A Global Vaccine Library:

Giving Humanity a Head Start Against Pandemic Threats

Richard Hatchett and Kate Kelland

Among the most important lessons the world should learn from the COVID-19 pandemic is that being prepared—being ready to act urgently with the right technology, know-how and resources—can give the world a crucial head start in tackling a newly-emerging infectious disease outbreak.

With COVID-19, many countries and regions of the world were seriously deficient on many important epidemic and pandemic preparedness measures, putting them way behind the line. However, in one key aspect of the race against the novel viral threat—vaccine development—the world had put itself a few critical steps ahead by the time the SARS-CoV-2 coronavirus emerged in 2020.

This was in large part a result of many years of studying other similar viruses, whereby scientists had the chance to develop and hone techniques to facilitate new vaccine designs. Research initially on respiratory syncytial virus (RSV)—a virus first identified in 1956 that can cause respiratory tract infections—and subsequently on the SARS coronavirus that emerged in China in 2003, then on the MERS coronavirus that was first reported a

decade later in Saudi Arabia, meant scientists had well-developed insights into these types of viruses and knew how to go about designing effective vaccines against them.

Those decades of work allowed scientists to understand, for example, the importance of the spike protein of the coronavirus for the production of neutralising antibodies. They had also developed and refined techniques for manipulating the spike protein to make it more visible to the immune system and therefore more able to illicit a potent immune response.

In early 2020 when the novel coronavirus SARS-CoV-2 emerged, drug developers were able to create new candidate vaccines at record speed. They pulled off the shelf previous research, data and knowledge on RSV, SARS and MERS virology, vaccinology and immunology, and tweaked it to figure out how to best tackle the novel threat. Therefore, despite never before having seen the COVID-19-causing virus, they were not reinventing the wheel in developing COVID-19 vaccines. Humanity had a head start.

Consider also the case of Mpox. Formerly known as monkeypox, Mpox is a contagious disease caused by a virus from a family called the orthopoxviruses—a viral family that also counts smallpox, cowpox and many other pox viruses among its members. When Mpox began to spread in 2022 in a far larger outbreak that reached more geographies, humanity had again put itself a few critical steps ahead. It was in the late 1800s when vaccines against the highly deadly smallpox were developed, before being refined and ultimately deployed to greatest effect in the 1970s and 1980s when smallpox became the first—and so far only—human disease to be eradicated. After this success, however, many governments remained highly concerned about the potential for the smallpox virus to be used one day as a weapon of bioterrorism. This led national and international health security bodies to decide to maintain stockpiles of smallpox vaccines.

Fortunately, those smallpox vaccines also offer broad protection against other viruses in the orthopoxvirus family, including Mpox. When Mpox case numbers ballooned into an epidemic of international emergency proportions in 2022, the bank of knowledge, data and vaccines that could help public health authorities curb the outbreak was significant. Again, humanity had a head start.

What if humanity could get itself a similar head start against any viral threat—known or unknown, novel or re-emerging? What if we could get ahead of any infectious pathogen with the potential to cause a serious and deadly epidemic? Doing that would give us a far better chance of winning the containment race against an emerging virus and of controlling a nascent pandemic before it is able to spread across the world.

A Proposed 'One World Vaccine Library'

At the Coalition for Epidemic Preparedness Innovations (CEPI), of which the authors of this essay are part, we have a concept for how the world could do just this—by creating and stocking a library of knowledge, data and prototype vaccines against every one of the viral families we already know have the potential to cause human disease outbreaks. CEPI calls this the 'One World Vaccine Library'—a vaccine library for the whole world that will help the global community achieve greater health security by being better prepared to beat the next pandemic threat, wherever it emerges, and whatever form it takes.

Vaccines are among the most potent tools against pandemic threats and will be critical to any future response to dangerous and deadly outbreaks of infectious disease. The faster an effective vaccine can be developed and deployed, the faster it can be used to mitigate and potentially contain an incipient pandemic. This is why we need to work on getting those head starts against as many as possible of our potential opponents.

Getting ahead of any potential viral threat, known or unknown, can at first sound like an impossible task. There are between 250 and 300 viruses from around 25 viral families that are already known to have the ability to infect people, and the world's scientists cannot create new vaccines against every one of them, just on a chance that they might one day pose a deadly threat.

Yet the beauty of a One World Vaccine Library is that we do not need to. As those several hundred viruses all come from just 25 families, scientists can take a viral-family-based prototype vaccine approach to preparing the world's defences against them. They can gather knowledge, scientific

insights and research data on a selection of representative viruses from each family and create vaccines that target their most common threatening features. That way, the world will have a bank of detailed fundamental knowledge about the threats posed by these virus families.

As things currently stand, scientists have already made meaningful progress—proven safe and effective vaccines are available against scores of viruses that come from and represent at least 15 of the 25 virus families. For the One World Vaccine Library to be able to help the world respond at speed to a newly emerging threat, however, those vaccines will need to be transferred onto so-called rapid response platforms—technologies like mRNA platforms or viral vector platforms that can be rapidly scaled up to allow for hundreds of millions of doses to be produced within months if needed.

Beyond that, the library will need to be stocked with data and research and potential vaccine candidates against viruses that represent all the remaining families, and its sections on the most threatening virus families must be filled with as much preparatory work as possible. That way, new vaccine development will be faster and more efficient, saving precious time, and potentially lives, that would otherwise be at risk if new vaccines had to be started from scratch each time a pandemic threat looms.

Take the paramyxoviruses, for example. The paramyxovirus family includes a number of well-known human disease threats, including measles and mumps, as well as several less well-known ones, such as Hendra and Nipah.

If the aim is to make similarly fast—indeed, ideally, faster—progress against a future emerging novel paramyxovirus threat as was made in 2020 with the novel coronavirus, the One World Vaccine Library's paramyxovirus section should be stocked with as much research, data and technical knowledge about how to design and make effective vaccines against the known and closely related viruses in that family.

In other words, the library will collate scientific knowledge and prototype rapid-response vaccine candidates for measles, mumps, Nipah, Hendra and

other known paramyxoviruses. If and when a novel paramyxovirus emerges and begins to infect people in a fast-spreading outbreak, the library can be accessed for knowledge that can help rapidly create vaccines or other medical countermeasures to prevent that spread as much and as soon as possible.

An Ambitious Yet Achievable Global Endeavour

Building a One World Vaccine Library and stocking it to its fullest possible capacity is a substantial task and will require sustained investment of time, effort and money. Such a Library, however, will mean the fruits of human ingenuity—the benefits of scientific progress—can potentially be made available to all, whenever and wherever they are needed. It will mean that when the next viral pandemic threat emerges—whether it is a known virus or a novel one—humanity will have the knowledge and the technology to develop vaccines and other medical defences far more swiftly than it has ever done before.

Researchers assessing a new outbreak and the virus causing it, wherever and whenever it occurs, will be able within days and weeks to sequence its genome, match it against related viruses and select prototype vaccines from the library to develop and deploy new vaccines against the epidemic or pandemic threat.

CEPI's current work includes prioritising the development and stocking of sections of the One World Vaccine Library for the virus families that pose the greatest and most urgent threats to global health security. CEPI is engaging virus experts to systematically rank each family to assess its potential to spawn the next Disease X. For each family selected, the aim is to create vaccine candidates for at least one and potentially several different viruses, depending on the family's complexity and genetic diversity. Vaccines in the library will be taken through preclinical and early-stage clinical testing to build vital knowledge about the safety and immunogenicity of both the platform and the antigens they target. The larger goal is to establish clinical proof of concept for the lead candidates in multiple families over the next five years.

The '100 Days Mission' and the Need for Speed

Creating and stocking a One World Vaccine Library is a critical enabler of CEPI's 100 Days Mission, embraced by the G7 and the G20, to compress the development timeline for new vaccines against emerging disease threats to 100 days. Coupled with improved surveillance providing earlier detection and warning of potential viral disease threats, and with swift and effective use of non-pharmaceutical interventions such as testing, contact tracing and social distancing to suppress disease transmission, delivering an effective new vaccine within 100 days would give the world a real chance to extinguish the existential threat posed by a future Disease X pandemic virus.

The head starts in these viral races—and there are sure to be ever more frequent ones in this era of novel epidemic threats—will come from having a One World Vaccine Library that is comprehensive and extensive and, crucially, immediately accessible to all nations and regions whenever they need it. As the bank of knowledge builds up in the library, so too, does the potential for scientists to significantly accelerate vaccine development against a wide and growing range of virus families over time.

Like the 100 Days Mission, the ambition of creating a One World Vaccine Library is a bold one. It is also an essentially equitable one that seeks to help people across the world bolster their defences against the ever-increasing risk of viral infectious diseases.

Building and stocking the library will take the combined resources, will, and ingenuity of the world's best scientific minds, political leaders and health security experts. In return, the library's evolving knowledge and increasingly sophisticated contents will be a living gift from generation to generation: the prospect of a future free from the deadly threat of pandemics.

Dr. Richard Hatchett *is Chief Executive Officer of the Coalition for Epidemic Preparedness Innovations (CEPI).*

Kate Kelland *is CEPI's Chief Scientific Writer.*