

Why are we seeing so many public health challenges? And what can we do about it?

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It seems like a particularly troubling time for public health, both in the U.S. and internationally. The [first U.S. case of polio in 10 years](#) was diagnosed in New York. There have been a number of [unexplained cases of hepatitis](#) in children. [Tuberculosis cases are on the rise](#). And there's been [an uptick in cases of scarlet fever](#) in the United Kingdom. What's going on? And what can we do about it?

To learn more about some of these broader [public health](#) challenges, we spoke with Julie Swann and Matt Koci. Swann is a systems engineer with expertise in public health whose work focuses on making [health care](#) more efficient, effective and equitable. Swann is the department head and A. Doug Allison Distinguished Professor of the Fitts Department of Industrial and Systems Engineering at NC State. Koci is a virologist and immunologist whose work focuses on host-microbe interactions; he is a professor in NC State's Prestage Department of Poultry Science.

The Abstract: It feels like we're seeing an increase in both the emergence of new diseases, such as COVID-19, and a re-emergence of diseases that many people associate only with history books—such as polio and scarlet fever. What's contributing to this apparent increase in public health problems?

Julie Swann: I think there are a couple of things going on. We may have more attention from the media on reporting disease, and we could have more awareness from the public about the potential of a new outbreak to impact our lives. Those are generally positive.

On the other hand, I do think that we are seeing disease trends that matter, in terms of new diseases (e.g., from Zika virus), diseases affecting new populations or transmitting in new ways (e.g., monkeypox), and diseases reoccurring that were almost eradicated (e.g., polio). I expect these to continue over the coming years. We have almost 8 billion people in the world, and that is projected to grow to almost 10 billion by 2050. We have an increase in natural disasters that can lead to displacement of people and animals, bringing them in critical contact. Compared to previous centuries, the level of global travel and connectivity is astounding. Science has delivered us effective vaccines

for some diseases like polio, although the (unneeded) rise in vaccine hesitancy is leaving communities vulnerable to preventable disease. We also do not focus enough of our resources on preventing disease in the U.S. and globally, and we find ourselves scrambling to respond to new, preventable, or neglected diseases. Unfortunately, I expect this to be the "new normal."

Matt Koci: The answer depends on which disease you're talking about. The new diseases are the hardest to know for sure. Some of it is just really bad luck. The wrong person comes in contact with the wrong wild animal infected with a strain that just happens to be well suited for jumping to humans. The more humans move into previously wild areas, the more the numbers of these interactions go up, the more the likelihood of that happening goes up year after year.

Then we have diseases that aren't new but historically they've only happened in one region of the world and now they're moving into new areas. Dengue fever, chikungunya and Zika are good examples of these types of diseases. As the mosquitos that carry these viruses move into new geographic areas they bring the viruses with them. This is going to continue to get worse as climate change allows for these insects to continue to expand where they can survive.

Then we have antibiotic resistant bacteria. The causes of antibiotic resistance are complicated, but the short version is that we've overused antibiotics for too many years. Human medicine, veterinary medicine and agriculture still squabble over who deserves the most blame, but at this point that doesn't really matter. We are quickly running out of antibiotics that work, and it's increasingly likely that we will go back to a world where any simple scratch or puncture could lead to a fatal infection.

Lastly, we have the most maddening of all the reasons: the growing anti-

science and anti-vaccine movement. We're seeing a return of things like polio and measles, diseases we had under control in the U.S. The anti-vaxxers got a lot of press over the past two years related to the COVID-19 vaccines, but really they've been working hard to undermine these lifesaving tools for a lot longer. Whether it was Jenny McCarthy on Oprah in the 90s, or Facebook groups over the past 20 years. COVID-19 just gave them the opportunity to take their anti-science rhetoric center stage. Along with indoor plumbing and blood transfusions, vaccines are among the top three medical advancements in all of human history. They are credited with saving over a billion lives.

The data on vaccine effectiveness as a public health tool is undeniable. But the real public health power of vaccines is how when everyone who can get vaccinated does, they end up providing protection for those who can't. That system of looking out for each other is the reason why measles, mumps, rubella, diphtheria, pertussis, polio, smallpox and tetanus are all rare to nonexistent in the U.S. It is enraging that a handful of people trying to make money selling conspiracy books and quack cures have gained enough of a following that now we are seeing a return of some of these diseases. If these trends continue, it's possible we see more come back.

TA: At what point does an increase in cases stop becoming a 'surge' and start becoming an 'epidemic' or a 'pandemic'? And what's the difference between an epidemic and a pandemic, anyway? Does the distinction matter?

Swann: It is confusing, isn't it? Informally, I think of a surge or outbreak is an unexpected rise in cases in a community or geographical area; an epidemic is an outbreak that is broader (such as across communities or national); and a pandemic is an epidemic that affects multiple countries

and typically requires international collaboration. It can also be useful to include the term "endemic," which means a disease is usually present in a population and fairly stable (even if not desirable). Now you know something from Epidemiology 101.

The distinction does matter for some purposes, although different language is typically used. A few years ago the World Health Organization began using a designation of "Public Health Emergency of International Concern," which many consider to be equivalent to a pandemic. There is a legal definition, and it is important for the 196 countries who participate in implementing International Regulations. It means there is a public health risk that is serious, affects more than one country and may require international actions. It can catalyze international collaboration and funding. Under these regulations, from 2005 to 2020, five outbreaks (associated with H1N1 influenza, polio, Zika, and twice for Ebola) had been declared a PHEIC, and two have been declared recently (COVID-19 and monkeypox).

Within the U.S., the secretary of the Department of Health and Human Services can declare a public health emergency. This allows for things like access to additional funding, modification of telemedicine rules, waiver of some paperwork or authorization requirements, etc. Individual states can also declare a "State of Emergency," as many governors did in 2020 (such as the declaration from Gov. Roy Cooper). These declarations can also give hospitals more flexibility in staffing, such as utilizing retirees or students to supplement other staff when demand exceeds capacity.

While these designations have real, tangible impacts on the system, they may or may not impact individuals, depending on where they live and their risk factors. However, even if it is not in your community yet, it may be important for states and countries to address in order to help prevent the disease from reaching more communities.

Koci: The way the terms are used in the media I think some have the impression that endemic, outbreak, epidemic, and pandemic are the disease version of the hurricane category system, where each step up means the disease is a more serious threat to them personally. That's not how it works.

The disease is going to cause the level of illness in each infected person, no matter whether we call it an outbreak, an epidemic or a pandemic. What the different terms tell us is how widespread the disease is. An outbreak could be something like norovirus going through all the students in a classroom. Whereas an epidemic involves cases over a wider geographical area. Could be a whole neighborhood, county, state, country or larger region. A pandemic is essentially an epidemic that's going on everywhere on Earth at the same time.

TA: Do we expect this increase in new and re-emerging diseases to be an isolated incident, or could this be a longer-term trend?

Swann: Unfortunately, I believe this is the new normal. There are even other diseases and public health risks on the horizon that could turn worse. The WHO and Gavi vaccine alliance named several diseases that could lead to a pandemic (monkeypox was number 10). We are also at risk due to the growing resistance of disease treatments including antibiotics, cited as contributing to more than one million deaths in 2019. We need to shore up public health systems worldwide and the associated infrastructure in preparation before these become a pandemic, while continuing to invest in science for new preventions and treatments.

Koci: I hate to be the bearer of bad news, but I think we're just getting started with what Mother Nature is going to be throwing at us. The

majority of new infectious diseases of humans have jumped from animals. This isn't a new thing, but it does seem to be happening with more regularity. A U.K. government report from February 2019 does a good job showing a timeline of some of these diseases over the past 20 years. Some are brand new. Some we've known about but they keep evolving. Still more that we've known about but they've moved to countries or regions where they've never been before.

TA: Recent research suggests that climate change may be playing a role in increased public health challenges related to disease. What role does climate change play in all of this?

Swann: This is a great question, and it may not be obvious to those who don't spend their day thinking about disease. Climate change can lead to disease transmission in several ways. As climate changes, we know that animals migrate to new locations (which likely contain human and/or other animal populations). Deforestation (e.g., for agriculture) leads to loss of habitat, which in turn increases animal migration. Industrial food production can also create reservoirs of disease that can jump to humans. Certain types of disasters (e.g., flooding) related to climate changes could also bring microorganisms into greater contact with humans. One recent study estimated that changes in climate could lead to more than 15,000 new cases of viruses jumping between mammal species.

Koci: As Julie noted, [climate change](#) is putting ecosystems under stress, which forces animals to move to different areas and brings them into contact with other animals (humans and others) they haven't encountered before. This gives the diseases of one species the chance to jump to another. Who knows how many hops, skips and jumps it takes for the next COVID-19 to emerge.

Julie also mentioned flooding. Pakistan is currently experiencing indescribable flooding. Over 1,300 confirmed lives lost. Over 100,000 homes destroyed. Millions displaced. There is now a lake 70 miles by 210 miles in the middle of the country which wasn't there before. Most here in the U.S. probably think that's horrible but something that is far away and isn't going to impact us. But the lesson we all should have learned from the past two years is that everything on this big blue marble is connected. Pakistan is one of the few places where polio wasn't fully controlled by vaccines. Polio is spread through water. Floods have just displaced millions of people from a region where polio is endemic. Many of those people are going to be forced to leave Pakistan altogether. Some may join family members living in the U.S., maybe bringing polio with them. Let me be clear, this is NOT an argument for vilifying refugees. If you've been vaccinated for polio you have nothing to worry about. If you or your kids aren't vaccinated because you didn't think these viruses posed a real risk, there is still time to rethink that decision but the window might be closing.

But we also have other stuff to worry about. The arctic is thawing. What kinds of diseases of animals or people from centuries ago have been locked in ice? Smallpox? Plague? Anthrax? Or there may be a disease of plants locked in ice that if turned loose today would threaten our global crop supply. We don't know if such a thing is really going to happen, but it's something people are taking seriously. One study testing melting glacier water identified over 100 new species of bacteria. There's no reason to think those bacteria pose a threat, but it does feel like an opening scene to a science fiction movie.

TA: What about science—are there innovations that can help us address these new or expanded diseases?

Swann: There are lots of ways that science continues to help move us

forward. Scientists are always on the hunt for new treatments, and universal vaccines that can prevent an entire class of diseases. There is also more and more data, which is available for advanced analytics that can enable an efficient, effective, and equitable response to a disease while also supporting personalized medicine that will tailor treatment to someone's needs. These and other scientific innovations are explored by university researchers, along with ones from companies, non-profits and government. Our governmental agencies also invest in core research and translational research through channels such as the National Institutes of Health, the National Science Foundation, the Biomedical Advanced Research and Development Authority of the U.S. Department of Health and Human Services, small business partnerships, and more. Foundations also help to fill important gaps in innovations not created by other channels along with supporting implementation of programs.

Koci: Scientists are always going to work to stay ahead of the diseases and save lives. We are developing better and better ways to detect these diseases as soon as possible. Better ways to produce vaccines, antivirals and other therapies. But I think the bigger question is will societies and governments listen? Will the public? I maintain that from the science side of things, COVID-19 was largely a success. Science warned governments for nearly 20 years that a pandemic was possible and a coronavirus was a class of viruses we were most concerned about. Scientists around the world collaborated and shared data in unprecedented ways. Highly effective vaccines and other therapies were produced at speeds never seen before. Where we struggled wasn't the biology, it was the sociology. If we're going to keep pace with everything Mother Nature is throwing at us, we need advancements on the societal and government side of the equation to keep pace with the scientific advancements.

TA: What can, or should, governments and other

institutions be doing to address these challenges?

Swann: Whew, weighty topics, and a lot to do! In the health arena, we should build systems that help us prevent disease, detect and monitor for new disease and trends, and ensure we have the infrastructure for distribution and administration of tests and treatments. We need to continue investing in scientific innovation, which can lead to new treatments and vaccines, both for diseases currently in the U.S. and ones globally. We also should work to build trust in science, continue educating the public and address misinformation across social media. We should build public-private partnerships to enable a strong health system that is also sustainable in feast or famine. Universities have many important roles to play in these challenges. We as a society also need to continue to address the inequities in health outcomes, many of which result from inadequate access to healthcare, greater risk due to employment exposures, and underlying comorbidities caused by a variety of factors.

While we are improving our health systems, we also need to tackle the growing crises associated with changes in the climate. I believe it is going to lead to greater insecurity in housing, food and livelihood. There are also a number of areas of health that are and will be negatively impacted for many years to come. I think of the changing climate as a slow pandemic—the impacts will be felt across borders and communities and require national and international collaboration to reduce the public health risk. While it is slower moving than a novel virus like SARS-CoV-2, which causes COVID-19, it is a big ship that is difficult to steer so requires multiple levers to truly move the needle.

Koci: I really think this is the most important question we should be asking, but I don't know that I'm the right person to answer it. When we're talking about government policies related to public health, what we're talking about is how do we best balance safety and security with

civil liberties. Or to be blunt about it, how many dead bodies are we willing to tolerate before we want the government to step in and help manage things?

No one wants to have that conversation. No politician wants to go on record as saying 5,000, or 10,000, or 100,000, or 1 million deaths a year is acceptable. As a society, historically we've decided that 30,000–50,000 deaths a year from influenza was acceptable. There wasn't a meeting to decide this, it's just what the numbers have been and no one demanded we do better. As a result, many in public health thought 30,000–50,000 was the upper limit of what we should shoot for as an acceptable number of annual COVID-19 deaths moving forward. But right now, society seems to have moved on from COVID-19. From June to September the U.S. has had a median of 2,700 deaths per week. That translates out to roughly 140,000 deaths per year, 3–5 times the annual deaths from influenza (note that deaths for 2022 will be a lot higher than that as deaths in February were peaked at over 17,000 per week). Is that really how many deaths we're willing to tolerate as a society? Or is it just that because it's no longer on the news every day people don't realize that new cases, hospitalizations, and deaths are all higher this summer than they were in the summer of 2021?

For governmental policies to better address the challenges these types of threats are going to pose, we need to clearly define what we as a country consider success. Then we can design the systems to achieve that goal. The choice isn't lockdown or nothing. We put a man on the moon 50 years ago, and today we all carry a computer in our pocket 33,000 times more powerful than the computers that were used for the Apollo missions. I personally believe we can do better, and we can do so while also respecting people's privacy, civil liberties, and likely boosting the economy at the same time. The people who tell you otherwise likely have a vested interest in keeping the status quo.

TA: Regardless of what governments do, what can individuals do—to better protect themselves and their communities?

Swann: Great question! I cannot emphasize enough the importance of vaccines and boosters for many diseases. We are so lucky to live in a time and place where we do not have to fear the high fatality rate in children due to measles, or the paralysis that polio can cause. My immediate family and primary extended family is vaccinated against COVID-19, and I look forward to having a booster or next vaccine when approved.

I also think masks are one of the greatest tools in our arsenal to help reduce morbidity and mortality associated with infectious disease of several types, including COVID-19 and seasonal influenza. I have my favorite designs from Enro that have great filters, and I regularly wear them in large indoor gatherings, when traveling, and/or when in close contact with people who are vulnerable.

Individuals and households can and should try to address the health problems that we know about. The rate of sexually transmitted infection has grown in recent years, and syphilis (which is curable) is one of several that has risen. Screening for these diseases and getting appropriate treatment can improve health in those while possibly reducing transmission of other diseases like monkeypox. If we can reduce obesity, diabetes and/or heart [disease](#) through lifestyle changes and/or medical care, then we will be less vulnerable to new diseases.

As individuals, we should also understand the implications of investments in public health and in global health. We cannot expect a system to be ready to meet emergency needs when it does not have adequate time to prepare in advance. Our votes and advocacy are

important for ensuring that our society enables life, liberty and the pursuit of happiness for all.

And, as Douglas Adams might say, "Don't Panic, and Always Carry a Towel."

Koci: I agree with everything Julie said, but I'll add these ideas as well. It seems like every other week the news is showing some 100 year event in one part of the country or another. The weather is not following the script we're used to, and some of these events come with little warning. You need to have emergency plans. Ready.gov has some great tools and suggestions for what you need to help protect yourself and your family. Decide ahead of time, if you have time, if you're going to try and ride out the disaster at home or evacuate somewhere else. Have an evacuation route and/or meet up points clearly communicated to family and friends. Make sure you have enough water, food, batteries, medication, first aid, and other essentials for everyone in your group (including pets) for at least three days, but longer if possible. Talk to your neighbors and make sure they have plans too.

The last thing I would suggest relates back to the question about the government. Individuals can make sure they let their representatives know what they expect from the government. Get involved in the conversation. The challenges likely coming our way are going to cost us billions of dollars one way or the other. Preparing for, trying to prevent, and mitigating these disasters won't be cheap, but neither are the lives lost and all the money spent to recover from the damage from each new disaster.

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