ALAN NEAIGUS, PHD

# The Network Approach and Interventions To Prevent HIV among Injection Drug Users


## SYNOPSIS

**Objective.** To review human immunodeficiency virus (HIV) risk reduction interventions among injecting drug users (IDUs) that have adopted a network approach.

**Method.** The design and outcomes of selected network-based interventions among IDUs are reviewed using the network concepts of the dyad (two-person relationships), the personal risk network (an index person and all of his or her relationships), and the "sociometric" network (the complete set of relations between people in a population) and community.

**Results.** In a dyad intervention among HIV-serodiscordant couples, many of which included IDUs, there were no HIV seroconversions. Participants in personal risk network interventions were more likely to reduce drug risks and in some of these interventions, sexual risks, than were participants in individual-based interventions. Sociometric network interventions reached more IDUs and may be more cost-effective than individual-based interventions.

**Conclusion.** Network-based HIV risk reduction interventions among IDUs, and others at risk for HIV, hold promise and should be encouraged.


**Dr. Neaigus is a Sociologist and a Principal Investigator in the Institute for AIDS Research at National Development and Research Institutes, Inc., in New York City.**

Address correspondence to:
Dr. Neaigus, National Development and Research Institutes, Inc., Two World Trade Center, 16th Floor, New York NY 10048; tel. 212-845-4480; fax 212-845-4698; e-mail <alnea@ix.netcom.com>.

In the United States, injecting drug use is a major route of transmission for the human immunodeficiency virus (HIV). In many cities, the prevalence of HIV among injecting drug users (IDUs) is high. For example, in New York City it was 50% or higher from the mid 1980s through the mid 1990s,[1] and more recently close to 40%.[2,3] It has been estimated that more than half of all new infections in the United States are occurring among IDUs, their sex partners, and their children.[3] The high rate of HIV infection among IDUs is reflected in the large number of acquired immunodeficiency syndrome (AIDS) cases attributed to injecting drug use, which by June 1997, accounted for one-fourth (612,078) of all AIDS cases and more than one-third of all AIDS cases when other routes of transmission associated with injecting drug use are taken into account.[4]

Given the importance of injecting drug use as a route of HIV transmission, there is an indisputable need for interventions to prevent the spread of this pathogen among IDUs, their sex partners, and their children. This need is heightened by the absence of any effective vaccine against HIV infection and the lack of any well-proven therapies to prevent progression to AIDS.

Most interventions among IDUs, as well as among other at-risk populations, have sought to change individual risk behaviors by targeting the intervention at the individual. This tactic stemmed from the recognition that HIV was a pathogen that was spread predominantly, although not entirely, through certain risk behaviors among individuals. A variety of interventions were developed, including outreach interventions that targeted individual drug users in their communities to provide information about the risks of infection with HIV and how to prevent it. Many of these interventions also included the distribution of risk reduction materials; HIV risk reduction counseling, which was often associated with antibody testing; and many other sophisticated interventions that sought to change the knowledge, attitudes, beliefs, and intentions of individuals so they would reduce their risk behaviors. Some of these interventions were theoretically based and used theories such as the health belief model,[5] the theory of reasoned action,[6] and social cognitive theory.[7]

While many of the individual-based interventions among IDUs have contributed to reducing injecting risk behaviors,[8,9–12] these interventions have been less successful in reducing sexual risk behavior, particularly in relationships with primary sex partners.[10,13–14] Some injecting risk behaviors, such as syringe sharing, also remain difficult to change when they occur between injecting partners who have a close relationship, such as sex partners.[15–17] In addition, whether long-term change and the maintenance of risk reduction can be achieved through an individual approach has not yet been adequately demonstrated.[18]

The limitations in individual approaches suggest that there are other causal factors, besides the characteristics of the individual, that contribute to HIV risk. Among these other causal factors is the social context in which individuals engage in HIV risk behaviors and in which they become exposed to HIV. In particular, the probability that an individual will engage in risk behaviors and will be exposed to HIV may not only be a function of individual characteristics (for example, a person's knowledge, attitudes, and beliefs, or biological factors that may increase the likelihood that he or she will become infected if exposed to HIV). The probability of risk behaviors and exposure also may be a function of the relationships between individuals and the people with whom they engage in risk behaviors or with whom they engage in other kinds of interaction—their risk and social networks.[19] The network approach addresses this level of social causation. (Other levels of social causation at the macrolevel, such as community factors and political institutions and policies, also are relevant for HIV risk, but are not the main focus of this chapter.) This approach has been increasingly applied in research on the determinants of HIV infection and risk behaviors and is now also being developed as an intervention tool. Before considering examples of interventions that have used a network approach among IDUs (and among other at-risk populations), this chapter briefly discusses a few network concepts and reviews some of the relevant research on network-based determinants of HIV infection and risk behaviors.

## The Network Approach and HIV Risk

The justification for using a network approach in research on the determinants of HIV infection and risk behaviors and in developing interventions to reduce HIV risk resides in the manner in which HIV is transmitted. Compared with infectious diseases that are spread through casual contact and contagion, HIV is transmitted, in large part, by risk behaviors that involve close contact between infectious and susceptible individuals. As a result, the transmission of HIV is structured by social relationships. These social relationships organize how susceptible and infectious individuals come into contact with one another (for example, who has sex with whom or who injects with whom), the pattern of HIV exposure and transmission, and, through social influence, the risk or protective behaviors in which they engage with each other.

Drug injectors' networks include both their relationships with the people with whom they use drugs or have sex and their relationships with the people with whom they have other kinds of interaction, such as work or emotional support. IDUs' networks can therefore function both as channels of infection and as channels of social influence.

These networks can be approached at three levels:

1. The dyadic risk relationship (for instance, the relationship between the index injector and his or her drug or sex partner).

2. The personal risk network (including the direct ties of an index person with all of his or her network members and the aggregate characteristics of these network members and of their relationships with each other).

3. The "sociometric" network[2] (also called the social network[20] or full relational network[21]), which refers to the complete set of relations between people (or "nodes") in a population, including indirect and direct ties. Such networks can include a large group or even a community or neighborhood.

The network approach has been used successfully in research to analyze the distribution and spread of HIV across populations. A structural feature of networks that can shape the extent to which HIV spreads within a population is the extent to which networks of at-risk populations are highly connected, and the location of HIV-positive individuals within these highly connected network components, or "cores."[2,20,22–25] The mixing pattern between infectious and at-risk groups also is important in determining the spread of HIV. For example, Morris and colleagues[26] found that the risk of HIV infection among young gay men was increased if their personal sex risk networks included older sex partners, and Neaigus and colleagues[27] found that syringe sharing and having a personal drug risk network member who was high risk was a risk factor for HIV infection among injectors who had injected for six years or less.

The network approach also has been used in studies to examine the role of social influence on HIV risk behaviors. In a study of methadone clients, Friedman and associates[28] found a strong association between subjects' reports that they had attempted to reduce their drug-related risks and their reports that their friends also had done so. Magura and colleagues[29] found that syringe sharing is influenced by friends' attitudes about it. Peer social influence has been found to be associated with sexual risk reduction and condom use among IDUs.[30,31] In a cross-national study, Des Jarlais and associates[32] found that predictors of risk reduction in a majority of cities included talking with friends or sex partners about AIDS. Social influence is likely to have a greater effect in relationships that have strong affective ties. Thus, El-Basel and Schilling[33] found that higher social support was associated with feeling more comfortable in discussing safer sex with sex partners and believing that one's sex partner would not be upset at suggested changes in safer sex practices. On the other hand, in a study that analyzed the characteristics of the relationships in which IDUs engaged in receptive syringe sharing, there was an increased likelihood for receptive syringe sharing to occur in those relationships described by IDUs as "very close" or in sexual relationships.[16]

The way that relationships are organized in personal networks also has been found to be associated with risk behavior. In the SAFE (Stop AIDS for Everyone) prevention study in Baltimore, which recruited a nontreatment sample of drug injectors from the AIDS Linked to Intravenous Experiences (ALIVE) study at The Johns Hopkins University, Latkin and colleagues[34] found that baseline network characteristics were associated with injecting risk behaviors at follow-up. IDUs who had a higher personal network density (actual social ties among network members as a proportion of all possible social ties among them) and a larger drug network size were more likely to share syringes at follow-up, and those with a smaller material aid network (indicating fewer economic resources) and larger positive feedback network (indicating more and closer social ties with other drug injectors) were more likely to inject at a shooting gallery. Relationships between personal network structure and injecting risk behaviors also have been found in studies by Trotter and associates[21] of drug users in a midsized town in the U.S. Southwest and by Williams and associates,[35] which compared drug users in Houston, Texas; Dayton/Columbus, Ohio; and Rio Piedras, Puerto Rico.

## Network Interventions

An accumulating body of research shows that drug injectors' networks are important determinants of HIV infection and risk behaviors. Informed by this research, several interventions using a network approach have been developed to reduce HIV risk among IDUs and other drug users. Some of these interventions have operated at the personal network level and have sought to change risk

**Table. Selected examples of network interventions for HIV risk reduction among IDUs and other drug users**

| *Author(s)* | *Target group* | *Design* | *Intervention components* | *Intended unit of change* | *Outcomes* |
|---|---|---|---|---|---|
| *Dyads* | | | | | |
| Padian et al. 1993 | HIV serodiscordant couples (30% of index subjects were IDUs) | Longitudinal, no comparison group | Couples counseling; buddy system; social gatherings. | Individual, couple | Condom use and sexual abstinence increased; no HIV seroconversions. |
| *Personal networks* | | | | | |
| Latkin et al. 1995 | IDUs, nontreatment, recruited by community outreach, word of mouth | Randomized control trial, network *vs.* standard intervention | Group meetings with drug-sharing network members. | Group and individual | Network members more likely to carry bleach, clean needles, reduce needle sharing, reduce injecting at shooting galleries. |
| Latkin et al. 1996 | HIV seronegative IDUs, nontreatment, recruited by community outreach, word of mouth | Randomized control trial, network *vs.* standard intervention | Group meetings with drug sharing network members. | Group and individual | Controls more likely to share needles and report sharing cookers. |
| Latkin this volume | IDUs, including IDU opinion leaders nominated by IDUs and opinion leaders' drug risk network members | Treatment group *vs.* comparison group (SAFE study controls who received standard intervention) | IDU opinion leaders conduct outreach with drug and sex network members. | Group and individual | Opinion leaders increased condom use; network members more likely to bleach needles, less likely to share unbleached needles; opinion leaders reached >80% of network members. |
| Trotter et al. 1996 | Drug users (IDUs, crack smokers), nontreatment recruited, targeted and network sampling | Randomized control trial, network *vs.* standard intervention | Group meetings among drug network members; intensive educational outreach or individual problem solving. | Group and individual | Participants in enhanced interventions with network components reduced sexual risk more than expected from standard intervention alone. |
| *Sociometric networks/communities* | | | | | |
| Valente et al. this volume | IDUs attending Baltimore Needle Exchange Program | Cross-sectional comparison of SEs with individual exchangers | Use high-volume SEs to diffuse new, sterile syringe use. | IDUs in the community | SEs reached almost 10 times more IDUs than did individual exchangers. |
| Grund et al. 1992 | IDUs attending community-based HIV prevention program in Rotterdam | Comparison of collective exchangers with individual exchangers | Use high volume syringe exchangers (collective exchangers) to diffuse new, sterile syringe use. | IDUs in the community | Collective exchangers reached large numbers of IDUs who would otherwise not be reached by syringe exchange programs. |
| Jose et al. 1996 | IDUs in a Brooklyn community; nontreatment recruited | Longitudinal comparison of meeting attenders and nonattenders | Group meeting and outreach to mobilize peer pressure. | IDUs in the community | Condom use increased; IDUs attending group meetings more likely to use condoms. |
| Broadhead et al. 1995 | IDUs in a community in eastern Connecticut; nontreatment recruited | Comparison of peer-driven intervention with traditional outreach | Monetary incentives for recruitment, education; chain referral. | IDU recruiters, IDUs in the community | Recruitment of larger and more diverse group of IDUs representative of community; IDU recruiters increased knowledge. |

behaviors using social influence among network members. Network interventions also have been conducted at the dyad level by intervening with couples, and at the sociometric network and community level. In addition to the level at which network interventions are implemented, the components of these interventions have varied. For example, interventions may include couples counseling, group meetings, focus groups, drug user-facilitated or staff-facilitated meetings, opinion leader creation, and advocacy. While in all network interventions the target of the intervention is the network (at the level of the dyad, personal network, and sociometric network or community), the unit of change may vary. For example, a personal network intervention may be developed in order to change the behavior of individuals rather than explicitly changing group norms or practices. In other interventions the unit of change may be the personal network or the community. However, the unit of change need not be mutually exclusive; individual change may coexist with change at the community level.

**Interventions at different network levels.** Examples of network-based interventions at different network levels are discussed below. These examples were chosen either because IDUs were explicitly included as the target population or because the interventions appear relevant for the future development of network-based interventions among IDUs.

*Dyads.* These interventions target the relationship between couples and provide counseling to help each partner recognize and deal with situations that may increase the probability of their engaging in risky behaviors with each other.

An example of an intervention at the dyadic level is provided by Padian and colleagues.[36] They conducted a longitudinal counseling intervention among a cohort of HIV-positive individuals (30% of whom were IDUs) and their heterosexual partners. The couples were monogamous and had a long-term relationship. Couples counseling and risk assessments were conducted at average intervals of six months. The counseling sessions not only included counseling about how to reduce the risk of HIV transmission but also addressed other aspects of the couples' lives associated with HIV, such as what the index case would do if the other partner or a child became infected or how child care would be provided should a parent become ill. The counseling intervention also was combined with a "buddy" system among individual participants and social gatherings with other couples in the intervention. Among 144 couples who were HIV serodiscordant, condom use and sexual abstinence increased over time, and there were no HIV seroconversions. Although this intervention focused on sexual risk behaviors, it may provide a useful model in dealing with both sexual and injecting risk among drug-injecting sex partners.

*Personal networks.* These interventions start with the group of network members as the target of the intervention. However, the unit of change can be the group as a whole, the individual network member, or both. As a vehicle for behavior change, personal network interventions typically use the group meeting in various forms, such as didactic sessions and semistructured focus groups. A main goal of such group meetings is to elicit group norms that promote risk behaviors and then institute group norms that lead to a reduction in risk behaviors and encourage prevention. In these meetings, members of risk networks can discuss norms influencing risk behaviors, such as the "rules" governing the use of syringes and other injecting equipment, the conditions under which syringes are shared, and the meanings they attach to a refusal to give used syringes to other network members. Group meetings also can be used to develop group strategies and practices for reducing or avoiding HIV risk. What distinguishes the group meeting in a personal network intervention from a group meeting in a peer intervention is that membership comprises people who have a social connection to each other. These connections may be based on their drug use together or on other forms of social interaction, such as people who live together and nondrug-using family members or friends.

Personal network interventions also can utilize certain structural features of those networks. One such feature is the extent to which certain individuals in a personal network are "locally" central[37] or more prominent than other individuals. These individuals may function as "opinion leaders" and are able to influence others to adopt certain beliefs, behaviors, or practices. Such people may be opinion leaders because they occupy powerful or important roles or because they are held in high esteem. To determine which individuals are opinion leaders in their networks, network members can be asked to nominate other network members, such as someone whose opinion is respected or someone from whom network members would seek advice about a personal problem. The person receiving the largest number of such nominations would be considered an opinion leader.

An intervention that focused on the personal networks of drug users was conducted in Baltimore, Maryland,[34] among the drug-sharing social networks of IDUs who

were recruited by community outreach and word of mouth for the ALIVE study. Subjects were randomly assigned to either an experimental social network intervention or to a standard intervention control group, which involved being given information on risk reduction and being provided HIV counseling and testing. In the social network intervention, subjects brought in members of their drug-sharing networks. This intervention involved a group self-help, peer-led model to increase self-efficacy and skill efficacy and to develop risk reduction norms. At a three-month follow-up interview, those in the social network intervention compared to those in the standard intervention were more likely to report an increase in always carrying bleach and in always cleaning their needles before injecting. They also were more likely to have reduced their frequency of needle-sharing partners and to have reduced injecting in shooting galleries. This type of intervention also was conducted among HIV-seronegative IDUs.[38] When HIV risk behaviors were measured 18 months after the baseline interview, those in the network intervention engaged in fewer such behaviors than did the controls. The long time interval over which changes in risk behaviors were measured also suggests the possible long-term efficacy of personal network interventions.

Trotter and colleagues[39] explicitly compared the efficacy of a network-based approach with an individual-based approach among 225 drug users (47% of whom were IDUs) in two midsized towns in the U.S. Southwest. The standard individual intervention involved outreach recruitment and two office-based sessions. At these sessions, participants were provided with information on HIV risk and risk reduction and were offered HIV pretest and posttest counseling and testing. Also included was a demonstration in the use of bleach kits and condoms, which were distributed to participants. Two enhanced interventions included a network component. In one intervention the network component was combined with intensive educational outreach; in the other it was combined with individual problem identification and problem solving. The network component included a focus group discussion, where network members talked about behaviors and norms that placed the group at risk of HIV infection and how to develop group rules to protect the group. All participants received the standard individual intervention. In addition, half of the participants were assigned to the enhanced interventions after being randomized by network. Self-reported risk behaviors were measured at baseline and at a six-month follow-up interview. Composite drug and sex risk measures were created.

Although the enhanced interventions included a "cocktail" of components (focusing both on the individual and the network), the results of the study suggest that interventions that include network components may be more effective than standard individual interventions alone, particularly for sexual risk. Among men, sexual risk was lower among those participating in the network intervention (with intensive educational outreach) than would be expected from the standard individual intervention alone. For women, the network intervention (with individual problem identification and problem solving) also led to greater sexual risk reduction than would be expected from the standard individual intervention alone. In a comparison of the interventions among IDUs and non-IDUs on drug risk, the network intervention (with individual problem identification and problem solving) was associated with lower drug risk among both groups.

In another intervention, conducted among drug injectors in Baltimore (Latkin, this Supplement),[40] a personal network intervention was combined with the use of opinion leaders. Opinion leaders were selected by asking IDUs who were participating in the study to nominate and recruit people whom they considered leaders in the IDU community. After agreeing to participate, the nominated leaders were trained in how to be opinion leaders with their drug and sexual risk network members (opinion leaders nominated people with whom they had sex or had injected in the prior six months). This intervention also used techniques to determine the extent to which the intervention was diffused among network members by the opinion leader. These techniques included a brief contact survey and the use of the acronym "APB" (AIDS prevention behaviors) in training sessions and on a button worn by the opinion leaders. The HIV risk behaviors reported by the opinion leaders at baseline and at a three-month follow-up interview were compared with the HIV risk behaviors reported by controls in the SAFE study. Also, the HIV risk behaviors reported by opinion leaders' risk network members were compared with the HIV risk behaviors reported at baseline by SAFE study controls. The study found that opinion leaders significantly increased their use of condoms and that the proportion of opinion leaders who always cleaned used needles with bleach prior to injecting increased. Among the controls in the SAFE study there was no significant increase in these protective behaviors. In the comparison between the network members and the SAFE controls at baseline, the network members were more likely to always use bleach to clean their used needles before injecting, and were less likely to share needles without first cleaning them with

bleach. The opinion leaders also were effective in diffusing risk reduction. More than 80% of the risk network members reported that they received written HIV risk reduction materials from the opinion leaders, and a majority reported that they received bleach and condoms (of those receiving condoms). Also, more than 80% knew the meaning of APB or that it was about preventing AIDS. Most (84%) of the contacts of the opinion leaders were with drug users.

*Sociometric networks.* Interventions to reduce HIV risk also can be conducted at the level of the sociometric network or the community. Both direct and indirect ties among individuals are used to diffuse risk reduction knowledge, practices, and materials among a large number of individuals at risk. The unit of change in these kinds of interventions is more likely to be the group rather than the individual; the aim is to bring about individual change through group change. Two important elements in such interventions are to identify and utilize individuals who occupy important locations in the sociometric network. Such people are "globally" central,[37] in that they are strategically located for reaching a large number of individuals. They can be bartenders at gay bars, shooting gallery operators, needle sellers, or other individuals who occupy central roles. These roles can be thought of as structurally equivalent, since it is their location within a set of socially organized activities (such as the distribution and use of drugs or settings in which sexual partnerships are formed or maintained) that places them at the confluence of social ties relevant for the transmission of HIV. Often, the individuals who occupy central roles and advocate for HIV risk reduction in the sociometric network undergo substantial behavior change.[40,41]

An extension of interventions at the sociometric level is the community intervention. Network-based community interventions use social ties within a community, or in some cases develop social ties, which can then be used to diffuse risk reduction throughout a community. The Chicago Model, which targeted social networks of drug injectors, used indigenous outreach workers to promote HIV risk reduction among IDUs in their natural settings. These outreach workers functioned as advocates among IDU networks and encouraged IDU participants to become advocates themselves among the IDUs in their own social networks.[42] Community organizing among drug users also has been used to create organizations that extend beyond the personal networks of drug users and represent drug users as a social interest group within a community.[43,44] Network-based community interventions have the potential for laying the groundwork for social movements to encompass the social and political goals that address the macrosocial determinants of HIV risk.[45]

The feasibility of developing a sociometric intervention using IDUs who participate in needle exchange programs (NEPs) is explored in the chapter by Valente and colleagues in this Supplement.[46] This study also was informed by the diffusion of innovations approach.[47,48] They sought to determine whether the efficacy of NEPs could be increased by using satellite exchangers (SEs) to transform these programs from interventions that target individual injectors into interventions that target large sociometric networks of IDUs in the community. SEs as defined in the study are high volume exchangers who obtain new, sterile syringes from NEPs and redistribute them to other injectors in order to obtain money, goods, or services from these other injectors. The study developed methods to identify SEs attending the Baltimore needle exchange program. It then examined their syringe acquisition and distribution patterns to determine their potential utility for distributing new, sterile syringes and HIV risk reduction messages to those injectors not reached by the program.

Using a variety of methods to define SEs, approximately 9% of those attending the needle exchange were classified as satellite exchangers; these SEs acquired more than 64% of the needles distributed by the program. Since syringes distributed by the program were bar coded, it was possible, through a needle acquisition and return matrix, to link participants who acquired and returned needles distributed by the program. Network analysis techniques determined the number of other IDUs who returned syringes originally acquired by program participants (indicating the number of other IDUs to whom program participants distributed program syringes) and the number of other IDUs who originally acquired syringes that were returned by program participants (indicating the number of other IDUs for whom program participants returned their used program syringes). Very large differences were found in the number of IDUs who were reached by the SEs compared with the individual exchangers. On average, SEs distributed syringes to nine times as many other IDUs as did the non-SEs and returned program syringes from eight times as many other IDUs as did the non-SEs. This extensive reach of SEs indicates a potential for diffusing new, sterile syringes and HIV risk reduction information and materials among large numbers of drug injectors.

An earlier attempt at this type of diffusion of new, sterile syringes from an NEP was attempted in Rotterdam, The Netherlands.[49] They also found that IDUs who

were collective exchangers—IDUs who received one or more boxes of sterile syringes from and returned one or more boxes of used syringes to the needle exchange—were effective in reaching large numbers of IDUs who would otherwise not be reached by the NEP.

An intervention that utilizes both direct and indirect ties among IDUs and peer influence, conducted in eastern Connecticut, is the peer-driven intervention (PDI) model.[41,50,51] This model uses a combination of monetary and altruistic incentives to encourage active IDUs to recruit and educate other IDUs about HIV risk reduction. Individuals recruited by the IDU recruiter are in turn offered the opportunity to become IDU recruiters. Through these chain-referral links, a large number of IDUs can be reached. In addition to building on the direct and indirect social ties among IDUs, the intervention also uses social influence and peer pressure as incentives. As well as being directly paid for being interviewed, IDU recruiters are paid for each recruit they bring to the study and then are paid again if the recruit successfully passes a test on preventing AIDS. In a comparison of the PDI site with a traditional outreach site, the PDI site recruited a more diverse population of IDUs in terms of their racial/ethnic group and residential geography, and the recruits in the PDI site scored higher on a test of AIDS knowledge than did the recruits at the traditional site. Another beneficial effect was that IDU recruiters themselves improved their level of AIDS knowledge from their first interview to when they returned to receive their payment for recruiting their peers.

Interventions among IDUs also have been carried out at the community level. For example, a major goal of the Community AIDS Prevention Outreach Demonstration project (an enhanced intervention in the NADR program) in the Williamsburg section of Brooklyn,[19] which targeted an entire neighborhood in New York City, was to mobilize peer pressure among drug injector networks through group meetings, one-on-one counseling, and the distribution of condoms and other risk reduction materials.[45] Condom use increased among IDUs in the neighborhood, and 49% of subjects who attended a group meeting always used condoms at follow-up compared with 29% of those who never attended.[52]

Although not directed at drug users per se, the interventions conducted by Kelly and colleagues,[53–55] which targeted gay men in small cities, are instructive for conducting similar interventions among drug users. (Aspects of this type of intervention were used by Latkin.[40]) In the intervention cities, popular gay men in the communities who were nominated by bartenders at gay bars were trained to endorse risk reduction among their peers by talking to their friends and acquaintances; in the control cities, HIV educational materials were placed in gay bars. A survey of men attending the gay bars was conducted at baseline and one year later. Results from the study comparing four intervention cities and four control cities found significant reductions in levels of risk behaviors in the intervention cities compared with the control cities.[55]

As part of the Centers for Disease Control and Prevention multisite AIDS Community Demonstration Projects,[56,57] community-based networks were used to conduct outreach, distribute risk reduction materials, and advocate for risk reduction among drug injectors and other groups at risk. In these interventions, "networkers," who were people from the community, were trained to promote risk reduction among their friends and family members. Although, in these interventions, networks were in many cases developed as part of the intervention rather than being naturally occurring, they have been used effectively in large-scale dissemination of risk reduction information and materials.

## Conclusion

Evidence is mounting that drug injectors' networks are not only an important determinant of their risk for becoming infected with HIV but also that they can be successfully used for prevention. To further develop and refine network-based interventions, several issues need to be addressed.

One issue is to determine which kind of network intervention is appropriate and customize it depending on the characteristics of the network. For example, the instability of many drug users' networks, much of which is linked to social marginalization, makes it difficult to conduct network interventions that require close relationships between network members. Thus, network interventions that seek to use influence and reciprocity among network members are facilitated if there is some degree of stability in network membership and a shared commitment toward risk reduction. Where the social ties are weaker and drug users' networks are not naturally occurring, such as among IDUs who congregate at certain semi-anonymous injecting settings (shooting galleries, parks, or other outside locations), a network intervention may need to use opinion leaders and organizing techniques to create social relationships that can form the basis for the development of a risk reduction peer culture.

Since networks not only influence behavior but also shape the distribution of HIV through contact patterns

and viral exposure, there may be situations where it is not advisable to increase the probability that infectious and susceptible populations mix with each other. In interventions among drug injectors, some caution may be needed in bringing new and long-term injectors into close contact, since long-term injectors are more likely to be infected with HIV.

Network interventions can be made more effective by a fuller understanding of how social influence shapes HIV risk behaviors—for example, which aspects of social influence, in what kinds of relationships, with what intensity or "dose" to generate a given response, with what frequency, and over what duration of time.

The evaluation of the effectiveness of network interventions raises certain methodological issues. Booth and Watters,[18] in their review of HIV interventions (most of which were individual based) among drug users, found that very few used a randomized design with control groups and testing prior to and after the interventions. Evaluating the efficacy of a network intervention adds another level of complexity, since network interventions need to develop and utilize interaction and communication among drug users to change risk behaviors. This makes it difficult to evaluate network interventions because of possible "contamination" between treatment and control groups (although, for the intended effect of a network intervention, such contamination may be a resource and lead to the large-scale diffusion of risk reduction). Nevertheless, network intervention designs using randomization have been implemented in network interventions at the level of the individual,[34,38] the network,[21] and the community.[55]

The network approach in HIV interventions among drug users holds promise. It addresses a level of causation that, although increasingly found to be important in the determination of HIV infection and risk behaviors, has not yet been widely used for interventions. By changing behavioral norms and the peer culture of drug users, network-based interventions may provide for large-scale and sustainable risk reduction. The use of a network approach also may prove to be cost-effective, since large numbers of drug users can be reached through a multiplier effect generated by the social links among drug users.[41,46]

Network approaches also can complement approaches at the individual level. HIV risk factors with complex biographical or biological origins—such as a prior history of sexual abuse, high levels of drug dependency, and psychological dysfunction—may require a more individualized approach. However, insofar as HIV risk among IDUs and other at-risk groups is a function of their networks, and it is feasible to modify such networks, then network-based interventions have the potential to be an appropriate and effective means to reduce HIV risk.

This study was supported by National Institute on Drug Abuse Grant No. R01 DA09920.

Kristine Ziek assisted in the preparation of this paper.

## References

1. Des Jarlais DC, Friedman SR, Sotheran JL, Wenston J, Marmor M, Yankovitz SR, et al. Continuity and change within an HIV epidemic: injecting drug users in New York City, 1984 through 1992. JAMA 1994;271:121–7.
2. Friedman SR, Neaigus A, Jose B, Curtis R, Goldstein M, Ildefonso G, et al. Sociometric risk networks and risk for HIV infection. Am J Public Health 1997;87:1289–96.
3. Holmberg SD. The estimated prevalence and incidence of HIV in 96 large US metropolitan areas. Am J Public Health 1996;86:642–54.
4. Centers for Disease Control and Prevention (US). HIV/AIDS surveillance report. 1997;9:8–12.
5. Becker MH. AIDS and behavior change. Public Health Rev 1988;16:1–11.
6. Ajzen I, Fishbein M. Understanding attitudes and predicting social behavior. Englewood Cliffs (NJ): Prentice-Hall; 1980.
7. Bandura A. Social cognitive theory and exercise of control over HIV infection. In: DiClemente RJ, Peterson JL, editors. Preventing AIDS: theories and methods of behavioral interventions. New York: Plenum Press; 1994.
8. Deren S, Davis WR, Tortu S. The Harlem AIDS Project: preliminary outcomes of a skills development intervention. Presented at the Second Annual National AIDS Demonstration Research Conference; 1990 Nov 28–30; Bethesda, MD.
9. McCusker J, Stoddard AM, Zapka JG, Morrison CS, Zorn N, Lewis BF. AIDS education for drug abusers: evaluation of short-term effectiveness. Am J Public Health 1992;82:533–40.
10. Neaigus A, Sufian M, Friedman SR, Goldsmith DS, Stepherson B, Mota P, et al. Effects of outreach intervention on risk reduction among intravenous drug users. AIDS Educ Prev 1990;2:253–71.
11. Needle RH, Coyle SL. Community-based outreach risk reduction strategy to prevent HIV risk behaviors in out-of-treatment injection drug users (IDUs). Paper presented at the National Institutes of Health Consensus Development Conference on Interventions to Prevent HIV Risk Behaviors; 1997 Feb 11–13; Rockville (MD): National Institute on Drug Abuse (US). p. 3–6.
12. Stephens RC, Feucht TE, Roman SW. Effects of an intervention program on AIDS-related drug and needle behavior among intravenous drug users. Am J Public Health 1991;81:568–71.
13. Van den Hoek A, van Haastrecht HJA, Coutinho RA. Little change in sexual behavior in drug users in Amsterdam. Abstract No. 122. Presented at the Sixth International Conference on AIDS; 1990 Jun 20–25; San Francisco, CA.
14. Watkins KE, Metzger D, Woody G, McLellan AT. Determinants

of condom use among intravenous drug users. AIDS 1993;7:719–23.
15. Barnard M. Needle sharing in context: patterns of sharing among men and women injectors and HIV risks. Addiction 1993;88:805–12.
16. Neaigus A, Friedman SR, Goldstein M, Ildefonso G, Curtis R, Jose B. Using dyadic data for a network analysis of HIV infection and risk behaviors among injecting drug users. In: Needle RH, Coyle SL, Genser SG, Trotter RT II, editors. Social networks, drug abuse, and HIV transmission. National Institute on Drug Abuse Research Monograph 151. Washington: Government Printing Office; 1995. p. 20–37. NIH Pub. No. 95-3889.
17. Strathdee SA, Patrick DM, Archibald CP, Ofner M, Cornelisse PGA, Rekart M, et al. Social determinants predict needle-sharing behavior among injection drug users in Vancouver, Canada. Addiction 1997;92:1339–47.
18. Booth RE, Watters JK. How effective are risk-reduction interventions targeting injecting drug users? AIDS 1994;8:1515–24.
19. Neaigus A, Friedman SR, Curtis R, Des Jarlais DC, Furst RT, Jose B, et al. The relevance of drug injectors' social networks and risk networks for understanding and preventing HIV infection. Soc Sci Med 1994;38:67–78.
20. Klovdahl AS. Social networks and the spread of infectious diseases: the AIDS example. Soc Sci Med 1985;21:1203–16.
21. Trotter RT II, Baldwin JA, Bowen AM. Network structure and proxy network measures of HIV, drug and incarceration risks for active drug users. Connections 1995;18:89–104.
22. Auerbach DM, Darrow WW, Jaffe HW, Curran JW. Cluster of cases of the acquired immune deficiency syndrome: patients linked by sexual contact. Am J Med 1984;76:487–92.
23. Klovdahl AS, Potterat JJ, Woodhouse DE, Muth JB, Muth SQ, Darrow WW. Social networks and infectious disease: the Colorado Springs study. Soc Sci Med 1994;38:79–88.
24. Rothenberg RB, Woodhouse DE, Potterat JJ, Muth SQ, Darrow WW, Klovdahl AS. Social networks in disease transmission: the Colorado Springs study. In: Needle RH, Coyle SL, Genser SG, Trotter RT II, editors. Social networks, drug abuse, and HIV transmission. National Institute on Drug Abuse Research Monograph 151. Washington: Government Printing Office; 1995. p. 3–19. NIH Pub. No. 95-3889.
25. Woodhouse DE, Rothenberg RB, Potterat JJ, Darrow WW, Muth SQ, Klovdahl AS, et al. Mapping a social network of heterosexuals at high risk of HIV infection. AIDS 1994;8:1331–6.
26. Morris M, Zavisca J, Dean L. Social and sexual networks: their role in the spread of HIV/AIDS among young gay men. AIDS Educ Prev 1995;7 Suppl 5:24–5.
27. Neaigus A, Friedman SR, Jose B, Goldstein MF, Curtis R, Ildefonso G, et al. High risk personal networks and syringe sharing as risk factors for HIV infection among new injectors. J Acquir Immune Defic Syndr 1996;11:499–509.
28. Friedman SR, Des Jarlais DC, Sotheran JL, Garber J, Cohen H, Smith D. AIDS and self-organization among intravenous drug users. Int J Addict 1987;23:201–19.
29. Magura S, Grossman JI, Lipton DS, Qudsia S, Shapiro J, Marion I, et al. Determinants of needle sharing among intravenous drug users. Am J Public Health 1989;79:459–62.
30. Abdul-Quadr A, Tross S, Friedman SR, Kouzi AC, Des Jarlais DC. Street-recruited intravenous drug users and sexual risk reduction in New York City. AIDS 1990;4:1075–9.
31. Magura S, Shapiro JL, Siddiqui Q, Lipton DS. Variables influencing condom use among intravenous drug users. Am J Public Health 1990;80:82–4.
32. Des Jarlais DC, Friedman SR, Friedmann P, Wenston J, Sotheran JL, Choopanya K, et al. HIV/AIDS-related behavior change among injecting drug users in different national settings. AIDS 1995;9:611–7.
33. El-Basel N, Schilling RF. Social support and sexual risk taking among women on methadone. AIDS Educ Prev 1994;6:506–13.
34. Latkin CA, Mandell W, Vlahov D, Oziemkowska M, Celentano DD. Personal network characteristics as antecedents to needle-sharing and shooting gallery attendance. Soc Networks 1995;17:219–28.
35. Williams ML, Zhou Z, Siegal HA, Robles RR, Trotter II RT, Jones A. A comparison of drug use networks across three cities. In: Needle RH, Coyle SL, Genser SG, Trotter RT II, editors. Social networks, drug abuse, and HIV transmission. National Institute on Drug Abuse Research Monograph 151. Washington: Government Printing Office; 1995. p. 109–30. NIH Pub. No. 95-3889.
36. Padian NS, O'Brien TR, Chang Y, Glass S, Francis DP. Prevention of heterosexual transmission of human immunodeficiency virus through couple counseling. J Acquir Immune Defic Syndr 1993;6:1043–8.
37. Scott J. Social network analysis. Newbury Park: Sage Publications; 1991.
38. Latkin CA, Mandell W, Vlahov D, Oziemkowska M, Celentano DD. The long-term outcome of a personal network-oriented HIV prevention for injection drug users: the SAFE Study. Am J Community Psychol 1996;24:341–64.
39. Trotter RT, Bowen AM, Baldwin JA, Price LJ. The efficacy of network-based HIV/AIDS risk reduction programs in midsized towns in the United States. J Drug Issues 1996;26:591–605.
40. Latkin CA. Outreach in natural settings: the use of peer leaders for HIV prevention among injecting drug users' networks. Public Health Rep 1998;113 Suppl 1:151–9.
41. Broadhead RS, Heckathorn DD, Grund JC, Stern LS, Anthony DL. Drug users versus outreach workers in combating AIDS: preliminary results of a peer-driven intervention. J Drug Issues 1995;25:531–64.
42. Wiebel WW. Combining ethnographic and epidemiologic methods in targeted AIDS interventions: the Chicago model. In Battjes RJ, Pickens RW, editors. Needle sharing among intravenous drug abusers: national and international perspectives. National Institute on Drug Abuse Research Monograph 80. Washington: Government Printing Office; 1988. p. 137–50. DHHS Pub. No. (ADM) 89-1567.
43. Carlson G, Needle R. Sponsoring addict self-organization (Addicts Against AIDS): a case study. Presented at the First Annual National AIDS Demonstration Research Conference; 1989 Oct 16–18; Rockville, MD.
44. Friedman SR, Des Jarlais DC, Ward TP. Social models for changing health-related behavior. In: DiClemente RJ, Peterson JL, editors. Preventing AIDS: theories and methods of behavioral interventions. New York: Plenum Press; 1994. p. 95–116.
45. Friedman SR, de Jong W, Wodak A. Community development as a response to HIV among injectors. AIDS 1993;7 Suppl 1: S263–S269.
46. Valente TW, Foreman RK, Junge B, Vlahov D. Satellite exchange in the Baltimore Needle Exchange Program. Public Health Rep 1998;113 Suppl 1:90–6.
47. Rogers EM. Diffusion of innovations. New York: The Free Press; 1983.
48. Valente TW. Network models of the diffusion of innovations. Creskill (NJ): Hampton Press; 1995.

49. Grund JC, Blanken P, Adriaans NFP, Kaplan CD, Barendregt C, Meeuwsen M. Reaching the unreached: targeting hidden IDU populations with clean needles via known user groups. J Psychoactive Drugs 1992;14:41–7.
50. Grund JC, Broadhead RS, Heckathorn DD, Stern LS, Anthony DL. Peer-driven outreach to combat HIV among IDUs: a basic design and preliminary results. In: Rhodes T, Hartnoll R, editors. AIDS, drugs and prevention: perspectives on individual and community action. New York: Routledge; 1996. p. 201–15.
51. Heckathorn DD. Respondent-driven sampling: a new approach to the study of hidden population. Soc Probl 1997;44:174–99.
52. Jose B, Friedman SR, Neaigus A, Curtis R, Sufian M, Stepherson B, et al. Collective organisation of injecting: drug users and the struggle against AIDS. In: Rhodes T, Hartnoll R, editors. AIDS, drugs and prevention: perspectives on individual and community action. New York: Routledge; 1996. p. 216–33.
53. Kelly JA, St. Lawrence JS, Diaz YE, Stevenson LY, Hauth AC, Brasfield TL, et al. HIV risk behavior reduction following intervention with key opinion leaders of population: an experimental analysis. Am J Public Health 1991;81:168–71.
54. Kelly JA, St. Lawrence JS, Stevenson LY, Hauth AC, Kalichman SC, Diaz YE, et al. Community AIDS/HIV risk reduction: the effects of endorsements by popular people in three cities. Am J Public Health 1992;82:1483–9.
55. Kelly JA, Murphy DA, Sikkema KJ, McAuliffe TL, Roffman RA, Solomon LJ, et al. Randomized, controlled, community-level HIV-prevention intervention for sexual-risk behaviour among homosexual men in US cities. Community HIV Prevention Research Collaborative. Lancet 1997;350:1500–5.
56. Guenther-Grey C, Noroian D, Fonseka J, Higgins D. Developing community networks to deliver HIV prevention interventions. Public Health Rep 1996;110 Suppl 1:41–9.
57. Simons PZ, Rietmeijer CA, Kane MS, Guenther-Grey C, Higgins DL, Cohn, DL. Building a peer network for a community level HIV prevention program among injecting drug users in Denver. Public Health Rep 1996;111 Suppl 1:50–3. ■