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An Investigation of the HIV Risk Behaviors of Drug Use Networks[1]

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Introduction

The risk of acquired immune deficiency syndrome (AIDS) among intravenous drug users and their sexual partners remains one of the most critical health problems facing the United States. The proportion of the national AIDS caseload composed of individuals who have acquired the human immunodeficiency virus (HIV) through the use of contaminated syringes or as the result of having sex with an intravenous drug user continues to grow. In some major metropolitan areas, the number of AIDS patients who have acquired the disease through behaviors associated with intravenous drug use now exceeds the number of individuals who became infected as the result of male to male sexual transmission (Metzger *et al.*, 1991). The risk of HIV infection either directly or indirectly as the result of intravenous drug use is greatest among those in American society least able to cope with the consequences of disease. Minority poor residing in the nation's urban centers are most at risk of succumbing to AIDS (Friedman, *et al.*, 1987; Friedland & Klein, 1987; Newmeyer, 1988; Curran *et al.*, 1988). A number of

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behavioral or sociodemographic variables have been found to be associated with a higher risk of HIV infection due to drug injection. Among the behaviors and conditions implicated are: minority status (Hahn *et al.*, 1989; Friedman, *et al.*, 1990), frequency of drug injection (Schoenbaum, *et al.*, 1989; Marmar, *et al.*, 1987), years of injection (Schoenbaum, *et al.*, 1989), number of persons with whom syringes are shared (Friedland & Klein, 1987; Des Jarlais, 1992), use of a shooting gallery (Chitwood, *et al.*, 1990; Friedman *et al.*, 1990), use of injected cocaine (Chaisson, *et al.*, 1989; Kahlsa *et al.*, 1992), and homelessness (Siegal *et al.*, 1991).

Variation in the risk of HIV infection associated with injection drug use demonstrates that not all injection drug users are at equal risk of infection. Some injectors are more likely to become infected than others. Drug injection is a not a simple act. Studies have found that the injection of drugs, not to mention the lifestyle of an injection drug user, is a complex set of social behaviors and interactions (Watters, 1988; 1989; Grund *et al.*, 1991; Singer *et al.*, 1992). The circumstances of the drug injection scene and who is present when drugs are injected can influence the dynamics of disease transmission (Battjes *et al.*, 1989; van den Hoek *et al.*, 1989; Grund *et al.*, 1991; Friedman *et al.*, 1992). If the act of injecting involves more than one person, a number of behavioral norms and customs may become involved (Williams & Johnson, 1993; Zule, 1993). Who injects, how much each participant injects, the order of injection, and whether or not a needle is cleaned, among other behaviors, are regulated by a complex set of rules recognized by most injectors. Each "rule," such as who injects first is determined by who contributed most to purchasing the dosage, may potentially have an effect on the transmission of HIV.

Our increasing knowledge of the factors and circumstances associated with HIV infection has not increased our understanding of the dynamics of transmission or of risk of the disease (Samuels, *et al.*, 1992). Our lack of understanding is, to a large degree, due to the absence of a strong theoretical perspective from which to relate our increasing knowledge of the micro level factors associated with HIV infection to the macro level dynamics of the epidemic. A theory of social networks has been used to explain other phenomena related to drug abuse and may hold promise in the investigation of drug use and HIV infection (Kandel & Davies, 1991; Fraiser & Hawkins, 1984a; 1984b; Wills, 1990). However, if social network theory is to have an relevance to our understanding of the dynamics of HIV infection among drug users, then, at minimum there must be a relationship between how networks are structured and level of HIV infection within an at risk population (Klovdahl, 1985). The purpose of this paper is to present the results of an investigation of the structures of intravenous drug use networks in three cities in the Unites States and Puerto Rico. The cities participating in the study were Rio Piedras, Puerto Rico, Houston, Texas and Dayton/Columbus, Ohio. The HIV infection rate among injection drug users in Rio Piedras, Puerto Rico is reported at 60% of drug injectors or higher (Robles *et al.*, 1992). By comparison, the rates of HIV infection among drug injectors in Houston, Texas and Dayton/Columbus, Ohio are about 6% and 1% respectively (Williams, 1990; Siegal *et al.*, 1991). Prior to beginning the study, it was hypothesized that there would be significant variation in network structures among drug injecting networks in Rio Piedras and the other two cities.

Data Collection

Data used in this study were abstracted from a larger study of out-of-treatment drug users in the United States and Puerto Rico. Data were collected in Dayton/Columbus, Ohio, Houston, Texas, and Rio Piedras, Puerto Rico. To be eligible to participate in data collection activities, study participants were required to have injected a drug or smoked crack cocaine at least once during the 30 days before participation, have a positive urine screen for cocaine or opiates or show evidence or recent track marking, and not have been in drug treatment during the month preceding participation. In addition to these criteria, participants were required to be 18 years of age and recruited from selected geographic areas (Watters and Biernacki, 1989) Study participants were recruited by trained outreach workers and by referral from participants who had previously interviewed with the study. The method used for recruitment resembles a modified snowball sampling technique (Kaplan *et al.*, 1987; Lee, 1993). Prior to participation in the study, all individuals were asked to sign an informed consent form. All study participants were provided the opportunity to participate in HIV prevention programs and to be tested for HIV infection at no cost to themselves.

Data were collected using the Risk Behavior Assessment (RBA) and the Social Network Questionnaire (SNQ). The RBA was developed by the National Institute on Drug Abuse as a method for collecting HIV infection risk data related to drug abuse and sexual behaviors at the community level. The instrument was designed to collect demographic, drug use, needle sharing, sexual behaviors, and medical and drug treatment history data. The reliability and validity of the RBA have been found to be quite high (Needle *et al.*, 1993; Weatherby, *et al.*, in press). The SNQ was developed as a supplement to the RBA. This short interview was designed to assess the strength and characteristics of drug use network linkages and the context in which drug use occurs. Questions developed to assess linkages among drug users included the number, characteristics, and types of drug use relationships of the respondent. To be consistent with the RBA, the time frame of the SNQ was limited to the 30 days before the interview. Therefore, all network relationships solicited by the SNQ are those relationships in which the respondent participated during the 30 days prior to being interviewed. As the SNQ was developed as a supplement to the RBA, data about networks were collected from the perspective of the respondent. Data could not be linked from one respondent to others in the same drug use networks. Nor was data collected from all members of a respondent's network.

Interviews were conducted in private settings by trained interviewers. Most interviews took place at locations convenient to the respondent. Interviewers were trained to use both the RBA and the SNQ. Although the SNQ was developed as a supplement to the RBA, time of administration varied from site to site. Some sites chose to administer the SNQ immediately after the RBA. Others chose to collect SNQ data during a separate session, usually one week after the administration of the RBA when respondents returned for HIV test results. Respondents were paid for the time spent responding to both questionnaires, although method and amount of payment varied from site to site. The usual gratuity for participating in the study was $10.

Data Analysis

Network data collected were egocentric or unlinked among members of the same networks. Unless otherwise indicated, the level of analysis for this study was the network. Data presented by the respondent on drug use contacts during the previous 30 days were aggregated

to the network level. Specifically, the analysis sought to characterize the number and frequency, strength, and heterogeneity of drug use linkages within networks. Only drug use relationships are presented. The data does not include relationships the respondent may have with others with whom he or she did not use drugs in the thirty days before data collection. Number and frequency of network linkages were assessed by the number of drug use contacts reported by the respondent and the frequency of drug use within the network. Heterogeneity of network linkages was assessed by gender, age groups, race/ethnicity, and drug use. Strength of network linkages was measured by the length of time that members of a network had used drugs with each other. In addition to these variables, needle sharing and sexual relationships within a drug use network were measured.

Two measures of the number and frequency of drug use linkages were used. A categorical variable ranging from one, indicating a drug use network of only the respondent, to five or more members was used to measure the number of individuals reported in a network. The frequency of drug use contact with other drug users was measured by a categorical variable ranging from less than or equal to 3 times a month to 4 or more times daily. As well, frequency of drug use was measured by a categorical variable ranging from three or fewer times per month to twice or more daily. Strength of drug use links was measured by the average duration of time the respondent reported having used drugs with each network member. Duration of time was measured by a categorical variable ranging from six or fewer months to greater than four years.

Network heterogeneity was assessed by gender, age group, race/ethnicity and drug use within the reported network. Gender of a network was measured by whether members of a network were all male, all female or were both male and female. Age groups were categorized into broad groups: 30 years and younger, 31 to 40, 41 to 50, and 51 years or older. Because the exact ages of a respondent's drug use contacts were not requested, a network's age group was assessed to be the same if the ages of the members were within one group. Race/ethnicity of a network was measured to be the same if all members were of the same racial/ethnic group. Drug use of the network was measured by the drugs, either intravenous drugs or crack cocaine, a respondent reported he or she used with other members of his or her network.

Three HIV risk variables were also analyzed: receiving a used needle from a network contact, giving a needle to a network contact, and having sex with a network contact. Unfortunately, the SNQ asked only if the respondent had given or received a needle or had sex with a network member and did not request frequency or duration of the behavior. All three risk variables were measured as categorical variables ranging from zero to greater than or equal to two risk contacts within the network.

All sample characteristic and network variables were investigated controlling for each city. Preliminary analysis of the data controlling for site had shown that there were significant variations in the data depending on the city in which the data were collected. Sample and network characteristic data were analyzed using contingency tables and chi square tests of significance. The interrelationship of network characteristics was investigated using Pearson correlation coefficients. The site where data were collected was not controlled in the correlational analysis.

Respondent Characteristics

The sample included 192 respondents reporting 275 drug use linkages. Data were obtained from 76 networks in Houston, 59 in Dayton/Columbus, and 57 in Rio Piedras. As shown in Table 1, demographic characteristics of the respondents in the sample varied across most variables by site. There were no statistically significant differences among the sites as to the gender of the respondents. On the remainder of the demographic variables presented in Table 1, the sample varied depending on where the data were collected. All respondents in Rio Piedras (RP) were Puerto Rican. Two-thirds of the sample collected in Dayton/Columbus (D/C) were African-American and one-third White. Sixty-four percent of the Houston (H) respondents were African-American, 19% Hispanic of Mexican descent and 17% White.

The average age of respondents in the study was 34.2 years in Rio Piedras (sd=7.0), 38.2 years in Houston (sd=7.8), and 39.8 years in Dayton/Columbus (sd=8.7). The largest number of respondents in Rio Piedras and Dayton/Columbus were between the ages of 31 and 40 years. The greatest proportion of respondents in Houston were between the ages of 41 and 50 years. The level of educational attainment was highest among participants in Dayton/Columbus. Almost two-thirds of the Dayton/Columbus sample had completed high school, a GED program, or continued their education after high school. Forty-six percent of the Houston sample and 40% of the Rio Piedras sample reported having a high school education or greater. Forty-six percent of the Houston sample reported less than a high school, but more than an eighth grade education. Forty percent of the Rio Piedras sample had less than an eighth grade education.

Most respondents at all three sites reported that they were not married at the time of the interview. However, how respondents classified their non-marital status varied significantly among the three cities. The greatest number of respondents in Houston and Dayton/Columbus reported that they were single at the time of the interview. The largest proportion of respondents in Rio Padres reported that they were separated. The majority of respondents in Dayton/Columbus and Rio Piedras reported living in their own house or apartment, 47% and 57% respectively. The majority of respondents in Houston, 57%, reported living in someone else's house or apartment. The Rio Piedras sample had the greatest proportion of participants reporting that they lived on the streets, 7%. Yet, only 9% of the Rio Piedras sample considered themselves homeless, compared to 21% in Houston and 23% in Dayton/Columbus.

Injection drug use in the 30 days before the study was limited to either heroin, cocaine, or heroin and cocaine. Patterns of cocaine or heroin injection varied significantly among the samples. The primary drug injected by 70% of the participants in Houston was cocaine. Most respondents in the Puerto Rico sample reported injecting heroin and cocaine mixed together. The majority of respondents in Ohio, 55%, reported injecting heroin and cocaine mixed together. Seventeen percent reported injecting cocaine.

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS (N=225)

	D/C	H	RP
Gender p<.13	(n=70)	(n=85)	(n=70)
male	.74	.62	.76
female	.26	.38	.24
Race/Ethnicity p<.000			
African-American	.67	.64	
Hispanic		.19	1.00
White	.31	.17	
Age p<.000			
≤30	.13	.19	.34
31-40	.47	.38	.50
41-50	.29	.40	.13
≥51	.11	.04	.03
Education p<.000			
< 8th grade	.06	.08	.40
<High school	.31	.46	.20
High school	.30	.31	.27
>High school	.33	.15	.13
Marital status p<.000			
single	.33	.44	.26
married	.30	.20	.20
separated	.10	.18	.43
divorced	.21	.12	.10
widowed	.03	.06	.01
Living arrangements p<.000			
own house/apartment	.47	.24	.57
somone else's house/apartment	.37	.57	.34
hotel/halfway house/shelter	.13	.13	.15
streets	.03	.05	.07
Homeless p<.051			
no	.77	.79	.91
yes	.23	.21	.09
Injected drug use p<.000			
cocaine	.18	.70	.04
heroin	.27	.13	.09
cocaine/heroin	.55	.17	.87

Analysis

Network Characteristics

The average size of the networks reported by participants in the 30 days before being interviewed was 2.43 persons. As shown in Table 2, network size did not vary among the sites ($p<.066$). Approximately 15% of the sample reported injecting drugs with no other person and therefore, had a network size of one. Twenty-eight percent reported a network size of two people, 20% a network size of three people, 17% a network size of four to five people, and 17% a network size of six or more people. Individuals who reported a network size of one were excluded from further analysis.

TABLE 2. CHARACTERISTICS OF DRUG USE CONTACTS

	D/C	H	RP
Network size p<.07	(n=70)	(n=85)	(n=70)
1	0.16	0.11	0.19
2	0.21	0.24	0.39
3	0.17	0.18	0.21
4-5	0.24	0.27	0.11
≥6	0.21	0.2	0.1
Age p<.37	n=59*	n=76*	n=57*
Same age group	0.2	0.25	0.32
Mixed age group	0.8	0.75	0.68
Race/Ethnicity p<.001			
Same racial group	0.78	0.76	0.98
Mixed racial group	0.22	0.24	0.02
Gender p<.001			
Single gender	0.22	0.33	0.47
Mixed gender	0.78	0.67	0.53
Drug use p<.000			
IV only	0.31	0.25	0.51
IV and crack	0.7	0.75	0.49
Average time respondent used with others in the network p<.21			
≤6 months	0.22	0.20	0.40
7-12 months	0.15	0.13	0.14
1-2 years	0.12	0.17	0.11
2-4 years	0.12	0.18	0.12
> 4 years	0.39	0.32	0.23
Average time as a bivariate measure p<.018			
≤ 6 months	0.22	0.2	0.4
> 6 months	0.78	0.8	0.6
Frequency of drug use interactions with others in the network p<.001			
≤monthly	0.29	0.26	0.04

weekly	0.39	0.41	0.18
daily	0.18	0.2	0.24
>daily	0.14	0.13	0.54

Received a syringe from a network member p<.092

No	0.71	0.68	0.7
1	0.17	0.11	0.23
≥2	0.12	0.21	0.07

Gave a syringe to a network member p<.066

No	0.66	0.65	0.63
1	0.19	0.11	0.26
≥2	0.15	0.25	0.11

Sexual relationships with network members p<.000

None	0.46	0.49	0.84
1	0.49	0.38	0.12
≥2	0.05	0.13	0.04

*excludes networks with only one member

The average frequency of drug use within a network varied significantly by site (p<.000). The majority of networks in Rio Piedras, 57%, reported using drug together two or more times daily. The majority of networks in Dayton/Columbus and Houston reported using together weekly or less, 61% and 67% respectively. The differences in average frequency of network drug use is reflected in the frequency of drug use interaction between the respondent and individual members of the network. The majority of respondents in Rio Piedras reported using drugs with other network members two or more times daily. The majority of respondents in the Ohio and Texas samples reported using drugs with other network members once a week or less, 68% and 67% percent respectively.

There were no differences in the average length of time respondents reported using drugs with their networks (p<.210). Twenty-seven percent of respondents reported using with network members an average of six months or less. Fourteen percent reported using with their network 7 to 12 months, 14% one to two years and 15% an average of two to four years. Thirty-one percent of respondents reported using with their network for more than four years. Although there was no statistically significant difference in the average time a respondent reported using with his or her network when average time was investigated as a categorical variable, when average time was coded as a dichotomous variable ranging from six months or less to greater than six months, a significant difference among the sites did emerge (p<.000). Forty percent of the networks in Rio Piedras reported using drugs with their networks an average of six months or less compared to 22% in Dayton/Columbus and 20% in Houston.

Network heterogeneity varied significantly among the samples. Only the age groups of those in the networks did not vary significantly (p<.370). Approximately two-thirds of the networks were composed of members from at least two age categories. A higher proportion of networks in Dayton/Columbus and Houston were composed of both men and women than in the Rio Piedras sample, (p<.001). Fifty-three percent of the networks in Rio Piedras were single gender networks, compared to 22% in Ohio sample and 30% in the Texas. Networks in which both intravenous drug use and crack cocaine use linkages were reported was high in Dayton/Columbus, 70%, and Houston, 75%. The high rate of both intravenous and crack cocaine

linkages in Ohio and Texas varied significantly from Puerto Rico. Forty nine percent of the networks in the Rio Piedras sample reported both intravenous and crack cocaine linkages ($p<.000$). The proportion of networks reporting only intravenous drug use in Rio Piedras was 51%.

There was no statistically significant difference among networks at the three sites in regard to the respondent reporting that he or she received a needle in the previous thirty days from another network member ($p<.092$). Approximately 30% of study participants reported receiving at least one needle from another network member. Nor was there a statistically significant difference in the number of networks in which the respondent reported giving a needle to another network member ($p<.066$). About two-thirds of the networks did not involve the respondent giving a needle to another drug user within the network. Seventeen percent of the networks involved the respondent giving a needle to at least one other network member and 17% to two other network members. There was a statistically significant difference among the sites in regard to the number of networks where the respondent reported one or more sexual linkages with other network members ($p<.018$). The majority of networks in Dayton/Columbus, 54%, and Houston, 51%, involved a sexual relationship. Only 16% of the networks in Rio Piedras involved sexual relationships among network members.

TABLE 3. CORRELATION OF NETWORK CHARACTERISTICS

	G	A	R	NS	AT	AF	GS	SR
Gender (G)								
Age (A)	.22*							
Race/ethnicity (R)	.19*	.14						
Network size (NS)	-.19*	-.24**	-.06					
Average time (AT)	-.08*	.06	.09	-.11				
Average frequency (AF)	-.17	.04	-.10	-.08	.01			
Gave syringes (GS)	.19*	.17	.26**	-.07	.04	-.01		
Received syringes (RS)	.27**	.18	.17	-.06	.04	-.06	.82**	
Sexual relationship (SR)	.51**	.17	.20*	-.10	-.03	-.14	.12	.23*

As shown in Table 3, a number of network characteristics investigated were interrelated. A network of mixed gender was positively correlated with network linkages with more than one age group ($r=.22$, $p<.01$) and more than one racial/ethnic group ($r=.19$, $p<.01$). However, a network with both men and women was negatively correlated with network size ($r=-.19$, $p<.01$). Networks with mixed gender linkages were positively correlated with all three HIV risk behaviors investigated, the respondent giving needles to another network member ($r=.19$, $p<.01$), the respondent receiving needles from another network member ($r=.27$, $p<.001$), and the respondent having a sexual relationship with another member of the network ($r=.51$, $p<.001$). Network size was negatively correlated with networks composed of more than one age group ($r=.24$, $p<.001$). Networks composed of more than one racial/ethnic group were positively correlated with a respondent reporting he or she gave needles to ($r=.26$, $p<.001$) and had a sexual relationship with another network member ($r=.20$, $p<.01$). Giving and receiving needles within a network were very highly interrelated. Giving a needle to another network member and receiving a needle from another network member had a correlation coefficient of .82 ($p<.001$). Although having a sexual relationship with a network member was not correlated with giving

a needle to another network member, having a sexual relationship and receiving needles from another network member were positively correlated ($r=.23$, $p<.001$). Two variables, the average time network members had been using with each other and the average frequency network members used drugs together were not found to be significantly related to any other variable in the analysis.

Summary and Discussion

There are a number of limitations to this study and, as a result, the findings must be interpreted with caution. The sample used was not derived using a random sampling procedure. The assessment relied on modified snowball sampling techniques. The degree to which the sample is representative of drug injectors in the three cities can only be vaguely estimated. Therefore, the generalizability of the findings is unknown. The relative age of the respondents in this sample would suggest that participants were more likely to have been less mobile than younger drug injectors. Recruitment for this study was strongly tied to recruitment measures used for the HIV risk behavior assessment, of which this smaller study was only a part. A requirement of the risk behavior assessment was that participants were to be relocated at six months after intake for re-evaluation. The requirement that study participants be relocated for the re-assessment may have had the unwitting consequence of excluding drug users who were less stable and far more likely to have had drug use linkages with a larger number of more varied people than those in the sample. As well, the time frame of data collection, 30 days before the interview, may have had the effect of obscuring relationships or behaviors that are relatively rare. As the respondents in the study were not linked to other members of their networks, the degree to which the respondents were reporting the same networks is unknown. It is possible individuals reported data on the same networks. However, given these limitations, the study does provide worthwhile information and suggests some potentially meaningful avenues for further investigation.

Differences in network characteristics between the Rio Piedras and the other two samples, given the significantly different rates of HIV infection among drug injectors in Puerto Rico, Ohio, and Texas, would suggest that network structures are related to rates of infection. The homogeneity of networks in Rio Piedras may have the effect of removing barriers that inhibit forming weak drug use linkages. The heterogeneity of networks in Texas and Ohio, on the other hand, may have the opposite effect. African-Americans in Texas and Ohio may be reluctant to inject with Whites or Hispanics. Hispanics may be reluctant to inject with Whites or Blacks, and so forth. Men and women, particularly if they have a sexual relationship, may be reluctant to inject with someone who is not a current network member (see Williams & Johnson, 1993). For example, it would be expected that there would be far less sexual tension in single gender than in mixed gender drug use networks. The lack of sexual tension within single gender networks may act to facilitate the formation of new drug use contacts outside the existing network membership. The larger number of drug use relationships of six months or less in the Rio Piedras sample would support such a speculation. As well, the frequency of drug use interaction within the network in Rio Piedras would also tend to support the formation of new, weak link relationships. Injecting one or more times daily likely presents a situation in which it is much more difficult to coordinate drug use activities with others network members. If such is the case, it may be a matter of practicality and far easier to use with whomever is present. Although it requires more analysis, homogeneity of network structures may actually facilitate

the formation of weak drug use relationships and, thereby, once introduced into a network, the transmission of HIV.

The greater proportion of weak contacts and the frequency of drug use interactions in the Puerto Rico sample suggest that there may be a multiplicative effect among these two network measures. If duration of relationships is short and frequency of drug injection is high, the effect of each would seem to be amplified by the other. There are a number of ways to assess this possibility controlling for the duration of drug use among injectors within a network and the frequency of injection using a multi-site sample. Such a study would increase our understanding of the effects of the two network structures on HIV transmission.

Interrelationships between network characteristics, risk behaviors, and between network characteristics and risk behaviors suggest that networks having different characteristics have different risk profiles. While risk of HIV infection in Puerto Rico may be more related to the frequency of injection and brief relationships among homogenous network members, in Texas and Ohio, risk within a network may be more related to syringe sharing and sexual behaviors among heterogeneous members. For example, respondent reports of receiving and giving needles and a sexual relationship between network members were interrelated with measures of network heterogeneity. This suggests that the risks of infection in a heterogeneous network may be more related to the strength of the relationships, rather than the weakness. It is not uncommon for those investigating risk behaviors to hear of needle sharing between sexual intimates. Such sharing, because of the emotional bond involved, is usually not considered sharing or a behavior that puts the participants at risk of infection by those involved (Williams & Johnson, 1993). A multi-site investigation of the inter-relationship between the risks of transmitting HIV and network characteristics may provide a much better understanding of rates of transmission in diverse geographic areas.

The need for longitudinal studies of network linkages among drug users at risk for HIV infection is great. Short term, egocentric studies are helpful, but are not capable of collecting information on a number of important network characteristics. Although a significant number of respondents in this study from all three cities reported sharing syringes, the rate of HIV infection is far higher in Rio Piedras than in either Houston or Dayton/Columbus. One place to begin looking for differences which may account for the variation in infection rates among different localities, if behaviors are the same, is in the structure of the networks over time. Such an analysis could show that, rather than one network structure predominating among drug users within a city, multiple structures related to HIV serostatus are evident. For example, in Houston, independent social network structures were found to be related to race/ethnicity and, although not shown through an analysis of network structures, HIV infection in Houston is related to race/ethnicity (Williams & Johnson, 1993; Williams, 1990). As well, specific network structures deserve more research attention. Data presented here show that there is a tendency among drug injectors in Puerto Rico to form a limited number of intense drug use linkages, but that linkages are of short duration. These short term drug use linkages resemble serially monogamous sexual relationships. During the stable phase of the network, members use drugs or share needles predominantly with other members of the network. Drugs are injected together frequently. But because the duration of network stability is relatively short, the chances of exposure to HIV infection are high. Only longitudinal studies could adequately investigate the complete structure of these types of network relationships.

The implications for prevention of HIV disease among drug injectors from a thorough understanding of drug use networks is significant. A behavioral paradigm gaining some popularity as the theoretical basis for constructing prevention programs is a theory of reasoned action (Terry *et al.*, 1993). Many of the constructs used in the theory of reasoned action, such as normative belief, subjective judgment, or outcome evaluation, are influenced by the beliefs and judgments of others. Salient beliefs and judgments concerning HIV prevention are, for injection drug users, most likely to originate from others in their drug use networks. As well, the network is the context for most behaviors that would be targeted by prevention programs. For example, one prevention strategy that makes sense is to discourage indiscriminate drug or syringe sharing. Data presented in this paper, however, suggest that, most of the time, neither drug use nor syringe sharing is indiscriminate. Both drug and syringe sharing tend to occur within the context of a well defined network. Over time, however, some injectors who share syringes, like those in Puerto Rico, will share with many other injectors as network composition changes. According to a theory of reasoned action, behaviors and the time-frame targeted for change should be well defined. Time frames are usually defined very narrowly, such as "the next time.". As a consequence, interventions may miss significant sharing behaviors among some injectors simply because their assessment instruments and interventions do not capture a dynamic of network change over time.

For injectors who tend to be in stable drug use networks, such as the injectors in Houston or Dayton/Columbus, the challenge is to discourage syringe sharing and unprotected sexual activities among long-time network members. Modifying these behavior is likely to be very difficult. Again, as the theory of reasoned action prescribes, the context of behavior targeted for change may present substantial barriers to change. Syringe sharing and sexual behaviors, more so than many health related behaviors, involve a dynamic of identity of self and others. Among long-time syringe sharing and sexual partners, syringe sharing and sexual behaviors very likely involve deeply felt understandings of commitment and trust. As such, changing these behaviors not only involves significant changes for an individual, but also for the network as a whole. As a consequence, HIV prevention strategies may need to target an entire network for prevention and adapt prevention measures to be acceptable to the network as a whole.

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