Virus Trackers and Preventing Pandemics

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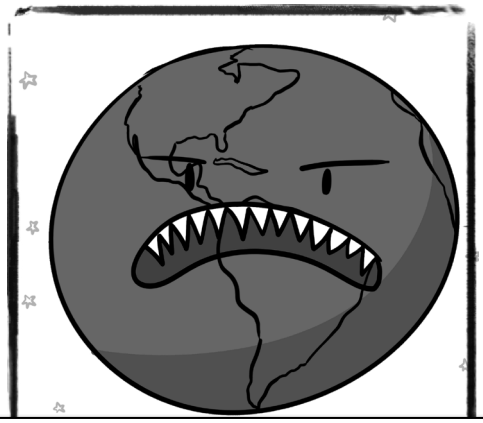

A pandemic is when a disease is so infectious that it can spread across a country or even globally. The world has faced numerous viral pandemics throughout history.

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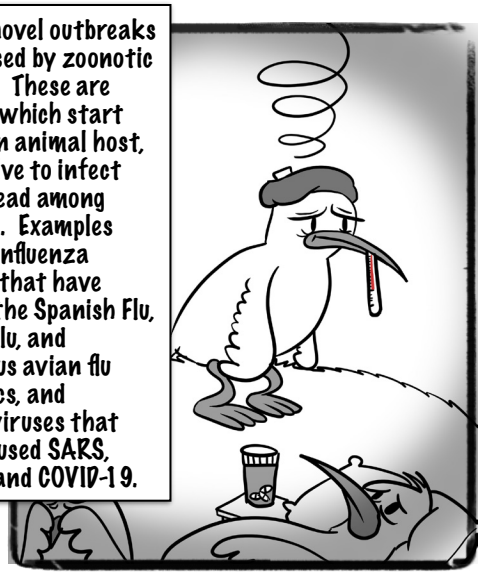
Many novel outbreaks are caused by zoonotic viruses. These are viruses which start off in an animal host, but evolve to infect and spread among humans. Examples include influenza viruses that have caused the Spanish Flu, Swine Flu, and numerous avian flu epidemics, and coronaviruses that have caused SARS, MERS, and COVID-19.



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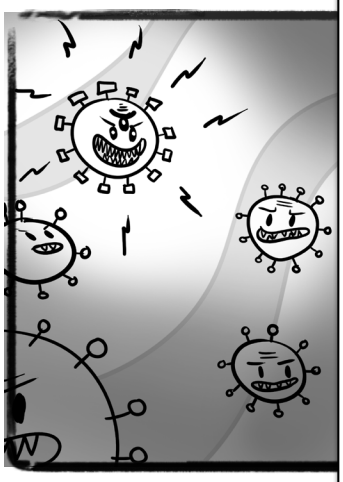

Many viruses can mutate quickly. They can make mistakes when they replicate, or even swap genetic material with other strains if they infect the same cell. These changes can give zoonotic viruses new ways to infect humans and can also make it challenging for our immune systems to combat them.

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Dr. Peiris and Dr. Guan have been researching viruses for over 20 years. They have tracked influenza strains in birds, pigs, humans, and other animals, to understand the evolution of zoonotic viruses and monitor their risk of causing pandemics in humans.

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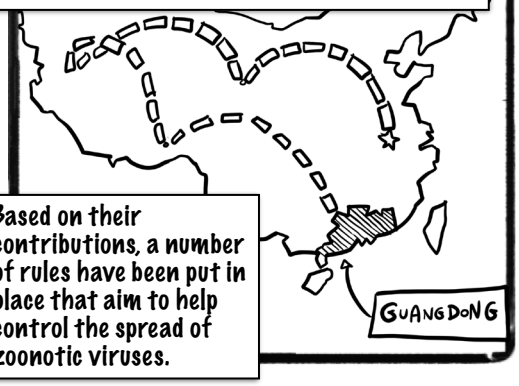
In 2003, Dr. Peiris did important work to discover that the first SARS outbreak was caused by a coronavirus. And Dr. Guan played a crucial role in tracking the zoonotic disease to wild animal markets in Guangdong.



Based on their contributions, a number of rules have been put in place that aim to help control the spread of zoonotic viruses.

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Overall, Dr. Guan and Dr. Peiris have helped respond to novel influenza and coronavirus outbreaks throughout their scientific careers, and their work continues to be crucial in helping the world prepare for future pandemics.

Art by Armin Mortazavi and text by Nicole Wang. October 2021

Virus Trackers and Preventing Pandemics

The best pandemic response is to be prepared, before animal viruses infect humans

Written by Nicole Wang
Art by Armin Mortazavi

October 2021

In the year 2021, the topic of pandemics, a scientific term that describes a disease outbreak of global proportions, has been inescapable. This is because the world has been (and still is) dealing with the all-encompassing effects of the COVID-19 pandemic.

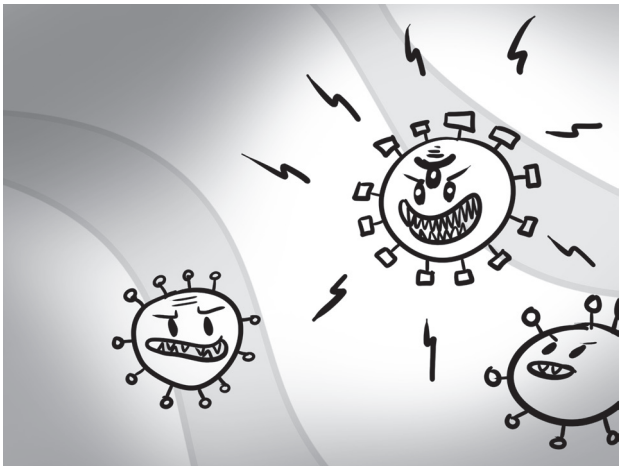
But pandemics aren't a new phenomenon and it's easy to forget that the world has seen and survived viral pandemics throughout history. Just within the last 20 years, there have been pandemic outbreaks of viruses that caused Severe Acute Respiratory Syndrome (SARS) in 2002, the H1N1 Swine Flu in 2009, and the Middle East Respiratory Syndrome (MERS) in 2015.

However, you're also probably aware that being infected by viruses is something that happens all the time. People regularly get sick from common colds or the seasonal flu. These viruses can make you ill, but don't seem to cause devastating outbreaks. So what makes a virus like SARS-CoV-2, the one responsible for the COVID-19 pandemic, especially dangerous?

Comfort in the familiar

The primary difference between viruses that cause common diseases, and those that cause pandemics boils down to familiarity. In effect, there is a benefit to having already seen certain infections, because common colds are "common," and seasonal flus are "seasonal."

Our bodies are trained to fight viruses in a variety of ways, and this includes specialized immune memory cells that can remember a virus that they've encountered before. These cells essentially act as an early warning system should a person be re-infected with the same virus, or even another virus that has strong similarities. This in turn leads to a much quicker and stronger immune response that often results in milder, or even no infection.



Add to this, we also have the luxury of effective ways to predict and therefore prepare for outbreaks of these common viruses. For instance, as part of global health initiatives, scientists around the world diligently track the seasonal flu: where it is spreading and also whether there are genetic

changes that could be cause for concern. Using this information, they can predict what the next version of the flu might look like, and ready the production of useful flu vaccines. These flu shots are designed to proactively trigger those memory cells that can provide protection before the seasonal flu actually comes to town.

Ultimately, we are less concerned with these common viruses because our immune systems have seen them before, either by way of past infections, or through proactive vaccine initiatives. This familiarity means that rapid rates of infections tend not to occur making them less of a threat to global health.

The hidden threat of zoonotic viruses

Meanwhile, unfamiliar or novel viruses are a completely different beast. If a virus is new to human society, they can enter our bodies, cause sickness, and spread quickly, all before our immune systems even have a chance to properly react. This is usually how a pandemic might start: essentially, the world is immunologically naive to the disease. It's also important to note that some of these pandemic viruses may be no deadlier than the common viruses, but without the protection of immunological memory, we end up facing the full force of the virus and higher rates of infection. The virus can therefore spread rapidly within a population and beyond, sometimes to devastating effects.

Many of these viruses are zoonotic, meaning that they were originally only able to infect certain animals, but over time have evolved the ability to infect or "jump" to humans. This can happen because when viruses make copies of themselves, the replication of their genetic code can result in mistakes, small copying errors or even drastic swapping of genetic material, leading to random changes called mutations. Although these changes are usually inconsequential or even harmful to the virus, some mutations might give a virus an edge to cause disease.

Luckily, only a very miniscule proportion of animal viruses will evolve to infect humans, as they need to overcome many barriers to infect a new species. For example, the virus will likely need mutations that: (1) allow recognition of human cells; (2) provide some protection against the human immune system; and (3) infect in ways that allow efficient spread from person to person.

This is why the "jump" is more likely to happen in situations where people are frequently exposed to infected animals. This can happen, for example, at live animal markets, during livestock transportation, or even in situations where habitat loss cause wildlife to be forced into new areas. Such environments could be the unwitting origin points for a pandemic.

Although jumping from an animal to a human host is rare, these zoonotic viruses are potentially very dangerous to global health. They are globally unfamiliar. Because of this threat, one of the best ways to stay prepared for a zoonotic virus is to attempt to track it before it spreads to humans.

Staying prepared and predicting pandemics

While research can't predict exactly when a pandemic will occur, studies have shown that you can predict which animal viruses are the most likely to cause novel disease outbreaks. Here, scientists

Dr. Joseph Malik Peiris and Dr. Yi Guan, winners of the 2021 John Dirks Canada Gairdner Global Health Award, have done pivotal work on this type of surveillance. They have been collaborating since the 1997 H5N1 avian flu outbreak in Hong Kong (caused by an influenza virus), and continue to be extremely involved in international efforts to track viruses in animals.

In this case, potential hosts such as wild birds, chickens, pigs, and humans are routinely sampled for influenza viruses. This sampling allows scientists to track mutations in the genetic sequences of these viruses. They monitor whether these viruses have jumped between different animal hosts in the past, as well as evaluate whether they can cause disease. All of these considerations help to predict whether these viruses might pose a threat to human health. Over time, this data has also allowed scientists to understand the evolution of zoonotic viruses in their natural hosts, and figure out key mutations important for their jump from animals to humans.

Based on their studies, Dr. Guan and Dr. Peiris have provided warnings about avian flu subtypes that have the potential to cause pandemics in humans. And in order to protect against these threats, they have published many protocols on pandemic preparedness and have suggested ways to prevent the spread of zoonotic influenza viruses, including measures to close live animal markets, as well as develop strategies to quickly produce vaccines for high-risk influenza strains.

Virologists in action: How to deal with novel outbreaks

When a novel outbreak occurs, there are a number of key objectives to work towards. First, it's important to figure out the source (for instance the animal of origin in zoonotic cases) to prevent it from further infecting new people. Second, there needs to be an effective way to diagnose and track the disease in humans so that spread can be monitored. And of course, in order to treat the disease, work needs to be done to understand how the virus interacts with and affects human cells.

In late 2002, a novel viral outbreak appeared in Guangdong, China, and started to spread worldwide. Due to their experience tracking zoonotic influenza viruses, Dr. Guan and Dr. Peiris immediately got to work, initially thinking that this mysterious disease might be caused by an influenza strain. However, their research groups soon realized this was not the case and became the first to identify that the new infectious disease, known as SARS, was actually caused by a coronavirus called SARS-CoV.

Dr. Guan's team was the first to isolate the coronavirus from wild animal markets in Guangdong, China, showing that it was a zoonotic virus as well as the importance of closing animal markets. Meanwhile, Dr. Peiris's team developed tests that could quickly and non-invasively detect the virus in patient samples, and began work to uncover how SARS-CoV was causing disease. The work of these two scientists was critical for the early diagnosis of SARS, helping doctors effectively treat patients, and helping public health agencies and the scientific community to track the spread and evolution of the disease worldwide. Their work greatly contributed to the eradication of the SARS pandemic, to the point where the outbreak was ultimately controlled by testing and isolating those who were sick, before a vaccine was even needed.

In addition to working with SARS, Dr. Peiris and Dr. Guan have also contributed to research on subsequent coronavirus pandemics, MERS and Covid-19. They also remain very active in tracking influenza viruses in animals, especially those with a high pandemic risk.

Importance of global collaboration

Dr. Peiris looks back fondly at the memories and collaborative relationships he developed throughout his career. He also credits the rapid de-escalation and control of the SARS pandemic to the global effort organized by the World Health Organization, who hosted daily meetings between scientists around the world to discuss new hypotheses, data, and challenges. “I don’t think we would have been able to resolve this fairly quickly, if not for this daily sharing of information,” Dr. Peiris recalls.

Overall, the research of Dr. Peiris and Dr. Guan powerfully exemplifies the importance of scientific collaboration. Global cooperation is essential to solve global challenges, whether it is preventative (such as tracking animal viruses around the world), or reactive (fighting a pandemic). As we currently deal with the enormous impacts of the COVID-19 pandemic, and as we look towards the possibility of future pandemics, we can be grateful for the groundbreaking work of Dr. Peiris and Dr. Guan.