Q&A: Modeling measles amidst a global disruption in vaccine supplies

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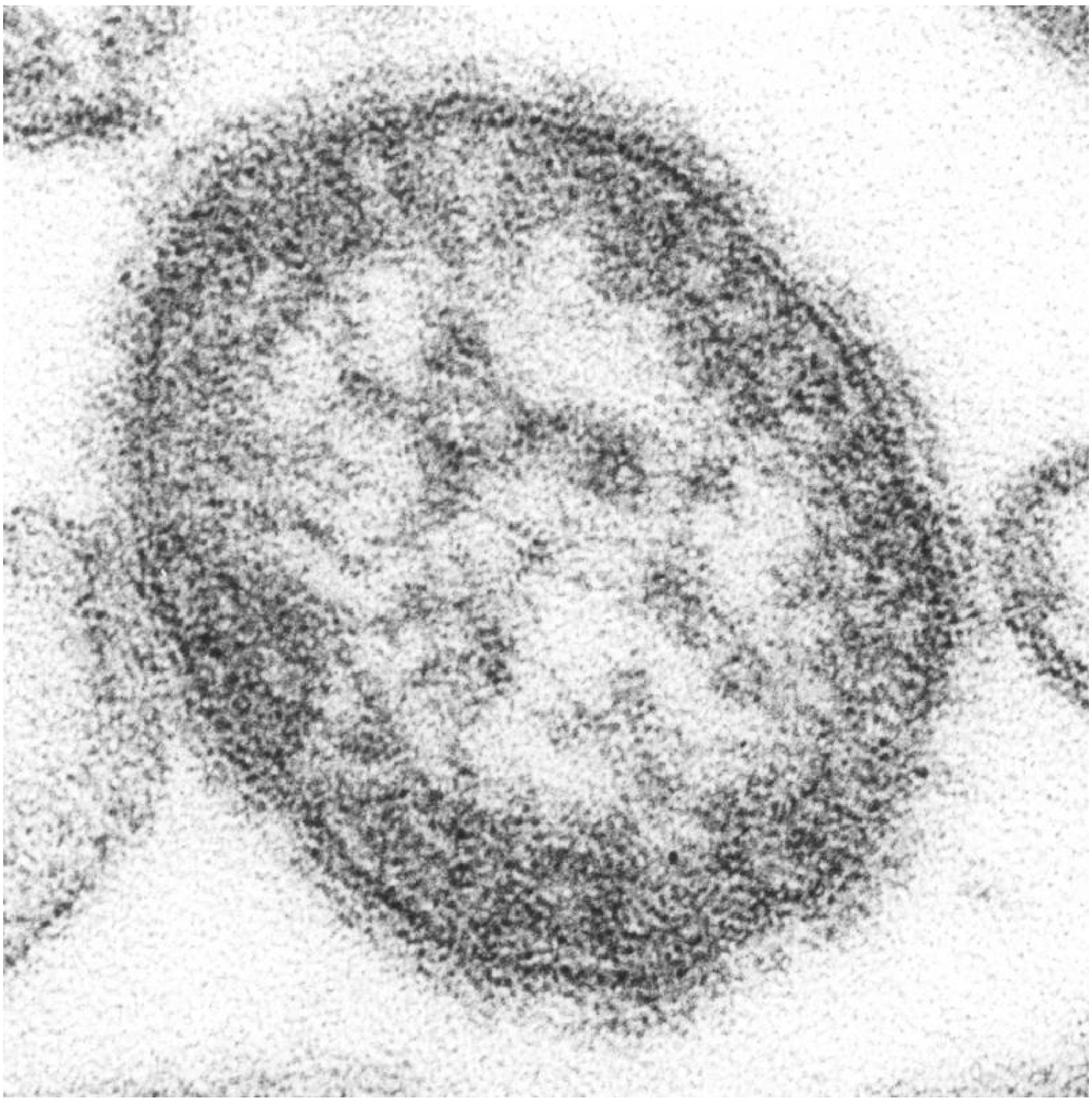

An electron micrograph of the measles virus. Credit: CDC/ Courtesy of Cynthia S. Goldsmith

Measles vaccination rates among children worldwide declined during the COVID-19 pandemic to the lowest level since 2008, likely due to lockdowns and difficulty accessing vaccines. According to a new report by the World Health Organization (WHO) and the U.S. Centers for Disease Control and Prevention (CDC) that published today (Nov. 17) in the CDC's *Morbidity and Mortality Weekly Report*, this drop in vaccination coverage led to a 72% increase in reported measles cases and a 43% increase in measles deaths during 2021-22.

Report co-author Matthew Ferrari, director of the Center for Infectious Disease Dynamics and associate professor of biology at Penn State, began working with the WHO in 2010 to develop models to estimate the burden of measles disease globally. Ferrari spoke with Penn State News about the team's most recent findings, as well as his experiences over more than a decade providing guidance to the world's leading health agency.

Q: How did you get involved in helping the WHO study measles?

In 2010, the WHO put out a request for proposals to develop models to predict measles cases and deaths globally. I wasn't even a faculty member yet, so I was very excited to get this award. After I helped to develop the initial models, the WHO was able to run them on its own for several years. However, in 2020, it became apparent that the models needed to be updated.

Q: How did the models change over time?

Initially, the WHO used a simple demographic accounting model, which included the number of births and deaths in each country and the number of people who received measles vaccinations in those countries. They then applied the same multiplier for all countries to determine each country's measles risk.

The problem was that the model didn't include actual measles surveillance data, so it didn't reflect the number of cases countries were seeing on the ground. The reason they left out the surveillance data was because they were worried that the data weren't informative enough. They knew that the number of reported cases was just the tip of the iceberg, and it's hard to know what the rest of the iceberg looks like. Unfortunately, it meant that the policy recommendations weren't as useful as they could be. We came up with a way to estimate the underwater portion of the iceberg so this information could be incorporated in the models.

Another update we made was to add a calculation that accounted for the new data that came in each year. So, not only do the models now estimate what is happening in the current year, but they also refit the entire past and incorporate it into the new prediction.

Q: What do the newly updated models reveal?

We found that following a dramatic decline in measles vaccine coverage during the pandemic, reported measles cases increased by 72% and estimated measles deaths increased by 43% during 2021-22. However, as of 2022, measles vaccination rates were showing signs of recovery, with 83% of children receiving their first dose and 74% receiving their second dose.

Q: Why are the findings important?

Measles is a highly contagious, airborne disease that can cause serious illness and even death. That's why it's critical that children everywhere benefit from the lifesaving potential of two doses of the measles vaccine. Additionally, the ability of a country to deliver measles vaccines in early childhood is an indicator of its ability to provide other essential vaccines, so our data revealing low measles vaccine coverage could reveal failures of the health system to reach children more broadly.

Importantly, measles represents a global disparity in access to health care. While the number of children dying from measles each year has declined, the probability that a child with measles will die has actually gone up. This is because the places that have been most left behind by global development and improvement in vaccination programs are also the places where there's the lowest access to care. In these places, kids who get sick are more likely to suffer their measles disease in the home, and therefore, are more likely to die. We're in a situation where the last mile is the hardest.

Q: How might the findings influence health care practices?

There's a cautionary tale here about how important it is to maintain vaccination programs. We learned that measles can come back. We also learned that there is a lag between a decline in vaccine coverage and an increase in disease cases. It took almost two years for the repercussions to hit, and that's powerful information for planning. If you know the amount of time you've got to play with, then you can plan much better. Those are the kinds of insights we gained from this year's analysis, and we can incorporate them into subsequent planning so countries can account for future disruptions.

This is particularly important given that disruptions due to disease pandemics, climate change, military conflict and others are expected to increase in the future as the global population continues to rise. These types of disruptions tend to hit things like preventative care first. When people go into survival mode, they're more worried about staying alive today than planning for the future. We need to acknowledge that and plan to fill in the gaps after those disruptions happen.

Q: Why did you decide to become a modeler rather than a clinician or experimentalist?

The classical experimental scientific method is a better way to do things. However, it's an impossible way to explore different vaccination strategies. You can't do that on human subjects; not only is it unethical but it would be difficult to find comparable populations where you can have a control and a treatment group. Mathematical models give us an objective way to address these kinds of problems that cannot be addressed with conventional experimentation.

Q: What is it like to provide guidance to the world's leading health organization?

It's exciting to know that the data we generate directly impact how much money is allocated for measles programs, and ultimately, the number of measles cases overall. But it's also daunting because there is a finite amount of public health money in the world. If too much gets spent on measles, there is less available for other things. We have to be as accurate as possible with the numbers and as transparent as possible about the models' limitations.

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