

A universal coronavirus vaccine

CORONAVIRUS has already produced catastrophic social, economic, and public health consequences, with more than 107 million documented cases and 2.3 million deaths. Although this pandemic is far from over, we now have the tools to end it, with the largest and most rapid global deployment of vaccines under way. That we got this far so quickly is remarkable, but next time we might not be so lucky. More virulent and deadly coronaviruses are waiting in the wings. Thus, the world needs a universal coronavirus vaccine.

The speed with which safe and effective COVID-19 vaccines have been developed and made available is unprecedented, taking less than a year. However, if faced with a more virulent strain with a higher case fatality rate than severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), even this rapid time frame may not be enough to prevent a death toll on the scale of the 1918 influenza pandemic, which killed more than 50 million. Moreover, there is a continuing risk that the virus will mutate in ways that render existing COVID-19 vaccines less effective—as we’ve already seen for the B.1.351 variant first identified in South Africa—or even ineffective.

As with influenza, the case for a vaccine that protects all people against all forms of coronavirus is strong. SARS-CoV-2 belongs to a diverse group of viruses of which there are thousands capable of infecting a wide range of animals, from bats and pangolins to pigs and mink. SARS-CoV-1, which emerged in 2002, had a 10% fatality rate; Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012 was 34% fatal.

The potential is increasing for other coronaviruses to jump species and cause more pandemics. The reasons are many. The animals that the viruses infect are ones that humans regularly come into contact with. Modern agricultural practices, viral evolution, and relentless human encroachment on the natural environment mean there is an increasing risk of people encountering previously isolated animal populations that harbor new strains with pandemic potential. With human migration, population growth, urbanization, rapid global travel, and climate change hastening the spread, it has never been easier for outbreaks to turn into epidemics and escalate into pandemics.

At the same time, the recent convergence of technological advances in biomedical, computing, and engi-

neering sciences has ushered in a new era in antigen and vaccine discovery. High-performance supercomputing and machine learning, coupled with structural modeling, have the potential to greatly accelerate identification of common antigenic targets shared across coronaviruses. Databases of genetic sequences of animal isolates of coronaviruses can be used to model the evolutionary emergence of the viruses. Ongoing efforts to decode the principles of immunity in aging populations can enhance the effectiveness of vaccines for those most vulnerable. Collectively, studies now suggest that developing a universal coronavirus vaccine is scientifically feasible.

This must be a worldwide effort. A roadmap is needed to lay out the core scientific issues as well as a framework for funding and sharing of information, data, and resources. Early on, it will be essential to establish a global surveillance network for zoonotic coronaviruses like the World Health Organization’s Global Influenza Surveillance and Response System or the United States Agency for International Development’s PREDICT program (which was defunded last year). In addition, a global effort to identify coronavirus-specific broadly neutralizing antibodies is needed to facilitate cross-reactive coronavirus antigen discovery.

None of that can happen until all stakeholders, across governments, industry, academia, and nongovernmental organizations, recognize this as a global public health priority. With COVID-19, much of the groundwork has been laid. To wait until after this crisis passes could prove to be a missed opportunity. It is estimated that the current pandemic will end up costing between US\$ 8 and 16 trillion globally, ~500 times more than would be required for preventing the next pandemic.

That is not to say that this will be easy, and a stepwise approach from COVID-19 to pan-coronavirus to universal coronavirus vaccines may be required. SARS-CoV-2 is rapidly adapting to humans, and other novel coronaviruses are mutating, recombining, and replicating in bats and other animal species, positioning to jump species sometime in the future. If we choose to wait for the next coronavirus to emerge, it may be too late, as it was with COVID-19. Creating the tools for preventing the next coronavirus pandemic is within our means and should be considered a global health priority. We can either invest now or pay substantially more later.

—Wayne C. Koff and Seth F. Berkley

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