

## VIEWPOINT

# An HIV Vaccine Is Essential for Ending the HIV/AIDS Pandemic

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**Today, highly effective modalities** of HIV treatment and prevention are available, and these essential tools, if properly implemented, could end the current HIV/AIDS pandemic. Yet, the pandemic continues.<sup>1</sup>

Most of the major infectious diseases affecting humans, such as smallpox, polio, and yellow fever, have required effective vaccines for their control and in some cases elimination, and so the question arises whether the HIV/AIDS pandemic can be effectively addressed without an HIV vaccine. The answer to that question is not straightforward, but needs to be addressed from both a theoretical and a practical standpoint. Theoretically, the HIV pandemic can be ended without an HIV vaccine. More than 30 highly effective anti-HIV drugs are currently available. When given in combinations of 3 or more, these medications can durably suppress the virus such that patients who are treated soon after infection and continue therapy throughout their lifetime can expect to have an almost-normal life expectancy.

Importantly, effective treatment can reduce the level of virus in a person with HIV so low that it is extremely unlikely that this person will transmit the virus to his or her uninfected sexual partner. This concept is referred

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**However, an anti-HIV vaccine that is 50% to 60% effective could have an important effect on the trajectory of the epidemic if implemented together with nonvaccine prevention and treatment tools.**

to as “treatment as prevention.” Therefore, theoretically, if most or all of the people living with HIV in the world could be identified, accessed, and treated, it would be possible to stop all infections and end the epidemic. People who are uninfected, but whose behavior or life situation puts them at high risk of HIV infection, can take a single pill containing 2 anti-HIV drugs and decrease the likelihood of acquiring HIV infection. This approach—“preexposure prophylaxis” or PrEP—can lower the risk of acquiring HIV through sexual activity by more than 90%, or from injection drug use by more than 70% if the medications are taken consistently.<sup>2</sup> Accordingly, if both of these treatment and prevention modalities were effectively implemented throughout the world, the HIV/AIDS pandemic would end.

However, from a practical standpoint, ending the HIV/AIDS pandemic without a vaccine is possible, although it is unlikely. Although an estimated 19.5 million of the estimated 36.7 million HIV-infected people globally are receiving anti-HIV therapy (an extraordinary accomplishment), more than 17 million people are not receiving

therapy.<sup>1</sup> This leaves a substantial treatment gap. These 17 million people can continue to infect others, allowing the pandemic to be sustained. In addition, although PrEP is highly effective in preventing acquisition of HIV among people at high risk of infection, only a very small percentage of these individuals are actually taking these medications. In the United States, it is estimated that only approximately 10% of people who could benefit from PrEP are actually receiving it,<sup>3</sup> and this proportion is much smaller elsewhere in the world.<sup>1</sup>

The Joint United Nations Programme on HIV/AIDS (UNAIDS) has set an ambitious target to help end the HIV pandemic.<sup>1</sup> Called “90-90-90,” the goal for 2020 is to have 90% of HIV-infected people throughout the world know their HIV status, 90% of people diagnosed with HIV receiving anti-HIV treatment, and 90% of people who receive treatment having their virus suppressed to undetectable levels. If successful, the result would be that an estimated 73% of all people in the world with HIV would have undetectable viral levels. Since suppressed viral levels result in a marked reduction in the risk of HIV transmission to other individuals, mathematical models suggest that achieving the 90-90-90 goal would reverse the kinetics and trajectory of global HIV disease such that it would no longer be of pandemic proportions. A recent study in rural Kenya and Uganda demonstrated that implementation of community-based testing and treatment resulted in increased HIV diagnosis, initiation of antiretroviral therapy and viral suppression, and the

study communities reached the UNAIDS target within 2 years.<sup>4</sup> In addition, some entire countries have been successful in reaching the goal of 73%, largely through the efforts of the President’s Emergency Plan for AIDS Relief and the Global Fund to Fight AIDS, Tuberculosis, and Malaria. However, the global figure for achieving this goal in all countries is just 44%.<sup>1</sup> Also, modeling studies have suggested that in certain high-prevalence regions of the world, the geographic dispersion of the infected population, would make it extremely difficult to reach them effectively with HIV treatment.<sup>5</sup>

The question also arises whether it is economically feasible to end the HIV pandemic in the absence of a vaccine. In this regard, the resource requirements to achieve such a goal are continually increasing. The 19.5 million people currently receiving anti-HIV drugs must be maintained on these medications for the rest of their lives; at the same time, anti-HIV drugs need to be provided to the 17.2 million infected, but untreated people. Furthermore, the estimated 1.8 million people who are newly infected with HIV each year<sup>1</sup> also need

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to be treated. In addition, the cost of providing PrEP and other prevention services to the millions of people who are at risk for HIV infection is substantial. In 2016, UNAIDS estimated that the total investments needed for an adequate treatment and prevention response for HIV in low- and middle-income countries between 2016 and 2030 would amount to approximately \$350 billion.<sup>6</sup> Against this backdrop, a recent Kaiser Family Foundation and UNAIDS study found that donor-government funding for HIV decreased by 7% in 2016, which represents the lowest funding level since 2010.<sup>7</sup>

Despite the remarkable gains in the treatment and prevention of HIV infection, development of an effective HIV vaccine will likely be necessary to achieve a durable end to the HIV pandemic. An important question is how effective that vaccine must be. One vaccine tested in a large vaccine trial<sup>8</sup> in Thailand reduced the risk of infection by 31%, a figure inadequate to justify licensure of the vaccine. In contrast, other vaccines used in controlling or ending global outbreaks have been much more effective. For example, the measles, polio, and yellow fever vaccines are nearly 100% effective. Given the difficulty for the human immune system to mount a protective re-

sponse against HIV, it is extremely unlikely that an HIV vaccine will be as effective as those other proven vaccines.

In fact, modeling studies have suggested that if current treatment and prevention efforts are continued and an HIV vaccine that is about 50% effective is developed and deployed, millions of additional new HIV infections could be averted, and the pandemic could slow substantially.<sup>9</sup>

Despite extraordinary advances in the treatment and prevention of HIV infection, it is theoretically possible to end the HIV epidemic by aggressively and effectively implementing these interventions, although from a practical standpoint this goal would be difficult to achieve. Therefore, development of a moderately effective vaccine together with optimal implementation of existing treatment and prevention modalities could end the current HIV pandemic. Recent advances in HIV vaccine research provide hope that at least a moderately effective vaccine can be developed. It is critical to continue to accelerate a robust research effort in that direction while aggressively scaling-up the implementation of current treatment and prevention tools. To do anything less would lead to failure, which for HIV is not an option.

#### ARTICLE INFORMATION

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#### REFERENCES

1. Joint United Nations Programme on HIV/AIDS (UNAIDS). Ending AIDS. Progress towards the 90-90-90 targets. [http://www.unaids.org/en/resources/documents/2017/20170720\\_Global\\_AIDS\\_update\\_2017](http://www.unaids.org/en/resources/documents/2017/20170720_Global_AIDS_update_2017). Published July 2017. Accessed August 15, 2017.
2. Centers for Disease Control and Prevention (CDC). Pre-Exposure Prophylaxis (PrEP). <https://www.cdc.gov/hiv/risk/prep/index.html>. Published 2016. Accessed August 19, 2017.
3. Giler RM, Magnuson D, Trevor H, et al. Changes in Truvada (TVD) for HIV pre-exposure prophylaxis utilization in the USA: 2012-2016. 9th International AIDS Society Conference on HIV Science, Paris, abstract WEPEC0919, July 2017. <http://programme.ias2017.org/Abstract/Abstract/1614>. Accessed August 15, 2017.
4. Petersen M, Balzer L, Kwarisiima D, et al. Association of implementation of a universal testing and treatment intervention with HIV diagnosis, receipt of antiretroviral therapy, and viral suppression in east Africa. *JAMA*. 2017;317(21):2196-2206.
5. Coburn BJ, Okano JT, Blower S. Using geospatial mapping to design HIV elimination strategies for sub-Saharan Africa. *Sci Transl Med*. 2017;9(383):eaag0019.
6. UNAIDS. Snapshot #HLM2016AIDS - HIV investments. [http://www.unaids.org/sites/default/files/media\\_asset/HIV\\_investments\\_Snapshot\\_en.pdf](http://www.unaids.org/sites/default/files/media_asset/HIV_investments_Snapshot_en.pdf). Published May 2016. Accessed August 19, 2017.
7. Kaiser Family Foundation and UNAIDS. Financing the response to AIDS in low- and middle-income countries: International assistance from donor governments in 2016. <http://www.kff.org/global-health-policy/report/donor-government-funding-for-hiv-in-low-and-middle-income-countries-in-2016/>. Published July 2017. Accessed August 15, 2017.
8. Rerks-Ngarm S, Pitisuttithum P, Nitayaphan S, et al; MOPH-TAVEG Investigators. Vaccination with ALVAC and AIDSVAX to prevent HIV-1 infection in Thailand. *N Engl J Med*. 2009;361(23):2209-2220.
9. Medlock J, Pandey A, Parpia AS, Tang A, Skrip LA, Galvani AP. Effectiveness of UNAIDS targets and HIV vaccination across 127 countries. *Proc Natl Acad Sci U S A*. 2017;114(15):4017-4022.