Public Meeting of the

President's Council of Advisors on Science and Technology (PCAST)

March 30, 2023

Meeting Minutes

Meeting Participants

PCAST Members

1. Frances Arnold, Co-Chair
2. Arati Prabhakar, Co-Chair
3. Maria T. Zuber, Co-Chair
4. Dan E. Arvizu
5. Dennis Assanis
6. John Banovetz
7. Frances Colón
8. Lisa A. Cooper
9. John O. Dabiri
10. William Dally
11. Sue Desmond-Hellmann
12. Inez Fung
13. Andrea Goldsmith
14. Laura H. Greene
15. Paula Hammond
16. Eric Horvitz
17. Joe Kiani
18. Jon Levin
19. Steve Pacala
20. Saul Perlmutter
21. William Press
22. Jennifer Richeson
23. Vicki Sato
24. Lisa Su
25. Kathryn Sullivan
26. Terence Tao
27. Phil Venables
28. Catherine Woteki

PCAST Staff

1. Lara Campbell, Executive Director
2. Reba Bandyopadhyay, Deputy Executive Director
3. Bich-Thuy Sim, Assistant Director for Transformative Medicine and Health Innovation
4. Kevin Johnstun, Research Analyst
5. Alexia Sare, Policy Analyst
6. Jonathan Judd, Intern

Invited Speakers (in order of presentation)

1. Robert Hampshire, Deputy Assistant Secretary for Research and Technology and Chief Scientific Officer, U.S. Department of Transportation
2. Chris Atkins, Deputy Director for Technology, U.S. Department of Transportation

START DATE AND TIME: THURSDAY, MARCH 30, 2023, 9:20 AM Eastern Time

LOCATION: Eisenhower Executive Office Building and livestreamed via Zoom.gov

WELCOME

PCAST Co-chairs: Frances Arnold, Arati Prabhakar, Maria Zuber

The PCAST co-chairs—Frances Arnold, California Institute of Technology; Arati Prabhakar, Science Advisor to the President; and Maria Zuber, Massachusetts Institute of Technology—called the public session to order. Zuber noted that PCAST was excited to discuss and potentially vote on two reports and hear from representatives from the Department of Transportation (DoT) about the newly established Advanced Research Projects Agency for Infrastructure (ARPA-I). Zuber turns to Arnold to introduce the discussion of the first report.

SESSION: DISCUSSION AND CONSIDERATION FOR APPROVAL OF PCAST REPORT TO THE PRESIDENT ON EXTREME WEATHER RISK IN A CHANGING CLIMATE

Arnold introduced the session by stating that PCAST was finalizing a report with recommendations on how to help Americans understand and respond to the risk of extreme weather events. She pointed out that science and technology and understanding climate can play a key role in modeling the probabilities and effects of droughts, heat waves, hurricanes, floods, and other extreme weather events. She then introduced the co-chairs of the extreme weather working group, Stephen Pacala and Jon Levin, who summarized the report's findings and recommendations, and answered questions from PCAST members.

STEPHEN PACALA

Pacala said that the most immediate danger that Americans face from climate change is the worsening of extreme weather disasters, such as hurricanes, floods, droughts, heatwaves, and wildfires. He noted that extreme weather disasters have caused over $1 trillion in damages over the last seven years, and in 2022 alone, displaced some 3.4 million Americans from their homes. As a result of years of work, the fundamental modeling capabilities exist within federal agencies to better characterize these risks and inform households, businesses, and community leaders of the probabilities of extreme weather events. He added that the report recommends steps to dramatically improve the quantification of extreme weather risk and develop a national adaptation plan to protect the lives, livelihoods, and property of Americans for generations to come.

Pacala explained that the National Oceanic and Atmospheric Administration (NOAA) is responsible for operational weather prediction—the prediction of weather based over the short-term based on current conditions of the atmosphere. Operational weather prediction is limited by the inherent unpredictability of dynamic systems such as the atmosphere, which is why weather forecasts only cover a short distance into the future. Along with operational weather prediction, the federal government engages in climate science research, where climate is the likelihood of weather, such as the chance of a 90-degree day on a specific July day in Washington, DC, the chances of Miami experiencing a Category 5 Hurricane in

September 2023, or the chance that a tornado will strike Mississippi on the first day of spring. These likelihoods are called climatologies.

Pacala said that for decades NOAA, the National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), and Department of Energy (DOE) have funded climate centers with sufficient computing power to improve the nation's capacity to predict climatologies. This progress comes from advances in modeling, data analysis, bias correction, and the fusion of models and data. In particular, there has been progress on predicting the chances of tail risks—the most extreme and damaging events. As a result of surges in the past year in global modeling of extreme weather risk, PCAST decided that there is capacity to improve on historical weather models with new methods that include the effect of recent climate change. To capitalize on this promising new capability, the working group's first recommendation called for NOAA, NASA, NSF, and DOE to engage in an operational effort to estimate extreme weather risks at fine geographical scale through midcentury. In this focused federal effort, the U.S. climate modeling centers should enhance their high-resolution modeling capabilities and state-of-the-art statistical methods to quantify the current and near-future risks of extreme weather at a resolution of 10 kilometers or finer. This recommendation also calls for the White House to designate a lead agency to maintain an extreme weather data portal where observations and modeling products are updated regularly and are widely available. Pacala noted that the United States has a burgeoning ecosystem of climate risk assessment companies that need accurate data of the sort the portal would provide to deliver accurate information to their customers.

The second recommendation calls for the nation to develop an improved ecosystem for climate risk assessment that can predict the severity of resulting weather hazards and the human and economic losses they will cause. The vehicles for doing this are weather-hazard models, which predict events like floods, fires, and droughts, and hazard-loss models, which predict the human and economic loss from weather hazards. Pacala explained that the insurance industry has developed these models, but the insurance industry considers the information the models generate to be proprietary, which means that the data to advance this area have not been widely available. However, the federal government has accumulated a wealth of data that could advance this effort, and so Recommendation 2.1 calls for the release of disaster claims information with privacy safeguards to support this burgeoning ecosystem and advance progress on model development.

Pacala said that Recommendation 2.2 aims to improve skill scoring, or assessing the accuracy of weather hazards and hazard-loss models to predict past events. To accomplish this, NOAA and the Federal Emergency Management Agency should develop guidelines for measuring the accuracy of weather-hazard and hazard-loss models with skill scores and promote the use of skill scoring among federal agencies that rely on assessments of climate and weather hazards including flood, drought, storm, and wildfire, and the human and economic damages they cause.

Capitalizing on the explosion of interest and activity in this area requires a larger investment in the workforce and research. Recommendation 2.3 addresses this need by calling for multiple agencies to fund research on risk assessment modeling systems that use extreme weather probabilities, weather-hazard models, and hazard-loss models to quantify the likelihood and economic costs of extreme weather events.

JON LEVIN

Levin began by explaining that the working group spent considerable time over the preceding 18 months focused on the impact of extreme weather events on people and communities across the country. Levin noted that while the government plays an important role in helping communities and the American people prepare for and mitigate extreme weather, many decisions that are most important are made at the local level by local communities, homeowners, insurance companies, property developers, and others. As a result, the problem of adaptation is complicated because it involves many decisions by many people.

To help prepare for changes in the risk of extreme weather over the coming decade, the working group made two additional recommendations, said Levin. Recommendation 3.1 calls for developing a national adaptation plan that would provide decision-making tools and frameworks to help local communities make decisions and policies that would prepare for changes in extreme weather risk. This plan should include a systemic approach to mapping high-danger zones for each extreme weather hazard that is updated as estimates of risk improve. It should also include decision frameworks to assist local communities in planning to mitigate or adapt to extreme weather risk, including changing building codes, building weatherization, community relocation plans, and changes to insurance and real estate prices. Levin adds that a national adaptation plan should include guidance for distributing federal funds for disaster preparation that reduces existing barriers for low-income communities to access and use federal grants and programs, and guidelines for equitable allocation of disaster relief that anticipate the potential for recurring extreme weather events and that support mitigating future dangers to the community.

In addition, said Levin, Recommendation 3.2 calls for funding research on how households, real estate, insurance markets, and local governments adapt to climate change and extreme weather risk. This effort, which NSF may be best positioned to lead, should aim to illuminate the behavior of households and firms in response to evolving climate and weather risks, and the benefits and costs of alternative policies aimed at mitigating and adapting to these risks.

Levin concluded his remarks by thanking the members of the working group, staff at the Office of Science and Technology Policy, and the many people at all levels of government who helped develop this report. He noted that the report also benefited from the guidance and input of PCAST members not on the working group.

After the working group co-leads' presentation, discussion among PCAST members followed.

ARNOLD MODERATED THE Q&A AND DISCUSSION BETWEEN PCAST MEMBERS AND PACALA AND LEVIN

Laura Greene asked Pacala and Levin how they envision getting NOAA, NASA, NSF, and DOE to share best practices. Pacala replied this is a problem, as parallel activity is unusually easy and does not require cooperation more broadly. What is needed is known as "an ensemble" of model runs, comprising hundreds of realizations from as many models as possible of what the weather might look like on a fine geographic grid between now and midcentury. Each agency has one or two models and the computing power necessary to run these ensembles, and they already create these in order to participate in the Intergovernmental Panel on Climate Change (IPCC) reports, for example. Coordinating activity across these agencies and ensuring that they meet priorities requires an entity, preferably at the White House level, to establish those priorities. This central entity does not have to be large, but is necessary because operational weather forecasting has been NOAA's responsibility exclusively and not part of the mission of

NASA, NSF, or DOE. Pacala added that he does not believe coordination among these agencies will be difficult.

Kathy Sullivan noted that while these agencies have the necessary computing resources, they will have to reallocate computer cycles and she wondered what the impact of that reallocation will be over the long haul. Levin, acknowledging that this effort will require a considerable amount of computing resources, said one possibility would be to provide incremental resources through agency budgets to make this an incremental activity at the agencies. The working group did not recommend that approach because it wanted to scope out how it could be done within existing budgets, e.g., by shifting research priorities within the agencies to perform this type of climate modeling. What the working group suggests is that this is such an important problem for the American people that it would be worth making this effort a top priority for the agencies in the coming years. In that regard, Congress might be wise to allocate more resources for advanced modeling, but that is a budget process decision. Pacala added that while shifting computing resources from sea ice research, for example, into climate modeling and creating large ensembles will require shifting resources, this type of activity has tremendous value for research. In fact, he said, the agencies do this type of activity already.

Sullivan, pushing back on the idea that coordination will not be difficult, asked how much alignment would there need to be between agencies about the composition and nature of the ensemble sets, given that there is a virtue to each agency approaching the problem differently. Pacala noted that the agencies already coordinate their activities to participate in IPCC comparison projects. Levin added that there is a tremendous amount of private investment currently going into climate modeling and a startup ecosystem around climate modeling. That investment can be amplified and made more productive and valuable if the federal government provides the foundational modeling upon which the private sector can build. In that way, federal resources and prioritization around climate modeling will have a multiplier effect across the broader modeling ecosystem, making it particularly timely for federal activity in this area. Sullivan noted this is how the U.S. private weather industry started and continues to be supported with federally funded foundational work. Levin said that example illustrates the working group's vision for how climate modeling might develop in the years ahead.

Frances Colón commented that as someone who has served on a Florida city's advisory board trying to make decisions related to climate change, this type of investment by the federal government will be welcomed by municipalities that do not have the resources to pay for the expensive private sector versions of these models. Levin said the report's discussion on creating a national adaptation plan includes the importance of ensuring that low-income communities have equitable access to federal grant programs for addressing the risks from climate change.

Colón then asked if there is a direct connection between the administration's Justice40 Initiative and the working group's third recommendation to accelerate preparedness by creating a national plan to mitigate extreme weather risk that would guide and support investment at all levels. Levin said that there is a connection, and the working group hopes that its recommendations would help identify which communities will be at greatest risk of increased flooding, tropical storms, drought, or wildfires. Having that information will help ensure that allocated federal funds can help communities—and particularly vulnerable communities—prepare for and adapt to the risk of climate change. He noted that highly granular information is currently lacking about which communities and households are most at risk from

climate change. The additional information from advanced modeling can help implement the Justice40 policy and ensure that federal funds are spent in the most effective way possible.

Pacala added that a better understanding of where the risks are will enable an examination of distribution of those risks across incomes and ethnicity. He noted there has been a tremendous amount of attention paid to how air pollution disproportionately affects communities of color, and a well-developed federal plan to not recreate the same mistakes as the country's energy transition occurs. However, there has not been the same attention paid to climate risks, and as a result, there is has been no systematic study of how heat waves, for example, disproportionately affect communities of color, even though there are small-scale studies showing that they do. The report's research recommendations aim to address this information deficit, and the working group plans to add a section to the report to further highlight this issue.

Andrea Goldsmith asked how new data tools such as artificial intelligence and machine learning will change or improve the ability to fulfill the first recommendation's call for a national effort to quantify extreme weather risk. Pacala replied that artificial intelligence will play a large role in developing better calculations of extreme weather climatologies. As far as getting access to the data needed to power these new tools, this is a significant problem both inside the United States and an even bigger problem in all but the most developed countries. The situation is somewhat better in the federal government, which has recorded every claim from every disaster. However, while this data exists, it has not been used, even by the Federal Emergency Management Agency. Globally, remote sensing can help address this deficit. The second recommendation's call to improve hazard loss and weather hazard modeling will require a focus on getting the data to power modeling work.

Dan Arvizu asked how the federal government will manage the regulatory environment given that the property and casualty insurance industry's pricing is regulated by the states with some level of political undertones or overtones that cannot be predicted. Levin replied this is one of the challenging issues involving changes in extreme weather risk. If the probability of a certain hazard goes up in an area, there will be increased damages, raising the question of who bears that risk. In some cases, such as with flood insurance or disaster relief, the federal government bears the risk. In other cases, private insurers bear the risk and sometimes pass that risk on to property owners in the form of higher rates. The report does not address the fundamental political problem about who is going to bear the risk, and those decisions will have to be made at the federal, state, and local levels. Making decisions about bearing the cost of climate change is going to be a looming problem for the nation. Pacala added that the working group talked to senior people in the insurance industry and regulatory bodies, and all of them welcomed the public good that the kind of analysis the report recommends would generate. Today, however, insurers do not know how to price their risk, so making the information publicly available as it is generated will help the insurance industry thrive and provide frontline services regarding climate change. Given that, it is in the nation's best interest to make sure the industry prospers when providing that service.

Eric Horvitz asked how the current understanding of climate change aligns with what happened when an EF4 tornado hit Mississippi at an atypical time. He also asked how the results of this report might have helped proactively to make the situation after that tornado better in terms of outcomes. Pacala, who noted the President was on his way to visit the communities affected by the EF4 tornado, said there was a paper published in the Bulletin of the American Meteorological Society in January 2023 in which the

authors used the type of technologies discussed in the PCAST report to address the potential impacts of added greenhouse gases on tornado frequency. While this is just one paper, it did predict where this tornado occurred and the time of year during which it occurred. Given the prediction that there is a set of meteorological conditions that make the affected area a tornado hotspot at that particular time of year, the response might be, for example, to change building codes so that structures are better able to withstand 200-plus mile per hour winds, in line with the current building codes in areas of the country where tornadoes are more common.

Vicki Sato asked Levin and Pacala for their thoughts about the rate at which the ability of new technology to enhance predictability will be incorporated into changes to increase resilience to extreme weather events. Levin replied that he and Pacala do not have an answer to that question. He then said that one challenge in this area regards tail events—those with a low probability of occurring but that produce an extreme amount of damage, such as Hurricane Katrina. A small change in the probability could have large consequences for the nation, which is why this is an important problem. At the same time, given that such events are not going to happen often in a given location, it is hard for individuals and communities to get their minds around the risks associated with tail events. This reality poses a real challenge in terms of how to make plans for a low-probability event, even if that event has become more likely because of climate change. The report does not have an answer to that, and it is something that communities and markets will have to grapple with as these changes that the models are predicting occur.

As a final question, John Dabiri asked how agencies will be able to prioritize research going forward. Pacala said one reason why the report does not specify the coordinating structure for the climate modeling centers that NOAA, NASA, NSF, and DOE support is that there needs to be a process that integrates an operational role and a research role. That will be foundational to how the agencies interact and plan, and it needs to occur at the White House level.

With the discussion concluded, PCAST voted unanimously to accept the report.

SESSION: DISCUSSION AND CONSIDERATION FOR APPROVAL OF PCAST REPORT TO THE PRESIDENT ON SUPPORTING THE U.S. PUBLIC HEALTH WORKFORCE

Zuber introduced this session by noting that the COVID-19 pandemic laid bare the challenges the nation's public health system faces. Numerous studies, both completed and ongoing, aim to glean lessons from the experience, and PCAST considered where it might contribute to this effort. The public health working group settled on the topic of the public health workforce. Zuber then introduced the co-chairs of the public health workforce working group, Lisa Cooper and Sue Desmond-Hellmann, who summarized the report's findings and recommendations.

SUE DESMOND-HELLMANN

Sue Desmond-Hellmann stated that the United States pays far more for health care with worse outcomes than peer nations. One issue is that health care dollars in United States largely go for treatment, with prevention and public health underfunded. Three consequences of the decades-long underfunding of public health, compounded with the impact of the COVID-19 pandemic, have been inequitable health outcomes, a decrease in U.S. life expectancy, and the public health workforce being undercompensated

and under fire. She pointed out that other countries also saw their life expectancy fall during the COVID-19 pandemic, but unlike in the United States, those decreases began to reverse in 2021.

The good news, said Desmond-Hellmann, is that the U.S. can do better. A key to doing better will be bolstering the public health workforce, which includes health professionals, environmental and occupational health professionals, laboratory personnel, data analysts, administrators and managers, and social and community health workers. She said that the U.S. public health system must be strengthened if the nation is to realize its vision of health equity, where every person has a fair opportunity to attain their full health potential and no one is disadvantaged from achieving this potential because of social position or other socially determined circumstances.

Desmond-Hellmann explained that the PCAST working group focused on the public health workforce because improvements in the overall health of the nation will require a well-defined, well-trained, and well-compensated public health workforce that will serve the needs of all Americans. In addition, the working group realized that the new programs and funding for strengthening the public health workforce that the Biden Administration initiated during the COVID-19 pandemic has provided a unique opportunity to produce advances that can be sustained over the long term.

LISA COOPER

After speaking with over two dozen organizations, federal agencies, and academics, the working group developed a set of recommendations that Lisa Cooper said would be acceptable, timely, and actionable. The first recommendation was to establish a common lexicon and standardized classification system for the public health workforce at the federal level. She explained that establishing a common vocabulary and standardized system is the foundation that will enable consistent, nationwide enumeration of the public health workforce, including identification of workforce gaps, through regular and systematic data collection. Standardized workforce definitions, Cooper added, will help identify the skills and credentials needed for different job types, recognize individuals who perform public health work but are not currently categorized as being part of the public health workforce, signal where more diversity is needed in the workforce, and inform educational and training programs and organizational best practices.

Cooper said to fulfill this recommendation, the working group determined that the Bureau of Labor Statistics (BLS) and Office of Management and Budget (OMB) should work together to create a new Standard Occupational Classification (SOC) system for public health and include the public health workforce in key surveys of the labor market as part of the next revision of the SOC manual. This work should be done in consultation with the Department of Health and Human Services (HHS)—and particularly the Centers for Disease Control and Prevention (CDC) and the Health Resources and Services Administration (HRSA). Cooper noted that detailed classification systems have been developed in the academic literature, so the working group suggested using an existing taxonomy as the foundation for the proposed SOC. The process for developing the SOC should be completed with input from state, local, and Tribal governments, as well as professional and academic organizations.

The second recommendation, said Cooper, calls for expanding recruitment, retention, training, and personnel exchanges to strengthen public health talent. Some surveys have shown that approximately 40 percent of the current public health workforce is considering leaving their job in the next few years,

highlighting the imperative to make public health jobs more attractive and to provide more support and training.

Cooper said that following through on the second recommendation will require an all-of-government campaign to recruit and retain people in public health careers. This campaign should include fast-track hiring authority, the creation of a new job series for public health, and expansion of loan repayment and forgiveness options for public health workers. As part of this effort, HHS and the Departments of Labor and Education should create a robust, high-profile communication campaign that will advertise the value of public health careers and make the public aware of federal programs available to support public health education and the workforce. In addition, the Office of Personnel Management (OPM) should lead a coalition of agencies in developing a government-wide direct hiring campaign for public health jobs. While this effort would target many types of public health workers, including data scientists, epidemiologists, policy analysts, clinical advisors, environmental health professionals, and community engagement specialists, it would have a particular focus on recruiting frontline community health workers.

The second part of recommendation 2, said Cooper, calls for establishing new pathways and increasing existing opportunities for personnel exchanges between federal, state, Tribal, and territorial health officials, as well as supporting exchanges with local health systems and private sector organizations. Such exchanges would enable public health professionals to gain leadership skills and experiences from working in other environments, including private sector organizations. They would also provide federal workers with a better understanding of some of the challenges existing at the local level, which could enable the federal government to better support state and local public health agencies. The working group suggested that CDC should hire people from the private sector and provide them rotational assignments, similar to NSF rotators. The Centers for Medicare and Medicaid Services could support such programs by supporting exchanges between health system staff and health departments as part of local collaborations to improve population health, said Cooper.

Cooper said the working group's final recommendation called for advancing health equity through strengthening public health's capacity for community engagement. This recommendation aims to address the nation's inequities in health outcomes based on race, ethnicity, social class, and geography—inequities that result from negative social determinants of health that rarely are addressed within the health care setting. This recommendation, said Cooper, builds on the administration's February 2023 Executive Order to further advance racial equity and support for underserved communities through the federal government by requiring agencies to strengthen community partnerships and engagement. She noted that while the federal government provided funding during the COVID-19 pandemic to boost the community health workforce, without action that funding will end when the public health emergency ends.

In particular, said Cooper, this recommendation aims to support community health workers who are deeply rooted in and trusted by their communities. Toward that end, the Departments of Education and Labor should develop sustainable and non-degree career pathways for community health workers and ensure equitable workplaces that foster diversity and inclusion. This work should be done in consultation with HHS and by leveraging the updated occupational classification of community health workers from BLS.

In addition, the third recommendation calls for expanding a national community of practice focused on scientifically informed, community-engaged practices for health equity that includes public health agencies. A national community of practice, said Cooper, would fuel innovation and research related to health equity, promote development of a holistic approach to addressing social determinants of health, and enhance communication and coordination across public health agencies and other sectors. Existing communities of practice, such as the National Institutes of Health's Community Engagement Alliance Against COVID-19, could serve as a model.

ZUBER MODERATED THE Q&A AND DISCUSSION BETWEEN PCAST MEMBERS AND DESMOND-HELLMANN AND COOPER

Prabhakar, commenting on Cooper's statement that the health care system does not address the social determinants of health, asked her to discuss the factors that determine health outcomes. Cooper replied that studies suggest the environments in which people live, work, play, and age account for more than 60 percent of what shapes health. Typically, health care settings do not address factors such as housing quality, air and water quality, and access to food. Therefore, people need a better understanding of how to navigate the challenges they face in their exposure to these different factors, and the nation needs policies that would address those factors more effectively.

Cooper noted that public health policies such as changing laws around smoking, the availability of sugar-sweetened beverages in large quantities, and changing the amount of sodium in food have increased life expectancy. However, data are needed to inform such policies, as are people who can educate communities, better understand their needs, and then use that information to inform policy that will improve lives. Prabhakar pointed out that progress in reducing cancer deaths has been driven overwhelmingly by reductions in lung cancer, which have come from gains in smoking cessation rather than improved treatments for lung cancer.

Levin asked how the report's recommendations regarding investing in the public health workforce might impact U.S. life expectancy over the next decade or longer. Desmond-Hellmann replied that though the United States excels at the "hardware" of health care, such as making a COVID-19 vaccine, it is less successful at training the people who can communicate with the public and build trust in the scientific and technological improvements. In that regard, the public health workforce is essential for building trust and translating potential scientific or policy remedies into language the public can understand.

Paula Hammond asked about the types of career paths people see when they think about becoming a community health worker and how the report's recommendations provide more incentives to become a community health worker. Cooper replied that many community health workers are people who live in the communities they serve and just have an interest in and passion to improve the lives of other people. However, most community health workers have not received formal training in health or health care. Some community health workers want to stay in that profession, and they should be able to do that, earn a living wage, and work in an environment that recognizes and values them. At the same time, there are people who enter public health through community worker training and determine they want further training or even go to medical school. The idea is to then help people see these different career pathways that they can pursue and provide them with the foundational skills and organizational support for the work they do as they are doing it. This will not be possible, though, if the funding for such programs is so

limited that people can only be employed for a short period of time, leaving them unable to pay back loans or pursue higher education.

Cathie Woteki said that her professional society, the American Society for Nutrition, has been closely examining training opportunities for dietitians and nutritionists and is concerned about the lack of opportunity at Tribal colleges, historically Black colleges and universities, and Hispanic-serving institutions. As a result, the current public health and nutrition workforce does not look like the communities in which it works. She asked how the report's recommendations would help improve those training opportunities at the two-year, four-year, and graduate levels. Desmond-Hellmann replied that the working group found it profoundly important to have continuous funding for training programs. Today, too many assets are linked to COVID-19 and so are operating on emergency-type funding. The need to have an actual position supported by consistent funding is central to having people get good at their jobs and feel they can spend their attention on their job and training, rather than searching for the next job when funding expires. Cooper added that current programs have done an amazing job engaging and attracting a diverse workforce. One issue these programs face is they need technical support to rigorously evaluate their program so they can demonstrate effectiveness and advocate for additional support.

Terence Tao asked what the primary obstacles are to retention and recruitment. Desmond-Hellmann replied that low salaries, a lack of prestige, lack of support, and lack of information about opportunities are important obstacles. So, too, is the big wave of retirements in public health professions, which makes it critical to replace those people and ensure good mentoring for the new workers coming into the field. Regarding prestige, this is particularly important if the campaign to get new public health workers is to be successful. In fact, an important purpose of the recommended communication campaign is to increase respect and esteem for public health workers in this country. In that regard, a little more public relations activity would go a long way.

Horvitz, a member of the working group that produced this report, said the group had the sense that there are deficits in the area of data and computing expertise, and he wondered how the recommendations might help attract and retain talent in computing and data science given the critical need for better data collection, analysis, and synthesis in public health. Cooper replied that data scientists are included in the recommendation to expand recruitment, retention, and training. Part of this comes down to the prestige of the public health workforce. During the COVID-19 pandemic, for example, the public recognized the important of health care workers, but there was little mention of the people who were crunching numbers to produce prevalence rates on a weekly basis or provide data on when the public could feel safe because a good proportion of their community was vaccinated. Cooper said the working group grappled with this issue for a long time as to whether to focus the entire report on data for the public health system, and while the decision was made to center the report on workforce, the report does discuss data scientists.

William Press said the COVID-19 pandemic was the impetus for people in other sciences to get to know those who were workers and researchers in public health and be impressed by the dedication of that workforce. At the same time, he and many others were struck by the fact that those working in public health received their education from schools of public health with outdated curricula that did not discuss data science, modeling, or the use of statistics. His question was whether this was an accurate view of public health education and whether there is a way to make progress in this area. Desmond-Hellmann

replied that there is a great deal of variability in schools of public health, including various tracks that are more or less data-oriented or policy-oriented. Given that, she would not subscribe to Press's generalization and believes the bar has been raised on data in public health. However, there is no doubt there is a need for continuing education or increasing the focus on data across the public health enterprise. Toward that end, philanthropic organizations have stepped up their support of excellence in data and data gathering in public health in a manner that national efforts do not always mirror.

Cooper agreed with Desmond-Hellmann and added there are many opportunities within schools of public health for that kind of training. However, once people graduate and go to work in a local public health department, they do not have a critical mass of individuals with whom they can work and learn, which is where communities of practice could help. In her view, this is less a problem of curricula at schools of public health and more an issue of ongoing professional development and the need for professional networking, including with private sector groups. She also emphasized that estimates of the needs in the public health workforce came from global health modeling studies showing the number of community health workers per population that are needed to achieve a decrease in mortality rates from cancers are preventable by screening. While this work is being done, it is not necessarily being shared across the agencies working on the front line.

Pacala wanted to know which countries are doing public health well and if there are models the United States could follow. Desmond-Hellmann replied that Costa Rica and at times Ethiopia or other countries with a public health program are considered successful. Whether these efforts can be sustained remains to be seen. Many European countries with single-payer health care do integrate public health into their health care systems more efficiently than the United States does.

For a final question, Arvizu asked if the working group considered mental health in its discussions. Cooper replied that mental health did come up as a concern that arose from the community. She noted that the community health workforce can be trained to do basic mental health first aid and to know when to refer a person to a health professional. Frontline people are needed who can help people identify when they are in crisis and get them into the health care system more quickly, as well as do prevention, e.g., by education of the public on how to recognize mental health concerns.

With the discussion concluded, PCAST voted unanimously to accept the report.

SESSION: ADVANCED RESEARCH PROJECTS AGENCY - INFRASTRUCTURE (ARPA-I)

ROBERT HAMPSHIRE

The nation's infrastructure, said Robert Hampshire, is critical to both national security and economic prosperity, and it is also essential for connecting people to opportunities and connecting communities to each other. He explained that the Advanced Research Projects Agency for Infrastructure's (ARPA-I's) mission is to catalyze the development of innovative technologies, systems, and capabilities that transform the nation's physical and digital infrastructure to ensure that the United States has a 21st century infrastructure system and reach the goal of net-zero greenhouse gas emissions by 2050. ARPA-I aims to build a future of transportation that is safe, secure, efficient, and resilient to shocks and stresses, while achieving net-zero emissions and increasing equity and access to mobility for all. It will also work

to make the nation's logistics and supply chain systems more resilient to shocks and stresses. The $1.2 trillion Bipartisan Infrastructure Law, which is being implemented within the Department of Transportation (DoT), authorized the establishment of ARPA-I.

Hampshire said that ARPA-I will leverage and build upon the business practices of the successful ARPA model that focuses on innovation-led research and developing high-risk/high-reward programs. These programs will align with the Department of Transportation's goals and include deployment and commercialization of the fruits of that research and development activity. Like other ARPAs, ARPA-I will be a highly nimble organization with term-limited leadership and program directors and that uses unique funding mechanisms. ARPA-I's goal is to ensure that the United States is a global leader in developing and deploying advanced transportation infrastructure technologies, materials, and capabilities that will enhance the nation's transportation safety and climate resilience. In that respect, ARPA-I will be to transportation as the Defense Advanced Research Projects Agency (DARPA) is to defense and ARPA-E is to energy.

CHRIS ATKINS

Chris Atkins reiterated that the idea behind ARPA-I is to engage new ecosystems of research and development to determine whether it can unleash U.S. innovation to solve persistent problems with the nation's transportation infrastructure in the same way that the DARPA created new ecosystems that have turned into multi-billion-dollar industries. He noted that transportation is the largest sector of the U.S. economy without an advanced research project agency, as well as being the largest sector of the economy that suffers enormously from a lack of advanced research writ large. Transportation research and development funding, for example, is significantly lower than federal spending on health and energy, and while the nation spends an enormous amount of money on infrastructure, an ever-increasing proportion of that spending goes toward filling potholes. In fact, one ARPA-I goal is to develop next generation asphalt that would be less likely to degrade and form potholes.

Topics of interest for ARPA-I, said Atkins, address DoT priority goals pertaining to safety, climate, transformation, and equity. These topics include materials, structures, and construction; digital infrastructure for mobility; automated surface, air, and maritime vehicles; and cross-cutting and enabling technologies. One of ARPA-I's first program opportunities, for example, will investigate an intersection safety system to reduce fatalities at intersections, which account for over 10,000 deaths a year in the United States, using machine perception, artificial intelligence and machine learning, real-time decision making, and active warning systems.

Another potential project Atkins mentioned will involve developing advanced construction methods and materials for the built infrastructure that would reduce the energy intensity of road construction, for example. He also noted that ARPA-I will fund projects for creating a digital and virtual infrastructure for vehicle and pedestrian safety, traffic management, and transportation logistics optimization for improvements to the supply chain. For traffic safety, one idea is to take the technologies that power autonomous vehicles and embed them in the fixed infrastructure at intersections to identify potential conflicts between vehicles and vulnerable road users, including pedestrians.

PRABHAKAR MODERATED THE Q&A AND DISCUSSION BETWEEN PCAST MEMBERS AND HAMPSHIRE AND ATKINS.

PUBLIC COMMENT

No oral public comments were presented.

CLOSING COMMENTS

Zuber thanked the two working groups for their hard work and getting their reports over the finish line. She then adjourned the public meeting.

PUBLIC MEETING ADJOURNED: 11:55 AM Eastern Time

SUMMARY OF PREPARATORY MEETING

During the preparatory (closed) sessions, PCAST received an overview of the President's 2024 Budget Request and a short briefing on trends in R&D spending. PCAST discussed new working group topics and briefed one another on the status of ongoing working groups. PCAST prepared for their meeting to discuss artificial intelligence with the President, which took place on April 4.

Remarks by President Biden in Meeting with the President's Council of Advisors on Science and Technology

I hereby certify that, to the best of my knowledge, the foregoing minutes are accurate and complete.

Frances Arnold, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology

Arati Prabhakar, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology

Maria Zuber, Ph.D.
Co-Chair
President's Council of Advisors on Science and Technology