Dr. Dylan George
About 50, 60 years ago, we weren't very good at numerical weather forecasting. The federal government spent a lot of money to try to help us get better at numerical weather forecasting, to the point that they invested in modeling, they invested in data systems, they invested in ways of collecting new data, and our ability to anticipate what's happening in the weather has improved markedly. That's what we want to try to accomplish with infectious disease forecasting, with infectious disease capabilities.

LuAnn Heinen
That's Dylan George, Director of the Center for Forecasting and Outbreak Analytics, CFA for short, at the Centers for Disease Control and Prevention. An expert in analytical approaches to infectious disease monitoring, Dr. George was recruited from the private sector to lead CDC's renewed effort to build the data and analytics capabilities necessary to guide interventions in public health emergencies and pandemics. In its short history, CFA has already been engaged to help manage a local measles outbreak, address Mpox concerns, and monitor H5N1 bird flu in dairy cattle.

I'm LuAnn Heinen, and this is the Business Group on Health podcast, conversations with experts on the most relevant health and well-being issues facing employers.

The COVID-19 pandemic taught us the importance of a quick, coordinated, and data-driven public health response, and the need to prepare for future outbreaks. Today, Dr. George makes the case for disease forecasting to help achieve these aims. He explains what disease forecasting is and why it matters, with real-world examples of how such data motivates better decisions. We also discuss how businesses can benefit from forecasting and outbreak analytics, including the ability to leverage CFA's modeling tools.

Welcome, Dylan, to the Business Group on Health podcast.

Dr. Dylan George
It's great to be here. Thanks for having me.

LuAnn Heinen
Yes, well, you're the first director of the Center for Forecasting and Outbreak Analytics at CDC. It's a Center that aims to provide better and faster information to protect public health during a disease outbreak. We'll get into that. First, though, tell us a bit about your past work in the private sector, at the White House, and with DOD related to mission readiness.

Dr. Dylan George
Thanks for the opportunity. I was an academic for a handful of years and then I decided that I was going to work in the federal government to help out in a couple different venues. So, as you've mentioned, I worked in the Department of Defense. I also worked in the Biomedical Advanced Research and Development Authority in Health and Human Services, and then I worked in the Office of Science and Technology Policy in the White House. In all of those positions, though, I was using data or advanced analytics to help us understand, mitigate, or confront infectious diseases in some capacity, so that we could actually be either the warfighter or civilians would be more prepared to meet infectious disease outbreaks in some capacity. Recently, before joining the CDC, I was working in the private sector, as you'd mentioned, at a great organization called In-Q-Tel. It worked like a venture capital organization that invested in companies that were trying to develop things that would be useful for national security. What I did for them was I vetted data technologies and biotechnologies that could be potentially useful for a pandemic response in some capacity.

LuAnn Heinen
So it seems you have specialized skills that really add value to seemingly diverse organizations, but as you say, there's a sort of a thread line. Was this strategy on your part or serendipity?

Dr. Dylan George
It was a bit serendipity. Some people looking at my career trajectory and look at it as a bit peripatetic and bouncing from place to place, but it's like all in the service of trying to advance capabilities that could be used to keep people safe during an outbreak. There was just progressively more opportunities in different

organizations and they presented themselves in such an interesting time to actually keep moving forward. I think this goes to a broader point, though too, is that we do live at this transformative time in history right now where there is a lot of data technology and a lot of other biotechnologies that are available to us right now, but we're not using them as effectively as we can within public health to keep people safe from outbreaks. We experienced that during the COVID pandemic and we've seen some of that going forward. It does present a lot of opportunities of how do we use those technologies more effectively. And that's one of the reasons why I came to CDC is to build this new organization that would generate new capabilities that would keep people safe during an outbreak. So that's why I've been very grateful for the opportunity to be here at the CDC and to be a part of the exceptional team that is building this new capability.

LuAnn Heinen
That's great. It's exciting news. Have we not been using those technologies? What are the reasons why?

Dr. Dylan George
It's a great question. One of the challenges that we've had, public health is one of those things that is invisible if it works well. And so we tend to ignore it if it's working well all the time. Unfortunately, we've underfunded public health for the past 20 or 30 years. Some of the cracks in the public health foundation that we've seen over the last while, because we've underfunded it as a nation, came to bear during the pandemic. But the thing that's been exciting about this, it does present these opportunities to actually do better and to do more going forward. Again, that's one of the reasons why I came back to the federal government to help build this new organization such that we could have better resources and better capabilities to keep Americans safe.

LuAnn Heinen
There was quite a bit of criticism of CDC during the COVID-19 crisis, really enough to begin to threaten the credibility of such a well-respected science-based agency. It seems that the Center for Forecasting and Outbreak Analytics created in the back half of the pandemic is a truly positive response.

Dr. Dylan George
There were challenges that were presented due to the pandemic and the processes and the performance of how we were doing as public health. Some of those were warranted and we need to take them very seriously and improve upon them. Some of them I think were off base, but also it did afford us this opportunity to find ways of actually improving our capabilities. The Center for Forecasting Outbreak Analytics is exactly one of those things where one of those capabilities of how do we use data more effectively to keep Americans safe and to help them both at the federal, state, and local levels know how to actually use different interventions more effectively. That's what we're really about. Our ultimate objective is to use advanced analytics more effectively to extract as much information as we can out of the available data to keep people safe. It is an exceptional opportunity that we have right now to improve upon the general public health enterprise going forward. That's one of the reasons why we're really excited about it.

LuAnn Heinen
CFA has been compared to NOAA, National Oceanic and Atmospheric Administration, for weather forecasting. Do you like that parallel?

Dr. Dylan George
There's certain things about that analogy that are useful. For example, people don't fully appreciate that about 50, 60 years ago, we weren't very good at numerical weather forecasting. The federal government spent a lot of money to try to help us get better at numerical weather forecasting to the point that they invested in modeling, they invested in data systems, they invested in ways of collecting new data. And our ability to anticipate what's happening in the weather has improved markedly over that 50, 60, 70-year trajectory to the point now that I guarantee that almost everybody listening to this podcast has some sort of mobile device that they check the weather on and they make decisions based on that information in acute way. For example, last night where I live in the D.C. area, a thunderstorm came through and I knew exactly when the rain was going to start and when it was going to end and when I needed to stay inside. It helped me keep myself and my kiddo and my wife safe in the face of that severe weather. That's what we're inspired by. That's what we want to try to accomplish with infectious disease forecasting, with

infectious disease capabilities. Now are we where the National Weather Service is or where NOAA is and being able to affect this and be able to develop those forecasts? Absolutely not. We're in the early stages of developing this and moving forward. But that analogy we do take a lot of inspiration from and we try to pattern after them in a lot of ways and how they do business. There's challenges with that analogy but it's a very strong one as well.

LuAnn Heinen
One of the other things you said that struck me is infectious disease causes acute social disruption. We certainly experienced that in COVID with loss of life on a massive scale, you know, trauma for survivors and so on, health care providers, mental health effects. What did you mean when you said that? Was it that, yeah, I think it's trying to bring awareness to the importance of disease forecasting because it's a little bit out of sight, out of mind.

Dr. Dylan George
Yes, I mean one of the things that we see with natural disasters is when a natural disaster hits like a hurricane coming and bearing down on the East coast of the United States, I mean it's an opportunity for people to come together and to really help one another out to prevent and to recover from that natural disaster in a really acute way. And it's really impressive to see how Americans really stand up for one another and take care of one another in those really stressful times. What was really challenging about infectious disease outbreaks is it really tears at that social fabric because how we interact with one another, it creates challenges in how we connect with one another and how we have to interact. So it really tears at that social contract that we have with one another going forward in a way that natural disasters don't really do. As you pointed out, there was a lot of mortality and morbidity associated with the pandemic and it just, you know, it breaks my heart to think of some of my friends who have lost family in COVID and trying to think about what could have been done better to help them know the risks that they were confronted with so that they could have avoided some of that. That's one of the things that really drives me and drives our team is can we give people better information going forward so that we avoid that morbidity mortality, so we avoid the challenges that we have in interacting with one another and we're going forward.

LuAnn Heinen
What are some of the sources of data to forecast and build models?

Dr. Dylan George
The traditional sorts of data that are used for developing different analytics in an outbreak are things like the number of cases of a particular outbreak, where they're located, the laboratory data, the death records, the immunization status, or how much immunity is in the population or the serosurveys and things along those lines. That's the traditional data, so death records, hospitalization records, case counts, and things along those lines. That's the kind of lifeblood of what we use to forecast what's going on in a community and what we anticipate that community is going to see over the next handful of days to weeks. We're also very interested in exploring new data sets and how they can help us in unique ways. For example, there's been a lot of discussion about wastewater data because the waste through our toilets actually excrete different viruses and different pathogens. As we use the toilet, we were able to actually discharge those and we actually able to pick up various outbreaks and various infections in the community and abroad. So we can use that kind of data as well to understand how a community is being impacted by an outbreak. In fact, there's some real strong advantages of using some novel data like that in terms of it's faster, meaning it takes less time for us to actually get that data going forward. So we can actually use that data to understand how the pathogen is circulating in the community, but then also anticipate how it's moving forward. We're not only looking at the traditional data sources, but we're looking at some of these novel data sources to improve our capabilities in forecasting as we go.

LuAnn Heinen
I saw the article in *Nature*, you were quoted, the article's called *What the Toilets Can Tell Us*. Pretty catchy. It does make you think though, is it a sampling process? I mean, how is all that volume of data in all those places, all the zip codes or wherever, evaluated?

Dr. Dylan George
Yes, my colleagues in the National Wastewater Surveillance System, they affectionately refer to that as NWSS, have been doing an exceptional job of supporting infrastructure to collect, test, and analyze that data and so then make it available. And they've been exceptional partners working with us to actually incorporate wastewater data into infectious disease forecasts for influenza and for COVID. There has been a concerted effort to support that kind of infrastructure going forward. It's critically important that we keep doing that going forward because it's been an invaluable resource that we've been able to develop over the last handful of years.

LuAnn Heinen
I think you've also said that these wastewater data are a really good leading indicator for the COVID-19 burden on hospitals. That means you've got to look at lots of geographies to figure out, I guess, which hospitals are going to be feeling the burden.

Dr. Dylan George
Exactly and one of the things that has been very exciting about building the Center for Forecasting Outbreak Analytics is that what happened with us incorporating wastewater data into hospitalization forecasts for COVID-19 is that we really want to have a good assessment of what is the burden that a hospital and hospital system is going to experience. Because if our hospital system goes down, that means there's bigger problems across society in a lot of ways. Going back to this social disruption topic that we were discussing earlier, we really want to have good analytical capabilities to do that. Now, one of the challenges that we've had with wastewater data is it primarily helps us understand what is the disease that is circulating in the community. It doesn't really help us understand what the hospital burden is going to be. They're translating it from what's circulating in the community to what the hospitals will experience in terms of burden hasn't been what wastewater data has been exceptionally good at until the team within CFA was able to work with our colleagues in NWSS and look at that data and incorporate it into the hospitalization forecast that we have developed. And lo and behold, it was because CFA exists, we were able to actually do that research very quickly and not only demonstrate that it can be done, but we operationalized it and pushed it out to over 40 different jurisdictions across the United States, so they had wastewater informed forecasts of hospitals burden due to COVID at their disposal. So not only did we develop a new capability, but we pushed it out into an operational context very quickly and if a CFA didn't exist, that would not have happened as fast as it did.

LuAnn Heinen
That's awesome. I know you have some more examples of data forecasting in action. Maybe talk about the Chicago experience.

Dr. Dylan George
One of the things that within the United States, the public health infrastructure is, it's a federalism system so a lot of the authorities and action happens at the state and local level, and so we're in a support role at the federal level to try to help our colleagues that are doing the really heroic work on the front lines. So recently, there was an outbreak in the spring of 2024 in Chicago of measles. They reached out to us to help them with technical assistance to actually model the ongoing measles outbreak so that they could understand, it's like, is it getting worse, is it getting better, or are we in the throes of it, or are we coming out of the forest in this outbreak? We were able to help them forecast what was going on in that outbreak. But not only that, we were also able to put together what we refer to as scenario models to help them think through the complexity of the outbreak. So if they used mitigation package A versus mitigation package B, what would be the logical conclusion of doing that going forward in a counterfactual thought experiment? Models are really good for helping you think through those complexities. One of the things that was very gratifying about that is that our colleagues on the ground in Chicago were able to use that information to talk with the political leaders about, you know, it's like going big to really confront this measles outbreak. It wasn't the only bit of information that they used to justify going very strongly against that. Our modeling did show that going with a rapid intervention would be significantly more effective at reducing the infection, and it would reduce by hundreds of cases. Fewer people would have cases if they would go big. They convinced them to do it and they went big. And, you know, I'm a big fan boy of what the folks in Chicago were able to accomplish in terms of the numbers of vaccinations and the speed with which they were able to do it. But they were able to get that measles outbreak under control very quickly. I

was very humbled and grateful for the opportunity to support them in their efforts, both through the measles forecasting, but also the counterfactual scenario modeling that helped them make the case to go big and to go fast on responding to that. They are the heroes on the ground. We were just supporting from a distance. They did a fantastic job and I was humbled to be a part of helping them out.

LuAnn Heinen
That's a good story and probably great marketing to other states and local communities, cities, and counties who may need help going forward. You know, I hadn't thought much until getting ready for this interview about just how many infectious diseases there are in the world. We kind of think globally about this, as we know, things travel across borders. So what are the infectious diseases or pathogens of focus and how do you prioritize what to monitor and model? I know you'll get special requests like the measles request, but when you're being proactive, how do you decide what's important?

Dr. Dylan George
Yes, it's a great question. It's hard. Quite honestly, it's very hard because as you mentioned, there's lots of pathogens out there and lots of issues that public health needs to address to keep people safe from infectious diseases broadly. Now, because we are a new organization, because we're relatively small, and when we first started out, we were five people and now we're about 80 people, we're able to take on more bandwidth and more problem sets and that sort of thing, but in our early stages, we're focusing on respiratory infectious diseases that would cause, you know, social disruption. So the biggest ones out there right now are COVID, influenza, and RSV. They're the big three respiratory pathogens that cause a significant hospitalization burden. You know, it's like we've been helping out with a range of other outbreaks, like I've already talked about the measles outbreak. We're helping as well with the Mpox outbreak back in 2022, and we're also helping our colleagues in the National Center for Emerging and Zoonotic Infectious Diseases right now with preparations for a potential Clade 1 infection, if that were to spread much more broadly than where it's currently located in the Democratic Republic of Congo.

LuAnn Heinen
I didn't get Clade. What is that?

Dr. Dylan George
Yes, sorry. There's at least two variants of Mpox. In 2022, the Clade that was transmitted and caused the big outbreak, not only in Africa, but also in Europe, in the United States and other places globally, was referred to as Clade 2b. That had a certain contagiousness and a certain virulence associated with it. You can think of a Clade as a new variant that is circulating. Clade 1 Mpox is circulating within Democratic Republic of Congo right now, and we're watching it very closely to see how it moves about and how it potentially could explode and break out in other places in the world like it did in 2022, like Clade 2 did. The reason that this is concerning is Clade 1 Mpox, it's more contagious and it causes more virulence or it causes more disease. We were actually able to use scenario models to understand and explore the impact of this new Clade if it were to spread much more broadly in the United States. What kind of impact would that have and where would we be most vulnerable in the United States? So that was another example of how scenario modeling can help us prepare for and anticipate different challenges. That was one of the reasons why we're focusing so much on this Clade 1. It's more contagious and it's more virulent and it could cause problems like Clade 2 did two years ago.

LuAnn Heinen
What about H5N1? Are you looking at that as well?

Dr. Dylan George
Yeah, our colleagues in the National Center for Immunization and Respiratory Diseases have been very focused on following the infection of H5N1 influenza in dairy cattle right now. It's a very concerning issue largely because the case fatality rate for H5N1 has 40% to 50% based on the data that we've seen globally over the last 20, 25 years or so. The one saving grace that we have with H5N1 is that it actually doesn't transmit very well among mammals because the receptors that we have versus the receptors that birds have are different. So birds are more susceptible to the infection than humans are. What's concerning about the H5N1 event is that it's transmitting within dairy cattle. They have similar receptors to what we do in humans and so if it transmits more effectively in mammals, then humans would be at higher risk. And

if the case fatality rate would hold steady with H5N1, you can see the concern that it would be a big issue for if it transmitted within humans and we would be very concerned about what kind of loss of life we would have there. We've been following it very, very closely, working with our colleagues at the state and local level to track all of the dairy cattle cases, what herds are infected and who's infected. Gratefully, it doesn't transmit so far as well in humans. There's only been four cases and there's largely been conjunctivital or infections in people's eyes. And so they've been very mild, but that's why we're paying a lot of attention to it. Now, how we've been helping out with that is one of the things that we did early on in the outbreak is we were working with our colleagues at Northeastern University, who we fund to do some work and do some innovation. They were able to put together an assessment of where dairy cattle is being moved and transported within the United States to help us assess what would be risk areas within the United States, because a lot of the H5N1 was being transmitted amongst herds by moving cattle about between states. They were able to put together the transportation model that shows where the highest number of cattle were being moved from state to state to give us a sense of what would be the risk of particular states that are not currently infected going forward, so they could start thinking about whether there should be some movement restrictions or at least testing for those movements. That was one example of how we were trying to help out in that case to do some assessment of where risk was greatest for H5N1.

LuAnn Heinen
Well, I can see that you really do need partners around the country and the world. You can't have boots on the ground everywhere and you need relationships and people who are partnering with everywhere.

Dr. Dylan George
Exactly. As the director of the CDC, Mandy Cohen, likes to say, public health is a team sport and we need to work together.

LuAnn Heinen
Are you thinking about any areas beyond respiratory diseases?

Dr. Dylan George
We are thinking about areas other than respiratory diseases. Now, there's a lot of other infectious diseases that are of high consequence as well. We saw the Zika outbreak a handful of years ago that went pandemic, and that's a vector-borne disease. We're also experiencing a lot of dengue outbreak, especially in South and Central America right now. There's colleagues within CDC that do a lot of work on all of those areas on vector-borne diseases, and we're going to potentially be supporting them in the years to come. Now, also in the space of chronic diseases, we're very interested in trying to find ways of helping out with understanding the distribution of chronic diseases as well. Because as we experienced during COVID, it was hard to understand or to get a good sense of where people that had multiple comorbidities or things like heart conditions or diabetes or things of that nature, where they were, how they were being impacted by COVID, and so we do think that we need to work as well on chronic diseases such that we can have a better understanding of how an infectious disease would go across the population as well. So we do anticipate that we will expand our focus beyond respiratory infectious diseases to include things like vector-borne diseases or direct contact infectious diseases, but then also chronic conditions as well.

LuAnn Heinen
What do you see for the future? Are there future focus areas and goals as you continue to grow? And I hope that you're successful in your budget requests.

Dr. Dylan George
Yes, definitely. We are very excited about the team that we've built. They are crazy good. We're very excited about the tools that we're building in terms of the forecasting tools, the scenario modeling tools, the ability to actually assess different diseases much more quickly and making them much more broadly available. We're excited about the partnerships that we're strengthening and expanding. The example that we had working with our colleagues in Chicago, we wanted to expand our ability to support other cities and other states in some of the technical assistance that they might need in confronting different outbreaks. We're very excited about the successes that we've had so far. We need to continue to build the

team, the tools, and the partnerships to meet our mission going forward. And that's going to be the focus over the next handful of years as we move forward.

LuAnn Heinen
How can businesses leverage CFA's modeling and perhaps benefit from forecasting and outbreak analytics? I know that you've said transparency and public access is a goal.

Dr. Dylan George
Yeah, we really want to make our tools and our results as broadly available as possible. So we're going to be making the code that we use for our modeling as broadly available as possible. We want to do this for a couple reasons. One, we want different jurisdictions or even private sector entities, if they want to use those models for their purposes to keep their employees or their citizens in those particular jurisdictions safe, they can take them off the shelf and use it, apply it how they would. We also want to have this like peer-to-peer engagement with people where it's like, you know, if we make a mistake or if we could do the forecasting functions better within the modeling and within the code, we want people to help us improve what we're doing. So we want to use it as a way to a peer-to-peer improvement process. And then also, we just want to make sure that they can evaluate the algorithms and the approaches that we're using. They're the best ones if they're fit for purpose. Different jurisdictions or different private sector organizations, different businesses can use those models to assess their particular populations. We're hopeful that people will do that and we would want to partner with them as they go about that process. Then we're also hopeful that, you know, businesses will use the forecasts that we're generating, just like you would with a weather forecast. We need to get to that point where people understand the forecasts that we're putting out and intuitively how to use them for decision-making either at the private sector, within public health jurisdictions, or in other places. So we're really anxious to hear feedback on how we're doing, number one, but then also how we're communicating those results effectively so people can use them.

LuAnn Heinen
Well, another analogy is air quality analysis. People are increasingly using that to decide is today a running day or am I going to work out indoors.

Dr. Dylan George
Exactly. Same kind of idea.

LuAnn Heinen
What is it that keeps you up at night, Dr. George?

Dr. Dylan George
Yeah, well, outside of my seven-year-old kicking me in the stomach while he sleeps next to me, definitely thinking about, you know, the next pandemic. We live in an era of infectious disease outbreaks, without a doubt. We are going to experience another pandemic within our lifetimes. I'm pretty convinced of that. So one of the reasons why I came back from the private sector to help build this capability at CDC is to make sure that we have better capabilities that will help people use information so that they can be enabled to make decisions to keep themselves, their families, and their communities safe during a pandemic. I've been telling stories about my son, too. It's like thinking that he would have, if we were wildly successful in the Center of Forecasting and Outbreak Analytics, we will develop over the next 10 to 15 years, we will develop capabilities similar to what you might have in weather forecasting, or at least we'll make significant advancements in that space. He will experience a different world than I have growing up, because these new capabilities will be out there. And that's the kind of thing that really drives me. It drives, I know, a lot of the people within CDC broadly, and also within the CFA as well. They're very mission-focused. They're very driven to try to make an impact in the world, and using advanced analytics to help people have as much information as they possibly can to make the right decisions to keep themselves safe is what really drives them and it drives me, and that's why I really love working with the team that I'm on at CFA. They're just absolutely wonderful.

LuAnn Heinen
Well, thank you for that. That was great. Thank you so much for your time today, Dylan. It was great.

Dr. Dylan George
I appreciate the time. Thanks for having me.

LuAnn Heinen
I've been speaking with Dr. Dylan George of the Center for Forecasting Analytics at the CDC, who likens disease forecasting to weather forecasting. Both provide timely, actionable information to help people stay safe. Listeners can find out more about CFA by visiting the CDC website.

I'm LuAnn Heinen, and this podcast is produced by Business Group on Health, with Connected Social Media. If you liked this episode, please rate us and leave a review.