Policy Brief

Estimating the Global Impact of an AIDS vaccine

Nearly 40 million people are living with HIV/AIDS worldwide. Each year, five million more people are infected and three million die of the disease.

Antiretroviral therapy (ART), which is increasingly available, helps extend and improve life for some who are already infected. At the same time, prevention efforts using proven tools such as condom promotion and youth education have had success in a number of developing countries (for example, Senegal, Thailand, Uganda). Yet despite the successes of ART and prevention programs, the pandemic continues to grow.

Vaccines have proven highly effective in controlling other diseases, even leading to the eradication of smallpox and the near-eradication of polio. An AIDS vaccine could be a powerful tool in the effort to control the pandemic. The benefits to families and societies, measured in terms of suffering, economic loss and social disruption avoided, would be enormous.

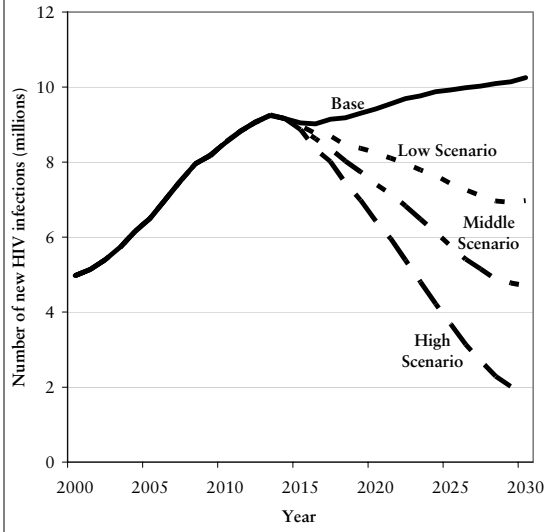
This brief summarizes recent policy research undertaken by the International AIDS Vaccine Initiative (IAVI) to estimate the possible impact of preventive AIDS vaccines on the course of the pandemic in developing countries. The results (Figure 1) suggest that even under very conservative assumptions, the impact of a vaccine would be considerable, lowering the number of people infected annually by more than 30%.

Impact of AIDS vaccines – what the literature tells us

Simulation modeling studies have investigated the potential impact of AIDS vaccines in a variety of developing country settings. More than 30 studies have been published in the last ten years, based on data from Eastern and Southern Africa and India.[i] While their results focus on individual countries and are based on specific assumptions, these studies generally find that:

- Even vaccines that are only partially effective[ii] (30-50%) could significantly reduce the number of new infections.
- Effectively protecting a quarter of the adult population with a vaccine could reduce HIV prevalence – the number of people infected – by more than half over 20 years. Effectively protecting half of the adult population could reduce long-term prevalence by 80%.
- Complete eradication of the AIDS epidemic using vaccines alone is unlikely.

Figure 1. New adult and child HIV infections in low and middle income countries by year and vaccine scenario



- Availability of a vaccine could lead to riskier behavior, erasing some of the gains from vaccination. As a result, vaccines must be accompanied by other prevention efforts.

New findings on the global impact of an AIDS vaccine

Using the trends observed in these earlier studies, IAVI has produced preliminary estimates of the global impact of an AIDS vaccine (Table 1).

Table 1. The global impact of an AIDS vaccine, 2015-2030

Scenario	Annual infections by the year 2030 (millions)	People Newly infected with HIV (millions)	Infections averted by an AIDS vaccine (millions)
Base	10.2	150	N/A
Low	7.0	121	29
Medium	4.7	103	47
High	1.8	79	71

These results are based on three scenarios reflecting different levels of vaccine efficacy and population coverage (Table 2):

Table 2. Efficacy, coverage, and effective coverage by scenario

Scenario	Efficacy	Coverage	Effective Coverage*
Low	40%	20%	8%
Medium	60%	30%	18%
High	95%	40%	38%

**Efficacy x Coverage*

These scenarios were combined with long-term projections from UNAIDS on the expected trajectory of the AIDS pandemic over the next twenty-five years, assuming that existing prevention and treatment programs continue to grow until 2012, then plateau at 80% coverage. For purposes of illustration, the simulation assumes that an AIDS vaccine is introduced in 2015.

Impacts at the global level (Figure 1):

- The *Base Scenario* gives a situation with no vaccine. The number of people infected would rise to 10.2 million a year by 2030. Between 2015 and 2030, 150 million people would be infected.

- In the *Low Scenario*, a 40% effective AIDS vaccine provided to 20% of the population would reduce the number of people infected annually by 32%, to seven million by 2030. It would prevent 29 million new infections or 19% of people who would otherwise be infected from 2015 to 2030.

- In the *Medium Scenario* an AIDS vaccine with 60% efficacy provided to 30% of the population would reduce the annual number of new infections by 54% to 4.7 million by 2030. It would prevent 47 million new infections or 31% of those people who would otherwise be infected from 2015 to 2030.

- In the *High Scenario* an AIDS vaccine with 95% efficacy provided to 40% of the population could substantially affect the course of the pandemic. It would reduce the annual number of new infections by 82% to 1.8 million by 2030. It would prevent 71 million new infections, 47%, over 15 years.

Impacts at the regional level

As might be expected, the largest impact would be in the developing country regions with the highest current burden of illness and deaths from AIDS: sub-Saharan Africa and South and Southeast Asia (Figure 2). In the Medium Scenario, for example, a vaccine could prevent as many as 28 million infections – two million each year – in sub-Saharan Africa. The impact of a vaccine in South and Southeast Asia would also be substantial – 7 to 19 million HIV infections avoided, depending on the scenario.

Next Steps

IAVI plans to do additional work on modeling the pandemic, as well as the costs and health, demographic, and economic benefits of a vaccine, in collaboration with others including WHO/UNAIDS. In the next phase of work, IAVI will assess the potential impact of an AIDS vaccine in selected developing countries, and will also analyze the effects of vaccines that might lower infectiousness and slow disease progression even if they do not completely block HIV infection. At the same time, additional research is needed by the field to refine these estimates and

to understand them in the broader context of a comprehensive response to the AIDS pandemic.

The positive effects of a partially effective AIDS vaccine could be undermined if people respond to vaccine introduction by adopting riskier behavior (e.g., forgoing condoms) because they believe that they are completely protected by a vaccine. A vaccine must be part of a comprehensive response and used alongside other prevention methods, not as a stand-alone intervention. Efforts to encourage people to be vaccinated against AIDS would have to be combined with continued promotion of condom use and other types of behavioral interventions that help to lower rates of HIV infection.

It is expected that existing prevention programs will continue to scale up in the coming years. The projected HIV prevalence used in these scenarios might thus be too high,[iii] overstating the number of infections averted by an AIDS vaccine. However, our modeling work has shown that the proportion of new infections that could be averted by a vaccine would be similar to the figures given here even if other prevention activities expand rapidly. The combination could reduce HIV incidence to very low levels in the future.

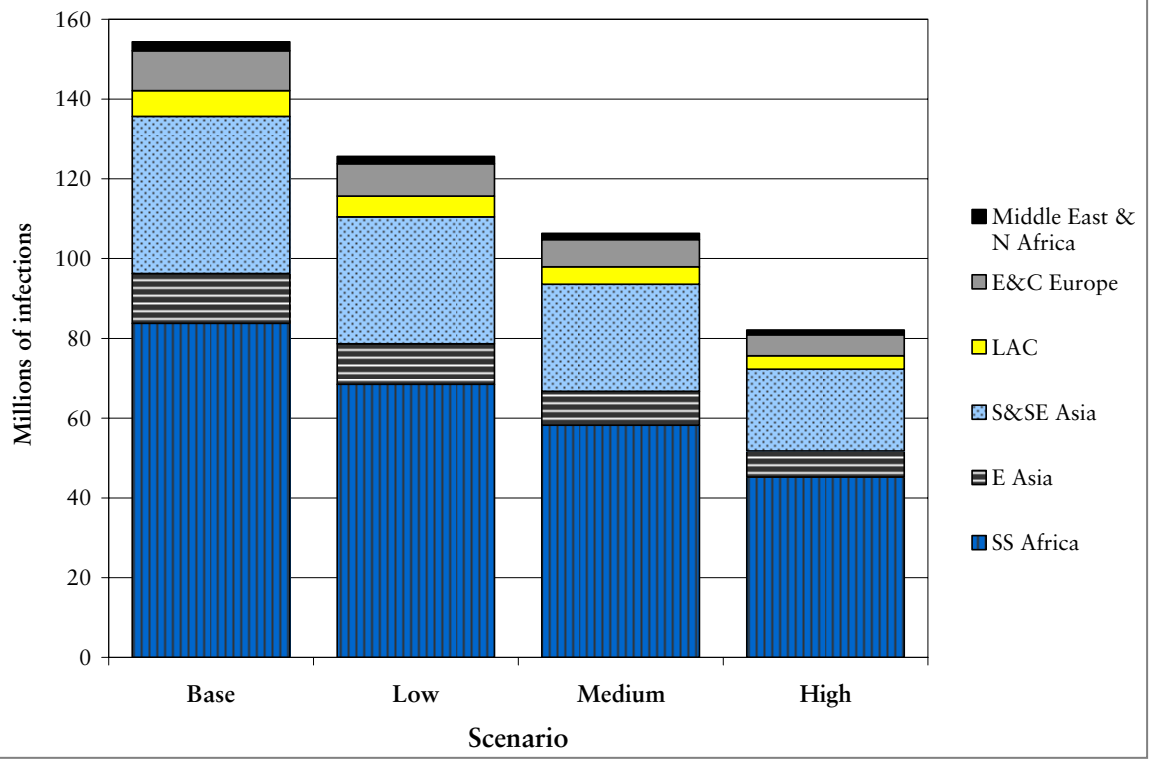
The number of people vaccinated to achieve maximum impact depends on the vaccine delivery strategy followed and the need for periodic re-vaccination to maintain effective coverage. Recent studies estimated that 260 million people could be vaccinated in the first five years of a global program.[iv] If developing countries adopt mass vaccination campaigns, the number of people vaccinated would be much larger.

Lastly, the costs of implementing these vaccine scenarios are not yet known. However, since the negative effects of the AIDS pandemic are known to be very substantial (as measured in terms of lost lives and lower economic productivity, as well as in health care and treatment costs), a vaccine program that can reduce the number of new infections by 20% to 50% can be expected to produce significant savings and thus be highly cost-effective.

What else needs to be done?

Research on AIDS vaccines is ongoing, with over $600 million spent each year and more than 30 vaccine candidates currently being tested. Unfortunately, no vaccines are yet ready for licensure and delivery to those at risk of HIV infection.

Figure 2. New adult and child HIV infections from 2015 to 2030, by region and scenario



To speed the discovery, development, and delivery of a vaccine, a number of actions are required today. More funding needs to be efficiently used for R&D, with the bulk of the extra resources directed to critical research projects carried out in large consortia of the top scientists and companies in the world. New and better incentives must be implemented to increase investment by industry and so harness the expertise of these groups, including large biopharmaceutical companies, smaller biotech firms, and vaccine suppliers from developing countries like India, Brazil, and China.

In spite of the uncertainties surrounding the exact cost and characteristics of an AIDS vaccine, it is clear that the availability of a vaccine would aid tremendously the effort to control the global AIDS pandemic. Although prevention and treatment programs are expanding rapidly in many countries, they are unlikely to reverse the rising number of new infections, and they will not end the pandemic on their own. For this, a vaccine is critical. The results of this research can help us to understand the huge potential impact of a vaccine, and thus sustain interest and support for vaccine research in the coming years as we work toward a long-term solution to the global AIDS crisis.

Notes and references

[i] The methods and key results from these studies are summarized in two recent IAVI-sponsored literature reviews: International AIDS Vaccine Initiative (2005). *Modeling the Impact of an AIDS Vaccine: A Review of the Literature.* (Policy Research Working Paper #5); International AIDS Vaccine Initiative (2005). *Methodologies for Modeling the Impact of an AIDS Vaccine in Developing Countries: Recent Studies* (Policy Research Working Paper #6).

[ii] A vaccine could be partially effective either by protecting completely a fraction of the population, or by protecting everyone in the same way, i.e., by lowering their chances of becoming infected as compared to the situation without a vaccine. In other words, a 50% effective AIDS vaccine could protect half the population completely while bringing no benefit to the rest of the population, or lower by 50% everyone's chances of becoming infected.

[iii] Stover, J., Walker, N., Garnett, G.P., Salomon, J.A., Stanecki, K.A., Ghys, P.D., Grassly, N.C., Anderson, R.M., & Schwartlander, B. (2002). Can we reverse the HIV/AIDS epidemic with an expanded response? *The Lancet*, 360, July 6, 2002, 73-77.

[iv] Esparza, J., Chang, M.-L., Widdus, R., Madrid, Y., Walker, N., & Ghys, P. (2003). Estimation of "needs" and "probable uptake" for HIV/AIDS preventive vaccines based on possible policies and likely acceptance (a WHO/UNAIDS/IAVI study). *Vaccine*. 21: 2032-2041.

About IAVI: IAVI (www.iavi.org) 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. IAVI's financial and in-kind supporters include the Bill & Melinda Gates, Rockefeller, Alfred P. Sloan and Starr foundations; the governments of Canada, Denmark, Ireland, the Netherlands, Norway, Sweden, the United Kingdom and the United States; multilateral organizations including the European Union and the World Bank; corporations such as BD (Becton, Dickinson & Co.), Continental Airlines and DHL; leading AIDS charities such as Crusaid, Deutsche AIDS Stiftung and the Until There's A Cure Foundation; and other private donors such as the Phoebe W. Haas Charitable Trust B.