American Journal of Community Psychology, Vol. 24, No. 3, 1996

The Long-Term Outcome of a Personal Network-Oriented HIV Prevention Intervention for Injection Drug Users: The SAFE Study[1]

Carl A. Latkin,[2] Wallace Mandell, David Vlahov, Maria Oziemkowska, and David D. Celentano

Johns Hopkins University School of Hygiene and Public Health

Social influence processes have been found to affect numerous drug and health-related behaviors. We postulated that by using a network-oriented intervention it may be possible to capitalize on social influence processes to reduce human immunodeficiency virus (HIV) risk behaviors. The present study used an experimental study design for delivering a psychoeducational acquired immunodeficiency syndrome (AIDS) preventive intervention to injection drug sharing networks. Participants were recruited from the ALIVE study, an epidemiological study in Baltimore. In the present paper we examine the self-reported behavioral outcomes of 117 injection drug users 18 months after the baseline interview. HIV seronegative experimental participants reported significantly less frequent needle sharing and less injecting of heroin and cocaine than controls. In multiple logistic regression models of HIV seronegative participants, there was a significant negative association between assignment to the experimental group and the HIV-related behaviors of needle sharing and sharing of cookers in the prior 6 months; controls were 2.8 times more likely than experimentals to report needle sharing and were 2.7 times more likely to report sharing cookers. The results of this 18-month follow-up suggest that among injection drug users network-oriented interventions may be a promising approach to HIV prevention.

[1]This research was supported by grants (DA04334, DA05911, DA06326, & DA08985) from the National Institute on Drug Abuse. We would like to thank Amy Knowlton for her contributions to this manuscript.

[2]All correspondence and reprint requests should be sent to Dr. Carl A. Latkin, Department of Mental Hygiene, The Johns Hopkins University, School of Hygiene and Public Health, 624 N. Broadway, Baltimore, Maryland 21205.

0091-0562/96/0600-0341$09.50/0

KEY WORDS: acquired immunodeficiency syndrome (AIDS); injection drug users; human immunodeficiency virus (HIV); social networks; prevention; experimental intervention.

Injection drug users continue to have high human immunodeficiency virus (HIV) seroconversion rates, and male injection drug users are a major source of HIV infection for women and their children. HIV/acquired immunodeficiency syndrome (AIDS) prevention interventions for injection drug users have had mixed results. Reviews of HIV/AIDS prevention studies (Fisher & Fisher, 1992; Magura, Qudsia, Shapiro, et al., 1991) have pointed out methodological inadequacies of the majority of interventions: some lack comparison groups, few include control groups, and many studies assess only changes in knowledge of HIV/AIDS risk or intentions to change behaviors. Almost all quasiexperimentally designed interventions (i.e., those without a control group) report evidence of reduction in risk behaviors (Magura, Grossman, Lipton, et al., 1991). However, the results of experimental interventions often reveal that the control group improves as much as the experimental group. A few experimental behavioral studies have reported risk reduction in injection drug users. Stephens, Feucht, and Roman (1991) found self-reports of HIV risk reduction. The study, however, did not use random assignment. Sorenson et al. (1994) conducted an experimental preventive intervention with random assignment of methadone maintenance and detoxification patients. In the experimental condition patients received 6 hours of psychoeducation. Although the authors found pronounced decreases in self-reported risk behaviors immediately after the intervention, at a 3-month follow-up they found little evidence of sustained reduction in injection-related risk behaviors. In our previous 90-min educational intervention with injection drug users we failed to find posttest differences between the experimental and control groups (Mandell, Latkin, Oziemkowska, Vlahov, & Celentano, 1993). In postintervention debriefings many participants reported that their drug-sharing partners impeded their efforts at risk reduction. These results led us to an intervention strategy of targeting drug-sharing networks in order to guide intranetwork social influence processes to reduce HIV-related behaviors.

Social influence, especially by friends, has been found to affect numerous drug and health-related behaviors (Gottlieb, 1985). Several studies have suggested that perceived normative expectations and peer pressure are determinants of risky injection behaviors (Des Jarlais, Friedman, & Hopkins, 1985; Friedman et al., 1987; Magura et al., 1989). Ethnographic studies have identified various social factors found to support needle-sharing practices (Page, 1990). To date, most HIV preventive interventions have been individually oriented; social factors, such as peer influence, have sel-

dom been experimentally examined or capitalized on. An exception is an HIV preventive intervention among gay men living in small towns (Kelly et al., 1992). The authors found that popular individuals, as rated by bartenders in gay bars, could be taught to communicate to their peers the importance and desirability of reducing HIV-related sex behaviors. Posttest surveys of gay men in the intervention communities indicated substantially greater reduction in self-reported sexual risk behaviors as compared with self-reports of gay men in control communities.

One method of studying interpersonal influence is through network analysis. A network is typically defined as a set of nodes, which can be individuals or organizations, that are tied by one or more specific types of relations between them, e.g., a person's sex network is individuals with whom s/he has sex. A *personal network* includes a focal individual, or index, and his/her ties. A *social network* is a constellation of linked personal networks. Network analysis allows for the study of both individuals and their social environments. Investigators have used network methodologies to examine socialization, diffusion of innovation, and norm formation (Marsden, 1990). Networks may influence behaviors through social comparison processes, fear of social sanctions, information exchange, and socialization of new members (Fisher, 1988; Hall & Wellman, 1985). Previous research suggests that personal network characteristics are associated with adoption of health-related behaviors (Gottlieb, 1985; Hunter, Vizalberg, & Berenson, 1991), that they buffer against psychological stress (Veiel & Baumann, 1992), and that they differentiate drug use behaviors (Fraser & Hawkins, 1984a, b; Hunter et al., 1991).

Most social support interventions use nonnetwork groups. Typically these interventions are comprised of individuals who have the same condition, illness, or life event and meet each other for the first time in the support group. Few interventions have used existing peer networks (Chapman & Pancoast, 1985). Although a few studies of personal networks of injection drug users' have been reported (e.g., Fraser & Hawkins, 1984a, b) there is little systematic information on the role of personal networks in their adoption or maintenance of HIV-related behaviors. The utility of using a network-centered intervention for reducing HIV risk behaviors among drug-sharing networks is supported by previous research on injection practices and social influence within the drug-injecting community. Research on drug use patterns has verified the strong relationship between adolescents' and their friends' patterns of drug use (Brooks, Nomura, & Cohen, 1988; Elliott, Huizinga, & Ageton, 1985). Several social factors have been identified as influencing HIV-related behaviors. Friedman and his colleagues have found that in New York City 70% of drug injectors reported sharing syringes, and that injectors with more frequent contact with noninjectors re-

ported fewer injection risk behaviors (Friedman et al., 1993; Neaigus et al., 1994). Friedman et al. (1987), reporting on injection drug users in New York City, found that friends' HIV-related behaviors were strong predictors of behavioral change. Magura et al. (1989) reported that friends' attitudes are a strong determinant of needle sharing. Friedman et al. (1991) described the existence of small friendship groups that work together to obtain money, drugs and protection against assault. The authors suggested that the group norm of cooperation includes sharing of injection equipment.

Group norms have been shown to influence members' behaviors (Myers & Bishop, 1970; Newcomb, 1958). Norms have been characterized as conservative factors, working against the initiation of new behaviors, and may help to explain the resistance of many injection drug users to adopting HIV-protective behaviors (Nadler & Fisher, 1988). The strength and endurance of group norms may help to partially explain why in a recent study in New York one-third of those interviewed reported they were not able to maintain their HIV risk reduction behaviors (Des Jarlais, Abdul-Quander, & Tross, 1991).

In the present study the HIV-related injection behaviors of drug sharing networks were the focus of the intervention. The drug-sharing network was the unit of analysis. The study design was experimental and used pre- and postintervention, face-to-face interviews as the basis of evaluation. The study population was inner-city, "street" injection drug users living in Baltimore, Maryland. The proximal outcome was reduction of self-reported HIV-related behaviors of sharing unhygienic injection equipment.

We have previously reported on results from our first follow-up assessment (Latkin, Mandell, Oziemkowska, et al., 1994; Latkin et al., 1995). At the 3-month follow-up we found that participants in the experimental condition reported a significantly greater reduction of HIV-related injection practices as compared with participants in the control condition. We also found, both cross-sectionally and prospectively, that the network structural characteristics of size of drug-sharing network and personal network density were associated with needle sharing and frequency of injecting heroin and cocaine (Latkin, Mandell, Vlahov, Oziemkowska, & Celentano, 1995). Furthermore, within participants' social support networks, having fewer people to rely on for material assistance was associated with increased attendance at shooting galleries. The perceived norm of network members encouraging each other to disinfect their needles was also found to predict needle sharing (Hawkins, Latkin, & Mandell, 1995). In the present paper we examine the outcome 18 months after the initial interview and assess the role of HIV serostatus as a possible mediating variable of behavior change. HIV serostatus has seldom been assessed in interventions, though its association with behavior change may have significant implications for public health.

METHOD

Participants

The participants were predominately unemployed, African American males on public assistance, with a median age of 40 years, residing in Baltimore, Maryland. The sample had high levels of histories of homelessness, arrest, and incarceration (Table I). Cocaine and heroin by injection were the drugs of choice in this sample (Table II). These individuals could be characterized as "street addicts," i.e., dependent on street-level sources of drugs and money (Inciardi, 1993). Over 85% of the indexes and 80% of the controls reported at the baseline interview that they shared needles, and over 32% of the indexes and 28% of the controls reported that they had been to a shooting gallery within the last six months (Table II).

Recruitment

Participants were a nontreatment sample recruited from the AIDS Links to Intravenous Experiences (ALIVE) study, a prospective epidemiological study of the natural history of HIV infection in injection drug users, which began in 1988 (Vlahov, Anthony, Celentano, Solomon, & Chowdhury, 1991). The means of recruitment for the ALIVE study were community outreach and word-of-mouth, with 86% of the participants first learning about the study by word-of-mouth. Enrolled in the ALIVE study were 2,291 individuals who were currently injecting drugs or had injected within the prior 10 years. The ALIVE sample was predominately inner-city African-American (89%) males (81%), who were unemployed (77%) and had annual incomes of under $5,000 (73%). At the ALIVE study baseline, 90% reported injecting drugs and 60% reported sharing needles within the prior year. Twenty-four percent were found to be HIV seropositive. ALIVE participants are interviewed every 6 months about their risk behaviors and asked to submit to a blood test. Those who are HIV seronegative receive an HIV antibody test and seropositive participants receive a test of immune function. The follow-up rate for ALIVE participation has exceeded 85%.

Procedures

At the ALIVE clinic participants who at their regular 6-month follow-up visits reported they had injected drugs in the preceding 6 months and had shared drugs were provided information about the Stop AIDS for Everyone (SAFE) study. The SAFE clinic was located three blocks from

Table I. Demographic Characteristics and Life Events at Baseline of Injecting Drug Users Enrolled in the SAFE Study, Baltimore, 1991-1992

Variables	Indexes who completed the study (%) (n = 47)	Indexes who did not complete the study (%) (n = 142)[a]	χ^2	Indexes who completed the study (%) (n = 47)	Controls who completed the study (%) (n = 70)	χ^2
Gender: Male	87.2	85.0	0.14	87.2	80.9	0.81
Race: African-American	100	96.4	1.72	100	92.9	3.51
Education: > 12th grade	29.8	46.8	4.14[b]	29.8	50.0	4.67[b]
Married	8.5	3.6	3.41	8.5	5.7	3.82
"Living together as if married"	30.2	18.8	2.51	30.2	27.7	0.08
Currently employed	12.8	10.3	0.22	12.8	9.2	0.35
Arrested in last 10 years	83.0	79.9	0.22	83.0	77.9	0.44
Public assistance in last 10 years	80.9	88.5	1.76	80.9	86.8	0.73
Homeless in last 10 years	44.6	64.0	5.44[b]	44.7	45.3	0.73
HIV seropositive	17.0	30.7	3.33	17.0	26.5	1.42
40 years old or younger	46.7	50.7	0.21	53.2	44.1	0.91

[a]Missing data on two participants.
[b]$p < .05$.

Table II. Self-Reported Drug Use for the Last 6 Months at Baseline Interview of 117 Participants in the SAFE Study, Baltimore, 1991-1992

Variables	Indexes who completed study (%) (n = 47)	Controls who completed study (%) (n = 70)	χ^2
Injecting cocaine once a day or more	31.9	41.5	1.08
Injecting heroin once a day or more	38.3	44.3	0.41
Injecting cocaine and/or heroin once a day or more	48.9	58.6	1.09
Injecting in a shooting gallery	31.9	27.9	0.21
Frequency of sharing cookers			
Less than half the time	22.1	12.8	2.36
Half the time	19.1	27.7	
More than half the time	58.8	59.5	
Frequency of sharing needles			
Not at all	14.9	19.1	0.88
Less than once a month	29.8	29.4	
Once a month or more	55.3	51.5	

the ALIVE clinic. The neighborhood has a high concentration of injection drug users. The SAFE clinic was a rowhouse used solely for the study. It is situated on a block with a mixture of commercial and university buildings and is close to major bus routes. On the exterior of the building there is no information that would identify it as an HIV prevention study.

There were 411 ALIVE study participants who were informed at the ALIVE clinic they were eligible to participate in the SAFE study; of these, 293 (71%) presented themselves at the SAFE clinic and enrolled in the study. Upon arriving at the SAFE clinic, potential participants were again screened for eligibility. Enrollment requirements of the SAFE study were being 18 years or older, reporting sharing drugs in the prior 6 months, having a drug-sharing network, and not being enrolled in other HIV prevention studies. Those who were eligible were administered a detailed, face-to-face interview on their background, HIV-related behaviors, and personal networks. As part of the personal network interview, participants were asked to provide the names of individuals with whom they shared drugs, i.e., their drug network.

After the baseline interview participants were randomly assigned to either the experimental or control condition. Participants who were assigned to the experimental condition were asked to bring into the clinic for the intervention members of their drug network whom they had listed

in the network interview. Participants assigned to the experimental condition were called "index" participants. The individuals with whom the index reported "doing drugs" were called members of the "index's drug network." For the purposes of this paper the terms *indexes' drug networks* and *controls' drug networks* refer to drug networks excluding the indexes and controls, respectively, whereas the term *drug networks* refers to drug networks including the indexes and controls. After random assignment the indexes met with a group facilitator to discuss the study and approaches the indexes could use to talk to their drug networks about the intervention and to encourage their participation. The indexes were informed that the goal of the project was HIV prevention among networks of drug users and that in order to participate they were required to bring into the clinic members of their drug network and to participate in six group intervention sessions. There was no limit to the number of network members the indexes could bring into the study. Participants were informed, however, that only individuals whom they named before leaving the clinic would be eligible for the study. This requirement was to prevent individuals from simply gathering strangers or acquaintances for the intervention. Another criterion for the network members was that they had not previously participated in the intervention. The minimum allowable network size was four, including the index. All participants were paid $15 for the initial interview and $10 for each of the six, $1\frac{1}{2}$-hour intervention sessions. In addition, index individuals were compensated ($25) for bringing their network members to the SAFE study. This compensation is in accordance with local practices for study participation and with previous research on street drug users, typically a "hard-to-reach" population.

Before and after entering the SAFE study (beginning in 1988-1989) the controls and indexes had been given risk reduction information, and HIV testing and counseling every 6 months as part of the ALIVE study. During the 18-month period of the SAFE study both controls and participants had received at least two HIV testing and counseling sessions. Hence, we considered that the controls were given this "usual treatment" for HIV prevention. Antibody to HIV-1 was screened by licensed enzyme immunoassay (Genetic Systems, Seattle, Washington), with confirmatory Western blot (DuPont, Wilmington, Delaware). HIV seropositive participants were also given blood tests at their ALIVE visits. All indexes and controls had been informed of their HIV serostatus. For the SAFE study we chose to select as indexes injecting drug users who continued to report at their ALIVE interview engaging in the HIV-related practice of sharing needles. These individuals had been repeatedly provided information on acquiring and spreading HIV from sharing needles but continued to report needle

sharing, which suggests that their self-reports of risk behaviors were not merely attempts to please the study interviewers.

Measures

All participants, indexes, network members, and controls, were administered a personal network interview based on Barrera (1980, 1981) and a survey on demographic background, drug use, and HIV-related behaviors. The network survey asked participants to list members of their personal networks by giving their names or pseudonyms. Participants were first asked to list individuals who could provide social support in the domains of intimate interactions, material assistance, socializing, physical assistance, positive feedback, and health information. For example, the question on material assistance asked, "If you needed to borrow $25 or something valuable, who are the people you know who would lend or give you $25 or more, or something that was valuable?" Participants were also asked to list individuals with whom in the last 6 months they had had sex and individuals with whom they had shared drugs. Frequency of drug use was delineated on a 7-point scale, ranging from *never* to *more than twice a day, every day*. Responses on three 7-point scales of frequency of injecting cocaine, heroin, and cocaine and heroin were added to obtain the total frequency of opioid injections. Participants were asked about their frequency of injecting in shooting galleries and their frequency of sharing needles. Included in the survey were the following two questions: (1) "During the last six months how often did you use a needle right after somebody else had used it but you first cleaned it with bleach?" and (2) "During the last 6 months how often did you use a needle right after somebody else had used it, without first cleaning it with bleach?" Frequency of needle sharing was also delineated on a 7-point scale, ranging from *never* to *more than twice a day, every day*. Due to evidence that injection drug users who report cleaning needles with bleach continue to have high rates of HIV seroconversion (Vlahov, Muñoz, et al., 1991), participants who reported sharing with or without first cleaning their injection equipment with bleach were categorized as having shared needles. Frequency of sharing "cookers" was also delineated on a 7-point scale. Cookers are the containers, usually bottle tops, used to mix the dry form of drugs with water. The heroin solution is then heated in the cooker. Attendance at a shooting gallery was determined by responses to the interview section that elicited settings, including shooting galleries, in which participants injected drugs in the prior 6 months. Shooting galleries are locations where injection equipment is typically available for rent.

Criteria for Completion

Each intervention session included one index participant and members of his or her drug network. For an intervention session to occur the index and over half of the network members were required to be present. If the group did not meet these conditions their session was rescheduled. Those index individuals who had attended four or more sessions were considered to have received an adequate amount of the intervention to be included in the outcome analysis. The two posttest interviews occurred between 1991 and 1993. The first follow-up, or second interview, occurred, on average, 3 months after the last intervention session. The second follow-up, or third interview, was administered, on average, 15 months after completion of the intervention. Participants in the control and experimental groups were re-interviewed within the same time frame. After the second follow-up interview participants in the control condition were given the opportunity to enroll in the intervention.

Intervention

The group intervention procedure utilized self-help, network-centered, and psychoeducational approaches to behavior change (Anderson, Reiss, & Hogarty, 1986). The intervention was highly scripted and was facilitated by former heroin users who maintained contact with and were respected by active drug users in Baltimore. By using their personal experiences the facilitators were able to increase the sessions' relevance. Although the facilitators guided the sessions, the aim was to maximize participants' awareness of how each member's behaviors affected the other network members and how the network members could help monitor each other and facilitate their collective risk reduction.

The goal of the intervention was to reduce the risk behaviors of sharing unhygienic needles and having unprotected sex. The theoretical approach was harm reduction; participants were provided opportunities to choose among options to reduce their HIV risk behaviors. The intervention sessions provided an opportunity for participants to reconceptualize their HIV-related behaviors and examine social and personal factors that may have been influencing their behaviors. The intervention sessions focused on every member and the group as a whole, emphasizing the interdependence of their HIV-related behaviors. Integral to the intervention was the network planning safer practices and the monitoring and reinforcement of safer behaviors of each member. Participants were taught about social

norms and social influence. Role playing of problem situations was also employed. Group exercises based on the work of Garfinkel (1967) and Sommer (1969) were designed to demonstrate the power of social norms and their influence on behaviors.

The first intervention session was structured to lead from recognition of the general risk of HIV/AIDS to injection drug users, to recognition of participants' personal risk of infection. The group exercise was designed to stimulate individual recognition of risks from sharing needles among members of the drug network. When this risk recognition occurred, members recognized their own risk, and that the group has a great stake in all members' HIV protective behavior. This recognition led to a group decision to practice both individual and network-level vigilance. At this point the facilitator elicited a public commitment from network members to risk reduction. Throughout the intervention sessions the network engaged in a process of group decision making about risk reduction, including planning how to monitor and reinforce safer behaviors of each member. At the beginning of each session participants discussed the effectiveness of their previous plans and obstacles they encountered in implementing them.

A major segment of the intervention sessions was devoted to developing and practicing effective assertiveness skills, in particular being able to reject high-risk settings and negotiate risk reduction with network members. For example, in one role play participants were presented with the scenario of the group having only one set of injection equipment and one member wanting to share equipment without disinfecting it. The other network members attempted to convince this individual, using skills they learned in the intervention, to refrain from sharing the injection equipment. In addition to assertiveness skills, participants were taught methods of providing positive feedback to network members. Skills practiced in sessions were based on real-life situations, with barriers and attitudes about needle sharing provided by the network members. This permitted the tailoring of the intervention to the life situations of this population.

Participants were encouraged to focus on specific behavioral objectives in planning for risk reduction and relapse prevention. The networks used decision-making techniques to access various methods for assuring the availability of sterile needles, and the relative merits of alternatives to sterile needles, such as cleaning injection equipment with bleach. Impediments to behavior change were identified by the participants, including inadequate information about risk reduction techniques, inadequate decision-making procedures, difficulties in managing risk behavior relapse, and failure of the drug network to promote risk reduction behaviors. On

completion of the intervention participants were awarded certificates of completion.

Analyses

This study used an experimental, pre- and posttest design. The sample size of the intervention group was considered to be the number of networks. Because our interest was accessing differences between independent observations, data from the index individuals, not the total number of participants in the experimental group, was compared with that from individuals in the control condition. Completion of the study was defined as attending at least the first four sessions. As the controls did not bring in their drug networks for the study, in the data analysis only the index participants were compared to the controls. We also compared index individuals who completed the study with those who dropped out before the fourth session.

As HIV status was hypothesized to be a mediating variable for behavior change, respondents were stratified by HIV serostatus. HIV antibody tests were available on 115 of the 117 participants. The two participants who did not have antibody tests from the ALIVE study reported that they were HIV negative. Two sets of analysis were conducted: one including these two cases as seronegatives and one excluding these cases. Both sets of analyses revealed similar results. The analyses presented here that categorized participants by HIV status excluded the two cases with missing HIV antibody tests.

Attrition and Attendance

Of 189 potential indexes, 22.2% completed an initial interview but did not return with members of their drug network. Another 36.5% brought in to be interviewed at least one member of their drug network but never initiated the sessions. Seventy-eight (41.3% of 189) indexes started the sessions, and 66 (35% of 189) graduated. The completion rate for those who started, i.e., attended the first session, was 85%. Between the first and third sessions, three of the 78 indexes were unable to complete the study; one died, one was hospitalized, and one was incarcerated. A mean and median number of three network members, not including the indexes, attended each session.

The majority of the indexes' drug network members attended all the intervention sessions. A total of 207 of the indexes' network members enrolled in the study, an average of four per network; 60% attended all six sessions, 19% attended five sessions, 9% attended four sessions, and only 12% attended three or fewer sessions.

The second follow-up occurred on average 18 (17.6) months (SD = 2.9) after the completion of the baseline interview. At the time of this follow-up eight participants (four controls and four indexes) had died and one control was incarcerated. The follow-up rate was 71% (47) for the indexes who had completed the intervention and 70% (70) for the controls.

There were few lifestyle or demographic differences between indexes who had completed the study and those who did not. Of 11 comparisons between the indexes who had completed the intervention and were interviewed at the 18 month follow-up and those indexes who dropped out, two statistically significant differences emerged (Table I). Indexes who completed the study had significantly less education; 70% had less than a high school education, as compared to 53% of those assigned to the experimental group who did not complete the intervention ($\chi^2 = 4.14, p < .05$). Indexes who completed the study were also significantly less likely to have been homeless within the last 10 years (45% vs. 64%, $\chi^2 = 5.44, p < .05$). The indexes who completed the sessions and the 18 month follow-up were marginally less likely to be HIV seropositive (17% vs. 31%, $\chi^2 = 3.33, p = .07$). The mean number of drug network members listed by the indexes who completed the intervention and 18 month follow-up was 6.1 (SD = 4.3), and the mean for those who did not complete the intervention was 5.4 ($SD = 3.0, p = .25$). The mean sizes of the social support networks for the two groups was 7.2 (SD = 2.7) and 7.1 (SD = 3.2), respectively ($p = .74$).

The next analysis compared the 17 baseline background and HIV-related behavioral variables between the controls and the indexes who completed the 18 month follow-up interview (Tables I and II). A significant difference between the two groups was that, as seen in Table I, controls who completed the 18 month follow-up interview were more likely than the indexes to have completed 12 or more years of education (50% vs. 30%, $\chi^2 = 4.67, p < .05$). There were no significant age differences among the groups. For all groups the mean year of birth was 1953 (SD = 5). Statistical comparisons between the 78 indexes who began the intervention and the 121 who did not were highly similar to the abovementioned results, as were the comparisons between the 104 controls and the 78 indexes.

RESULTS

The first analysis of self-reported HIV-related behaviors at the 18-month follow-up interview examined frequency of injecting heroin and co-

caine, sharing needles, sharing cookers, and attending shooting galleries. *T*-tests and chi-square statistics were used to examine bivariate associations. As seen in Table IIIa, HIV seronegative experimentals reported significantly less needle sharing and less injecting of heroin and cocaine. For the HIV seronegative individuals there was no significant difference between indexes and controls in self-reports of shooting gallery attendance, and there was a marginal difference in self-reports of sharing cookers; 36% of the indexes reporting they had not shared a cooker in the prior 6 months, as compared with 19% of the controls ($\chi^2 = 3.19$, $p < .08$). As seen in

Table IIIa. Differences Between Experimental and Control Group in Injection Behaviors at 18-Month Follow-Up for HIV Seronegative Injection Drug Users in the SAFE Study, Baltimore, 1991-1993

Risk behaviors	Experimental, mean (*SD*) (*n* = 39)	Control, mean (*SD*) (*n* = 50)	*t*-value	*p*
Frequency of injecting heroin and cocaine[a]	9.31 (4.74)	13.34 (11.02)	2.13	<.05
Frequency of needle sharing	3.67 (1.91)	4.68 (2.45)	2.13	<.05
	%	%	χ^2	*p*
Attendance at shooting galleries	38.5	28.8	0.93	.34
Frequency of sharing cookers	64.1	80.8	3.19	.07

[a]Computed as frequency of injecting heroin plus frequency of injecting cocaine.

Table IIIb. Differences Between Experimental and Control Group in Injection Behaviors at 18-Month Follow-Up for HIV Seropositive Injection Drug Users in the SAFE Study, Baltimore, 1991-1993

Risk behaviors	Experimental, mean (*SD*) (*n* = 8)	Control, mean (*SD*) (*n* = 18)	*t*-value	*p*
Frequency of injecting heroin and cocaine[a]	15.50 (3.89)	9.78 (5.17)	2.79	<.05
Frequency of needle sharing	4.88 (1.81)	3.39 (1.54)	2.16	<.05
	%	%	χ^2	*p*
Attendance at shooting galleries	12.5	38.9	1.81	.18
Frequency of sharing cookers	100	66.7	3.47	.06

[a]Computed as frequency of injecting heroin plus frequency of injecting cocaine.

Table IV. Multiple Logistic Regression Models for Any Needle Sharing and Any Sharing of Cookers in Prior 6 Months at 18-Month Follow-Up Interview for 89 HIV Seronegative Injection Drug Users in the SAFE Study, Baltimore, 1991-1993

Variables	*B*	*SE*	*Wald*	Significance	Odds ratio
Needle sharing in the prior 6 months					
Age (0 = 40 or younger, 1 = 40+)	0.86	.49	3.05	.08[a]	2.36
Gender (0 = male, 1 = female)	0.69	.68	1.03	.31	1.99
Education (0 = ≤12th, 1 = 12th or greater)	0.17	.51	0.11	.74	1.18
Frequency of needle sharing at baseline (continuous)	0.32	.17	3.52	.06[a]	1.38
Group assignment (0 = experimental, 1 = control)	1.04	.49	4.51	.03[b]	2.83
Cooker sharing in prior 6 months					
Age (0 = 40 or younger, 1 = 40+)	0.42	.54	0.61	.44	1.53
Gender (0 = male, 1 = female)	1.03	.84	1.49	.22	2.79
Education (0 = ≤12th, 1 = 12th or greater)	0.10	.55	0.04	.85	1.11
Frequency of needle sharing cookers at baseline (continuous)	0.42	.24	3.12	.08[a]	1.53
Group assignment (0 = experimental, 1 = control)	1.01	.53	3.57	.06[a]	2.74

[a] $p < .10$.
[b] $p < .05$.

Table IIIb, the HIV seropositive individuals who had been in the intervention as compared to the control group reported higher levels of injecting drugs, frequency of sharing needles and sharing cookers.

The next analyses examined the relationship between any sharing of needles in the prior 6 months and group assignment. Multiple logistic regression analysis was used to adjust for other variables. Included in the model were the independent variables of age, gender, level of education, group assignment, HIV serostatus, and the interaction between HIV serostatus and group assignment. Those who reported sharing needles were

Table V. Multiple OLS Regression of Frequency of Injecting Heroin and Cocaine for 115 Injection Drug Users in the SAFE Study, Baltimore, 1991-1993[a]

Variables	*B*	*SE*	Beta	*t*	Significance
Group assignment (1 = experimental, 0 = control)	-2.64	1.07	-.24	2.48	.01
HIV status[b] (1 = HIV +, 0 = HIV-)	11.57	3.20	.92	3.62	<.01
Interaction of group assignment and HIV status	8.80	2.25	1.00	3.92	<.01
Arrested in last 10 years (1 = yes, 0 = no)	1.04	1.14	.08	0.91	.36
Homeless in last 10 years (1 = yes, 0 = no)	-.29	.92	-.03	0.32	.75
Frequency of drug use (< 1 a day = 0, ≥ 1 a day = 1)	3.35	.92	.31	3.63	<.01
Gender (0 = male, 1 = female)	.71	1.20	.05	.59	.56
Race (0 = white, 1 = African American)	3.78	2.48	.13	1.52	.13
Education (continuous)	.47	.18	.23	2.66	.01
Age (continuous)	.14	.08	.16	1.82	.07

[a]In the prior 6 months reported at 18-month follow-up interview. Multiple $R = .53$, $df = (10, 104)$.
[b]HIV = human immunodeficiency virus.

compared to those who reported not sharing needles in the prior 6 months. The initial multiple logistic regression models revealed several empty cells or cells with one individual. Due to these distributions, separate analyses were conducted for the HIV seronegative and HIV seropositive participants. For the HIV seronegative participants, group assignment continued to be significantly associated with not sharing needles: those in the control group were 2.8 times more likely than the experimental participants to report sharing needles (Table IV). A second multiple logistic regression model was used to examine predictors of sharing cookers in the prior 6 months. Included in the model were the independent variables of age, gender, level of education, and reported sharing of cookers in the prior 6

months at baseline. Assignment to the experimental group was marginally ($p < .06$) associated with not sharing cookers in the prior 6 months: those in the control group were 2.7 times more likely to report sharing cookers (Table IV). Another set of multiple logistic regression analyses were conducted for the HIV seropositive participants. Group assignment was not associated with either needle sharing ($p = .86$) or sharing cookers ($p = .87$) (data not shown in table).

Finally, a linear Ordinary Least Squares (OLS) multiple regression model examined associations with frequency of injecting. As each injection event presents a risk for acquiring or transmitting HIV, frequency of injecting cocaine and heroin were combined in this analysis. Included in the model were the baseline variables of demographics, frequency of drug use, histories of arrest and of homelessness, group assignment, HIV serostatus, and the interaction between HIV serostatus and assigned group. Group assignment was added to the model after all other variables were first entered (Table V). In this model, group status significantly increased the multiple regression coefficient (F-change = 6.12, $p < .05$). There was also a statistically significant interaction between HIV status and group assignment. An analysis of the residuals revealed no outliers, and there was no evidence of either homoscedascity or multicollinearity. The multiple R for the final model was .53 ($R^2 = .28$).

DISCUSSION

Based on an 18-month follow-up survey, the present study found that for HIV seronegative participants a clinic-based experimental intervention utilizing drug-sharing networks was associated with lower frequency of the self-reported HIV-related injecting behaviors of sharing needles, sharing cookers, and frequency of injecting heroin and cocaine. These findings point to the potential importance of examining and intervening in personal network processes as a strategy for HIV infection reduction among injection drug users.

In this study there was unequal attrition in the experimental and control groups. This threat to internal validity cannot be ruled out as a possible explanation for these findings. However, when the differences at baseline (i.e., HIV status, level of education, and homelessness) between participants in the experimental group who dropped out and those who completed the study were adjusted for, HIV-related behaviors continued to be associated with group assignment.

A troubling finding was the high level of reported HIV-related behaviors among the HIV seropositive participants in the experimental group.

There are several possible explanations for these results. They could in part be due to a selection bias, as more seropositive individuals dropped out of the experimental group than the control group; it is possible that those who remained differed from those who did not participate. Alternatively, the intervention may have increased group cohesion, and one plausible unanticipated consequence of increased group cohesion is that the drug network members increased their support of seropositive individuals by helping them acquire drugs.

Attrition is a critical issue in developing health interventions for injection drug users. As Des Jarlais (1989) noted, "street IV drug users are not particularly good at either making or keeping appointments." Mobility, poor health, economic deprivation, and distrust of social services, factors characteristic of this population, all contribute to poor attendance in health education programs (Green & Kreuter, 1991). In the present study between the first and third sessions, a period of 2 weeks on average, one index had died, one had been hospitalized, and a third incarcerated. Of 189 individuals who volunteered to participate and were randomly assigned to the experimental group, 145 brought in at least one member of their drug network, 78 groups began the sessions, 66 completed at least four sessions, and 57 completed all six sessions. The 5-month follow-up rates were 94% for the indexes and 88% for the controls. The 18-month follow-up rates were 71% and 70%, respectively.

The greatest impediment to participation was the index's inability or lack of interest in bringing in his or her drug network. We telephoned some of the indexes who did not start the sessions. Of those whom we were able to contact the majority reported either that they were unable to convince their drug network members to come to the clinic or that the index him or herself was not interested in joining the study. If the index and network members did attend the first session it was highly probable that they would return; 85% of the indexes who came to the first session with their network members completed all six sessions. In the postintervention debriefing sessions participants informed us that paying them was strong inducement to begin the intervention, but that they were motivated by the content of the sessions to continue attending.

These results do not necessarily contradict the results of previous HIV prevention studies with injection drug users that did not find intervention effects. It is plausible that earlier in the AIDS epidemic injection drug users had little knowledge of HIV and brief interventions resulted in reports of substantial risk reduction. Subsequently, once higher levels of knowledge have been attained, more intense efforts have been needed to produce risk reduction.

Limitations

The generalizability of the study's findings may be a function of the selection criteria. Criteria for enrollment included having injected drugs within the prior 6 months and having a drug network. Ability and motivation to bring into the clinic members of one's drug network may also be important selection factors. This was primarily a sample of unemployed individuals who were on public assistance and reported a history of arrest. The cohort was comprised of volunteers, most of whom were recruited by word-of-mouth. It is possible that volunteers differ from those who did not volunteer or those who withdrew from the ALIVE or the SAFE studies.

There are several factors that may have affected the intervention outcome and may limit generalizations. One important demographic factor is income level; drug users with higher incomes or reliable sources of income may not be motivated by the study's incentive structure. A second factor is age. Participants were, on average, older drug users. We do not know if this intervention is feasible with younger participants. A third factor that may limit generalization is the geographic location of the intervention. Many of the network members had known each other since grade school; in other cities and countries drug networks may be less stable. A fourth limitation is that individuals who were not able to bring in their networks for the baseline interview or the intervention may be different or have qualitatively different types of networks than individuals who did bring in their networks. For example, those individuals who were unable to bring in network members may have been psychologically impaired, have had less intimate network members, or have had network members who were more geographically dispersed. A fifth factor that may limit generalizability is the stigma of drug use. Individuals who feared that study participation may have identified themselves as drug users may have chosen not to participate. Barnard (1993) reported that women in Scotland are less likely than men to use needle exchange programs due to fear of others identifying them as drug users. Finally, if individuals did not self-identify as "injection drug users," they may not have enrolled. For example, those who inject sporadically may not perceive themselves as "injection drug users."

The intervention did not produce significant changes in self-reports of injecting in shooting galleries. These results heighten the credibility of the self-report data. However, although several studies have found a high level of agreement between self-reported illicit drug use and urine analysis (e.g., Barbor, Brown, & Del Boca, 1990; Brown, Kranzler, & Del Boca, 1992; Ehrman & Robbins, 1994), the reliance on self-report data is problematic. The private and illicit behavior of injecting drugs makes it difficult to obtain other reliable measures of needle sharing. One method of validating self-

reports is the use of biological markers, yet, with an HIV seroconversion rate of approximately 4% for injection drug users in Baltimore, a cohort of hundreds of participants would be needed to detect a significant difference in seroconversion. In the study of sexual risk behaviors, sexually transmitted diseases are feasible biological markers. Another approach to validating self-reports is to measure socially desirable response bias and then use response bias as a covariate. We are currently working on culturally appropriate measures of socially desirable response bias for this population. A third approach is to use observational data, such as injection partners' observations. However, since many injection drug users share drugs with a variety of partners it may be difficult to obtain valid observational data, and if their injection partners were in the intervention these observations would be subject to experimental demand effects.

Social Influence

Although the results of this network intervention appear promising, the outcome of greater risk reduction in the experimental group as compared with the controls may not necessarily have been due to social influence processes. It is possible, for example, that the group differences were due to individuals in the experimental condition receiving training in risk reduction skills. There were several study findings, however, that do suggest an association between measures of social influence, risk behaviors, and intervention outcome. We have reported on the finding that size of drug network and proportion of network members who inject drugs were significantly associated with needle sharing (Latkin, Mandell, Vlahov, et al., 1995). Also, the number of network members who injected drugs at baseline was found to be significantly associated with indexes' needle sharing, frequency of drug use at baseline, and needle sharing at follow-up.

Other indications of the role of social influence in HIV-related behaviors were found in an analysis of the relationship between the network members' risk behaviors and the indexes' risk behaviors (Latkin, 1995). To examine this association the network mean, excluding the index participant, was first calculated for the five risk behaviors of injecting cocaine and heroin, attending shooting galleries, always cleaning used needles with bleach, and recency of sharing unhygienic needles. These scores were then correlated with the same self-reported risk behaviors of the index participants. Four of the five associations between networks' level of risk behavior and indexes' level of risk behavior were statistically significant (heroin, $r = .25$, $p < .001$; cocaine, $r = .23$, $p < .02$; attending shooting gallery, $r = .22$, $p < .02$; always cleaning used needles with bleach, $r = .22$, $p < .02$; recency

of sharing unhygienic needles, $r = .16$, $p = .08$, $n = 119$). Another indication of the role of social influence in needle sharing was that at baseline perceptions of friends always cleaning used needles was significantly correlated with self-reports of frequency of needle sharing ($r = .33$, $p < .01$) and reports of always cleaning used needles ($r = .24$, $p < .01$).

Intervention and Social Influence

Before the intervention there was no relationship between group assignment (experimental or control) and the association between self-reported cleaning of used needles and reports of friends' cleaning of used needles. After the intervention, at the 18-month follow-up, only 13% of the indexes reported that their friends' behaviors were different from their own behaviors, whereas 36% of the controls reported differences between their own needle hygiene and the behavior of their friends ($\chi^2 = 6.94$, $n = 127$, $p < .01$).

It was hypothesized that the intervention would facilitate changes in the network norms of discussing the topic of HIV/AIDS, and consequently that individuals in the experimental group would discuss it more frequently than those in the control group. Frequency of discussion of HIV/AIDS after the intervention was assessed. At the 3-month follow-up interview 90% of the experimentals and 80% of the controls ($\chi^2 = 2.85$, $n = 153$, $p < .10$) reported discussing AIDS in the prior 6 months. The high proportion of both controls and experimentals reporting discussions of HIV/AIDS suggests a possible ceiling effect.

One strategy participants may have used to alter deleterious social influence was to reduce the frequency of interactions with high-risk individuals. During the intervention some participants reported in the group sessions that they were no longer associating with individuals who continued to insist on sharing needles. These anecdotal reports were verified: there was a statistically significant difference in reduction of size of drug networks for the indexes in the experimental condition as compared to the controls. The mean reduction in the size of drug networks was 2.6 versus 0.8, respectively ($t = 2.14$, $p < .05$). The findings of associations between size of drug network, level of risk behaviors of drug network, and perceptions of network members' risk behaviors suggest that social influence is an important factor in injection drug users' HIV-related behaviors. The greater association between perception of network members' risk behaviors, greater reduction in size of drug network, and a trend toward greater frequency in discussing HIV/AIDS in the experimental group, compared with

the controls, suggest that this network approach for reducing risk behaviors may be mediated by social influence processes.

The data from this study suggest that drug networks are identifiable, and that a proportion of the members of these personal networks are willing to enroll in an experimental intervention for HIV prevention. Those who do enroll report significantly fewer risk behaviors 18 months later. The results suggest that networks may be used to encourage members' health promoting behaviors. However, the study was notable to recruit all the members of drug networks, which may speak of the dynamic nature of drug users' personal networks.

Although the intervention described in this study may not be appropriate for all injection drug users, it holds promise for a group that is difficult to access, build and maintain rapport with, and enroll in health services. It may be useful in future studies to examine personal networks as components of larger social networks and how these networks might be used in promoting community-wide HIV prevention among the inner-city disadvantaged populations who are disproportionately at risk for HIV.

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