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WHAT WORKS, AND WHAT REMAINS TO BE DONE, IN HIV PREVENTION IN THE UNITED STATES

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■ **Abstract** Since the beginning of the HIV epidemic in the United States, HIV prevention programs have prevented hundreds of thousands of HIV infections, and the investment in these programs has actually been cost-saving to society in terms of medical costs averted. A substantial body of evidence exists (including randomized controlled trials and careful meta-analyses) which demonstrates that various HIV prevention services are effective; an increasingly large body of data also demonstrates the cost-effectiveness of these interventions. However, the efforts to utilize these interventions in a comprehensive HIV prevention program are hampered by insufficient funding, imperfect targeting strategies, and a problematic policy environment that creates barriers to the use of some of these life-saving interventions. Progress toward reducing new HIV infections will likely be as much a function of improvements in funding and policies as it will in the development of new tools for HIV prevention.

INTRODUCTION

Status of the HIV Epidemic in the United States: A Brief Overview

The HIV/AIDS epidemic has caused tremendous human suffering, loss of life, and financial loss in the United States. From the beginning of the epidemic in the late 1970s until December 2002, there were over 859,000 cumulative AIDS cases, and over 501,699 cumulative AIDS deaths (5, 8, 10). The annual AIDS death rate fell from 51,677 in 1995 to 16,371 in 2002; this drop in death rates is in large part due to advances in HIV treatment in that same era, but may also reflect the effects of prevention programs from a decade earlier (10, 23).

By the year 2000, there had been over 1.4 million cumulative HIV infections in the United States (21). There are still an estimated 40,000 new infections per year

(9, 21, 45). However, this annual infection statistic contains substantial uncertainty as there is no systematic, national measurement of HIV incidence (42). The number of cases of perinatal HIV infection has fallen from about 1000 to 2000 per year in the early 1990s to about 300 per year (11–14).

According to CDC estimates, as of 2000, new HIV infections were distributed in the following manner among at-risk populations: (*a*) men who have sex with men, 42%; (*b*) injection drug users, 25%; and (*c*) at-risk heterosexuals, 33% (9). As of 2000, new infections were distributed among racial/ethnic communities in the follow manner: (*a*) African American, 54%; (*b*) white, 26%; (*c*) Latino/Latina, 19%; (*d*) Asian and Pacific Islander, less than 1%; and (*e*) Native American, less than 1% (9). The percentage of new HIV infections among women was 30% in the same year (9). More than half of all new HIV infection in the United States are projected to be among persons under 25 years of age (15).

Since the advent of highly active antiretroviral therapy (HAART), it has been estimated that for each HIV infection in the United States, medical costs may reach $200,655 (discounted to net present value at a 3% rate, and expressed in June 2003 dollars) (24, 36). Also, for each new HIV infection, approximately 23.87 quality-adjusted life years are lost (undiscounted; 11.23 discounted at a 3% rate) (36).

This articles focuses in great detail on one particular country (the United States) with a unique HIV-related history and set of HIV prevention challenges. Although this chapter does not discuss HIV prevention efforts in other countries, it is important to emphasize that global HIV prevention is a truly critical and timely issue, and one of key public health importance (22). Further, although the topics of HIV-related care, treatment, housing, and other ancillary services are extremely important and related to HIV prevention, this chapter focuses almost exclusively on prevention research, policies, and programs per se.

HIV PREVENTION EFFECTIVENESS TO DATE

National Estimates of HIV Prevention Effectiveness and Cost-Effectiveness

The HIV epidemic began in the late 1970s in the United States. New HIV infections peaked at approximately 160,000 per year in the mid-1980s, and then fell to roughly 40,000 annual infections by 1990 (a rate roughly unchanged since, although recent estimates contain substantial uncertainty) (4, 9, 42, 45). These estimates of HIV incidence are based on backcalculation methods in which reported AIDS cases, AIDS deaths, and knowledge about the natural history of HIV disease are used to estimate what pattern of HIV incidence might have given rise to the observed AIDS-related statistics (4, 35, 45). The number of annual new HIV infections has been estimated to be roughly the same for the past 14 years, but again, there is substantial uncertainty in this 40,000 annual incidence estimate because the United States does not have a direct, annual, national measure of HIV incidence (9, 42, 45).

Because the number of new infections has been estimated to be roughly constant for over a decade, it might appear that HIV prevention efforts have done little good. However, the number of annual new infections is a representation of the HIV prevention work remaining, not a measure of intervention effectiveness. To properly gauge the effectiveness of HIV prevention, one must compare the "observed" HIV incidence curve with an incidence curve that would have occurred had HIV prevention programs not been in place. We have previously estimated via scenario analyses four different counterfactual simulations of HIV incidence in the United States without HIV prevention programs in place (all with conservative assumptions) (29). These analyses suggest that from 1978 to 2000, the HIV prevention programs fielded in the United States averted between 204,000 and 1,585,000 HIV infections. Even though these programs cumulatively cost over $10.1 billion in federal, state, and private investments to deliver, the cost per HIV infection prevented ranged from $6400 to $49,700. When compared with the medical cost of caring for one case of HIV disease, these results indicate that the HIV prevention programs delivered in the United States have actually resulted in an overall cost savings to society (29).

Changes in HIV Transmission Rates

Another way of examining the effectiveness of HIV prevention strategies is to examine how rates of HIV transmission, rather than rates of HIV incidence, have changed over the course of the epidemic. The annual HIV transmission rate for the United States may be defined as the number of new HIV infections in a year divided by the total number of persons living with HIV/AIDS in that year (i.e., annual HIV incidence divided by HIV/AIDS prevalence as of that year). In the United States, the annual HIV transmission rate was approximately 43.09% in 1983, 25.23% in 1985, and since 1990, has varied between roughly 4.0% and 4.34% (26). Because some persons living with HIV will transmit to more than one person in a given year, the roughly 4% transmission rate implies that over 96% of persons living with HIV do not transmit the virus to anyone else in a given year (26).

Although this reduction in the HIV transmission rate can be seen as an important prevention success, it is desirable to lower the rate even further. The remaining 4% transmission rate is determined by a combination of behavioral, biologic, situational, social, and cultural factors that is still not entirely known, and research in this area is urgently needed. However, it is clear that possessing knowledge of one's HIV seropositivity and receiving counseling services along with an HIV test reduces HIV transmission. It has been estimated that the annual HIV transmission rate for persons unaware of their HIV seropositivity is approximately 10.79%, and approximately 1.7% for persons aware of their HIV status (32).

It is also instructive to compare the overall national, annual HIV transmission rate with the perinatal HIV transmission rate in the United States The findings of NIH clinical trial 076 in the mid-1990s determined that HIV therapies delivered in a timely manner to pregnant women could reduce HIV transmission to their infants by roughly two thirds. The reduction in perinatal transmission is considered a

tremendous HIV prevention success. However, there are still about 300 annual perinatal HIV infections in the United States; these 300 HIV-infected infants are born from a population of about 6000 to 7000 pregnant women living with HIV (11–13). This implies that the perinatal HIV transmission rate is still about 4.29% to 5.00% (32), roughly the same as the overall U.S. HIV transmission rate.

NATIONAL HIV PREVENTION GOALS

What Are the National HIV Prevention Goals?

While HIV prevention efforts have reduced HIV incidence levels and HIV transmission rates in the United States, and have done so in a fashion that has led to cost-savings in terms of medical costs averted, work remains to further reduce new HIV infections. In January 2001, CDC set forth a national plan for HIV prevention in the United States (7). Among the many subgoals, objectives, strategies and action steps (numbering in the hundreds), the plan had one, key overarching national goal: "reduce the number of new HIV infections in the United States from an estimated 40,000 to 20,000 per year by the year 2005, focusing particularly on eliminating racial and ethnic disparities in new HIV infections" (7).

What Are the Consequences of Failing to Meet the Overarching National Goal?

The human and fiscal consequences of failing to meet this national goal are substantial. In a previously published analysis, we compared a scenario of a continuation of 40,000 new infections per year to a scenario in which the goal of 20,000 annual infections was achieved and then the annual incidence of HIV cases remained flat from 2005 through 2010 (34). If incident infections are not reduced to below 40,000 per year, an excess 130,000 persons will become infected in the United States by 2010. Further, the net present value of medical costs for these 130,000 infected persons will be approximately $18 billion (34).

Is Progress Being Made Toward Achieving the National Goal?

A framework has been published for monitoring progress toward achievement of the national HIV prevention goal (25). One segment of the framework examines annual HIV incidence in the United States and finds that as of 2004, CDC had not updated its estimate of 40,000 new infections per year, providing no new evidence of movement toward the national goal. Reliable annual, national HIV incidence measurements are sorely and urgently needed to better track trends. In the meantime, one crude, temporary proxy for HIV incidence is HIV diagnosis information from 30 states with HIV reporting. From 2000 to 2002 the number of HIV diagnoses in these states rose from 25,522 to 26,464 (10, 25).

Another national objective is to reduce racial/ethnic disparities in HIV incidence (25). The use of HIV diagnoses reports from the 30 states with such reporting

systems in place as a rough approximation to HIV incidence provides little evidence of alleviating these disparities. From 2000 to 2002, HIV diagnoses experienced little change in non-Hispanic whites (31.52% of new HIV diagnoses in 2000, 31.64% in 2002), in Latino communities (11.53% of new HIV diagnoses in 2000, 12.59% in 2002), and in African-American communities (55.78% of new HIV diagnoses in 2000, 54.58% in 2002); there was a similar lack of change in Asian and Pacific Islander and Native American communities (10, 25). Reliable measurements of national, annual HIV incidence as categorized by race/ethnicity deserve a high priority.

Is lack of progress in reducing HIV incidence related to national investment in HIV prevention (25)? Prior analyses have shown that generally from the beginning of the epidemic until 2000, as funding increased, HIV incidence decreased; as funding levels flattened, so too did the decline in new infections (35). From fiscal year 2001 to 2004, funding levels for HIV prevention in the United States remain nearly unchanged after adjustment for inflation ($652.5 million in fiscal year 2001; $653.2 million in fiscal year 2004—expressed as October 2000 dollars) (25). In summary, from 2001 to 2005, little progress was achieved nationally in reducing new HIV infections (25, 54), reducing HIV-related racial/ethnic disparities, or making additional resources available to address unmet HIV prevention needs (25). This conclusion does not mean that the existing prevention programs in place are not reducing new HIV infections; one must compare "observed" HIV incidence with estimates of incidence that would occur without HIV prevention programs in place to estimate prevention effectiveness (29). Rather, insufficient efforts are being made to significantly further reduce new infections and disparities in racial/ethnic HIV incidence (25).

WHAT REMAINS TO BE DONE?

What are the Elements of a Comprehensive National Program?

While HIV prevention programs have reduced new HIV infections and HIV transmission rates, the national goal of further reducing new HIV infections (by as much as 50%) is not being achieved. This raises the question of what elements are needed in a comprehensive, multilevel, effective national HIV prevention program that will further reduce HIV infections. (30). The core elements of public health activities needed to achieve the central public health missions in any disease area usually include the following: (*a*) surveillance [here, including HIV and AIDS surveillance; HIV and sexually transmitted infection (STI) incidence studies, behavioral surveillance, and social determinants monitoring]; (*b*) service delivery (focusing on clients with highest need, interventions of known effectiveness and efficiency at all ecologic levels from individual counseling to mass media campaigns, and delivering the interventions via well-equipped service providers); (*c*) capacity building (including organizational development, intervention assistance, and community mobilization activities) (18); (*d*) program evaluation (including formative,

process, outcome, impact, and economic evaluation); (*e*) research (including epidemiologic research, behavioral and social determinants studies, and intervention testing); and (*f*) policy and planning (including structural intervention deployment, policy analysis, and strategic planning). A complete review of all six areas is beyond the scope of this paper; therefore, we focus below on key intervention, targeting, and policy issues.

Which Specific Prevention Tools Work?

There have been dozens of well-conducted scientific studies of the effectiveness of HIV prevention interventions, including a number of randomized clinical trials [for reviews see (6, 20, 42, 52, 56, 57)]. The literature on the effectiveness of HIV prevention intervention is sufficiently well developed that carefully conducted meta-analyses have been published on interventions for each of several key populations (20): (*a*) men who have sex with men, (*b*) injection drug users, (*c*) at-risk heterosexual adults, and (*d*) sexually experienced adolescents. This literature has been synthesized by CDC, an NIH-sponsored consensus development conference, an Institute of Medicine Panel, and, for international prevention interventions, by the Bill and Melinda Gates Foundation and UNAIDS (6, 20, 22, 42, 47).

In a 2003 review in *Nature Medicine*, Valdiserri and colleagues stated that for prevention of sexual transmission of HIV a number of intervention types had strong empirical bases: (*a*) small-group behavioral interventions, (*b*) HIV counseling and testing, (*c*) community-level interventions, and (*d*) structural-level interventions (56). The authors also noted that whereas treatment of non-HIV STIs made excellent sense from both clinical and public health perspectives, there did not yet exist definitive empirical evidence to demonstrate that STI treatment will lead to reductions in HIV infection.

Valdiserri and colleagues (56) also described scientifically supported interventions to prevent parenteral transmission: (*a*) screening to ensure blood safety, (*b*) universal precautions to prevent infections (including needlestick injuries) in occupational settings, and (*c*) multiple types of interventions for injection drug users (including behavior change counseling, drug treatment, and access to sterile injection equipment). These authors also state that AZT and nevirapine are effective in preventing perinatal HIV transmission (56).

Schwartlander and colleagues (52) published a global review on the effectiveness of HIV prevention intervention in *Science* and identified the following interventions as effective: (*a*) teacher training and peer education, (*b*) male and female condoms, (*c*) condom promotion and social marketing, (*d*) treatment of STIs, (*e*) voluntary counseling and testing, (*f*) workplace programs, (*g*) blood transfusion screening, (*h*) prevention of mother-to-child transmission, (*i*) mass media campaigns. (*j*) harm-reduction programs, and (*k*) peer counseling.

Although not precisely the same, the reviews by Schwartlander et al. and Validserri et al. do yield substantially the same types of effective HIV prevention interventions (52, 56). Further, the findings of these reviews are in substantial

agreement with the Institute of Medicine, NIH Consensus Development Conference, and CDC syntheses of the literature (including extensive quantitative meta-analyses by CDC) (20, 42, 47). In summary, the common themes across reviews are that individual- (including counseling and testing), group-, and community-level behavioral interventions can effect changes in HIV-related risk behaviors; condoms can reduce HIV transmission risk when used consistently and correctly; sterile injection equipment exchanges can reduce HIV transmission and serve as a conduit to drug treatment; blood and occupational safety can be effectively safeguarded via careful screening and universal precautions; and perinatal infections can be reduced substantially via the use of HIV therapies administered to pregnant women.

A number of other promising HIV prevention tools have been yet to be empirically demonstrated to be effective. As with other epidemic infectious diseases, the ideal HIV prevention tool is a safe, effective, and accessible vaccine to prevent infection. Ideally, such a vaccine would be administered to the entire population and remain close to completely effective for a decade or longer. The quest for such a vaccine has been hampered by the lack of natural adequate human immune response to HIV. However, understanding of HIV immunopathogenesis has progressed rapidly and over two dozen HIV vaccine candidates and combinations are under investigation.

The situation is similar for microbicide development. As with family planning, ideal personal protective tools for preventing sexual transmission of HIV would allow control by either partner and be separable in time from onset of sexual activity. For example, female control of pregnancy has been revolutionized by oral contraception and both genders can utilize sterilization. In addition to male and female condoms, which, though highly effective, require consent of both parties, much scientific attention is being paid to the development and testing of microbicides that, if proven highly effective, could add to the capacity for women to more independently control risk of HIV and other STIs and, perhaps, enhance condom effectiveness as well.

Another biomedical advance that has promise as an HIV prevention intervention is HIV treatment itself (in particular, highly active antiretroviral therapy, HAART). HAART has been demonstrated to reduce viral load, which could reduce transmissibility (51). However, at the community level, this biomedical promise might not be realized. Katz and colleagues (46) have demonstrated that in San Francisco, the increase in HAART availability has been accompanied by an increase in STD and in HIV-related risk behavior; further, HIV infection rates did not drop during the same time period in San Francisco. Hence, while HAART could theoretically be employed as a prevention intervention, there has yet to be empirical support for its community-level prevention effectiveness. This might suggest that for HAART to realize its prevention (in addition to treatment) potential, it must be deployed with concomitant behavioral and education prevention services and campaigns. In fact, the need for these prevention services and media campaigns might be even higher in an era of treatment advances so as to combat potential complacency.

Are These Prevention Tools Cost-Effective?

In 1993, there were 47 articles on the economic evaluation of HIV-related interventions of which 31 focused on prevention (41). In 1995, there were 93 papers in this literature, with 73 focused on prevention (39). As of August 2004, the literature on economic evaluation of HIV prevention had grown to over 140 articles. Many types of HIV prevention interventions discussed above have now been subjected to cost-effectiveness analyses and have been found to be either cost-saving or cost-effective relative to other life-saving interventions in public health and medicine [for reviews see (44, 50)]. Cost-saving interventions are those for which the costs—often medical costs—averted by a prevention program outweigh the cost of prevention service delivery; cost-effective interventions do not actually save public money but the cost-per-quality-adjust-life-year-saved is considered reasonable relative to other readily accepted medical and public health interventions.

For several at-risk populations, published studies have identified as cost-saving some types of HIV prevention interventions. For men who have sex with men, the following types of HIV prevention interventions have been shown to be cost-saving in terms of medical costs averted by prevention of infections: (*a*) one-session group intervention, (*b*) 12-session group intervention, and (*c*) peer-led community-level intervention (48, 50). For at-risk men who have sex with women and/or men, several cost-saving interventions have been identified: (*a*) video-based, one-session intervention; (*b*) condom social marketing; (*c*) outreach-based services; and (*d*) seven-session group intervention (50). For at-risk women, cost-saving interventions include (*a*) condom social market, (*b*) outreach services, and (*c*) five-session group intervention (50). For injection drug users, syringe exchange services, multisession group interventions, and drug treatment have been shown to be cost-saving (37, 44, 50, 53). For STD clinic clients, HIV counseling, testing, referral, and partner notification have been shown to be cost-saving (50). Other interventions beside those listed here have also been shown to be cost-effective if not cost-saving (e.g., 33, 49). Here, we list these populations and interventions to demonstrate that peer-reviewed studies have identified several types of HIV prevention interventions as cost-saving, not as an assertion that all of these interventions will be cost-saving (or even necessarily effective) in all settings.

Important gaps still exist in the economic evaluation literature. Insufficient attention has been devoted to determining the optimal cost-effectiveness of a bundle of various types of HIV prevention interventions across a variety of populations (although research is under way in this arena) (16). Also, only two cost-effectiveness studies have focused directly on interventions developed specifically for racial/ethnic minority communities. Only one paper has discussed explicitly the complex influences of race/ethnicity on parameters used in cost-effectiveness analyses (27). Here too, research is under way to address these gaps in the literature. Further, economic evaluation studies are needed in the examination of structural interventions, communication strategies, and efforts to reduce HIV-related

complacency (31), as well as on which elements of specific HIV prevention interventions make them effective and cost-effective.

How Should Prevention Tools be Targeted?

Knowing that various HIV prevention tools can be effective does not answer the question of how they should be deployed across a variety of communities; furthermore, this knowledge does not address all external validity questions (e.g., how effectiveness differs by community, etc.). However, some general principles about intervention targeting are of use in HIV prevention. The first principle, which is quite traditional, asserts that interventions should be more intensively delivered in communities with higher needs for HIV prevention (40, 55). The communities traditionally would be defined by geographic area, demographics (e.g., age, gender, and race/ethnicity), as well as by HIV-related behaviors (e.g., unsafe sexual behaviors among men who have sex with men, and among at-risk heterosexuals; as well as drug injection practices that pose a risk of HIV transmission).

However, HIV prevention services could also be productively targeted by some less traditionally employed factors. One is a community's HIV transmission rate (26, 32). For instance, as noted above, persons unaware of their HIV seropositivity may have an HIV transmission rate of near 11%, persons who are aware of their HIV seropositivity may have a rate of roughly 2% (26, 32). Clearly, in light of this differential HIV transmission rate, persons unaware of their HIV seropositivity should be a high priority for HIV prevention services, including but not limited to voluntary HIV counseling and testing (26, 32).

Another approach is to target HIV prevention interventions based on a combination of an individual client's knowledge of HIV serostatus, level of ongoing risk behavior, and actual HIV serostatus. In 2001, CDC published its Serostatus Approach to Fighting the Epidemic (SAFE) (43). CDC described this targeting strategy as highlighting four key populations: (*a*) persons unaware of their HIV serostatus, (*b*) persons aware of their HIV-seronegative status and at very low continued risk of infection, (*c*) persons aware of HIV seronegativity but at high behavioral risk of infection, and (*d*) persons aware of their HIV seropositivity. The final category could be subdivided into those persons aware of their HIV seropositivity who have eliminated risk behaviors for HIV transmission and those who have not.

This update of SAFE (43) is to be contrasted with CDC's 2003 Advancing HIV Prevention Initiative (AHP) (11–13), which focuses on HIV testing (with or without counseling), rapid testing, prevention for persons living with HIV, and perinatal transmission; indeed, this update of SAFE is considerably more comprehensive than AHP.

Each of these five populations has particular HIV prevention needs. Persons who are unaware of their HIV serostatus need current, essential HIV-related information, as well as access to voluntary counseling and testing. Persons testing HIV

seronegative but at little continued risk could be equipped to be carriers of HIV prevention messages to their family, partners, friends, children, and other members of their social networks; however, the effectiveness and cost-effectiveness of this strategy have been little studied.

HIV-seronegative persons aware of their status but at high behavioral risk of infection could benefit from the following: (*a*) HIV counseling and testing customized for persons testing repeatedly (given the increase of repeat testing over the past several years); (*b*) intensive individual-, small group-, or community-level interventions; (*c*) effective linkages to STD, substance abuse, mental health, hepatitis, housing, and social services as warranted; (*d*) prevention case management; and (*e*) structural interventions, including sterile syringe exchange.

HIV-seropositive persons who have eliminated risk behaviors for HIV transmission may benefit from (*a*) linkages to medical care and treatment, STD, hepatitis, mental health, substance abuse, housing and social services as needed; (*b*) periodic risk assessment to ensure continued lack of transmission risk behaviors (and prevention services if risk behavior relapse occurs); and (*c*) partner counseling and referral services. HIV-seropositive persons who engage in continued risk behavior for HIV transmission might benefit from (*a*) linkages to medical care and treatment, STD, hepatitis, mental health, substance abuse, housing, and social services as needed; (*b*) intensive, ongoing prevention services; (*c*) partner counseling and referral services; and (*d*) prevention case management.

Spanning all five populations is the need for structural interventions (e.g., policy, environmental, legal, and other macro-level interventions) that address HIV-related stigma and discrimination. HIV disease is still highly stigmatized, and this stigma puts in place substantial barriers to accessing HIV-related services (1). Some persons do not wish to access any services labeled as being HIV/AIDS-specific for fear that others will suspect them of being HIV-seropositive or having engaged in risk behaviors. Also, some persons living with HIV suffer continued civil rights abuses such as substandard delivery of HIV care, or inhumane treatment while receiving medical services (1).

At What Level Should These Prevention Tools be Funded?

We noted above that, after adjustment for inflation, federal investments in HIV prevention are flat. The question then is what level of investment would allow for meeting the HIV prevention needs of persons in the United States in need of such services. There are two answers to this question in the literature. CDC's paper on SAFE estimated that the implementation of needed, serostatus-specific services would cost an additional $300 million per year for each of 4 years (on the margin of CDC's HIV prevention budget, which is approximately $700 million per year) (43).

Subsequently, Holtgrave et al. (38) performed a different type of cost of unmet needs analysis. They first estimated the number of persons at risk of HIV infection in the United States. Second, they identified science-based interventions that would be needed by persons at continued risk. Third, they identified the per-client costs of

these services. Finally, they totaled (across clients and types of services) the overall cost of addressing unmet HIV prevention needs in the United States. Depending on whether brief or multisession behavioral interventions would be used to address sexual risk behaviors, the overall costs would range between $817 million and $1.85 billion. However, this cost range is for a massive HIV prevention effort rolled out in one fiscal year. If this effort were implemented over four years, and one half of the clients were given brief interventions and one half of the clients given multisession interventions, the annual incremental cost would be $334 million, a figure rather close to the $300 million per year estimate noted above.

Threshold analyses indicate that if this additional investment were made, between 5300 and 12,000 HIV infections would have to be prevented for the program to be cost-saving, and somewhat fewer prevented for the program to be cost-effective instead of cost-saving (38). Previous analyses have indicated that the syringe exchange component of this service bundle alone would prevent over 12,350 HIV infections (37). Hence, the thresholds appear highly attainable. It would also be a very high priority to measure carefully the effects of the interventions funded with such resources to ensure that they did in fact have the anticipated beneficial effect.

What Type of Policy Environment is Necessary for These Prevention Tools to Work?

Available are interventions that work to prevent HIV infection, and well-grounded strategies exist for targeting these programs. Further, incremental investment could be cost-saving. One barrier to implementing a cost-saving HIV prevention strategy is lack of sufficient political support for a larger incremental federal investment.

Another critical barrier is the ban on the use of federal funds for syringe exchange programs. Syringe exchange as an intervention for HIV prevention has been reviewed extensively, found to be effective, and endorsed by leading medical and public health organizations (2, 37, 53, 56). Although some localities and private organizations have found ways to deliver such services without federal funds, this ban on federal support limits their use.

Additionally, there have been clear instances in which scientific information is censored in whole or in part. For example, important information about condom effectiveness and interventions that work for youth was removed for an extended time from the website of a federal agency. We have also directly witnessed public health agencies receiving advice from external consultants that clearly is based on personal politics and not on science (28). We have argued that when science-based public health agencies receive suggestions that go beyond the realm of well-established codes of public health ethics and declarations of basic human rights, such suggestions should be rejected (28). A common theme of the Code of Ethics of the American Public Health Association and the multiple global declarations of human rights is that everyone should be treated with respect and have access to necessary medical and public health services.

CONCLUSIONS AND FUTURE DIRECTIONS

Since the beginning of the HIV epidemic in the United States, HIV prevention programs have averted hundreds of thousands of HIV infections, and the investment in these programs has actually been cost-saving to society in terms of medical costs averted. A substantial body of evidence, including randomized controlled trials and careful meta-analyses, demonstrates that various HIV prevention services can be effective; an increasingly large body of data also demonstrates the cost-effectiveness of these interventions. However, the efforts to utilize these interventions in comprehensive HIV prevention programs are hampered by insufficient funding, imperfect targeting strategies, and a problematic policy environment that creates barriers to the use of some of these life-saving interventions. Progress toward CDC's national goal of reducing new HIV infections by 50% will likely be as much a function of improvements in funding and policies as will development of new tools for HIV prevention.

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LITERATURE CITED

1. Am. Civil Liberties Union. 2003. *HIV & Civil Rights: A report from the frontlines of the HIV/AIDS epidemic*. Washington, DC: ACLU
2. Am. Med. Assoc., Am. Pharm. Assoc., Assoc. State Territ. Health Off., Natl. Assoc. Boards Pharm., Natl. Alliance State Territ. AIDS Dir. Oct. 1999. *HIV prevention & access to sterile syringes*. http://www.nastad.org/PublicPolicyResources/HIVPrevSterileSyrines.pdf
3. Ashman JJ, Conviser R, Pounds M. 2002. Associations between HIV-positive individuals' receipt of ancillary services and medical care receipt and retention. *AIDS Care* 14(Suppl. 1):S109–18
4. Brookmeyer R. 1991. Reconstruction and future trends of the AIDS epidemic in the United States. *Science* 253:37–42
5. Cent. Dis. Control. 1993. *HIV/AIDS. Surveillance Report: U.S. HIV and AIDS cases reported through December 1993 (Year-end edition)*. 5(4):Table 13
6. Cent. Dis. Control. 1999. *Compendium of HIV Prevention Interventions with Evidence of Effectiveness*. Atlanta, GA: CDC, Nov. (revised)
7. Cent. Dis. Control. 2001. *HIV Prevention Strategic Plan Through 2005*. Atlanta, GA: CDC
8. Cent. Dis. Control. 2001. *HIV/AIDS Surveillance Report*: *U.S. HIV and AIDS cases reported through December 2001 (Year-end edition)*.13(2):Table 33
9. Cent. Dis. Control. 2002. *A glance at the HIV epidemic*. http://www.cdc.gov/hiv/publs.facts.htm
10. Cent. Dis. Control. 2002. *HIV/AIDS*

Surveillance Report: U.S. Cases of HIV and AIDS in the United States, 2002 (Year-end edition). 14:Table 7

11. Cent. Dis. Control. 2003. Advancing HIV Prevention: new strategies for a changing epidemic–United States, 2003. *MMWR* 52:329–32
12. Cent. Dis. Control. 2004. *Advancing HIV Prevention: Progress fact sheet*. http://www.cdc.gov/hiv/partners/AHP/progressfacts.htm on 6/30/2004
13. Cent. Dis. Control. 2004. *Advancing HIV Prevention: The science behind the new initiative*. http://www.cdc.gov/hiv/partners/ahp_science.htm on 6/30/2004
14. Cent. Dis. Control. 2004. *Status of perinatal HIV prevention: U.S. declines continue.* http://www.cdc.gov/hiv/pubs/facts/perinatl.htm on 9/14/2004
15. Cent. Dis. Control. 2004. *Young people at risk: HIV/AIDS among America's youth.* http://www.cdc.gov/hiv/pubs/facts/youth.htm on 9/14/2004
16. Cohen DA, Wu SY, Farley TA. A cost effective national strategy for preventing HIV transmission across the United States. *Int. Conf. AIDS, 15th, Bangkok*, *Thailand.* Abstr. TuPeC4931
17. Comm. Public Financ. Deliv. HIV Care. 2004. *Public Financing and Delivery of HIV/AIDS Care: Securing the Legacy of Ryan White*. Washington, DC: Inst. Med., Natl. Acad. Press
18. Collins CB, Harschbarger C, Sawyer R. 2004. Broad diffusion of twelve effective behavioral interventions for HIV prevention. *Int. Conf. AIDS, 15th, Bangkok, Thailand*. Abst. ThPeE8182
19. Curran JW. 2003. Reflections on AIDS, 1981–2031. *Am. J. Prev. Med.* 24:281–84
20. Des Jarlais DC, Semaan S. HIV prevention research: cumulative knowledge or accumulating studies? An introduction to the HIV/AIDS Prevention Research Synthesis Project Supplement. *J. AIDS* 30(Suppl. 1):S1–7
21. Fleming PL, Byers RH, Sweeney PA, Daniels D, Karon JM, Janssen RS. 2002. *HIV prevalence in the United States, 2000*. Presented at Conf. Retroviruses and Opportunistic Infections, 9th. http://www.retroconference.org/2002/Abstract/13996.htm
22. Global HIV Prev. Work. Group. 2004. *HIV Prevention in the Era of Expanded Treatment Access*. Seattle: Bill & Melinda Gates Found.
23. Holtgrave DR. 2006. Causes of the decline in AIDS deaths, United States, 1995–2002: prevention, treatment or both? *Int. J. STD AIDS.* In press
24. Holtgrave DR. 2006. Determining the intensity of prevention interventions for persons living with HIV: an application of economic threshold analysis. *AIDS.* In press
25. Holtgrave DR. 2005. A proposed format for tracking CDC's National HIV Prevention Goal. *J. Public Health Manage. Pract.* 11(1):4–6
26. Holtgrave DR. 2004. Estimation of annual HIV transmission rates in the United States, 1978–2000. *J. AIDS* 35(1):89–92
27. Holtgrave DR. 2004. HIV prevention, cost-utility analysis, and race/ethnicity: Methodological considerations and recommendations. *Med. Decision Making* 24(2): 181–91
28. Holtgrave DR. 2003. Science, values and the public health agencies. *AIDS Educ. Prev.* 15:203–4
29. Holtgrave DR. 2002. Estimating the effectiveness and efficiency of HIV prevention efforts in the U.S. using scenario and cost-effectiveness analysis. *AIDS* 16:2347–49
30. Holtgrave DR. 2002. A framework for gauging the comprehensiveness of governmental HIV prevention programs. *J. Public Health Manage. Pract.* 8:22–29
31. Holtgrave DR, ed. 1998. *Handbook of Economic Evaluation of HIV Prevention Programs*. New York: Plenum
32. Holtgrave DR, Anderson T. 2004. Utilizing HIV transmission rates to assist in prioritizing HIV prevention services. *Int. J. STD. AIDS* 15(12)789–92

33. Holtgrave DR, Kelly JA. 1996. Preventing HIV/AIDS among high-risk urban women: the cost-effectiveness of a behavioral group intervention. *Am. J. Public Health* 86:1442–45
34. Holtgrave DR, Pinkerton SD. 2003. Economic implications of failure to reduce incident HIV infections by 50% by 2005 in the United States. *J. AIDS* 33(2):171–74
35. Holtgrave DR, Pinkerton SD. 2002. Implications of economic evaluation for national HIV prevention policy makers. In *Quantitative Evaluation of HIV Prevention Programs*, ed. EH Kaplan, R Brookmeyer, pp. 32–54. New Haven, CT: Yale Univ. Press
36. Holtgrave DR, Pinkerton SD. 1997. Updates of cost of illness and quality of life estimates for use in economic evaluations of HIV prevention programs. *J. AIDS Hum. Retrovirol.* 16:54–62
37. Holtgrave DR, Pinkerton SD, Jones TS, Lurie P, Vlahov D. 1998. Cost and cost-effectiveness of increasing access to sterile syringes and needles as an HIV prevention intervention in the United States. *J. AIDS Hum. Retrovirol.* 18(Suppl. 1):S133–38
38. Holtgrave DR. Pinkerton SD, Merson M. 2002. Estimating the cost of unmet HIV prevention needs in the United States. *Am. J. Prev. Med.* 23:7–12
39. Holtgrave DR, Qualls NL, Graham JD. 1996. Economic evaluation of HIV prevention programs. *Annu. Rev. Public Health* 17:467–88
40. Holtgrave DR, Thomas CW, Chen H, Edlavitch S, Pinkerton SD, Fleming P. 2000. HIV prevention community planning and communities of color: Do resources track the epidemic? *AIDS Public Policy J.* 15:75–81
41. Holtgrave DR, Valdiserri RO, West GA. 1994. Quantitative economic evaluations of HIV-related prevention and treatment services: a review. *Risk* 5:29–47
42. Inst. Med. 2001. *No Time to Lose: Getting More from HIV Prevention*. Washington, DC: Natl. Acad. Press
43. Janssen RS, Holtgrave DR, Valdiserri RO, Shepherd M, Gayle HD, DeCock KM 2001. The serostatus approach to fighting the HIV epidemic: prevention strategies for infected individuals. *Am. J. Public Health* 91:1019–24
44. Kahn JG. 1998. Economic evaluation of primary HIV prevention in injection drug users. See Ref. 31, pp. 45–62
45. Karon JM, Fleming PL, Steketee RW, DeCock KM. 2001. HIV in the United States at the turn of the century: an epidemic in transition. *Am. J. Public Health* 91:1060–68
46. Katz MH, Schwarcz SK, Kellogg TA, Klausner J, Dilley JW, et al. 2002. Impact of highly active antiretroviral treatment on HIV seroincidence among men who have sex with men in San Francisco. *Am. J. Public Health* 91:388–94
47. Natl. Inst. Health. 1997. Interventions to prevent HIV risk behaviors. *NIH Consens. Statement Online* (1997 Feb. 11–13). 15(2):1–41
48. Pinkerton SD, Holtgrave DR, DiFranceisco WJ, Stevenson LY, Kelly JA. 1998. Cost-effectiveness of a community-level HIV risk reduction intervention. *Am. J. Public Health* 88:1239–42
49. Pinkerton SD, Holtgrave DR, Jemmott JB. 2000. Economic analysis of an HIV risk reduction intervention for male African American adolescents. *J. AIDS* 25:164–72
50. Pinkerton SD, Johnson-Masotti AP, Holtgrave DR, Farnham PG. 2001. Using cost-effectiveness league tables to compare interventions to prevent sexual transmission of HIV. *AIDS* 15:917–18
51. Quinn TC, Wawer MJ, Sewankambo N, Serwadda D, Li C, Wabwire-Mangen F, et al. 2000. Viral load and heterosexual transmission of human immunodeficiency virus type 1. *N. Engl. J. Med.* 342(13):921–29
52. Schwartlander B, Stover J, Walker N, Bollinger L, Gutierrez JP, et al. 2001. AIDS: resource needs for HIV/AIDS. *Science* 292:2434–36

53. Strathdee SA, Vlahov D. 2001. The effectiveness of needle exchange programs: a review of the science and policy. *AIDScience* 1(16) http://www.aidscience.org/Articles/aidscience013.asp
54. Valdiserri RO. 2003. CDC deputy chief says trend 'very worrisome.' U.S. far from goal to cut new infections by half. *AIDS Alert* 18(6):75–55
55. Valdiserri RO, Ogden LO, Janssen RS, Onorato I, Martin T. 2004. Aligning budget with U.S. national HIV prevention priorities. *J. Public Health Manage. Pract.* 10(2):140–47
56. Valdiserri RO, Ogden LL, McCray E. 2003. Accomplishments in HIV prevention science: implications for stemming the epidemic. *Nat. Med.* 9(7):881–86
57. Wolitski RJ, Janssen RS, Holtgrave DR, Peterson JL. 2003. The public health response to the HIV epidemic in the United States. In *AIDS and Other Manifestations of HIV Infection*, ed. G Wormser, pp. 983–99. San Diego: Academic. 4th ed.

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