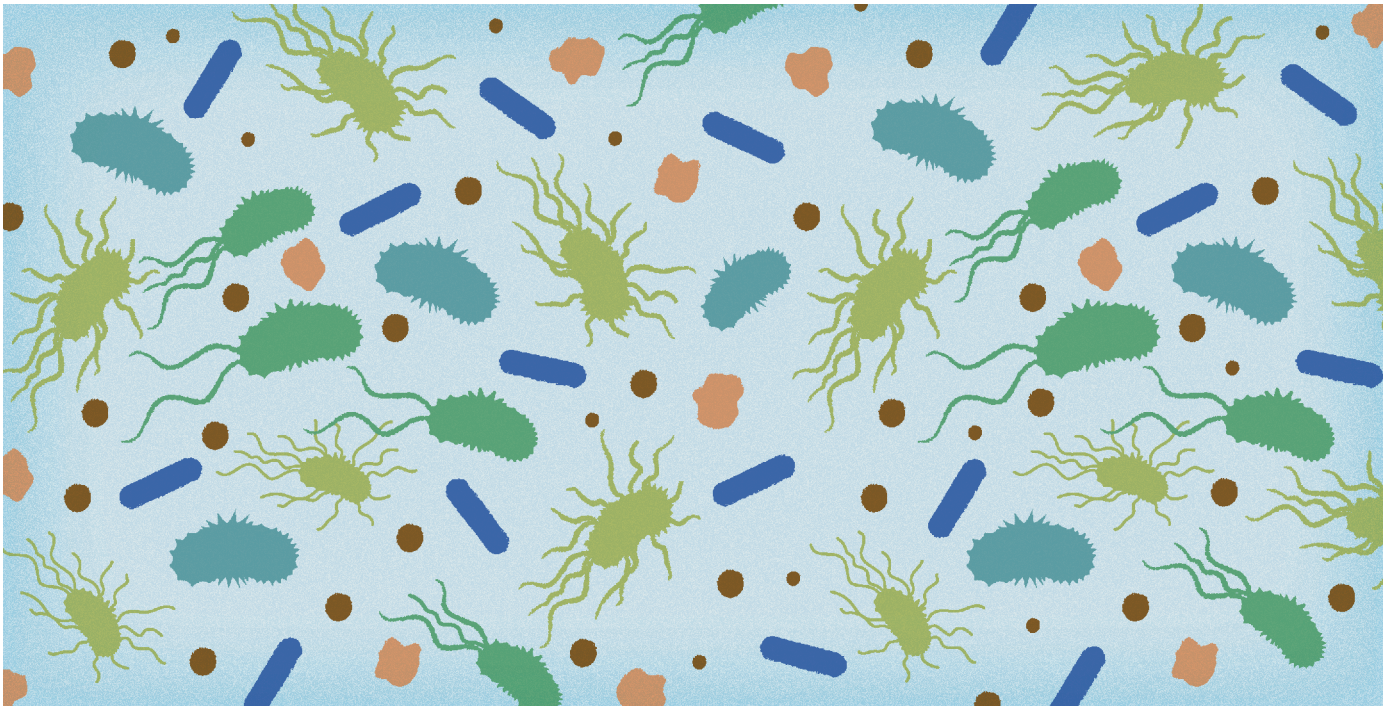

Tomorrow's biggest microbial threats

Although many health experts around the world must stay focused on the ongoing viral pandemic caused by SARS-CoV-2, similar viruses and microbial organisms such as bacteria could create the next global killer. Experts discuss the most likely culprits.

Mike May

In the midst of the winter rampage of COVID-19—with more than 92 million confirmed cases and closing in on 2 million deaths globally—it is difficult to even consider the possibility of something similar lying in wait for the next opening in human vulnerability to disease. But that is exactly what health experts around the world must contemplate to prevent or reduce the impact of other potential causes of a pandemic. Equally importantly, that thinking should already be underway, and it is.

Fear of the known

The unknown—in this case, novel and maybe even unimaginable diseases—creates the most fear for some people, but there are plenty of known types of diseases to worry about, and some experts see those as the most dangerous. For instance, Amesh Adalja, an expert in preparing for pandemics and a senior scholar at the Johns Hopkins Center for Health Security, says, "The biggest threats are still going to come from ones that we've already characterized." For a top global threat, Adalja picks influenza virus, noting that it "has proven time and time again that it's capable of causing pandemics and based on its genetic structure it's really only a matter of time before new strains emerge that have the capacity for efficient human-to-human transmission."

There is a list of deadly influenza outbreaks. The 1918–1919 influenza pandemic killed an estimated 50 million people, which was about 2.5% of the world's population. About 1 million people died in the 1957–1958 influenza pandemic, and there have been others. However, influenza is not the only known threat.

As SARS-CoV-2 continues to ravage many areas around the globe, other members of the coronavirus family should not be ignored. The US Centers for Disease Control and Prevention lists seven coronaviruses that can infect humans, but overall there are hundreds of coronaviruses. Although the respiratory syndromes MERS and SARS, both caused by coronaviruses, did not spread very efficiently among humans, Adalja says that "the events this year have shown that this viral family must be taken much more seriously than it had been in the past." For example, MERS is not easily transmitted between people, but about 35% of the people who get it die—which makes it far more deadly than COVID-19.

In 2018, Adalja wrote: "The most probable naturally occurring [global catastrophic biological risk]-level threat that humans face is from a respiratory-borne RNA virus, and so this class of microbes should be a preparedness priority." He was right, because SARS-CoV-2 is just such a virus. Thinking even more broadly, he now says that "any kind of efficiently spreading respiratory virus, whether or not it comes from influenza or coronavirus families, should also be thought of as potentially having pandemic potential because they all have these similar characteristics in that they spread efficiently from human to human."

Reacting to resistance

In addition to defending against coronaviruses, public-health experts must also defend against other known microbial threats, such as antimicrobial-resistant (AMR) bacteria. Even now, these microbes cause about 700,000 deaths a year around the world, and multidrug-resistant tuberculosis accounts for about one third of those. Experts already forecast far more AMR-related deaths ahead, with the United Nations Interagency Coordination Group on Antimicrobial Resistance warning that drug-resistant disease could kill 10 million people a year by 2050.

According to Linfa Wang, a professor in the Programme in Emerging Infectious Diseases at Duke–National University of Singapore Medical School, AMR bacteria remain a key concern, but he says, "at least we can do systematic and targeted surveillance and monitoring, which will provide some early warning."

Despite such recognition of the potential danger from AMR bacteria, few drug-makers have addressed the growing concerns. "Common bacterial infections will continue to build resistance to antibiotics, and we have very little new developments in antibiotic portfolios of pharmaceutical companies," says Moses Alobo, program manager for Grand Challenges Africa at the Alliance for Accelerating Excellence in Science in Africa, which is headquartered in Nairobi, Kenya, and COVID-19 chair of the African Academy of Sciences. "There is, therefore, a threat from antimicrobial-resistant species from our hospitals."

Inter-species interactions

Infectious agents that jump from non-human species to humans—even ones beyond coronaviruses—also appear to be increasingly dangerous. "There are millions of animal viruses for which a jump to humans becomes increasingly likely as our populations and those of our livestock grow and expand into new territories and niches," says Iruka Okeke, a professor of pharmaceutical microbiology at the University of Ibadan in Nigeria. "However, between now and when that happens, millions of people will be sickened and/or killed by existing pathogen threats."

Many existing zoonotic threats create intense public-health challenges. As examples, Alobo points out that "viral haemorrhagic fevers like Ebola, Marburg, Lassa fever, and yellow fever will be potentially hazardous." Some of these infections are far more deadly than infection with SARS-CoV-2. On average, Ebola virus kills about half of the people it infects, but some outbreaks killed 90% of the people infected. Fatalities from Marburg virus are about the same.

Keeping track of zoonotic diseases also poses a problem. For emerging zoonotic diseases, Wang says, "We don't have a reliable and affordable monitoring system yet, so the responses will always be reactive rather than proactive."

Plus, there is so much to monitor. Over than a decade ago, scientists reported that more than 70% of new pathogens come from animals. It will be difficult to stay ahead of these potential threats.

Working with the unknown

In many ways, healthcare systems will remain reactive to deadly infections. For example, Kevin Marsh, the senior advisor for the African Academy of Sciences, says, "It is in the nature of such threats that we can't predict the next one either in timing or pathogen, but we can be pretty sure that there will be new ones." So, he says, "The key is active surveillance and having mechanisms for rapid identification and response to new outbreaks."

A sophisticated surveillance system might even prevent another disease from spreading around the world so fast. "The world needs to build proper microbial surveillance networks to monitor any developments in infections within regions—essentially have a pathogen genetic surveillance group that concentrates on these activities," Alobo states. "Early warning systems are needed."

Warning systems would help. In the face of so much uncertainty, however, healthcare systems cannot afford to wait on outbreaks before reacting.

Science meets society

Perhaps as much as anything else, some public reactions to COVID-19 surprised experts. A year ago, Okeke believed that the biggest challenge with an emerging microbial threat would come from detecting it and developing a vaccine. Now, after watching the reaction to COVID-19, she says the biggest challenge "will be convincing people to take the steps that are necessary to protect humankind from a threat." Despite the rapid success in detecting SARS-CoV-2 and developing several effective vaccines, Okeke says, "it has been impossible to make people stay home or masked to avoid transmission in most countries." She adds, "When given the choice between skipping a holiday and posing mortal risk to another's life, sufficient numbers of people have chosen the latter and we have to presume that they will do it again." So, preparation goes beyond science and deep into societies around the world.

Figuring out how to accomplish that will depend on many forms of research. For instance, Okeke says, "I would like to see some political, social and behavioral science research so that public health can be better informed about how to convince or persuade people to make life-saving decisions in epidemics."

The need for improved policy decisions does not stop with citizens or hospitals. As Wang discusses, "The real difference will come from policy and legal framework changes in the context of transparent and efficient reporting of 'unusual cases' and a united international system of pandemic preparedness that is as far away from geopolitics as possible."

At the same time, more basic science should be pursued. Here, Okeke recommends more research into infectious-disease biology, including epidemiology, microbiology, immunology and vaccine development. Such studies could help scientists predict the next big threat, as well as its most likely source, and even to "stall it in its tracks faster, and respond to it even faster than the record times seen with COVID-19," Okeke explains.

Taking an ongoing perspective

Instead of focusing on the biggest disasters in global health, such as the 1918 influenza and current COVID-19 pandemics, public-health experts know that people always face serious problems with infectious disease. With investment in ongoing research around the world, many benefits could arise. "In addition to averting the next public health disaster, this would also make it possible to address endemic threats that have plagued us for centuries and will continue to do so without a concerted push for discovery and action," Okeke says.

The world might never be free of microbial threats, but research combined with technology could greatly reduce the odds of diseases getting out of control. Achieving that goal, however, depends on staying ahead of these diseases whenever possible. ❐

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