

Evidence-Based Efforts to Prevent HIV Infection: An Overview of Current Status and Future Challenges

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Since the early 1990s, the incidence of human immunodeficiency virus (HIV) infection in the United States has been ~40,000 cases per year. Because this rate has not decreased substantially in >15 years, the efficacy and cost-effectiveness of programs to prevent HIV infection have come under intensifying examination. In this article, several issues are addressed, including the efficacy of HIV prevention strategies at the national level in the United States, the status of the goals from the current (albeit expired) national HIV prevention plan, the role of opt-out HIV testing in a new comprehensive national HIV prevention plan, and a review of evidence-based prevention strategies that should be emphasized in a new plan.

In recent years, the evaluations of efforts to prevent HIV infection have received increasing attention. This article will make the case that, at the national level, HIV prevention programs are effective in averting new infections and are cost-effective. Furthermore, to suggest future directions for a new national HIV prevention plan (the current national plan expired in 2005), the role of opt-out HIV testing in that plan will be discussed, and evidence-based prevention strategies that should be integrated into the plan will be reviewed.

MODELING THE EFFECTIVENESS OF PROGRAMS TO PREVENT HIV INFECTION

Figure 1 shows that, in the United States, the annual incidence of HIV infection decreased from ~160,000 infections in the mid-1980s to ~40,000 infections in 1990, where it has roughly remained since [1]. One might conclude that, because the rate has not decreased, programs to prevent HIV infection have not been successful in recent years.

However, the success of HIV prevention programs can be more accurately measured by estimating the

number of infections that would have occurred if the programs had not been in place or had been discontinued. Using mathematical modeling, we have examined different assumptions about how the epidemic might have continued, on the basis of what is known about the natural history of HIV. Elsewhere I showed that, during 1985–2000, at least several hundred thousand, and perhaps as many as 1.5 million, HIV infections were averted in the United States and that approximately \$10 billion in federal, state, and private investments was actually cost saving in light of the HIV-associated medical care costs averted (table 1) [1].

The annual HIV transmission rate at the very beginning of the epidemic was ~100%; that is, nearly everyone infected with HIV transmitted the virus to someone else. In the mid-1980s, the HIV transmission rate was ~25%. Since 1990, the annual HIV transmission rate has been ~4% (figure 2) [2]. Overall, these findings suggest good progress in preventing HIV infection. For a more detailed analysis of the rate of HIV transmission, one might consider whether infected patients who are aware of their positive serostatus transmit HIV at a rate different from those who are unaware of their positive serostatus. For persons who are unaware that they are infected with HIV, the transmission rate has been estimated to be 8.8%–10.8%; the transmission rate for persons who are aware of their HIV seropositivity has reported to be 1.7%–2.4% [3–5].

Mortality rates are another way to examine the effectiveness of HIV screening. The advent of HAART

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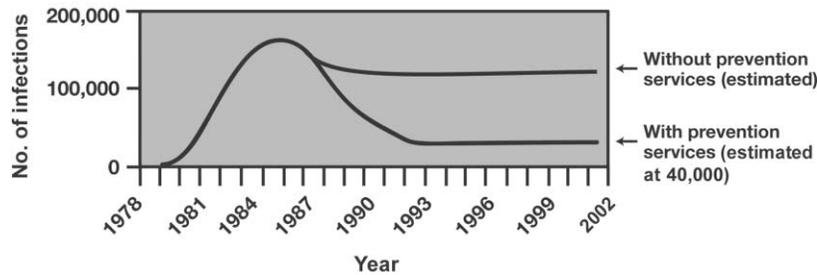


Figure 1. Estimated annual numbers of HIV infections in the presence or absence of HIV prevention services. Adapted with permission from the following article published by Lippincott Williams & Wilkins: Holtgrave DR. Estimating the effectiveness and efficiency of US HIV prevention efforts using scenario and cost-effectiveness analysis. *AIDS* 2002; 16(17):2347–9.

profoundly decreased the mortality rate. Use of HAART as the primary medication regimen resulted in a more precipitous and much earlier decrease in the mortality rate than would have occurred had HAART not been an option. However, given the natural history of HIV disease, even if HAART had not been developed, a decrease in HIV mortality would have been likely by the late 1990s because of the success of prevention efforts implemented a decade earlier (figure 3) [6].

It seems intuitive that there would be a relationship between funding for prevention strategies and the incidence of HIV infection. Figure 4 compares the incidence of HIV infection with the inflation-adjusted size of the Centers for Disease Control and Prevention (CDC) HIV prevention budget during 1978–2006. Not unexpectedly, there is a relationship between the 2 variables. A colleague and I [7] conducted a lag correlational analyses that revealed that, until the mid-1980s, the HIV epidemic was driving the investment; that is, as the nation responded to the emergency, the incidence of HIV infection was driving the size of the budgetary response (figure 5) [7]. However, in 1986, the incidence of HIV infection started to be driven by the budget, and after the mid-1980s, the incidence of HIV infection could be predicted on the basis of the previous year’s HIV prevention budget [7].

STATUS OF THE CDC’S GOALS TO REDUCE THE INCIDENCE HIV INFECTION

The goal of the CDC’s national strategic plan for reducing HIV infection during 2001–2005 was to “[r]educe the number of new HIV infections in the US from an estimated 40,000 to 20,000 per year by 2005, focusing particularly on eliminating racial and ethnic disparities in new HIV infections” [8, p. 2]. On the basis of estimates from the 33 states that submitted confidential name-based reports of HIV infection to the CDC, this goal was not met. During 2001–2004, a total of 157,252 diagnoses of HIV infection were made. There were 41,207 diagnoses made in 2001, which decreased to 38,685 diagnoses in 2004 [9]. It is not always the case in an epidemic that the incidence of disease is greater than the number of diagnoses; however, if there were almost 40,000 diagnoses per year in just 33 states, it may well be that the number of new infections annually was >40,000. In any case, the incidence of HIV infection does not appear to be decreasing at the desired rate. Furthermore, the epidemic continues to disproportionately affect communities of color [10, 11].

The first subgoal in the CDC’s plan was to “decrease by at least 50% the number of persons in the United States at high

Table 1. Modeling the effectiveness and efficiency of overall national response to HIV infection in the United States, 1985–2000.

Model of HIV incidence	Estimated no. of infections averted	Gross cost in US\$ per infection averted	Net cost
Flattens (after peaking) at 161,000 infections/year	1,585,000	6,400	Cost saving
Decreases (after peaking) and then flattens at 123,000 infections/year	1,031,000	9,800	Cost saving
Decreases (after peaking) at a rate of 6%/year	672,000	15,100	Cost saving
Decreases (after peaking) at a rate of 12%/year until flattening at 40,000 infections/year	204,000	49,700	Cost saving

NOTE. Each modeling scenario involved the assumption that programs to prevent HIV infection were not in place. Adapted with permission from the following article published by Lippincott Williams & Wilkins: Holtgrave DR. Estimating the effectiveness and efficiency of US HIV prevention efforts using scenario and cost-effectiveness analysis. *AIDS* 2002; 16(17):2347–9.

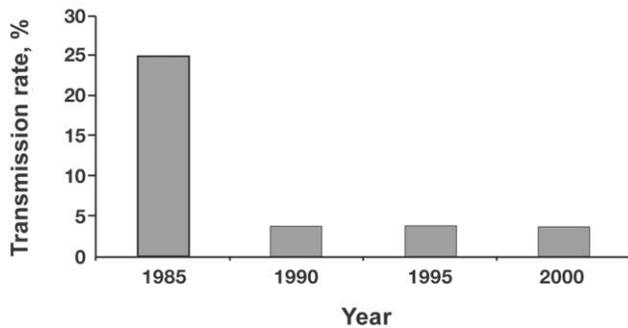


Figure 2. Estimated percentages of US persons living with HIV/AIDS who transmitted HIV to ≥ 1 person. Data are from [2].

risk for acquiring or transmitting HIV infection by delivering targeted, sustained and evidence-based HIV prevention interventions” [8, p. 2]. Progress toward achieving this subgoal is difficult to quantify because of the subgoal’s wording and because we do not have optimal data at the national level on the incidence of sexually transmitted HIV infection. HIV-positive persons have been shown to reduce the frequency of high-risk behavior by 68% after learning of their serostatus [12]. On the basis of 2002 data from the National Survey of Family Growth, 11.7%–11.9% of persons in the general US population have a heightened risk of HIV infection, because they engage in high-risk sexual behavior, abuse drugs, or have a sexually transmitted disease [13, 14]. These findings give a sense of the percentage of persons at risk but do not give a sense of changes in risk over time.

The second subgoal was to increase the percentage of infected people who know their serostatus to 95%, up from the baseline

level of 70%, through implementation of voluntary counseling and testing programs [8]. In 2005, the CDC estimated that 73%–76% of HIV-infected patients were aware of their serostatus [15]. Therefore, although very modest progress was made, this progress was closer to the baseline than the to goal.

The third subgoal was to increase the percentage of infected people who are linked to appropriate medical care to 80%, up from the estimated baseline level of 50% [8]. In 2004, the Institute of Medicine estimated that 49.7% of persons in need of HAART were receiving HAART [16]. Thus, substantial progress remains to be made with regard to this subgoal.

PROPOSED HIV PREVENTION GOALS FOR 2007 AND BEYOND

This year, the CDC will likely issue a new national plan to prevent HIV infection. My colleagues and I [11] propose that the CDC commit to reducing the incidence of HIV infection by 50% by 2010, with continued focus on reducing racial and ethnic disparities. To monitor progress, an annual report and outcome assessment should be issued to ensure transparency regarding budgetary investment, changes in the incidence of HIV infection and rates of high-risk behavior, and changes in the disproportionate burden shouldered by minorities [17].

Several interventions are needed to achieve further progress. Table 2 is an update of a report in which a serostatus-specific framework was proposed for fighting the HIV epidemic [18]. This framework, referred to as the Serostatus Approach to Fighting the Epidemic, is focused on HIV-infected persons, including those currently unaware of their serostatus, and uninfected persons who have been tested but continue to engage

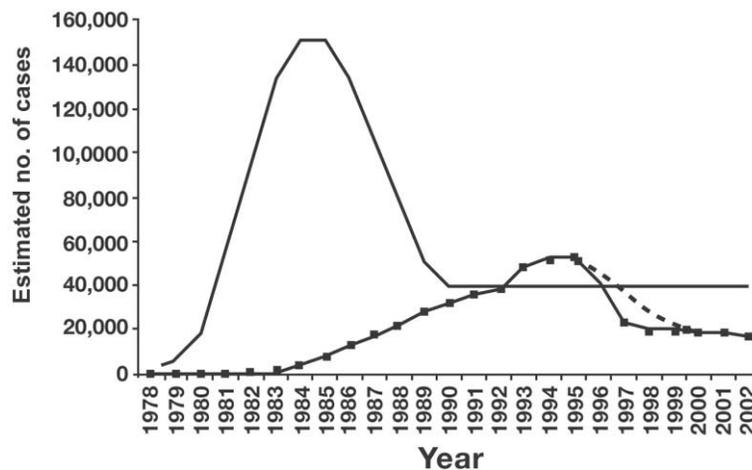


Figure 3. Epidemiologic characteristics of the HIV/AIDS epidemic. *Boxed line*, number of deaths due to AIDS; *dashed line*, number of deaths due to AIDS had HAART not been developed; *solid line*, annual incidence of HIV infection. Adapted with permission from the following article published by Royal Society of Medicine Press, London: Holtgrave DR. Causes of the decline in AIDS deaths, United States, 1995–2002: prevention, treatment or both? *Int J STD AIDS* 2005;16:777–81.

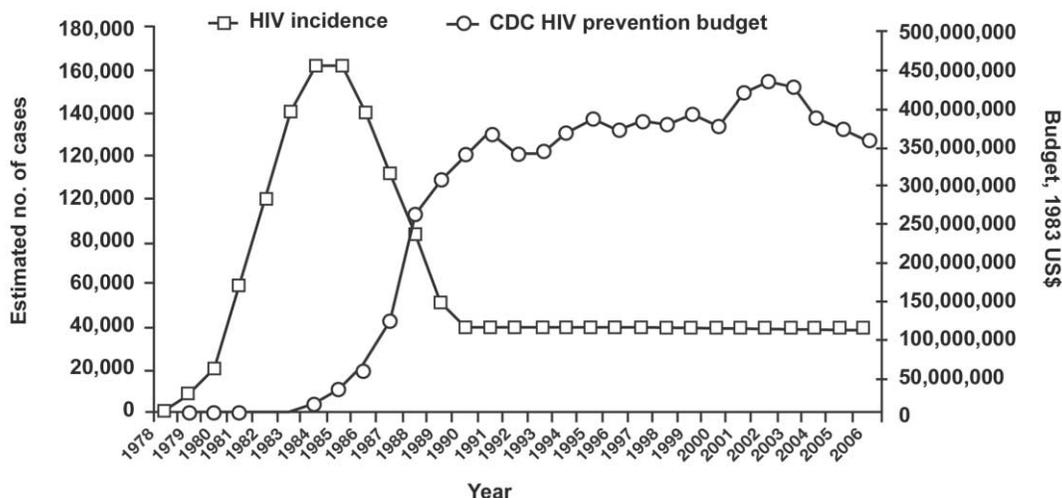


Figure 4. US incidence of HIV infection and Centers for Disease Control and Prevention (CDC) budget for preventing HIV infection. Adapted with permission from the following article published by Elsevier: Holtgrave DR, Kates J. HIV incidence and CDC's HIV prevention budget: an exploratory correlational analysis. *Am J Prev Med* 2007;32:63–7.

in high-risk behaviors. It is important to implement intensive prevention services for the ~16% of HIV-infected persons who have not changed their risky behavior [11, 12]. The framework recommends linkage to medical treatment and related services, as well as case management, partner counseling, and structural interventions.

For persons who test negative for HIV but engage in high-risk behavior, repeated counseling may be necessary, and the counseling message may need to be customized and updated for individuals whose testing frequency increases. Table 2 lists a variety of other evidence-based HIV prevention interventions for seronegative persons who engage in high-risk behavior.

For persons who are unaware of their positive HIV serostatus, testing and counseling should be implemented, using the best

available testing methods relative to the individual's level of risk. For the general population, dissemination of current information about HIV is essential. A recent Kaiser survey found that relatively high percentages of Americans still think that HIV can be spread through kissing an infected person (37%), sharing a drinking glass with an infected person (22%), and touching a toilet seat used by an infected person (16%) [19]. Stigmatizing attitudes toward persons living with HIV are still held by too many Americans, and these attitudes must be addressed.

Many behavioral tools are both effective and are cost saving. Every intervention listed in table 3 has been found to be cost saving in at least 1 article published in a peer-reviewed journal [20, 21].

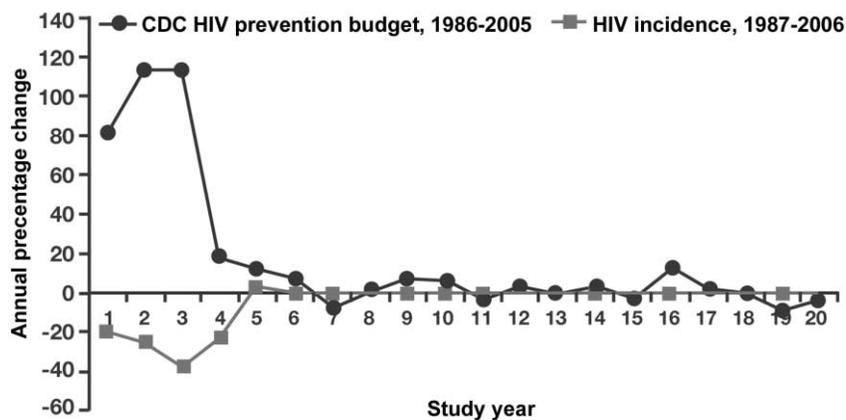


Figure 5. Percentage changes in the US incidence of HIV infection and the Centers for Disease Control and Prevention (CDC) budget for preventing HIV infection (adjusted to 1983 US dollars), with a 1-year lag. Adapted with permission from the following article published by Elsevier: Holtgrave DR, Kates J. HIV incidence and CDC's HIV prevention budget: an exploratory correlational analysis. *Am J Prev Med* 2007;32:63–7.

Table 2. HIV prevention recommendations from the Serostatus Approach to Fighting the Epidemic program, by population.

Persons who tested positive for HIV
Intensive prevention services, especially for the minority of persons living with HIV/AIDS who do not change their high-risk behavior
Linkage to treatment of HIV infection, sexually transmitted diseases (STDs), hepatitis, mental illness, and substance abuse and to housing and social services programs, as needed; resources for treatment and services are inadequate in the United States
Comprehensive case management
Partner counseling and referral services
Special efforts for those who recently became infected
Structural interventions, including efforts to reduce barriers to care
Persons who recently tested negative for HIV and continue to engage in high-risk behaviors
Efforts to eliminate perinatal transmission
HIV counseling and testing; counseling should be customized for persons who are tested often
Intensive individual or small-group counseling
Community-level interventions
Linkage to treatment of STDs, substance abuse, mental illness, and hepatitis and to housing and social services programs, as needed
Prevention case management
Structural interventions, including access to sterile syringes
Persons who are unaware of their HIV serostatus
Encourage HIV counseling and testing, using the best available testing methods relative to the level of risk
General population
Provide current, essential HIV-related information: >40% of population is misinformed in some way about HIV
Reduce stigmatization of HIV disease and services: ≥19% of population has stigmatizing attitudes toward persons living with HIV

NOTE. Adapted with permission from the following article published by the American Public Health Association: Janssen RS, Holtgrave DR, Valdiserri RO, Shepherd M, Gayle HD, De Cock KM. The serostatus approach to fighting the HIV epidemic: prevention strategies for infected individuals. *Am J Public Health* 2001;91:1019–24.

With regard to structural interventions, other programs, including federal programs, may play a role in preventing HIV infection. Programs established by the Health Resources and Services Administration, the CDC, and the Centers for Medicare and Medicaid Services are discussed elsewhere in this supplement. The Housing Opportunities for Persons with HIV/AIDS program is funded by the Department of Housing and Urban Development. Published studies have shown that there is a strong relationship between housing status and risk behavior as well as detectability of viral load [22].

As discussed elsewhere in this supplement, it is important to consider the relationship between poverty, income inequality, and social capital or social organizations in society. Table 4 illustrates that social capital and income inequality or social

injustice are important predictors of AIDS and several sexually transmitted diseases [23, 24]. Therefore, building stronger communities has the potential for strengthening HIV prevention efforts.

HIV COUNSELING AND TESTING: COSTS AND CONSEQUENCES

So, where does increasing awareness of HIV serostatus fit in this framework? A colleague and I [5] estimated the impact of increasing awareness of HIV serostatus on incidence in the United States. We demonstrated that increasing awareness to even 100% will not alone achieve a reduction in new infections of 50%. Still, the reduction in incidence would be appreciable. For instance, raising serostatus awareness to 95% may reduce incidence by 32% (down to 27,200 new infections per year in the United States). Hence, raising awareness of serostatus is important but is not by itself a comprehensive HIV prevention program.

Furthermore, we might ask whether opt-out HIV testing in health care settings is the best use of HIV counseling and testing resources. Elsewhere, I examined the costs and consequences of CDC's opt-out testing recommendations for health care settings [25]. I estimated that opt-out testing in the United States would cost just more than \$864 million to implement in the first year, newly diagnose infection in nearly 57,000 persons living with HIV, avert just >3600 HIV transmissions, and require identifying more than \$961 million in medical care ser-

Table 3. Cost-saving behavioral interventions to prevent HIV infection.

At-risk men having sexing with men
1-session group
12-session group
Peer-peer interaction in the community
At-risk men having sexing with men and/or women
Video-based, 1-session intervention
Social marketing of condoms
Outreach-based services
7-session group
At-risk women
Social marketing of condoms
Outreach-based services
5-session group
Injection drug users
Needle and syringe exchange
Multisession group
Substance-abuse treatment program
Patients at sexually transmitted diseases clinics
HIV counseling and testing, linkage to HIV treatment, notification of sex partner(s)

NOTE. The list is not exhaustive and does not necessarily include cost-effective interventions. Data are from [20, 21].

Table 4. Social determinants of sexually transmitted diseases and AIDS in the United States, 1999.

Determinant	Pearson product moment correlation coefficient, by disease			
	Gonorrhea	Syphilis	Chlamydial infection	AIDS
Poverty	.204	.232	.358 ^a	.099
Social capital	-.671 ^a	-.591 ^a	-.532 ^a	-.498 ^a
Income inequality	.203	.133	.395 ^a	.469 ^a

NOTE. Adapted with permission from the following article published by BMJ Publishing Group Ltd.: Holtgrave DR, Crosby RA. Social capital, poverty, and income inequality as predictors of gonorrhoea, syphilis, chlamydia and AIDS case rates in the United States. *Sex Transm Infect* 2003; 79:62-4.

^a $P < .01$.

vices for persons who are newly diagnosed and in need of public assistance with HIV treatment. In contrast, dedicating the same level of resources to a targeted HIV counseling and testing program that could achieve a 1.0% HIV seropositivity rate would test fewer persons but newly diagnose infection in 188,170 persons living with HIV, prevent >14,500 HIV transmissions or infections, and require identification of more than \$3.1 billion in HIV treatment for persons in need of public assistance with medical care. This suggests that a targeted program of counseling and testing may diagnose more persons living with HIV and prevent more HIV infection.

CONCLUSIONS

Programs to prevent HIV infection have substantially altered the course of the HIV epidemic in the United States. However, the nation now needs a new, multilevel, evidence-based, comprehensive national HIV prevention plan. Implementation of such a plan will require substantial new resources in order to improve serostatus-awareness efforts, to provide high-quality care to newly identified HIV-positive persons, and to field a truly comprehensive national HIV prevention program. Indeed, progress toward reducing the rate of new HIV infection by 50% by 2010 will be determined in large part by improvements in funding and policies and uptake of old and new tools for HIV prevention [26].

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Potential conflicts of interest. D.H.: no conflicts.

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