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# Syringe Exchange Programs:
# Lowering the Transmission of
# Syringe-Borne Diseases and Beyond

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**SYNOPSIS**

**Objectives.** This chapter attempts to describe the factors influencing the transmission of syringe-borne viruses, to review the effects of syringe exchange programs (SEPs) in terms of these factors, and to explore the gamut of health-promoting activities of SEPs.

**Results.** The chapter is divided into six sections: biological factors in syringe-borne viral transmission, behavior and viral transmission, quantifying viral transmission, preventing viral transmission, impediments to preventing viral transmission, and research for preventing viral transmission. Understanding how biological and behavioral factors influence transmission of human immuno-deficiency virus (HIV) and hepatitis builds a framework to investigate the epidemiology and the impact of SEPs on disease transmission. Even under circumstances in which these programs do not appear to be effective, understanding the implications of the biological and behavioral factors can contribute to our understanding of program benefits and limitations. Furthermore, program benefits may not be restricted to direct effects on disease transmission. Many programs offer services to drug injectors that include risk reduction training, facilitated entry into substance abuse treatment, and medical care.

**Conclusions.** SEPs can reduce the transmission of syringe-borne viruses without increasing illicit drug use. However, lack of resources, acceptance, and, consequently, protection of many of

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those at risk when they are most vulnerable have hampered program effectiveness. New studies need to be designed to explicate the full measure of program benefit within covered communities and identify the means by which SEPs can expand benefit to individuals at greatest risk.

In its present form, the epidemic of human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) in the United States remains focused in the high risk groups of intravenous drug injectors (IDUs) and men who have sex with men. In the past few years, the incidence in IDUs has exceeded, for the first time in the epidemic, the incidence in any other risk group.[1] Attempts to implement practical measures to decrease incidence in IDUs have been studied by AIDS and substance abuse researchers who met in August 1997 at the Research Synthesis Symposium on the Prevention of HIV in Drug Abusers held in Flagstaff, Arizona. Two major goals of the symposium were to identify which prevention measures have proven effective and to develop a consensus on what further research needs to be undertaken. Among the prevention strategies receiving the most attention were syringe exchange programs (SEPs). SEPs were first established in 1984 in Amsterdam, The Netherlands. By 1986, the first illegal programs in the United States had begun, followed within two years by the first legal SEP. By the end of 1997 there were 123 programs in 33 states, the District of Columbia, Puerto Rico, and Guam. SEPs have repeatedly been shown to be effective in slowing the spread of HIV transmission among IDUs.[2,3]

The growth of SEP operations in the 1980s was based on the premise that such programs can reduce the sharing of syringes and other injection paraphernalia. Epidemiological studies had left little doubt that the sharing of injection equipment is the major route of HIV-1 transmission among IDUs.[4-6] The consequences of sharing are influenced by four factors that control the syringe-borne transmission of HIV and other pathogens such as hepatitis B virus (HBV) and hepatitis C virus (HCV). Three of these are biomedical in nature; the fourth is behavioral.

**Biological Factors in Syringe-Borne Transmission**

The three biomedical factors are (1) the prevalence of active infection within the community of IDUs, (2) the infectivity of a given injection with a contaminated syringe, and (3) the durability of the virus inside the syringe. The prevalence of active infection is related to the prevalence of primary infection and the probability that, once infected, the individual continues to produce virus at a level that can result in disease transmission. Within communities of IDUs, prevalences of infection appear to vary for HIV but are fairly constant for HBV and HCV. HIV seroprevalence among IDUs varies from as little as 5% in cities such as Seattle and Denver to as

much as 60% in cities such as Newark and San Juan. In contrast, HBV and HCV seroprevalence has been found to be 70% or higher wherever it has been measured, regardless of HIV-1 seroprevalence.[7-9]

Given seroprevalence status, the prevalence of active infection differs. Almost all individuals infected with HIV-1 produce discernible levels of virus that can lead to transmission. Most individuals infected with HBV recover fully, and only 5% to 10% go on to develop chronic HBV infections. The data for HCV are not comprehensive since the virus was identified only in 1989,[10] but most recent studies consistently find that approximately 70% of individuals infected with HCV progress to become chronic carriers. Thus, the prevalence of active HIV infection ranges from less than 5% to 60%, the prevalence of HBV is between 3.5% and 10%, and the prevalence of HCV is approximately 50% (Table 1). In other words, the likelihood of encountering an IDU actively infected with HCV is approximately ten-fold greater than the likelihood of encountering an IDU actively infected with HBV; while the likelihood of encountering an IDU actively infected with HIV ranges between the likelihoods for the two hepatitis viruses.

The best information on the relative infectivity of the three viruses comes from hospital needle-stick data.[11] In these studies, it was observed that HIV is transmitted in three of 1000 needle sticks; HCV is transmitted in 20 of 1000 cases and HBV is transmitted ten-fold more readily, in 200 of 1000 cases (Table 1). The transmission of syringe-borne viruses when syringes are shared between an infected and an uninfected IDU may be higher,[12] but the relative rates are likely to be the same.

The syringe may transmit the virus as long as the virus remains viable inside the syringe and is not inactivated by the vicissitudes of time or active disinfection with an agent such as hypochlorite bleach. Our studies on the longevity of HIV in syringes containing blood parallel studies showing that HIV can remain viable for periods in excess of two weeks.[13-15] There appear to be no data on the duration of viability of the hepatitis viruses; obtaining

experimental data is complicated by the absence of in vitro systems for propagating HBV and HCV. Depending on its application, bleach disinfection may be more or less efficacious, but epidemiological studies have consistently suggested that self-reported use of bleach has not been associated with reductions in HIV prevalence.[16-19]

## Behavior and Viral Transmission

The fourth factor is behavioral—the degree to which individuals and communities share contaminated injection equipment. The frequency of syringe sharing in many U.S. cities has been obtained based on self-report on behaviors in the previous 30 days to six months. In the absence of intervention, sharing rates in the years prior to 1991 have ranged from 35% to 70%.[5,20-27] Among these is a multicity study using a common instrument, the Risk Behavior Assessment (RBA) developed by the National Institute on Drug Abuse (NIDA) and its grantees. Unfortunately, among the least reliable measures in the instrument are the questions regarding equipment sharing.[20]

There appears to be a trend among IDUs in recent years toward lower rates of sharing ($\lambda$), as reflected in self-reported frequencies of syringe sharing. In New York City, the use of shared syringes was reported to have decreased from occurring in 51% of all injections in 1984 to occurring in only 7% of all injections in 1990–1992.[28] In Hartford, Connecticut, the percentage of individuals who shared syringes fell from 68% in 1992 to 52% in early 1993 in one study,[29] and as was reported in Flagstaff, sharing among new enrollees in that city's SEP from mid-1993 on was 16%. Also reported in Flagstaff were data from Oakland, California, in which sharing was reported by more than 50% of respondents in the first quarter of 1992 but had fallen to less than 30% of IDUs interviewed in the first quarter of 1995.

None of these decreases occurred in a vacuum; each was associated with active interventions at the individual, community, or structural level that benefited IDUs. For example, changes in Hartford were associated with legalization of pharmacy sale and possession of syringes. In all three cities, changes were concomitant with the initiation and institutionalization of SEPs. However, concerns about self-reported behavioral data remain. Behavioral data reliability is weakened by the absence of quantification of the influence of socially desirable response biases. While the aggregate conclusion reached following the analysis of multiple studies of self-report in drug users is that "...self-reports...may be considered reasonably

## Table 1. Biomedical factors influencing the transmission of syringe-borne infections

| | Prevalence of active infection | Infectivity | Survival duration |
|---|---|---|---|
| HIV | <5% to 60% | 0.3% to 0.7% | 15 to 30 days |
| HBV | 3.5% to 10% | 20% to 30% | ? |
| HCV | 50% to 60% | 2% to 3% | ? |

accurate," the exceptions are associated with desired or aversive outcomes,[30] and reduction of sharing is widely recognized by IDUs as the desired outcome of many investigators. Therefore, the most satisfactory conclusions to be reached about syringe sharing is that it appears to be a practice with declining prevalence, but that the magnitude of the decline is questionable.

## Quantifying Viral Transmission

Once the nature and ranges of these four factors are understood, we can translate them into a simple equation that predicts the incidence of new syringe-borne infections. An equation was developed by Kaplan to describe the consequences of shooting gallery visitation on HIV incidence, but it was later adapted in a more general form for any risk of syringe-borne transmission.[31,32] It relates the incidence rate to five other factors:

$$\mu = (1\text{-}\pi) \times \beta \times (1\text{-}\theta) \times \lambda \times \alpha$$

The equation states that the incidence rate ($\mu$) is equal to the rate at which syringes are shared ($\lambda$) by an uninfected individual ($1\text{-}\pi$) times the probability of using a potentially infectious syringe ($\beta$) without first disinfecting it ($1\text{-}\theta$) times the rate at which such contact transmits the infection ($\alpha$).

This equation tells us exactly what needs to be done to lower incidence. While infectivity ($\alpha$) may differ from individual to individual, there are some things we can do to decrease $\alpha$. Currently, we can treat infected individuals with combinations of antiretroviral drugs that lower viral load and, as a result, decrease the likelihood of transmission. In the future we may be able to lower the likelihood of an exposed individual becoming infected by developing an effective vaccine or by interfering with the binding of HIV to its coreceptor. But the most effective current measures to lower $\mu$ result from interventions that alter identified risks and risky behaviors; either risky behavior needs to be decreased by decreasing the sharing rate ($\lambda$) or increasing the probability of disinfection ($\theta$), or potentially infectious syringes must be removed from circulation and replaced with clean ones, thus decreasing $\beta$.

## Preventing Viral Transmission

Direct evaluation of the effectiveness of syringe exchange has measured changes in both the rate of sharing (decreasing $\lambda$) and the likelihood of coming in contact with potentially infectious syringes (decreasing $\beta$). The

first generation of SEP research used self-report to determine the correlation between program participation and risky behaviors, focusing on changes in $\lambda$. As detailed in the chapter by Vlahov and Junge in this Supplement, the vast majority of these studies revealed that the frequency of sharing decreased and syringe disinfection increased.[33]

The second generation of research used epidemiological methods to determine how participation in SEPs correlated with incidence of syringe-borne infections. Three studies conducted in the United States have found that syringe exchange participation exerts a protective effect or is associated with decreased incidence of infection. These studies used different methods and endpoints, but all found substantial reductions for the incidence of HIV-1,[34–36] HBV,[37,38] and HCV.[37] The studies in New Haven demonstrated significant and long-lived decreases in the probability of encountering potentially infectious syringes ($\beta$).[38,39] Thus, in studies conducted in the United States through 1996, SEPs were found to be protective. Fatally, these studies have not led to broad adoption of SEPs. A critique of the failure of U.S. public health to respond to the epidemic of HIV/AIDS in IDUs calculated that the success of individual SEPs in reducing incidence coupled with the programmatic failure to implement SEPs in a broad manner between 1988 and 1996 has led to between 4400 and 9700 avoidable infections.[40]

Within the past year, reports from two Canadian cities have demonstrated that syringe exchange is not sufficient to prevent outbreaks of HIV among IDUs. In Vancouver, high HIV incidence has been observed among syringe exchangers.[41] It is unlikely that the SEP has caused this high incidence. Instead, it appears that three factors have overwhelmed the preventive effect of the well-established but slow-to-respond SEP. The first factor was the introduction and spread of injectable cocaine. The second factor was the marginalized living conditions of those newly infected, which included residency in single-room-occupancy hotels that maintained a policy of locking residents in at night. The third factor was the uniform delivery of government benefits, which resulted in numerous drug users having large amounts of cash on the same day. These factors led to communal binge injecting and a scarcity of clean, unused syringes at the very time when they were most needed—in the hotels during periods of bingeing.

In Montreal, Canada, incidence of HIV-1 was higher among participants of the Montreal SEP than among a comparison group of nonexchangers.[42] Again, it seems unlikely that the SEP is to blame. Needle exchange partic-

ipants appeared to be distinct from the comparison group, most notably in that they used an SEP that was open only late at night.[43] So, instead of faulting the SEP for the high incidence rate, we need to remember our equation,

$$\mu = (1\text{-}\pi) \times \beta \times (1\text{-}\theta) \times \lambda \times \alpha$$

Once we set up two parallel equations—one for the exchangers and one for the comparison group—we can recognize that the factors influencing the dynamics of transmission are at play in Montreal. Exchangers were nearly three times more likely to have a prevalent HIV-1 infection; thus, the $\beta$ in syringes circulating among exchange participants was likely to be three-fold higher. Furthermore, exchangers were twice as likely to be exposed to HIV-1 by engaging in risky injection practices; that is, sharing rates ($\lambda$) were doubled. Since incidence ($\mu$) is proportional to both $\beta$ and $\lambda$, and $(1\text{-}\pi)$ was not much different (0.84 for exchangers, 0.94 for nonexchangers), it should be expected that the incidence among exchange participants would be more than five times higher (Table 2). Instead, it was only two and a half times higher, a reduction from the expected that can be attributed to the role of the exchange in removing infected syringes from circulation.

## Impediments to Preventing Viral Transmission

The lessons from the two Canadian examples of elevated HIV transmission despite the existence of needle exchange should be incorporated into the next generation of SEP research. In an ideal world, every injection would be performed with a new, sterile syringe. The medical community has recognized this as a goal. In a recent prevention bulletin issued jointly by the Centers for Disease Control and Prevention (CDC), Health Resources and Services Administration (HRSA), NIDA, and Substance Abuse and Mental Health Services Administration (SAMHSA), it was recommended that health care workers counsel injectors to use a new, sterile syringe each time they prepare and inject drugs.[44] However, this document is seriously flawed. First, it advises those with the power of writing medical prescriptions that they should counsel drug injectors to use only clean syringes, but it does not advise the same individuals to use their prescriptive power to fight syringe-borne diseases. Second, it fails to mention that SEPs can be a source of clean syringes.

However, the problem of preventing the spread of syringe-borne viruses is larger than that countenanced by recognizing the immediate failings of the prevention

bulletin. In the absence of Federal funding and a concerted federally sponsored propagation of SEPs, it is unlikely that the goal of the prevention bulletin could be met by SEPs alone. There are an estimated 1.1 to 1.5 million drug injectors in the United States.[1,45] According to data compiled by NIDA using the RBA instrument, the mean number of injections per day per injector is 2.9. Thus, to achieve the goal of a new syringe for each injection, it would require the purchase and distribution of between 1.25 billion and 1.6 billion syringes (Table 3). In an ideal world, this would necessitate the creation and funding of new SEPs. In 1995, 87 of the 101 SEPs in the United States distributed 14 million syringes.[46] Therefore, to reach the ideal goal, more than 5000 and as many as 10,000 new SEPs need to be created and funded. But this is not an ideal world and the resources available to SEPs are small and, in some locations, shrinking. A better, more realistic goal for SEPs is to get more clean syringes into the hands of at-risk injectors at times when they need them most.

## Research for Preventing Viral Transmission

In pursuing this more reasonable goal, we need a third generation of SEP research that provides better identification of who is served by SEPs and to what extent their needs are met. Research needs to focus on determining which strategies maximize the impact of SEPs, on targeting individuals who are at highest risk for infection, and on elaborating new strategies to reduce risk. For example, we need to determine the efficacy of undertaking exchange in high risk sites such as shooting galleries and single-

**Table 2. Factors increasing heightened HIV incidence in Montreal, Canada**

| Relative HIV prevalence | Relative risk | Estimated incidence | Observed incidence |
|---|---|---|---|
| 2.76 | 1.92 | 5.29 | 2.55 |

**Table 3. Estimated number of syringes needed to meet U.S. Public Health Service guidelines**

| Estimated number of injectors in the United States | Per capita mean injections per day | Syringes per year |
|---|---|---|
| 1.1 to 1.5 million | 2.9 | 1.25 to 1.6 billion |

room-occupancy hotels. SEP research needs to evaluate whether SEPs can devise and implement interventions that target and enroll homeless or marginally housed individuals and young drug users who have recently begun injecting. As data from Baltimore have revealed, new injectors, especially those within one year of initiating injection, are at great risk of syringe-borne infections.[47]

The effectiveness of SEPs resides not only in the provision of sterile syringes in exchange for used ones but also in the provision of other services that reduce the harm of illicit drug injection. These services include referral and facilitated entry of individuals into substance abuse treatment. While it has been shown that SEPs can act as a conduit to treatment, such service provision has been found to be fragile. The absence of effective treatment for cocaine addiction, limited treatment slots in effective programs for treating opiate addiction, and bureaucratic systems that effectively reduce the access to these slots can blunt the success of referral services.[48,49] Furthermore, although 97% of SEPs make referrals to substance abuse treatment services,[46] few substance abuse treatment providers refer their relapsing clients to SEPs.

Medical care also can be offered through contact with the SEP. For example, the New Haven SEP van is accompanied by a larger van operated by the Yale AIDS Program. The latter vehicle provides primary medical care both to users of the SEP and to other members of the community in which exchanges are situated. Equipped with three private exam rooms, this van delivers HIV, sexually transmitted disease (STD), pregnancy, and tuberculosis (TB) screening; hypertension and diabetes diagnoses; and acute primary medical care. Patients are then linked to community sources for continuing medical care, including substance abuse treatment, and, for those making multiple visits, case management to provide hierarchical social services. This linkage may, in turn, enhance use of and adherence to the provision of medical care. In another example, the Lower East Side Needle Exchange Program

in New York City collaborates with researchers at Beth Israel Medical Center in offering TB screening and prophylaxis at its storefront location. Between March and August 1995, screening was offered to 493 SEP participants, 476 (96.5%) of whom consented; 432 (90.8% of those tested) returned for skin test reading and 373 (78.4% of those tested) completed screening including chest X-ray when indicated.[50] Directly observed prophylaxis at the storefront was begun on 14 of those screened, and as was recently reported, adherence was better among these individuals than among patients beginning TB prophylaxis at Beth Israel's HIV clinic.[51] One reason for the better results from the SEP may be that the individuals were making regular use of the SEP and the prophylaxis could be easily grafted onto their normal routine.

The last point illustrates two of the reasons why SEPs can be successful in reducing the dangers that face injectors of illicit drugs. First, SEPs can exceed their primary mission. They often become convenient providers of a host of prevention measures, including avoidance of risky injection and sexual practices, facilitation of entry into substance abuse treatment, comprehensive primary medical care, and special needs medical care. Second, SEPs can provide IDUs—who are often alienated from the health care system by their poverty, their criminal status, and their inferior housing status—with these services in a physical and psychological context that fosters the reduction of the risk associated with the injection of illicit drugs. Research has shown that this is mostly like to happen if the SEPs are well run, sufficiently financed, free from police harassment, and interconnected with the medical establishment.[2,48] In the current political climate, it may be difficult to operate SEPs that meet these goals.[52,53] However, research into the efficacy and adaptability of SEPs presents an unambiguous demonstration that these programs are the best available tool to intervene in the intertwined epidemics of substance abuse and syringe-borne diseases.

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