is conducting discussions on the topic to generate conclusions that can be delivered to industry leaders.

West urged media companies to provide greater transparency for researchers. “If researchers could have more access to some of this information, they could come back to the public and policymakers and say, ‘Here’s what we found.’ But researchers mostly hit a tall brick wall when it comes to access.”

Bringing science to bear on the communication of information could help ease the social conflicts exacerbated by the pandemic.

Information that goes viral tends to tap into people’s emotions, and being empathetic to those emotional reactions is a good starting position in conversations about the content and influence of social media. The expression of diverse perspectives can help, said West, because conversations can engage with those perspectives and make progress on issues like vaccination policy or the science behind mRNA vaccines. “If you don’t engage those and you pretend that those walls don’t exist, the conversation closes down.”

Social media and information technology are not going to disappear, though they may look quite different in the future. Nevertheless, in-person venues to discuss these topics can be very helpful, “because you can then capture the nuances. You see a person on the other side, it’s not just a name. . . . I have seen so much of this acerbic conversation online that getting in-person conversations would help.”

Throughout the pandemic, science has been working “remarkably well,” West concluded. It has unraveled the molecular structure of the virus, has tracked its evolution as it has spread around the globe, and has developed effective vaccines with unprecedented rapidity. Bringing science to bear on the communication of information could help ease the social conflicts exacerbated by the pandemic.

4. Opportunity

The third and final panel looked at the impact of COVID-19 on the local economy—businesses, agriculture, and the foundational systems of cities and towns. In particular, presenters examined COVID-19’s regional impact on the public and private sectors in Washington State and how policies could fuel the industrial and structural recovery necessary to combat the pandemic’s disparate impacts.

THE ECONOMIC IMPACTS OF COVID-19 ON WASHINGTON CITIES

Economic shocks tend to magnify existing trends rather than create new trends, and that was as true of the pandemic as it has been of recessions, said Philip Watson, professor of applied economics at the University of Idaho. Pent-up forces that existed before the shock are often released by the event and accelerate pre-shock trends. The result can be what the political economist Joseph Schumpeter called “creative destruction,” where new ideas and processes move in to replace old ideas and processes, and not only for businesses and employers but for employees and the labor market as well.

Prior to the pandemic, a powerful trend shaping Washington State was the interplay between attractive forces that concentrate economic activity in cities and repulsive factors that spread economic activity to less urban areas. The attractive forces had been dominant for years, leading many urban and regional economists to predict that the repulsive forces would have to kick in sometime as a result of factors such as congestion and high land prices. However, the repulsive forces did not kick in as expected, as places like the Puget Sound and San Francisco regions kept getting more crowded and more expensive.

The pandemic may have finally acted as a repulsive force, noted Watson. For example, rents in major urban areas, including Seattle and especially San Francisco, dropped substantially during the pandemic and have not returned to their previous levels. In contrast, rents in smaller cities, such as Spokane and Boise, have been rising during the pandemic. “These aren’t the big megalopolises that have dominated growth in the US for so long,” said Watson. “While it’s still early, it seems that COVID may be adding to a new repulsive force that is spreading some economic activity to smaller cities and, there’s some evidence, to rural areas.” A major caveat, added Watson, is that the attractive forces remain strong and will persist

into the future, even if repulsive forces are beginning to have an effect at the margin. Also, though rents are not necessarily the best measure of an economy’s strength, they indicate where people are moving and therefore capture a measure of opportunity.

Economic shocks tend to magnify existing trends rather than create new trends, and that was as true of the pandemic as it has been of recessions.

A major factor involved in economic and social shocks is resilience, which can be assessed by how growth paths deviate in response to that shock. During the Great Recession that began in 2007, finance and housing suffered while agriculture fared well. As a result, rural areas tended to do better than urban areas, with suburban areas being especially hard hit.¹ However, urban areas in Washington State fared better than did urban areas nationally, especially in King, Snohomish, and Thurston counties, Watson observed. Similarly, urban areas in Washington State appear to be weathering the pandemic. Technology firms have prospered during the pandemic, and Washington has a high concentration of technology firms. In addition, Washington is a highly diversified economy, and diversified economies tend to do better during economic shocks than more concentrated economies. Finally, the tourism and service sectors in Washington State are heavily weighted toward more local and outdoor recreation, such as Washington’s national parks, which also do better during shocks than cities emphasizing other forms of recreation.²

DECLINING LABOR FORCE PARTICIPATION

Watson also discussed a phenomenon called the Great Resignation, a term coined before the pandemic that gained more relevance during it. The labor force participation rate, which measures the percentage of the adult population engaged in the labor force, has been dropping since its peak of about 67 percent around the year 2000 (Figure 4-1). The previous rise was wholly a

7 Lauryn Ringwood, Philip Watson, and Paul Lewin. 2018. A quantitative method for measuring regional economic resilience to the great recession. *Growth and Change* 50(1):381–402.

8 Philip Watson and Steven Deller. 2021. Tourism and economic resilience. *Tourism Economics*.

function of an increased female labor participation rate, with male labor participation falling since the 1950s. But in the 2000s, the female labor participation rate also started to decrease and male labor participation rates fell even faster than before.

The COVID-19 pandemic created an unprecedented drop in labor participation, which has not returned to anywhere close to pre-pandemic levels. However, labor participation rates in Washington State have consistently been higher than national rates, and while the state's response to COVID-19 was severe, it was not as steep or as drastic and is coming back faster than the national rate (Figure 4-2).

Wages that have not kept pace with inflation, especially for lower wage workers, are one hypothesized cause for the decline in labor participation. According to some indicators, wages have been rising in response to recent labor shortages, which will incentivize people to take jobs. However, higher wages also put pressure on household budgets as prices and living expenses increase. This puts a higher opportunity cost on working outside the home, especially when childcare costs increase, which could lead to more households having one partner work

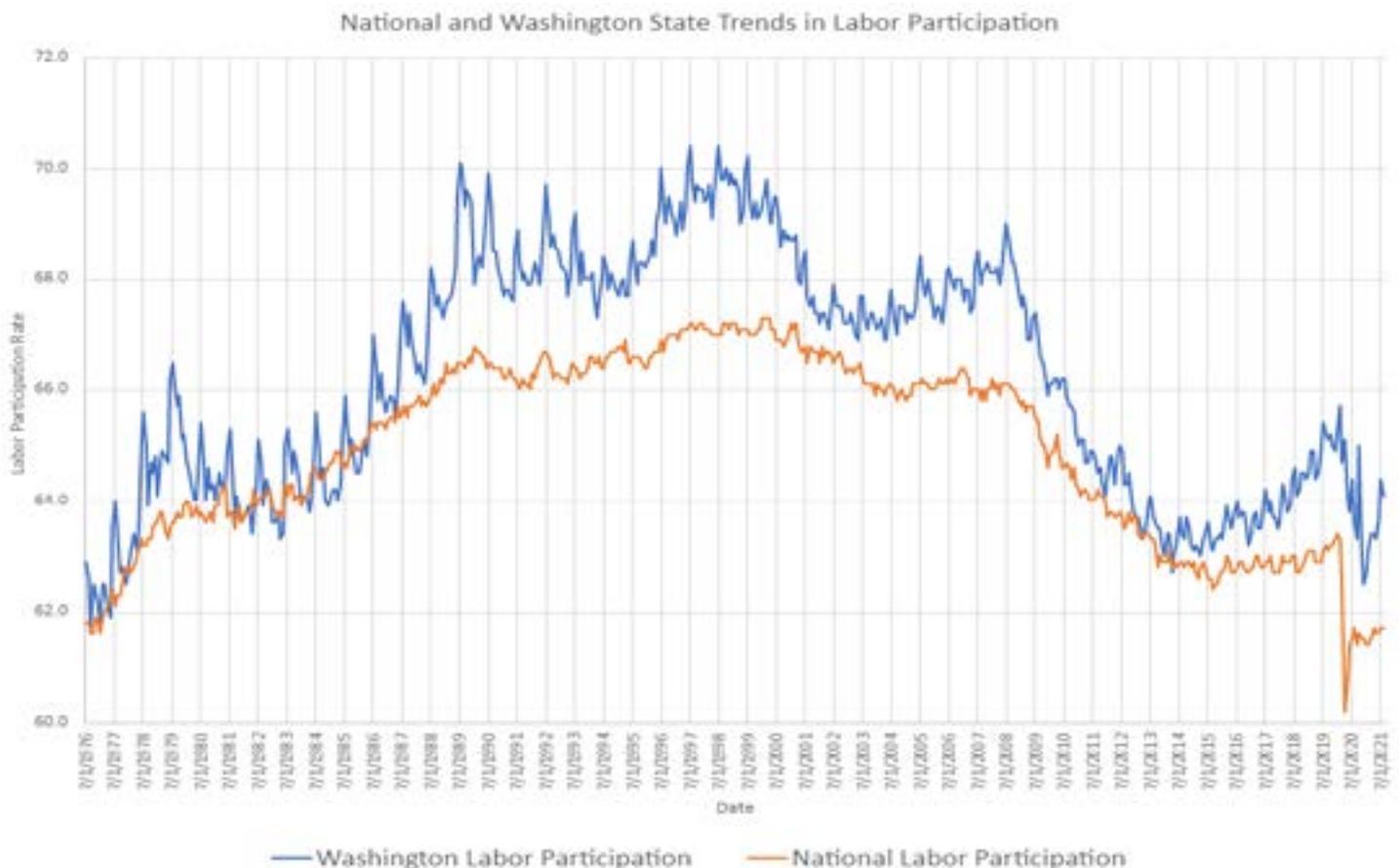
inside rather than outside the home.

Higher wages are expected to heighten urbanization, though contrasting forces could counterbalance this trend. For example, some evidence has suggested that the pandemic has led workers to want more flexibility in both where and when they work. Also, companies may be looking at different ways of doing business, and changes in the rate of retirement are uncertain. The persistence of these forces will depend to some extent on how quickly people lose their unease with social interactions when the pandemic ends.

The COVID-19 pandemic created an unprecedented drop in labor participation, which has not returned to anywhere close to pre-pandemic levels.

Watson wondered how the pandemic will change society. Some people found out they like to work remotely; others decided that they didn't. Some missed social interactions; some didn't. Are movie theaters going to come back? Are sports? The pandemic accelerated ongoing

FIGURE 4-1. After declining since its peak around the year 2000, the national labor force participation rate fell dramatically during the pandemic and has not fully recovered. The labor force participation rate in Washington State did not fall as much during the pandemic as the national rate. Source: Federal Reserve Economic Data.



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changes “because it provides an opportunity for people, either employers and businesses or employees and households, to rethink what they want.”

Watson recommended that policymakers create as much stability and predictability for businesses as possible. “Telegraph policy changes, restrictions, requirements, and mandates so that businesses know as much as possible about what’s coming and can adapt and evolve as efficiently as possible,” he said. “Washington businesses are innovative and can adapt. The more stability we can provide them, the more prosperous our economy can be moving forward.”

He also urged involving communities in decision making. Policies should not presuppose what communities want. Rather, community members, including women, need to be part of conversations that feature “people with different viewpoints and political takes on life.”

DISRUPTIONS IN FOOD AND AGRICULTURAL MARKETS

The pandemic also caused abrupt changes in food purchases and habits because of both supply and demand shocks, reported Jill McCluskey, Regents Professor and director of the School of Economic Sciences at Washington State University. Stay-at-home orders resulted in huge reductions in demand for food eaten in restaurants, cafeterias, and other food-away-from-home settings. At the same time, the demand for food purchased at grocery stores and supermarkets spiked. In late March 2020, for example, sales in grocery stores increased 90 percent relative to the prior year, with the largest gains in categories such as toilet paper, frozen foods, packaged foods, and meat. Online food sales also rose at the onset of the shutdown and continued to increase.

Policies should not presuppose what communities want. Rather, community members, including women, need to be part of conversations that feature “people with different viewpoints and political takes on life.”

–Philip Watson

Normally, U.S. consumers spend more than half their food dollars on food away from home, which tends to be more expensive and have higher calories than food prepared at home. But the COVID-19 pandemic seems to have created a long-term change. More people ate at home every day after the beginning of the pandemic than

before—up from 33 percent to 44 percent for breakfast, 18 percent to 31 percent for lunch, and 21 percent to 33 percent for dinner. Food eaten away from home and food eaten at home have two different supply chains. These parallel supply chains create efficiencies that help keep the price of food down, but they are so efficient that they have little redundancy or room for disruptions, McCluskey noted. Growers may be locked into contracts within one supply chain, and packaging and other specifications may be very different across supply chains. For example, most of the potatoes grown in the Pacific Northwest are made into French fries consumed primarily in away-from-home venues, and most of the potato industry is under contracts between growers and processors that specify prices and provide for the participation of the buyer in management decisions. In return, growers have market security, income stability, and access to capital, technology, and credit. However, contracts that lock growers into a specific buyer create a lack of resilience to changes in demand. “In Pullman, I saw this huge line of cars and wondered what was going on,” recounted McCluskey. “It was people lined up to get free potatoes. The lockdowns and restaurant closures had severely impacted demand for processed potatoes, and because they’re bulky, potatoes had nowhere to go. This had a chain effect on processors and growers, so they started giving their potatoes away.”

At the same time, panic buying and hoarding were striking grocery stores, which were not prepared for the spike in demand. Some products, like flour, experienced an increase in aggregate demand consistent with stocking up, buying more than usual, and possibly hoarding. “One problem is that hoarding behavior can feed on itself,” said McCluskey. “When consumers see empty shelves, they panic and try to buy whatever’s left.” If consumers anticipate higher prices or limited availability for products in the future, they have an incentive to buy more now. They also may have been buying more at stores to limit the number of times they had to go shopping. When the media reported shortages of food items needed to “hunker down,” additional shortages ensued. Even if individual consumers were not worried about their own mobility or income, they might reasonably observe other consumers’ behavior and infer they should change their behavior as well.

Consumers also changed their product mix during the pandemic. The pandemic produced an increase in sales of processed comfort foods, such as soup or macaroni and cheese, which were on the decline prior to the pandemic. Because many consumers do not have cooking skills, they may have needed to rely on processed foods, and consumers appeared to want familiar foods in times of uncertainty. In addition, anecdotal evidence suggested

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that being home all day caused people to snack more and gain weight. At the same time, demand for meal kits, which are generally considered more healthful than highly processed foods, grew during the pandemic.

Before the pandemic, even though farm wages were rising, reports of agricultural labor shortages were becoming more frequent. Nearly half the crop workforce is unauthorized, and 10 percent are international shuttle migrants who go back and forth between countries. In March 2020 the U.S.-Mexican border was closed to non-essential migration, and in April an executive order was issued that temporarily restricted immigration. Meanwhile, a drastic decline in boarder apprehensions suggested that fewer unauthorized immigrants were attempting to enter the United States.

The government designated workers in agriculture and food manufacturing, distribution, and retail industries as essential and exempt from stay-at-home orders. However, many outbreaks occurred among agriculture and food workers, who often live in close quarters, sleep in bunkbeds, share bathrooms and kitchens, and ride in crowded buses to fields. In addition, slaughterhouses and food processors often put workers at higher risk due to shoulder-to-shoulder and indoor working conditions. Closures of slaughterhouses and processing facilities created bottlenecks for livestock farmers, leading to culling of hogs and chickens and a meat shortage, while quarantines of large portions of the labor force revealed further vulnerabilities in the food supply chain.

One consequence of these changes was a substantial increase in food prices. The Bureau of Labor Statistics reported that, from 2019 to 2020, food at home increased 3.5 percent in price after three previous years of less than 1 percent increases. Meat, fish, and poultry had one of the biggest increases, 6.3 percent, in part because of the slaughterhouse shutdowns and limits. The price of beef and veal increased by almost 10 percent.

Future research will need to look at longer time periods, other crops, and more consideration of labor issues to answer an overriding question: How can we make our food system more resilient, more affordable, more healthful, and more sustainable?

One exception to the trend of increasing food prices was fresh fruit, where prices went down. However, end uses mattered, McCluskey observed. According to data she and her colleagues gathered and analyzed, the pandemic had a statistically significant and negative effect on potato prices, most of which are used for food service, but had little to no effect on apple prices, two-thirds of which are

eaten as fresh fruit.

When people do not have enough income and food prices increase, they sometimes go without. At the national level, there were 54 million food-insecure Americans in 2020, approximately 17 million higher than in 2018.¹ Some states were hurt more than others. For example, the substantially higher rates of food insecurity in Nevada were due primarily to the state's reliance on service sector jobs, which have been disproportionately affected by COVID-19.

McCluskey and her colleagues have also studied how media coverage affects consumer risk perceptions and subsequent demand for business services and products. The media provide information and influence consumer perceptions, such as whether it is safe to eat at restaurants. But the media also have their own incentives, including profits. Traditional media want more subscribers or higher ratings to maximize profits, while social media players want more followers, impressions, and likes, which can be monetized. Their objective to sell stories and amass clicks often results in a negative slant or in a bias toward the sensational, and the media coverage of COVID-19 fit this narrative for both traditional and social media.

The pandemic disrupted the food market across many dimensions, McCluskey concluded. Future research will need to look at longer time periods, other crops, and more consideration of labor issues to answer an overriding question: How can we make our food system more resilient, more affordable, more healthful, and more sustainable?

PLANNING FOR POST-COVID RESILIENCE IN WASHINGTON STATE

The central Puget Sound region of King, Snohomish, Pierce, and Kitsap counties has a population of about 4.3 million people and is home to 82 cities and towns and 9 tribal nations. Its 6,300 square miles are both urban and rural with 1,000 square miles in urban growth areas.

The COVID-19 pandemic and the Black Lives Matter protests of 2020 had a dramatic effect on the four-county region, said Paul Inghram, director of growth management for the Puget Sound Regional Council (PSCR). Tourism essentially stopped, stores and restaurants closed, and people who could shift to remote work did so, with women in the workforce experiencing especially great impacts. Transportation was disrupted, resulting in supply shortages and freight delays. Meanwhile, the demand for neighborhood services and deliveries increased.

Some areas have largely recovered, but the recovery

¹ Craig Gundersen, Monica Hake, Adam Dewey, and Emily Engelhard. 2020. Food Insecurity during COVID-19. *Applied Economic Perspectives and Policy* 43(1):153–161.

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is not complete, said Inghram. People want to get back together, whether in sports stadiums or restaurants. But the pandemic remains a “divisive force” that has slowed a return to normalcy.

With respect to population, both natural growth and migration into the four-county region slowed. The PSCR region added only about 39,000 people from April 2020 to April 2021, a lower amount than in the previous seven years (Figure 4-3). When population growth will recover remains uncertain, said Inghram, though growth of about 1.5 million people is still expected in the four counties before 2050, bringing the population to almost 6 million people.



FIGURE 4-3. The population of King, Snohomish, Pierce, and Kitsap counties, and of the state as a whole, grew more slowly during the pandemic than in previous years.

The pandemic caused a loss of almost 300,000 jobs statewide and almost 200,000 in the four-county region. However, the number of jobs has partly recovered, with the 2.1 million wage and salary jobs in the PSCR region and the 3.4 million jobs statewide similar to 2017 levels. The big tech companies that are well represented in the four counties, including Microsoft and Amazon, are continuing to build office space in urban spaces that offer amenities for employees. Inghram mentioned a study of New York City businesses, where about a quarter were expecting to return to full-time in-office work, 5 percent did not expect to bring their employees back to an office, and about 70 percent were planning to institute a hybrid model. Having people in an office three days a week instead of five will change the demand for office space, though the nature of those changes remains hard to predict.

Communities worked hard to retain businesses through such steps as allowing sidewalk dining, curbside markets, and the use of off-street parking areas. Some cities closed streets to traffic in an effort to create more economic activity for their businesses and maintain the vitality of their communities.

By the first quarter of 2021, retail sales and use taxes

for the region rebounded to levels slightly above the first quarter of 2020, though the recovery varied from place to place. For example, the city of SeaTac lost much of its sales and use taxes, which come largely from businesses associated with the airport. Some suburban cities where retail sales taxes are based on deliveries to residences saw retail sales increase.

Transportation for work dropped dramatically, but transportation for other uses was not as far off and has recovered more quickly. In the Puget Sound region, congestion has returned to normal in the midday section and is about 80 percent of what it was before the pandemic during the commuting hours. Some data indicate that the overall number of trips is higher, though the distances may be lower. Transit boardings for the first six months of 2021 were down almost 65 percent across all agencies and modes compared with 2019. However, almost 30 miles of light rail were scheduled to open in the next 4 to 5 years, including 10 new light rail stations in 2023 and 6 in 2024, along with expanded bus systems, freeways, and fast ferries.

Travel to parks increased by 40 percent in Washington State during the pandemic, highlighting the need for more green space in the region. The region has a need for 463,000 acres of open space conservation and about 24 more urban parks, said Inghram. With regard to housing, in July 2021 the median sales price for a home in the Seattle metropolitan region was over \$749,000—an all-time high for the region and up from \$585,000 in May 2020. In July 2021, the median rent for a home or apartment in the Seattle metropolitan region was around \$1,950 per month. The average rental cost is lower than the previous record highs in early 2020 but began to increase in the summer of 2021. The inventory of available housing remains low, despite strong construction in the region.

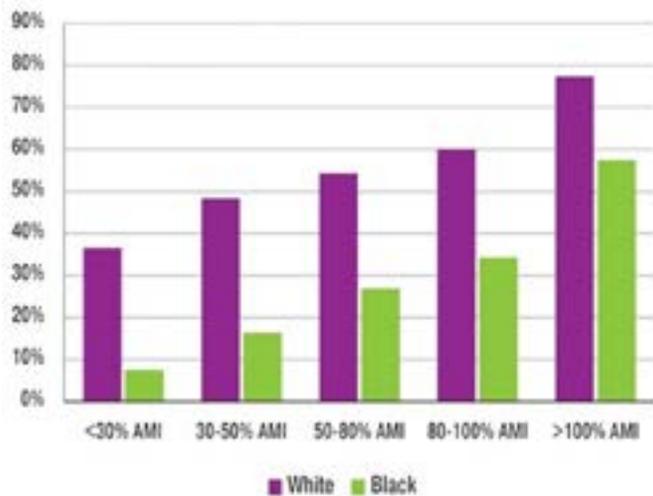
Homeownership is less for Blacks than for whites, even after correcting for different income levels (Figure 4-4). In addition, areas with higher percentages of people of color remained more dependent on transit.

Local jurisdictions have taken steps to increase the amount of housing, observed Inghram. They have developed and adopted Housing Action Plans, which are redesigned to identify needs, review existing strategies, and identify new ideas to meet needs. Two major state laws addressing housing require cities to do additional planning work by 2024. However, even where cities are trying to improve supply, the amount of time it takes to go through the planning and zoning processes and build housing is typically measured in years.

The economy of Washington State is much more diversified now than it was in the past, which has given the state greater economic resilience.

However, COVID-19 is unlikely to go away completely,

FIGURE 4-4. Home ownership by race and income exhibits major disparities even when organized by area median income (AMI).



which raises many questions about the pandemic’s long-term effects. How long will people have to wear masks in public? Will people continue to work at home? Will people commute in the same ways as in the past? How will that change downtowns and the surrounding population centers? How will investments in light rails, freeways, and ferries change the choices people make about where to live and where to work? For example, the South Lake Union neighborhood has been completely transformed over the past decade by the growth of Amazon in the area, and similar changes are happening in suburban centers like Lynnwood, Bothell, and Tukwila. “We will see urban development, because businesses and people want and are demanding places that are fun, interesting, have stores, have plazas, have places to visit. Employers—at least many of the employers that we have in the high-tech businesses—are chasing employees. They want to provide office spaces and work environments that are attractive to their employees. That’s where we see a number of communities continuing to develop in that way.”

However, COVID-19 is unlikely to go away completely, which raises many questions about the pandemic’s long-term effects.

5. Final Conversations

Befitting a symposium geared to both specialists and the general public, conversations during the final breakout session centered on the need for effective science communication and on how science and society both can hasten their recovery from the pandemic.

A TWO-WAY ROAD

Science is effective only when people understand and can follow it. The central question is how everyone, and not just researchers, can contribute to that understanding.

Science communication is often based on what symposium organizer Howard Frumkin called an “empty head model,” where communicators take the top off, pour knowledge in, and then put the top back on.

Science communication needs to be a two-way road. It needs to involve listening, finding shared values and commonalities, and then moving forward with a shared belief system. And people with diverse backgrounds, including different political views, need to be represented for this process to succeed. People also need to know how science works. If politicians said something 30 years ago and now say they have changed their minds, it is counted against them. But science works differently. Conclusions change as evidence accumulates, as experts argue about the significance of that evidence, and as they draw conclusions from that evidence. People need to know about this process, and scientists should not imply that scientific knowledge is set in stone.

Science communication could take the form of “preemptive outreach” to communities so that people have the knowledge they need before a crisis occurs. An obvious example from the pandemic is the understanding that vaccines protect not just the individuals who receive them but all members of the community. Again, outreach needs to occur in both directions, with communities making clear to researchers what their own priorities are.

Science communication needs to be a two-way road. It needs to involve listening, finding shared values and commonalities, and then moving forward with a shared belief system. And people with diverse backgrounds, including different political views, need to be represented for this process to succeed.

Science education is also a critically important part of science communication. Young people are more open to the messages that science conveys, and when they get inspired they can convert their parents. For people to become better-informed citizens, they need to have a better education from elementary through high school and beyond. They need to understand how data are gathered and analyzed, be able to think in probabilistic terms, and recognize evidence-based information, all of which require training. Scientists can work with schools both to make information available and to ensure that science education is engaging and accurate.

The Washington State Academy of Sciences has an important role to play in science communication, both through its annual symposium and through other activities it undertakes throughout the year. For example, with support from the National Science Foundation, the Academy has been holding virtual workshops with scientists and local communities on responses to the pandemic. The events are being co-designed and co-created with local decision makers and community leaders, with a goal of examining communities’ key questions about COVID-19 recovery. The first event was held in the Tri-Cities, with subsequent events planned for the northern Olympic Peninsula and the Spokane region.

COUNTERING MISINFORMATION AND DISINFORMATION

A critical part of science communication is dealing with misinformation and disinformation. Distortions of scientific information have been around for a long time—the anti-vaccination movement is centuries old—but social media have added a powerful new ingredient to the mix. Social affiliation has also come to play a role. When a person’s family, friends, and Facebook group all believe a certain thing, believing that thing helps identify who a person is. If confronted with contrary information, a person is more likely to discount the information than change a self-image.

Even more worrisome is a loss of trust in science and other forms of expertise. If people become convinced that experts are in collusion with a shadowy elite or are in the service of an industrial complex, they are likely to reject scientific information out of hand.

One suggested model for countering misinformation and disinformation is something like Wikipedia, which

has systems in place for screening and quickly correcting misinformation. But even newspapers and scientific papers can spread misinformation, and if and when the misinformation is corrected, far fewer people may learn about the correction.

Telling stories is an especially effective means of conveying scientific information. People understand and grasp the significance of stories, whereas confronting them about their mistaken beliefs can cause them to dig in. For example, personal stories from trusted people and friends can convey the message that vaccines against COVID-19 are safe and effective, with mandates providing an additional incentive to get vaccinated.

A crucial step in science communication is building trust and respect, which requires that all the members of a conversation be respected. People's positions may not change much as the result of a conversation, but they can be exposed to information that will influence their actions in the long term.

Early exposure to accurate information matters. For example, early in the pandemic the government did not have effective websites or other platforms, so when people looked for information they were more likely to encounter anti-vaccine misinformation. Providing accurate information proactively could help people learn about complex issues before misinformation or disinformation can take hold.

A crucial step in science communication is building trust and respect, which requires that all the members of a conversation be respected.

INDICATORS OF SUCCESS

Finally, symposium participants discussed what a return to normalcy might look like.

The pivotal role of scientific information during the pandemic may lay the groundwork for a newly invigorated dialogue between scientists and members of the general public. This is an area where the Washington State Academy of Sciences could lead by not only fostering but studying the effects of enhanced two-way communication.

A stronger and more resilient public health system can support economic recovery, even if people do not make that connection. If states that have not taken strong protective measures against the virus lag economically, they may have an incentive to act more forcefully.

Supply chains may be reengineered so that they are less susceptible to disruption. More robust and flexible supply chains may increase costs, but the long-term returns from enhanced stability would be greater in a world where external disruptions are increasingly likely.

The challenge posed by COVID-19 has been broad, affecting nearly all of science and nearly all of society. Both will change as a result of the pandemic, even if many of those changes are difficult to foresee. The symposium was a way for scientists and members of the broader society to discuss their mutual interdependence and how each can make the other stronger.

Appendix A

2021 SYMPOSIUM MATERIALS

Symposium Agenda	26
Symposium Speakers	28



COVID-19: SCIENCE AND SOCIETY

COVID-19 : Science and Society

WASHINGTON STATE ACADEMY OF SCIENCES'
14TH ANNUAL SYMPOSIUM

September 23, 2021

Agenda

10:00—10:10 AM	<p>Welcome Howard Frumkin, Professor Emeritus of Environmental and Occupational Health, UW, and Senior Vice President, Trust for Public Land</p>
10:10—10:30 AM	<p>Keynote Apoorva Mandavilli, Health and Science Journalist, The New York Times <i>Covering a Rapidly Changing Pandemic</i></p>
10:30—11:15 AM	<p>Session 1: Immunity Chair: Wesley Van Voorhis, Professor of Medicine and Director, Center for Emerging and Re-emerging Infectious Diseases, UW</p> <p>Helen Chu, Principal Investigator, Seattle Flu Study, UW <i>Developing a Citywide Pandemic Surveillance Platform</i></p> <p>Ruane Barnabas, Infectious Disease Physician-Scientist, UW <i>Public Health Strategies to Control COVID-19: Estimates of Effectiveness and Modeling for Potential Impact</i></p> <p>Umair Shah, WA State Secretary of Health, WA Department of Health <i>The Public Health Response to a Once-in-a-Century Pandemic</i></p>
11:15—11:30 AM	Q&A
11:30AM—12:00 PM	<i>Breakout Discussions</i>
12:00—12:30 PM	LUNCH
12:30—1:00 PM	<p>Keynote Lisa Brown, Director, WA State Department of Commerce <i>Equitable Recovery: Why Data and Facts Aren't Enough</i></p>
1:00 —1:45 PM	<p>Session 2: Community Chair: Ann Bostrom, Weyerhaeuser Endowed Professor of Environmental Policy, UW</p> <p>Stephan Blanford, Executive Director, Children's Alliance <i>Children and COVID: As If Things Weren't Already Complicated</i></p> <p>Celestina Barbosa-Leiker, Vice Chancellor for Research, WSU Health Sciences Spokane <i>The Impacts of COVID-19 on Women and Families: Stress and Coping in Pregnant and Parenting Individuals</i></p> <p>Jevin West, Director, UW Center for an Informed Public <i>Disinformation-laden Discourse In and About Science</i></p>
1:45—2:00 PM	Q&A
2:00—2:30 PM	<i>Breakout Discussions</i>
2:30—2:45 PM	BREAK

Agenda cont'd

2:45—3:30 PM **Session 3: Opportunity**

Chair: Ronald Mittelhammer, Regents Professor of Economics, WSU

Phil Watson, Professor of Applied Economics, University of Idaho

The Economic Impacts of COVID-19: Implications for Urban and Rural Washington

Jill McCluskey, Regents Professor of Economics, WSU

COVID Disruptions in Food & Agricultural Markets

Paul Inghram, Director of Growth Management, Puget Sound Regional Council

Planning for Post-COVID Resilience in Washington's Cities and Towns

3:30—3:45 PM Q&A

3:45—4:15 PM *Breakout Discussions*

4:15—4:30 PM **Closing Remarks**

Chair: Howard Frumkin, UW

SYMPOSIUM SPEAKERS

**APOORVA MANDAVILLI**

Health and Science Journalist, *The New York Times*

Keynote Address

Apoorva Mandavilli is a reporter for *The New York Times*, focusing on science and global health. She is the 2019 winner of the Victor Cohn Prize for Excellence in Medical Science Reporting. She is the founding editor in chief of Spectrum, an award-winning news site on autism science that grew an audience of millions. She led the team there for 13 years. She joined The Times in May 2020, after two years as a regular contributor. Ms. Mandavilli has won numerous awards for her writing. Her work has been published in The Atlantic, Slate and The New Yorker online, and in the anthology "Best American Science and Nature Writing." She co-founded Culture Dish, an organization dedicated to enhancing diversity in science journalism, and was the founding chair of the Diversity Committee for the National Association of Science Writers. Ms. Mandavilli has a Master of Arts degree in journalism from New York University and a Master of Science degree in biochemistry from the University of Wisconsin-Madison. She is fluent in English, Hindi, Tamil, Telugu and Kannada.

**LISA BROWN**

Director, Washington State Department of Commerce

Keynote Address

Lisa J. Brown, Ph.D., was appointed Commerce director by Gov. Inslee and began serving the agency in February of 2019. Lisa is a longtime resident of Spokane. Prior to serving as Commerce director, she served as chancellor of Washington State University and led the health science campus there, including the creation of the Elson S. Floyd College of Medicine. Lisa represented the Spokane area in the state House from 1993-1996 as minority whip and minority floor leader, breaking ground as a single working mother. She then went on to the state Senate where she became the first Democratic female majority leader and served until 2013. Lisa is an economist and has taught at Eastern Washington University and Gonzaga University. She earned her bachelor's degree in economics at the University of Illinois and her masters and doctoral degrees at the University of Colorado in Boulder. She has worked extensively on efforts to create jobs and support working families across Washington state. Her top two priorities, in no particular order, are an equitable and sustainable economic recovery and her baby grandson, Blaze.



HOWARD FRUMKIN

Professor Emeritus of Environmental and Occupational Health, University of Washington, and Senior Vice President, Trust for Public Land
Symposium Organizer and Chair

Howard Frumkin, a physician and epidemiologist, is Professor Emeritus of Environmental and Occupational Health Sciences at the University of Washington. Previously he was head of the Our Planet, Our Health initiative at the Wellcome Trust, Dean of the University of Washington School of Public Health, Director of the National Center for Environmental Health at the U.S. Centers for Disease Control and Prevention, and Professor and Chair of Environmental and Occupational Health at Emory University. His career has focused on health aspects of climate change, the built environment, energy policy, nature contact, and sustainability. He is author or co-author of over 250 scientific journal articles and chapters, and his ten books include *Making Healthy Places: Designing and Building for Health, Well-Being, and Sustainability* (2011), *Environmental Health: From Global to Local* (2016), *Planetary Health: Protecting Nature to Protect Ourselves* (2020), and *Planetary Health: Safeguarding Human Health and the Environment in the Anthropocene* (2021). He was educated at Brown (A.B.), the University of Pennsylvania (M.D.), and Harvard (M.P.H. and Dr.P.H.).



ROGER MYERS

R Myers Consulting, LLC and Executive Director, In-Space Programs Aerojet Rocketdyne (retired)
WSAS President

Roger Myers has worked on in-space transportation and propulsion for over 30 years. After 9 years at NASA's Glenn Research Center, he joined Aerojet Rocketdyne's Redmond Operations, the world's leading developer of spacecraft propulsion systems, where he held several executive positions before serving as General Manager and as Executive Director of Advanced In-Space Programs until 2016, when he retired to consult. He has worked on dozens of successful commercial, civil, and defense space missions and R&D programs. Dr. Myers was elected a Fellow of the American Institute of Aeronautics and Astronautics in 2010 and to the Washington State Academy of Sciences in 2012. He was awarded the AIAA Wyld Propulsion Award in 2014 and the Electric Rocket Propulsion Society Stuhlinger Medal for Outstanding Achievement in Electric Propulsion in 2017. He is the Board President for the Washington State Academy of Sciences, the Board Chair for Washington State's Joint Center for Aerospace Technology Innovation (JCATI), Past-President of the ERPS, and a Trustee at Seattle's Museum of Flight. Dr. Myers earned his PhD from Princeton University and a BSAE from the University of Michigan.



ANN BOSTROM

Weyerhaeuser Endowed Professor of Environmental Policy, University of Washington

Moderator-Community Panel

Ann Bostrom is the Weyerhaeuser Endowed Professor in Environmental Policy at the Evans School of Public Policy & Governance, University of Washington. She researches mental models of hazardous processes (how people understand and make decisions about risks). Bostrom is the recipient of the Chauncey Starr and the Distinguished Educator Awards from the Society for Risk Analysis, of which she is a Fellow and Past President. Bostrom is also a Fellow and elected member of the Boards of Directors for the American Association for the Advancement of Science (AAAS) and the

Washington State Academy of Sciences. Dr. Bostrom holds a B.A. in English from the University of Washington, an M.B.A. from Western Washington University, and a Ph.D. in policy analysis from Carnegie Mellon University. She studied at Stockholm University on a Fulbright award as part of her doctoral studies and completed postdoctoral studies in Engineering and Public Policy at Carnegie Mellon University and in cognitive aspects of survey methodology at the Bureau of Labor Statistics.



CELESTINA BARBOSA-LEIKER

Vice Chancellor for Research and Associate Professor, Washington State University

Panelist—Community

Dr. Celestina Barbosa-Leiker is an Associate Professor in the College of Nursing and Vice Chancellor for Research at Washington State University (WSU) Health Sciences Spokane. She is also a member of the Committee on Cannabis Research and Outreach and on the Executive Committee of the Program of Excellence in Addictions Research at WSU. Dr. Barbosa-Leiker's primary research investigates infant and maternal health and gender differences in substance use. Her research has demonstrated sex differences in the measurement of opioid withdrawal, relapse while in treatment, and predictors of relapse. Her research also focuses on the

transition from pregnancy to parenthood in women with substance use disorders. She is currently leading an interdisciplinary research team to assess mothers, infants, and healthcare providers in order to better care for women with substance use disorders, with emphasis on all perinatal women during the COVID-19 pandemic. The results of these studies will help better educate healthcare providers and pregnant women, inform maternal and infant health policy, and improve standards of care.



RUANNE BARNABAS

Professor of Global Health and Infectious Disease, University of Washington
Panelist—Immunity

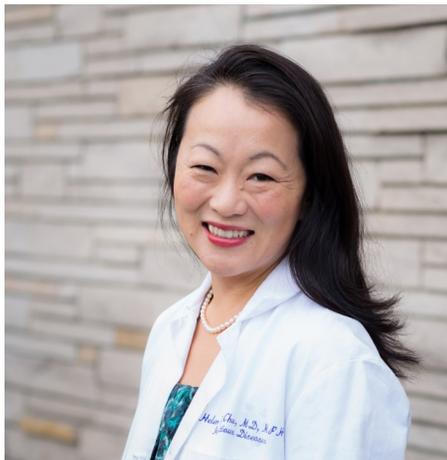
Ruanne V Barnabas, MD, DPhil, is a Professor in Global Health and Infectious Diseases at the University of Washington and affiliate at the Fred Hutchinson Cancer Research Center. She is a South African Physician-Epidemiologist. Her research focuses on interventions for HIV and sexually transmitted infection (STI) treatment and prevention. She is the Protocol Chair of the KEN SHE Study to assess the impact of single-dose HPV vaccination in Kenya. A key focus of her work is testing client-centered approaches to deliver effective interventions. She is the Protocol Chair of the Delivery Optimization for antiretroviral (DO ART) Study, which will evaluate the effectiveness and cost-effectiveness of community-based treatment for HIV compared to clinic-based care. She also leads work assessing innovative strategies to increase access to care including lottery incentives and home delivery. Recently, her work has extended to COVID-19 prevention. The ultimate aim of her work is to identify effective and scalable HPV, HIV, and infectious disease treatment and prevention strategies to increase access across diverse communities and promote equity in health.



STEPHAN BLANFORD

Executive Director, Children’s Alliance
Panelist—Community

Dr. Stephan Blanford is a leader committed to social justice in education and social services. Dr. Blanford serves as the Executive Director of Children’s Alliance and leads a team of employees, volunteers and more than 9,000 members across Washington state committed to improving outcomes for children and families. Before assuming that role, he was elected and served on the Seattle School Board in 2013 and at the conclusion of his term, he received the “Leadership for Equity” award for his unapologetic advocacy for educational and racial justice. Dr. Blanford holds a Bachelor of Arts in Liberal Studies (Social Justice) from Antioch University Seattle, a Masters degree in Public Administration from the Evans School of Public Policy & Governance and a doctorate in Educational Leadership and Policy Studies from the College of Education, both on the University of Washington campus. He is the proud father of a high school senior who will soon leave their home for college.



HELEN CHU

Associate Professor of Medicine and Public Health and Principal Investigator, Seattle Flu Study, University of Washington

Panelist—Immunity

Dr. Chu is Associate Professor of Medicine and Public Health at the University of Washington, and an expert on respiratory viruses and vaccines. She has made substantial contributions to the COVID response in Washington State. Along with a team of scientists, she leads the Seattle Flu Study, a study focused on pandemic preparedness which first identified COVID-19 community transmission in the United States. She established the first cohort of COVID-19 survivors in the United States, which allowed for major early contributions to development of treatments and vaccines for SARS-CoV-

2. She has worked closely with local public schools in Snohomish, Seattle, and Yakima to do studies in young children to understand testing and school-based transmission, and has led the Husky Coronavirus Testing program, the testing program for University of Washington students, faculty, and staff. She has also worked with multiple other underserved populations including the homeless populations in Seattle. She serves on the NIH Expert Working Groups for Maternal COVID Vaccines, COVID, and Respiratory Viruses.



PAUL INGRAM

Director of Growth Management, Puget Sound Regional Council

Panelist-Opportunity

Paul Inghram's leadership in growth management and sustainability has established models for building vibrant urban neighborhoods and stopping sprawl. His work has ranged from planning for small towns to leading planning for the Seattle-Tacoma metro region, covering four million people. His work, heralded as a national example, has resulted in innovations in transit-oriented development, regional planning, and environmental restoration that has elevated the practice of planning. Paul serves as the Director of Growth Management for the Seattle-Tacoma metro region with the Puget Sound Regional Council. By actively engaging communities throughout the region, Paul is working to build trust and support to implement an ambitious plan for managing growth, building healthy communities, and

responding to climate change. Inghram mentors and guest lectures at the University of Washington, served as the president of the American Institute of Certified Planners from 2010 to 2011 and served on the Board of the American Planning Association and continues to be actively involved in the planning profession. He holds a degree in planning and design from the University of Washington and an MBA from Seattle University.

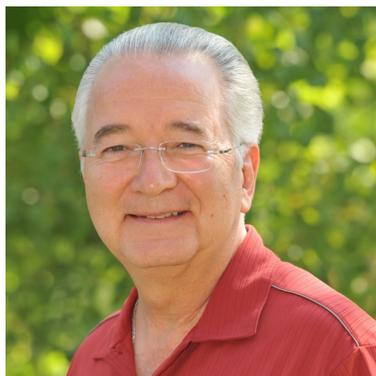


JILL MCCLUSKEY

Regents Professor and Director, School of Economic Sciences, Washington State University

Panelist-Opportunity

Jill J. McCluskey is Regents Professor and Director of the School of Economic Sciences at Washington State University. McCluskey's research focuses on product quality and reputation, sustainable labeling, consumer preferences for new technology, and representation of women in STEM. An award-winning researcher, she is widely published and cited. Her research has been funded by private foundations, NSF, and USDA. An award-winning mentor, she has served as major professor to 42 Ph.D. graduates, many of whom are Professors at major research universities. She is an incoming Editor of the *American Journal of Agricultural Economics*. She is past President and Fellow of the Agricultural and Applied Economics Association and Fellow of the Western Agricultural Economics Association. She is a member of the Board on Agricultural and Natural Resources of the National Academies of Sciences, Engineering, and Medicine. Her research has been highlighted by various media outlets including the *New York Times*, National Public Radio, and *Newsday*. She received her Ph.D. in Agricultural and Resource Economics in 1998 from the University of California, Berkeley.



RONALD MITTELHAMMER

Regents Professor of Economics, Washington State University

Moderator-Opportunity

Ron Mittelhammer was promoted to Regents Professor, Washington State University's highest academic rank, in 2004. He served as Director of the School of Economic Sciences from 2004-2010. He received his B.S. and M.S. degrees from Rutgers University in 1972 and 1974, and his Ph.D. from WSU in 1977. He is the author of over 250 publications and presentations, including over 100 refereed journal publications, three major books on statistics and econometrics including *An Information Theoretic Approach to Econometrics* published by Cambridge University Press, 2012, and the 2nd edition of his statistics textbook, *Mathematical Statistics for Economics and Business*, published by Springer-Verlag, 2013, as well as numerous book chapters. He is a celebrated graduate-level teacher, having received national and university-wide awards for instruction, including the national Agricultural and Applied Economics Association award for Distinguished Graduate Teaching, the Washington State University Sahlin Faculty Excellence Award in Teaching, and the College of Agriculture and Home Economics Teaching Excellence Award. He was recognized as a *Journal of Econometrics* Fellow, a Fellow of the Agricultural and Applied Economics Association, a Fellow of the Western Agricultural Economics Association in 2004, served as President-elect, President, and Past President of the AAEA from 2008-2011, and is a board member of the Washington State Academy of Sciences. He served as Dean of WSU's College of Agricultural, Human, and Natural Resource Sciences from 2013 - 2018, and also served the University as Interim Co-Provost in 2015-2016. He received Washington State University's highest faculty honor, the *Eminent Faculty Award*, in 2014, and recently received the *Lane Rawlins Distinguished Lifetime Service Award* from WSU in 2019.



UMAIR SHAH

Secretary of Health, Washington State Department of Health
Panelist-Immunity

Umair A. Shah, MD, MPH, was appointed Secretary of Health by Governor Jay Inslee and joined the Department of Health in December 2020. Prior to this role, Dr. Shah served as Executive Director and Local Health Authority for Harris County Public Health (HCPH) – the nationally accredited county public health agency for the nation’s 3rd largest county with 4.7 million people. Dr. Shah earned his BA (philosophy) from Vanderbilt University; his MD from the University of Toledo Health Science Center; and completed an Internal Medicine Residency, Primary Care/General Medicine Fellowship, and MPH (management), at the University of Texas Health Science Center. He also completed an international health policy internship at World Health Organization headquarters in Switzerland. Upon completing training, Dr. Shah began a distinguished career as an emergency department physician at Houston’s Michael DeBakey VA Medical Center. He started his formal public health journey as Chief Medical Officer at Galveston County’s Health District before joining HCPH to oversee its clinical health system and infectious disease portfolio. Under his leadership, HCPH has won numerous national awards including recognition as Local Health Department of the Year from the National Association of County and City Health Officials (NACCHO) in 2016. Dr. Shah currently holds numerous leadership positions with respected entities like the National Academies of Sciences, Engineering, and Medicine; U.S. Centers for Disease Control & Prevention; Trust for America’s Health; Network for Public Health Law; and Texas Medical Association. He previously served as president of NACCHO (and its Texas affiliate) representing the nation’s nearly 3,000 local health departments. Over his career, Dr. Shah has been a clinician, an innovator, an educator, and a leader in health.



PHIL WATSON

Professor of Applied Economics, University of Idaho
Panelist-Opportunity

Dr. Philip S. Watson is an Associate Professor of Applied Economics at the University of Idaho in Moscow, Idaho. Phil is a teaching and research faculty member who focuses on regional economic development, economic growth, and agricultural and natural resource policy. He has previously worked with the National Oceanic and Atmospheric Administration, National Park Service, National Forest Service and the Bureau of Land Management. He received his Ph.D. from Colorado State University and possesses a quantitative background in Computable General Equilibrium (CGE) modeling, input-output analysis, benefit-cost analysis, and spatial econometrics. Dr. Watson has published over 100 refereed journal articles in such journals as *Economic Inquiry*, *The Quarterly Review of Economics and Finance*, *The American Journal of Agricultural Economics*, *The Journal of Agricultural and Resource Economics*, *Regional Studies*, *Growth and Change*, *Marine Resource Economics*, *Environmental Management*, *Land Use Policy*, and *Applied Economics*. Phil lives in Pullman, Washington with his wife Kaitlin and three children.

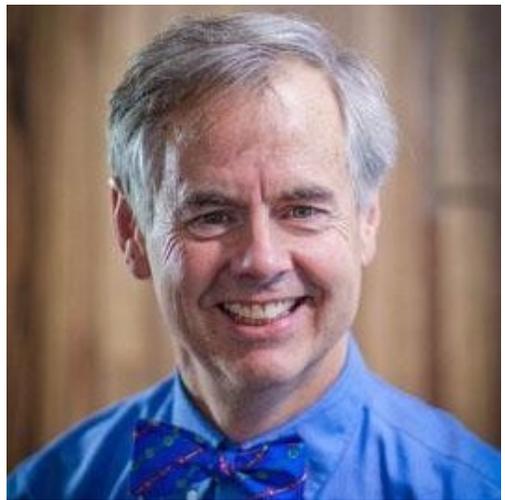


JEVIN WEST

Associate Professor and Director, Center for an Informed Public,
University of Washington
Panelist-Community

Jevin West is an Associate Professor in the Information School at the University of Washington. He is the Director of the new Center for an Informed Public at UW aimed at resisting strategic misinformation, promoting an informed society and strengthening democratic discourse. He is also the co-founder of the DataLab at UW, a Data Science Fellow at the eScience Institute, and Affiliate Faculty for the Center for Statistics & Social Sciences. His research and teaching focus on the impact of technology on science and society, with a focus on slowing the spread of misinformation. He is also the co-author of the new book, *Calling*

Bullshit: The Art of Skepticism in a Data-Driven World, which helps non-experts question numbers, data, and statistics without an advanced degree in data science.



WESLEY VAN VOORHIS

Professor and Director, Center for Emerging and Re-emerging Infectious
Diseases, University of Washington
Moderator-Immunity

Wesley Van Voorhis attended Cornell Medical College and Rockefeller University (RU) for his MD/PhD degrees. At RU, he was the first to discover and characterize human dendritic cells (antigen presenting accessory cells). Wes' PhD advisor, Dr. Ralph Steinman, was awarded the 2011 Nobel Prize for Medicine for Dr. Steinman's discovery of dendritic cells. He trained in Internal Medicine at UC San Francisco and in Infectious Diseases (IDs) at the University of Washington (UW). Wes practices medicine, teaches, does laboratory research, and is the Director of CERID, the UW Center for Emerging and Re-emerging Infectious

Diseases. CERID takes a multidisciplinary approach to identifying and developing diagnostic, therapeutic and vaccine solutions to emerging IDs. For the past 25 years, Wes has worked on pre-clinical drug development for malaria, trypanosomes, leishmania, and cryptosporidium. In the past 2 years, he's been doing pandemic virus detection research, leading a group called United World Antivirus Research Network, or UWARN, which has international partners in Brazil, Pakistan, Senegal, South Africa, and Taiwan. He has published over 260 peer-reviewed papers and won numerous academic awards.

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