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Social Networks of Drug Users in High-Risk Sites: Finding the Connections

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Social network research increasingly expands our understanding of the social environment of drug users' health risks, particularly those associated with the transmission of HIV, hepatitis, and other sexually transmitted and bloodborne infectious diseases. Our study of the networks of drug users who use high-risk sites, where people gather to inject drugs and smoke crack cocaine, is designed to explore the relationships and interactions of drug users in settings in which potential risk occurs, and to assess the opportunity to create prevention linkages. This paper describes the ego-network characteristics and macro-network linkages among a sample of 293 drug users recruited through street outreach and personal drug-use network referral in Hartford, Connecticut. Characteristics of the largest connected component of the network are also described and analyzed. We discuss uses of network analyses as well as implications of network connections for peer-led AIDS prevention intervention conducted in high-risk drug-use sites.

KEY WORDS: HIV; drug users; social networks; drug-use settings; African Americans; Puerto Ricans.

INTRODUCTION

The study of social networks has gained importance in recent years within social and behavioral research on HIV and AIDS. Increasing emphasis on the need to understand better the conditions of risk and viral transmission has drawn many researchers to look more closely at interpersonal relationships, social ties, and interconnections among people who may be exposed to the virus through blood or sexual contact (Friedman *et al.*, 1999; Latkin, 1995a; Rothenberg *et al.*, 1995). Social network research offers a means to map routes of potential viral transfer, to analyze the influence of peer norms and practices on the risk behaviors of individuals, and to trace communication channels through which prevention interventions might diffuse within a social group.

Our study of the places where people go to use illicit drugs, called the Study of High-Risk Drug Use Settings for HIV Prevention (or High Risk Settings [HRS] study), documents the personal (ego-centered) social networks of and interactions among drug users who make use of various kinds of high-risk sites in Hartford, Connecticut (Singer *et al.*, 2001; Weeks *et al.*, 2001). Additionally, we have tracked connections among project participants and their personal network members that form a larger (macro) network of drug users in the city. In this study, we analyze various aspects of the social context of risky drug-use practices and the resulting potential for HIV transmission. We also seek to understand aspects of drug user relationships and social organization that support the development of prevention intervention conducted within drug-use sites. By understanding these relationships, we aim to identify potential peer leaders who use or have access to those sites and train them as peer educators to disseminate prevention messages and materials through network

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and site-use connections to drug users around the city.

This paper describes the process we used to document and analyze drug user social networks in Hartford and the implications of network relationships for HIV risk and promoting prevention within high-risk drug-use sites. We present findings on the characteristics of study participants regarding their personal networks, ties that link these individuals to each other, and the larger connected network evident through mapping these ties among participants. We discuss the implications of our findings for development and dissemination of peer-led HIV prevention approaches conducted within drug-use sites.

SOCIAL NETWORK RESEARCH IN THE STUDY OF HIV/AIDS

Since the mid-1980s, a growing number of researchers have incorporated social network concepts and analyses into the study of drug use and disease transmission among drug users, particularly HIV and sexually transmitted infections (STIs) (Friedman *et al.*, 1999; Klovdahl, 1985; Klovdahl *et al.*, 1994; Latkin *et al.*, 1995a, 1995b; Neaigus *et al.*, 1994; Needle *et al.*, 1995; Potterat *et al.*, 1999). This work emerged from recognition that a focus solely on individual behavior has limited explanatory power to address the emerging and progressive HIV epidemic, even if transmission of the disease is primarily the result of specific risky practices (Auerbach *et al.*, 1994; Des Jarlais and Friedman, 1998; Friedman, 1993; Rhodes and Hartnoll, 1996; Singer and Weeks, 1996). The individual-level approach fails to consider micro-social (e.g., personal network) and macro-level (i.e., network structural) factors that shape patterns of transmission (Klovdahl, 1985), as well as other contextual conditions in the social and political environment (Rhodes and Hartnoll, 1996). Studies have additionally drawn attention to the difficulty of sustaining reduced risk behaviors (Coyle *et al.*, 1998; Des Jarlais *et al.*, 1991; Singer, 1996; Trotter, 1996). These limitations have generally been ascribed to lack of changes in the *social context* and among the *social relationships* in which risk behavior takes place (Des Jarlais and Friedman, 1998; Joseph *et al.*, 1987; Needle *et al.*, 1998; Rhodes and Hartnoll, 1996; Singer and Weeks, 1996; Trotter, 1996; Zapka *et al.*, 1993).

Social network analysis offers a broader approach to prevention than is characteristic of the dominant individual education and counseling methods. In designing HIV prevention that takes into account the social contextual factors affecting individual behavior, a number of models have been developed and tested that target social networks for group-level change. Many of these network interventions are tied to concepts of peer leadership and drug user social organization (Broadhead *et al.*, 1998; Latkin, 1995, 1998; Neaigus, 1998; Trotter *et al.*, 1995; van Ameijden *et al.*, 1992). They can broadly be categorized into two general types of models. The first type is those using peers to disseminate interventions widely through macro-network linkages or snowball contacts, often based on what Friedman and colleagues (1994, p. 100) call "leadership-focused" diffusion models (Broadhead *et al.*, 1995, 1998; Kelly *et al.*, 1992; Latkin, 1998; Latkin and Knowlton, 2000; Valente *et al.*, 1998). The second type of model brings groups of personal (micro) risk networks together to provide intervention to this "peer influence" group collectively (Koester *et al.*, 1999; Latkin, 1995, 1998; Trotter *et al.*, 1995). Both general network intervention approaches begin to address key group-level and social context factors that condition HIV transmission, including peer influence and modeling.

The study of social networks also offers an important framework for understanding the process by which HIV harm reduction practices diffuse through a population, specifically, to what degree and how they are accepted by drug users at the social-network or the peer-group level, as well as how infectious agents like HIV spread (Friedman *et al.*, 1994; Klovdahl, 1985; Rhodes and Hartnoll, 1996; Rogers, 1995; Rothenberg *et al.*, 1995). The diffusion framework meshes neatly with social network theories from both a structural and a relational perspective. As an illustration of this process, diffusion of HIV is conditioned by network structures, such as network density and centrality of infected individuals (Klovdahl, 1985; Rothenberg *et al.*, 1995). Additionally, though peer influences may not be necessary for transmission to occur, the spread of HIV happens within the social context of practices that allow the virus to pass between two people. These practices are defined by specific characteristics of the relationships of dyads or larger groups engaged in risky practices that create opportunities for transfer of the virus (Klovdahl, 1985; Neaigus *et al.*, 1995; Price *et al.*, 1995). Deeper understanding of these factors and processes of HIV transmission and intervention diffusion could greatly enhance efforts to impede the ongoing epidemic.

The High-Risk Settings (HRS) study is designed to look at the ways and degree to which HIV

prevention implemented in high-risk sites can potentially diffuse along drug user network pathways. To assess this possibility, we studied the networks of drug users who entered our project and their ties to other drug users in the city.

METHODS

We documented the social networks of Hartford drug users through a combination of ethnographic interviewing and observation, drug-use site tracking, epidemiological survey, and social network interviewing and tracking. All participants interviewed in this study provided informed consent, and all information about them and their network members was kept confidential. The consent forms (for interviews) and verbal consent procedures (for field observations), our network member recruitment procedures (described below), and our methods to protect data confidentiality were all approved by an Institutional Review Board (IRB). Ethnographic research methods allowed us to document hidden drug injection and crack cocaine utilization sites, to observe the social interactions of people who make use of those sites for drug use or living space, and to assess whether those sites can provide a base for sustainable HIV prevention interventions. The epidemiological and social network surveys allowed us to assess the risks, network connections, and changes in these among a cohort of active drug users, each of whom we attempted to interview three times at 6-month intervals.

The survey sample was constructed through two primary methods. The majority (55%) was recruited through street outreach in neighborhoods of high drug-use activity. Outreach recruitment followed a targeted sampling plan similar to that developed in earlier HIV prevention studies (Singer and Weeks, 1992; Watters and Biernacki, 1989). The rest of the cohort was referred into the study by survey participants through a "respondent-driven" sampling process similar to that outlined by Heckathorn (1997). Specifically, we asked each survey participant if he or she would recruit for us two drug-using network members. Participants made the initial inquiry of their network members, after which staff screened and followed up with those who agreed to participate. Any participants who successfully recruited an eligible network member into the study received a $5 finder's fee. Not all participants referred network members, but some referred two or more individuals. Eligibility criteria for survey participants recruited through any method included being at least 18 years of age and reported active use (in the prior 30 days) of heroin, cocaine/crack, or other injected illicit drug.

The epidemiological component of the survey instrument measured self-reported drug use, HIV risk practices associated with drug use and sexual behavior (e.g., needle/drug-solution use/sharing; unprotected sex, sex-for-money/drugs exchanges, etc.), use of high-risk drug-use sites (namely, the participant's first and second most often used sites), and characteristics of those sites. The social network component of the survey included generating a list of personal network members identified as having a significant relationship with the participant, and measuring characteristics of those listed and their relationship and interactions with the participant.

To generate the name list of their personal network members, we asked survey participants to provide us with full names and/or nicknames of everyone they consider to have been important in their lives over the prior 6 months. We then probed specifically for those with whom they used drugs, had sex, were close, or had conflicts during that period. Interviewers encouraged participants to include family members if they were close to them. The network survey instrument allowed a total of no more than 16 names in order to control the size of the database, but only four participants named that many network members.

After generating the list of personal network names, we asked a series of questions about each network member's characteristics, including sex, ethnicity, age, kind of relationship with the participant (kin, non-kin), and HIV status if known. For our analyses here, we included noncasual sex partners (spouse, lover) as "kin," in addition to blood or other family members. We additionally asked length of time known, frequency of contact in the prior 30 days, trust in and importance of the relationship, drug-use or sexual HIV-risk practices in which the participant and network member engaged together, and mutual use of drug-use sites.

This series of questions provided descriptive information about each participant's close contacts, the kinds and level of HIV-related risk behavior among personal (ego) network members, potential support (economic and social) within the network available to the participant, and other information for which network measures could be calculated (e.g., network size, ethnic/gender/age diversity, intensity and duration of interaction, presence of HIV risk, and so on) (Cochran *et al.*, 1990; Granovetter, 1973; House and Kahn, 1985; Maguire, 1983; Marsden and Lin, 1982;

Mitchell, 1969; Neaigus *et al.*, 1994; Wasserman and Klovdahl, 1994; Zapka *et al.*, 1993). We compared subgroups in the survey sample by ethnicity and gender. We posited that variations in network characteristics based on these factors differentially affect network members' risks of exposure to infectious diseases like HIV, hepatitis, and STIs, their patterns of drug-related and sexual HIV-risk practices, and their receptivity to peer-led efforts to relay and promote HIV prevention (Cochran *et al.*, 1990; Cross, 1990; Wellman, 1981).

To analyze network structures and interrelationships, we imported the information about naming (who named whom), as well as characteristics of the network members (nodes) and their relationships (ties) into a social network data analysis program called UCINET (Borgatti *et al.*, 1999). This program permits us to analyze the network structure of linkages across and within participants' personal networks. We also used UCINET to map out and analyze the larger set of relationships we identified as the macro network of drug users within our study.

To construct this macro network, we systematically identified and verified the network ties among study participants. We did so by using our direct interaction with them in the course of ethnographic field observations, in-depth and survey interviewing, and tracking for follow-up interviews. Our first step in mapping this macro network was to provide field staff with the full name list of survey participants and their personal network members. Additionally, we had permission from most participants in the study to take snapshot pictures of them at intake, which project outreach staff could use for follow-up tracking and to help confirm cross-network membership. Staff reviewed these name lists and photographs, and indicated ties when they could verify that a survey participant was also someone else's network member or that two names were indeed the same person. Staff presence in the community offered the primary means to verify network ties while visiting drug use locations and recruiting or tracking participants for interviews over the 2 years of data collection. When constructing the macro drug network, we only included individuals who participated in the study directly, though these participants named many others on their ego-network lists. We limited our macro network data in this way primarily because we had greater confidence in the personal information provided first hand by study participants for our comparative, HIV risk, and social network analyses. After all linkages we could confirm were demarcated, we used the ego-network and personal information from project participants' survey responses to indicate other characteristics of network members and their relationships, such as HIV status and shared risk.

Once we constructed the macro network, our final task was to use this information to guide identification of a set of individuals who could be recruited and trained as peer educators to disseminate, demonstrate, and support HIV prevention practices among their peers within the network. We determined the smallest number of peer educators required to reach at least 50% of the largest connected component of the macro network, that is, the largest group of connected individuals in the study. (Selection of additional peer educators beyond those needed to reach half of the network resulted in increasingly diminishing returns.) For this exercise we made several assumptions, two most notably. First, we only considered potential diffusion of information to those people mentioned by or who mentioned these peer educators, that is, their direct connections. We chose to focus exclusively on direct ties because of the potential for message degradation to a third party. Second, we proceeded under the assumption that all individuals would have equal skills as a peer educator.

Individuals were selected from the macro network as potential peer educators based on a specific set of criteria. The first person selected was the one with the greatest number of connections to others in the network, whether named by or naming those individuals. Given the goal of reaching as many in the connected component as possible, the most important criterion for selecting subsequent individuals was the number of *new* ties, that is, the number of people that individual could reach who had not already been reached by a previously selected peer educator. During each iteration of the selection process using this criterion, if multiple individuals reported the same number of unduplicated ties, our second criterion was to examine each of these persons' overall network "degree" (defined as the sum of the number of network members the individual mentioned, plus the number who mentioned that individual), including ties already mentioned by other peer educators. Use of the "degree" criterion would allow for a potential booster effect in the population for those individuals who were listed in multiple peer educators' networks. Finally, if multiple individuals were equal on both number of new ties and total number of ties ("degree"), our third criterion was to select the person with the highest network "outdegree" (that is, the number of people they named only). This allowed us

to account for the relative importance of an individual naming someone else in his or her network as opposed to simply being named. After determining the smallest number of peer educators needed to reach half of the connected network component, we examined the characteristics of those chosen. We also examined the composition of the members of the full connected component reachable by the selected peer educators compared to those who were not.

RESULTS

HRS Sample Characteristics and Personal Social Networks

From May 1998 to December 1999, we interviewed 293 participants with the epidemiological/social network survey. The sample consisted of 99 African Americans, 155 Puerto Ricans, and 39 Whites and other ethnic groups (including two Native Americans), of whom 205 were male, 88 were female, and all were active heroin or cocaine users (see Table I). The mean age of survey participants was 37.3 years ($SD = 8.7$ years), and 43% reported that they consider themselves to be homeless at the time of the interview. Eighteen percent reported that they were HIV-positive (testing was not provided in this study), with significant differences in self-reported seroprevalence among ethnic groups: 33% of African Americans reported being HIV-infected, compared to 11% of Puerto Ricans, none of the Whites, and 1 of the 2 Native Americans. Sample members included 160 street (index) recruits and 133 of their network referrals. Participants recruited through street outreach were more likely to be women ($\chi^2 = 11.29$, $p < .001$) compared to those recruited through referral; however, there were no significant ethnic differences by recruitment method nor, among injectors, in injection frequency.

Most survey participants said they used multiple illicit drugs. The primary drug of choice for the majority of participants was injected heroin, followed by crack cocaine, and 75% reported having injected an illicit drug in the prior month. Slightly more than half of the survey respondents reported that their primary (51%) and/or secondary (61%) drug-use sites were open, publicly accessible, or unregulated places such as an abandoned building, park, woods, alleyway, cemetery, or vacant lot. Others in the sample reported using their own or someone else's home or apartment as their primary or secondary site for illicit drug use (Weeks *et al.*, 2001).

In generating the lists of close personal network members (including those who do and do not use drugs), project participants named a mean of 5.6 individuals (range = 1–16, $SD = 3.0$), of whom, on average, they reported 4.5 (range = 0–16, $SD = 2.6$), or 85%, of their personal network members were drug users (see Table II). They named an average of 0.9 (range = 0–9, $SD = 1.6$) kin members in their total networks, including consanguineal and affinal relations, and 0.4 (range = 0–5; $SD = 0.8$) kin members in their drug-using networks. The mean number of years they reported having known their network members was 9.8 years (range = 0–39, $SD = 8.8$ years) and 8.9 years (range = 0–39, $SD = 8.8$) for their drug-using network members. Some of these, both drug-using and non-drug-using, were family members or friends from childhood. Some they reported having known for only a few days or weeks.

Table I. HRS Project Survey Sample Characteristics ($N = 293$)

Ethnicity		Recent drug use (prior 30 days)	
African American	34%	Injected heroin	68%
Puerto Rican/Latino	53%	Smoked crack	55%
White/other	13%	Injected speedball	42%
Sex		Injected cocaine	40%
Male	70%	Sniffed heroin	36%
Female	30%	Sniffed cocaine	13%
Age (years, mean)	37.3	Injected any drug	75%
Currently homeless	43%	Injected drugs yesterday	61%
HIV-positive (self-report)		Primary drug-use-site type ($N = 286$)	
Total ($N = 50$)	18%	Public (abandoned building, park, etc.)	51%
African American ($N = 31$)	33%	Private, own apartment/home	30%
Puerto Rican/Latino ($N = 17$)	11%	Private, other's apartment/home	16%
Recruitment method		Secondary drug-use-site type ($N = 260$)	
Targeted street outreach	55%	Public (abandoned building, park, etc.)	61%
Network referral	45%	Private, own apartment/home	10%
		Private, other's apartment/home	29%

Table II. Personal (Ego) Network Characteristics of the HRS Survey Sample: Differences by Sex in Total and Drug-Using Personal Networks

Personal network characteristic	Total sample ($N = 293$)	Men ($N = 205$)	Women ($N = 88$)
Total network size (mean)	5.6	5.6	5.5
Drug-using network size (mean)	4.5	4.6	4.3
Percent drug users in total network	85%	85%	83%
Kin in network (mean)	0.9	0.8	1.0
Percent kin in total network	15%	14%	19%
Kin in drug-using network (mean)	0.4	0.4	0.4
Percent kin in drug network	11%	9%	13%
Duration of total network (mean years known)[a]	9.8	10.5	8.1
Duration of drug network[a]	8.9	9.6	7.1
Intensity, total network (mean days contacted in last 30)	19.8	19.6	20.3
Intensity, drug-using network	20.1	20.1	20.1
Strength,[b] total network	2.2	2.2	2.1
Strength,[b] drug-using network	2.1	2.1	2.0

[a] Differences in duration of network relations by gender in total networks and drug networks were statistically significant ($p < .05$).
[b] Score is the mean of two scales for relationship strength ranking 0–4 on "How much you trust X" and "How much would it matter if X disappeared from your life tomorrow," with 0 = not at all and 4 = extremely.

We measured the current intensity of their relationships with their network members by asking how many days in the prior month they had had contact with those individuals. On average, participants reported 19.8 days of contact with their total network members ($SD = 8.3$) and 20.1 days with the subgroup of their drug-using network members ($SD = 8.2$). We also asked participants two questions regarding the importance, or strength, of the relationship with each network member, including how much they trust the individual and how much it would matter if that person disappeared tomorrow (both measured with a Likert scale of 0 [not at all] to 4 [extremely]). Participants reported strength of network relationships to average 2.2 for their total networks ($SD = 1.0$) and 2.1 ($SD = 1.1$) for their drug-using networks. We found a correlation between strength and duration of association in both the total networks ($r = .18$, $p < .005$) and drug networks ($r = .13$, $p < .05$), indicating that longer relationships were also stronger. Table II also compares descriptive characteristics of ego networks reported by men and women in the project. Only duration of network ties in both their total and drug-using networks were significantly different by gender ($p < .05$).

Data from our HRS network survey indicate that social network characteristics and social relations within the drug-using population in Hartford differ significantly by ethnicity for most ego-network measures, with the exception of numbers of kin in the personal network (Table III). For example, total network size for African Americans in the sample averaged 7.4 members, while for Puerto Ricans the mean total network was 4.4 members. Personal drug-risk networks (i.e., those using drugs with the participant) named by most survey respondents averaged 5.8 per index among African Americans and 3.7 per index among Puerto Ricans. African-American network relationships were of longer duration than Puerto Ricans', but of less intensity measured in days contacted in the prior 30, and less strength.

The two primary ethnic populations in the study also described differences in the degree to which their personal network members come from within the same ethnic group. African Americans in the survey sample reported that 84% of their network members were also African American, and Puerto Ricans reported that 93% of their network members were also Puerto Rican. These and the other important ethnic differences indicate the need for targeted efforts when designing a social network or peer-led intervention, to include identifying the appropriate number of peer educators and specific individuals needed to reach drug-using networks effectively with prevention messages. The need for and possible ways to target intervention to reach specific ethnic and gender subgroups is further indicated when looking at the macro-connected network of drug users in the study.

Macro Drug-Network Connections in the HRS Survey Sample

To understand better the potential connections among drug users in Hartford and their implications for HIV prevention intervention, we looked at the linkages that formed the macro network of drug users in the HRS study. Despite relatively small name lists of ego networks among survey participants, numerous ties linked many of those interviewed to each other in a broader macro network. This suggests connections that could potentially be used to diffuse intervention information and materials to a wide group of drug users through network ties. Also, some key linking individuals might be appropriate peer educators for providing network-level intervention.

Table III. Personal (Ego) Network Characteristics of the HRS Survey Sample: Differences by Ethnicity in Total and Drug-Using Personal Networks

Personal network characteristic	African Americans ($N = 99$)	Puerto Ricans ($N = 155$)	p values (2-tailed)
Total network size (mean)	7.4	4.4	<.001
Drug-using network size (mean)	5.8	3.7	<.001
Percent drug users in total network	80%	88%	<.05
Kin in network (mean)	1.0	0.9	ns
Percent kin in total network	13%	19%	<.05
Kin in drug-using network (mean)	0.4	0.4	ns
Percent kin in drug network	7%	14%	<.05
Duration of total network (mean years known)	14.8	7.2	<.001
Duration of drug-using network	14.2	6.1	<.001
Intensity, total network (mean days contacted in last 30)	15.6	22.8	<.001
Intensity, drug-using network	15.9	23.1	<.001
Strength,[a] total network	2.0	2.3	<.05
Strength,[a] drug-using network	1.9	2.2	<.01

[a]Score is the mean of two scales for relationship strength ranking 0–4 on "How much you trust X" and "How much would it matter if X disappeared from your life tomorrow," with 0 = not at all and 4 = extremely.

Through the process described above, we identified one major and several minor connected components. The major component was a group of 193 linked individuals, including 109 Puerto Ricans (57% of the connected component), 70 African Americans (36% of the connected component) and 14 Whites/others (7% of the connected component), 148 men (77% of the connected component) and 45 women (23% of the connected component). We also identified three triads, five dyads, and 81 isolates (i.e., no confirmed links to any other project participants). The largest connected component included over half the survey sample (66%). Participants in this component were significantly more likely than other study participants to be male ($\chi^2 = 14.89$, $p < .001$) and less likely to be White ($\chi^2 = 10.04$, $p < .05$). Specifically, 75% of the men, but only 52% of the women in the study were members of the largest connected component. Likewise, 70% of African Americans and 70% of Puerto Ricans, but only 52% of Whites in the sample were members of this component. In addition, whereas total personal network size was not significantly different, the individuals in the largest component did have significantly larger drug networks (with a mean of 4.75 individuals) compared to participants not in that component (who reported a mean of 4.04 individuals) ($t = -2.18$, $p < .05$).

Both the overall size of the connected component and the distribution of ethnic and gender subgroups within it are notable. Figures 1 and 2 illustrate the largest connected component of the HRS macro network by ethnicity and gender using the Pajek software program (Batagelj and Mrvar, 1996). Figure 1 shows that each of the three primary ethnic groups within the component cluster closely to each other, with very few links between them and the other two ethnic clusters. Specifically, eight Whites are relatively close, according to their verifiable reported ties to other survey participants, with only two White individuals providing reported links to the Puerto Rican sector of the connected component and no identified links between this cluster of Whites and the African-American sector. Likewise, the two large African-American and Puerto Rican sectors are linked by only two reported bridges between these sectors. In addition to the clear clustering of participants in the network by ethnicity, Figure 2 shows that men are concentrated in the centers of each of the two primary ethnic clusters and most women are located on the periphery.

After identifying the connected component of 193 people, we used the methods described previously to determine the minimum number of peer educators required to reach at least half of this group. We found that it required 14 individuals to do so. Among the peer educators selected through these incremental steps (first, largest number of new ties, followed by highest network "degree" [total ties in both directions], then highest "outdegree" [only the ties the selected individual named]), it is clear that there was a rapid drop-off in the number of new ties obtained with

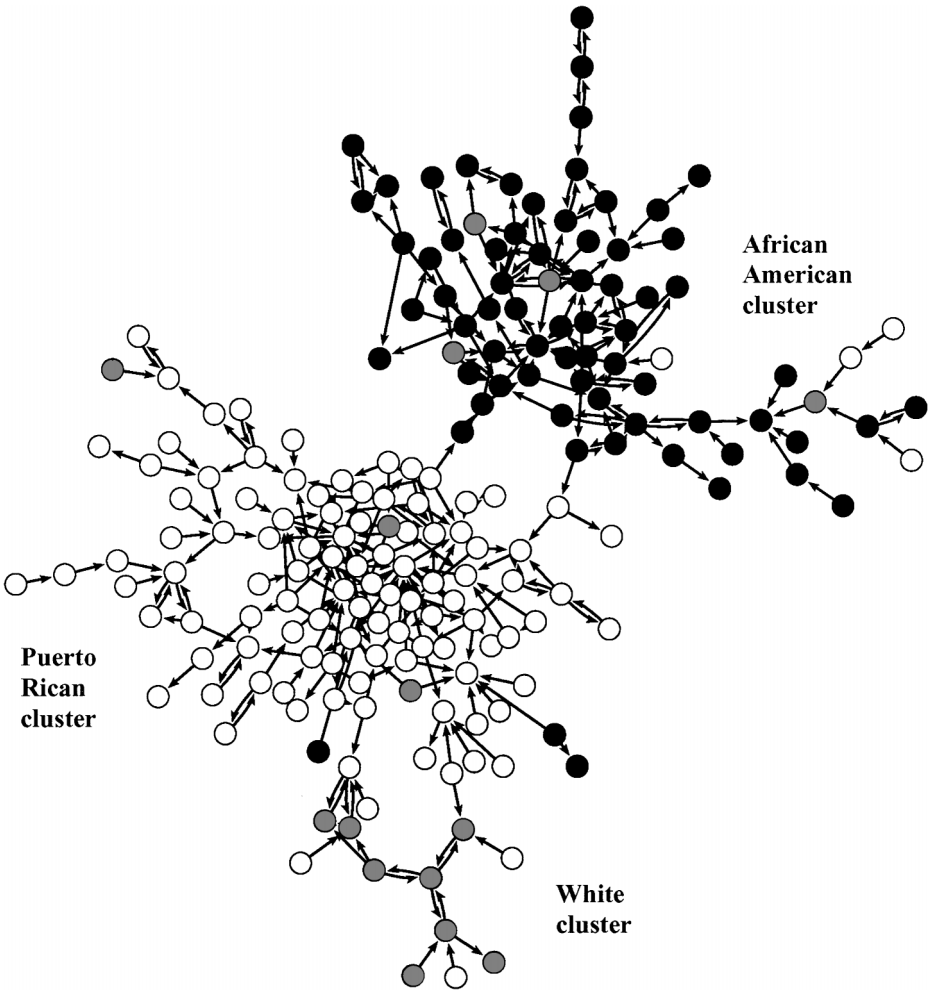

Fig. 1. HRS study macro-network largest connected component by ethnicity. Total $n = 193$: ●, African Americans ($n = 70$); ○, Puerto Ricans ($n = 109$); ◍, Whites/others ($n = 14$).

each new peer educator (see Table IV). In addition, the "degree" of the peer educators selected was significantly higher than the "degree" for the entire sample (mean of 7.9 and 3.5, respectively, $t = 4.78$, $p < .001$). Other details about the peer educators' network characteristics can be seen in Table IV.

A comparison of those selected as peer educators with the total membership of the largest network connected component indicated remarkable similarity between the two groups (see Table V). For example, 21% of the peer educators and 22% of the full connected component were women. Similarly, 57% of both the peer educators and the full network component were Puerto Rican, 36% of both groups were African American, and 7% of both groups were White. Clearly, regarding demographics, the selected peer educators are representative of the largest component as a whole, though this was *not* an explicit criterion for selection. By contrast, however, we identified notable differences between these two groups in HIV seroprevalence and homelessness (two potentially important factors in HIV risk), with the peer educators being less likely to be HIV-infected (14% as compared to 21%) and more likely to be homeless (64% compared to 41%). Although neither of these differences was statistically significant, the differences in homelessness did approach significance ($\chi^2 = 3.37$, $p < .07$).

The 14 selected peer educators were able to reach a total of 97 people in the connected component, which constituted 50% of the network, including 44% of the women and 52% of the men. Furthermore, they were able to reach 53% of the Puerto Ricans, 46% of the African Americans, and 39% of the Whites in

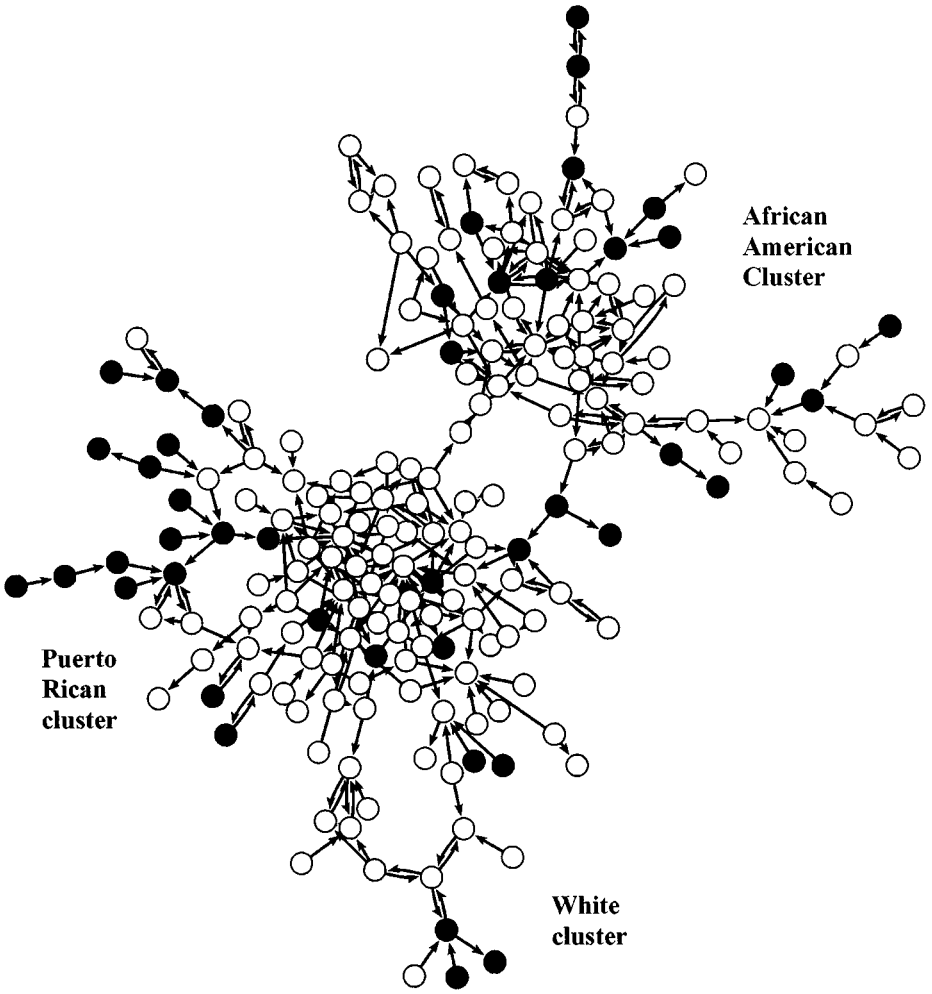

Fig. 2. HRS study macro-network largest connected component by gender. Total $n = 193$: ●, Men ($n = 148$); ○, Women ($n = 45$).

the largest component. Comparing those who were reached to those who were not reached in the large component, we found no statistically significant differences in gender, ethnicity, or risk behavior.

One potential shortcoming of the selection criteria inherent in any social network method is a focus on those who are interconnected, thereby underrepresenting those who are more isolated. In the present study a larger percentage of men than women from the survey sample were present in the largest connected component. This can also be seen in the differences among the people reached in the current exercise. Among the total study sample, including both members of the largest connected component and study participants who were not members of that network, 39% of all men were reached by the 14 selected peer educators, but only 22% of the women. This difference was statistically significant ($\chi^2 = 7.26$, $p < .01$), and suggests greater isolation of women drug users compared to men who use. On the other hand, the differences in ethnicity between those reached by the 14 peer educators and those not reached in the total survey sample were not statistically significant, indicating that membership in the total network was not differentiated by ethnicity.

DISCUSSION

In studying social networks to understand structures of ties that affect HIV transmission and prevention, it remains crucial to take into account the political, economic, and social conditions within which these social networks exist. In Hartford, demographic

Table IV. Order and Criteria for the Selection of Peer Educators from the HRS Survey Sample's Macro-Network Largest Connected Component

	Peer educator characteristics		Selection criteria		
	Ethnicity[a]	Sex	New ties[b]	Degree[c]	Outdegree[d]
PE 1	PR	M	16	16	5
PE 2	AA	M	11	11	3
PE 3	PR	M	9	12	4
PE 4	AA	F	7	7	4
PE 5	PR	M	6	12	1
PE 6	PR	M	6	8	0
PE 7	AA	M	6	6	5
PE 8	PR	F	6	6	2
PE 9	PR	F	5	6	2
PE 10	PR	M	5	6	1
PE 11	AA	M	5	6	0
PE 12	PR	M	5	5	4
PE 13	AA	M	5	5	4
PE 14	W	M	5	5	2

[a]Ethnic groups in the network included Puerto Ricans (PR), African Americans (AA), and Whites (W).

[b]New ties refers to the number of unduplicated ties to other network members, i.e., individuals not named by any previously selected peer educator.

[c]Degree is the sum of a network member's total ties in both directions (i.e., those the participant named and those who named the participant). Because we only included study subjects in the macro-network analyses, "degree" in this table only includes named personal network members who were also participants in the study.

[d]Outdegree is the number of network members the participant named (including in these analyses only those personal network members who were also study participants).

and economic history as well as racial and ethnic antagonisms may account for the segregation of, and some of the comparative differences in, the African-American, Puerto Rican, and White drug-user networks described here. Major African-American migration into the city occurred in the 1930s and 1940s (Sutherland, 2002; White, 2001). Thus, many current African-American city residents grew up with their neighbors, their family members are close by, and even their drug-using partners may have been acquaintances since childhood. This could explain the greater size of personal networks and longer average duration of network relationships among African Americans compared to Puerto Ricans in the study. The largest Puerto Rican migration to the city was much more recent, in the 1970s and 1980s (Sutherland, 2002), which may result, for many, in fewer relations with long-term acquaintances and fewer local ties altogether. Likewise, recent arrival from the island combined in some cases with the language barrier may result in Puerto Ricans having social ties of greater intensity despite their shorter duration. It is possible that the small drug-using ego-network cliques our Puerto Rican study participants described are so intensely interactive and strong because they represent the full support system for these participants. Additionally, racial and ethnic tension helps to maintain the distinct ethnic divisions between Black, Puerto Rican, and White neighborhoods and social networks within the city.

Table V. Comparison of Selected Peer Educators and Total Members of HRS Survey Sample's Macro-Network Largest Connected Component

Demographic and risk characteristics	Peer educators[a] ($N = 14$)	Total connected component ($N = 193$)
Males	79%	78%
Females	21%	22%
African Americans	36%	36%
Puerto Ricans	57%	57%
Whites	7%	7%
HIV-positive	14%	21%
Homeless	64%	41%

[a]Peer educators were drawn from the total connected component based on (1) largest number of unduplicated ties to other network members (new ties), (2) largest number of total ties in both directions (degree), and (3) largest number of network members named (outdegree), in that order.

As we found with this population, other studies have shown that personal and structural network characteristics vary significantly by ethnicity (Bell, 1999; Cross, 1990; Friedman *et al.*, 1999). These variations should be assessed as they differentially affect ethnic subpopulations. Factors like strength of network ties (trust and durability) and centrality of infected individuals have important implications for diffusion of prevention messages, as well as the transmission of HIV, through ethnic subgroups (Friedman *et al.*, 1997, 1999; Klovdahl *et al.*, 1994; Wasserman and Klovdahl, 1994; Weeks *et al.*, 2000). However, the relative absence of kin in most participants' networks, though somewhat more prominent among African Americans and men in this study, suggests that conditions of addiction may jeopardize close relationships regardless of ethnicity or gender.

Despite the relatively small number of named personal network members in all groups, we found a large enough number of verifiable ties to link two-thirds of all the drug users in our study to each other into a macro network of relationships. Drug-use sites create additional linkages among study participants (not indicated here, see Weeks *et al.*, 2002) by participants' mutual use of these locations; these links are also important for understanding potential

diffusion of intervention through drug user networks in the city. Ethnic separation and clustering, evident in the identification of distinct ethnic sectors in the largest connected component, calls for development of HIV prevention intervention that reaches into the core and periphery of each distinct sector, including working with those who act as bridge links between ethnic clusters. It also reaffirms the need to ensure ethnic–cultural appropriateness of messages and messengers to increase the likelihood that prevention information, materials, and practices will be accepted, adopted, and promoted within the network (Singer and Weeks, 1996; Weeks *et al.*, 1995).

In our study of Hartford drug users, we have been able to identify individuals whose strategic location in the largest connected network component suggests they might be effective as peer educators to disseminate prevention information and materials through the network, by virtue of their centrality or the overall number of people with whom they have direct contact. Neither network location nor number of drug-using contacts indicates a person's adequacy as a persuasive communicator or a trustworthy source of information and model practices for harm reduction or HIV prevention. However, these network characteristics do suggest a degree of potential peer influence (if many people name him or her as important in their personal networks) and logistical advantage for diffusing messages to the broadest possible membership of the network group (Kelly *et al.*, 1992; Mitchell, 1969; Rogers, 1995). Lacking the benefit of a full network study, collecting information on personal contacts and repeated mention by others might provide a substitute for identifying such individuals. This approach may be a proxy for the "peer leader" identification method Kelly and colleagues (1992) applied in the circumscribed context of gay bars. No comparably delimited context is available when working in the open (albeit ethnically bounded) context in which urban drug users engage in risk, given the diminishing presence of public "shooting galleries" and crack houses in Hartford (Weeks *et al.*, 2001).

Focusing exclusively on central or highly connected network members, however, has limited potential for reaching more isolated drug users not tied into the network core. This has implications in particular for the more separated ethnic groups (including Whites in the city) and for women, who tend to be fewer in number and less likely to be connected to or represented in the central network structure. Thus, it is important to include some of the more distant individuals as peer educators to extend into marginal sectors of the network, as well as individuals who act as bridges to smaller networks or others not connected to the larger group (Granovetter, 1973). Additionally, use of key individuals, such as drug-use site gatekeepers (Latkin, 1995; Page *et al.*, 1991; Trotter *et al.*, 1995; Weeks *et al.*, 2001), might reach users of some private sites who may be more detached from the broader drug-using network. Furthermore, it is likely that a network design alone is insufficient to gain access to the truly isolated, like women, and that a more widely broadcast media program or specifically targeted outreach approach is perhaps the most effective way to reach these individuals.

The present study has several limitations that could affect its generalizability. Because analysis of social networks rests on the elicitation of names and relationships from study participants, the limitations to this list bear mentioning, as these might affect interpretation of findings. Among drug users in particular, significant people and linkages among them may be missing simply because participants did not list those network members, or because nonconventional naming of people on the streets may impede the ability of field staff to verify network links. The transient nature of many interpersonal interactions in the daily routine of acquiring and using drugs leads drug users to have difficulty remembering some important relationships or knowing the names of some people with whom they interact, even routinely. Moreover, the stigmatized and illegal nature of heroin, cocaine, and other illicit drug use creates the need to protect identities and limit sharing of names for protection from the criminal justice system, and not infrequently from each other. Furthermore, drug users may not assign importance to or fail to remember drug-sharing or equipment-sharing incidents that may have occurred once or rarely, and possibly with a stranger, and might thereby exclude ties that are potentially significant for disease transmission.

Whereas unnamed network ties and possible inaccuracies in the identity of drug-using network comembers limit our ability to illustrate the full macro structure, these limitations suggest an even greater number of linkages than indicated on our diagrams. Even the available information can be used to identify potential diffusion routes for disseminating prevention messages and resources through drug user networks. These data have allowed us the possibility of identifying members of the macro network who may serve as effective peer educators to reach a broad set of drug users at risk in Hartford. In this capacity, these individuals are likely to reach

many more people than suggested by our study data, given the likely number of their unnamed ties and ties to drug users who did not participate in the study.

Analysis of drug user social networks offers a look at some of the factors that shape the context of risks for exposure to HIV and other infectious diseases, or of the acceptance and maintenance of prevention messages. The study of networks further enhances our understanding of individuals and their relationships that influence drug users' ability, willingness, and means to adopt prevention practices. In Hartford, we have been able to document differences in ethnic ties and ethnic divisions that may have contributed to distinct AIDS epidemics in the African-American, Puerto Rican, and White communities of drug users and their contacts in this city. With knowledge of social ties and structural linkages among drug users, we can begin to move beyond individual-centered, behavioristic explanations of HIV risk, transmission, prevalence, and formulas for prevention.

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REFERENCES

Auerbach, J., Wypijewski, C., and Brodie, H. K. H. (Eds.). (1994). *AIDS and behavior: An integrated approach*. Washington, DC: Institute of Medicine.

Batagelj, V., and Mrvar, A. (1996). *Pajek [Spider]: Program package for large network analysis*. Ljubljana, Slovenia: University of Ljubljana. Available at http://vlado.fmf.uni-lj.si/pub/networks/pajek/sunbelt.97/pajekman.htm.

Bell, D. C. (1999, April). *Network relationships among drug users and nonusers*. Presented at the Society for Applied Anthropology Annual Meetings, Tucson, AZ.

Borgatti, S., Everett, M., and Freeman, L. (1999). *UCINET 5 for Windows: Software for social network analysis.* Natick; MA: Analytic Technologies.

Broadhead, R. S., Heckathorn, D. D., Weakleim, D. L., Anthony, D. L., Madray, H., Mills, R. J., and Hughes, J. (1998). Harnessing peer networks as an instrument for AIDS prevention: Results from a peer-driven intervention. *Public Health Reports*, *113*(Supplement 1), 42–57.

Broadhead, R. S., Heckathorn, D. D., Grund, J. C., Stern, L. K. S., and Anthony, D. L. (1995). Drug users versus outreach workers in combating AIDS: Preliminary results of a peer-driven intervention. *Journal of Drug Issues*, *25,* 531–564.

Cochran, M., Larner, M., Riley, D., Gunnarsson, L., and Henderson, Jr., C. R. (1990). *Extending families: The social networks of parents and their children*. Cambridge: Cambridge University Press.

Coyle, S. L., Needle, R. H., and Normand, J. (1998). Outreach-based HIV prevention for injecting drug users: A review of published outcome data. *Public Health Reports*, *113*(Supplement 1), 19–30.

Cross, Jr., W. E. (1990). Race and ethnicity: Effects on social networks. In M. Cochran, M. Larner, D. Riley, L. Gunnarson, and C. R. Henderson, Jr. (Eds.), *Extending families: The social networks of parents and their children* (pp. 67–85). Cambridge: Cambridge University Press.

Des Jarlais, D. C., and Friedman, S. R. (1998). Fifteen years of research on preventing HIV infection among injecting drug users: What we have learned, what we have not learned, what we have done, what we have not done. *Public Health Reports*, *113*(Supplement 1), 182–188.

Des Jarlais, D. C., Abdul-Quader, A., and Tross, S. (1991). The next problem: Maintenance of AIDS risk reduction among intravenous drug users. *International Journal of the Addictions*, *26,* 1279–1292.

Friedman, S. R. (1993). AIDS as a sociohistorical phenomenon. In G. Albrecht and R. Zimmerman (Eds.), *The social and behavioral aspects of AIDS* (pp. 19–36). Greenwich, CT: JAI Press.

Friedman, S. R., Des Jarlais, D. C., and Ward, T. P. (1994). Social models for changing health-relevant behavior. In R. J. DiClemente and J. L. Peterson (Eds.), *Preventing AIDS: Theories and methods of behavioral interventions* (pp. 95–116). New York: Plenum Press.

Friedman, S. R., Neaigus, A., Jose, B., Curtis, R., Goldstein, M., Ildefonso, G., Rothenberg, R. B., and Des Jarlais, D. C. (1997). Sociometric risk networks and risk for HIV infection. *American Journal of Public Health*, *87,* 1289–1296.

Friedman, S. R., Curtis, R., Neaigus, A., Jose, B., and Des Jarlais, D. C. (1999). *Social networks, drug injectors' lives, and HIV/AIDS.* New York: Kluwer Academic/Plenum Publishers.

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, *78,* 1360–1380.

Heckathorn, D. D. (1997). Respondent-driven sampling: A new approach to the study of hidden populations. *Social Problems*, *44,* 174–199.

House, J. S., and Kahn, R. L. (1985). Measures and concepts of social support. In S. Cohen and S. L. Syme (Eds.), *Social support and health* (pp. 83–108). Berkeley, CA: School of Public Health, University of California.

Joseph, J. G., Montgomery, S. B., Emmons, C., Kessler, R. C., Ostrow, D. G., Wortman, C. B., O'Brien, K., Eller, M., and Eshleman, S. (1987). Magnitude and determinants of behavioral risk reduction: Longitudinal analysis of a cohort at risk for AIDS. *Psychology and Health*, *1,* 73–96.

Kelly, J. A., St. Lawrence, J. S., Stevenson, L. Y., Hauth, A. C., Kalichman, S. C., Diaz, Y. E., Brasfield, T. L., Koob, J. J., and Morgan, M. G. (1992). Community AIDS/HIV risk reduction: The effects of endorsements by popular people in three cities. *American Journal of Public Health*, *82,* 1483–1489.

Klovdahl, A. S. (1985). Social networks and the spread of infectious diseases: The AIDS epidemic. *Social Science and Medicine*, *21,* 1203–1216.

Klovdahl, A. S., Potterat, J. J., Woodhouse, D. E., Muth, J. B., Muth, S. Q., and Darrow, W. W. (1994). Social networks and infectious disease: The Colorado Springs study. *Social Science and Medicine*, *38,* 79–88.

Koester, S., Clement-Johnson, A., and Sosa, C. (1999, April). *Ethnography as praxis: The evolution of a socially focused intervention model.* Presented at the Society for Applied Anthropology Annual Meetings, Tucson, AZ.

Latkin, C. A. (1995). A personal network approach to AIDS prevention: A peer group intervention for street-injecting drug users: The SAFE study. In R. H. Needle, S. L. Coyle, S. G. Genser, and R. T. Trotter II (Eds.), *Social networks, drug abuse and HIV transmission* (pp. 181–195). Rockville, MD: National Institute on Drug Abuse.

Latkin, C. A. (1998). Outreach in natural settings: The use of peer leaders for HIV prevention among injection drug users' networks. *Public Health Reports*, *113*(Supplement 1), 151–159.

Latkin, C. A., and Knowlton, A. R. (2000). New directions in HIV prevention among drug users: Settings, norms and networks approaches to AIDS prevention (SNNAAP), a social influence approach. *Advances in Medical Sociology*, *7,* 261–287.

Latkin, C. A., Mandell, W., Oziemkowska, M., Celantano, D., Vlahov, D., Ensminger, M., and Knowlton, A. (1995a). Using social network analysis to study patterns of drug use among urban drug users at high risk for HIV/AIDS. *Drug and Alcohol Dependence*, *38,* 1–9.

Latkin, C. A., Mandel, W., Vlahov, D., Knowlton, A., Oziemkowska, M., and Celentano, D. (1995b). Personal network characteristics as antecedents to needle-sharing and shooting gallery attendance. *Social Networks*, *17,* 219–228.

Maguire, L. (1983). *Understanding social networks*. Beverly Hills, CA: Sage.

Marsden, P. V., and Lin, N. (Eds.). (1982). *Social structure and network analysis*. Beverly Hills, CA: Sage.

Mitchell, J. C. (1969). The concept and use of social networks. In J. C. Mitchell (Ed.), *Social networks in urban situations: Analyses of personal relationships in central African towns*. Manchester, UK: Manchester University Press.

Neaigus, A. (1998). The network approach and interventions to prevent HIV among injection drug users. *Public Health Reports*, *113*(Supplement 1), 140–150.

Neaigus, A., Friedman, S. R., Curtis, R., Des Jarlais, D. C., Furst, R. T., Jose, B., Mota, P., Stepherson, B., Sufian, M., Ward, T., and Wright, J. W. (1994). The relevance of drug injectors' social and risk networks for understanding and preventing HIV infection. *Social Science and Medicine*, *8,* 67–78.

Neaigus, A., Friedman, S. R., Goldstein, M., Ildefonso, G., Curtis, R., and Jose, B. (1995). Using dyadic data for a network analysis of HIV infection and risk behaviors among injecting drug users. In R. H. Needle, S. L. Coyle, S. G. Genser, and R. T. Trotter II (Eds.), *Social networks, drug abuse and HIV transmission* (pp. 20–37). Rockville, MD: National Institute on Drug Abuse.

Needle, R. H., Coyle, S. L., Genser, S. G., and Trotter II, R. T. (Eds.). (1995). *Social networks, drug abuse and HIV transmission*. Rockville, MD: National Institute on Drug Abuse.

Needle, R. H., Coyle, S. L., Normand, J., Lambert, E., and Cesari, H. (1998). HIV prevention with drug-using populations—Current status and future prospects: Introduction and overview. *Public Health Reports*, *113*(Supplement 1), 4–18.

Page, J. B., Smith, P. C., and Kane, N. (1991). Shooting galleries, their proprietors, and implications for prevention of AIDS. *Drugs and Society*, *5,* 69–85.

Potterat, J. J., Rothenberg, R. B., and Muth, S. Q. (1999). Network structural dynamics and infectious disease propagation. *Journal of Sexually Transmitted Diseases and AIDS*, *10,* 182–185.

Price, R. K., Cottler, L. B., Mager, D., and Murray, K. S. (1995). Injecting drug use, characteristics of significant others, and HIV risk behaviors. In R. H. Needle, S. L. Coyle, S. G. Genser, and R. T. Trotter II (Eds.), *Social networks, drug abuse and HIV transmission* (pp. 38–59). Rockville, MD: National Institute on Drug Abuse.

Rhodes, T., and Hartnoll, R. (1996). *AIDS, drugs and prevention: Perspectives on individual and community action*. London: Routledge.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.

Rothenberg, R., Woodhouse, D. E., Potterat, J. J., Muth, S. Q., Darrow, W. W., and Klovdahl, A. S. (1995). Social networks in disease transmission: The Colorado Springs Study. In R. H. Needle, S. L. Coyle, S. G. Genser, and R. T. Trotter II (Eds.), *Social networks, drug abuse and HIV transmission* (pp. 3–19). Rockville, MD: National Institute on Drug Abuse.

Singer, M. (Ed.). (1996). Evaluating the efficacy of HIV prevention among drug users: Models, methods, and measures. *Journal of Drug Issues* (Special Issue), **26**(3).

Singer, M., and Weeks, M. R. (1992). *Hartford target sampling plan*. Hartford, CT: Community Alliance for AIDS Programs, Hispanic Health Council.

Singer, M., and Weeks, M. R. (1996). Preventing AIDS in communities of color: Anthropology and social prevention. *Human Organization*, *55,* 488–492.

Singer, M., Scott, G., Wilson, S., Easton, D., and Weeks, M. R. (2001). "War Stories": AIDS prevention and the street narratives of drug users. *Qualitative Health Research*, *11,* 589–611.

Sutherland, J. (2002). Immigration. In *Connecticut's heritage gateway: Encyclopedia: Topical surveys*. Available at http://www.cthum.org/encyclopedia/topicalsurveys/immigration.htm.

Trotter II, R. T. (Ed.). (1996). *Multicultural AIDS prevention programs*. Binghamton, NY: Haworth Press.

Trotter II, R. T., Bowen, A. M., and Potter, J. M. (1995). Network models for HIV outreach and prevention programs for drug users. In R. H. Needle, S. L. Coyle, S. G. Genser, and R. T. Trotter II (Eds.), *Social networks, drug abuse and HIV transmission* (pp. 144–180). Rockville, MD: National Institute on Drug Abuse.

Valente, T. W., Foreman, R. K., Junge, G., and Vlahov, D. (1998). Satellite exchange in the Baltimore Needle Exchange Program. *Public Health Reports*, *113*(Supplement 1), 90–96.

van Ameijden, E. J. C., van den Hoek, J. A. R., van Haastrecht, H. J. A., and Coutinho, R. A. (1992). The harm reduction approach and risk factors for human immunodeficiency virus (HIV) seroconversion in injecting drug users, Amsterdam. *American Journal of Epidemiology*, *136,* 236–243.

Wasserman, S., and Klovdahl, A. S. (1994). *Social networks, drug abuse and HIV transmission*. Bethesda, MD: National Institute on Drug Abuse.

Watters, J. K., and Biernacki, P. (1989). Targeted sampling: Options for the study of hidden populations. *Social Problems*, *36,* 416–430.

Weeks, M. R., Schensul, J. J., Williams, S. S., Singer, M., and Grier, M. (1995). AIDS prevention for African American and Latina women: Building culturally and gender appropriate intervention. *AIDS Education and Prevention*, *7,* 251–264.

Weeks, M. R., Clair, S., and Borgatti, S. P. (2000, April). *High-risk sites and drug user social networks: Linkages for HIV transmission.* Paper presented at the 20th Annual Sunbelt International Social Network Conference, Vancouver, BC, Canada.

Weeks, M. R., Clair, S., Singer, M., Radda, K., Schensul, J. J., Wilson, D. S., Martinez, M., Scott, G., and Knight, G. (2001). High-risk drug use sites, meaning and practice: Implications for AIDS prevention. *Journal of Drug Issues*, *31,* 781–808.

Weeks, M. R., Borgatti, S. P., Clair, S., Martinez, R., and Rooks, R. (2002, February). *Linking people through places: Drug user social networks and connections through drug-use sites*. Paper presented at the 22nd Annual Sunbelt International Social Network Conference, New Orleans, LA.

Wellman, B. (1981). Applying network analysis to the study of support. In B. H. Gottlieb (Ed.), *Social networks and social support* (pp. 171–200). Beverly Hills, CA: Sage.

White, D. O. (2001). Blacks in Connecticut. In *Connecticut's heritage gateway: Encyclopedia: Topical surveys*. Available at http://www.cthum.org/encyclopedia/topicalsurveys/blacks.htm.

Zapka, J. G., Stoddard, A. M., and McCusker, J. (1993). Social network, support, and influence: Relationships with drug use and protective AIDS behavior. *AIDS Education and Prevention*, *5,* 352–366.