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China: Estimating the Impact of an AIDS Vaccine

Vast increases in Chinese government support of HIV/AIDS treatment, prevention, and care initiatives over the past decade have proven effective in slowing the country's epidemic. Yet, even with increasing government commitments, the Chinese Ministry of Health has consistently reported 40,000 to 50,000 new HIV cases per year for each of the past five years (Chinese Center for Disease Control and Prevention 2010). HIV/AIDS recently became the leading infectious cause of death in China, and remains a serious public health threat in China.

Engaging in the global effort to develop a safe and effective AIDS vaccine to prevent new HIV infections could add a critical tool to China's domestic HIV prevention programs, strengthen its role as a champion of development in Africa and advance the country's leadership in biomedical innovation.

Vaccines are among the most cost-effective and efficient tools for fighting infectious diseases. Adding an AIDS vaccine to existing and emerging prevention and treatment strategies offers a potential end to 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 a vaccine is still being developed?
- Would a vaccine be cost-effective?

To address these questions, over the past six years, the International AIDS Vaccine Initiative (IAVI) and the Futures Institute have collaborated to develop a computer simulation model to study the impact of a potential HIV vaccine on the pandemic, both globally and in specific countries such as Kenya, Brazil, Uganda, and now China.[1] (IAVI 2006)

The Spectrum HIV vaccine model used in this analysis is part of the larger Spectrum Policy Modeling system, which has been used to explore the impact and costs of other HIV-prevention and treatment interventions. The model is an accessible tool available for use by national governments to explore the potential impact of AIDS vaccines on their epidemics by applying country-specific demographic, epidemiological, and vaccine-uptake data.

In China, IAVI collaborated with the Chinese National Center for AIDS/STD Control and Prevention (NCAIDS). A team of epidemiologists from the HIV/AIDS surveillance departments of NCAIDS and 13 provinces led the technical work, with assistance from the Futures Institute.

The aim of the study was to analyze the potential impact of an AIDS vaccine, in combination with other prevention interventions, on the epidemic in 13 Chinese provinces and estimate the potential health and economic benefits that could result from widespread vaccination among the populations most at risk of HIV infection. These results provide a tool to aid Chinese policymakers and scientists in developing policies that support research and help guide future strategies for the implementation of an

[1] These and other related IAVI publications can be accessed on IAVI's website.

UNAIDS
CDC CHINESE CENTER FOR DISEASE CONTROL AND PREVENTION
NATIONAL CENTER FOR AIDS/STD CONTROL AND PREVENTION
iavi International AIDS Vaccine Initiative

AIDS vaccine and other prevention interventions.

Models have been set up for 13 provinces in China. Some of these models have been extensively validated, while others are still undergoing further validation. This brief utilizes the results from Sichuan province to illustrate the potential effects of a vaccine. While the specific results vary by province, depending on the course of the local epidemic, the relative results are similar across provinces over the long projection period.

Baseline Projections

The baseline projection coverage of prevention services for sex workers and clients assumes a continuing increase from about 30% today to 60% by 2030. The coverage of prevention services for men who have sex with men (MSM) increases from about 10% today to 70% by 2030. Other prevention interventions remain at their current coverage levels.

ART coverage is currently high in Sichuan, with services reaching about 90% of those identified/tested with CD4 counts under 200. In the baseline projection, ART coverage rises gradually to 90% of those with CD4 counts under 350 by 2020, reflecting the recent recommendation by the World Health Organization in its ART provision guidelines. Drawing on the results of recent clinical trials of early ART provision, the model also assumes a 90% reduction in HIV transmission by an infected individual on ART stemming from a reduced viral load, in turn showing how increased ART coverage can also avert new infections.

Vaccine Scenarios

Through consultations with leading researchers and policymakers in China, three plausible scenarios were constructed to reflect current understanding of vaccine science and the Chinese response to the epidemic. The Low, Medium, and High scenarios looked at the impact of a vaccine with varying levels of effectiveness (30%, 50% and 70% respectively) and population coverage (30%, 50%, and 70% of the adult population 15-49 years of age, respectively). In the model, the vaccine is assumed to be introduced in the year 2020 and coverage (percentage of adults vaccinated) scales up from 0% in 2019 to the maximum coverage by the year 2025, after which coverage remains constant. All scenarios assume a vaccine that will provide protection for an immunized individual for a duration of 20 years.

RESULTS

Impact on HIV Incidence and Prevalence in Sichuan Province

The figure below shows the projected number of new adult HIV infections in Sichuan province under the baseline projection and with the Low, Medium and High vaccine scenarios. In the Base projection, the number of new

Figure 1. Number of New Adult HIV Infections in Sichuan Province by Scenario (2020-2030)

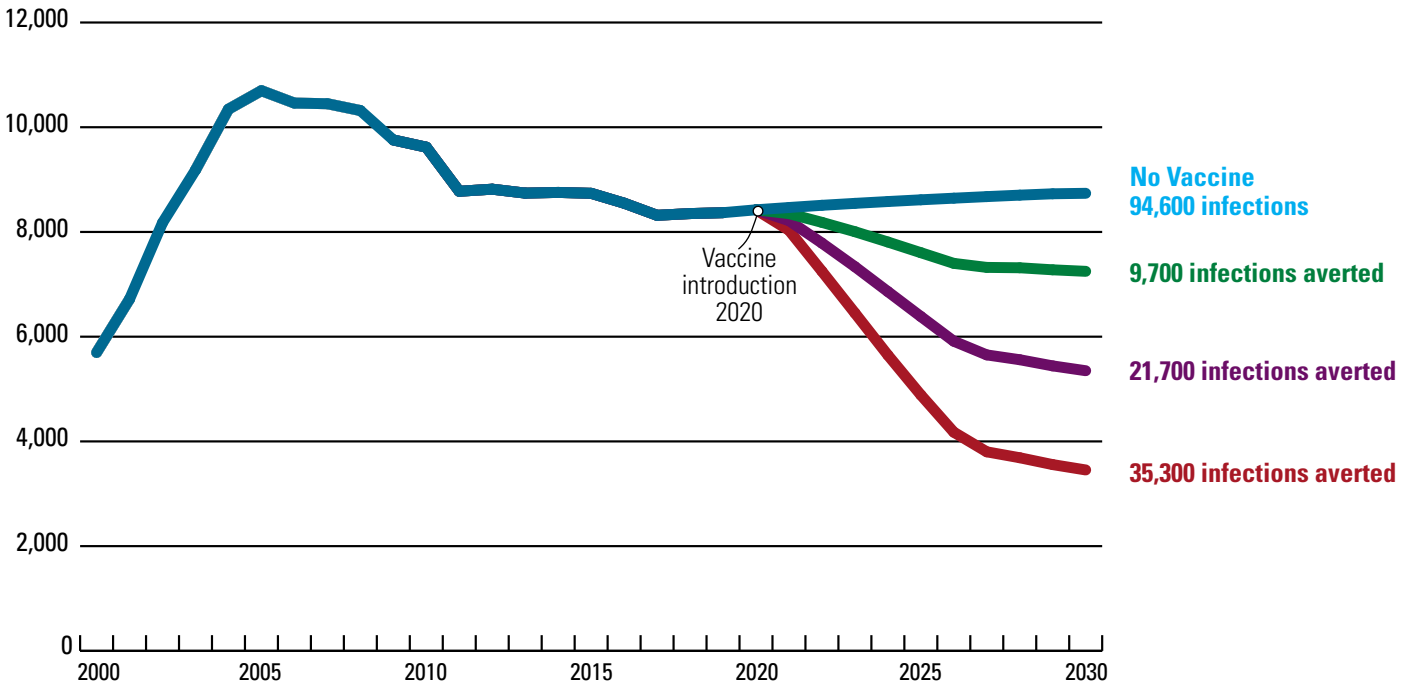

Table 1. AIDS Vaccine Scenarios and Impact on New Infections, Sichuan Province

Vaccine scenario	Vaccine effectiveness	Percentage of adult population given vaccine	New infections averted, 2020-2030	Percentage reduction in new annual infections, 2030
Low	30%	30%	9,700	17%
Medium	50%	50%	21,700	39%
High	70%	70%	35,300	60%

infections stabilizes at about 8,500 per year from 2015 to 2030.

- The Low vaccine scenario reduces the number of new annual infections by 17% by 2030 (to 7,300) and averts a cumulative 9,700 infections from 2020 to 2030, or 10% of all new infections.
- The Medium vaccine scenario reduces the number of new annual infections by 39% by 2030 (to 5,400) and averts a cumulative 21,700 new infections from 2020 to 2030, or 23% of all new infections.
- The High vaccine scenario reduces the number of new annual infections by 60% by 2030 (to 3,500) and averts a cumulative 35,300 new infections from 2020 to 2030, or 37% of all new infections.

New infections in Sichuan province occur in different population groups. Exact information is not available, but the modeling suggests that the largest number of new infections occur among MSM and among those who have a single partner, but that partner has other partners. The modeling further suggests that commercial sex and injecting drug use also contribute to new infections.

The results of the modeling vaccines would reduce new infections in all risk groups. The number of annual vaccinations peaks in 2025 as coverage is scaled up, and then declines to a maintenance level in subsequent years.

- In the Low scenario, that number of vaccinations peaks at 2.1 million in 2025 and then drops to about 680,000 per year. From 2020-2030, a total of 14.9 million vaccinations are required.
- For the Medium projection, the number peaks at 3.3 million in 2020, then drops to about 1 million and requires a total of 22 million through 2030.
- For the High projection, the peak is 4.3 million in 2025 before dropping to 1.4 million per year. From 2020 to 2030 30 million vaccinations would be required.

The number of vaccinations per infection averted for the period 2020 to 2030 would be 1,540 for the Low scenario, 1,030 for the Medium scenario and 850 for the High scenario.

Targeted 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 one that targets specific population groups with increased vulnerability to HIV. Targeting vaccine delivery to the population groups with the highest incidence rather than to the entire adult population will result in fewer infections averted, but effectiveness could be dramatically improved in terms of vaccinations per infection averted. For example, if the Low, Medium and High vaccine scenarios were targeted only to MSM, then the total impact in terms of infections averted would be 17-21% lower without targeting, but the number of vaccinations required per infection averted would drop dramatically to 52 (Low), 32 (Medium) and 24 (High) respectively—30 times fewer vaccinations than an untargeted program.

Potential Cost Savings

The future cost of a preventive HIV vaccine remains unknown, and thus we can only speculate about the resources needed to achieve the levels of coverage indicated in the Low, Medium and High scenarios. However, we can quantify some of the potential financial benefits of

[2] This figure is calculated using the 2010 prices of ARVs for low- and middle-income countries of $155 for first-line and $1678 for second-line [WHO, Towards Universal Access: Scaling up priority HIV/AIDS interventions in the health sector, Progress Report 2010, WHO, UNAIDS, UNICEF] and assuming that prices for second line ARVs decline to $980 by 2015. The cost of diagnostics and monitoring tests is $180 per patient, per year and the service delivery costs are $176 per patient, per year [Stover J, Bollinger L, Avila C. Estimating the Impact and Cost of the WHO 2010 Guidelines for Antiretroviral Therapy, AIDS Research and Treatment, Vol 2011, Article ID 738271, doi:10.1155/2011/738271]. Need for treatment begins eight years after infection and annual survival on first and second line is assumed to be 92% to 99% depending on the patient's CD4 count at treatment initiation (IeDEA Consortium). With these assumptions a typical patient survives for about 28 years on first-line treatment and 12 years on second-line. All costs are discounted at 3% per year to the time of infection. For more information, see the interactive ART costs calculator, which can be accessed through the 'Policy Tools' link on the Futures Institute website, www.FuturesInstitute.org.

a vaccine. Every infection averted by vaccination also averts the cost of lifetime ART provision to an individual, currently estimated at about US$8,900, discounted to present value[2]. Such costs are currently higher in China, though they may decrease through price negotiations. The Low, Medium and High vaccine scenarios would reduce future treatment costs in Sichuan province by $86 million, $193 million and $314 million, respectively.

The averted treatment costs divided by the number of people that need to be vaccinated to avert one infection provides an estimate of the amount a vaccine could cost and still be cost savings. For the Low, Medium and High vaccine scenarios, vaccination would be cost-saving if it cost $5.80 - $10.50 per person vaccinated, in the Low, Medium and High scenarios. If the vaccine were targeted to the highest risk groups, then the cost could be as high as $171 - $377 and still be cost-saving.

CONCLUSIONS AND NEXT STEPS

The Chinese government has successfully slowed the number of new HIV infections by expanding access to HIV prevention, treatment, and care interventions. However, AIDS continues to be a serious threat to public health in China. The addition of an HIV vaccine to existing prevention and treatment interventions could prove valuable to ending the epidemic in China.

Even if a vaccine is not available until 2020, after other prevention and treatment activities have expanded, the introduction of an AIDS vaccine will still have a significant impact on the Chinese epidemic. This modeling shows that introducing even a low-efficacy HIV vaccine with limited coverage as part of a comprehensive package of treatment and prevention could significantly lower the number of new HIV infections in China. This, in turn, could have a large potential economic benefit in China, as each infection averted by a vaccine would translate into thousands of dollars saved in averted ART costs.

This study involved teams using surveillance, behavioral and economic data on the HIV epidemics in 13 Chinese provinces to examine the potential contribution of HIV vaccines in combination with other prevention tools to reducing the number of new HIV infections. The modeling results for Sichuan outlined in this brief provide one provincial illustration of an HIV vaccine's potential impact and strategies around vaccine delivery. Similar exercises in other provinces could help policy makers and program managers to better understand the potential impacts of AIDS vaccines and further inform the development of appropriate policies to accelerate AIDS vaccine research and development.

China's expanding R&D capacity is already engaged in the global effort to develop an AIDS vaccine that could have a significant impact on the country's domestic HIV epidemic. Modeling the impact of a preventive HIV vaccine in the context of China can help to continue building support for vaccine development and make a case for investment in AIDS vaccine R&D both in China and in a global context.

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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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