

The Potential Impact of an AIDS Vaccine in Low- and Middle-Income Countries

“Implementation of proven HIV-prevention strategies needs to be bolstered with the development and validation of additional, effective prevention tools, such as ART-based prevention methods and a safe and effective HIV vaccine.” (Carl W. Dieffenbach and Anthony S. Fauci)

Efforts to fight HIV/AIDS are at a crossroads of evidence and resources. Proven new HIV-prevention strategies and breakthrough scientific research are both being confronted with a constrained economic environment following a decade of global political and financial resource mobilization against the pandemic. While 6.6 million people in low- and middle-income countries (LMICs) had access to life-saving antiretroviral treatment (ART) in 2010, in that same year 2.7 million new people were infected with HIV and 1.8 million people died of AIDS-related causes (UNAIDS 2011). An expanding body of research on effective HIV prevention has allowed for the incorporation of new tools such as voluntary adult male circumcision into HIV/AIDS programming, and new evidence regarding the ability of ART to prevent as well as treat HIV infection has further expanded the number of available prevention options. Still, research into new tools such as preventive vaccines and methods to

KEY MESSAGES

- Targeted scale-up of existing HIV/AIDS interventions through implementation of the UNAIDS Investment Framework would greatly lower the number of new HIV infections in low- and middle-income countries over the next decade, but would be insufficient to drive the trajectory of incidence toward zero.
- The rollout of an effective preventive AIDS vaccine would build on strategic scale-up of existing HIV interventions and would further drive down the number of new infections.
- A preventive AIDS vaccine of just 50% efficacy given to 30% of the population in low-and-middle income countries could avert almost 20% of all infections between 2020 and 2030.
- A long-term strategy to ultimately end the AIDS pandemic must include both scale-up of existing HIV combination prevention, treatment, and care programming, and sustained investment in research and development (R&D), including R&D for a preventive AIDS vaccine.



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clear HIV infection from the body intends to widen the scope and effectiveness of HIV programming.

The lasting effects of the global economic recession on the public sector entities providing the majority of support for HIV/AIDS programs in LMICs have fueled calls for greater efficiency and “value for money” in order to ensure that the billions spent on HIV/AIDS programs maximize the number of infections averted and lives saved. The Joint United Nations Programme on HIV/AIDS (UNAIDS) has formulated a new Investment Framework to illustrate how the rapid scale-up of comprehensive combination HIV prevention, treatment, and care interventions by 2015 could significantly drive

down the number of new infections, save more lives, and begin to lower the total annual cost of addressing the pandemic (Schwartländer 2011). Through efficient utilization of existing HIV programs and a targeted approach toward the structural drivers of each country’s epidemic, the Framework projects a significant decrease in the number of new infections and cases of AIDS-related disease and deaths.

However, modeling data from the Framework projects 870,000 new HIV infections in the year 2020 even if the goals of the Framework were met. This prompted the authors to note that “novel strategies will be needed to increase the momentum in radically reducing new HIV infections after 2015,” and to cite

progress in the “development of an HIV vaccine, microbicides, and other new modes of antiretroviral therapy-mediated HIV prevention.” AIDS vaccine research is undergoing a period of accelerated scientific discovery, propelled by cross-sectoral collaborations to understand and improve the efficacy of the RV144 HIV vaccine candidate recently tested in a clinical trial conducted by the government of Thailand and the United States Military (IRIN 2011). The HIV vaccine field also continues to examine the potential elicitation of broadly neutralizing antibodies against the virus, and other efforts are exploring strengthening the durability and breadth of the body’s immune response to HIV through the use of replicating vectors or mosaic antigen inserts (IAVI Report 2011, Burton et al 2011, Corey et al 2010). As these scientific pathways are expanded and investigated, projections about the potential impact of preventive AIDS vaccines can underscore the importance of such research to policymakers, advocates, and other key stakeholders.

Exploring the Potential Impact

Mathematical models can illustrate the capabilities of AIDS vaccines at various efficacy and coverage levels to change the trajectory of the AIDS pandemic, just as they were used to project the potential impact of scaled-up AIDS programming in the UNAIDS Investment Framework. IAVI and the Futures Institute developed an AIDS vaccine impact model as an accessible tool to explore the health and economic benefits likely to result from widespread vaccination in countries most

The Potential Impact of an AIDS Vaccine in Low- and Middle-Income Countries

affected by HIV. The model applies country-specific demographic, epidemiological and vaccine uptake data derived from a number of sources, including UNAIDS and the recent aids2031 project (IAVI 2006, IAVI 2009, UNAIDS 2010, aids2031 2010).

The projections summarized in this brief demonstrate the potential impact of preventive AIDS vaccines introduced from the year 2020 through the year 2030. This is set in the context of two HIV/AIDS programming environments: one in which current trends in HIV program coverage are continued through 2030, and one in which strategic and accelerated scale-up of HIV programming per the UNAIDS Investment Framework is achieved. Both scenarios incorporate updated epidemiological data provided by UNAIDS and apply a methodology used in the modeling of the UNAIDS Investment Framework.¹

While a widely available AIDS vaccine that is close to 100% effective would provide the greatest benefit in terms of averted infections and AIDS-related deaths, it is likely that early generation AIDS vaccines will be only partially effective and that uptake of such partially effective vaccines would be lower than that of more effective ones. The analysis in this brief projects the impact of a



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preventive AIDS vaccine under three combinations of vaccine efficacy and coverage (Tables 1 & 2).²

AIDS Vaccines Under Current Trends of HIV Programming

In a scenario where current coverage trends in HIV treatment and prevention continue through 2030, the model shows that an AIDS vaccine introduced in 2020, even one that is only partially effective, could

have a substantial impact on the AIDS pandemic in LMICs and lead to a dramatic decline in the number of new infections (Figure 1). For example:

- In the Low Impact scenario, an AIDS vaccine with 50% efficacy and provided to 30% of the general population would prevent 5.2 million infections between 2020 and 2030, or 19% of the expected infections during that time period.

¹ The analyses described in this Brief applied a method used by the UNAIDS Investment Framework Study Group that involves preparing individual epidemic models for 23 countries that together account for 77% of the total global HIV burden (Brazil, Cambodia, Cameroon, China, Ethiopia, India, Indonesia, Kenya, Lesotho, Malawi, Mexico, Mozambique, Nigeria, Russia, South Africa, Sudan, Tanzania, Thailand, Uganda, Ukraine, Vietnam, Zambia, Zimbabwe) and creating a baseline projection of new infections, deaths and costs under current trends in spending and intervention scale-up. These were aggregated and extrapolated to construct global projections for new HIV infections and AIDS deaths in low- and middle-income countries.

² Information regarding model inputs and assumptions can be found in a supplementary technical report, available upon request.

- In the **Medium Impact** scenario, an AIDS vaccine with 70% efficacy and provided to 40% of the general population would prevent 8.9 million infections between 2020 and 2030, or 33% of the expected infections during that time period.

Without a significant scale-up of existing prevention and treatment interventions, the model projects that the annual number of new HIV infections would begin to increase slightly each year, as population growth contributes to increasing numbers of new infections (as seen

in Figure 1). For example, in a country with 3% annual population growth, HIV incidence would need to be reduced by 3% annually to maintain a stable number of new infections. In this scenario, the model predicts that 2.5 million new infections will occur in LMICs

Figure 1. Number of Global New HIV Infections by Year and Vaccine: Current Trends Scenario (2020-2030)

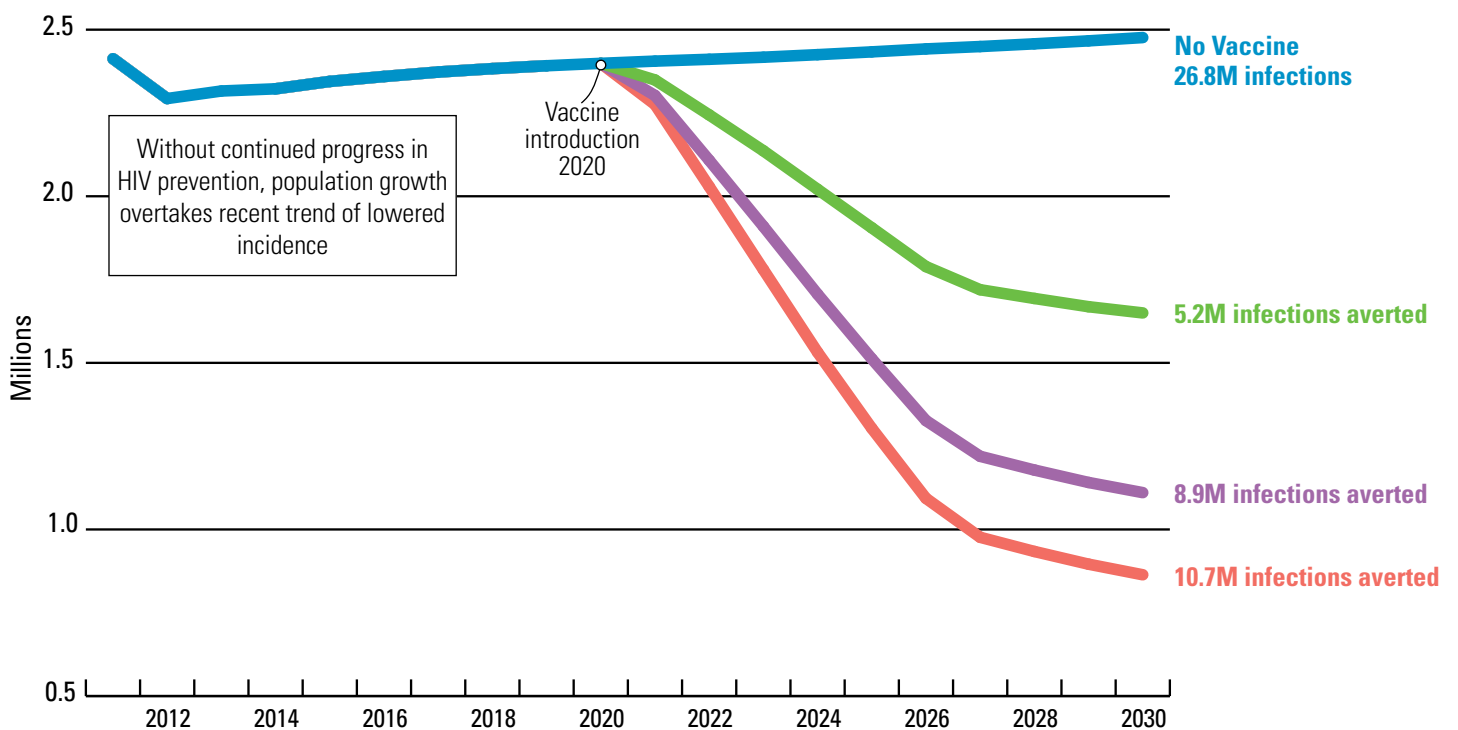


Table 1. The Global Impact of a Vaccine on AIDS Incidence and Mortality: Current Trends Scenario

Scenario	Vaccine effectiveness	Population coverage	Annual infections by the year 2030	AIDS deaths in 2030	Cumulative AIDS deaths, 2020-2030	Cumulative HIV infections 2020-2030	Cumulative infections averted 2020-2030
No Vaccine	n/a	n/a	2.5M	2.3M	24.9M	26.8M	-
Low	50%	30%	1.6M	2.2M	24.5M	21.6M	5.2M
Medium	70%	40%	1.1M	2.1M	24.3M	17.9M	8.9M
High	90%	40%	0.9M	2.0M	24.1M	16.1M	10.7M

M=Millions

The Potential Impact of an AIDS Vaccine in Low- and Middle-Income Countries

annually by 2030, reversing the downward trend in annual HIV infections that has persisted since the mid 1990s. Maintaining the downward trend in annual HIV infections will require an increase in prevention programming in the near term, a trend that could be furthered

by the addition of AIDS vaccines to existing HIV-prevention options.

AIDS Vaccines and the Investment Framework

Under accelerated scale-up of current prevention and treatment

programs to UNAIDS Investment Framework targets by 2015, the model estimates that approximately 2.3 million new infections would occur in low- and middle-income countries in 2011. This number would drop to 1.1 million new infections in 2015, and then

Figure 2. Number of Global New HIV Infections by Year and Vaccine: Investment Framework Scenario (2020-2030)

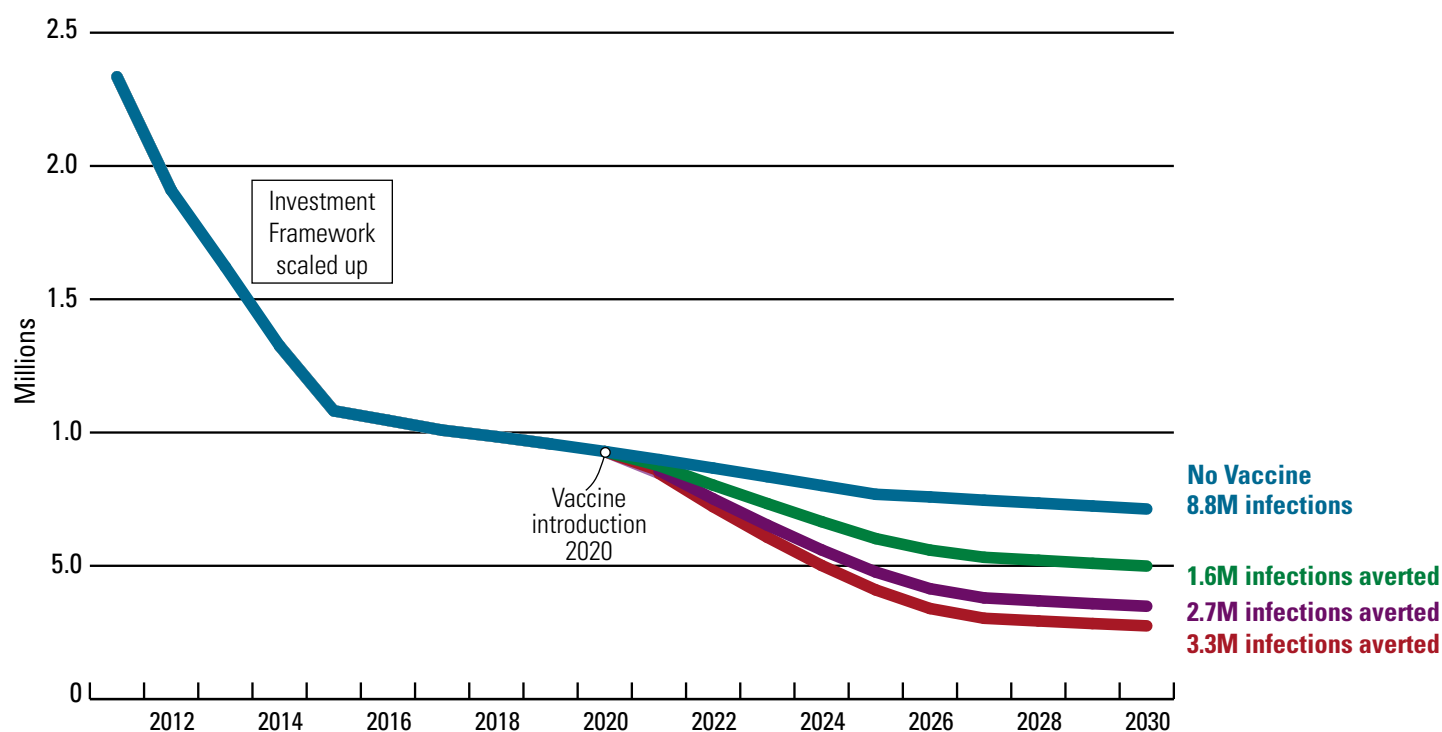


Table 2. The Global Impact of a Vaccine on AIDS Incidence and Mortality: Investment Framework Scenario

Scenario	Vaccine effectiveness	Population coverage	Annual infections by the year 2030	AIDS deaths in 2030	Cumulative AIDS deaths, 2020-2030	Cumulative HIV infections 2020-2030	Cumulative infections averted 2020-2030
No Vaccine	n/a	n/a	0.7M	0.7M	9.1M	8.8M	-
Low	50%	30%	0.5M	0.7M	9.0M	7.2M	1.5M
Medium	70%	40%	0.3M	0.7M	9.0M	6.1M	2.7M
High	90%	40%	0.3M	0.7M	9.0M	5.5M	3.3M

M=Millions

decrease gradually over time to 0.7 million new infections in 2030. While significant, the number of new infections would never approach zero. In the Investment

Framework scenario, a preventive AIDS vaccine would have significant additive impact on the reduction of new infections and AIDS-related deaths.

- In the Low Impact scenario, an AIDS vaccine with 50% efficacy and provided to 30% of the general population would prevent 1.5 million infections between

Figure 3. Number of Global New HIV Infections: Comparing AIDS Vaccine Impact Under Current Trends and AIDS Vaccine Impact Under Investment Framework Scenarios (2020-2030)

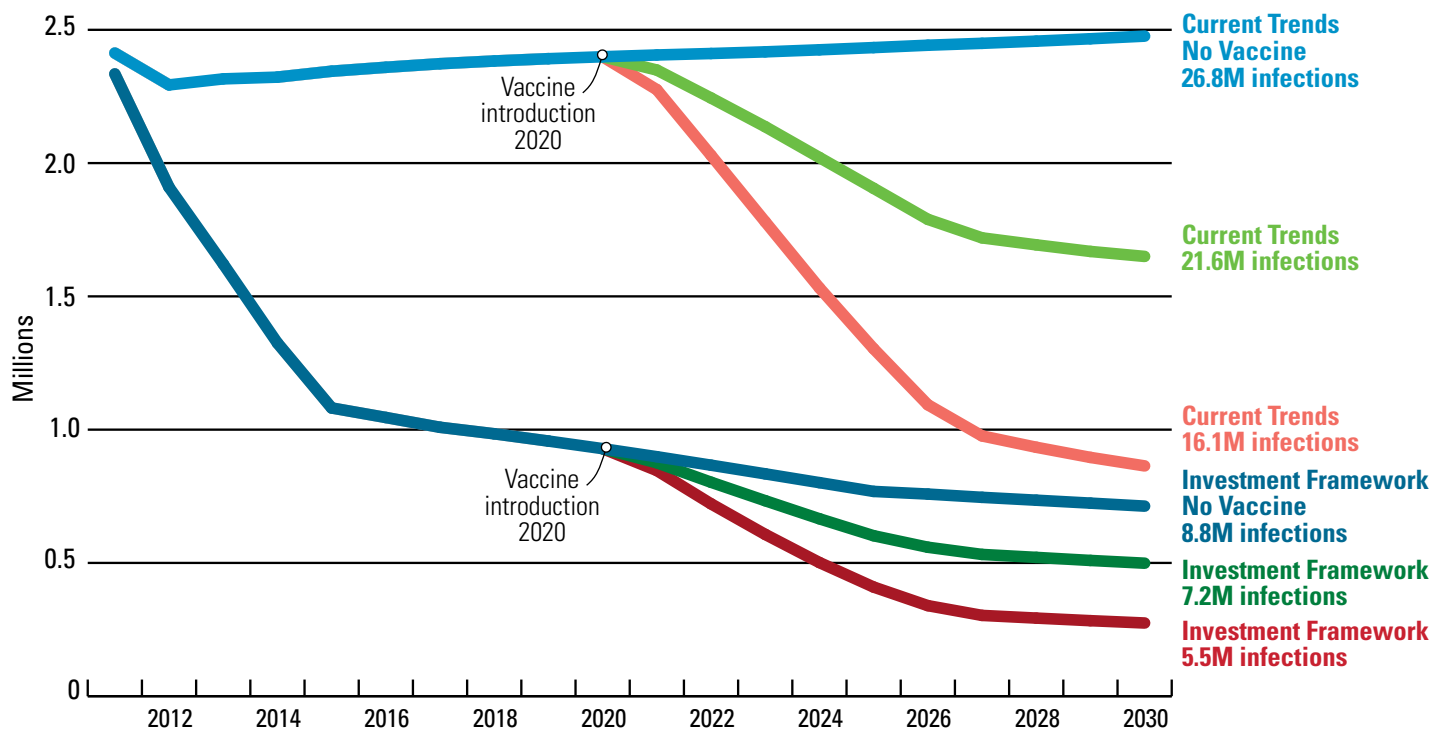


Table 3. The Global Impact of a Vaccine on AIDS Incidence and Mortality: Compared Scenarios

Scenario	Vaccine effectiveness	Population coverage	Annual infections by the year 2030	AIDS deaths in 2030	Cumulative AIDS deaths, 2020-2030	Cumulative HIV infections 2020-2030	Cumulative infections averted 2020-2030
CURRENT TRENDS							
No Vaccine	n/a	n/a	2.5M	2.3M	24.9M	26.8M	-
Low	50%	30%	1.6M	2.2M	24.5M	21.6M	5.2M
High	90%	40%	0.9M	2.0M	24.1M	16.1M	10.7M
INVESTMENT FRAMEWORK							
No Vaccine	n/a	n/a	0.7M	0.7M	9.1M	8.8M	-
Low	50%	30%	0.5M	0.7M	9.0M	7.2M	1.5M
High	90%	40%	0.3M	0.7M	9.0M	5.5M	3.3M

M=Millions

The Potential Impact of an AIDS Vaccine in Low- and Middle-Income Countries

2020 and 2030, or 18% of the expected infections during that time period.

- In the Medium Impact scenario, an AIDS vaccine with 70% efficacy and provided to 40% of the general population would prevent 2.7 million infections between 2020 and 2030, or 31% of the expected infections during that time period.

Maximizing the HIV/AIDS Response Now and in the Future

The UNAIDS Investment Framework presents a strong case for scaling up HIV prevention, treatment, and care strategies specific to populations most at risk. The importance of an increased response to HIV/AIDS is underscored in the context of the “Current Trends” scenario, which illustrates the prospect that prior success of HIV-prevention efforts in low- and middle-income countries could be reversed without additional resources and political will (Figure 3). Modeling of the Framework shows a significant drop in the number of new HIV infections and AIDS-related deaths. Such analyses connecting epidemiological and clinical trial data in support of more effective HIV/AIDS programming should be revisited periodically, as the characteristics of country epidemics evolve over time.

Modeling the impact of an AIDS vaccine shows the dramatic reduction in new infections a vaccine could catalyze upon introduction, even if funding and programmatic targets set under the Investment Framework are



CHARLOTTE RAYMOND/IAVI

not realized; however maximizing the number of infections averted would require new prevention tools to work in concert with a scaled-up and strategic response to the HIV pandemic. These projections underscore the importance of a comprehensive investment and policy approach to ending the spread of HIV through strategic use of existing prevention, treatment and care programs in the near-term while sustaining the effort to build upon the recent scientific progress toward development of vaccines, curative strategies, and other new prevention tools. Realizing the potential of existing and future interventions can lead to a drastic decline in the number of new HIV infections, reduced stress on existing HIV/AIDS programs and a realistic end to the AIDS pandemic.

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About IAVI

The International AIDS Vaccine Initiative (IAVI) is a global not-for-profit organization whose mission is to ensure the development of safe, effective, accessible, preventive HIV vaccines for use throughout the world. Founded in 1996, IAVI works with partners in 25 countries to research, design and develop AIDS vaccine candidates. In addition, IAVI conducts policy analyses and serves as an advocate for the AIDS vaccine field.

About Futures Institute

The Futures Institute is dedicated to enhancing social and economic development in the fields of HIV and AIDS, family planning and reproductive health, child survival and health systems strengthening by providing tools and technical assistance in policy, planning, modeling, resource allocation and evaluation. Recent Futures Institute projects have involved modeling the health and cost implications of the UNAIDS Investment Framework and working closely with international agencies and national programs in strategic planning and resources allocation around new prevention and treatment options. For more information, visit <http://www.futuresinstitute.org>.

Insights

IAVI's policy brief series outlines key public policy issues in the research, development, and eventual distribution of AIDS vaccines.

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