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Kenya: Estimating the Potential Impact of an AIDS Vaccine

The potential game-changing impact of an AIDS vaccine on the Kenyan epidemic underscores the importance of sustaining political support and financial investments to accelerate research and development of an AIDS vaccine.

Kenya's AIDS epidemic continues to have a devastating impact on all sectors of society, resulting in more than 85,000 deaths per year (UNAIDS/WHO, 2008). An estimated 1.4 million people, or roughly 7.4% of the adult population, are living with HIV (Kenya Ministry of Health, 2009). Although the country has significantly expanded treatment, care and prevention programs, the number of new HIV infections continues to outpace Kenya's ability to treat and care for those living with the disease. Kenya, like many other countries in the region, is in critical need of new prevention technologies—in particular an AIDS vaccine—to combat and ultimately end the AIDS pandemic.

Vaccines are among the most cost-effective and efficient tools for fighting infectious diseases. An AIDS vaccine, integrated with existing prevention and treatment strategies, could potentially end the global AIDS pandemic. However, some key questions remain:

- Would a vaccine be useful if it were less than 100% effective?
- Would a vaccine still be needed if current prevention programs and antiretroviral therapy (ART) were significantly expanded while the vaccine is still being developed?
- Would a vaccine be cost-effective?

To address these questions, the International AIDS Vaccine Initiative (IAVI) has drawn upon robust data and mathematical models to examine the future epidemiology of the AIDS pandemic and the impact that a vaccine could have both globally and in countries such as Kenya, Uganda and Brazil. In Kenya, IAVI developed this research in collaboration with the Kenya HIV and AIDS Research Coordinating Mechanism (KARSCOM). A team of researchers at the Kenya AIDS Vaccine Initiative (KAVI) led the technical work with assistance from the Futures Institute.

Estimating global impact

IAVI and the Futures Institute developed a model using Spectrum software to explore the potential impact of an AIDS vaccine. This model

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enables policymakers to consider AIDS vaccines with a range of characteristics that reflect the vaccine candidates now in the research and development pipeline, including first-generation vaccines that may provide only partial protection against HIV. The model also allows policymakers to examine different vaccination strategies, from broad coverage of the adult population to targeting higher-risk groups.

A global analysis using this modeling tool showed that a vaccine that is 50% effective and given to 30% of the general population could reduce the number of new infections in the developing world by approximately 24% over 15 years (IAVI, 2009). These results indicate that even partially effective vaccines integrated into a comprehensive AIDS response can make a significant impact on the pandemic in the coming decades.

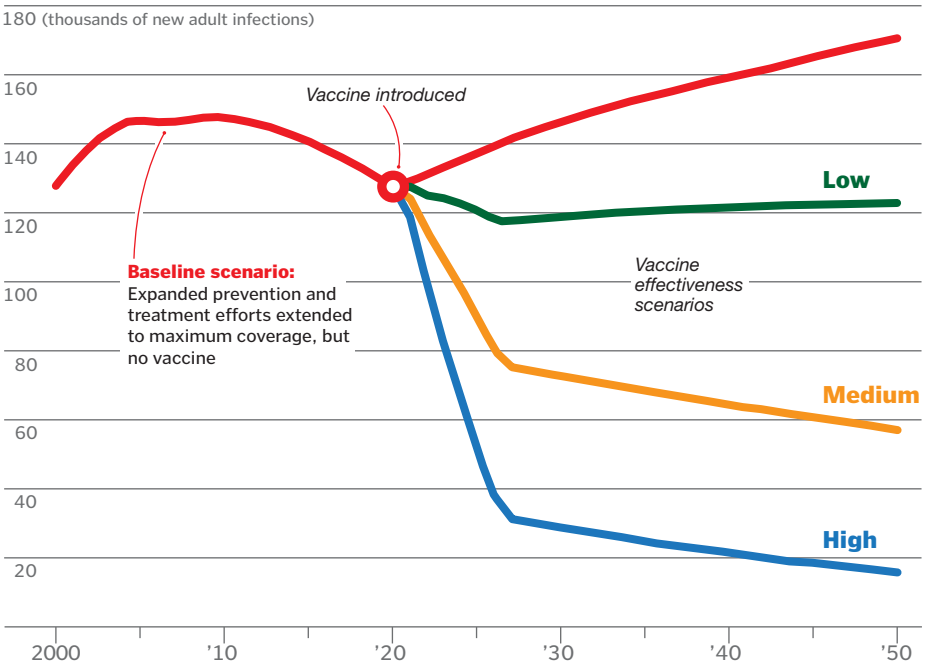
Potential vaccine scenarios

Since declaring HIV and AIDS a national disaster in 1999, Kenya has succeeded in significantly reducing the national prevalence rate through a combination of aggressive treatment and prevention programs. However, the more than 140,000 new HIV infections that occur each year continue to challenge Kenya's ability to cope with the epidemic (Kenya Ministry of Health, 2009). An AIDS vaccine, together with other prevention strategies, could significantly curb the rate of new infections, cap growing treatment costs and drastically transform the battle against AIDS in Kenya and across the globe.

To explore the potential impact of a vaccine, the Kenyan research team modeled the national epidemic using the most current data from national sources, including epidemiological and behavioral surveillance. Various published sources provided additional demographic, health and behavioral data. The model's baseline projection was validated against adult HIV prevalence as recorded in HIV surveillance at antenatal clinics and two general population surveys. The research

Estimated number of new infections in Kenya

Results generated by this analysis show that an AIDS vaccine could substantially alter the course of the epidemic in Kenya and reduce the number of new infections, even if vaccine efficacy levels are relatively low and other programs for treatment and prevention are scaled up.



Vaccine scenarios	Efficacy	Percentage of population given vaccine	New infections averted 2020-50	Deaths averted 2020-50	Percentage reduction in new infections
LOW	30%	30%	1.4 million	409,000	25%
MEDIUM	50%	50%	2.4 million	850,000	65%
HIGH	70%	70%	3.5 million	1,233,000	90%

- The baseline scenario projects the future trajectory of the epidemic in Kenya if a vaccine is not introduced and existing treatment and prevention strategies are extended to maximum coverage by 2020, consistent with the goals set out in Kenya's National AIDS Plan. In this sceanrio, the number of new infections is projected to increase after 2020 due to population growth. In the absence of an effective vaccine, the number of new infections is projected to rise from 147,560 in 2010 to 170,406 per year by 2050.
- A medium-efficacy vaccine (one that reduces the chance of becoming infected by 50%) given to half the adult population is forecast to have a substantial impact by preventing around 65% of new HIV infections and averting 850,000 deaths from 2020 to 2050. A vaccine with higher efficacy (70%) given to more than half of the population (70%) would have an even greater impact on the epidemic, averting an estimated 90% of new infections and 1.2 million deaths from 2020 to 2050.

team led the effort to ensure the model fit the Kenyan epidemic and to explore different scenarios.

Although the level of protection that first-generation vaccines could provide is still unknown, scientists believe they might be only partially effective in preventing HIV infection. Based on the vaccine candidates currently being tested, a vaccine could employ a combination of the following three mechanisms to fight the virus:

- Protect the vaccinated individual against HIV infection (i.e., reduced susceptibility).
- Reduce the probability that a vaccinated individual who later becomes infected will transmit the virus to others (i.e., reduced infectiousness).
- Slow the rate of progression from HIV infection to death in vaccinated individuals (i.e., an increase in average survival time after infection).

Through consultations with leading researchers and policymakers in Kenya, three plausible scenarios were constructed to reflect current understanding of vaccine science and the characteristics of the Kenyan response to the epidemic.

The scenarios outlined in the graph and chart on the opposite page assume that a vaccine is introduced in 2020 and maximum coverage is reached by 2025 because of the time needed to scale up coverage. The level of coverage is assumed to increase as vaccine efficacy increases. A higher-efficacy vaccine is likely to be implemented more broadly by governments and is likely to have greater uptake by individuals. All scenarios assume the continuation and expansion of existing prevention and treatment efforts.

Vaccination strategies

When a vaccine first becomes available, a key policy question will be whether to employ a vaccination strategy that covers the general population or instead targets specific population groups with increased vulnerability to HIV, such as men who have sex with men (MSM), injecting drug users (IDUs), heterosexuals with multiple partners and sex workers and their customers. The table below details the vaccination strategies explored by the researchers using a medium-efficacy vaccine.

According to the model, the higher-coverage scenario, which aims to cover 80% of medium- and high-risk populations along with 50% of low risk groups, would be the most effective vaccination strategy, averting 72% of new infections from 2020 to 2050. However, it may be challenging to reach 80% of the medium- and high-risk population with the vaccine and this strategy requires the largest number of vaccinations. In a resource-limited setting, the most cost-effective strategy in terms of number of vaccinations per infection averted would be the medium- and high-risk only strategy that aims to cover 50% of medium- and high-risk groups. This strategy would require only one-eighth the number of vaccinations as the higher-coverage strategy and result in a 26% reduction in new infections from 2020 to 2050.

The data show that the lowest impact on curbing the epidemic resulted when targeting only high-risk groups in a vaccination strategy, which would avert only 3% of new infections. Because Kenya's epidemic is generalized and affects all segments of the population, it is critical that a vaccination strategy covers a wide cross section of the population, rather than solely targeting those at highest risk of infection, in order to have a significant impact on the national epidemic.

Key conclusions and next steps

The results of the modeling show that even with full scale-up of currently available treatment and prevention programs, new infections will continue

Potential impact of vaccination strategies in Kenya with a medium-efficacy vaccine

Vaccination strategy	Coverage of target population	Percentage reduction in new infections 2020-50	New infections averted 2020-50	Vaccinations required	Vaccinations per infection averted
Higher coverage	80% coverage of medium- and high-risk groups and 50% of low-risk groups	72%	2.67 million	69.4 million	26
Medium- and high-risk only	50% coverage of medium- and high-risk groups	26%	950,000	8.6 million	9
High-risk only	50% coverage of high-risk groups	3%	120,000	1.4 million	12
Medium	50% coverage of entire adult population	65%	2.4 million	62.4 million	26

Would a vaccine be cost-saving?

Kenya is highly reliant on foreign governments and multilateral institutions to fund its response to the epidemic, with an estimated 98% of HIV funding coming from international donors (UNAIDS, 2008). Within government health spending, more than 50% of the health budget is spent on HIV and AIDS treatment and care and is reaching only 40.5% of adult Kenyans in need of ART (HRW, 2008; Kenya Ministry of Health, 2009). The resources required to scale up treatment, care and prevention programs will continue to escalate in the coming years as Kenya's population grows and new infections increase.

Although it is unclear at this time what the full cost of a vaccine will be, preliminary cost analyses suggest that AIDS vaccines would result in significant savings when compared to growing treatment costs. The maximum price at which a vaccine would be considered cost-saving can be calculated using several different approaches; we provide one example below.

Vaccines v. ART: An infection averted by a vaccine will mean that a person will not need ART in the future. Thus the cost of a vaccine can be compared to the present value of future treatment costs to determine cost-effectiveness. In Kenya, if each new infection implies a cost of US$ 8,700* to maintain an individual on ART throughout his or her lifetime, then any intervention that prevents infections for less than US$ 8,700 would not only be cost-effective, but cost-saving.

In the medium-efficacy vaccine scenario, impact modeling estimates that approximately 62.4 million vaccinations would be required to avert 2.4 million infections from 2020 to 2050. This means that approximately 26 vaccinations are needed to avert one infection. In comparison to ART, a medium-efficacy vaccine could cost up to US$ 335 per vaccination (US$ 8,700 divided by 26) and still result in cost savings.

*This calculation assumes that on average, there is an eight-year period from infection to starting treatment. The cost of first-line drugs is anticipated to rise from US$ 170 per year to US$ 230 by 2015. The cost of second-line drugs is assumed to decline in price from US$ 1,215 per year to US$ 530 by 2015. Laboratory costs are estimated to be US$ 190 per patient per year, and service delivery is estimated at US$ 112 per patient per year. All costs are discounted at 3% per year . The modeling assumes a 15% failure rate of first-line drugs in the first year and a 5% failure rate in subsequent years, with 85% of patients moving to second-line drugs when the first line fails.

to burden Kenya. However, the analysis shows that introducing even a partially effective AIDS vaccine could significantly alter the trajectory of the epidemic. An AIDS vaccine could prevent a new generation of HIV infection in Kenya and throughout the region, lead to increased economic productivity, reduce the financial burden of the disease on the country's resources and alleviate the strain on health workers and facilities, thereby enabling a sustainable response to the epidemic. The potential game-changing impact of an AIDS vaccine on the Kenyan epidemic underscores the importance of sustaining political support and financial investments to accelerate the research and development of an AIDS vaccine.

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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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