



FEDERAL RESERVE BANK OF MINNEAPOLIS

Living in a COVID-19 World

On May 26, 2020, Tom Brokaw moderated a discussion with leading health and economics experts on reopening the economy safely, while maximizing health, as scientists aggressively pursue an effective COVID-19 vaccine or therapy. Below is the transcript of the discussion.

TB: Tom Brokaw NK: Neel Kashkari MH: Margaret Hamburg
MO: Michael Osterholm KB: Katherine Baicker LH: Lawrence Summers
JF: Jeremy Farrar JG: Julie Gerberding

TB: Hello, everyone. I'm Tom Brokaw, formerly on NBC News on a fulltime basis, now just part time, but it's my privilege to be with you today on one of the most important discussions that I have encountered in my life as a journalist. We're going to be talking today about what has happened in this country, what is likely to happen and what we can all do about it. I want to remind you as well, that thousands of viewers are watching now, livestream at the [MinneapolisFed.org/live](https://www.minneapolisfed.org/live), so there is an opportunity not just for a small group of people, but for this nation to be connected as it must be during this very difficult time. I want to especially thank the Federal Reserve Bank of Minneapolis and the Center for Infectious Disease Research and Policy at the University of Minnesota for hosting this event. We'll be hearing from the greatest authorities in the world. We'll also be hearing your questions as well.

But before we begin, if I may, as a matter of personal privilege, I've been a journalist since 1966; I've been through it all. The wars, the upheavals, the space disaster, the assassinations, the great changes in our country in every conceivable way. I never thought we would be going through something quite like this. Here's what we need to remember: we're all in this together. Facts matter. Individual choices are important, but not if they endanger others. We've had close to 100,000 deaths already; stop and think about that for just a moment—and then we'll go beyond this. Liberty is a coveted American tradition. It will not end with this, but liberty is not a coveted position. It's a price that is too high if the premise is a counter to the greater good. Remember, we are a united nation. We're not individuals who are making our own decisions as a risk to others.

So, to get us to begin today is a new friend of mine, someone I've been spending a lot of time with and that is Dr. Osterholm, who we met in the introduction. He is a Director of the Center for Infectious Disease Research and Policy at the University of Minnesota and

Living in a COVID-19 World

he is one of the world's foremost authorities on what we're dealing with. More than 10 years ago, he began to raise the flag and a warning that we could come into something quite like this. Alas, it has come true. Michael, where are we now and what do you have to share with us?

MO: Well, first of all, good morning, good afternoon, good evening to the audience around the world and thank you very much to you, Tom, for taking the time to bring your wisdom and your experience to this issue. I think you're right on the mark, in terms of the significance of what this is for any of us in our lifetime. If I can have the first slide, please.

Today, we're going to be talking about a journey. COVID-19: What is Our Future? And while none of us in this roundtable today can tell you with certainty what is going to happen, there are some things we do know that we need to be prepared for and understand. Next slide, please. I think to start off my very brief remarks, I want to quote two very famous Americans. Daniel Boorstin, who is a former librarian to Congress once said, "The greatest obstacle to discovering the shape of the earth, the continents and the oceans is not ignorance but the illusion of knowledge." Today, we'll tell you what we know and what we don't know. Richard Feynman once said, Nobel Prize Laureate, "For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled." Today, we'll talk about what the inevitable is, as it relates to Mother Nature and from there, decide what we can and must do in making human decisions. Next slide, please.

It is a sad commentary that over 5.6 million people have now become infected with the COVID virus worldwide. We know that more than 349,000 people have died. I'll tell you that we're in what I call the first wave of cases and what you see here is while the case numbers have gradually increased, we've seen many areas of the world that are decreasing. What we have is overlapping outbreaks of this in a local area that make up for the global pandemic and over time, you'll see they're shifting from one location to the other, just as we've seen the North American focus of infection now move south of the Equator. But, I would suspect that if this is as we think it might run, that we may be seeing the days ahead, particularly in this country, cases decreasing. Next slide.

In that regard, as Tom noted just now, we hit a very substantial and unfortunate mark today in that we've now just recorded our 100,000th death with the 1.7 million cases we've had in the United States. You'll get new cases of transmission in the United States, you can see that number decreasing, even though in some states, it is increasing. Now, we all recognize reported cases and even reported deaths are yet just a part of the entire pandemic, meaning that we know we've missed cases of infection that were not tested, we know that we've missed deaths. But, collectively, you can get the sense of the impact. To put this into perspective, 85 days ago, COVID-19 was not in the top 75 causes of death in the United States. Much of the last month, COVID-19 was the number one cause of death in this country day-by-day. Nothing has been seen like that since the 1918 Swine Flu situation. Next slide.

Living in a COVID-19 World

Now, let me just very briefly say what we know about respiratory pathogen associated pandemics. Those things that cause worldwide outbreaks are basically by breathing air and largely by breathing air. Influenza has been the Lion King of the respiratory pathogens. We've had 8 certain and likely 10 different pandemics in the last 257 years. The onset can occur anytime in the year. Of those 10, 2 began in our North American winter, 3 in the spring, 2 in the summer and 3 in the fall. In each instance, what happened was, a first wave of cases occurred often sporadic in nature, some communities hit hard, adjoining communities very few cases. The virus literally went away on its own and I say that without any understanding, as most of us don't have, of why that happened. Nothing humans did made that happen. But then, it came back and it came back typically with a vengeance in the second wave that often occurred 3-4 months later. We don't know if that's what will happen here, but we do know that the situation very well could be that. So, influenza's a model that we look at in terms of how one gets infected and it's very similar to that of what we see with coronaviruses. We also understand about immunity where a new virus comes into a community or a country that had never seen that before and no one is immune—which then gets us to the coronavirus-associated pandemics. SARS and MERS, both ones that have made the news about the world over the past 17 years, don't appear to have any of the kind of similar biologic potentials to cause a pandemic. And why? Because most patients do not become highly infectious till the fifth or sixth day of illness and we can actually rapidly identify those patients, we can isolate them, protect others from them and bring a stop to that particular localized epidemic. In the case of SARS, we can even identify the animal reservoir and eliminate that from the markets from places like the Guangdong Province. MERS is a bit of a different situation as camels on the Arabian peninsula are the primary animal reservoir. Those, we're not going to eliminate, so we just continued, basically, to suppress transmission from newly-infected humans.

So, where does this take us, though? Where are we going? This is where we have to be completely honest with you and say, we don't know. But, what we can tell you with certainty is the concept I like to call viral gravity. This virus will continue to infect humans as long as it can, wherever it can, and that's where we get into the concept of herd immunity. Far more than we need to get in today, a detailed lecture on herd immunity are not in this presentation. But, suffice it to say, the more effective a virus is in transmitting between people, in this case, this virus is a much more effective transmitter than influenza virus itself and in that case, what we know is that it's going to take a certain level in the community to result in durable or short term immunity, meaning that you have protection at least for months, to then serve as rods in that virus transmission reaction to slow it down. And with what data we have now, today, with the COVID-19 pandemic is that this virus will likely take at least 60 to 70% of the population to be immune before we just begin to slow down transmission, not stop it. It's like a plane at 30,000 feet about to descend to land. It doesn't just stop right there. So, it gives you a sense of what we're talking about in terms of where we have to go. What does that mean to where we're at right now? The best data we have supports that between 5-7% of our country has been infected with this virus. Some localized areas like New York City, it may be as high as 15-18%. When you think about all the pain, suffering, death and economic disruption that's occurred in this country to date, we have a long ways to go to get between 5-7% to 60-70%. Now, if we're fortunate, we will have a vaccine that will

Living in a COVID-19 World

help us achieve that 60-70 or even a higher percent of protection, but we can't count on that coming anytime soon and even if it does, we don't know how well it will work. We have to understand the concept of durable and short-term immunity. Will this antibody or construct of the immune response in humans last for a long time, if we do have a vaccine? How will it do even with natural infection? There are many questions. So, when we see the enthusiasm today for vaccines, it is in fact, a very important area, but I think that we must not get ourselves too far in front of our headlights and predict that a vaccine will be coming so shortly and that we'll be rescued and saved by it. We're a long ways from completing that. Next slide.

Very briefly, let me just say that to give you an idea of what a pandemic can look like, this was the 2009 H1N1 pandemic. What you see is the blue larger line that peaks in October and you compare that to the far right vertical axis. That is the percent of people who were seen in medical clinics in the United States in 2009 for influenza-like illness. And what you see is, is that early peak that occurred back in March, April and May of 2009 when the first H1N1 appeared that was this new virus, it literally disappeared over the summer and it wasn't until the last week of August, we began to see this peak occur again. And you can see it from that peak, how it rose and it was at least four times higher than we saw in the spring peak. This is the model we're talking about and as you can see from a delivery of influenza vaccine, that had little to do with bringing this down. By the time that the virus activity had decreased substantially in this country, only but a few percent of our population was vaccinated. Is this the model we'll see? Next slide.

Our center has put together a report called The Future of COVID-19: Pandemic Lessons Learned from Pandemic Influenza, with a group of notable experts from the United States. In this report, we lay out three different scenarios that might take us from that 5-7% to that 60-70%. Because we're dealing with a coronavirus, not a flu virus, we can't be certain. But, the first scenario we laid out set in these models, these are just conceptual understandings of how might we get to 60 or 70%. And the first one is just a series of these ups and down outbreaks that come and go and come and go, to get us there. These could last literally for several years.

The second one is the influenza model where you see that far left peak, which is what happened in Asia, kind of melding into the second peak, is what is happening worldwide right now, with a period of quiet, you might say, and then that much larger peak. If it's like 1918, which the peaks actually lasted for almost two years, with a very large peak in the fall of 1918, this would be by far, we believe the most devastating of all instances. My concern, which may seem somewhat misplaced, is in fact, if we were to see a big decrease in cases around the world right now that we could not attribute directly to human behavior changes, that would scare me because that would tell me that this is acting like a flu virus and maybe, just maybe we will see that big peak.

The final scenario is one where, again, a coronavirus-like situation where it just keeps burning out, it's just kind of basically a slow burn. Again, it will be in our communities day in and day out, but not any of the large big peaks and in many instances, potential suppression activities or distancing may play some role in keeping it like that. Next slide.

Living in a COVID-19 World

Let me just conclude that, as Lewis Carroll once said, “If you don’t know where you’re going any road will get you there.” Well, honestly, we don’t know where we’re going in any one of these models or scenarios, but I can tell you with the certainty of my entire professional career, we will be going somewhere. This virus will not leave us anytime soon. It will continue to transmit through our communities and we must be prepared to deal with that, however that transmission will occur. With that, I’d like to thank again the Federal Reserve Bank of Minneapolis and all the staff there and all of our speakers today and I’ll turn it back to you, Tom, and thanks again.

TB: Thank you so much, Michael. We so appreciate not just your appearance here today and your continuing good work, but your availability to the sources that so many people rely on across the electronic spectrum, newspapers and prints as well. One of the big differences between now and not so long ago, is that people do have access to information in a way that they did not. I went back and looked, for example, at what happened in this country in 1918 when we had an out of control true epidemic and the people didn’t have access to anything. It was kind of word of mouth, the best they could do. Now, obviously, we do have opportunities because of you and all the work that’s going on.

And speaking of that, our next speaker is going to give us even more to think about and I want to introduce him to you now. He’s becoming, like you, another very familiar figure in American life. He comes to us from Great Britain, Jeremy Farrar. Sir Jeremy Farrar is the Director of the Wellcome Trust and Infectious Disease Research who has studied H5N1, Ebola, Malaria and Dengue Fever, among others. The Wellcome Trust supports research and collaborative efforts to prepare and respond to epidemics. So, Jeremy, such a pleasure for all of us and a privilege really to be able to hear you today because of your wide range of interests and commitment to what we’re here talking about. If you would, please.

JF: Tom, thanks very much indeed and it’s a huge honor to join you and a real privilege and to follow Mike Osterholm, who’s been a good friend for many, many years and just to praise Mike’s leadership in this whole area in emerging infections over many, many years. Very warm thanks to the Federal Reserve Bank of Minneapolis, the science departments at the University of Minnesota, but also what this conference brings together is really crucial. This is clearly a health issue at the start, but unless we see this as a health issue in the context of society, in the context of economics and in the context of the changes that it will bring about in all of our societies, I don’t think we can truly appreciate what’s going to happen and I think framing it in that way by bringing together the Federal Reserve Bank of Minneapolis and science and society, is the way that we will start to see this. And with Mike, as was just beautifully illustrated, this is not about to go away. This is now a human endemic infection, but we will have to find ways across the world of living with, of countering and making sure that we can reduce the impacts of it. And so, you framed it very nicely, to start with your career, which obviously I’ve watched from a distance with huge admiration.

And when you look back in history, you read history books and you look back, yes, at 1918 over 100 years ago now, you read those history books and you marvel at what

Living in a COVID-19 World

happened, the leadership from certain people, the mistakes that were made, but when you're reading them, you almost get a sense of this sort of romantic period in history. The truth is, when you're living through those eras, it is incredibly difficult. It's hard, the social distancing that we're going through at the moment is difficult. Mental health issues are huge. We all have lost loved ones or family and friends that have died or have been affected by this. Living through these periods is very difficult and we have to live through them together because there is no way out of this unless we're joined up, unless we think of this together, both as a nation in the United States, but also in the world and we come together to try and find solutions from it.

The way I've always framed emerging infections and living for almost 20 years in Vietnam and going through SARS and then as you say, Bird Flu and many other epidemics, I think the best way in my mind of framing this is, in the middle of this, is the infection itself: in this case, COVID-19 and the health implications of that. In another ring around it, you have the broader health issues that are affected by it. At the moment, in hospitals around the world, people with cancer, with diabetes, people who are having children and being cared for, for every reason, this COVID pandemic is affecting their healthcare as well. Operations are being canceled the world over. People are fearful of going to hospitals. When the epidemic starts to wane a little bit, we will see a huge rebound in demand for healthcare in every society. And so, there is a secondary consequence, which is the impact beyond COVID of all of our health and particularly, of course, for mental health, it's a particular challenge.

Then there's a third ring around that and that is the impact that this infection has on society. It has an impact on economies, on jobs and a huge number of people, tragically in America, have lost their jobs through this. Some of those jobs may not come back or different jobs will come back and so, it's not just a health issue; it's not just a broader health issue; it's now also a societal issue with impacts on economies, with impacts on politics, with impacts on trust between the government and the governing. What is society there for? What is government there for? And this will force us to rethink all of those issues and come out of this in a better way.

And the final thing, which I think we cannot underestimate and we cannot avoid talking about and that is the international relations that come from this. The geopolitics, as we know, is tense at the moment between all sorts of parts of the world and those will be affected by how we think about this, how we deal with the pandemic and how we address it and how hopefully, at some point, we come out of that and it will have consequences for all of those activities.

To get back a little bit to COVID-19 and the central circle of this issue and Mike has laid it out very beautifully. If I was teaching in a university program and somebody asked me, what would you be most frightened about in December of 2019 before this started, what I would describe is an animal infection that jumps across the species barrier into humans and the human population has never seen that infection before and so therefore has no immunity, but that infection passes very easily from one person to another and in fact, from one person to more than one other person, the famous R_0 of this infection is three people. That means if I have it today, I would pass it to about three other people and that

Living in a COVID-19 World

causes an exponential rise in the epidemic. We have no human immunity, but if I had it today, I could pass it onto somebody else whether I was asymptomatic, whether I had symptoms and even when I was maybe one or two weeks later starting to recover, I may still be able to pass it onto somebody else. In other words, a long period when you were infectious. But, the virus was bound to the human receptors in the nose and throat and in the lung, with a very high affinity and therefore be able to get a hold within the human body and then replicate and cause all the damage it can do. And finally, we would have no diagnostics, we would have no treatment, we would have no vaccines and because of the transmission, we wouldn't know quite how to deal with it. It isn't flu; it's different to flu and it's different to SARS; it's different to MERS; it's different to Ebola. And you have to work all of this out in the early days of the epidemic in order to put in place the public health measures that will make a difference.

And just to remind everybody, we're at about 140 days into a completely novel human infection. 140 days ago, we had no idea of this virus; we had no idea that it would cause this sort of issue. That's how fast this pandemic has taken hold. Within 100 days, it was effectively in every country of the world. And we are, as Mike said, just at the start of this. This is not going to disappear like SARS. This is now something which is endemic in the human population and we will continue to learn about in the weeks and months ahead, truly tragic things that America has gone through its now 100,000th death and speaking as an outsider, all my thoughts are with the families, the healthcare workers and friends of people that have tragically lost their lives during this pandemic. But, even barring the deaths, there is the illness caused by the infection, there's the social isolation that comes with physical distancing and then, issues that we've only just started to appreciate which is the long term consequences of infection. Certain friends of mine and family members who have been infected find themselves sometimes 6, 7, 8 weeks after infection, although they've recovered, they still don't feel back to normal and that is something we will continue to learn about going into the future.

Although some parts of the world, parts of the United States, parts of Europe are now starting to see a slowdown in the number of new cases, we also have to appreciate that when you go into an epidemic, it's challenging enough. You make very difficult decisions to introduce physical distancing, lockdowns and other issues. But, coming out of it is even harder. The data is less certain, when you go into the epidemic period and the lockdowns and the physical distancing, those issues are almost forced upon you because you can see the impact it's having on people's lives, the deaths, the number of cases coming to hospital and those metrics are relatively easy to measure. What we don't know is how do we come out of it. How do we lift those restrictions and how do we do so safely in order to get people's lives back to something close to normal? How do we get economies moving again and how do we prevent the rebounds and the second waves which come, the autumn and winter months would be devastating in every country?

And in my opinion, the only exit strategy from all of this is through science and it is through collaborative international science that a sharing of data, a sharing of drugs and vaccines, if and when they become available, to make sure that when one country can produce and manufacture these incredibly important inventions that everybody in the world will benefit. And I think the science comes around to five things. It comes around

Living in a COVID-19 World

to public health and we must always make sure that we invest in public health for the long term. You never know when you're going to need public health. It prevents things and people don't get the credit they deserve for working in public health, but when you don't do it, you then see events like we're witnessing today and you realize the limitations when you do not have very strong public health institutions. Social science is crucial, but the moment, with the non-pharmacological interventions that are driving down R_0 and allowing the number of new cases to reduce and understanding social behavior, understanding how people respond to physical distancing, is absolutely critical and social science is a critical component of our ability to prepare and respond to these epidemics.

And then, of course, diagnostics, treatment and vaccines and the ability to test, to trace, to isolate and so keep the R_0 below one and keep the number of new infections down. And that science has to be smart. We don't have time to do everything. We have to be smart about the science we do, we have to be willing to share it across borders and we have to be willing to come together and pool the risks of science and pool the benefits that we hope will accrue from it. I believe that that is enlightened self-interest. I do believe in vaccine nationalism. I don't believe that any one country will be able to provide all of the answers to this and the innovation and the research and the manufacturing may well not come from traditional places. It may come from other parts of the world and we all need to benefit from it and so therefore, international partnerships, for me, are absolutely critical.

And then thinking along to the panel discussion, it's great to see a number of friends on there as well, which I look forward to debating this. We then have to think what sort of world do we want when COVID hopefully starts to wane into our memories. What sort of economy do we want? What sort of society do we want? What sort of geopolitical institutions and organizations do we want for the future? Because when it hit the world and humanity has faced these types of crises, you can come out of them and you have a choice and we will have a choice when we come out of this crisis. Do we want to build a world that we want to have for the 21st Century, that will allow us to address the key challenges of the 21st Century, which are, by their very nature, international, whether it be climate change or pandemics or drug resistance or mental health, we cannot answer any of these on our own. We have to be able to work in partnership. And I think when we come through this and hopefully science will point the way to coming out of this pandemic, then we will have to ask ourselves what sort of world we want. What sort of jobs do we want to recreate? What sort of public health structures do we need? And how can we rebuild our societies and systems to allow it to not allow the fragmentation and to not allow the gaps that have been accentuated through this pandemic because as Tom said at the start, it affects us all. The truth is, it hasn't affected us all equally and I fear that inequality that is prevalent in many of our societies is a fault line that we must address because pandemics like this and other crises tend to accentuate those fault lines rather than smooth them over. And that is the sort of world I think we need to build if we're going to address the great challenges of our time, which include pandemics, but also address the issues of trying to change social inequality, mental health, drug resistance and a number of others, which can only be solved by working together. So, with that, and an

Living in a COVID-19 World

optimism, I think about redefining that future, Tom, I'll hand it back to you and happy to stay for any questions or be involved in any discussions.

TB: Thank you so much, Jeremy. There are so many things that I'm eager to ask you about beginning with, what kind of a world, especially in an urban area, are we going to have for the workplace? Already there is discussion in New York City and other areas where there's a high density in one area, that there will have to be a redistribution of the workplace, that people not be going to those towers on Park Avenue in the future or other places like that. Do you see that as a critical component in how we reorganize our lives and our economies?

JF: I do. I think, again, as in the UK and Europe, as well as in North America, these conversations are going on now and it's almost unthinkable to me now, living through a lockdown here in the UK, that I would get onto a completely full commuter train every morning for an hour or so and go from Oxford into London with hundreds of other people and it almost feels countercultural now to think of doing it. I think people are starting to ask whether the office will be the workplace of the future. The technology companies, that we're lucky to have because we couldn't be holding this conversation five or ten years ago, they will change, I think, the way people see the workplace social interactions and the advanced economies and the cities and the mayors and scientists that lead this will have to rethink how do we rebuild that for the post-COVID world? And I think that the ones that start thinking about that sooner and can offer a slightly different future, which takes into the fact of fear and other things that will come from this, will be ahead of the curve and I would not want to be left behind in those discussions.

TB: Let me ask you another question. This comes from Debbie Goff of Ohio State University, that's beginning to get mentioned. The death, the collateral deaths from COVID-19 during social isolation, she says, for example now, that there is a fair amount of evidence that people are dying, not just from COVID, but also from suicide, drug overdoses, domestic violence, heart attacks. Does that affect, in your judgment, the big picture about how many people are dying from COVID and then does it trigger, if you will, ancillary causes of death?

JF: It absolutely does because I think the best measure, I'm a clinician, not a public health person, if you can separate those two, but I think that the most important measure of this is to look at the deaths that have occurred in this time in totality, both those directly caused by COVID directly and then that have been tragically brought forward earlier than they should have done by the impact on the broader health system. You mentioned domestic violence. It's a huge issue about closing schools. Some children, the only safe environment they have and they live in very difficult circumstances, the impact on their education opportunities is huge. The fact that people who need surgery, who have cancer, who need diabetic control or others are frightened about going into healthcare facilities the world over. That has a huge knock-on effect and to me, that's the second circle in these four concentric rings, is the broader impact on health. And we hope that we come out of this first wave of the epidemic in the coming weeks and months, that will be a demand that is going to come back into the system immediately and our hospitals and nurses or doctors ready for that when they've been working so remarkably hard for the

Living in a COVID-19 World

last three or four months, often not seeing their families and working in very dangerous and worrying conditions. So, I think the knock-on health consequences—yes, death, but also not death, long term illness, is very, very profound and underestimated.

TB: You are the authority on this. I'm just an outsider who travels the world, pays a lot of attention to the kind of conditions in which we now live, but it seems to me, as the world becomes ever more crowded, ever hotter and it becomes less able to deal with these kinds of unexpected arrivals in our midst, that we're going to be dealing with as not just as something that happens once in a century, but more often than that. Are there issues out there now, conditions that give you great pause and concern about the next kind of COVID, if you will, that we're not now paying attention to?

JF: Yeah, it absolutely does. If you just look at the 21st Century, we're only 20 years into it and without thinking about it, we've been through a Nipah virus outbreak in Malaysia, now Bangladesh, SARS, which everybody will have heard of and MERS in the Middle East. We've had a resurgence of Ebola, we've had the coming of drug resistance and we of course, had the pandemics in 2009 of influenza and now we've got COVID-19. It is not a coincidence that all of those have happened in 20 years. It is not an issue because we've got better surveillance. It's not an issue that is just random. It is because there are key drivers within society that are both more likely and more complex. And I believe that's a combination of the human-animal interface, the changing ecology. Yes, climate change is playing a role in this. It's the way we live in very dense, huge urban centers that are very closely connected with transport, nationally and internationally. And so, you have that coming together of everything which both allows the emerging infection to appear and then get established in a population which is very big and then can travel around the world within 12-24 hours. So, I think we're seeing the more frequent and more complex because of the way we live together than was true throughout most of the 20th Century. And we can anticipate that this will happen more frequently in the coming decades of the 21st Century.

TB: As you know, in the United States, there is already some political resistance to what we're going through now and how to deal with it. Do you feel that you and Mike and others in your field are able to get through to those who say, I like the way we were living before, why do I have to change? And how do you go about doing that? What's the best way for all of us, frankly, from a political, cultural, scientific point of view, to kind of rally around the reality, the truth that exists out there?

JF: Yeah. I think the best piece of advice anybody ever gave me is never comment on another country's politics because you're bound to get it wrong. So, I'll concentrate on the UK and you can decide if it has any relevance to the United States. I think we are going also through a dangerous era where people question science. I think some of it is just scientists as a whole have stayed in their ivory towers for too long. We need to get out and communicate. We need to share our experiences. We need to show people we're human. We make mistakes. Certainly, in the UK and I think it's probably true in the US, nobody could claim that we've dealt with this pandemic as well as we could have done. We knew warning signs were coming and we didn't respond as well as we should when it then came. And there are some facts which are undeniable, that the world is changing.

Living in a COVID-19 World

Population density, climate change, drug resistance and as I've said about emerging infections. We have to put that in a way which just doesn't speak to ourselves in a clique, living in an ivory tower and getting out. We have to go out there and make those cases in society, in the media and amongst politicians. Because I do think if we don't do that, that vacuum will be filled by others, with other agendas that I don't think meet the facts of today and that's not a civilization, that's not a society that I think can go forward. So, we need to get out there and make the case and again, just give praise to Mike because he's done this for years now to great effect, not just in the United States, but around the world.

TB: As they say, there's the rub. How do you do it? People like you and Michael and people in your field, when we have this very dramatic example of how quickly things can go wrong and how we didn't have any idea, we had no idea that this was just over the horizon, if you will and landed in our midst and it's not going to go away soon and yet, there's resistance, frankly, to the facts of reality of what we're dealing with. So, what does that take, beyond the science of the community, beyond the political? In this country, of course, we're going through a presidential campaign, which only heightens the resistance and the differences that exist, but how do you go to, as scientists and as social people and for that matter, big political and economic forces, how do they begin to say, we're in a different time, folks?

JF: Well, I'm an optimist. With every crisis, comes a reevaluation and as I said, at the end of my comments, every time in history, when the world has faced these crises, there is, afterwards, there is an interrogation of it, there's lessons learned and then the world faces a choice. Do we want to go into a more polarized world or do we come to appreciate the vulnerabilities and threats and we all define them differently, but there is no doubt in the 21st century, we face some real threat to humanity. And this is an example of that and as we come through this and eventually we will come through this. I do believe that through social science and through biomedical science, we can come through this, but when we do, we will face a choice about the sort of world we want to live in and I think we have to face up to the facts that are now obvious to us. This must come out of this crisis as a lesson and we must use our voices to make the case. I would say that I think, out of this as well and through the United States, we've watched scientists on our television programs here and they've been respected. I think they've been listened to and I think that gives an opportunity to build on that, to make the case that science is a part of society, it's a part of our culture and critically, it's a part of our civilization and it's got to be a part of our future.

TB: So, Jeremy, so many great things, so much gratitude to you for sharing your vision, your expertise and how you've gotten us to this point and I do hope that we'll be hearing a good deal more from you in the future on where we go next. So, thank you very much for being with us today and we look forward to seeing more of you in America on all the various media that exists out there.

JF: Thank you.

TB: I now want to bring in one of our hosts today, Neel Kashkari, who is the President of the Federal Reserve in Minneapolis and he's going to have an expert panel of people both in

Living in a COVID-19 World

the world that we've been talking about, but also in the social world and the economic world because this virus and what we're going through touches all parts of our lives. So, Neel, thank you very much, first of all, for being our host here today and arranging this and allowing us to use your facilities for it. Now we look forward to what you're going to be able to do with the panel that you have before you and how much we can learn from them as well.

NK: Thank you, Tom and thank you, Jeremy and Mike and everybody for joining us. We've got a great panel. We're a little bit ahead of schedule, so not all of our panelists are with us yet and I know we've got a bunch of questions that have been coming in off of Twitter and so maybe, Mike, if we could bring you into the conversation with Jeremy and Tom, maybe we could turn to a few of those questions and answer some of those while the rest of our panel has come on. So, I think, Mike, one of the first questions I saw was to you. Given an explanation for these big second peaks that come in the fall and these flu pandemics, why do they happen, why does it go dormant and why does it pop back up again?

MO: Well, let me just say with as much honesty and sincerity as I can, the older I get, the less I know. I knew much more about influenza, for example, 10 years ago than I know today and I think that's what we have to share, openly and honestly with the public is what do we know and not know. No, we don't understand why pandemics do what they do. We all are very familiar with seasonal influenza, for example. And we just count on it, our winters here in the Northern Hemisphere and the winters in the Southern Hemisphere will result in influenza epidemics each year. What we don't often understand is why we see transmission of the virus year around in the tropics. Why, in those 10 different pandemics I mentioned to you, which started in winter, spring, summer and fall, have this offset peak, 5-7 months later? We don't understand any of that and I think all we're doing right now is trying to understand from history, what models or scenarios unfolded to then anticipate what this might look like. I think, as you've already heard of Jeremy surely helped to reinforce that is that with this coronavirus, we're in uncharted territory, it's new. We don't know what this might do and all I can tell you is we all agree, I think in the infectious disease world, it will do what it's going to do. It won't stop transmitting and whatever our plans are for responding, they have to account for the fact that this virus will keep spreading widely throughout our communities. As we gain more information, we need to share that. For example, there have been a number of reports that somehow the virus had changed and that in fact, we've seen enhanced transmission. We saw that it was killing more effectively. None of those which actually bore out, the data do not support that. We've had issues around where the virus comes from. The data are quite convincing that this was an animal to a human situation that occurred, not in the context of a laboratory or an intentional act, but it was another example of Mother Nature in charge. And I think that's what we have to count on right now is what can we tell people with certainty and what can't we? And one of the things we can't tell us is why do these viruses do what they do, but we know that they do it.

TB: Run that by me again, so I absolutely understand what it is that you need to hear.

Living in a COVID-19 World

MO: Well, I think, in terms of this issue here, what we're talking about is if the virus itself, why do we see it do what it does in terms of a second wave? Why would it go away? Where does it go, what does it do? Why would it not continue to keep transmitting just on and on and on? Why do we have this potential break between a first wave and a second wave? And if we look at influenza, which is the only other good model we have to look at this, the other coronaviruses don't really give us the same information, is we don't know. Why do we have seasons for flu? Why do we not have seasons in the tropics? Why, when pandemics occur, do we see this, whatever time of the year it first appears, why do we have this second peak six to seven months later without regard to the seasons?

Think about 2009, a milder influenza pandemic, but it emerged in March and April into May in North America having arrived first from Mexico and then through much of the summer, the activity was minimal and then all of a sudden, as I showed you in that slide, late August into September, October, we saw a peak come up again. Early on, when that peak started to rise a second time, it was occurring in Southeast United States when the temperatures were approaching 100 degrees. That's not like a North American winter. So, that's what I don't think we understand and what we were really telling the audience here is that this is not going to stop. This will continue transmitting. What I can't tell you is how it's going to get there and I think that's the message that people have to understand, that this is not going to go away and it could be a much more severe presentation if all of a sudden, we see lots of cases occur at once. If anyone here can imagine if you have 100 patients presenting to a hospital in one day, that's one thing. If you have 100 patients presenting to a hospital, 10 a week for 10 weeks, that's another thing. And so, what we're trying to understand is, what might that model look like and we just don't know. And Jeremy has spent a better part of his career working with influenza, knows this well and understands the wisdom of trying to tell you what a flu virus will do when we just don't know.

TB: The modeling, it seems to me is as an outsider and someone who struggled with sophomore biology in high school, the fact of the matter is that what you just put your finger on is what I think puzzles so many people, given sanctuary to a lot of them. Well, we don't enough about it, so we're just going to go on with our lives and I think the most important thing that you can do and that we can do as a communicator to the general public is to say, we don't know, you can't make these assumptions. I was going back, as I said earlier, and looking at what happened in 1918 when people were suddenly swarmed with what was going on and they didn't know what to do and then they thought they had it under control and then it came back the second time and a third time, as I understand it. So, it seems to me that what the public is longing for and I would guess that all of you as well as scientists is, where do we find the key about how we can tell how it may behave and it may not be possible because of the nature of what we're dealing with. Is that wrong?

MO: No, I think you're right on the mark, Tom. I think the issue we have to do is just be honest and straight talk. Just tell people what we know and don't know. We surely can understand directly and we can know the impacts this virus is having. I think Jeremy did a wonderful job of laying out the various rings of impact that this virus has, but at the same time and I've always been someone who's believed, as an epidemiologist who has

Living in a COVID-19 World

had a fair number of graduate statistics classes, that all models are wrong and that some just give you more useful information. I think we have been fixated on these models here in the United States and not that we don't want to try to be informed or better informed, but you've seen the predictive value of some of these models and how they've changed.

What I'm telling you as a model is, it's not about change, it's about the fact this virus will continue to transmit, it is going to keep finding every human it can between now and the time we either develop a vaccine and we are able to stop transmission from that regard or until we get enough people who have been infected who are sick, who die and then we'll have that. I just keep reminding people when you're planning, when you're thinking, when you're anticipating, remember with about 5% of US population having been impacted with this virus to date, we still have a long ways to go to get to 60 or 70% and think how much pain, suffering and death, as well as economic destruction we've had. Now is our time to plan for the rest of that 55-60% that's going to occur. How are we going to address that? And if we just plan for today or next week, we will not be planning for that and that's what's critical and that's why we're actually here today, to talk about the partnership and how do we move forward and again, I just come back and say, I think Jeremy covered it so very, very well, what we need to be anticipating for the future.

TB: Well actually, what's going on in Brazil right now, for example, I've been to the favelas in Brazil, I've been all over that country. When you light the torch there, there's no containing it, it seems to me. So, how does that affect, for example, South American economies? How does it affect air travel? How does it affect the investments that people may have in this country in Brazil that have nothing to do with Brazil itself, it's just a market for that and that's what I don't think that we're dealing with enough, you can't deal with this just as a singular, if you will, phenomena that's going on. It has many, many parts to it and many legs to it that can travel so swiftly to so many places. It's kind of a global, if you will, approach to that.

MO: Yeah, I think Jeremy may have wanted to comment. Did you want to say something?

JF: Yeah. The epicenter for this pandemic is now Central and South America. I would predict...Mike's comment about predictions are very true, but we have to start trying to think globally. The pandemic hasn't really even taken off in Sub-Saharan Africa yet. It is smoldering. I spoke to people in Cape Town and Johannesburg today. The numbers are starting to go up exactly as you described, Tom, in the informal settlements around Rio and Sao Paulo and Lima in South America. Those similar settlements and worse, are very common in Sub-Saharan Africa and hygiene is difficult, density of populations is difficult. If this pandemic goes through the continent of Sub-Saharan Africa, we are going to face a human catastrophe. That is important to health, it's important for economies, it's also a security issue because you mentioned this pandemic getting into refugee camps or into migrant camps or into prisons, in the Middle East, in Yemen, in conflict zones, in Syria and until we have a global solution, which we don't have today, we need to be humble and have humility about this, we do not have a solution. Everything they're using at the moment was there in the 19th Century. This will continue to reverberate around the world, which is why I go back to this sense of an international

Living in a COVID-19 World

response rather than seeing this through the lens of one country because it'll keep returning.

TB: We'll just take your time for one more question here, which I think is an important one that has just come in. What about restructuring? Not just in America, but around the world, all the workplaces, all the places where people gather and aren't they going to have to be re-designed in a lot of ways, about how ventilation works, about where you can put people and then what kind of a congregation. This is a more profound, if you will, realignment of the world than just wearing some kind of a mask over your face or dealing with some kind of a quick fix when you go out. I think that we have not yet caught up, at least in my judgment, about how profound the rearrangement of all living spaces and all commercial spaces are going to have to be.

MO: I think this is such an important point and let me just add some clarification to this. There are far too many people in this country today that believe that this is just a disease of old people in long term care, people who work in meat packing plants, people who are in prisons or in drug treatment facilities and those few who are on cruise ships. Let me just make a point that is really I think a very essential point. For those who think that this pandemic will never touch them, I hate to say this, but your time will come and what I mean by that is, every family will be touched by this. What's happened early on in this pandemic in North America as well as in both Europe and Asia is the fact that we have, what we call congregate living or congregate work areas and what happens, if you have 1 in 500 people infected in your community, but that one person happens to work in a long term care facility or they happen to have been a visitor there and they were infected, that gets into those facilities and it's like a match to a gas can. Suddenly, you see major outbreaks, you see many, many deaths. This is true in the meat packing plants, everywhere, prisons and for a long time I think people felt like this outbreak is going to touch me, but maybe it's not, maybe it's just those people and we are, in a sense, burning through those facilities. That's a terribly painful thing to say because as you pointed out, these are real people's lives. So that to the extent that we have a situation today, once these happen, the cases will ultimately become really much more of a function of all of the rest of the community. It won't just be in that environment.

TB: Neel, I think it's time for you.

NK: Thank you, Tom, thank you Mike and they're all staying with us—Jeremy—a great kickoff to this conference. Now, I'm very excited to introduce our panel. As Jeremy mentioned, we're trying to bring together a healthcare conversation and an economics conversation. We want to merge them and have one conversation because we have to address these issues together. So, we said, let's bring together some of the very best economists in the world and some of the very best health experts to tackle some pressing issues. So, let me very briefly introduce our panelists: Dr. Katherine Baicker is the Dean of the Harris School of Public Policy at the University of Chicago. Dr. Julie Gerberding, Executive Vice President at Merck and the former Director of the Centers for Disease Control and Prevention, Dr. Margaret Hamburg is a Foreign Secretary of the National Academy of Medicine and a former Commissioner of the Food and Drug Administration and Dr. Lawrence Summers, Economics Professor and President Emeritus of Harvard

Living in a COVID-19 World

University, former Secretary of the Treasury for President Clinton and Director of the National Economic Council for President Barak Obama. Thank you, to our esteemed panelists for all being here today. It's great to have you with us.

Restoring the economy is going to take arresting the virus because ultimately, how do we get back to a full steam economy the way we had it in December or January? We all have to feel confident. We have to feel confident to take our families back out to restaurants, to go back onto a bus or a subway or an airplane or to go to a movie theater and what's going to give us confidence, ultimately, is arresting the virus. If there is a breakthrough in testing, where we have widespread testing and we'll talk about what's possible, so we knew who had it and who didn't. If we had a breakthrough in therapy so that if we got sick, we could go to the hospital, we could get treated and we could recover without serious health consequences, that would give us confidence. Or if we had a vaccine, an effective vaccine where we reach the herd immunity that Mike talked about 60-70 plus percent, through a vaccine where you get a vaccine and then you're safe, that would also give us confidence. So, anything that we can do on those fronts will accelerate the economic recovery.

So, in this panel, we're going to have two big picture questions and I want to go into them in as much depth as we can. That's why we've recruited these experts to be with us. One is -- what can we do to accelerate a breakthrough in either testing, therapies or vaccine? I'll call that technology development. Anything we can do to accelerate that would be money well spent. But then the second half of the discussion, if we do all those things, science is still hard. It's still hard to predict science, it's still hard to accelerate scientific breakthroughs. If we do all those things and we still don't have a breakthrough for a couple years, what do we do then? I think we've learned in the last few months, there are extraordinary economic and health costs to shutting down the economy. We can't simply shut it down for two more years until we get to herd immunity. How can we reopen safely? And then I want to have that discussion with our economists and our health experts. How do we reopen safely while we pursue those breakthroughs? So, that's the big picture. I'm going to encourage a lot of discussion within the panelists or between the panelists themselves. I'll let the experts listen and respond to one another and I'm excited to get going. So, I'm going to start us off by asking Larry Summers to kick off. He's been talking about the need for a massive investment in trying to pursue these breakthrough technologies. Larry, please kick us off and then we'll turn to the other panelists to respond to your ideas.

LS: Thank you very much, Neel. I would make four or five observations. First, a vaccine breakthrough or therapy breakthrough is worth it at any imaginable price. In rough numbers, this is costing the American economy \$80 billion a week. If you add in the health costs into that much more, \$80 billion a week is more than \$10 billion a day. And so, if by doing strategy A rather than strategy B, we reduce the expected length of this pandemic in the United States by one day, that's a \$10 billion return over a very short period of time and so, if we spend \$8 billion and we reduce the return by one day, that's a better investment than the vast majority of the investments that we make. If we add in the health consequences, the numbers probably increase by 50-100%. If we add in the fact that a breakthrough in the United States would be applicable very broadly around the

Living in a COVID-19 World

world, that produces another doubling. So, the first principle is that nothing about the expenditure of money is any reason for any constraint on what we do in order to succeed.

The second principle is, the principle that countries implicitly recognize during a war. When something is necessary, you don't try to procure it efficiently. The Manhattan Project pursued two entirely different strategies for producing a core of fissile material, each at a cost that today would, in today's dollars would be in the billions of dollars. There was the very real possibility that both would succeed, but if they both succeeded, that was a high class problem compared to the problem of not having a solution. And so, they went full-bore at both solutions recognizing the possibility of redundancy. And so, redundancy is irrelevant if it is marginally productive, is the second broad principle that should animate our efforts. That means that vaccines should go into production before they have been proven fully to be safe and efficacious. That means that drug therapies should go into production before they have been proven to be safe and efficacious. And so, those principles need to inform our procurement efforts rather than the normal principles of not overpaying, not doing things that are redundant and checking for evidence of success and staging as one makes investment.

The third principle—and this is elementary economics—if you want people to do something, you have to either give them a very big prize for success or very substantial insurance against failure or some combination of the two in order to have success. You can't give them a normal return if they succeed and expect people to do things that have only a limited probability of success. My judgment in this case, because redundancy is good and because promises to provide big prizes in the case of success are not likely to be credible and because it will be somewhat problematic to overpay for a lifesaving vaccine or therapy after the fact, is that the government needs, with respect to things that are even remotely credible, to provide very substantial downside insurance against a given strategy not being selected.

My fourth observation is that forming a research portfolio is like forming an investment portfolio. You need to think, not just about return and risk, but you also have to think critically about correlation. An alternative, a supplementary vaccine strategy that has a 30% chance of working, but has no correlation with the other strategies that are being pursued, adds more to the ultimate probability of success than a strategy that has an 80% chance of success, but will succeed or fail along with the other strategies. That's just a simple mathematics of independent events versus dependent events with probabilities. And so, we need to be going for all kinds of strategies including substantially unorthodox strategies as we go.

Two final words. Testing is in a somewhat different category than vaccines and therapy. If we had a vaccine that was universally applicable, we'd solve the problem. If we had a pill or a shot that cured you when you had COVID and would, for the foreseeable future, we would have solved the problem. It's more complicated with respect to saying if we have a test, we've solved the problem, but at the extreme, if we could costlessly implant a chip in everyone that would ring on a central registry at the first instant when they had COVID, that would solve the problem, essentially also because such people could be taken out of circulation and when they were taken out of circulation, there then wouldn't

Living in a COVID-19 World

be any further spread. The problems all come from the fact that you can't test continuously, they come from the fact that the people may not act on the tests, they come from the fact that the people may not respond, the tests may not be entirely accurate.

All of that said, I think the biggest change that I've had in my views about all this in the last month has come from the data on mobility and the data on spending, which I read as suggesting that people's behavior is less influenced by government lockdown mandates, than I would have expected and that people's behavior is more influenced by their fear of the virus. Consumer spending is down almost as much in Sweden as in Denmark. It's down essentially and follows essentially the same path in New York state and in Georgia. And so, I am increasingly impressed by decentralized response to conditions as they assess it. And I suspect if we have pervasive feasible testing by which I mean, you don't have to stick a swab up people's nose and make them gag. You don't have to wait four days. The whole thing is inexpensive. My suspicion is that all kinds of innovation will be generated by employers, by shopping centers, by transportation carriers, in terms of getting test results and then acting on them. So, the pervasively available cheap saliva, capable of unskilled or self-administration test, I think in ways that we can't fully predict, if such tests could be marketed at a cost of \$2, I suspect that there would be much more progress than most people now imagine and can envision. And so, I would put that as an extra priority for urgent research. Government should use the term, Manhattan Project to highlight the gravity. It should commit resources on an entirely different scale than people are now thinking of. As a rough rule of thumb, if we're not investing 1% of every recovery package in health innovation investments, that are about therapy, vaccines and tests, we're surely making a mistake and if somebody wanted to argue that the right number was 3%, I probably wouldn't take on that argument. But, if I look at the Cares Act or the Heroes Act, we seem to be falling way, and I think crazily short of those targets in our thinking and planning. Thank you very much.

NK: Thank you, Larry, that's a great kickoff. I'm going to turn to Julie here in a second. Just a few facts that I read about, as I was preparing for this. Today, the US has tested around 400,000 people per day, which is up from around 200,000 per day a month ago, so that's some progress. But, a month ago, some Harvard studies said that we should be testing 5 million per day by early June. We're not even at 10% of that level and they said we should be at 20 million per day by late July. On the flipside of that Wuhan, China reportedly tested 10 million of their residents in 10 days, so they seem to have scaled up testing to a much higher capacity than we have in the US. And then turning briefly to vaccines, reportedly there are more than 100 vaccines in development around the world and apparently, 10 or more are now in some form of human trials. So, Julie, you're a senior executive at Merck. You ran the CDC for many years. Would love to get both your reaction to Larry, but also your own ideas on how do we accelerate a breakthrough in any of these technologies?

JG: First, thank you so much for putting this panel together and for bringing up these provocative issues. I think the time is just perfect for that. I really appreciate Larry's remarks about the war metaphor here. We are fighting a war on this coronavirus. We're fighting it on two fronts: the scientific front, which is about vaccines and treatments and testing, etc., but we're also fighting it on a strategic front, which is really, how do we

Living in a COVID-19 World

kind of finesse keeping our businesses running and our economy operating to a better extent than it has in the past several weeks and not doing that at the expense of an acceleration in casualties and the morbidity and consequences of what we're dealing with.

Now, the phase of the pandemic that we're on right now is sort of generically referred to as the mitigation phase, but if you go back and read the doctrine that underlies the approach to managing a pandemic, during mitigation, you really are trying to do two things. One is you're trying to slow down and reduce the area under the curve of the morbidity and mortality, but you're also trying to sustain civil society and I think we can do the former, as we've proven. Our social distancing measures around the world really have had an impact and have helped with hospital surge, but we haven't been very successful at the latter, which is figuring out how can we do this and still maintain the essential services that go beyond healthcare delivery into broader segments of our society. And what I think we're facing right now is that balancing point where yes, we can perhaps improve our ability to conduct business and get more people back into the work environment contributing to the economy, but that will come at the price of hotspots. And the question is, can we identify those hotspots and tolerate them in the sense that that is the highest priority for using the tests that we do have, testing symptomatic people, testing their contacts and people they may have exposed, quench and contain those hotspots much more quickly than we've done in the early phases of this so that we can, instead of having broad societal lockdown, we can lock down in a much more focused and targeted way. That's the grand experiment that's going on right now and of course, that experiment would be a lot more successful if we had treatment, as Larry said, if we could give a shot and people would have a lower chance of serious consequences or deaths from this virus. And ultimately, the vaccine will be on our side, but of course, the timeline for that is, I think, longer than we hope. So, we really do have to figure out how to negotiate this two front war that we're fighting and still not end up causing more harm than good because of the social distancing and the shutdown in our economy that we're experiencing. As a physician, I'm alarmed, absolutely frightened about the reduction in immunization of young children in this country. What we do not need is a measles outbreak right now or a bad flu season on top of everything else. And yet, that's one of the unintended consequences of the situation we find ourselves in right now. So, I think science is on our side, but time isn't.

NK: And could I follow up? You've talked about the time and how long it takes to develop a vaccine. With 100 vaccines that are in development around the world and 10 in some form of human trial now, what do you think is possible to actually get a vaccine that we know is safe and scale it up at least for the United States or the United States and Europe. I know when we start talking about the whole world, the problem is an even bigger challenge.

JG: Well, I hope the people who are projecting a faster timeline than we've ever imagined are right, but we're talking about vaccinating the world, not just people in a given developed country. And so, I think we have to anticipate, as Jeremy was saying earlier, this pandemic hasn't really penetrated Africa yet and we're just seeing the upslope in Latin America. So, we really have to think about how do we create a safe vaccine for the world

Living in a COVID-19 World

and that is a challenge we've never accomplished for any vaccine preventable disease. So, we have to be realistic about that. And I think it's just impossible to say what's the fastest we could possibly do it if there was absolutely no limit to the resources and the scientific intention and the bandwidth that we in the manufacturing world could apply. I'm sure we can do it faster than we've ever done it before if we're lucky, but also, you used the word safe, Neel, and I think that's the thing that we have to be very careful of. Even in the US, our government doesn't have a stellar track record of bringing forward vaccines for health emergencies without really creating a safety risk, under certain circumstances. I got back to the Cutter incident with polio or the Swine Flu situation in 1976 where the pandemic did not emerge, but the Guillain-Barre paralysis from the vaccine did emerge. So, we have to be absolutely sure before we vaccinate the population, that we are actually protecting people from the virus and more importantly, not harming them through an unproven vaccine.

NK: Thank you. So, Peggy, I'm going to turn to you. Here's why economic policymakers are so focused on the time horizon. A couple months ago, when this first started to emerge, we thought, maybe naively, maybe foolishly, we thought maybe this was going to be a couple month process, shut down, clamp it down, turn things back on. The economic policy response to a two-month shutdown is pretty straightforward. Congress passed it, they provided grants to small businesses to float them for a couple months. It got a lot of money out the door, but if this is, in fact, an 18-month journey that we're on, the way we think about economic policy responses change completely. I don't think I would argue, you probably can't have Congress floating all of these restaurants to try to keep them alive for two years. More likely, you're going to end up seeing waves of bankruptcies of small businesses around the country, which brings its own economic devastation, but that's why economic policymakers are really focused on what's the duration of this crisis? And I know we're putting you in an unfair position asking you to answer this question, but you're here, so I'll take the opportunity to say, so Peggy, turn to you, I'd love to get your thoughts on this discussion so far, on what you heard from Julie, what you heard from Larry and your own ideas.

MH: Well, thank you and I really do appreciate this forum and the amazing set of panelists and speakers that you brought together. I think it's been already noted, this is, first and foremost, a public health problem, but the economic ramifications are huge and multifaceted and include impacts on health and wellbeing, prosperity in the future as well. So, we cannot look at this in isolated boxes. We have to recognize that the public health response and the economic issues have to be integrated and in fact, as was noted, the economic recovery is not going to be successful until we actually are successful in addressing the public health problems, but we can't put one on hold while we address the other. We do have to go forward in a paired and an integrated and a comprehensive way. I think we have reached a point where we have to recognize that we need to open up to some degree or another, even though we don't have all of the medical and healthcare tools that we would like. But, that doesn't mean that it's sort of all or none. It's OK, so, the economy can't stand it any longer, so we're going to open up. We have to open up slowly in a thoughtful measured way that reflects the best possible science and does enable tools that are effective to be used. It's been pointed out that, of course, testing is absolutely essential to a responsible strategy for opening up because we need to know the

Living in a COVID-19 World

contours of the epidemic, we need to know where the virus is, how it's penetrated into communities, where it is headed and we need to be able to identify those who are infected, make sure they get the care they need, also make sure that they don't spread to others, so isolating them. We need to do the contact tracing to identify those that the infected individual may have exposed and make sure that they're being adequately managed as well.

So, this is a critical time, as we think about opening up, that while we're investing in all of the biomedical product development and innovation which is so crucial and we need to do it in as accelerated a way as we possibly can, we also need to be making sure that we're building up that public health infrastructure that Sir Jeremy mentioned in his opening remarks because those are powerful proven tools to help us manage this situation and at the end of the day, if the public doesn't have confidence in both leadership and management of the public health and medical implications of this virus and the epidemic and disease that it causes, they are not going to vote with their feet, in terms of their own reengagement with the economy. So, I think that we really have to, as we have spoken about already in this session, look at how do we manage the virus, the pandemic and the economy in an integrated and fact-driven manner?

NK: Thank you. So, Katherine, let me turn to you. I'd love to get your thoughts. I saw your head nodding with a lot of Larry's comments, so I think the economists probably see things similarly, but I'm curious your take on how do we accelerate a breakthrough in any of these dimensions?

KB: Well, I absolutely agree with the speakers we've heard already that having a vaccine or a curative treatment would transform the way that we manage this, but it's going to be months and months and that leaves us with a period where policymakers ought to be making nuanced decisions about which businesses and economic activities are safe to reopen and which ones aren't. And there is a lot of granularity that underlies that and it's a difficult thing, as policymakers, to make different decisions sector-by-sector, but we have a lot of data on how much transmission risk different kinds of businesses entail and we know how much economic benefit is associated with that. So, I would look for policymakers in a pretty microgeographic level, smaller than states, although the decision making could be done at the state level, to choose to reopen those businesses that have the lowest transmission risk and are the most important to the wellbeing of the community. That's the employees, the customers, the essentialness of the goods and services that are produced. Because there are ways to modify business to really make it sustainable and very limited health risk, even before we have vaccines and treatments available.

NK: So, can you give some examples of what types of businesses do you think lend themselves to more risk or less risk?

KB: Sure. We took a look at data from cell phones from before the COVID period to get a baseline to see how much proximity risk there is posed by different sectors and there's a huge amount of variation between sectors and within sectors. So, if you think about restaurants, I think most of us would imagine fast food restaurants being very high risk

Living in a COVID-19 World

because of all the people who come through, but people come through all day at fast food restaurants and many of them have pretty big footprints, so maybe you're not likely to encounter that many people when you're there, whereas a sit down restaurant, a steakhouse, someplace where people linger for longer might pose a greater transmission risk. Or think about an ice cream shop, it has a pretty small footprint. Maybe there aren't that many people who come over the course of a week, but they all come on weekend afternoons and right after dinner. So, there's a lot of proximity risk there. We are seeing lots of businesses modify the way they do business. I brought up the restaurant as an example, restaurants are doing takeout and delivery rather than dining in for good reason and lots of states and mayors and policymakers are thinking about mechanisms to reduce the risk, both for the people who work there and for the customers. People aren't going to come back to these businesses until they feel safe. So, going back to a point that Dr. Summers made, yes, national policymaking is really important and having good information for people to go on is vital, but what people choose to do, in terms of going back to businesses is going to be dictated by their own feelings of safety, I hope based on really solid information and we need to give businesses the opportunity to make those modifications or customers aren't going to come back.

NK: Great. So, I want to come back to that point in a few minutes. I'm going to come back to Larry Summers and ask, Larry, what do you think about the analogies of the Manhattan Project or the moon landing? My reading of history is the government took 100% of the risk. They didn't do all the work themselves, they still used private sector firms, the big aerospace companies, for example, the moon landing, but the taxpayers bore 100% of the economic risk. Should that be the model here? Because it seems like today, many pharma companies are using their own resources to make these investments with uncertain payoffs. Would it be better to just say, you know what, here's a blank check, the taxpayers will bear all the risk and you can capture some of the upside?

LS: I'm not sure I can answer the question quite in the terms you asked it. In general, the taxpayers can bear risk because there's so many of them and they're so spread out across the whole economy, better than any one company can. So, in general, if the question is who's the right bearer of the risk, the answer is you're better off spreading risk more widely. The problem is, that if you spread risk so widely, then you don't like the incentive properties of it. If I say, I'll pay 110% of a cost for anybody who's doing a research program about a drug, then everybody will say they're doing a research program to find a drug because they'll be making 110% of their cost, so they'll be earning a reasonable profit, but it will have been a very foolish thing to have done because people who don't think they have any real chance will nonetheless try to do the research. And so, the reason for pushing risk to the private sector is not because it's an efficient way to bear the risk. It's because of a way of insisting on skin in the game. And that's the reason for doing it and in general, in a case like this, where it's maximum necessity, minimum emphasis on short run cost efficiency, in general, that's a situation where the government should be disproportionately bearing of the risk with some pushing of the risk to the private sector so that the people who know they have good projects are in a big hurry to come forward because they'll get the prize and the people who know they have bad projects will have no reason to come forward. But in general, I think with respect to something like this, economic logic would tell you that the government should be

Living in a COVID-19 World

disproportionately bearing the risk. That is a quite different thing from the government trying to actually do the project, which it's not likely to have the expertise to do on a substantial scale. But, in general, I think it's a much better idea for the government to be bearing, paying 85% of the cost of people who are doing R&D on what they believe will be projects that have a chance of producing a COVID vaccine. The government pays 80% of those costs and then provides a big prize if they succeed, that seems like a much better idea than the government saying that it's going to pay 80% of the costs of every restaurant that stays open regardless of whether the restaurant has people in it or not. So, I think we are underinvesting in government paying ongoing costs for research and development in any of these areas.

NK: Thank you. So, let me turn to Julie and Peggy and just say, do we have that risk sharing right today? Is the government bearing enough of the risk today if we really want to try to maximize our chances or accelerate the development of any of these breakthrough vaccines or therapies? I'll turn it to either of you to kick off.

JG: I can start just by saying that I think the answer is yes and no. Clearly, governments and particularly our government through BARDA and related mechanisms have really initiated and sustained a significant investment and I'll add to that, CEPI, which although the investment through the Coalition for Epidemic Preparedness Innovation, which is this private-public partnership, designed to do this more broadly, CEPI is also a very important funder of some of the early work going on for both antivirals and vaccines, but the scale of investment is not the order of magnitude that is necessary to really do this on a global basis. So, I think the government is attempting to motivate and incentivize, but the scale is still problematic. I think the broader issue is that individual governments can only do so much. We don't have a global, what some have called control tower, which is really the ability to look across those 130 candidates or whatever and really understand, we can't develop all 130 of them at scale, nor should we. So, how do we decide what are the leading opportunities in the places where government investments really can accelerate an end-to-end process? And that is something that is only in its rudimentary stages right now. We do have, from an NIH perspective, an effort ongoing in the US to try to do that within our domain, but that is not a global effort and when we're, again, really thinking about the global stage, we have to have broader mechanisms. And I would just say, I'm glad you said Manhattan Project or Moon Shot because I think the right metaphor for this concept really is the Moon Shot. It's really applying enormous science and technology in a government led process, but for a humanitarian purpose and I think that really is exactly what we're trying to do here. But again, it's not just a US engagement, it really needs to be much broader in terms of who's contributing, which governments are funding and how we go about organizing and orchestrating the collaboration around that.

NK: Thank you. Peggy?

MH: Well, two broad thoughts. One is, I think the issue of risk is very important, but there are also different types of risk. It's not just financial risk, I think it's also opportunity cost, it's investing in one set of activities as opposed to another. It's also the risks in terms of liability concerns, which matter to companies. It's also knowing if there will be a market

Living in a COVID-19 World

at the end because you need to make the risk investments in actually developing and then manufacturing your product, but then there's also risk in terms of if there will be a market, so advanced marketing agreements is another important aspect of some of the discussions going on. So, there are, I think, different types of risks and it's not just pouring money at the problem, but it's also sort of looking at the components of the problem and the steps that are going to need to be successfully achieved to get us where we want to be and where we want to be isn't just having a successful candidate, in terms of FDA review and approval or other regulatory authorities or even the manufactured product, but it's also getting it to the people who need it. So, I think we need to have a slightly more nuanced or complex view of what are the risks and how can we address them and how can we lower all of the potential barriers to success including those risks. I also think it is so important what Julie was saying and it echoes some of the earlier comments that we think about this in the global context because we really are only as safe as all nations and their people are safe, at the end of the day. We're all looking to the ability to produce these products, but if they aren't distributed where they need to be and if they aren't studied where the problem is, we won't ultimately achieve our goals. And I think one other part of both the scientific collaboration and the investments is recognizing that we are, as a people a global community and as nations inextricably intertwined and we won't be successful at advancing the science and the research if we're not thinking in this global way, both because the best and the brightest minds in science exist across borders as do some of the best companies. But also, we're going to need to test these products where the patients are and that is a moving target. We wouldn't have thought this a few months ago, but now China has a problem because they don't have the new cases in that country to do some of the studies that have to be done, so they have to collaborate with other countries. And as we see this shifting pattern of the epidemic, we need to be thinking about how to do the research as effectively and efficiently as possible and that will mean doing it in a collaborative way where governments have to be willing to invest across different kinds of boundaries, across sectors and across borders.

JG: Can I just add one thing, Neel? And that is that Merck is a company that has developed an emergency vaccine for Ebola and that vaccine was put on the fastest possible track and many of the lessons we learned are partly why we are not overpromising on delivery times because we have a basis in reality for understanding the complexities of trying to do this in an international manner. But, I think also, what Peggy said about the demand for the product at the end of the day, is also an issue. After everything was said and done and we finally were able to create a manufacturing supply for this vaccine and we are filling up the stockpile requirements, then what? And so, you have to really think about this from an end-to-end perspective and make sure that you're seeing the full picture including the liability consequence, which in the US, we've done a good job, I think, of managing, but on a global basis, we still have a long way to go. So, it's complicated, it's solvable, but we really have to understand that any one of these end stage issues can be game stoppers for people who aren't fully familiar with the complexities of what's involved here.

NK: Larry?

Living in a COVID-19 World

LS: Let me just say that I agree with my friend Peggy Hamburg about international cooperation being a good thing and I certainly worked for many years to promote US multilateral cooperation. When we give a dollar of foreign aid, we've given a dollar of foreign aid. When we give a dollar to the World Bank, we've leveraged \$6 of foreign aid because other countries contribute as well. I am very much on that side. However, my life experience teaches me that there are two words that never belong in the same sentence: multilateral and fast. And it seems to me that I do not think it would be wise for US efforts to become comingled and intertwined with efforts in many other countries that I think inevitably have some tendency to fall to a kind of convoy mentality and move at the pace of the slowest ship. And so, I don't have a set of detailed prescriptions, but I would rather see the United States proceed to, in a self-sufficient way, with close allies, move as rapidly as possible to develop a vaccine, a vaccine production capacity and a vaccine distribution capacity to Americans, making freely available that knowledge to others so that they can solve the problem for themselves. That I would like to see, but I would be very reluctant to see an international division of labor of any kind where if there are seven components of success, two of them involve things that are outside of the United States and outside of American control. And I say that as somebody who's supported more or less every initiative for 25 years to do anything on a more global basis. I suspect I may be overinterpreting what Peggy said, but I just want to caution that this is not an area where more multilateral is synonymous with better.

MH: Well, just to respond quickly, I mean I think I take your point and I understand it, but I think that we actually live in a world that is so interconnected that I think that even if we wanted to define a US only strategy, it might not really be the most efficient way because we have to recognize that, first of all, many of the US companies actually operate in many other countries and have manufacturing facilities in other countries, etc. So, we're already engaged with other countries. We have to recognize that in fact, to do some of these studies, we really probably can do them more efficiently when we get better clearer answers about what really works and for whom, by doing some studies that are collaborative studies that involve multiple different products and multiple different populations and WHO actually is coordinating some clinical trials, the Solidarity Trial, you've probably heard about, that I think are going to make for better science and more efficient efforts going forward and then I think coordinating the regulatory authorities early on, so that there are common standards and expectations for what the research study should look like, what critical questions need to be asked and answered and what kind of standards, not only for the R&D, but for manufacturing, are going to be anticipated. That will make the efforts far more efficient overall. It's not easy and there are rabbit holes you can do down, but I think that...and Julie has probably a more meaningful perspective working in a company that's US based, but has outposts around the world including the Ebola vaccine, I believe is manufactured in Germany. So, I think we both have to recognize that there's a global imperative here in terms of controlling a global pandemic, but also that the research and the biopharma enterprise is pretty international now.

JG: Can I just add that...I'm laughing because today, Merck announced three business development partnerships that are acquisitions related to two vaccines and an antiviral for COVID. It involved at least four different countries, including our own and just the process of managing that speaks to Larry's point in the fact that it is very complex and

Living in a COVID-19 World

takes time to iron out all of these details, but that's, as a practical matter, the reality of the world in which we live and if I were to describe the network of countries and entities involved in prosecuting the Ebola vaccine among the three companies that were in clinical trials in Western Africa, it would be a very long spreadsheet. So, the reality is, we have to figure out how to manage it because there's no other way to operate.

LS: Let me respectfully say, I appreciate the point, and there certainly may at some points, be no alternative to more global solutions and obviously when one speaks of international collaboration, one is more comfortable with the notion that the United States and Canada are collaborating than one is with some other possible collaborative partners. So, I take the point. But, let me also say, one, that I think efficiency is the wrong value and I think that the biggest longest term learning from this crisis for individuals, for communities and for countries is going to be that efficiency is less important and resilience is more important than we previously thought and the complexity of the network is in inverse proportion to its degree of resilience. We are moving from a just in time world to more of a just in case world.

Let me say second, that if I were the one making the decision, I would pay an extra 25% to Merck, for whatever it was that they were going to do, if they were going to do it all in the United States rather than if they were going to do it all over the world and the incentives for Merck are much more globalist than the appropriate incentives for the United States. So yes, we should spend money, yes, we should encourage developments everywhere, we should be positioned to benefit from scientific developments anywhere, but God, we have learned something about the importance from resilience and I think it was a criminally stupid act of the United States to stop funding the WHO, but as someone with aging parents, the further the vaccine development effort is that is potentially going to be applicable from Americans, the further that effort is from WHO control, the more comfortable I will be.

MH: I certainly wasn't saying give it all to WHO.

LS: I know you weren't, but I think one's habits of bias towards the globally cooperative and multilateral and generally humanitarian need to be balanced with some hardheaded cynicism about resilience at moments like this. I mean I think that's true very generally as we look at our whole economy, that we're going to have to think more about issues of...we used to think that the more global a supply chain, the better because it would knit nations together and keep us all talking in many different directions and be better and I think we've learned that past a point, that reaches diminishing returns and the risks...

NK: This is a great discussion. I want to move to the second part of our conversation and this Julie, you touched on it, the goal of creating a vaccine for all humans on earth is amazing and intimidating goal and it's a real goal, but I also know the citizens of each country are going to ask themselves, hey, wait a second, are they really going to do this for everybody at the same time? And so, I think this quickly goes into very complicated and important philosophical questions about fairness, which I don't think we're going to answer on this conference, but those are important questions.

Living in a COVID-19 World

I want to go to the second part of the discussion that Kathrine started, which is, let's say we do all of this great work, internationally, domestically, Congress puts massive amount of money behind it and it still takes a couple years because science is hard. How do we reopen safely? Now Kathrine, you talked about some businesses are more prone to spread, other businesses are less prone to spread. My own observation when I travel around Minnesota and I don't think we're unique, it kind of seems like businesses are making it up as they go along. And they are trying to pay attention to what the experts are saying. They're trying to give comfort to their customers, but just because they're doing things that look like they're comforting, that doesn't necessarily give me comfort. And if we look, by the way, what degree does the context of the spread, so in Minnesota, we're reopening but our cases keep going up, our hospitalizations keep going up, our ICU inhabitants keep going up for COVID. So, when I look at that, the broader context in Minnesota is lousy and yet, we're reopening and so, for me, I'm not getting much comfort from the fact that a restaurant says we're going to wear masks when we serve you dinner. So, Kathrine, could you give us more on how can we do this safely, not just to give people confidence that it's safe, but to really be safe.

KB: Sure and of course, there's a range of advice from experts that I rely on, that everybody else relies on and that expert advice has been changing as we learn more about the disease and that's the nature of science, but it is confusing for the general public for each of us individually to know what is real safety and what is safety theater in the way that you see security at the airport and some of it seems like it's really about security and some of it is about making you feel secure even though it probably isn't, but most important thing for actual security, I think we're seeing a lot of that in thinking about businesses reopening and we're trying to adapt to expert advice that is changing over time.

The other reality of it is that until there is a vaccine that is very widely taken up, we're going to be moving in and out of health crisis over time. It's not going to be a monotonically declining case rate. There are going to be flareups, there's real concern that the fall flareup could be even worse than what we've seen so far. It's going to come differently at different areas, different times in different areas and so thinking about how to set up flexible business operations that can dial up or down, based on local public health conditions, that's not the way people are thinking about it right now, but I think both public health officials and policymakers are starting to think about phases that don't just progress from [audio cuts out 01:51:44] everything's normal, but more, we're in Phase 2 this month, we're back in Phase 1, we're up to Phase 3 because the disease conditions on the ground are going to change and also the health capacity is going to change, thinking about flattening the curve so that we don't overwhelm our healthcare system, that depends on what our healthcare system looks like. So, in some places, the level of disease is going to be comfortably below the beds, the ventilators, the personnel, you can do adequate contact tracing and so if you can tolerate a higher level of prevalence than areas that are closer to capacity and where that kind of follow up isn't practical in the same way. So, I hope that the decision making will be very tailored to local conditions and that we get used to things being different week-to-week and month-to-month, probably for 18 months. I hope the optimistic scenarios are true too, but I don't think that we can be operating in a world where we think, we just have to ride it out for a

Living in a COVID-19 World

few more months and then everything's going to be fine and back to normal. It could be a lot longer and as you pointed out, Neel, the public policy response to everything being shut down for a month is very different from the optimal policy response to everything being shut down for 18 months. You can't float business loans to keep every business operational and liquid for years. You could easily do that for weeks and we're not in the state of the world where we're only talking about weeks now.

NK: Julie, let me come back to you. A month or six weeks ago, the White House put out guidelines for reopening the economy safely and I looked at them and it seemed like it was written by health experts. I mean, it seemed very consistent with what I heard from Mike and from others. Almost the entire country is now in some form of reopening and almost no state is meeting the guidelines that the White House put out six weeks ago. Is that concerning to you?

JG: Yeah, I think one of the things that we have to acknowledge is that we're learning as we go in this. We talked a little bit earlier about testing and clearly testing people with symptoms is the most important use of the test. Testing their contacts, the second most important use, but the third very important and not enough talked about use is the need to understand how the epidemic really is spreading. As Peggy said, the contours of spread and who's affected and where is it going and why. We have critical needs to understand what's happening with daycare, schools and colleges because if we could get those environments much more open and really understand what is the threat to kids and are they the harbingers of spread into the community or are they relatively poor transmitters and at much lower risk of the serious disease that we have been sort of assuming all along. So, these are important science-based questions that ultimately will inform reopening, but until we have those data, we have to do the best we can, observe what we learned in Korea and China and so forth and just kind of learn as we go. And I really like what Katherine said about sort of, we're going to make some progress and then we have to observe what happens and that means we may have to backtrack if it starts to really flare up and we've got a fire storm instead of a hotspot. So, there's going to be this coming and going and I think it's really hard to put that into guidelines. What I think is the right role for the broad sort of federal government or the WHO, for that matter, is to articulate the principles, the science behind the thinking and what needs to be looked at and examined at a local level, but you really do have to allow for local control. At Merck, what we've done is to say, here are the pandemic priorities for Merck. These are the principles that we're using in making decisions about who should be working onsite, keeping our supply chains operating, etc., who should be working at home, as we move to having more people working onsite or more people working face-to-face with customers, these are the principles, but we have to leave it to the Managing Director in each country and the site manager at each plant to really take a look at the local situation and requirements and make judgements about what makes sense there, all the while knowing that if we go too far too fast, we're going to have to backtrack and we have to help people anticipate and prepare for that and also, to make sure that we do have access to testing, so that if we have a hotspot in our own backyard, we can respond to it quickly and do the things that we're supposed to do. That's a really uncomfortable place for society and it's a real uncomfortable place for most businesses because you can't forecast that. You have to sustain that agility in an environment where we don't even have the

Living in a COVID-19 World

most rudimentary foundational understanding of the transmission dynamics that are most relevant to businesses. So, I go back to the testing argument. I'm all for tests and I wish we had a reliable test that we could take every day, blah-blah-blah, but the point is right now, we have a whole lot of unreliable tests and we need to make sure that we're applying the best tests for the things that matter most, diagnose patients, contain hotspots and then understand the basic epidemiology of what's going on, especially in daycare, schools, colleges and even in the workplace as we go forward.

MH: If I can just jump in for a second, I have had the opportunity to work in public health at different levels over many years including as New York City's Health Commissioner, and in a crisis, one really does want to be able to work with your other colleagues and partners and you want to be able to look to the Centers for Disease Control for broad based guidance, as Julie was saying, you don't want to be told what to do, but in a situation where information is limited, where understanding is evolving and insights are emerging day-to-day, I think that unfortunately, one of the things that has really been missing in our response has been the ability to really hear in a clear consistent way, from important public health agencies like the Centers for Disease Control. They have been marginalized in a way that's hard to understand, since they have still, some of the best people in public health and they are the gold standard and to be able to have guidance that comes out in a timely way and then to be able to align that with your own local and regional needs is very important and businesses shouldn't have to be inventing some of this themselves. They should be able to look to credible experienced public health agencies for assistance and guidance. It doesn't mean that they have to do it that way, but as we think about, for example, what Katherine was talking about earlier, which businesses are sort of ready to reopen more fully than others, it's both decisions about, number one, what are the really important businesses to try to reopen; two, how can they be reopened in safer ways to protect both the people who work there and the success of the reopening and how can leaders who don't have a reason to really understand the complexities of infectious disease outbreaks and their implications, they need to have a clear mechanism to connect with the expertise that they need, again, locally, regionally and on a more national basis. So, I think that that's been, unfortunately, an underdeveloped, but critically important component of what a really successful response would look like.

KB: Peggy raises a great point, that we need a common set of information from infectious disease experts that we can rely on in assessing the risk and the conditions on the ground and then that does give businesses the opportunity to be creative, entrepreneurial, innovative in thinking about ways of lowering risk, that have to be assessed by experts and conveyed to the public in a reliable way, but there are lots of ways we could modify the way we do business and we're going to have to because it's going to be with us for a while, so we're seeing rudimentary aspects of that in curbside pickup and the like, but there are lots of different ways that you could meter people into businesses, that you could have Group A and Group B that don't interact with each other to reduce network risk. All of those things can bubble up from lots of different places if there's a reliable expert-driven way to assess the health risk that's then posed by the new mode of doing business that can govern the rules under which businesses operate and can convey

Living in a COVID-19 World

information to both employees and customers about the kind of risk they incur when they go to that business.

NK: I guess what you're saying, Kathrine, works at a societal level or a population level, but you're still as an individual taking a risk as you're part of the guinea pig to figure out if this model works or not. So, I'm wondering for myself, why, if I don't have to go to a restaurant, I don't have to take my family to a restaurant. I introduced my wife to Hamburger Helper for the first time. I went shopping, I bought the ground beef, I said, try some Hamburger Helper, it went over pretty well. I don't need to go to restaurants. So, why would any of us who don't need to do something, take that risk unless we are totally certain that we and our families are going to be safe?

KB: We do a lot of things that incur some risk. If your only goal in life was to have zero health risk, you would never get in a car. That is for you to decide whether the risk that you incur is worth it, in terms of the wellbeing of you and your family and there are going to be lots of people who choose not to do a lot of things that we used to do, like I don't know when the next time lots of people want to go to a happy hour at a bar or a big sporting event is going to be, there's going to be a lot of individual variation and willingness to take on that risk. People should be clear about the risk that's incurred and so that requires that kind of infectious disease expertise and the imprimatur of a neutral assessment of the risk. You can't just trust the business and say, it is totally safe, come on in. So, we need that kind of review and expertise, but I imagine that in the world going forward, people are going to make different decisions about what's an acceptable risk for themselves and their families and as long as they're doing it with good information and as long as we're making sure that you're not putting others at risk by sort of thinking about the community health effects of different actions, I think that's going to be the reality.

MH: Neel, some people might think that eating Hamburger Helper was a health risk too. But, I think you just have to look at the pictures from this Memorial Day weekend that were shown all over the televisions of people crowding onto beaches and various kinds of bars in communal settings. People assess risks differently and in many activities, that's fine. This happens to be an activity where when you take on additional risk, you're also putting others at risk and so we have to find a better balance.

NK: So, let me jump in here just for one second. Julie, you mentioned schools and daycares. As our economists are looking at reopening the economy, schools are really important. They're really important in a number of dimensions. One is, we know that keeping schools closed limits people's ability, the parents' ability to go back to work. So, it has economic implications and we know there are enormous costs on kids' learning, either kids who don't have access to online and by the way, most of my friends who have school age children who do have internet access, don't think their kids are getting as good an education as they got. So, even the kids with access to technology and computers, may not be getting the same education that they were getting in person. So, there are costs to closing schools. On the other hand, if schools are these perfect little distribution mechanisms of the virus and maybe the kids aren't as big health risks themselves, but they could spread it to their parents or their grandparents, then maybe we don't get far

Living in a COVID-19 World

enough down below one, if we keep schools open. And so, what we do about schools seems like it's an enormously important question and we don't have a lot of time to figure it out because the fall's right around the corner. Julie, any thoughts on that, how do we answer that question?

JG: Well, the first point, I believe, is that the answer is knowable and there are some proper epidemiologic studies that are in progress. I don't know what the timelines or the milestones of those projects are, but this is a question that we can answer. We can do the evaluation and the testing to figure out what is going on with kids. I'm shocked actually at the relative low number of clinically significant infections in kids. Obviously, there are some and the more we watch this pandemic, the more we see, but compared to every other respiratory illness with which I'm familiar, it's striking how children have fortunately been spared. So, the question is, are they really all infected and are infecting others and they just are lucky enough not to have an illness or are they somehow relatively harder to infect or some have hypothesized that the biology of their respiratory system has changes in the receptors and they don't efficiently propagate the virus, etc., etc. We just simply don't know, but we need to and we need to find those answers on the fastest possible track and I do hope that those are among the highest priorities for the CDC and the NIH to really dig into because you're absolutely right. I know just working in a large company, we can't expect people to return to work if our daycare isn't operating and people have their kids at home, it's just impossible. I'm on the Board of Trustees of my university and the same dilemma is in play across our academic environments. We need people in universities and you can't do everything remotely. So, my vote is to fast track the answers to those questions with the same degree of investment and fervor that we're fast tracking the vaccine and the antiviral work because it will have a tremendous impact. It's almost like the vaccine for the economy is to get kids and children back into a place where they're learning, but also their parents are free to make the professional decisions that they need to be making.

MH: And if I can just add one other thought, Julie observed that what we should be doing is knowable, that we need to study it, but I think, of course, we're not going to know everything we need to know as decisions will be made about different models of going back in terms of school, both schools, elementary and middle school and high school and importantly, universities and colleges as well and there are different issues intrinsic to those different levels of education. But, we also should be building a system to collect information so we can learn as we go, as these different strategies for opening up go forward because we are going to be living with this virus and its implications for a longer period most likely, not just this upcoming September school opening and there are going to be other similar threats to health in the future and we really need to get more concrete answers and it's interesting, there are other countries that have had an earlier experience grappling with COVID-19 and this novel coronavirus and it's disappointing when you try to go and look at what can be learned from their experiences with closing schools or not closing schools, that there actually wasn't as much data collected as would be really useful about seeing whether in fact, for example, elementary schools are sort of vectors for spread, that the kids themselves don't get sick, but do they bring it back into their households and their families? So, it really, for me, also underscores that we're going to see different decisions made in different places with different leadership and

Living in a COVID-19 World

circumstances, but that we ought to be really trying proactively to build in systems so we can learn as much for the future and for me, of course, corrections as we go as well.

NK: So, Peggy, you touched on the international, what we can learn from other countries. I'm glad you did. Japan has now announced effectively that they have defeated COVID and maybe I'm saying that stronger than they did, but they've declared victory, they've ended their emergency. Allegedly, they didn't do very much testing. They didn't do very much contact tracing, they didn't lock down their economy. They just said, hey, everybody, wear a mask and socially distance the best you can. That's what I can gather from what they've announced. South Korea is held up as a model, where they apparently did very aggressive testing, very aggressive contact tracing. When I look around the world, it almost seems random why some countries have...they experience the virus very differently than other countries. When you all look around the world, are there things that you can see from other countries that we should learn from and say, we should do this or we should not do that?

MH: Well, certainly it's true that different countries have responded in different ways. I think there are some themes, but there is also a lot of confounding information about why did it look different in one country than another. I think one thing that clearly is true is that early response really matters and I think another is having some way of tracking the epidemic. Japan, as you say, didn't do a lot of testing, but they did have a pretty robust contact tracing mechanism, which looked different than our system for public health, but still, it was a strong and far reaching contact tracing mechanism. South Korea went sort of all in on testing. I would say that also those responses that really were expert and science-driven, maybe this is my bias, but tended to be stronger and also where there was clear government leadership, political will and commitment, but not politicization of the outbreak response and really engaging a sort of whole of government, make this a clear priority and focus kind of a response. And I think different countries have also very different frameworks, politically, economically, etc., but I think the importance of early engagement of the private sector along with governmental entities and agencies also is sort of one of the potential markers of a better response than others.

JG: Can I also jump in—particularly on South Korea, which I have been watching and am very impressed. Obviously, the initiation of the outbreak there was a little bit different because the early cases were associated with a particular religious group and was just another early example of how these large gatherings in sometimes confined areas really accelerate transmission. But, Korea is also a country that has recently been dealing with MERS and so their entire system was already geared up to do contact tracing for coronavirus infection and they used extremely entrepreneurial approaches to the MERS outbreak, including using cell phones to do geo-mapping and connecting contacts and sources, etc. So, they were primed and ready to go when SARS hit and their system was prepared. I think it relates to what Larry said earlier about the difference between just in time and just in case. Korea had already learned the lesson of the importance of the just in case and I think while we're all wrapped up in coronavirus right now, we also, as we often do in America, we fight the last war, but we need to be thinking ahead, how do we take what we're learning right now and make sure that going forward, we are much better prepared, that our investment profile looks much more like just in case than the sort of

Living in a COVID-19 World

reactive situation that we find ourselves in this circumstance. I say that having gone from the beginning of my career with AIDS, but certainly the beginning of my government service with the first SARS in 2003 and every single time we've had one of these worrisome outbreaks in the United States, we panic, we get emergency funding, we gear up and then complacency sets in as soon as the threat is gone and we go back to the sufficiency model, which really does not serve to prepare us for what really, I think, given everything going on in the world is going to be a series of ongoing emergencies, hopefully not as bad as this one, but certainly could be worse.

KB: Privacy issues and ability to trace contacts, to really map out hotspots early and different cultures in different countries make different choices about that tradeoff and I think there's some hope that technology will help us on this front in that there are entrepreneurial ways to try to track contacts without pooling a lot of individually identifiable information with the government and maybe there's a way to ease that tradeoff a bit, but I think we have to make a public policy decision about how invasive we're willing to be in order to track everybody's contacts to be able to get information about potential flareups as soon as possible. There's not an obvious right answer there and I hope technology will help us have a little bit of the best of both.

NK: Thank you. Larry?

LS: Let me make three points, if I could. First, as Julie and Peggy both emphasized, this is not the last time. Dean Jamison and I published a paper three years ago that said that the present value of what humanity was going to lose from pandemics, looking forward over a century, was broadly comparable within a factor of three, to the losses from climate change and yet climate change received 100 times the policy attention. That's not because climate change is receiving too much, it's because pandemic risk is receiving too little. Dan Ellsberg wrote the best serious historiography of the Vietnam War based on the Pentagon Papers and its central point was that in every key juncture, policymakers were presented with three choices. Option A offered a prospect of ultimate success. Option B was to acknowledge complete failure in the moment and Option C was to do what was necessary to avoid calamity for the next six months and see where you were then. And what he showed was that at every juncture, policymakers chose Option C. That has been the world's response to epidemic and pandemic risk and I discern next to no evidence that the world is now on a different path.

Second, a broad framework for your viewers to think about and I hope the scientists don't regard this as too egregious an oversimplification. In a normal Western society, living life normal, R_0 , the number of people who one person with COVID will spread that COVID to, is some number like two and a half, possibly three. In the United States, as it was when it was in lockdown two weeks ago, R_0 was some number like .8 or .9. It follows that if you go 20% of the way back from the way we were to when we were in lockdown, to the way it would be if there was normal and you have no major offsetting policy, you're back off to the races for the pandemic. What I think the diversity of international experience illustrates is that your major policy can be extensive testing, it can be super extensive masking and social norms that stop people coming close to each other. It can be extremely aggressive quarantining. It can be locking down until you're in an extremely

Living in a COVID-19 World

low level and then being extremely forceful to any case where there's suspicion. There are a variety of paths to sustainable control. Talking about the different paths to sustainable control without doing any of them aggressively is not one of the strategies that has been successful historically, but it is a risk that that is a strategy that we as a country are falling into.

I think the third thing I would say, in case there's anybody I haven't irritated yet is, that I think that it is true that as war is too important to leave to generals and as economic policy is too important to leave to economists, epidemiological policy is too important to leave solely to epidemiologists, that there are very important political decisions that have to be made and experts have a responsibility to be appropriately humble about what they do and do not know and to recognize the very wide range of possibilities that are open. And I think the epidemiological community has had some tendency through this crisis to focus on worst case outcomes in order to get the policy choices that they prefer, implemented and so, there's been some tendency to highlight forecasts that a million people will die and the like. And I think there has been some tendency towards excessive certitude about the results of a given projection and I think that has had some price in terms of the credibility of experts. And I am acutely well aware that political leaders do not want to hear about confidence bands, they want to hear about numbers and forecasts—acutely aware and that in order to preserve relevance and influence, there is a tendency to give them what they want in terms of simple judgments. And I would only caution that there is a price in terms of long run ultimate credibility, that on occasion, the economics profession has paid and on occasion, the military profession has paid and that I think it would be something useful now that they are so very much in focus for the epidemiological and health community to pay attention to.

NK: Well, thank you for those comments, Larry and I would just say, part of the reason we picked this panel of experts was everybody had, in their public commentary, demonstrated a lot of humility about what we do know and what we don't know and how much uncertainty there is. We have just about five minutes left and what I'd like to do is just wrap up. I know we have many staff from Congress who are watching, maybe some members themselves. We get called, I'm sure you all get called regularly saying, hey, what should we put in our next relief package and this is a chance to offer some advice to that. Maybe we could just go around, maybe we'll start with you, Katherine. If you had some recommendation of what you would like to see in this new relief package that Congress is debating, what would you like to see?

KB: I agree with Larry's starting point, that we ought to be spending more on developing vaccines and cures or effective treatments than we are right now, given the enormous economic return to that. So, I'd love to see more of that. And then I would also like to see sustained social insurance programs in that the costs of the epidemic are clearly borne disproportionately by the low end of the income distribution, both in terms of exposure to the disease through the workplace, preexisting health conditions that may get worse, limited access to medical care, all of these things combined in a really terrible way for some segments of the population, so robust social safety net spending continuing I think is going to be really important.

Living in a COVID-19 World

NK: Thank you. Peggy?

MH: Well, I'll echo Katherine's two points. I mean I think we do need to recognize that this disease, while the virus will infect anyone who comes in its path, is creating a disproportionate burden on certain vulnerable populations, underserved and minority populations. I also do completely agree that we need to be investing more in the science and I would say that this is a short term and a long term investment. I think to build the capacity for a truly comprehensive and robust end-to-end ability to develop the medical countermeasures, drugs, diagnostics, vaccines that we need for COVID-19 is terrific, but at the same time, let's reinvest in our biomedical product innovation ecosystem. For decades, we have been, as a country, preeminent in life sciences research and medical product innovation, but we have been losing ground, we've been underinvesting and I think in terms of both strengthening health and our healthcare systems and our economy, that is a terrific long term investment. And then let's not forget public health. Let's rebuild, reinvest in our public health infrastructure, which has been defunded now for many, many years and that is a critical component of our ability to manage this pandemic and future pandemic threats.

NK: Thank you. Julie?

JG: In terms of the supplement for short term investment, I agree with what Peggy said. I think that she's nailed it. I would add that we need to make sure that we have really provided for a healthcare surge, even though we're sort of under the curve right now and our hospitals are managing, they are not prepared for a significant increase in cases again and they are not going to be prepared if that happens during flu season. So, we really need to finish the job there and push the envelope on that. But, it isn't just about hospital ICU beds, it's about getting our clinics open again. The fact that we have dramatic reductions in vaccination, in cancer screening, in diabetes care. We ran a program for patient assistance for people who can't afford their medicines and ironically, we're seeing 60% fewer patients request assistance. Why is that? Not because they suddenly have a financial windfall. It's because they're not going to the doctor at all and they're not getting their prescriptions filled and they're not getting their medications. So, we need to make sure that in the context of this supplemental investment, that we're finding ways to reopen our clinics, our pediatric offices and our dental offices so that the primary care services will end up acquiring more hospital beds if we don't deal with this, don't get overlooked. I think that's a space that no one's talking about, but it actually is a very important piece of helping us get back on track with this pandemic. The longer term issue, of course, is the mind change from sort of again, the just in time mentality to the health defense mentality, which means we really need to rethink the whole way we approach pandemics and Larry, I would love to talk with you about your ideas on how we actually do that because I'm so tired of having the same conversation over and over again and if we haven't learned our lesson this time, I fear we're never going to.

NK: Thank you, Julie. And Larry, last word to you on what you'd like to see Congress do next.

Living in a COVID-19 World

- LS: It is a national scandal that we have spent five times as much money or some figure like that, on grants to the airline industry, to bail out their shareholders, as we have spent on incremental research to find a new vaccine or therapy. \$10 billion a day, every two and a half months, this costs us considerably more than the national defense budget, in terms of a loss to the economy. Any bill that does not contain more than 1% of the resources devoted to therapy, vaccines and tests, does not make sense. It's not just funding for research. As important is funding for the implementation and distribution of whatever we find and accelerating that process. The idea is pervasive that there are two domains of policy. There's a domain of health policy where people like Margaret and Julie have expertise and there's an area called economic policy where Katherine and conceivably myself have expertise. The reality is that the right health policy is the best economic policy. Anyone who doubted that should just consider what you said earlier, Neel, that the Governor of Minnesota can do whatever he wants, but you're not taking your family to a restaurant until things are in a very different place. That is typical and that is why way overinvesting in health is such an urgent imperative. If we've wasted some money, that would be fantastic. In fact, the one way, the one thing that could happen that would make me most certain that this had been managed badly would be if it turned out that we were all done and we had not done a single thing that was wasteful ex-post, that would mean that we had not tried nearly enough avenues. An oil company that never dug a dry hole would be an oil company that would soon be out of business because it wouldn't be expanding and exploiting the properties that it had. And that's the mentality that we need to be bringing as a country and that I do not believe we are currently bringing to this problem.
- NK: Thank you. I want to thank all of our panelists. We could have gone on for a lot longer. We got the right group of people and so thank you for your time and your thoughts and all of your experience. We really appreciate it. Much more to come, no doubt. Tom, I'm going to turn it back over to you.
- TB: Can't say that we haven't covered the waterfront, the continents and everything else that's been going on here. My own strong, strong impression is that for all the wisdom that we heard here in the last couple of hours, I don't think in a meaningful way, that there will be a movement, which everyone can agree, until this election is over. I just think that they are going to be stuck, frankly, in the campaigns and the politics and they're going to be looking at the minimum, not at the max of what they need to do. They're going to try to be as little disruptive as they possibly can be. When you look, frankly, at what's going on just in the last week, with armed people out on the streets and restaurants being opened, there's no one willing to speak up and step up and say, folks, we've got to make some hard calls here and we've got to make some tough sacrifices, but in an election year, not going to happen, in my judgment. Anybody disagree with me?
- MO: No, I'd only just say, I think one thing that will become very clear is, we're not driving this tiger, we're riding it. And I think the virus will determine a lot of what's going to happen over the months ahead. We will be in a response mode and in that regard, I think that decisions that we force, activities will be affected and resources and priorities will be altered not by what we do, but what the virus does. And so, I think that's a humbling place to be and since we don't know what all that virus activity will be or how it will

Living in a COVID-19 World

unfold, I think also makes for a challenge because we all want to plan for what will be coming, but we don't know yet how to do it.

TB: Well, I couldn't agree with you more and what I am long for are some...I'm not going to call them courageous, I'm going to call them sensible, members of both parties, frankly, whether they're in the Congress or whether they're in the big tents of the Republican or Democratic party to say, this is the greatest crisis in my lifetime and for many people, in fact, they could say that with great honesty. And then, how do we address it and how do we step up to it? And I just don't see much of an indication of that, beginning with the White House, obviously, about the false promises that he's making and people cling to that hoping that it's going to work out. There are going to be consequences, I need not tell this group, to just the opening up that is going on so far and what we're seeing, particularly now and it's just beginning to spike a little bit in places like South Dakota and North Dakota where they didn't have an enormous amount of activity. Now, it's beginning to creep into those places and we'll see what happens, but it's going to take political bravery and also the private sector has to get involved, the bankers and manufacturers and the people who are moving the economy, I think have to get out front of all this and it's a testing time for the country and all of its parts and how they can be persuaded to do that in the face of the resistance, as we've seen down in Florida. We've seen a lot of it in Florida. If you look across the South in Georgia, for example, especially in Arkansas and other places, we're less than the sum of our parts and there are a lot of parts in play right now, unless I'm wrong, we need a big cohesive unified approach to all of this, not an approach that has a lot of parts to it.

NK: You know, Tom, I mentioned this in the panel, that almost all states are reopening and almost none of those states that are reopening are meeting the White House's guidelines for when it's safe to reopen. And those are Republican states and those are Democratic states and I wonder if this is bigger than politics. It's just...you know, it's like climate change. It's very hard for people, if there's an amorphous threat somewhere in the future, that doesn't appear to be right in front of them, it seems like people are not willing to sacrifice very much to prevent that risk from happening. So, I almost feel like there's something bigger than politics going on where people say, I don't really feel this right now in front of me, therefore it can't be that bad, therefore leave me alone, I'm going to go back to life.

TB: I think you're absolutely right and part of the reason for that is modern communications. You don't have a single or even a unified set of conditions that are out there because everybody has access to their own mega forum and people are inclined to believe what they want to believe. You know, what we're doing here is one thing today, but I promise you, across the spectrum, there are others out there who are saying something totally contrary to what you experts have been saying and they've got a voice because it's easier to take that route. The other aspect of this is, if you look at it contextually, things were really going well, the economy had low unemployment, people were feeling good about it and then this strange arrival came and it was filled with death and sacrifice and people were resistant to that, so if they had some kind of a small opening, they were going to run through that if they thought they could be more comfortable in it. I do think that this is a moment for major bankers and automobile manufacturers and Silicon Valley and others,

Living in a COVID-19 World

to, if you will, seize the moment and seize the political climate and say, folks, this is not going to go away with a wave of a hand or a statement by the President of the United States. This is a crisis for us and I'm not an authority on this, but I do have a pretty good feel at this stage in my life for how people will respond to certain conditions and what they're going to respond to right now is the easiest route. They want to go back to how it was, even though we've had almost 100,000 deaths at this point and a big piece of it should be the younger people. This is their future and somebody should be mobilizing them in terms of getting involved and trying to carve out what their future is going to be because their future is not going to be what they expected it was going to be a year ago, quite honestly. I've got a daughter graduating this year and another daughter will graduate next year. I have children living in Geneva at the moment wondering what their future is going to be. I think you've got to try to motivate that generation to get involved and look for other places of leadership and they're out there, but how do we get them to kind of line up together. It's a tough call, it really is. I'm just curious, do you think I'm overstating it? Do you think that I've painted too dark a picture for what the country is likely to do and how they're likely to respond?

MO: Well, let me just come back to a statement I made earlier. This is just a lot of infectious disease physics, virus gravity. 5% of our population, roughly, has been infected to date, slightly higher in cities like New York City, but across the board, there still are many locations where people don't know someone who's been infected or more importantly, who has died. That's going to change and if you think of all the pain, suffering, death and economic disruption that's gotten us to 5%, think what it might take to get us to 60 or 70% if we don't have an effective vaccine in the foreseeable future. And so, I think that there's this kind of state of denial of what our future is going to be and again, I come back and say, I don't know how we're going to get to those numbers, but we're going to get there and I think that that's the reality we're not planning for, that's the denial that's still pretty much in the public's mind. They can't envision a two-year war against this virus, much as if our borders were attacked for a two-year war. And so, I think that that's the challenge we have right now is get them to understand that, number one, and then number two—and I know I sound very Pollyannaish about this—we need an FDR, we need a Churchill. We need to have the kind of leadership that is not about it is or isn't happening—it is happening, what do we do about it? How do we hang together? All the things you're saying, Tom, and I think that's going to be a critical part of getting through what is just the beginning or I say the second inning of a nine inning game.

NK: Jeremy, I'm curious, if I may, when you hear us talk about the American people's response to this, how is it in the UK? Does it sound similar?

JF: It does. I mean, there are a lot of parallels between the US and the UK. At the moment, from politics to all sorts of other areas. I mean, in the UK or the US and I speak for the UK, the UK cannot be proud of the way it's prepared for and responded to this pandemic. The UK will have the worst or close to the worst death rate in Europe. That is for a country that has been renowned historically for having very strong public health, for having a national health system and having some of the world's leading epidemiologists and public health people, but it's done badly. I don't want to talk for the US, but I think most people and friends of mine in the US would say the US could also have done better

Living in a COVID-19 World

and we have to learn lessons from that. I think it goes back to some of the polarization that Tom was talking about, at a time of national unity when you need people to come together, we live in polarized countries. At a time when you need clarity of decision making, chains of command, honesty and transparency with the public, certainly the UK is struggling with that and I think that is linked with the response that has happened. We are not passive observers of history. The decisions we make, make a difference. The decisions when to lock down, when to open up, when to test, when not to test, how to invest in research, how to invest...these are decisions which will matter to millions and millions of people and we have to get those decisions right and we've got to get more right than we get wrong and I think, certainly in the UK and I think maybe too in the US, we've got some of those decisions wrong in January and February and we're now seeing the consequences of that.

TB: We have an audience out there that has access to us as well on Twitter and I want to remind them that questions can come in. You can use the hashtag, #livingwccovid. I think I've got that right. Anyhow, we'd like to see some of those questions from our audience who has been very patient in listening to all of this and see what vox pop has to say about where they think this is going and what they learned today. How are we going to see that?

JF: Can I just pick up? I usually agree with Larry Summers, but there is just one area that I would disagree with him on what he said and that is whilst I have the absolute greatest respect for innovation and scientists in the US and friends of mine on this call will vouch for that. The truth is, you don't know where these innovations are going to come from. They may well come from America, you've led science and led innovation for many decades, but it may come from a country that you're not friendly with and yet, you will want access to that. Frankly, if China produces a vaccine three or four years ahead of America, you won't be able to be left behind. And so, whilst I absolutely agree to not get embroiled in complex bureaucracies and get held back by the slowest mover, I'd also ask you not to go back to a purely American approach. I don't think it's in your long term interest. It's certainly not in the interests of the world. US leadership in global health is critical and the rest of the world needs and wants that. So, please don't retreat into an American only approach.

TB: Mike, here's one for you. You've indicated that a manual approach to contact tracing is not effective at this stage in the pandemic. What is the potential for an automatic approach like using Apple or Google or one of our other online instrumentation that we have available? Would that work?

MO: First of all, we have to take a step back. There's been a great deal of groupthink that's happened around this issue. What are we testing, which we put a report out on last week about we don't want to do the kind of testing that's been proposed, we want to do smart testing. This is really strategic, tactical return on investment not just by money, but by actual outcome. The same thing is true with contact tracing. Right now, when up to 40% of the individuals who are infected have no idea that they've been around someone who was actually infectious and it makes for a very difficult time with contact tracing. Every other activity and contact tracing we've ever had in public health had a consequence for the individual we contacted, meaning we had a drug, we had a test, we had something we

Living in a COVID-19 World

could give them. Now, we give them 14 days staying away from other people. We just need to rethink contact tracing. So, I think the electronic device issue is an important one, but when you can't distinguish whether someone was really next to someone or was there a phone near a metal object that then made it seem that they were next to someone, we just have questions we have to answer and we don't have time to set up big elaborate studies. What I worry about though, is we are throwing everything at this without thinking about what can we accomplish, what can we do? If I were an island right now, an island nation that had no cases and I could screen people coming in and if a case did show up, I can do contact tracing that's very, very different than being in an environment where on a given day, 8,000 contacts are entered into a system. So, I think that what I was suggesting is the old methods of contract tracing won't work in these situations with thousands and thousands of contacts. Then we have to think about, so what will? And that's where the creative aspect of contact tracing has to come in and I haven't seen yet that it's really evaluating what can we do.

- TB: Neel, what about small businesses, especially in the food services business, the restaurants, the small markets that specialize in one thing or another? We're already seeing that most of the government aid is going to the big players. Is that going to be an endangered species in America at this pace?
- NK: Well, this is what's so tough. I mentioned during the panel, if this had really just been a two-month shutdown, then the paycheck protection program that Congress passed, roughly \$700 billion, was very powerful in helping these small businesses and these restaurants. A lot of money did go to small businesses. I mean, the media reported on some public companies that got it, but most of the money went to smaller businesses where it was intended. That was an effective bridge for a couple of months, but if this is an 18-month journey that we're on, I think it's really going to be tough for many of those businesses. Some businesses have said, well we'll reopen with one out of every four tables. So, a quarter of our customers, so we can spread. But, can they cover their costs if they have a quarter as many customers? Many of them probably can't, so they may have to change their business models to more of a takeout model. I think, unfortunately, this is really a long hard journey that we're on. I think it's going to be very difficult for some of those businesses to survive and I don't say that lightly because it's going to be very traumatic, probably for their employees, for their owners and for their communities. And then through the end of this, new businesses will need to emerge to then fill those voids that were created.
- TB: And that is on the minds of a lot of people, now that we know more about transmission and guidance and ventilation at the workplace...I recently had an experience in New York. We live in an older building built in 1928. We had a fire on the 14th floor. It was confined to the 14th floor because of the construction of the building, thank God. So, it stayed there, but in a modern building, they're porous, frankly. There is a whole different construct when it comes to the materials that they're using and what happens, so that in one place in the building now is much more likely to go rifling through the whole structure. Neel, you're going to be stuck with that one as well.

Living in a COVID-19 World

NK: That's a good question. In one of my preparation calls, a similar question for me is, what about airplanes? If you're on an airplane, are you breathing somebody else's air from all over the airplane, not just the people around you. Julie Gerberding, I think it was, shared with me that she thought the airplanes were actually designed to be much safer, so you're only exposed to people around you. So, I don't know enough about the ventilation of skyscrapers or big buildings to know how much things spread, but you have to wonder, if they spread in nursing homes and they spread in cruise ships, wouldn't they spread in tall buildings too? It's a very fair question and I don't know the answer to it. I don't know, Mike or Jeremy, if either of you know.

MO: Let me just put a plug in here. We are talking about the need for science. I have seen so many papers or expert opinions come out from people who have no basic background in aerosol science at all. And it really is a very complicated science. I surely don't consider myself an expert although I try to study hard at the foot of experts. And I think this is one of the areas that we need to really improve upon in understanding what does it mean to share air with someone else and what are the implications of that? And I think Tom has said on several occasions and you've said it, people won't go back to these places even if they're open if they don't feel safe. We have got to understand in a much more comprehensive way, how do these viruses transmit and what can we do to mitigate that at the personal level and at the facility level? And I think that we're hurting right now for that kind of information.

TB: I would think as well, that the hospitality business is going to be up against it. I'm talking about hotels and motels. As you know, we've become a nation of variety of hotels and motels and every community of whatever size, you've got a half a dozen choices now and I can't imagine that travelers, once they begin to travel again, are going to just check into whatever hotel happens to be available because that industry itself is going to have to persuade their customers and their industry and their bankers that they're up to it and that's a very costly number, it seems to me. Michael?

MO: I agree. I think this is going to be part of...and I think Jeremy, as you said, how we come out of this pandemic is going to tell a lot about how we will live our future. One of the areas that we have to understand is just that. How do people feel safe in the environment? This is a conversation most people never thought about before. They thought about safety in very, very different ways and now we do have to think about it this way and it's not just this, it's the next pandemic, but I think in general, we had never been conscious of, we share a lot of this planet, we share the air with everyone else breathing and that really does bring new challenges in terms of the transmission of diseases like this.

NK: But, you know, I wonder, and Jeremy talked about this earlier on, what kind of world, what kind of economy are we going to have when we come out of this? I guess I'm a little skeptical that we'll necessarily see major changes, only because we had the great financial crisis in 2008-2009—not much change. The banks had a few more regulations put around them, but they're bigger than they were before. I had expected more fundamental changes in our economy after the shock went away and it didn't happen. And you go back and read history, you had the pandemic of 1918, which was quickly followed by the Roaring 20s. So, our society's ability to forget is actually pretty

Living in a COVID-19 World

powerful. So, I don't know. We have to get through this in the next couple years, but it isn't obvious to me what comes after, if it's so different.

TB: The argument I would have with you about 1918 and the Roaring 20s is, I come from that part of America, South Dakota and the Great Plains, so they weren't the Roaring 20s there, frankly. They were doing the hard labor under very difficult circumstances. The Roaring 20s were confined mostly to the cities, but across America, I was very surprised to learn that in South Dakota, for example, they had almost instantly 280 deaths in a state of a very small population. The Governor had to be hospitalized. They shut down the entire town of Sioux Falls, completely shut it down and now they won't even deal with it when they've got the virus at the meat packing plant. It was an uneven kind of comparison, I think between then and now. And I was looking at some histories of my parents and they kind of almost brushed it off because they dealt with it in some fashion. Everybody kind of took care of everybody else. In this age of mobility and transmission, I just don't think that that's going to be the case. Mostly, I think I'm at a stage in my life when I'm wondering who's going to lead us out of this wilderness and I'm not talking about an individual, but I'm talking about all of you and I'm talking about those who are not necessarily going for elective office, but have an investment in our culture, either financially or otherwise and whether there is a movement that comes up out of this saying, we've got to do better. At the moment, the movement, it seems to me, is, hey, this is not that important. We can go back to the beach, we can go back to the restaurants. That's the movement at the moment. It's much more than the movement of, this is serious, folks. What are we going to do about it? So, that's I think the next hurdle we have to get over.

JF: Tom, we've been 140 days, we've been three or four months into this. If you compare great events in history, three or four months in, they weren't how they panned out in the end. Yeah, the Roaring 20s had a pretty good decade in some places, but they ended with the Great Depression and the 1930s wasn't a great decade either, to be honest. So, I think we haven't seen and actually, I don't feel the world has really got its head around the implications of this yet. The implications that this isn't just going to go away when the sunshine comes, that it isn't going to completely circulate...it will stop circulating after a few months. We've heard that 5% of Americans have been affected and that's 95% that have not. So, I don't think, in the non-health sector yet, there's really quite an appreciation that this isn't just a six-month thing, that it is actually going to have to think through 2, 3, 4, 5 years. And I was a junior doctor in the middle of the HIV epidemic and was promised a vaccine within 2-3 years. 40 years on, we don't have a vaccine. So, the last comment I'd make is, unless we invest in a scientific exit to this, then we are going to be using 19th Century interventions, which are powerful, but they're not an exit strategy. And in Julie's comment earlier about the Moon Shot, we're still reaping some of the benefits of that moon shot in the 1960s and if you invest in science, you'll solve this problem and you'll actually help rebuild your economy as well.

TB: My final observation is that, some of you know that I've written a lot about World War II and the economic and cultural climate at the time, part of the reason that we were prepared to go to World War II is that in the lives of a lot of the young people who stepped forward, it was an improvement. I talked to any number of them who said...I

Living in a COVID-19 World

said, what do you remember about boot camp? They said, they said, God, I'd never had a breakfast like that before, I'd never had boots like that before. I had new outfits to wear every day and we're all in it. Now, we're coming off this high, high in this country in terms of low unemployment, people kind of having what they want to have and it's a tougher call for them. It's a tougher transition for them to make.

Well, thank you all very much for being here. It was my pleasure to listen to all of you and I hope that others were listening and will act as well, not to me, but to you as well and we'll look forward to hearing more from you because, as you indicated today as you do every day, this is a long way from over and it's the greatest test in recent decades for this country and we hope to God that it doesn't get worse, that it begins to get better. But, the chances of that really, as you know better than I do, are a bit of a reach. So, thank you all very much. I know that we've generated a lot of conversation around the country, which is also important. Thank you.

[02:57:46 end of video]