National Institute on Drug Abuse

RESEARCH

MONOGRAPH SERIES

Social Networks, Drug Abuse, and HIV Transmission

151

U.S. Department of Health and Human Services • Public Health Services • National Institutes of Health

Social Networks, Drug Abuse, and HIV Transmission

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NIDA Research Monograph 151
1995

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
National Institutes of Health

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ACKNOWLEDGMENT

This monograph is based on the papers from a technical review on "Social Networks, Drug Abuse, and HIV Transmission" held on August 19-20, 1993. The review meeting was sponsored by the National Institute on Drug Abuse.

National Institute on Drug Abuse
NIH Publication No. 95-3889
Printed 1995

NIDA Research Monographs are indexed in the *Index Medicus.* They are selectively included in the coverage of *American Statistics Index, Biosciences Information Service, Chemical Abstracts, Current Contents, Psychological Abstracts,* and *Psychopharmacology Abstracts.*

Contents

Introduction: The Social Network Research Paradigm

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On August 19-20, 1993, the National Institute on Drug Abuse (NIDA) held its first meeting to explore the social network research paradigm and its application to the study of drug use and human immunodeficiency virus (HIV) transmission. The meeting was jointly sponsored by NIDA's Community Research Branch (in the Division of Epidemiology and Prevention Research) and Clinical Medicine Branch (in the Division of Clinical and Services Research) and included participants from the United States, Puerto Rico, and Australia. By the conclusion of the meeting, it was evident that the study of drug user networks was a promising theoretical and methodological complement to the more heavily relied upon and empirically established paradigm that focuses on individual risk behaviors. Network analysis offers a unique opportunity to examine nonrandom patterns of risk behaviors and HIV transmission, the potential of HIV spread, and opportunities for developing and implementing strategies to prevent drug use and the transmission of disease, including drug treatment linkages to nondrug-using networks.

Presentations at the technical review meeting examined the intertwined epidemics of drug abuse and acquired immunodeficiency syndrome (AIDS), with attention to HIV transmission in the context of a variety of networks-networks of drug injectors, sex workers, siblings and other relatives, and sexual partners or significant others. The studies reviewed at the meeting indicated that network characteristics did indeed affect behavioral practice as well as the probability of viral transmission. For example, seroincidence is affected by such structural characteristics of networks as their basis of affiliation, their density (the proportion of direct ties among network members out of all possible ties), and their reachability (proportion of network members connected by indirect as well as direct paths). Mixing strategies also affect seroincidence, as migration or other outgroup contacts constitute bridges to other networks, where viral infection may or may not be already seeded. What is more, network membership characteristics (e.g., an actor's centrality [an indexed number of his or her aggregate ties within a network]) and network norms (e.g., drug injection frequency, sexual solicitation,

abstinence) appeared to influence the adoption of individual risk behaviors. Finally, data presented at the technical review meeting demonstrated that network-oriented interventions aimed at diffusing information about HIV and at changing transactional patterns have been successful at introducing behavioral change among network members, reducing high-risk behaviors, accelerating readiness for treatment, and limiting the spread of HIV.

Many of the presenters to NIDA's technical review have contributed the chapters contained in this research monograph, including a summary review that reflects the discussions among investigators that took place at the technical review meeting. NIDA staff is enthusiastic about publishing these chapters and hopes that this monograph will stimulate greater interest and involvement in network research related to drug abuse and HIV infection.

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Social Networks in Disease Transmission: The Colorado Springs Study

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INTRODUCTION

Colorado Springs, a community of 400,000 located 65 miles south of Denver, has reported 740 occurrences of human immunodeficiency virus (HIV) through 1992. The number of HIV-positive cases, the number of acquired immunodeficiency syndrome (AIDS) cases, and the number of AIDS deaths have been fairly constant since 1986 (Potterat et al. 1993). More than 60 percent of infected persons have resided in Colorado Springs for less than a year. Intensive case investigation and partner notification have failed to reveal significant endogenous transmission. Yet a substantial, well-described nexus of prostitutes, persons who use injectable drugs, and their associates-all of whom practice behaviors that can transmit HIV-exists in Colorado Springs. Unlike the major epicenters, for which the question is why so much transmission is occurring, the question of concern in Colorado Springs is why there is so little transmission. With this concern in mind, a study of people who might transmit HIV by heterosexual or drug-related routes was initiated, and an attempt was made to add a social network perspective to traditional epidemiologic approaches (Woodhouse et al. 1994). This chapter uses network-analytic methods to examine the relative prominence of persons in this setting and its possible implications for HIV transmission.

METHODS

Study Design

This study of prostitutes, the paying and nonpaying partners of prostitutes, persons who use injectable drugs, and the sexual partners of drug users, was begun in Colorado Springs in 1988. Participants, all presumably at high risk of acquiring and transmitting HIV and other

organisms, were enrolled through the sexually transmitted disease (STD) clinic, a drug clinic, self-referral, and street outreach; persons named by two or more respondents were also sought as participants. Because random sampling is not an option with a mobile and elusive population (Johnson 1990), purposive enrollment was used to construct an interacting group of persons representative of the general milieu. The population is not representative of that of Colorado Springs in general.

All persons enrolled in the study were asked to participate in a series of yearly interviews. Of the original 595 respondents, 278 (47 percent) completed a second interview, and 100 (17 percent) completed a third; fewer than 20 were interviewed a fourth or fifth time (Johnson 1990). During each interview, which usually lasted over 1 hour, respondents were asked about demographic characteristics; knowledge, attitudes, and practices with regard to HIV/AIDS; past medical history; and self-perception of risk for HIV/AIDS. They were also asked for a complete enumeration of their personal contacts. Contacts were defined as social (specifically, sharing meals or lodging), sexual, using injectable drugs, or using noninjectable drugs. For each contact in the previous 6 months, the respondent was asked (as appropriate) if needles were shared, what specific sexual practices took place, and if a condom was used. Respondents were asked to identify the strength of their relationship with the contact and to indicate the types of relationships that existed among their contacts. Respondents were counseled about HIV and asked to undergo a blood test for HIV, hepatitis B virus, and syphilis. (Many participants already avail themselves of the routine counseling and testing services offered in Colorado Springs.)

Network Analysis

Graph Definition and Analysis Package (GRADAP), a multipurpose network analysis program that provides information on groups of interconnected persons (Inter-University Project Group of the Universities of Amsterdam, Groningen, Nijmegen, and Twente 1989), was used for the analysis. Such a group, known as a connected component, comprises persons who are associated with each other either directly or indirectly. In network terms, there exists a path of some length from one person to any other person in the connected component. Each person in the component can be connected to one or many; each relationship may be of a single type (exclusive: for example, only sexual) or of several types (multiple: for example, sexual and needle sharing). If X persons are sampled, the number of connected components can vary

from 1 (all persons are connected to each other) to Y (no one is connected to anyone else).

To analyze connected components, the first interviews for the 595 respondents were used (table 1). Using GRADAP, connected components were created in three ways: (1) using all possible relationships between people; (2) using only exclusive relationships (e.g., only sexual alone was counted; sexual in conjunction with other relationships was not counted); and (3) using multiple relationships (e.g., sexual was counted whether or not other relationships were present within the respondent-contact pair). The position of the 17 HIV-positive persons within the components of this network was then identified.

TABLE 1. *Enumeration of interviews, respondents, and contacts in the social network: Colorado Springs, 1988-1991.*

	Respondents	Contacts Plus Associates	Contacts Only	Persons
All interviews	990	10,033	9,050	6,995
First interview	595	6,474	5,894	5,162
First interview (complete)	559	6,474	5,819	5,090
Connected component of respondents	341	3,942	3,818	3,016

Measurement of Centrality

In 1989, Stephenson and Zelen (1989) described an approach for measuring centrality that was based on the analogy between the matrix of persons in a social network and the theory of statistical estimation in the design of experiments; this approach was applied to the Colorado Springs network data. This method creates a measurement for each person in a connected component that represents the average distance from that person to all other persons in the network. The measurement, called

information centrality, incorporates every possible pathway from one person to all other persons.

Unweighted information centrality scores were calculated for 341 respondents in the network who were interconnected (that is, who constituted the largest connected component among respondents) (table 1) and compared the unweighted score with scores derived from two methods for weighting. First, a risk-weighted centrality measure was created by assigning values to the types of connections between any two persons: 0.5 for injecting drug use, 0.3 for sexual contact, and 0.1 for noninjecting drug use and for social contact. These arbitrary values sum to 1 and were chosen to give relative weights to the probability for transmission. This weighting scheme was an attempt to capture information about the implications of multiple connections for disease transmission.

The second weighting scheme-relationship weighting-used a variable measurement that asked respondents to provide an index of the strength of their relationship with the contact (in this matrix, the contact is another respondent). Respondents were asked to grade their relationship with a named contact on a scale of 1 (casual acquaintance) to 10 (best friend). The responses ranged over the entire scale, with peaks at 1, 5, and 10, and they generally were evenly distributed over the range. This score was multiplied by 0.1 to provide a range from 0.1 to 1.0. Relationship-weighted centrality attempts to capture information about the strength of social interactions.

Though the information centrality score has a specific statistical definition, its absolute value does not convey immediate meaning, and small differences between centrality scores are hard to interpret. Centrality ranks, reflecting a person's position in the network, may be of more use. The persons who are most central (in the highest decile) were compared to those who are least central (in the lowest decile) with regard to behaviors and practices.

RESULTS

Over the 4 years of the study (1988 through 1991), 1,078 people were identified as eligible for the study, and 595 agreed to participate (Woodhouse et al. 1994). Nonparticipation was primarily related to mobility (63 percent could not be located) and refusal (28 percent). The

595 respondents named a total of 10,033 contacts (persons who have a direct relationship with the respondent) and associates (persons known to the respondent through someone else), but that simple enumeration requires further specification. In their first interview, the 595 respondents named 6,474 contacts and associates, of whom 5,894 were contacts (table 1). Because some respondents are also contacts, and because some contacts are named by more than one respondent, these 5,894 respondent-contact pairs comprised 5,162 different persons.

Characteristics of Persons in the Network

Descriptive information about the respondents confirms the appropriateness of the convenience sample and the respondents' potential to be involved in HIV transmission (Woodhouse et al. 1994). Of the 595 respondents, 133 were prostitutes, roughly one-half of the estimated number of prostitutes prevalent in Colorado Springs (Potterat et al. 1990). Two hundred persons who used injectable drugs were enrolled as respondents, but close to 600 additional persons were identified through the interview process (if the rate of use of injectable drugs in the United States is roughly 1 in 250, about 1,500 such persons would be expected in Colorado Springs) (Anderson and Way 1992). The prostitutes were the youngest group and their paying partners, the eldest. Whites predominated, except among the nonpaying partners of prostitutes. Most persons had slightly less than a high school education.

Most of the respondents had been in the Colorado Springs area for 3 to 5 years, but the time they had lived at their current residence was considerably less, particularly among prostitutes. The subgroup of HIV-infected persons—and prior experience in Colorado Springs (Potterat et al. 1993)—suggests that infected persons had been in residence for a shorter time, possibly contributing to their position in the networks. The overall impression is that this group consists of persons in early adulthood who are predominantly white, undereducated, and relatively mobile.

Information about risky behaviors is derived from two sources: the reports of actual interactions between respondents and their contacts, and the indepth interview information on respondents. Both sources indicated that risky behaviors were common. Among the 5,894 respondent-contact pairs, very few used condoms, and needles were shared in 13 percent of the events involving injecting drug use. Focusing on a subset of respondents for whom detailed information is complete (536 out of 595), the

substantial frequency of risky behaviors can be contrasted with the relative self-perception of low risk. For example, 17 percent stated that they rarely or never cleaned their works; 67 percent had sex with a person who used injectable drugs; and 30 percent said that they had exchanged sex for drugs or money. Perhaps even more important is the observation that 60 to 73 percent of people with these characteristics considered themselves at low risk of acquiring HIV. Similarly, the overall frequency both for sexual contacts (inflated because of the large number of prostitute contacts) and for taking drugs is high, but there does appear to be a difference in the behavior of those who consider themselves at high risk and those who do not. Interestingly, needle sharing is reported infrequently, a finding at variance not only with self-reported behaviors but with the actual reported occurrence described later in this chapter.

Interrelationships of Risk

The simple categorization of respondents does not capture the complexity of personal activities in this group. If viewed from a multifactorial rather than hierarchical perspective, one can see that risks occur simultaneously and that more categories exist than the six devised for enrollment. For example, 59 of the 133 prostitutes were also users of injectable drugs, as were 28 of their paying partners.

As the analysis moves toward a more network-oriented approach-one that looks simultaneously at multiple factors and multiple interrelationships-the richness of the human interchange and its potential impact on disease transmission become more evident. Thus, when the nature of the interactions of the 595 respondents with the 5,894 contacts named in the first interview is examined, 15 categories of overlapping risk that characterize the respondent-contact pairs are found (table 2). In social network terms, the uniplex relationships are found along the diagonal of the upper box. Duplex relationships are counted to the left and below the diagonal, and multiplex relationships are presented in the box below. Relationships involving social interactions and noninjecting drug use predominate. It is of interest that use of injectable drugs seems to occur less often in isolation than do the other forms of connection. Only 3 1 percent (147 of 475) of the relationships involving the use of injectable drugs occur in isolation. Overall, 29 percent (1,709 of 5,894) of all relationships involve interactions with the direct potential for HIV transmission.

TABLE 2. *Relationships among 595 respondents and their 5,894 contacts: Colorado Springs, 1988-1991.*

	Social	Drug	Sexual	IDU	Total
Social	1,648				
Drug	823	767			
Sexual	521	178	804		
IDU	137	112	31	147	
TOTAL	3,129	1,057	835	147	5,168

Sexual, IDU, drug		17
Social, IDU, drug		176
Social, sexual, drug		398
Social, sexual, IDU		53
Social, sexual, IDU, drug		82
	TOTAL	5,894

KEY: IDU = injecting drug user.

SOURCE: Woodhouse et al. (1994).

Connected Components

Using single relationships only, the pattern was found in each instance to be a large, single, connected component with many components of much smaller size. In general, the HIV-positive persons are found in the smaller components, peripheral, as it were, to the major group of interconnected persons (table 3). A similar pattern emerges from examining multiple components. Most HIV-positive persons appear in smaller, unconnected groups. For example, only 4 of 10 HIV-positive

TABLE 3. *Summary of connected components in the network of 595 respondents and 5,894 contacts using exclusive (uniplex) and multiple (multiplex) relationships: Colorado Springs, 1988-1991.*

Type of Connection	Total Number of Components	Total No. of Persons in Components	No. of Persons in the Largest Single Component	Number of HIV+ Persons in Largest Single Component	Size Range of Smaller Components	No. of HIV+ Persons in Smaller Components
Exclusive						
Sexual	171	1,109	406	0	2-19	5
IDU	39	176	64	1	2-6	2
Non-IDU	126	945	230	5	2-92	3
Social	226	2,733	977	3	2-41	11
Multiple						
Sexual	299	2,233	965	5	2-29	12
IDU	97	766	365	4	2-21	6
Non-IDU	139	2,336	1,253	5	2-66	7
Social	198	3,603	1,910	5	2-54	12
All	147	5,162	3,658	9	2-40	9

KEY: HIV+= HIV positive.

SOURCE Woodhouse et al. (1994).

persons are in the large connected component of 356 who use injectable drugs. When all forms of contact are considered simultaneously, about half of the HIV-infected persons are in the large component of 3,658, and the other half are in the remaining small components.

Centrality Scores

Unweighted, risk-weighted, and relationship-weighted centrality scores each have a different scale, but all have similar distributions (table 4). All three distributions are slightly skewed to the left (mean is less than median) but are nearly normally distributed. There is a high but imperfect correlation among the three (table 5). Both product-moment and rank-order correlation coefficients are similar and exhibit a lower correlation between risk-weighted and relationship-weighted scores than between each of these with the unweighted score.

In addition to its role in network analysis, the centrality score may function as a variable for descriptive purposes. Within this matrix, prostitutes and their nonpaying partners had the highest mean centrality scores (table 6). Though the differences were small, the unweighted score placed prostitutes first, and the risk-weighted score placed nonpaying partners first. All three measures put persons who use injectable drugs in a less central position.

Centrality Ranks

The upper and lower deciles for centrality appear to be similar in their self-perception of AIDS risk (about 40 percent believe themselves to be at high risk), and two-thirds of each group state that they have changed their behavior since the advent of AIDS (table 7). More than 90 percent of each group state that they clean their works, and the majority say that they do it most of the time. More than 70 percent of both groups have had sex with a person who uses injectable drugs. There are, however, some important differences. Sixty-five percent of the top decile have exchanged sex for money or drugs, compared with 27 percent of the lowest decile. Similarly, 77 percent of the former group have had active anal sex, compared to 19 percent of the latter group. About 1.5 times as many people in the highest decile than in the lowest decile claim to know someone with AIDS.

TABLE 4. *Information centrality scores for the matrix of 341 interconnnected respondents: Colorado Springs, 1988-1993.*

	Unweighted	Risk-Weighted	Relationship-Weighted
Mean	0.604	0.144	0.222
Standard deviation	0.207	0.050	0.078
Median	0.613	0.152	0.237
Maximum	0.978	0.222	0.334
90th percentile	0.888	0.203	0.314
10th percentile	0.317	0.222	0.106
Minimum	0.154	0.025	0.047

TABLE 5. *Correlation among centrality scores using unweighted, risk-weighted, and relationship-weighted measures: Colorado Springs, 1988-1991.*

	Unweighted		Risk-Weighted		Relationship-Weighted	
	P*	S+	P	S	P	S
Unweighted	1	1	0.903	0.914	0.877	0.910
Risk-weighted			1	1	0.809	0.859
Relationship-weighted					1	1

KEY: P* = Pearson's r.
S† = Spearman's r.

TABLE 6. *Mean centrality scores associated with behavioral categories of respondents: Colorado Springs, 1988-1991.*

			Centrality Score (Mean)		
Category	Sex	*N*	Unweighted	Risk-weighted	Relationship-weighted
Prostitute	Female	97	0.714	0.161	0.258
Paying partner	Male	58	0.599	0.145	0.207
Nonpaying partner	Male	39	0.687	0.164	0.257
IDU	Female	43	0.505	0.131	0.189
	Male	53	0.488	0.126	0.185
Sex partner of IDU	Female	3	0.490	0.099	0.209
	Male	4	0.438	0.103	0.137
Other	Female	21	0.602	0.132	0.245
	Male	8	0.486	0.120	0.181

KEY: IDU = injecting drug user.

Similarly, the highest and lowest decile are not uniformly distinguished by the frequency and intensity of certain behaviors (table 8). Judged by risk-weighted centrality, the highest decile of this matrix has a substantially larger overall number of sexual contacts (142 in 6 months, compared with 30 in 6 months for the lowest decile) and a much greater frequency of anal sex since the advent of AIDS. The highest decile has also had substantially larger numbers of contacts with whom noninjectable drugs were used. On the other hand, persons at both ends of the centrality spectrum have similar experience with sharing needles.

When relationship-weighted centrality was used, the results were found to be similar except for two activities. First, the extraordinary difference in the frequency of anal sex apparent in risk-weighted centrality is reversed: Those in the lowest decile have a larger mean number of persons with

TABLE 7. *Percent of persons with selected characteristics in the highest and lowest deciles for risk-weighted centrality: Colorado Springs, 1988-1991.*

	Highest Decile	Lowest Decile
High chance of getting AIDS	43	42
Changed behavior since AIDS	67	65
Clean works	93	90
Clean works > 75 percent of time	71	67
Had sex with an IDU	73	71
Had passive anal sex without a condom	20	19
Had active anal sex	77	19
Exchanged sex for money/drugs	65	27
Know someone with AIDS	60	39

KEY: IDU = injecting drug user.

whom they have had anal sex when relationship-weighted centrality is used. Second, those in the lowest decile also have a larger mean number of persons with whom they have shared needles during the past 5 years.

Finally, if one looks closely at the 8 HIV-positive persons in this network of 341 respondents, the predominance of persons who inject drugs (paralleling their predominance among all HIV-positive heterosexuals in Colorado Springs) is noted, and all but one are noncentral in the matrix (table 9). Their centrality diminishes even further (again with only one exception) when relationship-weighted centrality is examined. The one person who is central by the risk-weighted criterion moves out of the highest decile for relationship-weighted centrality.

TABLE 8. *Values for selected characteristics of persons in the highest and lowest deciles of risk-weighted centrality: Colorado Springs, 1988-1991.*

	Risk-Weighted Centrality		Relationship-Weighted Centrality	
	Highest 10 Percent	Lowest 10 Percent	Highest 10 Percent	Lowest 10 Percent
Lived at current address (mo)	20	21	18	20
Lived in region (mo)	45	42	43	39
Highest grade completed	12	11	12	13
Frequency of anal sex (10 yr)	264	1	3	14
Social contacts (no., 6 mo)	8	6	8	5
Sexual contacts (no., 6 mo)	142	30	163	54
Shared needles (no., 6 mo)	2	1	1	3
Shared needles (no., 5 yr)	5	7	4	12
Used drugs (no., 6 mo)	20	12	24	11
Used drugs (no., 5 yr)	511	100	542	91

TABLE 9. *Characteristics of HIV-positive persons: Colorado Springs, 1988-1992.*

Category	Sex	Race	Risk-Weighted Centrality	Relationship-Weighted Centrality
IDU	F	White, non-Hispanic	227	286
IDU	M	"	241	319
Prostitute (IDU)	F	"	293	302
Other (IDU)	M	"	215	249
IDU	M	"	196	211
Nonpaying partner (IDU)	M	Black, non-Hispanic	129	90
Prostitute	F	White, Hispanic	222	236
Nonpaying partner	M	Black, Hispanic	29	88

KEY: IDU = injecting drug user.

DISCUSSION

These network results, including the size of personal networks (on average, about 10) and the number and distribution of connected components, cannot be compared directly to most other networks analyses because of inherent differences in target populations. Further experience with such personal networks is needed for empiric validation of the completeness of network ascertainment.

Nonetheless, these data suggest that one possible reason for the absence of significant transmission of HIV in Colorado Springs is the position of

infected people within the larger social network. If the personal networks of infected people are small and not connected to larger, more interacting components, transmission may be impeded. The presence of transmitting behaviors alone may not be sufficient to produce significant spread of disease.

This potential explanation was examined further through a preliminary analysis of centrality within the network. The meaning of the term "centrality," as applied to persons within a network, is both intuitively obvious and elusive. The term attempts to define members of a network who are important, but importance itself is vague and requires considerable specification. Centrality, by default, is often defined by the tool developed to measure it. Freeman, for example, describes three such tools: degree, or the number of points that are directly adjacent to a given point; closeness, a measure of the distance between a given point and all points on the shortest paths (the geodesic) that touch the given point; and betweenness, which examines the frequency with which a given point falls on the geodesic that connects pairs of points (Freeman 1979). Information centrality, a relatively new measure, offers some promise for providing insights into the structure of networks and the relative importance of people within them.

Results using information centrality suggest that the central persons in this network participate in greater sexual risk taking than do noncentral persons, a finding that is in keeping with the high mean centrality score among prostitutes. The highest and lowest deciles are similar with regard to injectable drug use, however. In fact, on the the basis of relationship-weighted centrality, persons in the lowest decile may actually share needles more than members of the highest decile. This observation is consonant with the low mean centrality scores among injectable drug users. Finally, the comparison of risk- and relationship-weighing-particularly as applied to HIV-positive persons-may provide a measure of the degree to which people are socially marginalized. Taken together, observations on connected components and centrality suggest mechanisms by which social network structure may impede the transmission of HIV.

These conclusions must be viewed as tentative, since they are based on a subset of a nonrandom sample, involve data collection from an elusive population, depend to some extent on self-reported behaviors and practices, and do not fully explore the potential of network analysis. They do, however, suggest that such analysis may make a contribution to

understanding-and perhaps altering—the dynamics of disease transmission. Future research might focus on the hypothesis generated by this study that network structure may serve as barrier or facilitator in the transmission of disease. In addition, it is clear that the effort required to describe networks is considerable, and an important focus for future work will be the rapid and inexpensive delineation of network structure.

REFERENCES

Anderson, R.M., and May, R.M. Understanding the AIDS pandemic. *Sci Am* 266:58-66, 1992.

Freeman, L.C. Centrality in social networks: Conceptual clarification. *Soc Netw* 1:215-239, 1979.

Inter-University Project Group of the Universities of Amsterdam, Groningen, Nijmegen, and Twente. *GRADAP: Graph Definition and Analysis Package.* Computer program. Groningen, The Netherlands: ProGAMMA, 1989.

Johnson, J.C. Selecting ethnographic informants. In: Johnson, J.C., ed. *Sage University Paper Series on Qualitative Research Methods.* No. 22. Newbury Park, CA: Sage Publishing Inc., 1990.

Potterat, J.J.; Woodhouse, D.E.; Muth, J.B.; and Muth, S.Q. Estimating the prevalence and career longevity of prostitute women. *J Sex Res* 27:233-243, 1990.

Potterat, J. J.; Woodhouse, D.E.; Rothenberg, R.B.; Muth, S.Q.; Dar-row, W.W.; Muth, J.B.; and Reynolds, J.U. AIDS in Colorado Springs: Is there an epidemic? *AIDS* 7:1517-1521, 1993.

Stephenson, K., and Zelen, M. Rethinking centrality: Methods and examples. *Soc Netw* 11:1-37, 1989.

Woodhouse, D.E.; Rothenberg, R.B.; Potterat, J.J.; Dar-row, W.W; Muth, S.Q.; Klovdahl, A.S.; Zimmerman, H.P.; Rogers, H.L.; Maldonado, T.S.; Muth, J.B.; and Reynolds, J.U. Mapping a social network of heterosexuals at high risk for human immunodeficiency virus infection. *AIDS* 8:1331-1336, 1994.

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Using Dyadic Data for a Network Analysis of HIV Infection and Risk Behaviors Among Injecting Drug Users

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INTRODUCTION

The emphasis in much contemporary network analysis is on investigating and analyzing networks as structures of links between network members. Analyzing simpler network structures-dyads within egocentric networks-may also yield useful results and, under certain circumstances, may be a feasible way to conduct a network-informed study among hidden populations such as injecting drug users (IDUs). This chapter is based on a study of HIV risk among IDUs in a high-risk neighborhood in Brooklyn (the Social Factors and HIV Risk [SFHR] project). The chapter discusses some of the methodological and practical issues involved in establishing links and recruiting IDU networks. Issues of network data validation are also covered. The chapter reviews some analyses of the relationships between the character of dyadic links in egocentric networks of IDUs and the likelihood that subjects are infected with HIV and engage in high-risk behaviors. Finally, the chapter considers network turnover among IDUs.

METHODOLOGICAL ISSUES IN RECRUITING IDU NETWORKS AND ESTABLISHING LINKS

The primary unit in developing network data is the dyadic link. Networks are the arrangement of these links. Thus, developing methods to nominate, recruit, and validate network links is fundamental to analyzing social networks. This process is never an easy one. For example, both the characteristics of network members elicited from index subjects and the size of the network depend on the naming stimulus (Campbell and Lee 1991; van der Poel 1993), how many names a subject wishes to reveal, variations in the skill of interviewers to elicit names, and the content of the relationship being studied (Milardo 1992). In

particular, researchers studying networks within populations engaging in illicit or stigmatized activities may find index subjects extremely reticent about revealing the names of network members. In the case of populations such as IDUs, who may have anonymous relationships with those with whom they engage in illicit or stigmatized activities, subjects may not know (with sufficient detail to enable identification) who is in their network. In addition to a description of the project, this chapter explains how the SFHR project obtained the names of the IDU network members of index subjects, how these members were recruited, how the links were validated, and some of the issues that arose during this process.

The SFHR project was conducted in the Bushwick neighborhood in Brooklyn. This is a neighborhood with a large number of poor people (income below $10,000) and is predominantly Latino. The neighborhood borders on other areas with populations that are predominantly white (neighborhoods in Queens such as Ridgewood and Maspeth) and predominantly black (Bedford-Stuyvesant, which is also in Brooklyn). Bushwick has large concentrations of drug injectors, many of whom are HIV positive. There are also many crack users in the neighborhood, as well as an active trade by women in exchanging sex for money and drugs. The aims of the study, in part, are to determine what factors are associated with a lower risk of HIV infection among particular groups of injectors, especially new injectors. In the first phase of the study, ethnographic interviews were conducted over several days with individual injectors, and ethnographic observations were undertaken in the study area. These methods were used to understand the varieties of drug-injector networks and social patterns in the study area and to develop a structured survey instrument and sampling plan for a survey of drug injectors' risk networks in the second phase. Subjects for the structured survey were street recruited and were eligible for the study if they were 18 years of age or older and had injected drugs within the last 12 months. Both in- and out-of-treatment subjects were interviewed. Informed consent was obtained for the interviews and for blood tests for HIV, hepatitis B, and syphilis.

Data for the structured survey were collected from July 1991 through January 1993. In the structured interviews, subjects provided data on their sociodemographic characteristics, biography, current and historical drug- and sex-risk behaviors, medical history, health beliefs, and peer culture. Subjects also provided information on up to 10 members of their social networks. This information included how long subjects had known

their social network members, the nature of their relationships, their risk and other behaviors with their network members, and other risk behaviors by network members.

The sampling objective was to obtain a representative sample of IDUs in Bushwick, although the authors wanted to oversample new IDUs (defined as those who had been injecting for 5 or fewer years), as well as to obtain a sufficient number of white injectors and female injectors in order to make racial/ethnic and gender comparisons with sufficient statistical power. To achieve these sampling goals, the authors adopted an ethnographically directed, purposive sampling strategy. The project's ethnographer, assisted by two recruiters who were trained to understand IDU networks in terms of the needs of the authors' research design, carried out systematic observation in the target neighborhood. In addition, the project ethnographer conducted indepth interviews with IDUs to find out about the drug-using patterns and social networks of IDUs. To recruit IDU network members, chain-referral techniques were used, with recruiters enlisting the support of index IDUs who were asked to refer to the research storefront IDU members of their social network whom they had nominated in response to a naming stimulus during the structured interview.

Initial index subjects for the study were IDUs who were identified through ethnographic observation and qualitative interviews as having contacts with several other IDUs. In order to lessen bias in the sample that may have developed from relying on IDUs who were well connected to other IDUs, the authors also included as index subjects IDUs who were less cooperative and those who appeared to be "loners."

In the survey interview, subjects were asked to nominate people with whom they had more than casual contact in the last 30 days. The naming stimuli concentrated on people they used drugs with (the first naming stimulus) and people they had sex with (the second naming stimulus) and then, through a variety of other naming stimuli, other people they had more than casual contact with (e.g., people they lived with who had not been mentioned before). The 10-name limit was, except in a few instances, sufficient to handle the nominated list.

To maximize recruitment capability and the validity of the links among network members, the authors adopted two methods that relied on the index subjects' participation. One method was the use of auxiliary recruiters, who were index IDUs paid a small finder's fee for helping to

locate members of their network. The index subjects were asked to locate and recruit network members and to physically accompany them to the storefront. This type of link was called a storefront link. A second method of recruiting subjects and also a way of validating a link was what was termed a field link. Because it was not always possible for an index IDU to take time out from procuring and using drugs and other aspects of "taking care of business" to accompany a network member to the storefront, the recruiting team contacted interviewed IDUs in the field where they were asked if they would assist in identifying and recruiting members of their network.

Two other kinds of links were also established, but these were not directly verified through the joint appearance of the index subject and the network member. These linkages are the ethnographic link and the database link. In the former, a link is established when a nominated subject is observed in the field by the project's ethnographic team with the index IDU in a social or drug-related interaction. In the latter, a link is established by matching identifiers of interviewed subjects in a database with identifiers in index subjects' lists of network members. When there was a tie (which occurred with only a few respondents), the authors utilized ethnographic information to confirm the database link.

Even given these efforts to recruit network members, there were mixed results. Recruitment of IDU network members was hampered by a high degree of turnover among IDUs in the neighborhood. Of the 102 IDUs who lived in Bushwick at the time of the interview and who had nominated IDU network members, 45 percent had lived in Bushwick for less than 1 year and 35 percent for less than 6 months. A number of factors may have contributed to this turnover in the IDU population in Bushwick, including police sweeps (which may have led to the incarceration of IDUs or their decision to "hide out" during the sweeps), attrition through sickness and death, entry into treatment, and the constant flow of IDUs in and out of the neighborhood resulting from, for example, urban dislocation and the vagaries of the drug market.

In this environment of high turnover of IDUs in the neighborhood, some networks were recruited in depth while others were only partially recruited. Of those IDUs in index subjects' networks who were nominated and eligible for recruitment, the mean percent actually recruited was 61 percent. Also, some index IDUs turned out to have small networks. This may have occurred because some index IDUs, though observed to have contacts with other IDUs, may have held

themselves back from revealing the full extent of their network.' Others were "loners" and some, particularly those who injected in relatively anonymous multiuser settings such as shooting galleries and outside locations, were unable to recall exactly with whom they injected. The effect of turnover among nominated IDU network members, which reduces recruitment and underreporting of IDU networks, is that many IDU members of egocentric networks were not interviewed. These missing IDU links may limit researchers' ability to understand the size of and interconnections within egocentric networks and the structure of larger order networks. This chapter includes analysis of dyadic relationships as reported by IDU subjects. Issues encountered in validating data about linked pairs of subjects and examples of analyses using dyadic data are also discussed.

SAMPLE CHARACTERISTICS

Of 767 subjects who were interviewed, 70 percent were male. There was racial/ethnic heterogeneity, with 26 percent of subjects black, 34 percent Latino (nonblack), 8 percent Latino (black), and 32 percent white. The mean and also the median age were 35. The mean number of years injecting was 14 and the median 13. Sixty-nine percent had been in drug abuse treatment at one time or another. Of 687 subjects who were tested for HIV, 40 percent were seropositive.

The 767 subjects nominated a total of 3,175 network members. Excluding the subject, the mean number of nominees was 4.14 (standard deviation [SD] = 3.0). The mean number of nominees with whom subjects had at some time in the past injected was 2.51 (SD = 2.31), and the mean number of nominees who were non-IDUs was 1.42 (SD = 2.05).

VALIDATION OF DYADIC DATA

There were 5 11 linked pairs comprised of unidirectional and bidirectional links. When only one member of the pair was linked to his or her network nominee, there was a unidirectional link. If each member in a pair nominated and was linked to the other, there was a bidirectional link. Of the 5 11 linked pairs, 145 were bidirectional, and 366 were unidirectional. In total there were 656 dyads[2] available for analysis,

comprising the sum of the unidirectional links and both halves of the bidirectional links.

The authors examined 3 types of questions to evaluate the reliability and validity of the data obtained from the linked pairs. These were: (1) knowledge that each member in the dyad had about the other member's age, race/ethnicity, and gender (these analyses used all dyads, including unidirectional links and both halves of bidirectional links); (2) agreement on activities that both members engaged in together, for example, injecting together and having sex together (only both halves of bidirectional links were used); and (3) agreement by one member on the behavior of another member, for example, going to shooting galleries (as in question type 1, all dyads are used).

In establishing reliability of the dyadic data, Pearson correlation coefficients were used for continuous data and percent agreement for dichotomous and other categorical variables. The results are shown in table 1.

Subjects were reliable in reporting on the age, sex, and race/ethnicity of their network members. The Pearson correlation coefficient for a subject's estimation of a member's age by that member's self-reported age is 0.79 ($p < 0.001$). There is 100 percent agreement between a subject's report about a network member's gender and the member's self-reported gender, and 92 percent agreement between a subject's report about a network member's race/ethnicity and the member's self-reported race/ethnicity. (Percent agreement on race/ethnicity is calculated by adding agree-agree responses for four racial/ethnic categories-black, Latino, white, and other-and dividing by all responses.)

Subjects' reports on some shared behaviors were very reliable. There was 93 percent agreement on ever having injected drugs with each other and 99 percent agreement on ever having had sex with each other. Among those who had sex together, there was 84 percent agreement on whether condoms had been used. Subjects were quite reliable on reporting whether they had injected with a syringe after their IDU partner had used it first (receptive syringe sharing). In an analysis of 79 linked pairs of IDUs who had injected with each other (generating 158 injecting dyads), there was 69 percent (109 of 158) agreement on whether subjects engaged in receptive syringe sharing.

TABLE 1. *Reliability of index IDUs' reports about their network members {linked-pairs analysis).*

Variables	Statistic
Sociodemographics	
Age	R = 0.79 ($p < 0.001$)
Gender	100 percent agreement
Race/ethnicity (Categories are black, Latino, white, and other)	92 percent agreement
Mutual Behaviors (Last 30 Days)	
Injected drugs with each other	93 percent agreement
Had sex together	99 percent agreement
Condom use	84 percent agreement
Receptive syringe sharing	69 percent agreement
Network Member's Behavior (Last 30 Days)	
Injected at shooting gallery	74 percent agreement

Subjects were accurate in reporting on whether their IDU partner had injected at a shooting gallery. There was 74 percent agreement as to whether an IDU partner had injected in a shooting gallery.

In the examples given above, reliability was good. Thus, at least for some network data among street-recruited IDUs, there is reliable and

accurate reporting by IDUs about the characteristics and behaviors of IDU members of their social networks.

THE EFFECT OF DYADIC NETWORK CHARACTERISTICS ON HIV INFECTION, SYRINGE SHARING, AND CONSISTENT CONDOM USE

Although many IDU members of egocentric networks were not interviewed, a large amount of data was collected about network members and their relationships with index subjects that are based on the self-reports by index subjects. These data, with appropriate caveats, were used to examine the influence of egocentric networks on risks for HIV infection, syringe sharing, and consistent condom use. In the first example, the network variables qualitatively characterize index subjects' egocentric networks as high risk if they contain IDU members with high-risk behaviors or characteristics. The unit of analysis here is the individual subject. The latter two examples are based on the content of the dyadic relationship between the index subject and his or her network members, as self-reported by the index subject. One is an analysis of the characteristics of dyads in which the index subject engaged in receptive syringe sharing. The other is an analysis of dyads in which index subjects engaged in consistent condom use. In both of these analyses, the unit of analysis is the dyadic relationship.

Risk Factors for HIV Infection Among New IDUs

To a large extent, viruses are transmitted dyadically, although they can also be transmitted via "anonymous" networks, such as those which are mediated through renting used injecting equipment in shooting galleries. Thus, risk-factors-for-infection studies may fruitfully be done on the dyadic level. The present study examines factors associated with being infected with HIV among IDUs who had been injecting for 6 or fewer years.

The sample of new IDUs included 174 current drug injectors who started injecting 6 or fewer years ago.[3] Because the data used for individual risk behaviors were for the 2 years prior to the interview, three subjects who reported that they were diagnosed with acquired immunodeficiency sydrome or HIV more than 2 years prior to being interviewed were excluded from the analysis.

In addition to standard drug- and sex-HIV-risk behaviors (during the 2 years prior to the interview) and sociodemographic variables, the analysis also included network variables (based on subjects' social networks in the 30 days prior to the interview) that were dichotomized and treated as indicators of high-risk networks. Separate network variables measured whether the subject had any drug-injecting network member who:

1. Was 5 or more years older than the subject (an indicator of a greater likelihood of past exposure to HIV);

2. The subject had known 1 year or less (an indicator of greater network turnover);

3. Injected in shooting galleries in the prior 30 days (an indicator of potential exposure to a larger HIV-seropositive IDU network); or

4. Injected more than once daily (an indicator of an IDU network with greater injecting risk behavior).

The sample was 58 percent male, 19 percent black, 53 percent Latino, and 28 percent white. The mean age was 30 (SD = 5.7 years), mean years since first injection was 2.6 (SD = 1.7 years), and the median was 3 years. HIV seroprevalence among the new injectors was 20 percent (versus 45 percent among 494 subjects injecting more than 6 years, $p < 0.0001$).

The authors analyzed whether the probability of being infected with HIV among new injectors was higher among those who engaged in high-risk behaviors in high-risk networks. To do this, they examined whether network variables interacted with high-risk behaviors and modified their association with HIV serostatus. The high-risk behaviors that were analyzed for their interaction with high-risk networks were selected by separate multiple logistic regression analyses within categories of variables which, in addition to high-risk behaviors, also measured other subject characteristics. The categories of variables included sociodemographics, other social background, drug use frequencies, injection settings and needle use, sexual behaviors, individual biography, and medical and sexually transmitted disease history.

Four interaction terms were statistically significant ($p < 0.05$ or lower). The contingency table analyses of these terms are displayed in table 2.

TABLE 2. *HIV seropositivity by sociodemographic, behavioral, and settings variables and IDU network variables.*

(Table entries are % HIV seropositive.)

	Sociodemographic, Behavioral, and Settings Variables		
IDU Network Variables			P(x2)<
Any IDU network member 5 or more years older than the subject	Subject's gender		
	Male	Female	
No	18 %	17 %	0.888
Yes	11 %	41 %	0.004
Any IDU network member who injects > 1 per day	Subject injects speedball > 1 per day		
	No	Yes	
No	16 %	0 %**	0.586
Yes	12 %	54 %	0.0001†
Any IDU network member who injected in shooting galleries in prior 30 days	Subject injects speedball > 1 per day		
	No	Yes	
No	16 %	26 %	0.278
Yes	5 %*	69 %	0.0001†
Any IDU network member whom subject has known 1 year or less	Subject injects in outside settings		
	No	Yes	
No	10 %	25 %	0.059
Yes	0 %**	44 %	0.0001

KEY: † Fisher's Exact Test; * cell contains 1; ** cell contains 0.

NOTE: IDU = injecting drug user.

(The multivariate odds ratios for three of these terms were indeterminate since the tables contain cells with frequencies of 1 or 0.)

These analyses indicate that the probability that new injectors who engage in risk behavior are infected with HIV is increased if they are members of high-risk injector networks. Thus, the likelihood of being infected with HIV is greater among new injectors who:

1. Inject speedball more than once per day and have IDU networks that include members who are either (a) high-frequency injectors or (b) who inject in shooting galleries; or

2. Inject in outside settings (many of which are multiuser settings) and have IDU networks with a greater turnover in membership.

In addition, IDU women with older injectors (who may be more likely to be infected) in their IDU network are more likely to be infected with HIV than other IDU women.

In a stepwise multiple logistic regression analysis that included variables selected from the within-category multiple logistic regression analyses, the interaction term for being a female subject and having an injector 5 or more years older in one's egocentric network (odds ratio [OR] = 8.07, 95 percent confidence interval [CI] = 1.13, 57.64) remained significant, along with injecting at an outside setting (OR = 7.32, 95 percent CI = 2.66, 20.19), and Latino race/ethnicity (OR = 4.30, 95 percent CI = 1.55, 11.94).

Dyadic Relationships and Predictors of Receptive Syringe Sharing

This analysis sought to determine whether the social characteristics of drug-injecting dyads (index subjects and their IDU nominees who had injected together in the last 30 days) were associated with receptive syringe sharing occurring within the dyad. Of 583 respondents, 28 percent were black, 37 percent Latino, and 35 percent white; 71 percent male; and 41 percent HIV positive. The unit of analysis is the dyadic relationship; there were 1,713 injecting dyads (mean = 2.94 per subject). Index subjects were asked whether they injected with a syringe after their partner used it first (receptive sharing). The dependent variable was index subjects' reports of receptive sharing with their partners.

Receptive sharing occurred in 26 percent of the injecting dyads (448 of 1,713) . In stepwise (backward and forward) multivariate logistic regression, receptive sharing was significantly associated with dyad social characteristics (daily contact with partner, OR = 1.6; injecting together for more than a year, OR = 2.0; having a "very close" relationship, OR = 1.5; having a sexual relationship, OR = 2.1), as well as with subject characteristics (injecting speedball or cocaine, OR = 1.5; engaging in sex for money or drugs, OR = 1.9; not being black, OR = 1.6; not having been in drug abuse treatment, OR = 1.6). These variables all remained significant when HIV status, gender, and subjects' nominated injector network size were separately added to the final equation.

Receptive syringe sharing in dyads is affected by the character of the social relationships between injectors. These results indicate that it is more likely to occur in relationships between IDUs who have strong social ties.

Dyadic Relationships and Predictors of Consistent Condom Use

Condom use, because it usually requires mutual consent, is a characteristic of relationships (Sibthorpe 1992). Thus, studying the extent of condom use within relationships as the unit of analysis may add to the knowledge obtained from other studies that focus on the individual as the unit of analysis.

In the study reported here, the unit of analysis is the dyadic relationship of an IDU subject and his or her nominated heterosexual sex partner with whom sexual behavior occurred in the 30 days prior to the interview. The 3 17 subjects generated 421 dyadic heterosexual relationships, 34 percent of whom were HIV seropositive, 68 percent were men, 44 percent were Latino/a, 32 percent were white, and 24 percent were black. Subjects who had only one relationship comprised 60 percent of the relationships, those with two or three relationships comprised 29 percent, and those with four or more relationships were 11 percent. Of the 421 heterosexual relationships, 202 (48 percent) were with sexual partners who injected drugs, and 219 (52 percent) were with noninjectors.

The dependent variable is IDU subjects' reports of consistent condom use with partners of the opposite sex and is specific to the dyadic relationship. The behavior reported is for the 30-day period prior to the interview and

describes whether a condom was used every time IDU subjects and their nominated sex partners had sex together.

The validation of condom use among linked pairs (see "Validation of Dyadic Data," above) may be limited because the linkages are among IDUs and do not include non-IDU sex partners.

Always using condoms is reported in 33 percent of relationships (141 of 421). There is a greater proportion of consistent condom use in relationships with sex partners who have never injected drugs (43.8 percent) than in relationships with IDU sex partners (22.3 percent; $p < 0.001$), as well as in relationships of HIV seropositive subjects (46 percent) than in relationships of HIV seronegative subjects (27 percent; $p < 0.001$). Consistent condom use is less common in more intimate relationships: 26 percent in relationships with sex partners who are spouses, ex-spouses, or lovers versus 53 percent ($p < 0.001$) with friends or acquaintances; and 24 percent with sex partners with whom subjects feel "very close" versus 43 percent ($p < 0.001$) with other sex partners.

As shown in table 3, consistent condom use is particularly widespread (68 percent) in relationships in which the drug-injecting respondent is seropositive and the sex partner of the respondent is reported not to be an IDU. This finding holds when controlling for the closeness of the relationship. Thus consistent condom use is particularly likely to occur in relationships between seropositive IDUs and noninjecting partners even when these relationships are or are not "very close," or even when they are with a spouse, lover, ex-spouse, or with a friend or acquaintance (data not shown).

Consistent condom use in relationships between seropositive IDUs and non-IDU sex partners may help to reduce the spread of HIV to non-IDU heterosexuals. If this pattern in New York City, where approximately half of IDUs are infected with HIV, is found in other areas of the United States, then it may account for the relatively slow spread of HIV in heterosexuals from IDUs to noninjectors. Why this pattern of condom use occurs may be due to sex partner pressure or to IDU altruism (i.e., the desire to prevent others from becoming infected with HIV). This may also be a factor in the voluntary participation of IDUs as lay outreach workers and syringe exchange participants in many projects in the United States. However, since the main focus of the interviews in this project was on drug injectors' social networks and behaviors, data were

TABLE 3. *Proportion of relationships in which condoms were always used in the prior 30 days.*

	Does Sex Partner Inject Drugs?		
	No	Yes	p (row comparison)
Respondent is:			
Seronegative	31% (43 of 141)	23% (30 of 133)	0.137
Seropositive	68% (53 of 78)	22% (15 of 69)	0.001
p (column comparison)	0.001	0.895	

not gathered on subjects' altruism or sex partner pressure to help explain this pattern of condom use.

NETWORK TURNOVER

The authors analyzed the extent of short-term and long-term relationships with network members. These relationships included the length of time subjects injected with their drug-injecting network members, the length of time they knew their drug-injecting members, and the length of time they had been having sex with their sex partners. As shown in table 4, there was a large proportion of short-term injecting relationships, with fully 44 percent of relationships existing in which subjects injected with their network members for 1 year or less. However, there was also a substantial proportion of long-term injecting relationships, with 23 percent existing for more than 5 years. Subjects' relationships with their drug-injecting network members tended to precede the initiation of injecting with them, since only 28 percent of subjects had *known* their drug-injecting network member for 1 year or less, while fully 42 percent had *known* them for more than 5 years. Sexual relationships with network members were as likely to be long term as short term. Just over one-third (36 percent) of sexual relationships with network members had existed for 1 year or less, while similarly just over one-third (35 percent) had lasted for more than 5 years.

TABLE 4. *Duration of drug injectors' relationships.*

Length of time they have:	≤ 1 Year	> 1 Year, ≤ 5 years	> 5 Years
Injected with their drug-injecting network members	44%	33%	23%
Known their drug-injecting network members	28%	30%	42%
Been having sex with their sex partners	36%	29%	35%

Network turnover has methodological and substantive implications for conducting network-informed research on HIV risk and prevention among IDUs. Short-term relationships can affect the ease with which IDU networks can be recruited, since it may be more difficult to identify and locate short-term network members. In addition, short-term relationships imply that network structures are subject to substantial change, particularly on their peripheries. At the same time, to the extent that long-term relationships also characterize IDU networks, it may be easier to recruit network members who have long-term relationships and to identify the structure of relationships among these members. Substantively, short-term relationships may affect the rapidity with which HIV spreads among IDUs, while long-term relationships may be a basis for mobilizing social influence for HIV prevention.

CONCLUSIONS

Dyads derived from IDUs' egocentric networks can be used for analyzing network influences on HIV infection and risk behavior. The present analysis of the reliability of subjects' reports about each other, based on linked-pairs data, indicates that IDUs, with appropriate caveats, give reliable information about members of their IDU networks. Thus, IDUs' self-reports about their relationships with members of their egocentric networks and the characteristics and behaviors of these members can, even when linked-pairs data are unavailable, be a useful resource for analysis.

As discussed above, the qualitative characterization of IDUs' egocentric networks by virtue of the kinds of dyads and members they contain can be used to characterize IDU egocentric networks qualitatively as being high-risk if they contain IDU network members with high-risk behaviors or characteristics. High-risk networks were shown to be important in predicting HIV infection among new injectors. Dyadic data can also be used to specify the content of dyadic relationships, such as the closeness of the relationship. HIV-risk behaviors were more likely in dyads with close ties, and consistent condom use was more likely in relationships between HIV-positive IDUs and non-IDU sex partners.

Many of the predictors of risks for becoming infected with HIV, for syringe sharing, and for consistent condom use are variables that measure characteristics of the social relationships within IDUs' first-order networks. Risk behavior and risk reduction are clearly affected by the social relationships in which behaviors occur. Thus, there is a need to understand how social relationships affect risk behaviors and risk reduction and for prevention programs to focus on social relationships, as well as on individual characteristics.

Dyads may, therefore, be useful for analyzing certain features of drug injectors' networks that can affect the likelihood of IDUs' becoming infected with HIV and engaging in risk behaviors. Nevertheless, in order to more fully understand how HIV spreads through IDU populations and from IDUs to non-IDU populations, and how reductions in HIV-risk behaviors can be disseminated in the IDU subculture, the analysis of larger IDU network structures is necessary. Under certain societal conditions, however, the very nature of IDU networks makes this task difficult. The difficulty resides not only in devising the most appropriate method for analyzing the data but also in the initial steps in which index subjects are chosen, in the nomination of network members by index subjects, and in the recruiting and linking of network members, as discussed above.

Networks of street drug injectors may not have a stable structure, and many relationships can be short term. The nature of street life among drug injectors is that, in certain neighborhoods characterized by a "war on drugs" environment involving police sweeps, urban desertification, and urban gentrification, stable drug-injector networks can be fragmented. Some of them are thus emergent, setting-specific, and transient, although many dyads are, nevertheless, long term. Other networks, through attrition, may be shrinking. Thus, on a large scale, the structure of these

drug-injector networks is a mixture of stable, long-term relationships and of transient, short-term relationships.

The unstable relationships in IDU networks have implications for the spread of HIV and for prevention. To the degree that these unstable relationships represent weak ties to other IDU networks, they may increase the probability of exposure to HIV. High-turnover networks may increase the rapidity with which HIV spreads. Thus, short-term relationships may carry HIV across long-term networks and, thereby, across social categories.

The instability of IDU networks may increase the difficulty with which they can be used as channels of peer influence and pressure to reduce HIV risk. Under such conditions, network interventions among IDUs may need to first assist in the formation and stabilization of drug injectors' networks. Since IDU networks also contain longer term and more stable relationships, these relationships may be a better starting point from which to initiate efforts to utilize IDU social networks for HIV prevention. These more stable parts of scenes may become an initial focus for efforts to organize the more unstable segments of IDU networks and can be used as a base from which to create and expand those links through which peer influence and pressure may flow to reduce HIV-risk behaviors and control the spread of AIDS.

NOTES

1. IDUs were reluctant, even though they were given full assurance (which was backed up by a Federal Certificate of Confidentiality) that everything they reported was confidential.

2. The actual number of dyads used in any analysis varies depending on the type of characteristic or behavior analyzed.

3. In order to increase the sample size, new injectors were redefined from injecting 5 or fewer years ago to 6 or fewer years ago.

REFERENCES

Campbell, K.E., and Lee, B.A. Name generators in surveys of personal networks. *Soc Netw* 13(3):203-221, 1991.

Milardo, R.M. Comparative methods for delineating social networks. *J Soc Pers Relatsh* 9:447-461, 1992.

Sibthorpe, B. The social construction of sexual relationships as a determinant of HIV risk perception and condom use among injection drug users. *Med Anthropol Q* 6:255-270. 1992.

van der Poel, M.G.M. Delineating personal support networks. *Soc Netw* 15(1):49-70, 1993.

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Injecting Drug Use, Characteristics of Significant Others, and HIV-Risk Behaviors

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INTRODUCTION

The proportion of acquired immunodeficiency syndrome (AIDS) cases attributable to injecting drug use is growing rapidly (Allen et al. 1991; Barker et al. 1989). In 1987, approximately 17 percent of all U.S. cases of AIDS had been attributed to injecting drug use, excluding cases attributed to both injecting drug use and homosexual contacts. By November 1991, however, the proportion of AIDS cases among heterosexual injecting drug users (IDUs) exceeded the rate of AIDS among noninjecting drug-using homosexual men in some cities in the United States (Centers for Disease Control 1989). Also of pivotal importance is the risk of human immunodeficiency virus (HIV) transmission that IDUs present to their sexual partners. Heterosexual IDUs serve as "bridges" of infectivity to the heterosexual community at large (Des Jarlais and Friedman 1987; Fordyce et al. 1991; Murphy 1988). Forecasting the future trend of seroconversion among IDUs, as well as timely prevention and intervention efforts, are thus critical to minimize the spread of HIV in the IDU population and, ultimately, in the heterosexual population at large.

Projecting the time trend of HIV/AIDS, however, has proven difficult. Different methods have produced wide ranges of estimates for the future trajectory (Bregman and Langmuir 1990; Lemp et al. 1990; MacDonald 1986; Rosenberg et al. 1991). Currently, estimates of the HIV seropositivity in the IDU population vary markedly from community to community (Allen et al. 1991; Berkelman et al. 1989; Chaisson et al. 1989; Des Jarlais et al. 1988; Quinn et al. 1989; Siegal et al. 1991). The differences, however, do not appear to be a simple consequence of the size of the IDU pool in specific communities. As seen most dramatically, the seroprevalence rate among IDUs in Manhattan (New York City) increased from 9 percent to 50 percent in the 1978 to 1983 period (Des Jarlais et al. 1989). On the other hand, the rates among IDUs in San

Francisco, another HIV epicenter, remained in the mid-teens range until 1987 (Chaisson et al. 1989).

There are a number of plausible explanations for uneven prevalence and spread of HIV/AIDS across cities and regions in the United States. One obvious explanation is that the differences merely reflect the time lag due to the long incubation period of HIV, because HIV was introduced to each specific community at different points in time. A second explanation is that the current low-prevalence areas have benefited from the experience of the coastal cities. High-risk individuals in the current low-prevalence areas are taking more measures to prevent HIV infection than those in the high-prevalence areas did at the time the disease was still not well known. Reduction in high-risk drug-using behaviors among IDUs has been noted in response to the AIDS epidemic (Ottomanelli et al. 1990). It has not yet been determined if fear of eventual, possible infection is sufficient to reduce risk behaviors among those living in areas not currently plagued with the epidemic (Calsyn et al. 1992).

A third explanation is the possibility that the social structure of the high-risk groups is unique to each specific community. This argument is acknowledged in the epidemiological literature in forecasting the incidence of infectious diseases. The random mixing assumption, in which the probability of being contacted by infected persons is presumed to be constant across social groups, is violated in the transmission of HIV (Koopman et al. 1991). However, a particular local structure that faults random mixing is difficult to capture mathematically (Gupta et al. 1989). Descriptive studies, nevertheless, have shown that IDUs are not a homogeneous group even within a geographically limited area. Furthermore, they have found that the social milieu of drug-injecting behaviors is an important predictor of HIV transmission (Des Jarlais et al. 1986, pp. 111-125; Schoenbaum et al. 1989; Watters and Cheng 1987). These findings point to the research need for understanding local social relations in order to forecast the future spread of the disease within the community.

The present chapter explores this last question using dyadic data obtained from a seroepidemiological study of St. Louis drug users. Unlike some coastal cities, St. Louis is still in the low-prevalence phase of the HIV/AIDS epidemic. There are, however, indications that the rates for St. Louis may soon rise sharply. For example, the St. Louis rate of hepatitis-B, which is known to parallel the rate of AIDS, was until recently substantially lower than that of coastal cities such as New York

City and San Francisco. However, St. Louis' hepatitis-B rate is now comparable to rates in these cities (Storch et al. 1992, p. 302). Thus, data on social networks of HIV high-risk groups obtained prior to a rapid spread of HIV would be useful to determine if relational factors may be an element for slow spread.

The application of the social network approach to drug abuse is not new, but the focus has been primarily on issues of social control (Fraser and Hawkins 1984) or of social support (Saltz and Smith-Donals 1984; Westermeyer and Neider 1988; Wills 1990). The network approach is also particularly suitable for transmission of some concrete objects such as innovation, information, illicit substances, and infectious diseases. Thus, it was natural to extend the network approach to the AIDS epidemic (Klovdahl 1985; Laumann et al. 1989). More recently, a number of HIV projects in drug abuse were targeted specifically at capturing the effects of social networks on HIV transmission among drug users (see other chapters in this volume).

The networks of relations examined in this chapter are based on three significant others reported by a sample of drug abusers recruited from six drug abuse treatment centers in St. Louis. Drug abusers were first classified into three groups using their injecting drug use history and that of their reported partners and steady friends. Correlates of injecting drug use concordance of the proband (index subject) and his significant others were then examined, with several relational characteristics between them and high-risk behaviors and HIV seropositivity of probands. Multivariate categorical regression analyses were performed to identify composite characteristics of these subgroups with respect to high-risk sexual and drug-using behaviors, demographic characteristics, and drug abuse history.

The results of this chapter should be viewed cautiously because the network analysis included in it was not intended as a major aim of the original study. Some of the methodological limitations are discussed later.

METHODS

Ascertainment

The data were derived from the first longitudinal HIV epidemiological study of drug abusers and their sexual partners in St. Louis, known as Substance Abuse and Risks for AIDS study (SARA). The probands ascertained for this study consisted of a total of 5 14 persons admitted to six drug abuse treatment centers in St. Louis within a maximum of 6 months prior to the enrollment in the SARA study. The centers were selected on the basis of HIV risk assessment carried out in collaboration with the Division of Alcohol and Drug Abuse of the Missouri Department of Mental Health. These centers differed somewhat in treatment methods, socioeconomic status, gender composition of patients and the types of primary substances abused. The probands were enrolled in the study between October 1989 and December 1990. Further details can be found in Cottler and colleagues (1991).

The ascertained proband was given a baseline face-to-face interview. At its beginning, the proband was asked to name "his/her most steady girlfriend/boyfriend-the person who means the most to you," so that he or she could be included in the study as well. A total of 91 "partners" named by probands were subsequently ascertained. These partners were excluded in the analysis included in this chapter because partner ascertainment was found to be correlated with the injecting drug use concordance type.

Assessment

The National Institute on Drug Abuse (NIDA) high-risk assessment questions were adapted to examine high-risk sexual and drug-using behaviors for the 6 months prior to the interview. The National Institute of Mental Health (NIMH) Diagnostic Interview Schedule (DIS) III-R (Robins et al. 1989) was used to assess current and past symptoms and diagnoses of each of 10 classes of substance dependence and abuse (alcohol, amphetamines, cannabis, cocaine, hallucinogens, inhalants, opioids, phencyclidine [PCP], sedatives, and nicotine) and other major psychiatric disorders, as defined by *Diagnostic and Statistical Manual of Mental Disorder (DSM)-III-R* (American Psychiatric Association 1987).

In the brief "significant other" section of the interview, the proband was asked to provide information about the partner the proband named at the

beginning of the interview, as well as the proband's "most steady friend" and the "next most steady friend." Thus, a maximum of the proband's three significant others were assessed. The questions about these three persons included race, injecting drug use history (i.e., ever use), treatment and arrest records in the past 6 months, and proximity to the proband. These questions were modified from the questionnaires used in a study of recovering heroin abusers (Minor 1983, pp. 89-99; Price 1988). This social network assessment was limited to the alter-level, and no attempt could be made to link alters. Therefore, the study attempted to capture social relations at the dyadic (proband-alter) level only.

HIV antibody tests were performed using licensed Enzyme-Linked Immuno Sorbent Assay tests with confirmed Western Blots at the Core Retrovirology Laboratory of the Washington University School of Medicine. Information on significant others, HIV high-risk behaviors, and demographic characteristics for this chapter were derived from the baseline interviews, which took place from October 1989 to December 1990. In this chapter, HIV serostatus was followed up in the second wave of data collection, which ended in December 1991.

Injecting Drug Use Concordance

Altogether, 864 significant others were identified by the probands through the significant other section, and further information about them and the proband's relationships with them was obtained for 824 (95.3 percent) of them (figure 1). Although three significant others at maximum were allowed in this section, only a small portion of significant others appear to have been missed: across three groups, 79.0 percent gave names and other location information of their partners; 57.6 percent identified a second-most steady friend; but only 29.4 percent identified a third-most steady friend.

The initial intention of the significant other section was to identify sexual partners for subsequent interviews, rather than measuring the HIV transmission between the proband and the significant others of the proband. As a result, it was not possible to create a variable that would assess the extent of HIV transmission risk potential between the proband and his significant other. The proband was, however, asked to report his or her significant other's injecting drug use as well as the proband's own use. In this way, probands were classified based on the concordance of injecting drug use between probands and their significant others:

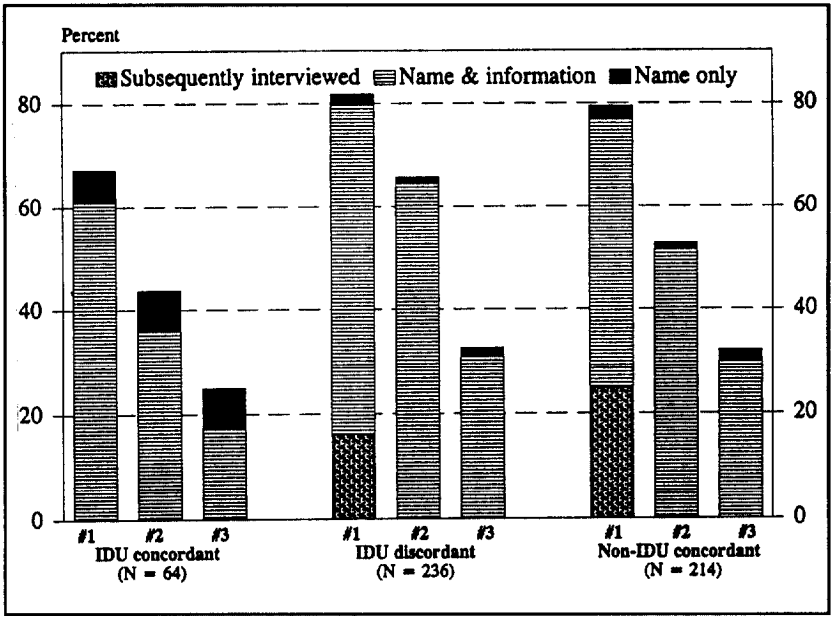

FIGURE 1. *Reporting pattern of three significant others by probands. #I: Reported "partner"; #2: "most steady friend"; #3: Reported "next steady friend."*

- The "injecting drug use concordant" (hereafter denoted as IDU concordant) was defined as a pair in which both the proband and *all* significant others were current or past IDUs;

- The "injecting drug use discordant" (hereafter denoted as IDU discordant) was a pair where the proband was an IDU but *at least one* partner or steady friend was not, or the proband was a non-IDU but at least one significant other was an IDU.

- The "noninjecting drug use concordant" (hereafter denoted as non-IDU concordant) was defined as a pair in which neither the proband nor *any* of his significant others were current or past IDUs.

It was thought that injecting drug use concordance could be used as an indicator of HIV high-risk dyadic relation since injecting drug use is a well-established HIV-risk factor among drug users. The concordance status was cross-examined with the subject's self-report on the number of the subject's injecting drug-using sexual partners and with the subject's interviewed partner's response about his or her own injecting drug use status (Price et al. 1992, p. 434). The concordance status was changed in

only a few cases as a result of the cross-examination. Thus, while this procedure might have increased the magnitude of correlation between the number of sexual partners and the concordance status, the net effect was considered negligible.

The two variables used for cross-examination-number of sexual partners, and number of IDUs who were sexual partners-were obtained on aggregate. Because there was no way of identifying who these partners and IDUs were, it was not possible to use these variables alone for dyadic classification.

Analysis

It has been long known that statistical analysis applied to alter-level network data is subject to sampling bias because alters nominated by probands are not randomly drawn from a population (Dow et al. 1982). The authors have thus chosen to present the results using measures at the individual level (i.e., the proband is the unit of analysis). Bivariate analyses were used to examine the association of the injecting drug use concordance typology with probands' demographics, characteristics of significant others, and probands' self-reported sexual and drug-using behaviors during the past 6 months.

Using the categorical data modeling procedure in the computer program SAS (Statistical Analysis System 1988, pp. 188-282) multivariate polychotomous and dichotomous categorical regression analyses were applied to examine demographic and risk factors which would differentiate the injecting drug use concordance type. The categorical regression analysis is an extension of dichotomous logistic regression in which the dependent variable consists of more than two categories. Although making causal inference was not intended, this method was judged advantageous because statistical power is increased and presentation is more parsimonious due to simultaneous estimation of the magnitude of effects of all variables on two categories of injecting drug use concordance type in comparison to the referent group. Dichotomous categorical regression analyses were also performed on the injecting drug-using proband subsample (N = 27 1) because a few variables were applicable only to IDUs (e.g., frequency of injection, sharing works).

RESULTS

Injecting Drug Use Concordance Type

When probands were classified according to injecting drug use concordance status of all of their pairs, 64 probands (12.5 percent) fell into the category of the IDU concordant. Because the definition of injecting drug use discordance required only one discordant pair, the IDU discordant group was the largest: It included 236 probands (45.9 percent), 87.7 percent of whom were IDUs. The proportion of the non-IDU concordant was similarly large, totaling 214 probands (41.6 percent).

Inspection of demographic characteristics stratified by injecting drug use concordance type revealed substantially different representations of gender, race, age, and other demographics (table 1). The IDU concordant

TABLE 1. *Demographic characteristics by injecting drug use concordance type (N = 514).*

	IDU Concordant' (N = 64)	IDU Discordant* (N = 236)	Non-IDU Concordan? (N = 214)
Male (%)[a,b]	48.4	67.0	67.3
Black (%) [a,b,c]	34.4	54.2	75.2
Age (mean years)[b,c]	34.3	33.9	29.9
Never married (%)[b,c]	42.2	42.8	62.6
No employment (%)[a,b]	48.4	26.2	18.2

KEY: [1] Proband is an IDU, and all significant others are IDUs.
[2] Proband is an IDU, and at least one significant other is a non-IDU, or vice versa.
[3] Proband is a non-IDU, and all significant others are non-IDUs.

[a] $P < 0.05$, IDU concordant versus IDU discordant.
[b] $P < 0.05$, IDU concordant versus non-IDU discordant.
[c] $P < 0.05$, IDU discordant versus non-IDU concordant.

was the oldest group (mean age = 34.3 years), with the least representation of males (48.4 percent) and blacks (34.4 percent), as well as the most unemployed (48.4 percent). The non-IDU concordant, on the other hand, was the youngest group (mean age = 29.9 years), with overrepresentation of blacks (75.2 percent) and those who reported they had never married (62.6 percent). Over 81 percent of this group was employed. The IDU discordant was similar to the IDU concordant with respect to age (mean age = 33.9 years) and the proportion never married (42.8 percent). However, they were similar to the non-IDU concordant with respect to gender composition (67.0 percent male).

Characteristics of Significant Others

The mean number of reported significant others was 1.1 among the IDU concordant, 1.8 among the IDU discordant, and 1.6 among the non-IDU concordant, corresponding to the size of each subtype. This is not surprising because those with more significant others have an increased chance to be placed into the discordant category.' However, the number of significant others in drug abuse treatment during the past 6 months was highest among the IDU concordant (mean = 0.6), next highest among the IDU discordant (mean = 0.3), and the lowest among the non-IDU concordant (mean = 0.1). The number arrested in the last 6 months showed the same descending pattern (means = 0.4, 0.2, 0.2, respectively) (table 2). These could *not* be an artifact, and the difference might actually be underestimated.

While the IDU-concordant probands reported that 39.7 percent of their significant others were living with them, the probands in the other two groups reported smaller proportions of their significant others living with them (25.7 percent in the IDU discordant and 20.7 percent in the non-IDU concordant). Moreover, 27.4 percent of the significant others reported by the IDU concordants were living with their families in comparison to 46.5 percent of IDU discordants and 47.0 percent of non-IDU concordants.

Across the three groups, only 6.7 percent of the relationships between probands and their significant others were interracial. Proportions of interracial relationships were the lowest in the IDU-concordant (3.2 percent) and highest in the IDU-discordant group (7.5 percent). However, these differences were not statistically significant.

TABLE 2. *Characteristics of reported significant others by injecting drug use concordance type *'† (N = 14).*

	IDU Concordant (N = 64)	IDU Discordant (N = 236)	Non-IDU Concordant (N = 214)
Mean number of significant others in drug treatmentl[123]	0.6	0.3	0.1
Mean number of significant others arrested[1,2]	0.4	0.2	0.2
Significant others living with proband (%)[1,2]	39.7	25.7	20.7
Significant others living with their family (%)[1,2]	27.4	46.5	47.0
Interracial significant others (%)‡	3.2	7.5	5.9

KEY: * Includes significant others probands identified and provided information (N_S = 824).

† Assessed for the past 6 months.

‡ Pairs other than white-white, black-black, and Hispanic-Hispanic.

1 P < 0.05, IDU concordant versus IDU discordant.

2 P < 0.05, IDU concordant versus non-IDU concordant.

3 P < 0.05, IDU discordant versus non-IDU concordant.

HIV High-Risk Behaviors and Seropositivity

IDU discordants reported the highest number of sexual partners (mean = 8.0) in the past 6 months, 3 times higher than the non-IDU concordant group (mean = 2.7) and more than 10 times higher than the IDU concordant group (mean = 0.7) (table 3). Because the number of

TABLE 3. *HIV high-risk behaviors* and seropositivity by injecting drug use concordance type (N = 514).*

	IDU Concordant (N = 64)	IDU Discordant (N = 236)	Non-IDU Concordant (N = 214)
Number sexual partners (mean number)[1,2,3]	0.7	8.0	2.7
Sexual partners' injecting drug use (%)	100.0†	10.0	0.0†
Sexual solicitation (%)	3.1	8.1	8.9
Prostitution (%)[1,3]	1.6	18.2	8.9
No condom use (%)‡[1]	85.0	67.6	70.2
Number of drug partners works shared (mean number)§	1.1	0.8	NA
Always clean needle (%)ǂ	50.0	22.8	NA
HIV positive (%)			
As of Dec. 1990	4.7	1.3	**0.5**
Incidence Dec. 1990 to Nov. 1991	0.0	1.3	**0.0**

KEY:
- * Assessment for the past 6 months.
- † True by definition.
- ‡ Among sexually active (N = 425).
- § Injecting drug use probands (N = 271).
- ǂ Among active IDUs (N = 152).
- [1] P < 0.05, IDU concordant versus IDU discordant.
- [2] P < 0.05, IDU concordant versus non-IDU concordant.
- [3] P < 0.05, IDU discordant versus non-IDU concordant.
- [4] T-ratio tests performed on the log score.

sexual partners is not totally independent of the number of significant others, the mean number of sexual partners would predictably be highest among the IDU-discordant group. Nevertheless, the difference seems much larger than expectations based on differences in the number of significant others alone.

Only 10 percent of the IDU discordant probands reported that their sexual partners injected drugs during the past 6 months. Prostitution and sexual solicitation (i.e., giving money or drugs for sex) during the past 6 months were high among the IDU discordant (18.2 percent for prostitution and 8.1 percent for solicitation), as well as among the non-IDU concordant (8.9 percent and 8.9 percent, respectively). These behaviors were more than five times more frequent in the IDU discordant than the IDU concordant group (combined 26.3 percent versus 4.9 percent). Further inspection showed that the high mean number of sexual partners in the IDU discordant group was in part attributable to high levels of prostitution and sexual solicitation in this group.

While the IDU discordant group reported the highest number of sexual partners, they also appeared to be more cautious about sex; nonetheless, 67.6 percent still reported no condom use during the past 6 months. A higher percentage (85.0 percent) was observed in the IDU concordant.

Among the IDU probands, the number of needle-sharing drug partners during the past 6 months was higher in the IDU concordant than the IDU discordant group (mean number 1.1 versus 0.8). However, 50 percent of the IDU concordant probands reported that they always cleaned needles, whereas only 22.8 percent of the IDU discordant probands reported the same. On balance, HIV transmission risk from unsafe needle sharing among concordant IDUs does not appear greater than that among the IDU discordant probands.[2]

At the end of the baseline data collection (December 1990), the HIV seropositivity rate was highest (4.7 percent) among the IDU concordant, lower (1.3 percent) among the IDU discordant, and lowest (0.5 percent) among the non-IDU concordant. The ranking of the seropositivity rates stratified by injecting drug use concordance type corresponded to that of the number of needle-sharing partners rather than of the number of sexual partners. At the end of the followup period (December 1991), three incident cases were found-all in the IDU discordant group, thus raising the prevalence of HIV seropositivity at that time to 2.6 percent in that group.

Multivariate Analysis

The foregoing bivariate analyses illuminated the differences in high-risk sexual and drug-using behaviors among the three dyadic groups. These analyses, however, do not reveal the relative importance of the variables that were found to differentiate the three groups. To assess the relative importance of sexual and drug-using behaviors, these variables were simultaneously controlled for in the multivariate categorical modeling analyses available in SAS. In addition to HIV high-risk behaviors, demographic characteristics (age, sex, race), drug abuse history (lifetime opiate or cocaine dependence or abuse), antisocial personality symptoms, and relational variables used in the previous analyses (significant others living with proband, number of significant others in treatment or arrested in the past 6 months) were also included in the models. The number of significant others was included to account for the effect of the size of the significant others on the injecting drug use concordance category, which may have inflated the statistical significance of the difference in the number of sexual partners among the three groups in the previous bivariate analyses. The injecting drug use probands were also analyzed only for models that included injecting behaviors (e.g., sharing works most often with spouse or partners, frequency of injection).

Several variables differentiated the three IDU concordant groups (table 4, left and middle columns). The IDU concordant, when contrasted with the other two groups, was characterized by "monogamous-like" relationships, indicated by the smaller number of sexual partners (OR = 0.7) and the living arrangements of significant others with probands (OR = 2.9). This group had a larger number of significant others with recent arrest records (OR = 3.8). Both the IDU concordant and IDU discordant had higher numbers of significant others recently in drug treatment in comparison to the non-IDU concordant. However, significant others' treatment status was more predictive of the IDU concordant (OR = 9.2) than of the IDU discordant (OR = 2.0). These results, consistent with the bivariate analyses, held up even when controlling for demographics, history of drug abuse, and antisocial behaviors. Further, the number of significant others was controlled for in this analysis; thus, the magnitude of the effect of the number of sexual partners is not overestimated.

Histories of opiate or cocaine dependence or abuse and of antisocial behaviors were predictive of both the IDU concordant and the IDU discordant group in comparison to the non-IDU concordant group. Among St. Louis drug abusers in the present study, blacks were less

TABLE 4. *Composite characteristics differentiating injecting drug use concordance groups (odds ratios).**

	All Probands (N = 514)†		IDU Probands (N = 271)‡
	IDU Concordant (N = 64)	IDU Discordant (N = 236)	IDU Concordant (N = 64)
Age¶	1.1	1.1	NS
Female╪	NS	NS	3.0
Black╪	0.3	0.5	NS
Number sexual partners (LOG)¶	0.7	NS	0.5
Number of significant others¶	0.2	NS	0.2
Significant others living with proband╪	2.9	NS	—
Number significant others in drug treatment¶	9.2	2.0	5.5
Number significant others arrested¶	3.8	NS	—
Opiate/dependence/abuse§, ╪	17.6	9.5	—
Cocaine/dependence/abuse§, ╪	3.4	1.7	—
Number antisocial behaviors¶	1.3	1.2	—
Sharing works most often with spouse/partner╪	—	—	21.1
Injection 1+ times/day╪	—	—	2.4╪

KEY:
- * NS: $p > 0.05$; ╫: $p = 0.053$; —: not included in the model.
- † Polychotomous categorical regression: the non-IDU concordant, referent group; $L^2 = 702$, df = 996, Prob.= 1.00, where the probability refers to the likelihood of "correct" specification.
- ‡ Dichotomous categorical regression: the IDU discordant, referent group; $L^2 = 145$, df = 246, Prob.=1.00.
- § Lifetime *DSM-III-R* diagnosis.
- ╪ Dummy variable.
- ¶ Effect is on per-unit increase of the measure.

likely to be IDUs, irrespective of their significant others' injecting drug use.

Overall, the polychotomous model fitted the data very well. The likelihood ratio (L^2 = 702, d.f. = 996, Prob. = 1.00) indicates that the set of variables chosen in this model sufficiently described the characteristics of the three subtypes of drug abusers in St. Louis, so that the probability that the model is "correctly" specified is close to unity.

A striking result, although intuitively clear, is that paraphernalia sharing with a spouse or a sexual partner was found to be a powerful predictor of the IDU concordant (OR = 21.1), compared with the IDU discordant, when the analysis was applied to the injecting drug use probands only and controlled for the frequency of injection (OR = 2.4) as well as demographics (table 4, right column). Past or current opiate and cocaine dependence or abuse or antisocial behaviors were all insignificant, indicating that they were risk factors of injecting drug use itself but were not associated with injecting drug use of significant others.

DISCUSSION

Early prevention and intervention efforts are more hopeful in the low prevalence areas such as the metropolitan St. Louis area than in areas already experiencing high prevalence. Present results could be useful in pointing out a direction for targeted prevention efforts before the epidemic really begins to escalate.

The SARA study was the first seroepidemiological study of drug abusers in St. Louis. It was not aimed at studying the association of social networks with HIV transmission, and there are several limitations in this chapter. The network assessment of the SARA study was not exhaustive. It was limited to assessing information about a maximum of three significant others. Present data suggest, nevertheless, that the majority of sample respondents did not have large networks of significant others; a sufficient pool of significant others appears to have been assessed.

Another limitation is the modest number of network questions asked about significant others. Present analyses, however, indicate that even a few questions can unveil some important aspects of drug abusers' networks in relation to HIV-risk behaviors.

Data analysis at the individual level was chosen for two reasons. The limitation of three significant others per proband made an alter-level analysis less meaningful, and, as mentioned earlier, special statistical treatment would have been necessary to control for the effect of differential probability of selection at the alter level. Injecting drug use concordance topology was chosen as the main focus of analyses. While the topology was found to be useful, it may not be the best way to describe the heterogeneity within the sample.

The probability of being classified into a specific injecting drug use concordance category depended on the number of significant others reported. As a result, the odds ratios and T-ratio statistics for metric variables such as the number of sexual partners may have been inflated. Analyses not shown here indicated that the number of significant others was only modestly correlated with the number of sexual partners and not with any other metric variables. Moreover, in the multivariate analysis, the two metric variables, the number of significant others, and the number of sexual partners were simultaneously controlled for. Thus, results appear valid despite this concern. A procedure to adjust for the statistical significance according to the size of network members is necessary for future network analyses that attempt to infer statistical significance of network variables on outcome variables.

Perhaps the biggest concern with respect to HIV is that the significant others were not identified on the basis of the proband's joint behaviors with them. Instead, they were identified in terms of relational descriptors such as "most steady girlfriend or boyfriend" and "next steady friend." Field reports indicated that respondents understood these relational descriptions to mean sexual partners. Nonetheless, this assessment strategy, while suited for the purpose of the original study, has made it difficult to make definite inferences about HIV transmission in the population based on findings.

These limitations considered, this chapter nevertheless has documented a relationship between dyadic topology with HIV high-risk behaviors. The three categories of drug abusers, classified according to the injecting drug use concordance with significant others, differentiated demographic characteristics, sexual and drug-using behaviors, and characteristics of significant others and their relationships with probands. The two main findings are:

- A minority of IDUs in this sample appeared to maintain intimate contacts only with IDUs. They were not sexually promiscuous. The HIV seroprevalence rate was the highest in this group, and the HIV transmission appears to be mainly through paraphernalia sharing with their significant others.

- A majority of IDUs in the sample were involved in intimate contacts with non-IDUs, consistent with an earlier finding (Des Jarlais et al. 1984). This mixed group was found to be highly promiscuous, which appears to be inconsistent with reporting from a New York sample (Neaigus et al. 1994). HIV seroprevalence had been lower in this group, but the incidence rate increased in 1991.

These findings may shed some light on the course of HIV spread in St. Louis and other cities with similar social stratification of the drug-abusing population. Apart from the late introduction of HIV to the city, the current low HIV rate in St. Louis might be in part due to relative isolation of a segment of IDUs who are more "deviant" than other IDUs. HIV appears to have begun spreading first among them. It is plausible that their relative isolation prevented HIV from spreading quickly to other IDUs.

HIV is already spreading within the mixed group of IDUs and non-IDUs, however. Because the pool of noninjecting drug use heterosexuals linked to IDUs is much larger in this group, the impact of the spread on the community at large could become more devastating.

While plausible, present inferences about HIV are highly speculative. Studies using specific behavior-based alter identification are required to produce more definitive findings that can test the IDU isolation hypothesis as an explanation for low prevalence and slow HIV spread in some areas of the nation (see Rothenberg, this volume).

Effective intervention and prevention strategies should target different risk groups with different strategies (Watters and Cheng 1987). Increased education on paraphernalia cleaning, reduction of sharing, and reduction of injecting drug use through treatment would be appropriate for paraphernalia-sharing IDUs. For drug abusers who maintain wider social networks of IDUs and non-IDUs, a rigorous approach to reducing high-risk sexual behaviors would yield better results to prevent the further spread of HIV.

NOTES

1. The authors thank an anonymous reader of an earlier version for making this point.

2. As one reviewer pointed out, the mean number of "unsafe" contact would be 1.1(1-0.5) = 0.55 for the IDU concordant probands and 0.8(1-0.228) = 0.70 for the IDU-discordant probands.

3. Preliminary results in this chapter were presented at the annual meeting of the College of Problems on Drug Dependence, Palm Beach, FL, June 16-20, 1991.

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REFERENCES

Allen, D.M.; Onorato, I.M.; Green, T.A.; and the Field Service Branch of the Centers for Disease Control. HIV infection in intravenous drug users entering drug treatment, United States 1988 to 1989. *Am J Public Health* 82:541-546, 1992.

American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders.* 3d ed. rev. Washington, DC: American Psychiatric Association, 1987.

Barker, L.S.; Brown, L.S.; Des Jarlais, D.C.; Friedman, S.R.; Hubbard, R.L.; Lindenbaum, S.; Miller, J.A.; and Stryker, J. In: Turner, C.H.; Miller, H.G.; and Moses, L.E., eds. *AIDS, Sexual Behavior and Intravenous Drug Use.* Washington, DC: National Academy Press, 1989.

Berkelman, R.L.; Heyward, W.L.; Stehr-Green, J.K.; and Curran, J. W. Epidemiology of human immunodeficiency virus infection and acquired immunodeficiency syndrome. *Am J Med* 86:761-770, 1989.

Bregman, D.J., and Langmuir, A.D. Farr's Law applied to AIDS projections. *JAMA* 263:1522-1525, 1990.

Calsyn, D.A.; Saxon, A.J.; Freeman, G., Jr.; and Whittaker, S. Ineffectiveness of AIDS education and HIV antibody testing in reducing high-risk behaviors among injection drug users. *Am J Public Health* 82:573-575, *1992.*

Centers for Disease Control. Update: AIDS associated with intravenous drug use. *MMWR Morb Mortal Wkly Rep* 38:165-170, 1989.

Chaisson, R.E.; Bacchetti, P.; Osmond, D.; Brodie, B.; Sande, M.A.; and Moss, A.R. Cocaine use and HIV infection in intravenous drug users in San Francisco. *JAMA* 261:561-565, 1989.

Cottler, L.B.; Helzer, J.E.; and Mager, D. Agreement between DSM-III and DSM-III-R dependence disorders. *Drug Alcohol Depend 29:* 17-25, 1991.

Des Jarlais, D.C.; Chamberland, M.E.; Yoncovits, S.R.; Weinberg, P.; and Friedman, S.R. Heterosexual partners: A large risk group for AIDS. Letter. *Lancet* 2:1346-1347, 1984.

Des Jarlais, D.C., and Friedman, S.R. HIV infection among intravenous drug users: Epidemiology and risk reduction. *AIDS* 1:67-76, 1987.

Des Jarlais, D.C.; Friedman, S.R.; Novick, D.M.; Sotherman, J.L.; Thomas, P.; Yancovitz, S.R.; Mildvan, P.; Weber, J.; Kreek, M.J.; Maslansky, R.; Bartelme, S.; Spira, T.; and Marmor, M. HIV-l infection among intravenous drug users in Manhattan, New York City, from 1977 through 1987. *JAMA* 261:1008-1012, 1989.

Des Jarlais, D.C.; Friedman, S.R.; and Stoneburner R.L. HIV infection and intravenous drug use: Critical issues in transmission dynamics, infection outcomes, and prevention. *Rev Infect Dis* 10:151-158, 1988.

Des Jarlais, D.C.; Friedman, S.R.; and Strug, D. AIDS and needle sharing within the IV-drug use subculture. In: Feldman, D.A., and Johnson, T.M., eds. *The Social Dimension of AIDS: Method and Theory. New* York: Praeger, 1986.

Dow, M.M.; Burton, M.L.; and White, D.R. Network autocorrelations: A simulation study of a foundational problem in regression and survey research. *Soc Netw* 4: 169-200, 1982.

Fordyce, E.J.; Blum, S.; Balanon, A.; and Stoneburner, R.L. A method for estimating HIV transmission rates among female sex partners of male intravenous drug users. *Am J Epidemiol* 133:590-598, 1991.

Fraser, M.W., and Hawkins, J.D. The social networks of opioid abusers. *Int J Addict* 19:903-917, 1984.

Gupta, S.; Anderson, R.M.; and May, R.M. Networks of sexual contacts: Implication for the pattern of spread. *AIDS* 3:807-817, 1989.

Klovdahl, A.S. Social networks and the spread of infectious diseases: The AIDS example. *Soc Sci Med* 21:1203-121, 1985.

Koopman, J.S.; Longini. I.M.; Jacquez, J.A.; Simm, C.P.; Ostrow, D.G.; Martin, W.R.; and Woodcock, D.M. Assessing risk factors for transmission of infection. *Am J Epidemiol* 133:1199-1209, 1991.

Laumann, E.O.; Gagnon, J.H.; Michaels, S.; Michael, R.T.; and Coleman, J.S. Monitoring the AIDS epidemic in the United States: A network approach. *Science* 244:1186-1189, 1989.

Lemp, G.F.; Payne, S.F.; Rutherford, G.W.; Hessol, N.A.; Winkelstein, W.; Wiley, J.A.; Moss, A.R.; Chaisson, R.E.; Chen, R.T.; Feigal, D.W.; Thomas, P.A.; and Werdegar, D. Projections of AIDS morbidity and mortality in San Francisco. *JAMA* 263:1497-1501, 1990.

MacDonald, D.I. Coolfront Report: A PHS plan for prevention and control of AIDS and the AIDS virus. *Public Health Rep* 101:341-348, 1986.

Minor, M.J. Panel data on ego networks: A longitudinal study of former heroin addicts. In: Burt, R.S., and Minor, M.J., eds. *Applied Network Analysis: A Methodological Introduction.* Beverly Hills, CA: Sage, 1983.

Murphy, D.L. Heterosexual contacts of intravenous drug abusers: Implications for the next spread of the AIDS epidemic. *Adv Alcohol Subst Abuse* 3:89-97, 1988.

Neaigus, A.; Friedman, S.R.; Curtis, R.; Des Jarlais, D.; Furst R.T.; Jose, B.; Mota, P.; Stephenson, B.; Snfian, M.; Ward, T.; and Wright, J.W. The relevance of drug injectors' social networks and risk networks for understanding and preventing HIV infection. *Soc Science Med 38:67-*78, 1994.

Ottomanelli, G.; Kramer, T.H.; Bihari, B.; Fine, J.; Heller, S.; and Mosely, J.A. AIDS-related risk behaviors among substance abusers. *Int J Addict* 25:291-299, 1990.

Price, R.K. "Kicking the Habit: A Social Network Approach to Recovery from Opiate Addiction." Ph.D. diss., Department of Sociology, University of California at Berkeley, 1988.

Price, R.K.; Cottler, L.B.; Mager, D.; and Keating, S. Tracing the bridges: Social network characteristics and risk behaviors among drug abusers and their significant others. In: Harris, L.S., ed. *Problems of Drug Dependence 1991: Proceeding of the 53rd Annual Scientific Meeting. The Committee on Problems of Drug Dependence, Inc.* National Institute on Drug Abuse Research Monograph 119. DHHS Pub. No. (ADM)92-1888. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1992.

Quinn, T.C.; Zacarias, F.R.K.; and St. John, R.K. HIV and HTLV-I infections in the Americas: A regional perspective. *Medicine* 68:189-209, 1989.

Robins, L.N.; Helzer, J.E.; Cottler, L.B.; and Goldring, E. *National Institute of Mental Health Diagnostic Interview Schedule, Version III Revised.* August 1989.

Rosenberg, P.S.; Biggar, R.J.; Goedert, J.J.; and Gail, M.H. Backcalculation of the number with human immunodeficiency virus infection in the United States. *Am J Epidemiol* 133:276-285, 1991.

Saltz, R.F., and Smith-Donals, L.G. *Social Networks and Reentry: A Panel Study of Former Heroin Addicts.* Final Report. Lafayette, CA: Pacific Institute for Research and Evaluation, 1984.

Schoenbaum, E.E.; Hartel, D.; Selwyn, P.A.; Klein, R.S.; Davenny, K.; Rogers, M.; and Feiner, C. Risk factors for human immunodeficiency virus infection in intravenous drug users. *New Engl J Med* 321:874-879, 1989.

Siegal, H.A.; Carlson, R.G.; Falck, R.; Li, L.; Fomey, M.A.; Rapp, R.C.; Baumgartner, K.; Myers, W.; and Nelson, M. HIV infection and risk behaviors among intravenous drug users in low seroprevalence areas in the Midwest. *Am J Public Health* 81:1642-1644, 1991.

Statistical Analysis System. *SAS/STAT User's Guide Release 6.03 Edition.* Cary, NC: SAS Institute, 1988.

Storch, G.A.; Cottler, L.B.; Compton, W.M., III; Price, R.; Pearl, R.; and Keating, S. Low rates of HIV infection among substance abusers reporting high risk behavior: Trend or time bomb? In: Harris, L.S., ed. *Problems of Drug Dependence 1991: Proceeding of the 53rd Annual Scientific Meeting. The Committee on Problems of Drug Dependence, Inc.* National Institute on Drug Abuse Research Monograph 119. DHHS Pub. No. (ADM)92-1888. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1992.

Watters, J.K., and Cheng, Y.T. HIV-1 infection and risk among intravenous drug users in San Francisco: Preliminary results and implications. *Contemp Drug Probl* 14:397-410, 1987.

Westermeyer, J., and Neider, J. Social networks and psychopathology among substance abusers. *Am J Psychiatry* 145:1265-1269, 1988.

Wills, T.A. Multiple networks and substance use. *J Soc Clin Psychol* 9:78-90, 1990.

ACKNOWLEDGMENTS

This work was supported in part by NIDA grant numbers DA05619, DA06163, and DA05585 and NIMH grant number MH17014. Acknowledgment is also due to Susan Keating for instrumentation and implementation of the SARA project.

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Sibling Homophily in HIV Infection: Biopsychosocial Linkages in an Urban African-American Sample

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INTRODUCTION

With the exception of studies that have looked at human immunodeficiency virus (HIV)-discordant couples and mother-to-infant vertical transmission, and some early work that disproved the possibility of casual transmission among family members, no research has been reported about familial clusters of infection. Similarly absent are reports concerning the range of biopsychosocial factors that might influence vulnerability to HIV infection among family members who are not known to be members of a procreational set.

One type of relational group or network, siblings, is examined in the study reported in this chapter. The study was undertaken to see if influences that go beyond individual-level or individually occurring determinants might account for differential distribution of HIV in sibling groups. A quarter-century study of African-American individuals who were adolescents growing up in Harlem during the late 1960s (Brunswick and Josephson 1972) provided an opportunity to explore whether historical as well as more recent contextual and intraindividual attributes shared by siblings changed their likelihood of HIV infection. The present study is essentially a descriptive one, undertaken in response to the unanticipated observation of sibling agreement or concordance in HIV serostatus.

The study cohort, furthermore, represents a population that is recognized to be at elevated risk of HIV infection. Initial data were collected from this group 25 years ago between 1968 and 1970. All children between the ages of 12 and 17, inclusive, who resided at that time in a probability sample of households in Central Harlem (New York City) were included in the sample. As a consequence of this design feature, a substantial

number of respondents in the study can be linked to their sibs who met the study's age criterion.

Sib-set membership is construed to be a proxy for a wide range of individual and social features sibs share that might increase their vulnerability to HIV infection. The possibility that infection among siblings was a consequence of direct infection or mutual infection from another person cannot be ruled out. Neither would it impact on the purposes or findings of this investigation. The study cohort is too old to have been exposed to vertical transmission from their mothers. With or without a mutual source of infection, common physical and social environment could endow them with shared risk, and that is the issue explored in this study.

Identifying Sibling Influence

Eight of the 55 sib sets in this study group included one or more members who were seropositive for HIV. The sibling sample (numbering 124 in all) showed an HIV seroprevalence rate of 9.7 percent (not significantly different from the 8.4 percent prevalence in the full assayed sample of 287) (Brunswick et al. 1993).

Gender-specific infection rates within the sib sample were 6.5 percent for females and 12.9 percent for males, once again not significantly different from the full assayed sample rates of 6 percent and 10.8 percent for females and males, respectively.

The kappa statistic, an intraclass correlation coefficient (Cohen 1960; Fleiss 1981; Hale and Fleiss 1993), was used to measure the concordance, or agreement, in serostatus within sib sets compared with that observed between sib sets.' The observed intraclass coefficient was 0.433771, standard error (s.e.) = 0.118422. A coefficient of this magnitude carries a probability of less than 0.001 that the observed concordance in sib results could have arisen by chance. This finding means that if one sib was positive, there was the likelihood of one or more other siblings also being infected. This also means that, when one sib was negative, the likelihood that others also were negative was well in excess of what could have arisen by chance.

In concrete terms, what was observed was that 7 of 12 seropositives in the sibling sample clustered in only 3 multiply infected sib sets. This was highly significant, not only as determined by the kappa test of

concordance, but also when replicated in a probability analysis of paired seropositive siblings. This procedure yielded a 0.009 probability of selecting a seropositive dyad at random from the overall sibling sample. Finding seven seropositives clustered in three sets had a probability that was ninetyfold greater than this overall probability. Some nonrandom processes were inferred to be at work to explain why close to 60 percent of all HIV-infected individuals from 55 sib sets were found in just 3 sib sets.

The obvious first step was to test the hypothesis that this finding resulted from shared patterns of injecting drug use. To test whether the observed sibling concordance was, in fact, capturing homophily in injecting drug use behavior, the same statistical analysis was repeated, with injecting drug use replacing HIV status as the dependent variable. This analysis yielded a kappa coefficient of 0.026755, s.e. = 0.1153 18 and a clearly nonsignificant z = 0.232. Without any scientific literature to suggest alternative hypotheses, the present exploratory study was designed to generate hypotheses to explain the observed familial concordance in HIV and, more specifically, to seek alternate explanations to direct sib-to-sib transmission.

Guided by an ecological model of behavioral influences (Bronfenbrenner 1979; Brunswick 1985, in press-u), 10 potential domains of influence were selected for testing, domains that captured social and physical as well as distal and proximal influences, in addition to intraindividual attributes. Distributions on these variables were examined to see if they correlated with the sibling clustering in HIV infection. In conceptual and methodological terms, this is an exploratory and descriptive investigation that hopefully will be followed by more purposively designed and causal analyses of factors that influence sibling homophily in HIV infection. (Note that this study was completed before the New Jersey health department reported two cases of brother-to-brother transmission of HIV infection in the absence of the commonly defined risk exposures [Brownstein and Fricke 1993].)

METHODS

Survey data covering a broad range of biopsychosocial domains have been collected from this uniformly African-American panel at four periods between 1968 and 1990. For the present analysis, the sample has been restricted to a subset (numbering 124) of respondents who were

interviewed in the fourth study wave (conducted between August 1989 and December 1990), who both agreed to have their blood drawn for research purposes only to test for the presence of HIV antibodies and who had at least one other sibling in the study who also was interviewed and had blood drawn in the fourth study wave. General procedures followed in the fourth study wave have been described in Brunswick and colleagues (1993).

To test for differential distribution on the 10 domains of direct and indirect risk factors, the sibling sample was subdivided into four HIV relational groups: (1) clustered or multiply infected sibs (those with at least one other seropositive sibling in the sample); (2) discordant or isolated seropositive sibs (positives from sib sets where all others were seronegative); (3) isolated or discordant seronegative sibs who had one or more seropositive siblings; or (4) clustered seronegatives who had only uninfected siblings. With the exception of one individual in group 3 who had two infected sibs included in group 1, groups 2 and 3 came from the same sib sets, of which group 2 represented the seropositive members and group 3 the seronegative.

Presumptive evidence for a shared sibling vulnerability to HIV infection was examined for each variable in a three-step fashion. First, reports were compared of siblings grouped into the above classification to see if the clustered positives were markedly different from the other three groups. In such a case, a variable was interpreted as exercising a synergistic effect on infection. Lacking this synergistic effect, the same data were examined to see if the group with homogeneous negative siblings was markedly different from others, in which case that factor's protective influence might be inferred.

The differentiation provided by the sib typology was then compared to the distribution obtained when the sibling sample was simply divided into seropositive and negative individuals. When the sib relational typology yielded stronger differentiation than simply sorting the sample into those HIV positive and negative, the inference that some shared experience or attribute was at work seems justified. In such a case, that variable's relationship to HIV was considered to be mediated by sibling factors. Otherwise, individually distributed conditions were presumed to be operating. When neither a sib-relational nor a simple HIV-positive versus negative difference appeared, that variable was considered unrelated to HIV infection in the sample.

A third analytic procedure compared the distribution of HIV positives and negatives in the nonsibling sample (N = 163) to that observed in the sibling sample. This was done to assess the reliability of observations from the sibling sample regarding linkages to HIV serological status (i.e., the extent to which the sib sample might be taken as representative of the full urban African-American community sample of which it was a part).

The reader is reminded again of the essentially exploratory and descriptive nature of this study. The restricted size of three of the four groups in the sibling typology mitigated against multivariate analysis. Instead, each of the 10 variable domains was examined, one at a time, for sibling mediation in the measures within it. Tests of significance, chi square and Fisher exact test (Fleiss 1981) for categorical variables and t-test for interval measures, were performed to guide the interpretation of results. Their inclusion does not imply a hypothesis-testing level of investigation. These tests were used as indicators of the magnitude of observed differences. (More detailed specification of the independent variables and results of significance tests are available from the chapter authors.)

Finally, the homogeneous African-American sample that contributed these results limits generalizing findings to other groups before appropriate replication is performed on samples of those populations.

FINDINGS

Analysis of Correlates of Seropositivity

The disposition of sibs into the four-group relational typology is shown in table 1. Table 2 presents results of the analysis of influences on sero-status. The first four columns show the results of the test for mediation effects using the sibling typology. Results are shown for significance tests that were run on all 62 independent variables comparing group 1 to all others or comparing group 4 to all others. Special attention should be given to those measures where clustered positives (group 1) or clustered seronegative respondents (group 4) differed from the remaining groups. Variables in table 2 are grouped into 10 domains: (1) HIV-risk practices and drug use; (2) macrosocial influences and early socialization exposures; (3) sib proximity and cohesion; (4) nonsib social supports; (5) risk networks; (6) role attainment/social position; (7) psychosocial

TABLE 1. *Distribution of siblings in HIV typology.*

		Positive		Negative	
		Two or More Sibs Positive	All Other Sibs Negative	One or More Sibs Positive	All Sibs Negative
		(++)	(+-)	(-+)	(--)
Sibsets Size	No. of Sets				
4 (N = 3)	1		1	3	
	2				8
3 (N = 8)	1	3			
	1	2		1	
	6				18
2 (N = 44)	1	2			
	1		1	1	
	1		1	1	
	1		1	1	
	1		1	1	
	39				78
Total	55	7	5	8	104

outlooks; (8) HIV perceptions, knowledge, and attitudes; (9) long-term somatic and psychological health; and (10) blood serology.

The next section of table 2, headed “All siblings,” shows each variable’s relation to serological status, independent of the type of sibship. Significance tests were run on these for gender and also for total positives versus negatives.

Table 3 repeats the sib findings classified by gender and seropositivity, and alongside them are data from “nonsiblings” similarly classified.

Overall Patterns

In brief, statistically significant associations (at p = 0.10 or less) were found for 37 of the 62 variables. All but six of these (i.e., 3 1 variables)

TABLE 2. *Sibling influences on HIV-Z (in percents, unless otherwise noted).*[1]

	Sibling Group[2]				All Siblings[3]				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
Composition									P
Male	57	68	74	46#	—	—	—	—	NS
Cohort 1951-1954	66	51	74	44#	56	67	51	43	NS
HIV Risk Factors									
A. Risk Exposures									
IDU 1978	77***	50	18	4	56**	83***	10	2	***
Needle risk	77***	24	18	5	43***	83*	8	4	***
Sex with IDU (women only)	0	50	0	15	—	11	—	15	NS
Homosexual, 1978 (men only)	40**	25	25	0	33***	—	3	—	NS
Total partners (% 2/more)	56	33	36	40	44	50	37	43	NS

1 All results reflect a small sample adjustment-a weighting-for differential ratios in initial recruitment into sample of younger adolescents (ages 12-15), who were twice as likely to be selected as older adolescents (ages 16 and 17). Fractional weights were applied to avoid inflating the aggregate numbers (see Brunswick and Josephson 1972).

2 Conventional significance notations (p) are included to indicate the magnitude of intergroup differences. Their purpose is descriptive: # < 0.10 > 0.05; * ≤ 0.05; ** ≤ 0.01; *** ≤ 0.001. Notation alongside group 1 indicates difference tested against all other individuals. Similarly, when significance notation appears for group 4. it refers to the contrast with all other groups. NS = not significant

3 Significance of all siblings within gender and total group. Seropositive versus seronegative are indicated in "Total" column. Gender-specific significance is indicated by a superscript in the "HIV Pos" column for appropriate gender.

TABLE 2. *Sibling influences on HIV-i (in percents, unless otherwise noted) (continued).*

	Sibling Group				All Siblings				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
Exchange $ or drugs for sex	44*	16	27	12	22	50#	12	16	P NS
B. Preventive Practice									
Positive behaviors (% 5/more)	33	50	45	72**	33#	50	68	72	*
C. Substance Use Patterns									
Cigarette (more than 1/2 pack per day)	56	33	36	23	44	50	15	32	NS
Alcohol (5/more drinks a few times/week)	44	66	54	23***	44	67#	24	28	*
Number of drugs (group means)	3.9*	2.6	3.2	2.0	3.0	4.0**	2.4	1.8	*
Crack use	56*	16	45	17	33	50*	27	12	#

met the $p \leq 0.05$ significance criterion. This number clearly is in excess of what would have occurred by chance, even if one acknowledges the likely collinearity of certain measures *within* domains. The predominant pattern of association supported a synergistic effect where clustered seropositive sibs were distinguished from the other three groups. Almost three-quarters (73 percent) of all significant effects (27 of 37) and 44 percent of all 62 tested variables conformed to this pattern. Ten additional variables exhibited a significant individual-level effect only for one or both genders. On these 10 variables, the two seropositive groups

TABLE 2. *Sibling influences on HIV-I (in percents, unless otherwise noted) (continued).*

	Sibling Group				All Siblings				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
Macro Influences									P
A. Antecedent SES									
Mom's ed. (elem. school only)	100***	0	18	23	56#	67#	22	23	*
Birthplace (North)	100	100	100	58***	100**	100*	57	66	***
Welfare household	67	50	72	45#	67	50	44	50	NS
Mobil. (residence change)	11*	100	72	43	56	20	53	38	NS

were distinguished from the two seronegative groups without demonstrating any synergistic sibling effect.

Risk Factors

Clustered seropositives scored higher on five of six HIV-risk exposures. A larger percentage of that group reported a history of intravenous drug use, risky needle practices, had exchanged money or drugs for sex (female linked), had engaged in male-to-male sex (obviously male linked), and reported multiple sex partners during the prior 5 years. In contrast, the isolated seropositives had risk behavior profiles that were not noticeably different from the seronegative groups except for an elevated report of intravenous drug use (but not of poor needle practices). The concordant negative group was noticeable for the absence of male homosexual risk, an observation that was not fully accounted for by the

TABLE 2. *Sibling influences on HIV-i (in percents, unless otherwise noted) (continued).*

	Sibling Group				All Siblings				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
B. Area Ecological Conditions									P
Poverty (census track 35%+)	77	48	54	51	43	100*	43	58	NS
Poverty district (poor, very poor) [a]	77*	74	54	57	57	100	48	64	#
Neighbor HIV rate [b] 401+ per 100,000 persons (1991)	100	100	82	94	100	100	89	96	NS
ZIP Code HIV rate [c] 401+ per 100,000 persons (1990)	23	—	27	35	29	—	36	33	NS
Sibling Propinquity									
Same or adjacent ZIP Code	100**	49	54	69	67	100*	58	66	NS

a Empirical classification of ZIP Codes was based on proportions of subsumed census tracts in poverty. Proportions shown are in ZIP Codes where all subsumed census tracts are poor.

b HIV neighborhoods defined as in NRC 1993. Classified high if 401 or more HIV cases per 100,000 population in 1991.

c Data obtained through New York State AIDS Institute, cases as of 1990. Classified high if 401 + HIV cases per 100,000 population.

TABLE 2. *Sibling influences on HIV-I (in percents, unless otherwise noted) (continued).*

	Sibling Group				All Siblings				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
Live with "other" relatives	66*	16	9	28	22	83*	30	22	P NS
Social Support									
Sibling helpers (group mean)	1.7	1.6	1.1	1.3	1.8	1.5	1.4	1.1	NS
Other relative helpers (group mean)	2.3*	3.8	6.8	4.9	3.2*	2.3	5.9	4.4	*
Other helpers (group mean)	1.8	2.2	3.2	2.8	2.6	1.0	3.3	2.4	NS
Number of helpers (group mean)[d]	5.7#	7.7	11.1	9.0	7.6	4.8	10.6	7.9	#
No helpers (prob. av.)[e]	1.1	0.2	0.2	0.4	0.2	1.5*	0.4	0.5	NS
Risk Network									
Drugs	79	83	55	56	89	67	60	51	#
Sex	56*	0	27	15	33	33	16	16	NS

a. Empirical classification of ZIP Codes was based on proportions of subsumed census tracts in poverty. Proportions shown are in ZIP Codes where all subsumed census tracts are poor.

b. HIV neighborhoods defined as in NRC 1993. Classified high if 401 or more HIV cases per 100,000 population in 1991.

c. Data obtained through New York State AIDS Institute, cases as of 1990. Classified high if 401 + HIV cases per 100,000 pop,

d. Summed across five potential problem areas.

e. Mean number of problems, summed over five, for which no help at all was available.

TABLE 2. *Sibling influences on HIV-I (in percents, unless otherwise noted) (continued).*

	Sibling Group				All Siblings				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
Social Attainment									P
Incompl. h.s.	66*	49	17	22	33	100**	20	24	*
Work (not working)	66	32	54	41	22	100**	34	48	NS
Welfare 1989-90	61	19	45	33	12	100**	26	41	NS
Never married	100**	66	91	54	78	100*	61	54	*
Became parent by 17	77***	16	9	17	33#	83**	8	24	**
# children (3 or more)	21	33	45	33	11#	50	27	41	NS
Psychosocial									
Religiosity adolescent 1968-1969 (group mean)	0.41	-0.57	-1.48	0.30*	0.06	-0.04	-0.03	0.30	NS
Religiosity early adult	-0.24	-1.44	-0.42	0.18*	-0.84*	-0.53	0.44	-0.12	#
Adolescent alienation (group mean)	2.2	2.1	2.5	2.5	1.9*	2.6	2.5	2.6	*
Young adult alienation	2.5	2.1	2.6	2.2#	2.2	2.6	2.1	2.3	NS
Adolescent personal efficacy (group mean)	7.2#	9.2	8.7	8.2	9.1	5.6**	8.2	8.3	NS
Young adult personal efficacy	7.7	8.6	8.2	8.7	8.7	7.1#	8.7	8.6	NS
Adolescent self-esteem (group mean)	9.3	10.2	8.7	8.4*	10.4**	8.0	8.7	8.2	*
Early adult self-esteem	7.8*	10.0	10.4	9.4	9.8	7.0***	10.0	9.1	#

TABLE 2. *Sibling influences on HIV-I (in percents, unless otherwise noted) (continued).*

	Sibling Group				All Siblings				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
HIV Knowledge, Attitude, and Beliefs									P
Knows symptoms (group mean)	1.7	3.2	3.1	2.0#	3.1*	1.0#	1.8	2.3	NS
Misinformed (group mean)	3.8	0.9	2.3	2.6	2.8	2.3	2.9	2.2	NS
Vulnerability (% high)	13	16	—	1#	12	17#	2	—*	*
Worry (% high)	100**	100	72	60	100**	100*	62	60	***
Severity (% high)	89	66	91	80	67	100	83	79	NS
Behavior efficacy (group mean)	8.1	9.0	9.2	8.8	8.6	8.5	8.9	8.8	NS
Salience (% high)	46	33	91	51	56	17	64	46	NS
Health and medical care (self-report)									
A. Physical Postadolescent number self-reported health problems (group mean)	10.6**	7.5	8.1	5.9	9.7**	8.8	5.2	6.9	*
Young adult number self-reported health problems (group mean)	8.2	4.0	9.9	4.6**	6.9	5.8	4.1	5.8	NS
Ages 32-38 number self-reported health problems (group mean)	13.8**	6.3	8.9	6.6	10.9**	10.7	4.8	8.6	*

TABLE 2. *Sibling influences on HIV-1 (in percents, unless otherwise noted) (continued).*

	Sibling Group				All Siblings				
	HIV Pos		HIV Neg		HIV Pos		HIV Neg		Total
	Concord (+ +)	Discord (+ -)	Discord (- +)	Concord (- -)	M	F	M	F	
N =	(7)	(5)	(8)	(104)	(8)	(4)	(54)	(58)	(124)
HIV symptoms (% any)	44*	50	9	13	44*	50#	8	16	P **
STD symptoms (% any)	—#	32	18	18	—	33	24	13	NS
B. Psychological									
Postadolescent psych. symptoms (group mean)	39	23	22	29	29	38	23	33	NS
Psych. symptoms, ages 32-38 (group mean)	35*	12	21	17	16	42#	14	21	NS
Postadolescent subjective distress (group mean)	0.4	-0.4	0.1	-0.1	0.1	-0.1	-0.2	-0.0	NS
Young adult subjective stress (group mean)	1.0**	-0.7	-0.0	-0.1	0.1	-0.1	-0.3	0.1	NS
C. Medical Care									
Private MD or health insurance	13	76	—	38	57	—#	33	36	NS
Serology									
Hepatitis B	79***	19	46	19	62#	50#	27	17	**
Hepatitis C	67***	—	56	10	50	33	21	8	*
Syphilis	11	19	27	4	12	17	8	12	NS

TABLE 3. *Influences on HIV: Siblings and nonsiblings[1] (in percents, unless otherwise noted).*

	Siblings					Nonsiblings[2]				
	HIV Pos		HIV Neg		Total	HIV Pos		HIV Neg		Total
	M	F	M	F		M	F	M	F	
N =	8	4	54	58	124	7	3	75	78	163
Composition					P					P
Male	—	—	—	—	—	—	—	—	—	—
Older cohort 1951-1954	56	67	51	43	—	50	75	41	49	—
HIV Risk Factors										
A. Risk Exposure										
IDU 1978	56**	83***	10	2	***	12	100***	10	4	**
Needle risk	43*	83***	8	4	***	12	100***	9	1	***
Sex with IDU (women only)	—	11	—	15	—	—	100	—	12	***
Homosexual, 1978 (men only)	33***	—	3	—	***	38	—	2	—	**
Total partners (% 2/more)	44	50	37	43	—	71	50	66	48	—
Exchange $ or drugs for sex	22	50#	12	16	—	38#	25	12	11	—
B. Preventive Practice										
Positive behaviors (% 5/more)	33#	50	68	72	*	38	75	58	0	—

1. Conventional significance notations are included to indicate the magnitude of intergroup differences. Their purpose is descriptive: # < 0.10 > 0.05; * ≤ 0.05; ** ≤ 0.01; *** ≤ 0.001.

2. Significance tested positives versus negatives within gender and total seropositive versus total seronegative.

TABLE 3. *Influences on HIV: Siblings and nonsiblings[1] (in percents, unless otherwise noted) (continued).*

	Siblings					Nonsiblings[2]				
	HIV Pos		HIV Neg		Total	HIV Pos		HIV Neg		Total
	M	F	M	F		M	F	M	F	
N =	8	4	54	58	124	7	3	75	78	163
C. Substance Use Patterns					P					P
Cigarette (more than 1/2 pack per day)	44	50	15	32	—	88***	75	20	30	—
Alcohol (5/more drinks a few times/week)	44	67#	24	28	*	38	25	22	22	—
Number of drugs (group means)	3.0	4.0**	2.4	1.8	*	3.0	3.2*	2.3	1.6	*
Crack use	33	50*	27	12	#	38	25	20	14	—
Macro Influences										
A. Antecedent Influence										
Mom's ed. (elem. school only)	56#	67#	22	23	*	43#	50#	9	9	*
Birthplace (North)	100**	100*	57	66	***	100	100	86	80	*
Welfare household	67	50	44	50	—	50	100#	48	45	—
Mobil.	56	20	53	38	—	—	25	24	40	#

1. Conventional significance notations are included to indicate the magnitude of intergroup differences. Their purpose is descriptive: # < 0.10 > 0.05; *≤ 0.05; ** ≤ 0.01; *** ≤ 0.001.

2. Significance tested positives versus negatives within gender and total seropositive versus total seronegative.

TABLE 3. *Influences on HIV: Siblings and nonsiblings[1] (in percents, unless otherwise noted) (continued).*

	Siblings					Nonsiblings[2]				
	HIV Pos		HIV Neg		Total	HIV Pos		HIV Neg		Total
	M	F	M	F		M	F	M	F	
N =	8	4	54	58	124	7	3	75	78	163
B. Area Ecological Conditions					P					P
Poverty (census track 35%+)	43	100*	43	58	—	62	75	49	65	—
Poverty district (poor, very poor)[a]	57	100	48	64	#	62	25	60	67	—
Neighbor HIV rate[b] 401+ per 100,000 persons (1991)	100	100	89	96	—	75	75	88	91	—
ZIP Code HIV rate[c] 401+ per 100,000 persons (1990)	29	—	36	33	—	12	50	20	25	—
Sibling Propinquity										
Same or adjacent ZIP Code	67	100*	58	66	—	—	—	—	—	—
Live with other relatives	22	83*	30	22	—	—*	25	37	22	—

a. Empirical classification of ZIP Codes based on proportions of subsumed census tracts in poverty. Proportions shown are in ZIP Codes where all subsumed census tracts are poor.

b. HIV neighborhoods defined as in NRC 1993. Classified high if 401 or more HIV eases per 100,000 pop. in 1991.

c. Data obtained through New York State AIDS Institute, cases as of 1990. Classified high if 401 + HIV cases per 100,000 population.

TABLE 3. *Influences on HIV: Siblings and nonsiblings[1] (in percents, unless otherwise noted) (continued).*

	Siblings					Nonsiblings[2]				
	HIV Pos		HIV Neg		Total	HIV Pos		HIV Neg		Total
	M	F	M	F		M	F	M	F	
N =	8	4	54	58	124	7	3	75	78	163
Social Support					P					P
Sibling helpers (group mean)	1.8	1.5	1.4	1.1	—	1.9	1.0	1.1	1.1	—
Other relative helpers (group mean)	3.2*	2.3	5.9	4.4	*	5.6	5.3	5.1	4.3	—
Other helpers (group mean)	2.6	1.0	3.3	2.4	—	2.5	1.2	3.6	2.8	—
Number of helpers (group mean)	7.6	4.8#	10.6	7.9	—	10.0	7.5	9.7	8.1	—
No helpers (group mean)	0.2	1.5*	0.4	0.5	—	0.2	1.0	0.7	0.4	—
Risk Network										
Drugs	89	67	60	51	#	62	75	58	43	—
Sex	33	33	16	16	—	50*	25	16	22	#
Social Attainment										
Incomplete h.s.	33	100**	20	24	*	38	75*	19	15	*
Work (not working)	22	100**	34	48	—	38	100**	31	34	#
Welfare 1989-90	12	100**	26	41	—	25	75#	25	26	—
Married (never)	78	100*	61	54	*	62	75	47	56	—
Became parent by 17	33#	83**	8	24	**	25	100**	9	20	*

TABLE 3. *Influences on HIV: Siblings and nonsiblings[1] (in percents, unless otherwise noted) (continued).*

	Siblings					Nonsiblings[2]				
	HIV Pos		HIV Neg		Total	HIV Pos		HIV Neg		Total
	M	F	M	F		M	F	M	F	
N =	8	4	54	58	124	7	3	75	78	163
% children (3 or more)	11#	50	27	41	P —	25	100*	18	25	P *
Psychosocial										
Religiosity adolescent (group mean)	0.06	-0.04	-0.03	0.30	—	-0.50	-0.73	0.13	0.17	—
Religiosity early adult	-0.84*	-0.53	0.44	-0.12	#	-0.27	0.46	-0.03	-0.12	—
Adolescent alienation (group mean)	1.9*	2.6	2.5	2.6	#	2.4	3.0	2.4	2.5	—
Young adult alienation	2.2	2.6	2.1	2.3	—	2.3	2.2	2.2	2.1	—
Adolescent personal efficacy (group mean)	9.1	5.6**	8.2	8.3	—	8.2	6.2**	8.6	9.1	*
Young adult personal efficacy	8.7	7.1#	8.7	8.6#	—	7.6	4.8***	8.8	8.8	***
Adolescent self-esteem (group mean)	10.4**	8.0	8.7	8.2	*	9.5	8.5	8.9	8.7	—
Early adult self-esteem	9.8	7.0**	10.0	9.1	#	9.3	8.0	9.5	9.1	—
HIV Knowledge, Attitude, and Beliefs										
Knows symptoms (group mean)	3.1	1.0#	1.8*	2.3	—	3.2#	2.5	2.1	2.6	—
Misinformed (group mean)	2.8	2.3	2.9	2.2	—	2.2	2.0	2.3	2.0	—
Vulnerability (% high)	12**	17#	2	—	*	12	25	—	—	*

TABLE 3. *Influences on HIV: Siblings and nonsiblings[1] (in percents, unless otherwise noted) (continued).*

	Siblings					Nonsiblings[2]				
	HIV Pos		HIV Neg		Total	HIV Pos		HIV Neg		Total
	M	F	M	F		M	F	M	F	
N =	8	4	54	58	124	7	3	75	78	163
Worry (% high)	100**	100*	62	60	P ***	100**	100#	60	66	P **
Severity (% high)	67	100	83	79	—	75	100	64	78	—
Behavior efficacy (group mean)	8.6	8.5	8.9	8.8	—	9.0	8.8	8.7	8.6	—
Salience (% high)	56	17	64	46	—	25	50	55	57	—
Health and Medical Care (Self-Report)										
A. Physical										
Postadolescent self-reported health problems (group mean)	9.7**	8.8	5.2	6.9	*	6.8	14.2**	4.2*	6.6	**
Young adult self-reported health probs. (group mean)	6.9	5.8	4.1	5.8	—	5.6	24.8***	3.8	6.1	***
Ages 32-38 self-reported health problems (group mean)	10.9**	10.7	4.8	8.6	*	6.9	34.0***	5.6	8.0	***
HIV symptoms (% any)	44*	50#	8	16	**	25	50#	17	12#	—
STD symptoms (% any)	—	33	24	13	—	38	25	28	15	—
B. Psychological										
Postadolescent psych. symptoms (group mean)	29	38	23	33	—	31	72***	27	27	*
Psych symptoms, ages 32-38 (group mean)	16	42#	14	21	—	15	72***	18	20	#

TABLE 3. *Influences on HIV: Siblings and nonsiblings' (in percents, unless otherwise noted) (continued).*

	Siblings					Nonsiblings[2]				
	HIV Pos		HIV Neg		Total	HIV Pos		HIV Neg		Total
	M	F	M	F		M	F	M	F	
N =	8	4	54	58	124	7	3	75	78	163
Postadolescent subjective distress (group mean)	0.1	-0.1	-0.2	-0.0	—	0.6*	1.2*	-0.2	0.1	**
Young adult subjective distress (group mean)	0.1	-0.1	-0.3	0.0	—	0.5	1.5**	-0.1	0.1	*
C. Medical Care										
Private MD or health insurance	57	#	33	36	—	50	#	30	41	—
Serology					(N)=	(3)	(3)	(68)	(74)	(148)
Hepatitis B	62#	50#	27	17		67	100	18	25	***
Hepatitis C	50	33	21	8		33	100*	8	14	***
Syphilis	12	17	8	12		67*	—	—	—	***

somewhat higher proportion of women in that group (table 2). Confirming their reduced risk exposure, concordant negatives scored lowest (or shared lowest position) on all risk factors. Consistent with this, they scored highest on a computed scale of behaviors protective against HIV (e.g., monogamy, condom use, clean needles). The clustered positives clearly scored lower than others on the protective behavior scale.

Drug Use Patterns

Excepting alcohol, the clustered seropositives scored highest on all drug consumption measures. The isolated positives reported a smaller amount

of illicit drug use than the discordant negatives (i.e., little crack use and a somewhat lower lifetime average number of drugs). The clustered negative sibs reported the lowest amount of use of all recreational substances.

Macrosocial Influences

Gender and Cohort. As has been true generally in the United States, males in this study cohort evidenced higher infection rates than females (Brunswick et al. 1993). Accordingly, males outnumbered females in all but the clustered negative group within the sibling typology. The ratio of men was highest in the two discordant groups. It would seem that, once at risk, being part of a multiply infected set reduced the gender gap and increased female risk.

Regarding birth cohort, given the diminished heroin use among younger cohorts that long has been observed in this study panel (Brunswick and Boyle 1979), the fact was not surprising that a higher proportion of younger cohort members (i.e., those born in the late 1950s) appeared in the clustered negative sib sets than in the others. Examined by gender, however, the cohort effect was substantial only for women. This was a likely consequence of selection factors arising from the excess mortality experienced among older male heroin users in the study cohort.

Historic (Background) Socioeconomic Status. Even within this relatively homogeneous cohort of urban African Americans, background characteristics sharply differentiated the sibling typology: Little education for the mother (elementary school only) as well as reduced geographic mobility characterized the multiply positive sib sets. Of particular note, all HIV-infected individuals in this sample (nonsibs as well as sibs) were northern born, as were discordant negatives (those who had one or more positive siblings)[2]. This compared to three-quarters of the full sample who were northern born.

Geographic Context (Current). Neither the sib types nor individually classified positives and negatives showed significant geographic variation as measured by poverty status of area of residence. When the sib sample was grouped according to gender and serostatus, however, an area difference appeared for women only: The small group of infected female sibs were concentrated in census tracts where greater than 35 percent of households were at or below the poverty level (i.e., lived in the poorest areas).

When census tracts were reassembled into broader neighborhood districts similar to those that had been used to classify HIV rates in a recent National Research Council report (National Research Council 1993), neighborhood infection rate did not differentiate positives and negatives in this sample: 100 percent of clustered positives versus 94 percent of concordant negative sib sets lived in high infection areas (classified as 401 and over HIV cases per 100,000 persons).

Sibling and Other Social Support

Sibs in the clustered seropositive sets reported greater proximity to one another—both spacial and social-than was seen in other groups. They all lived in the same or an adjacent ZIP Code, compared to 49 percent of discordant infecteds who lived near their sibs. Multiply infected sets also were more likely to live with relatives who were not spouses or children (taken as a possible proxy for living with sibs). Concordant infected sibs received less help for their life problems (money, health, etc.) from family members (other than sibs). The deficit in social support extended across infected females as well as males where support networks of the uninfected were clearly larger than for infected. Furthermore, clustered and isolated seropositives (i.e., all infected sibs) were more likely to report receiving help and advice from their siblings than seronegative respondents. Clustered and isolated seropositives, however, parted company with respect to general social supports: Sibs from multiply infected sets received less help from other family members, from peers, and from professional sources than did sibs in the other three groups.

Risk Networks

Increased reports of risky sexual networks (i.e., having friends who are prostitutes, bisexuals, or homosexuals) differentiated the clustered seropositives from the other sib types. Meanwhile, better than half the respondents in all sib types had drug-using friends, a clearly nondistinguishing measure in this sample.

Social Attainment

To be congruent with findings already reported, those in multiply infected sib sets might be expected to show reduced social attainment and the weaker ties to conventional institutions that are associated with it. Clustered positives did score most poorly on five of the six indicators in this domain, particularly on early parenting, never having been married,

and failure to complete high school. Gender, however, was a more powerful mediator than sib status in these relationships. Education and marriage discriminated between infected and uninfected women but not men, as did unemployment and welfare. Early parenting showed less distinct gender variation.

That these variables discriminated more strongly among women than men is consistent with other analyses of this longitudinal cohort that have shown African-American women to be better integrated into dominant culture norms than their masculine counterparts (Brunswick et al. 1992, pp. 4 19-472). This suggests that gender predominates over sibling context in the relationship between social attainment and HIV infection.

Psychosocial Attitudes

Psychosocial measures were examined both from the prior study wave 6 years earlier and also from subjects' adolescence 22 years earlier. The mixed results led to the conclusion that, whatever their etiological role in HIV, effects of psychosocial factors were not mediated by sibling status.

HIV Knowledge, Attitudes, and Beliefs

The few differences in this domain, perceived vulnerability and worrying about getting or having AIDS, were differentiated better by serological status than by sibship (i.e., sibling context did not influence these individual-level, HIV-centered attitudes and beliefs).

Health and Medical Care

At all study times (t_2 at ages 18-23 in 1975-76, t_3 at ages 26-31 in 1983-84, and concurrently t_4 at ages 32-38 in 1989-90), those in multiply infected sibsets reported more health problems than the concordantly negative and isolated positives. Isolated negatives were sicker than isolated positives at all study times. (General health was associated with serostatus in the nonsib sample as well.)[3] Conditions that might be associated with HIV infection, expectedly, were reported more often by those infected than those not infected, regardless of sibship. A history of sexually transmitted diseases showed no clear association with HIV in this cohort.

Clustered seropositives also gave evidence of greater psychological and emotional burden than did other sib groups. In both the past and present,

they reported more psychological (affective) symptoms and strain (dissatisfaction with varied aspects of their lives) (see also Brunswick et al. 1992). Isolated seropositives were more similar to the clustered seronegatives on these measures. The former reported fewer psychological as well as health problems (somatic) than were reported by isolated seronegatives.

Despite their high number of health problems, the clustered positive sibs, along with the discordant negative sibs, least often had a regular doctor in private practice or a health maintenance organization. The isolated positives reported the highest rates of regular physician care.

Serology

In this particular study, serology analysis (for markers of hepatitis B and C and syphilis) was performed as a validity check on self-reported risk behavior. Hepatitis markers were consistent with the greater risk exposure reported by clustered infected sibs (see section on "Risk Factors," above). Less clear, however, was why-on the hepatitis markers, which could be linked to parenteral drug use-discordant seronegative sibs were more similar to clustered positives than negatives. The reverse was observed for discordant positives, whose hepatitis marker levels were closer to those observed in the clustered negative sib group.

CONCLUSION

The study discussed here was exploratory in the true sense of the word. It represents an attempt to identify influences that might be linked to the unexpected sibling concordance in HIV infection that was observed in this uniform African-American community sample, a concordance that well exceeded what could have been expected by chance. No corresponding sibling concordance appeared in injecting drug use. The findings, overall, implicate historical factors (i.e., family background) and biological ones (i.e., earlier health status) as synergistic factors associated with increased HIV seropositivity risk. As such, these findings fit in with other analyses of the study cohort that demonstrate the enduring effects of early poor health status and of social factors in increasing vulnerability to HIV infection (Brunswick, in press-b; Brunswick and Titus, unpublished manuscript).

In addition, this analysis of sibling sets who were concordant and discordant with respect to HIV infection has suggested two pathways of susceptibility to infection. One is systematic and can be linked to an array of historical, social, and biological factors that appear synergized in sibling sets. This pathway applied to better than half (58 percent) of the infecteds within the sibling sample. This finding carries an implication for the utility of determining sib-set membership in infected persons and targeting familial prevention or intervention efforts when an HIV seropositive is diagnosed within a sibling network.

Discordant or isolated seropositives, who lacked most of the biopsychosocial detriments that were in evidence among those in multiply infected sib sets, suggest the other, more random trajectory or pathway to infection. This group, indeed, was offset by the random or discordant negatives whose biological deficits exceeded their randomly infected counterparts and who, as yet, had remained seronegative. Whether the latter's absence of infection was simply a matter of timing will be tested when the 3-year followup data, currently being collected, are analyzed.

In addition to the insights gained here about sibling correspondence in biopsychosocial risk factors, a good correspondence between blood serology and self-reported risk factors and health status was demonstrated. The differential in hepatitis markers between discordant seropositives and seronegatives, however, where seronegatives evidenced higher rates than seropositives, was counterintuitive and puzzling although not contradictory to the self-reported health data. Together with the random pathway logic discussed above, might these be a reflection of variations in vulnerability? That is, the social and biological correlates of HIV seropositivity that predominated in the condordant seropositive sibling group also were in evidence in the discordant seronegatives but absent among the discordant seropositives, leading the authors to call one a random pathway to infection versus unidentified or random protection from infection in the discordant seronegatives.

Returning to the main questions that motivated this analysis, at a minimum these findings demonstrate a congruence in biopsychosocial risks and multiply infected sib networks. While knowledge of risk exposures is a necessary precondition to understanding these phenomena, it seems far from a sufficient one. The study discussed here provides further evidence of the need for taking contextual social factors into account in attempts to modify HIV-infection risk and HIV-risk behaviors.

NOTES

1. Appreciation is expressed to Cecilia Hale, Ph.D., of the Biostatistics Division, School of Public Health, Columbia University, for performing the sibling concordance analysis.

2. Reduced mobility may be the explanatory link to the strong association between HIV infection and northern birthplace. Since Harlem historically was peopled by African-American migrants from the South, the less mobile northern-born would have remained after the more upwardly mobile of the southern migration wave(s) moved out. This "winnowing out" process had not yet occurred among the new first-generation wave from the South.

3. For reasons not readily seen, prior and concurrent general health disadvantage in the nonsib sample was stronger for women than men in the sib sample, it was stronger for men. This conceivably could relate to the diminished gender advantage in HIV-infection status when women had infected sibs. (See section on "Gender and Cohort," second paragraph.)

REFERENCES

Bronfenbrenner, U. *The Ecology of Human Development.* Cambridge, MA: Harvard University Press, 1979.

Brownstein, A., and Fricke, W. HIV transmission between two adolescent brothers with hemophilia. *Morb Mortal Wkly Rep* 42(49):948-951, 1993.

Brunswick, A.F. Health services for adolescents with impairment, disability, and/or handicap: An ecological paradigm. *J Adolesc Health Care* 6(2):141-151, 1985.

Brunswick, A.F. Bringing the context in from the cold: Substantive, technical and statistical issues for AIDS research in the second decade. In: Battjes, R.J.; Sloboda, Z.; and Grace, W.C., eds. *The Context of HIV Risk Among Drug Users and Their Sexual Partners.* National Institute on Drug Abuse Research Monograph 143. NIH Pub. No. 94-3750. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., in press-a.

Brunswick, A.F. Issues in HIV-AIDS natural history research methodology. In: Davenny, K., and Sloboda, *Z.*, eds. *Natural History/Longitudinal Studies of HIV in Drug Users.* National Institute on Drug Abuse Research Monograph 143. NIH Pub. No. 94-3750. Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., in press-b.

Brunswick, A.F., and Boyle, J. Patterns of drug involvement: Developmental and secular influences on age at initiation. *Youth Soc* 11(2):139-162, 1979.

Brunswick, A.F., and Josephson, E. A study of adolescent health in Harlem. Supplement. *Am J Public Health* October: 1-62, 1972.

Brunswick, A.F.; Aidala, A.A.; Dobkin, J.; Howard, J.; Titus, S.P.; and Banaszak-Holl, J. HIV-l seroprevalence and risk behaviors in an African American community cohort. *Am J Public Health* 83(10):1390-1394, 1993.

Brunswick, A.F.; Lewis, C.; and Messeri, P. A life span perspective on drug use and affective distress in an urban African American sample. *J Community Psychol* 19:123-135, 1992.

Brunswick, A.F.; Messeri, P.A.; and Titus, S.P. Predictive factors in adult substance abuse: A prospective study of African American adolescents. In: Glantz, M.D., and Pickens, R.W., eds. *Vulnerability to Drug Abuse.* Washington, DC: APA Press, 1992.

Brunswick, A.F., and Titus, S.P. "Differential Vulnerability: Poor Health as an Antecedent of HIV Infection." Unpublished manuscript.

Cohen, J. A coefficient of agreement for nominal scales. *Educ Psychol Meas* 20:37-46, 1960.

Fleiss, J.L. *Statistical Methods for Rates & Proportions.* 2d Ed. New York: Wiley, 1981.

Hale, C.A., and Fleiss, J.L. Interval estimation for kappa with binary classification under two study designs. *Biometrics* 49:523-534, 1993.

National Research Council. *The Social Impact of AIDS in the United States.* Washington, DC: National Academy Press, 1993.

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Focal Networks and HIV Risk Among African-American Male Intravenous Drug Users

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INTRODUCTION

The prospects appear poor for the development of an effective vaccine to prevent the number of those afflicted with the human immunodeficiency virus (HIV) from rising to perhaps 30 million by the year 2000. As a result, the "one clear message" sounded at the Ninth International Conference on AIDS in Berlin in 1993, according to many observers, was that "prevention is the only way to stop the alarming spread of the virus, HIV, throughout the world" (Altman 1993).

Prevention fundamentally involves either (1) reducing *the risk* associated with the well-known drug-taking and sexual activities that spread the virus or (2) reducing the frequency of the activities themselves. The former might be accomplished, for example, by the distribution of sterile syringes or condoms and the latter by efforts to reduce drug use, the sharing of infectious paraphernalia, or dangerous sexual relations.

The predominant approach toward influencing key groups to change their high-risk behaviors has been education about the causes and consequences of the disease (Koop 1987). Much research indicates, however, that individual awareness of consequences is often not enough-that the causal link between awareness of risks and actual change in high-risk behaviors is tenuous and uncertain (Flynn et al. 1987, p. 93; Jain et al. 1987, p. 42; Kelly et al. 1987, p. 39; Kleinman et al. 1987, p. 196; McAuliffe et al. 1987, p. 40; Solomon and DeJong 1986; Williams 1986). Intervention to change what are usually habitual, intimate, socially embedded behaviors may require more than merely increasing awareness of risks.

Just as education may not play its common role in this pandemic, so also the *usual individualized* conception of disease and treatment may be inappropriate. Individualized clinical treatment may have limited effects if social influences are ignored (Gottlieb 1981, p. 229; Pesce et al. 1987, p. 60; Schuster 1989, pp. 12-13; Yancovitz et al. 1991). It is crucial to appreciate that the high-risk behaviors associated with the spread of HIV are *social* phenomena. Other people are involved, both directly as coparticipants and indirectly in that social supports and pressures either encouraging or opposing risky behaviors may have great influence (Antonucci and Depner 1982, pp. 233-254; Bartlett et al. 1987, p. 41; Cleary et al. 1986; Emmons et al. 1986; Leventhal and Cleary 1980; Stanton and Todd 1982; Sterk and French 1987, p. 196).

Research generally seems to suggest significant associations between social network features, on one hand, and a wide range of health-related behaviors and problems, on the other (Berkmen and Syme 1979; DiMatteo and Hays 1981, pp. 117-148; Romano et al. 1991). Social network characteristics are apparently predictive of such addictive behaviors as smoking and drinking and even the tendency for drug users to seek or benefit from treatment (Caplan et al. 1976; Chassin et al. 1984; Earp 1979; Emmons et al. 1986). Therefore, it is not surprising that network characteristics are one of the six basic elements shared by all of the dozen or more health models reviewed by Ostrow (Ostrow 1986).

Problems also exist with the relevant corpus of research on social networks. Most such research has been very limited in approach and oriented mainly to positive effects. Three of the five literature reviews on networks and health lament the lack of "fine-grained analyses" (Barrera 1981, pp. 69-96). Network research on African Americans, especially males, is particularly lacking. Finally, the current invigoration of network research related to the acquired immunodeficiency syndrome (AIDS) pandemic has tended to stress "risk networks"-chains of persons linked by drug behaviors (or high-risk sexual behaviors). Such research is essential. No less essential is research into the close networks of the focal, potentially high-risk individual.

From this perspective, one can ascertain the relative influences, positive and negative, of the various people in the focal individual's entourage, the positive and negative substructures. The structural configuration of such forces may be decisive in shaping the risk or resistance behaviors of that individual.

The study discussed in this chapter provides data that begin to address the designated needs. It focuses on the social networks of male African-American injecting drug users (IDUs) currently in treatment. Its objective is to determine the significance of their close, focal networks for their high-risk behaviors related to HIV/AIDS. In contrast to previous studies, this work provides data on a crucial but relatively neglected set of respondents, interviewing not only the focal IDU but also those persons he identified as most influential in his life, that is, his "referrals" (RFs).

METHODS

Networks

A social network is a set of actors (individual people in the present case) together with a mapping of one or more sets of social relations onto those actors (e.g., communication, power, kinship, support, or drug sharing). Graphically, these relations are usually indicated by lines or arrows connecting appropriate actors; mathematically, they are represented by matrices. *Focal* networks consist of a designated focal respondent (FR) of prime reference and the RFs named by that FR. Apart from the defining focal links, focal networks can vary in the degree to which their members interact. Unlike many previous studies, in this research an effort was made to interview all referrals. A close network is one for which the network-defining relationship is relatively intimate and significant, such as kinship, strong friendship, or important influence.[1]

Study Population

The research subjects consisted of two groups: (1) 20 male African-American IDUs in clinical treatment in Philadelphia for opioid dependence (FRs) and (2) 85 of the 106 persons these FRs identified as members of their close social networks (RFs).

All FRs were part of a larger project that was studying the spread of HIV among IDUs in and out of treatment (Metzger et al., in press). This larger project included interviews with, among others, a random sample of 152 IDUs selected from the clients in the aforementioned treatment program. The sample of 152 IDUs was stratified by race and gender, and a simple random subsample of 32 male African-American respondents was drawn. Four of these became unavailable (due to death, illness, or imprisonment), leaving 28 who gave informed consent and were

interviewed from 1990 to 1992 along with as many of their RFs as possible, also with informed consent. For 8 of these 28 FRs researchers interviewed less than 60 percent of their total network, so these subjects were dropped from subsequent analyses. For the remaining 20 networks, 83 percent of all network members were interviewed. Comparison of the basic characteristics of the 20 networks that were included and the 8 that were dropped revealed no significant differences in either network or demographic attributes.

Instruments and Procedures

All respondents were interviewed by one of three specially trained interviewers using the same interview schedules and format. The instruments included items from previous public health research and items developed specially for this study.

High-risk drug-taking and sexual behaviors were the criterion (dependent) variables. Three types of predictor (independent) variables were used: (1) the FR's personal demographic characteristics, (2) general network features, and (3) network drug use patterns.

To obtain network information, all respondents were asked to "think about the main people in your life . . . the people who *most affect you (be* it good, bad, or mixed) and also the people you *most affect.* They can be relatives, friends, enemies, neighbors, people at work, people you do things with, and so on-anyone who importantly affects you or whom you affect." No limit was placed upon the number of referrals that could be named.

For each referral named, the interviewer inquired about the connection to the respondent, demographic characteristics, communication, influence, satisfaction, conflict, and other matters. A special format was used to expedite recording such information. Attempts were made to interview all referrals of the focal respondents. Respondents were paid $20 for participating and came to the clinic for most interviews.

Criterion Variables: Drug and Sex Risk

Both drug- and sex-risk variables related to HIV transmission were investigated. Drug risk was assessed via three main criterion variables: (1) whether the respondent injected drugs, (2) whether the respondent shared "works" (i.e., needles, syringes, and other paraphernalia), and

(3) the total number of different drugs the respondent had used during the previous 30 days. Moreover, all three variables were combined with essentially equal weights into a summary drug-risk index.

Sex risk was assessed by four criterion variables: (1) the number of different sex partners during the previous 6 months, (2) having had sex with a prostitute during the same period, (3) having had sex with an IDU during this period, and (4) whether the respondent reported always wearing a condom during sex. These four items were also combined with essentially equal weights (valence reversed for item 4) into a summary sex-risk index.

Predictor Variables

Three types of predictor variables, as noted, were examined: (1) the FR's demographic characteristics, (2) general network features, and (3) the drug use patterns of the RFs.

The demographic factors considered were age, education, employment, household size, marital status, number of children, number of dependents, time at current residence, subjective general health, and time spent watching television.

General network features included network size, percent female, percent relatives, percent of the FR's network claims that were reciprocated by the RFs, percent of reciprocal relations among the RFs, total density, referral density, kin (relatives) density, nonkin referral density, percent of claimed network links that were internal to the network, and the mean number of extra-network links per referral. *Reciprocity* refers to relations in which both individuals have the given relationship to each other (e.g., A influences B, and B influences A). *Density* refers to the number of actual links in the network divided by the maximum number of possible links in a network of that size. It expresses the proportion of the possible links in the network that is actually present. It is thus a rough measure of the degree of integration of the network for the given type of link. It should be noted that focal networks have a minimal density of N-I/N, where N equals the number of people in the network, which is not necessarily true for other types of networks.

The RF drug use patterns examined were: (1) the percent of network RFs using drugs, (2) the percent of RFs who inject drugs, and (3) the mean number of different drugs used by the RFs (excluding alcohol and

methadone), plus a summary index of these three variables. Note that these variables concerned only RFs and were conceptually independent of the FR's risk behaviors.

RESULTS

General Network Features

The basic initial question is whether the focal networks of these 20 male African-American IDUs in treatment are significantly different from most social networks. If not, further analysis would not seem promising.

On initial inspection, the 20 focal networks appear quite normal. The networks of most Americans and Canadians average from 4 to 8 persons in size; the focal networks of 20 IDU respondents averaged 6.3 persons. Most focal networks are racially homogenous; these 20 FR networks were virtually 100 percent African American. Most close focal networks are relatively evenly mixed by gender; in these networks, 51 percent of the RFs were female, and 49 percent were male. Most focal networks have a majority of relatives (i.e., kin); in these 20 networks, 61 percent were relatives. Two-thirds of those relatives (68 percent) were female. The nonkin RFs were thus predominantly male (74 percent).[2]

Most American and Canadian networks have average densities of from about 0.3 to 0.6. In other words, they have roughly 30 percent to 60 percent of the maximal number of links. For the 20 networks in the present study, the average density was 0.456, thus in the middle of the normal range.

There is, however, more to the picture; the superficial perspective is inadequate. When the data are inspected more closely, it appears that the normal density level of these 20 networks comes mainly from the dyadic (two-person) links radiating out from the FR like spokes on a wheel, while linkages among the RFs are unusually meager. The density among the RFs alone, excluding the FR, is but 0.13 1. Three-quarters of the reciprocal links involved the FR, and only one-quarter involved the much more numerous RFs by themselves. This does not mean, however, that reciprocal designation of the FR by his RFs was especially high. Only 43 percent of the FRs' RFs in turn named their FR. In particular, it is interesting to note that although nearly two-thirds of the FRs named their mothers, half of the mothers interviewed did not name their FR sons. In

general, these 20 networks, compared to those of most Americans, appear quite *Hypercentric* about the IDU focal respondent.

Criterion Risk Variables

Despite being in a treatment program forbidding such behavior, 60 percent of the FRs injected drugs, 25 percent shared works, and the average number of different drugs used during the preceding 30 days was 2.3, usually heroin, cocaine or crack, speedball, or marijuana. On the average, the FRs also had 1.75 different sex partners during the preceding 6 months. Over the same period, some 30 percent had sex with a prostitute, 10 percent reported having had sex with another IDU, and 30 percent claimed they always used a condom.

These various drug-risk measures are all significantly related to one another. Injecting drugs and sharing works were positively correlated ($r = 0.47\ 1$, $p = 0.036$), as were injecting and the number of different drugs used ($r = 0.755$, $p < 0.001$) and sharing works and the number of different drugs used ($r = 0.452$, $p = 0.046$). One type of drug risk predicts the other types rather well.

The interrelations among the sex-risk indicators are more varied. Significant correlations exist only between the number of sex partners and having sex with a prostitute ($r = 0.494$, $p = 0.027$) and between sex with a prostitute and sex with an IDU ($r = 0.509$, $p = 0.022$), presumably often the same person.

Perhaps surprisingly, for this sample the correlations between individual drug risk and sex risk were not significant. On the contrary, 9 of the 12 correlations were negative ($p = 0.07$, sign test) though not individually significant. In fact, the correlation between the summary drug-risk and sex-risk indices was $r = -0.190$, also negative though not significant. Therefore, the subsequent analysis will concentrate primarily upon drug risk.

Predictor Risk Variables and FR Drug Use

Demographic Characteristics. The demographic characteristics of the FRs, such as age and education, were the first type of predictor variables examined. Most of the correlations between the FR's demographic characteristics and the four criterion drug use variables (i.e., injecting, sharing works, using a wider variety of drugs, and the summary index)

were insignificant (see figure 1[a]). Overall, the FR's demographic characteristics were poor predictors of drug use.

Network Features. Limited but important associations were found between the general features of the FR's network and drug use (see figure 1[b]). The percent of the FR's relatives in the network was significantly *negatively* correlated with the FR's sharing works ($r = -0.470$, $p = 0.037$) and with his using a wider variety of drugs ($r = -0.466$, $p = 0.038$), while the density of interaction among his nonkin referrals was *positively* correlated with sharing works ($r = 0.429$, $p = 0.165$). This was not statistically significant since only 12 cases were available, the other 8 having too few nonkin RFs for meaningful calculation.

Referral Drug Use Patterns. In contrast to the exiguous associations between the FRs' demographic characteristics and drug risk or the moderate associations between general network features and drug risk, a very broad and strong set of associations existed between the network RFs' drug use and that of the FR. *Every presumably independent referral drug use variable was significantly and positively correlated with every presumably dependent FR drug use variable* (figure 1[c]). These correlations range from a low of 0.349 ($p < 0.10$, one-tail) for that between the percent of RFs who inject and whether the FR injects to a high of 0.697 ($p = 0.001$) for that between the two summary indices, one for drug use by the FR and the other for drug use by his RFs. More than two-thirds of the correlations are at the 0.500 ($p = 0.02$) level or higher, although there is obviously some collinearity. The RFs' summary drug use indices alone "explain" nearly half (48.6 percent) of the variation in the FRs' summary drug use indices.

A majority of the FRs (55 percent) used drugs with at least one of their network RFs. That majority averaged more than two members of their network with whom they used drugs. Of the 27 RFs with whom the FRs did drugs, 41 percent were relatives, and 59 percent were nonkin. Since the RFs in general were at least three-fifths relatives, this means that the FRs who did drugs did so with 17 percent of their relative referrals and with 38 percent of their nonkin referrals-more than double proportionately.

No FR did drugs with parents, grandparents, or children. Spouses, siblings, and cousins made up 91 percent of the kin with whom the FRs did drugs. For the nonkin, 81 percent of the RF drug partners were male

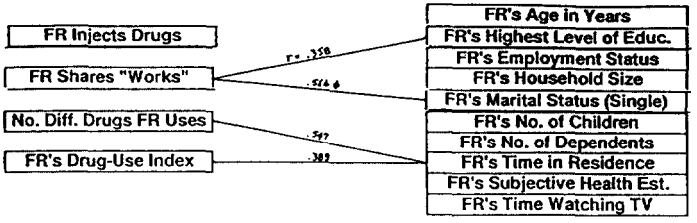

FIGURE 1(a). *Personal demographic characteristics by FR's drug risk variables ($p < 0.10$).*

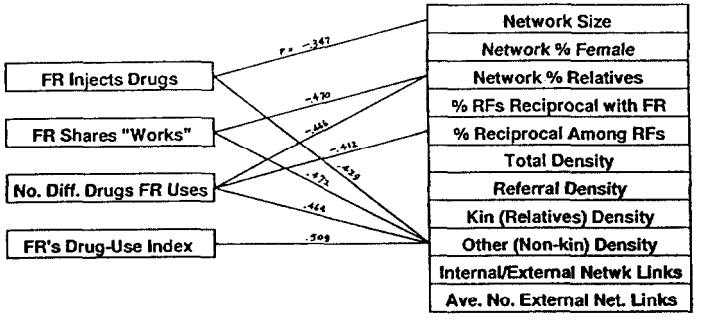

FIGURE 1(b). *Network structural features by FR's drug risk variables ($p < 0.10$).*

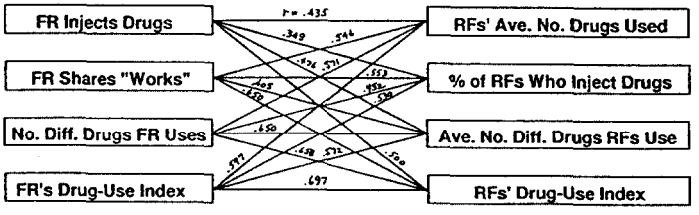

FIGURE 1(c). *Referral drug use patterns by FR's drug risk ($p < 0.05$).*

friends. Of the kin RFs who did drugs with the FR, 36 percent injected; of the nonkin RFs who did the same, 8 1 percent injected.

The correlation of what is perhaps the key criterion variable, FRs sharing works, with the summary drug-risk index for the RFs is 0.650 ($p = 0.002$). More than 42 percent of the variation in sharing works by FRs is "explainable" solely in terms of the drug use behaviors of their RFs (not including the RFs' sharing works). The best single predictor of the FR's sharing works is the percent of his RFs who inject ($r = 0.553$, $p = 0.011$).

Separating the FRs into two groups, those who share works and those who do not, yields yet another perspective. Kin averaged 43 percent of the RFs of those who shared, compared with 66 percent of those who did not ($T = 2.256$, 18 df, $p < 0.05$, two-tail). On the average, 85 percent of the RFs of those FRs who shared works used drugs, compared with only 43 percent of the RFs of those who did not share ($T = 2.763$, 18 df, $p < 0.02$). Similarly, on the average, 45 percent of the RFs of those FRs who shared works injected drugs in contrast to only 13 percent of the RFs of those FRs who did not share ($T = 2.814$, 18 df, p c 0.02). Finally, the average density among nonkin RFs of those FRs who shared was four times the density of the nonkin RFs of those who did not share ($T = 1.501$, 10 df, $p < 0.10$, one-tail).

If the best set of proximate explanatory factors for the FR's drug risk is the pattern of drug use among his network RFs, what factors in the present data best explain that RF drug use? Answer: These explanatory factors are general network characteristics, especially the separate densities of the kin and nonkin RFs in the network, working in opposite directions. In multiple linear regression, with the network RFs' summary drug use index as the criterion variable, these two predictor variables together produced an adjusted r^2 of 0.429, $p = 0.07$. Thus, the separate densities of the relatives and the nonrelatives among the FRs' RFs account for more than 40 percent of the variation in the RFs' summary drug use index, with more density among relatives being associated with less RF drug use and more density among nonrelatives being associated with more RF drug use.

Stepwise Regression Analysis. More than 60 predictor variables were examined, and more than a dozen of these displayed several statistically significant correlations with criterion variables. Therefore, stepwise regression analyses were also performed to sort out their relative

importance. In each analysis, all variables that were conceptually independent of the criterion variable and correlated with it beyond the 0.400 level were taken as predictors.

Focal Respondent's Drug Use

Using the FR's summary drug use index as the criterion variable, three significant predictor variables emerged (minimum tolerance for entry = .01). Most significant was the percent of his network for whom the FR would "get drugs if they needed it" (beta = 0.412), next was the network RFs' summary drug-use index (beta = 0.369), and third was the degree to which the FR approved of drug use (beta = 0.244). Together, these three best predictors "explained" more than 60 percent of the variation in FR drug use (r^2 = 0.606, F-ratio = 10.735, $p < 0.001$). Two of these three predictors are network-related features.

Focal Respondent's Sharing Works

Using the FR's sharing works as the criterion variable, four significant best predictors emerged: (1) the FR's felt risk of getting AIDS (beta = -0.442); (2) the network RFs' summary drug use index once more (beta = 0.412); (3) the FR's marital status (beta = -0.322); and (4) the ratio of what support the FR expected from his network RFs compared to what he would give (beta = -0.291). These four predictors together had an adjusted multiple r^2 of 0.738, thus accounting for nearly three-quarters of the variance in the sharing of works by FRs (F-ratio = 14.372, $p< 0.001$). Three of the four best predictors were network-related features.

Intervening and Elaborative Variables

From an intervention perspective, it is not enough to know that network features strongly affect our criterion drug use behaviors. Usually, one also needs to know how those network effects are produced (i.e., what the specific mediating processes are).

Close networks affect the behaviors of their members in at least two basic ways: (1) by interactions that directly impinge upon members' behavior (e.g., procuring drugs, occupying a person's time, providing material support), and (2) indirectly by affecting members' attitudes and orientations that, in turn, lead them to behave in certain ways.

Especially in the early stages of network research, it is important to discover the psychological factors that presumably mediate between network characteristics, on one hand, and the behaviors of interest on the other. In this way, greater confidence is generated in the validity of a causal interpretation of the network characteristics. The causal chain becomes more explicit.

Among the FRs, knowledge of how HIV is spread was not associated with reduced drug use and was *negatively* correlated with felt risk of getting the disease, although such felt risk was indeed linked to reduced sharing of works.

Two basic attitudes were, however, conspicuously and significantly associated with lower drug use-namely, happiness and felt social support (i.e., having others one can depend upon). Felt social support, moreover, is the kind of psychological factor that should plausibly mediate the found association between kin referral density and reduced drug use. Kin obligations provided general social support, whereas the interactions with nonkin referrals were more likely to primarily involve drugs. Thus, nearly two-thirds of FRs involved in the study expected at least some of their RFs to get drugs for them, usually nonkin RFs, and would do the same in return. These two variables (i.e., expectations of getting and receiving drugs from network members if needed) together explained nearly 60 percent of the variation in the FRs' drug use indices and were also strongly related to the referrals' drug use indices.

Along with associated psychological factors, another dimension of networks lies in the discussions and activities that typify them. In general, the FRs' level of discussion of family, work, money, and basic health with their RFs was unrelated to their drug-taking and sexual behaviors. Discussion of sex with RFs was, however, significantly and positively related to the number of different sex partners, having sex with a prostitute, and the overall sex-risk index. Discussion of drugs was significantly and positively related to sharing works and positively but not significantly (given the small subsample size) to injecting and the number of different drugs used. Discussion of AIDS, on the contrary, was significantly negatively related to injecting and the number of different drugs used, but, oddly, not with sharing works.

Finer analysis with a larger sample of networks is obviously necessary. Initially, however, it seems likely that sex and drugs are primarily discussed with sympathetic network members, often copractitioners,

while AIDS is a more likely topic with RFs opposed to high-risk behaviors. Again, the relative balance of forces within a conflicted network may be crucial for the FR's behavior.

Examination of network activities also provides some insight into the social processes involved. Lending or borrowing money and talking frequently with network members were not significantly related to risky behaviors. Watching television, though not significant, was consistently negatively correlated with all drug use dependent variables, perhaps as an alternative activity, especially for family members. Drinking together was not related to drug use but was significantly linked to the number of sex partners and having sex with a prostitute. The acknowledged drug activities were, of course, strongly linked to the drug use responses but, interestingly, not to sex risk.

DISCUSSION

General Network Characteristics

On initial examination, the close focal networks of these male, urban, African-American IDUs who are in methadone maintenance treatment appear quite similar to those found for other nondrug-using groups in the United States and Canada. Such networks have been described as "small, centered on kin, comparatively dense, and homogeneous by comparison to the respondent population . . . " (Marsden 1987). Closer scrutiny of the data, however, leads to quite different conclusions. These superficially normal networks are in certain fundamental respects not "normal" or typical at all. On the contrary, they appear quite distinctive if not pathological. They are relatively *hypercentered* upon the FR (perhaps deliberately structured that way by him) rather than being broadly interactive and integrated. Their density comes mainly from dyadic links radiating out like bicycle spokes from the FR, while the linkages among other network members are unusually sparse.

In an important sense, these hypercentric networks seem mainly those of the FRs alone rather than being those of most of the other members as well. The more linkages among referrals, the fewer linkages there are with the FR. Possibly, this is the only type of network that IDUs can maintain-separating their close relations from one another as much as possible to minimize criticism or influence or because they are incompatible. Perhaps such networks tend to generate or reflect the

problems that led to drug use. Comparative research on other groups is needed to confirm this finding and to fathom the causes and effects of such distinctive network patterns.

HIV-Related Risk Taking: Drugs and Sex

Although participating in a methadone maintenance program, many of the FRs appeared to be at considerable risk from their drug use and sexual activity. However, drug risk and sex risk were usually not correlated with each other. The primary focus of this analysis was on drug risk.

Demographic Characteristics and Drug Risk. In general, the demographic attributes of the FRs were not significantly linked to their drug use. Although a few scattered correlations were significant, the personal characteristics of the FRs usually were not very helpful in predicting drug use.

General Network features and Drug Risk. Certain general network characteristics, however, were significantly related to drug use. The primary finding of this analysis reveals a tendency toward a *fundamental bifurcation* of these networks along two axes: (1) *relatives* (kin) of the FR, mainly *female,* and usually antipathetic toward his drug use, and *(2) male friends* (nonkin), who differentially tend to support and participate in his drug use.

Since roughly three-fifths of the referrals are kin, it is not surprising to find that most general measures of the degree of integration (density) of the network are consistently negatively correlated with drug use by the FR. More specifically, kinship density in the network is negatively linked to drug use, while density among his nonkin RFs, on the contrary, is positively associated with drug use. The FRs displaying greater drug use seem to have assembled a largely male and nonkin subnetwork that supports and participates in their drug activities. Sometimes this pattern spreads to their kin-based subnet. When this happens, drug use is significantly greater and reduction of their risky behavior would appear especially difficult.

Network Drug Patterns and the FR's Drug Use. The patterns of drug use among network RFs were strong predictors of the FR's drug use. The percent of referrals who inject, who use drugs, the average number of drugs they use, and the summary index of these variables were all significantly related to all of the FRs' drug use measures. The composite

index of RF drug use plus the percent of relatives in the network together explain more than half of the variation in the FRs' drug use index, each predictor variable working in an opposite direction.

Despite the risk of being dropped from treatment, a majority of the FRs used drugs with at least one of their network RFs. Those who did so had, on the average, more than two RFs with whom they used drugs. The percentage of nonkin referrals who did drugs with the FR (38 percent) was more than double that of the kin who did drugs with him (17 percent).

The more his network RFs used drugs, the more the FR did so, and vice versa. Stopping or markedly reducing drug use by the FR therefore will often have major implications for his closest personal relations. It is in this sense that the risky drug use behaviors so significant for HIV transmission are strongly *socially embedded* and appear unlikely to yield to pressures for change that do not take this fact into account. Drug use relevant to the spread of HIV is clearly a social (network) problem rather than simply an individual one.

Finally, stepwise multiple regression indicated that the three best predictors of the FR's drug use were the percentage of his network for whom he would get drugs, the network RFs' composite drug use index, and the degree to which the FR approved of drug use. These three variables accounted for more than three-fifths of the variation in the FRs' drug use. Similarly, the four best predictors of the FR's sharing works were his felt risk of getting AIDS (negative), the RFs' composite drug use index (positive), the FR's being married (negative), and how much support he expected from his network compared to how much he expected to give (negative). These four predictor variables "explained" nearly three-quarters of the variation in the FRs' sharing works. Three of the four are network related.

CONCLUSION

This general pattern of significant relationships between drug use by FRs and by their network RFs provides substantial support for the assertion that the high-risk behaviors associated with HIV/AIDS tend to be strongly socially embedded. If the IDU is heavily involved with drug-using friends or if the female and kin-based links of his network are themselves drug involved, the prospects for successful intervention to alter drug use

seem markedly reduced. Other network patterns, however, seem more favorable and provide potential leverage for risk reduction.

Serious attention should be given to strengthening the interactions between the focal IDU and that subset of his network that works against drug use while correspondingly weakening the dysfunctional relations. The specific mechanisms for achieving these objectives must be developed. They would clearly include regular clinical collection of essential network information. Interventions that directly address the social network aspects of drug use should improve treatment outcomes and reduce the spread of HIV in this population.

NOTES

1. General introductions to social network analysis can be found in the following, inter alia: Berkowitz, S.D. *An Introduction to Structural Analysis.* Toronto: Butterworths, 1982; Burt, R.S., and Minor, M.J. *Applied Network Analysis.* Beverly Hills, CA: Sage Publications, 1983; Knoke, D., and Kuklinski, J.H. *Network Analysis.* Beverly Hills, CA: Sage Publication, 1982; Marsden, P.V., and Lin, N. *Social Structure and Network Analysis.* Beverly Hills, CA: Sage Publications, 1982; and the journal *Social Networks.*

2. For these and related data see, for example, Marsden 1987 and Wellman 1979.

REFERENCES

Altman, L.K. The doctor's world: Conference ends with little hope for AIDS cure. *New York Times,* June 6, 1993.

Antonucci, T.C., and Depner, C.E. Social support and informal helping relationships. In: Wills, T.A., ed. *Basic Processes in Helping Relationships.* New York: Academic Press, 1982.

Barrera, M., Jr. Social support in the adjustment of pregnant adolescents: Assessment issues. In: Gottlieb, B.H., ed. *Social Networks and Social Support.* Beverly Hills, CA: Sage Publications, 1981.

Bartlett, E.E.; Rabin, D.; Taggart, V.; et al. Behavioral diagnosis for effective education of HIV-seropositive patients. In: *III Internatl. Conf on AIDS (MP188).* Washington, DC: 1987.

Berkmen, L.F., and Syme, S.L. Social networks, most resistance, and mortality: A nine-year followup study of Alameda County residents. *Am J Epidemiol* 109:186-204, 1979.

Caplan, R.D.; Robinson, E.A.R.; French, J.R.P., Jr.; et *al. Adhering to Medical Regimens: Pilot Experiments in Patient Education and Support.* Ann Arbor, MI: University of Michigan, 1976.

Chassin, L.; Presson, C.C.; and Sherman, S.J. Cognitive and social influence factors in adolescent smoking cessation. *Addict Behav* 9:383-390, 1984.

Cleary, P.D.; Rogers, T.F.; Singer, E.; et al. Health education about AIDS among seropositive blood donors. *Health Educ Q* 13:317-329, 1986.

DiMatteo, M.R., and Hays, R. Social support and serious illness. In: Gottlieb, B.H., ed. *Social Networks and Social Support.* Beverly Hills, CA: Sage Publications, 1981.

Earp, J.A.L. The effects of social support and health professional home visits on patient adherence to hypertension regimens. *Prev Med* 8:155, 1979.

Emmons, C.A.; Joseph, J.G.; Kessler, R.C.; et al. Psychosocial predictors of reported behavior change in homosexual men at risk for AIDS. *Health Educ Q* 13:331-345, 1986.

Flynn, N.M.; Jain, S.; and Harper, S. Sharing of paraphernalia in intravenous drug users (IVDU): Knowledge of AIDS is incomplete and does not affect behavior. In: *Proceedings of the Third International Conference on AIDS (TP184).* Washington, DC: 1987.

Gottlieb, B.H. Preventive interventions involving social networks and social support. In: Gottlieb, B.H., ed. *Social Networks and Social Support.* Beverly Hills, CA: Sage Publications, 1981.

Jain, S.; Flynn, N.M.; and Keddie, E. Disinfection of IV drug paraphernalia using commonly available materials: hope for controlling the spread of HIV among drug users. In: *Proceedings of the Third International Conference on AIDS (MP191).* Washington, DC: 1987.

Kelly, J.A.; St. Lawrence, J.S.; Brassfield, T.L.; and Hood, H.V. Relationships between knowledge about AIDS risk and actual risk behavior in a sample of homosexual men: Some implications for prevention. In: *Proceedings of the Third International Conference on AIDS (MP174).* Washington, DC: 1987.

Kleinman, P.H.; Friedman, S.R.; and Mauge, C.E. et al. Beliefs and behaviors regarding AIDS: A survey of street intravenous drug users. In: *Proceedings of the Third International Conference on AIDS (THP).* Washington, DC: 1987.

Koop, C.E. *The Surgeon General's Report.* Washington, DC: Supt. of Docs., U.S. Govt. Print. Off., 1987.

Leventhal, H., and Cleary, P.D. The smoking problem: A review of the research and theory in behavioral risk modification. *Psychol Bull* 88:370-405, 1980.

Marsden, P.V. Core discussion networks of Americans. *Am Social Rev* 52:122-126, 1987.

McAuliffe, W.E.; Doering, S.; and Breech, P. An evaluation of using ex-addict outreach workers to educate intravenous drug users about AIDS prevention. In: *Proceedings of the Third International Conference on AIDS (MP181).* Washington, DC: 1987.

Metzger, D.S.; Woody, G.E.; McLellan, A.T.; et al. HIV sero-conversion among in- and out-or-treatment intravenous drug-users: An eighteen month projective follow-up. *J Acquir Immune Defic Syndr,* in press.

Norbeck, J.S. Social support: A model for clinical research. *Adv Nurs Sci* 1981, 43-58.

Ostrow, D.G., ed. *Behavioral Control of AIDS.* New York: Irvington Press, 1986.

Pesce, A.; Negre, M.; and Cassuto, J.P. Knowledge of HIV contamination modalities and its consequences on sero-positive patients' behavior. In: *Proceedings of the Third International Conference on AIDS (T.10.3).* Washington, DC: 1987.

Romano, P.S.; Bloom, J.; and Syme, S.L. Smoking, social support, and hassles in an urban African-American community. *Am J Public Health* 11:1415-1422, 1991.

Schuster, C.R. Drug abuse treatment and AIDS prevention. *The International Working Group on AIDS and IV Drug Use Newsletter. 4,* no. 2 (1989).

Solomon, M.Z., and DeJong, W. Recent sexually transmitted disease prevention efforts and their implications for AIDS health education. *Health Educ* Q 13:301-316, 1986.

Stanton, M.D., and Todd, T.C. *The Family Therapy of Drug Abuse and Addiction. New* York: Guilford Press, 1982.

Sterk, C., and French, J. An ethnography of needle sharing. In: *Proceedings of the Third International Conference on AIDS (THP* 196). Washington, DC: 1987.

Wellman, B. The community question: The intimate networks of East Yorkers. *Am J Sociol* 4:1201-1231, 1979.

Williams, L.S. AIDS risk reduction: A community health education intervention for minority high risk group members. *Health Educ Q* 13:407-421, 1986.

Yancovitz, S.R.; DesJarlais, D.C.; Peyser, N.P.; Friedman, P.; Trigg, H.L.; and Robinson, J.W. A randomized trial of an interim methadone maintenance clinic. *Am J Public Health* 81(9):1185-1191, 1991.

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A Comparison of Drug Use Networks Across Three Cities

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INTRODUCTION

The risk of acquired immunodeficiency syndrome (AIDS) among injecting drug users (IDUs) 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 IDU 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. 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 (Curran et al. 1988; Hahn et al. 1989; Lange et al. 1988; Newmeyer 1988). A number of 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 frequency of drug injection, years of injection, use of only injected drugs, use of a shooting gallery, the use of cocaine, and homelessness (Chaisson et al. 1989; Chitwood et al. 1990; Des Jarlais 1992; Kahlsa et al. 1992; Marmar et al. 1987; McCusker et al. 1992; Schoenbaum et al. 1989; Siegal et al. 1991).

Variation in the risk of HIV infection associated with injecting drug use demonstrates that not all IDUs 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 IDU, is a complex set of behaviors and interactions (Grund et al. 1991; Singer et al. 1992; Watters 1988, 1989). The circumstances of the drug injection scene and those who are present when drugs are injected can influence the dynamics of disease

transmission (Battjes et al. 1989; Grund et al. 1991; van den Hoek et al. 1992). If the act of injecting involves more than one person, there are a number of behavioral norms and customs associated (Williams and Johnson 1993). Who injects, how much each participant injects, the order of injection, and whether a needle is cleaned are regulated by a complex set of rules recognized by most injectors. Each can have an effect on the transmission of HIV.

Increasing knowledge of the factors and circumstances associated with HIV infection does not increase the macrolevel understanding of the dynamics of transmission or of risk (Samuels et al. 1992). Lack of understanding is, to a large degree, due to the absence of a strong theoretical perspective from which to evaluate knowledge of microlevel factors associated with HIV infection and to understand the macrolevel dynamics of the epidemic. Without a macrolevel theory that can put microlevel behaviors and circumstances of injecting drug use into a meaningful perspective, researchers are unable to evaluate the relationships among behaviors and circumstances or to explain how variations in these factors influence the rate of infection for a population. A theory of social networks holds some promise as a theory that can accommodate the translation of microlevel behaviors into macrolevel understanding. A social network is the sum of interpersonal linkages within a population. Put another way, a social network is the sum of personal network interactions (Klovdahl 1985). Linkages among people can vary in length of interaction, frequency of contact, number of contacts, heterogeneity of contacts, and strength of emotional ties (Auslander and Litwin 1987; Granovetter 1973; Pilisuk and Froland 1978; Saulnier and Rowland 1985). The sum of linkages across these network variables produce patterns of social networks that can have consequences for the transmission of disease within individual network structures.

The purpose of this chapter is to present the result of an investigation of the drug use network structures of intravenous drug users in two cities in the United States and one in Puerto Rico. One city involved in the study had a high rate of HIV infection among intravenous drug users and, by comparison, the other two cities had low rates of HIV infection (Robles et al. 1992; Siegal et al. 1991; Williams 1990). The drug use networks in each of the three cities were evaluated for differences in number of contacts, frequency of contacts, length of interactions, heterogeneity of interactions, and strength of emotional ties. Only intravenous drug use linkages between individuals were investigated in the analysis. Although

other interpersonal linkages may be significant in the transmission of HIV infection from one individual to another, the focus of this study was on the structures of social networks related to intravenous drug use only. It was expected, given the differences in rates of HIV transmission among the three sites, that there would be significant differences among the network structures.

METHODOLOGY

Data Collection

Data for this analysis were abstracted from a larger data set of out-of-treatment drug users collected in the United States and Puerto Rico. Data were collected in Dayton/Columbus, OH, Houston, TX, and Rio Piedras, PR. To be eligible to participate in data collection activities, respondents 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 requirements, participants were required to be 18 years of age, recruited from selected targeted geographic areas, and to have signed an informed consent form (see Kaplan et al. 1987; Lee 1993). All study participants were provided the opportunity to participate in HIV prevention programs and to be tested free of charge for HIV infection.

Data used for analysis were collected using the Risk Behavior Assessment (RBA) and the Social Network Questionnaire (SNQ). The RBA was developed for 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 has been found to be quite high (see Needle et al., unpublished manuscript). The SNQ was developed as a supplement to the RBA to assess the strength and characteristics of drug use linkages among chronic drug users and the context in which their drug use occurs. Questions developed to assess the linkages among drug users include the number, characteristics, and types of drug use relationships of the questionnaire respondent. To be consistent with the RBA, the timeframe of the SNQ was limited to the 30 days before the interview. Since the SNQ was

developed as a supplement to the RBA, data about networks were collected from the perspective of the respondent. No attempt was made to link data collected from respondents or to data collected from all members of a network. The SNQ also asked respondents about their drug use relationships and the context of drug use the last time that they used drugs, but those data are not presented in this study.

All data for this study were collected 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 data using the SNQ during a separate session, usually 1 week after the administration of the RBA. It is not known whether the timing of administration had any consequence for the data being collected. However, any effect of the timing of data collection using the SNQ is likely to be small. Respondents were paid for the time spent responding to both questionnaires, although method and amount of payment varied from site to site.

Data Analysis

Data collected for this study were unlinked; that is, data collected from one respondent were not linked to data collected from other respondents. 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 linkages within networks. Only drug use relationships are presented. The data do not include relationships the respondent may have with others with whom he or she did not use drugs in the 30 days before data collection. Heterogeneity was assessed by gender, age groups, race/ethnicity, and drug use. Number and frequency of linkages was assessed by the number of drug use contacts reported by the respondent and the frequency of drug use within the network. Strength of linkages was measured by the length of time that members of the network had used with each other. In addition to these variables, the level of needle sharing and sex within the drug use network was measured.

Four variables were constructed to investigate the heterogeneity of the networks within the data set. Networks were assessed to determine if members of a network were the same gender, within one or two age

groups, in the same racial/ethnic group, and used only intravenous drugs together. Gender of a network was measured by composition: all male, all female, or male and female members. Age groups were categorized into broad groups: 30 years and younger, 31 to 40, 41 to 50, and 5 1 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 age groups of the members were within one group. Race/ethnicity of a network was measured to be the same if all members belonged to the same racial/ethnic group. Drug use of the network was measured by the drugs, either intravenous drugs or crack cocaine, used by the respondent with other members of the network. Variables measuring the homogeneity of networks were measured by nominal variables where the network either matched or did not match a criterion.

The number and frequency of drug use linkages were measured by two variables. The number of linkages within a network was measured by the number of contacts reported by a respondent plus one. The number of network members was measured by a categorical variable ranging from one, indicating a drug use network of only the respondent, to five or more members. The frequency of drug use linkages was measured by the average frequency that the respondent reported using drugs with each contact within the network. Frequency of drug use contact was measured by a categorical variable ranging from less than or equal to three times a month to four or more times daily. Frequency of drug use also was measured by the absolute frequency of drug use between the respondent and each network contact. (Absolute frequency of 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 6 or fewer months to greater than 4 years.

Three HIV-risk variables were also analyzed for the networks: receiving a used needle from a network contact, giving a needle to a network contact, and having sex with a network contact. Unfortunately, the questionnaire asked only if the respondent had given or received a needle or had sex with a network member. Although a respondent reporting a risk behavior does provide evidence of the behavior occurring within a network, it is an inadequate measure of the true level of a behavior within a network. All three risk variables were measured as categorical variables ranging from zero to greater than or equal to two contacts within the network.

All sample characteristic and network variables were investigated, controlling for site. Preliminary analysis had shown that there were significant variations in the data by site where 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 for in the correlational analysis.

Respondent Characteristics

The sample used for this analysis was limited to respondents who had injected a drug at least once during the previous 30 days. The sample included 192 respondents reporting 275 drug use contacts. As shown in table 1, demographic characteristics of the respondents in the sample varied across most variables by site. There was no statistically significant differences among the sites as to the gender of the respondents. Thirty percent of the sample was female, and 70 percent was male. On the remainder of the demographic variables presented in table 1 (race/ethnicity, age, education, marital status, current living arrangement, and injected drug use), the sample varied depending on the city where the data were collected. All respondents in Rio Piedras were Hispanic. Two-thirds of the sample collected in Dayton/Columbus were African American and one-third was white. Sixty-four percent of the Houston respondents were African American, 19 percent Hispanic, and 17 percent white.

The average age of respondents in the study was 34.2 years in Rio Piedras (standard deviation [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 3 1 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 percent 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.

TABLE 1. *Demographic characteristics.*

	D/C	H	RP
Gender			
Male	.74	.62	.76
Female	.26	.38	.24
	p<0.13		
Race/Ethnicity			
African American	.67	.64	—
Hispanic	—	.19	1.0
White	.31	.17	—
	p<0.000		
Age			
≤30	.13	.19	.34
31-40	.47	.38	.50
41-50	.29	.40	.13
≥51	.11	.04	.03
	p<0.000		
Education			
<8th grade	.06	.08	.40
<High school	.31	.46	.20
High school	.30	.31	.27
> High school	.33	.15	.13
	p<0.000		
Marital Status			
Single	.33	.44	.26
Married	.30	.20	.20
Separated	.10	.18	.43
Divorced	.24	.12	.10
Widowed	.03	.06	.01
	p<0.000		
Current Living Arrangement			
Own house or apartment	.47	.24	.57
Someone else's house/apartment	.37	.57	.34

TABLE 1. *Demographic characteristics (continued).*

	D/C	H	RP
Current Living Arrangement (continued)			
Hotel, halfway house, shelter	.13	.15	—
Streets	.03	.05	.07
	p<0.000		
Homeless			
No	.77	.79	.91
Yes	.23	.21	.09
	p<0.051		
Injected Drug Use			
Cocaine	.18	.70	.04
Heroin	.27	.13	.09
Heroin/cocaine	.55	.17	.87
	p<0.000		

KEY: D/C = Dayton/Columbus; H = Houston; RP = Rio Piedras.

Most respondents at all three sites reported that they were not married at the time of the interview. However, how respondents classified their 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 Piedras reported that they were separated. The majority of respondents in Dayton/Columbus and Rio Piedras reported living in their own house or apartment, 47 percent and 57 percent, respectively. The majority of respondents in Houston (57 percent) 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 percent). Yet, only 9 percent of the Rio Piedras sample considered themselves homeless, compared to 21 percent in Houston and 23 percent in Dayton/Columbus.

Injecting drug use in the 30 days before the study was fairly limited to either heroin, cocaine, or heroin and cocaine in all three cities. However, the patterns of cocaine or heroin injection varied significantly between the sites. The primary drug injected in Houston was cocaine, used by 70 percent of participants. About one-fifth of the respondents in Houston reported injecting heroin and cocaine mixed together, and approximately one-tenth reported injecting heroin by itself. Few respondents in Rio Piedras reported injecting heroin (9 percent) or cocaine (9 percent). Most respondents in the Puerto Rico sample reported injecting heroin and cocaine mixed together. Twenty-seven percent of the sample in Dayton/ Columbus reported injecting heroin. Yet, like the sample in Rio Piedras, the majority of respondents in Ohio (55 percent) reported injecting heroin and cocaine mixed together. Seventeen percent reported injecting cocaine.

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 c 0.066). Approximately 15 percent of the sample reported injecting drugs with no other persons and, therefore, had a network size of one. Twenty-eight percent reported a network size of two people, 20 percent a network size of three people, 17 percent a network size of four to five people, and 17 percent a network size of six or more people. Individuals who reported a network size of one were deleted from the remainder of the analysis.

The homogeneity of networks did vary significantly by gender, race/ethnicity, and drug use by site. Only the age groups of those involved in the networks did not vary significantly between the samples ($p < 0.370$). Approximately one-third of those interviewed reported networks composed of individuals within the same age groups. The remainder reported that the network was 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 c 0.001). Fifty-three percent of the networks in Rio Piedras were single-gender networks, compared with 22 percent in the Ohio sample and 30 percent in the Texas sample. Networks in which both intravenous drug and crack cocaine use was reported were high in

TABLE 2. *Characteristics of drug use contacts.*

	D/C	H	RP
Network Size			
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	0.20	0.10
	p<0.066		
Age			
Same age group	0.20	0.25	0.32
Mixed age group	0.80	0.75	0.68
	p<0.37		
Gender			
Single gender	0.22	0.33	0.47
Mixed gender	0.78	0.67	0.53
	p <0.001		
Race/Ethnicity			
Same racial group	0.78	0.76	0.98
Mixed racial group	0.22	0.24	0.02
	p<0.001		
Drug Use			
IV only	0.31	0.25	0.51
IV and crack	0.70	0.75	0.49
	p<0.000		

TABLE 2. *Characteristics of drug use contacts (continued).*

	D/C	H	RP
Average Time Respondent Used With Others			
≤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
Average Time Respondent Used With Others			
2-4 Years	0.12	0.18	0.12
> 4 Years	0.39	0.32	0.23
	p<0.21		
Average Time (as a dichotomous variable)			
≤6 Months	0.22	0.20	0.40
>6 Months	0.78	0.80	0.60
	p<0.018		
Average Frequency of Drug Use With Network			
≤ Monthly	0.15	0.17	0.02
Weekly	0.46	0.50	0.14
Daily	0.22	0.24	0.28
2-3 times daily	0.10	0.07	0.39
≥4 times daily	0.02	0.03	0.18
	p<0.000		

TABLE 2. *Characteristics of drug use contacts (continued).*

	D/C	H	RP
Absolute Frequency of Interactions With Others			
≤ Monthly	0.29	0.26	0.04
Weekly	0.39	0.41	0.18
Daily	0.18	0.20	0.24
>Daily	0.14	0.13	0.54
	p<0.001		
Received a Needle From a Network Member			
No	0.71	0.68	0.70
1	0.17	0.11	0.23
≥2	0.12	0.21	0.07
	p<0.092		
Gave a Needle to a Network Member			
No	0.66	0.65	0.63
1	0.19	0.11	0.26
≥2	0.15	0.25	0.11
	p<0.066		
Sexual Relationships With Network Members			
None	0.46	0.49	0.84
1	0.49	0.38	0.12
≥2	0.05	0.13	0.04
	p<0.000		

KEY: D/C = Dayton/Columbus; H = Houston; RP = Rio Piedras.

Dayton/Columbus (70 percent) and Houston (75 percent), compared to 49 percent in the Rio Piedras sample ($p < 0.000$). The proportion of networks reporting only intravenous drug use in Rio Piedras was 5 1 percent.

There was no statistically significant difference among the three sites in the average time that respondents reported using drugs with their networks ($p < 0.210$). Twenty-seven percent of respondents reported using with network members an average of 6 months or less. Fourteen percent reported using with their network 7 to 12 months, 14 percent 1 to 2 years, and 15 percent an average of 2 to 4 years. Thirty-one percent of respondents reported using with their network for more than 4 years. Although there was no statistically significant difference in the average time a respondent reported using with his or her network among the three sites when average time was investigated as a categorical variable, when average time was coded as a dichotomous variable ranging from 6 months or less to greater than 6 months, a significant difference among the sites did emerge ($p < 0.000$). Forty percent of the network members in Rio Piedras reported using drugs with their networks an average of 6 months or less, compared to 22 percent in Dayton/Columbus and 20 percent in Houston.

The average frequency of drug use within a network varied significantly by site ($p < 0.000$). The majority of networks in Rio Piedras (57 percent) reported using together an average of two or more times daily. The majority of networks in Dayton/Columbus and Houston reported using together an average of weekly or less, 61 percent and 67 percent, 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 interactions in Rio Piedras occurred twice or more daily. The majority of interactions between respondents and individuals within their networks in the Ohio and Texas samples occurred weekly or less, 68 percent and 67 percent, respectively.

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 30 days from another network member ($p < 0.092$). Approximately 30 percent of respondents reported receiving at least one needle from another network member. There was no statistically significant difference in the number of networks in which the respondent reported giving a needle to another network member

($p < 0.066$). About two-thirds of the networks did not involve the respondent giving a needle to another network member. Seventeen percent of the networks involved the respondent giving a needle to at least one other network member and 17 percent 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 having sex with one or more network members ($p < 0.018$). The majority of networks in Dayton/Columbus (54 percent) and Houston (51 percent) involved a sexual relationship between the respondent and at least one other network member. Only 16 percent of the networks in Rio Piedras involved a reported sexual relationship between the respondent and another network member.

As shown in table 3, a number of network characteristics investigated were intercorrelated. A network of mixed gender was positively correlated with a network of members from more than one age group ($r = 0.22$, $p < 0.01$) and more than one racial/ethnic group ($r = 0.19$, $p < 0.01$). However, a network with both men and women was negatively correlated with network size ($r = -0.19$, $p < 0.01$). Mixed-gender networks were positively correlated with all three HIV-risk behaviors investigated, the respondent giving needles to another network member ($r = 0.19$, $p < 0.01$), the respondent receiving needles from another network member ($r = 0.27$, $p < 0.001$), and the respondent having a sexual relationship with another member of the network ($r = 0.51$, $p < 0.001$). Network size was negatively correlated with networks composed of more than one age group ($r = 0.24$, $p < 0.001$). Networks composed of more than one racial/ethnic group were positively correlated with a respondent reporting he or she gave needles to ($r = 0.26$, p c 0.001) and had a sexual relationship with another network member ($r = 0.20$, $p < 0.01$). 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 0.82 ($p < 0.001$). 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 ($r = 0.23$, p c 0.001). 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.

TABLE 3. *Correlation of network characteristics.*

	G	ARE	NS	AT	AF	GN	RN
Gender							
Age	0.22*						
Race/ethnicity	0.19*	.14					
Network size	-0.19*	-.24**	-.06				
Average time	-0.08	.06	.09	-.11			
Average frequency	-0.17	.04	-.10	-.08	.01		
Gave needles	0.19*	.17	.26**	-.07	.04	-.01	
Received needles	0.27**	.18	.17	-.06	.04	-.06	.82**
Sexual relationship	0.51**	.17	.20*	-.10	-.03	-.14	.12	.23**

KEY: * $p<0.01$;** $p < 0.001$; G = Gender; A = Age;
R/E = Race/Ethnicity; NS = Network Size; AT = Average Time;
AF = Average Frequency; GN = Gave Needles;
RN = Received Needles; SR = Sexual Relationship.

SUMMARY AND DISCUSSION

This study presented drug use network data collected in three cities in the United States and Puerto Rico. Respondents in the study were out-of-treatment intravenous drug injectors at risk for HIV infection. All respondents in the study had injected at least once during the previous 30 days. There were significant differences among the respondents related to the site where the data were collected. The racial/ethnic composition of the samples varied according to the city in which respondents were interviewed. Not surprisingly, all respondents in the Rio Piedras sample reported that they were Hispanic. About two-thirds of the respondents in the Houston and Dayton/Columbus samples were African American. In addition, respondents in the Puerto Rico sample were more likely to have been younger and to have injected heroin and cocaine mixed together. Respondents from the Houston site were more likely to have been older, considered themselves homeless, and to have injected cocaine. Given these significant differences in the samples, the number, heterogeneity, strength, and frequency of network linkages were investigated, controlling for site.

The number of drug use linkages reported by study participants did not vary significantly by site. Respondents at the three sites reported having

slightly over two drug use linkages or, put another way, a drug use network size of slightly over three people. However, there were significant differences in network characteristics among the sites in regard to heterogeneity, strength of linkages, and frequency of linkages. Respondents in Puerto Rico were more likely to be involved in networks that were relatively homogeneous, with relatively weak ties and frequent drug use interactions. Networks in Rio Piedras were much more likely to be all Hispanic, all male, use only injectable drugs, to have used drugs with each other a short period of time, and to use together multiple times daily. Injectors in the Dayton/Columbus and Houston samples, on the other hand, were more likely to be involved in heterogeneous networks, with comparatively stronger ties and less frequent drug use interactions. Networks in Houston and Dayton/Columbus were much more likely to be of mixed gender or race/ethnicity, to use both injectable drugs and crack cocaine, to have used drugs together a comparatively long time, and to use together once a week or less. Although these differences in network characteristics did emerge, there was no signiftcant difference between the sites in a respondent reporting that he or she received or gave a needle to another member of the network. There was a significant difference, however, in reported sexual relationships. Respondents in Dayton/ Columbus and Houston were more likely to have reported a sexual relationship with one or more network members.

Some network characteristics were found to be significantly correlated. Networks with mixed genders were related mixed-age groups, with the respondent giving needles to or receiving needles from one or more network contacts and the respondent reporting having sex with one or more network contacts. However, networks with mixed genders were negatively related to the size of the network. In addition, network size was negatively related to more than one age group in a network. Networks with members of more than one racial/ethnic group were significantly related to the respondent reporting that he or she gave one or more network contacts a needle and had a sexual relationship with one or more contacts. Networks in which the respondent reported giving a needle were highly correlated with the respondent receiving a needle. Receiving a needle from a network member was correlated with reported sex with a network member.

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 degree to which the sample is representative of drug injectors in the three cities can be only

estimated vaguely. Therefore, the generalizability of the findings is unknown. The requirements of the larger study to which this study was a supplemental effort, especially the need to relocate study participants after 6 months, may have served to bias the sample toward individuals who were less likely to be involved in risky behaviors. The relative age of the respondents in this sample would suggest that participants were more likely to have been more settled than younger drug injectors. Since the respondents in the study were unlinked, the degree to which the respondents were reporting the same networks is unknown. However, it is possible individuals may be reporting data on the same networks. Relying on egocentric unlinked data may also present another bias. Individuals included in the sample may be limited to those who are relatively stable in their living arrangements and lifestyle. Others with whom the respondents may be linked, but who were not recruited to participate in the study, may be less stable and far more likely to have drug use interactions with a larger number of more varied people. The timeframe of data collection, 30 days before the interview, may have had the effect of obscuring relationships or behaviors that are relatively rare. However, given these limitations, the study does provide some worthwhile information and suggest some potentially meaningful avenues for further investigation.

The 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 (Robles et al. 1992; Siegal et al. 1991; Williams 1990). 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 may have the opposite effect. African Americans may be reluctant to inject with whites or Hispanics. Hispanics may be reluctant to inject with whites or African Americans. 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 and Johnson, in press). 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 network. The larger number of drug use relationships of 6 months or less in the Rio Piedras sample would support such a speculation. In addition, 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 may present a situation in which it is much more difficult to coordinate drug use activities with others and far easier to use with whomever is present. Although it requires more analysis to assess, homogeneity of network structures may actually facilitate the formation of weak drug use relationships and, thereby, once introduced into a social network, the transmission of HIV.

The greater proportion of weak contacts and frequency of drug-using interactions in the Puerto Rico sample suggest that there may be a multiplicative effect among these two network measures. The chances for the transmission of HIV are increased if the number of contacts between drug injectors who have used only a short amount of time together is high, as suggested by the number of short-term relationships in the data from Puerto Rico. The chances for transmission would also seem to be increased if the frequency of injections is high. If duration is short and frequency high, the effect of each would seem to be multiplied 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 multisite sample. The use of a multisite sample would be necessary to control for the effect of local circumstances and conditions.

Intercorrelation among some of the network measures suggests that some types of risk behaviors may be interrelated and related to network structure. For example, respondent reports of receiving and giving needles and a sexual relationship between network members were intercorrelated with measures of network heterogeneity. This would suggest that the risks of infection in a heterogeneous network may be more related to the strength of the relationships in the network as measured by duration of drug use rather than weakness. For example, 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 not usually considered sharing by the respondent (Williams and Johnson, in press). Therefore, risk in this situation would be related to the strength of the relationship. In addition, the intercorrelation between giving and receiving needles and sexual relationships would suggest that sex may be an equally, if not more, important means of HIV transmission in strong-link networks.

A social network theory of HIV infection may prove a useful mechanism for understanding rates of infection in different populations. Although respondents in all samples reported sharing needles, 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, if behaviors are the same, is in the structure of the networks. Several significant differences were found. Although linked HIV data were not available for this study, an analysis of linked HIV social network data would be the next logical step. Such an analysis could show that, rather than one social network structure evident at a site, multiple structures related to HIV serostatus are evident. Multiple structures are possible. For example, in Houston, independent social network structures were found to be related to race/ethnicity (Williams and Johnson, in press). Whatever avenue of research is followed, social network theory does seem to have promise as a means for understanding the macrolevel implications of microlevel behaviors.

REFERENCES

Auslander, G., and Litwin, H. The parameters of network intervention: A social work application. *Soc Sew Rev* 61:305-318, 1987.

Battjes, R.; Pickens, R.; and Amsel, Z. Introduction of HIV infection among intravenous drug abusers in low seroprevalence areas. *JAZDS* 2:533-539, 1989.

Chaisson, R.E.; Bacchetti, P.; Osmond, D.; Brodie, B.; Sande, M.A.; and Moss, A.R. Cocaine use and HIV infection in intravenous drug users in San Francisco. *JAMA* 261:561-565, 1989.

Chitwood, D.D.; McCoy, C.B.; Inciardi, J.A.; McBride, D.C.; Comet-ford, M.; Trapido, E.; McCoy, V.; Page, B.; Griffin, J.; Fletcher, M.A.; and Ashman, M.A. HIV seropositivity of needles from shooting galleries in south Florida. *Am J Public Health* 80:150-152, 1990.

Curran, J.W.; Jaffe, H.W.; Hardy, A.M.; Morgan, W.M.; Selik, R.M.; and Dondero, T.J. Epidemiology of HIV infection and AIDS in the United States. *Science* 239:610-616, 1988.

Des Jarlais, D.C. The first and second decades of AIDS among intravenous drug users. *Br J Addict* 87:347-353, 1992.

Granovetter, M. The strength of weak ties. *Am J Social* 78:1360-1380, 1973.

Grund, J.; Kaplan, C.; and Adriaans, N. Needle sharing in the Netherlands: An ethnographic analysis. *Am J Public Health* 81:1602-1607, 1991.

Hahn, R.A.; Onorato, I.M.; Jones, T.S.; and Dougherty, J. Prevalence of HIV infection among intravenous drug users in the United States. *JAMA* 261:2677-2684, 1989.

van den Hoek, J.; van Hanstreet, H.; and Coutinho, R. Little change in sexual behavior in injecting drug users in Amsterdam. *JAZDS* 5:518-522, 1992.

Kahlsa, H.K.; Kowalewski, M.R.; Anglin, M.D.; and Wang, J. HIV-related risk behaviors among cocaine users. *AIDS Educ Prev* 4:71-83, 1992.

Kaplan, C.D.; Korf, D.; and Sterk, C. Temporal and social contexts of heroin-using populations: An illustration of the snow-ball sampling technique. *J Nerv Ment Dis* 175:566-574, 1987.

Klovdahl, A. Social networks and the spread of infectious diseases: The AIDS example. *Soc Sci Med* 21:1203-1216, 1985.

Lange, W.R.; Snyder, F.R.; Lozovsky, D.; Kaistha, V.; Kaczaniuk, M.A.; and Jaffe, J.H. Geographic distribution of human immunodeficiency virus markers in parental drug abusers. *Am J Public Health* 78:443-446, 1988.

Lee, R.M. *Doing Research on Sensitive Topics*. Newbury Park, CA: Sage Publications, 1993. pp. 60-74.

Marmar, M.; Des Jarlais, D.C.; Cohen, H.; Friedman, S.R.; Beatrice, S.T.; Dubin, N.; el Sadr, W.; Mildvan, D.; Yancovitz, S.; and Mathur, U. Risk factors for infection with human immunodeficiency virus among intravenous drug users in New York City. *AIDS* 1:39-44, 1987.

McCusker, J.; Stoddard, A.M.; Koblin, B.A.; Sullivan, J.; Lewis, B.F.; and Sereti, S.M. Time trends in high-risk injection practices in a multi-site study in Massachusetts: Effects of enrollment site and residence. *AIDS Educ Prev* 4:108-119, 1992.

Needle, R.; Weatherby, N.L.; Brown, B.S.; Booth, R.; Williams, M.L.; Watters, J.K.; Anderson, M.; Chitwood, D.D.; Fisher, D.G.; Cesari, H.; and Braunstein, M. The reliability of self-reported HIV risk behaviors of injection and non-injection drug users. Unpublished manuscript.

Newmeyer, J.A. The intravenous drug user and secondary spread of AIDS. *J Psychoactive Drugs* 20:169-172, 1988.

Pilisuk, M., and Froland, C. Kinship, social networks, social support and health. *Soc Sci Med* 12B:273-280, 1978.

Robles, R.R.; Colon, H.M.; Sahai, H.; Matos, T.D.; Marrero, C.A.; and Reyes, J.C. Behavioral risk factors and human immunodeficiency virus (HIV) prevalence among intravenous drug injectors in San Juan. *Am J Epidemiol* 135:531-540, 1992.

Samuels, J.F.; Vlahov, D.; Anthony, J.C.; and Chaisson, R.E. Measurement of HIV risk behaviors among intravenous drug users. *Br J Addict* 87:417-428, 1992.

Saulnier, K., and Rowland, C. Missing links: An empirical investigation of network variables in high risk families. *Fam Relat* 34:557-560, 1985.

Schoenbaum, E.E.; Hartel, D.; Selwyn, P.A.; Klein, R.S.; Davenny, K.; Rogers, M.; Feiner, C.; and Friedland, G. Risk factors for human immunodeficiency virus infection in intravenous drug injectors. New *Engl J Med* 321:874-879, 1989.

Siegal, H.; Carlson, R.; Falck, R.; Li, L.; Fomey, M.A.; Rapp, R.C.; Baumgartner, K.; Meyers, W.; and Nelson, M. HIV infection and risk behaviors among intravenous drug users in low seroprevalence areas in the midwest. *Am J Public Health* 81:1642-1644, 1991.

Singer, M.; Zhongke, J.; Schensul, J.; Weeks, M.; and Page, J. AIDS and the IV drug user: The local context in prevention efforts. *Med Anthropol* 14:285-306, 1992.

Watters, J. Meaning and context: The social facts of intravenous drug use and HIV transmission in the inner city. *J Psychoactive Drugs* 20:173-177, 1988.

Watters, J. Observations on the importance of social context in HIV transmission among intravenous drug users. *J Drug Issues* 19:9-26, 1989.

Williams, M.L. HIV seroprevalence among male IVDUs in Houston, Texas. *Am J Public Health* 80:1507-1509, 1990.

Williams, M.L., and Johnson, J. Social network structures: An ethnographic analysis of intravenous drug use in Houston, Texas. *Drugs and Society* 7:65-90, 1993.

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Ethical and Legal Issues in Social Network Research: The Real and the Ideal

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INTRODUCTION

The sine qua non of social network research is identifying "nodes" and describing the connections between them. When the nodes are people and the connections are intimate activities, ethical questions are inevitable. Ideal answers are relatively easy and emanate from the general principles of bioethics. The reality is more complex: When the people are "criminals" and their activities are illegal (such as injecting narcotics or buying and selling sex), legal and ethical dilemmas frequently arise and practical solutions are elusive.

To describe social network structures and their influence on the spread of human immunodeliciency virus (HIV), it is necessary to collect detailed information about people at risk, their behaviors, and how they connect to others. There are many obstacles to collecting information about sexual activity, drug use, and social connections. Beyond social and political resistance to investigating intimate aspects of human behavior, a fundamental obstacle that remains is ignorance about how to measure such things. These are methodological problems. More pressing issues concern researchers' obligations to society at large and to the people they study.

Behavioral researchers in the United States are guided both by express requirements for protecting human subjects in federally funded research, promulgated by the Office for Protection from Research Risks (OPRR), Department of Health and Human Services (DHHS) (45 CFR 46), and by general principles of biomedical ethics. These principles include respect for persons (a duty to respect others, to respect their autonomy, and to protect those with diminished autonomy), beneficence (the duty to maximize benefits to the subjects of research and to society at large), nonmaleficence (the duty to prevent harm to subjects), and justice

(the obligation to distribute equally both the benefits and burdens of research) (Department of Health, Education, and Welfare 1979).

These principles (the ideal) rarely constitute prescriptive measures to guide decisionmaking (Mulvey and Phelps 1988). In fact, they often conflict with each other or with the study design. Evaluating HIV seroepidemiologic research, Avins (1989) concluded: "*All* study design options result in some undermining of research ethics" (emphasis supplied). An ad hoc approach is thus required; just as judges must weigh opposing principles of law in making decisions, researchers must weigh conflicting ethical principles and consider the tradeoffs inherent in any course of action (Mulvey and Phelps 1988).

If collecting and using sensitive information about social connections is justified by the potential benefits, and if methodological hurdles are surmounted, the foremost problem network researchers face is protecting the data they gather. Investigators entrusted with information about intimate aspects of people's lives are ethically bound to protect the confidentiality and the privacy of their subjects.

Offered here is a description of ethical issues likely to arise in network research, as well as some observations based on the authors' experience studying social networks of injecting drug users and prostitute women in Colorado Springs, CO (Rothenberg, this volume).

HIV TESTING AND NOTIFICATION

Testing research participants for antibodies to HIV is necessary to map the loci of infection within specific networks and can directly benefit the subjects themselves. Uninfected participants can initiate or continue preventive measures, while infected subjects can seek medical care and avoid exposing others. Some people, however, are unwilling to learn their serostatus, and unauthorized disclosure of test results can have adverse psychological, social, financial, or legal consequences. All States require reporting of diagnosed acquired immunodeficiency syndrome (AIDS) cases to health authorities, and about half require the reporting of people with HIV infection.

Some investigators fear that HIV testing deters potential subjects or limits participation to those willing to be tested and learn their results (with implications for sampling and recruitment strategies). Others wish to

avoid the responsibility of informing subjects of their serostatus and offering appropriate posttest counseling and followup, or they reason that subjects themselves do not wish to know their serostatus. In such cases, HIV testing has been omitted from study designs.

Where knowledge of seroprevalence is desirable, however, various methodologies are available, ranging from "blind" testing to mandatory notification. Each raises ethical questions about whether and how to inform the participants of their serostatus.

As public health workers and advocates of partner notification (Potterat et al. 1989), the authors opted to treat HIV-infected participants identified through the present study in the same manner as those identified by other means. The consent form used in the study stated that individuals who tested positive for HIV would be informed of their results and that the results would be reported to health authorities in accordance with State law, All infected subjects were offered counseling, medical referral, and assistance with notifying partners. Positive test results did not preclude continued participation in the prospective study, and all participants were followed regardless of serostatus.

This approach-mandatory notification-is now public health policy; individuals whose results can be linked to personal identifiers must be informed of their results and offered appropriate counseling. Research subjects may no longer be given an option "not to know" (optional notification). This raises ethical questions, however, as it means that, once tested, it is impossible for a subject to "withdraw" from the study, an important element of respect for personal autonomy and an OPRR requirement.

Alternatives to mandatory notification include anonymous testing and blind testing (Avins 1989). In "anonymous" designs, participants may obtain their own results, but the investigators remain unaware of who was tested or of the test outcomes. Responsibility for obtaining results lies solely with the subject. With blind testing, *all* identifiers are deleted from specimens, rendering it impossible to link tests to individuals or to inform subjects of their results. Such approaches are of limited value in network research, where infection status and the location of infected people within networks are important outcome variables.

The effects of testing and procedures for notifying subjects of their results must be carefully considered in adopting a research design. To the extent

that testing discourages or limits participation, it may detrimentally affect sampling strategies and limit generalizability of the findings. Research that includes interventions aimed at reducing subjects' risk of infection may be enhanced by testing, which helps "personalize" that risk. If testing is incorporated in the study design, every effort should be made to inform infected subjects of their results. Experience suggests that, even in studies with elaborate mechanisms to shield researchers from knowledge of subjects' identity and serostatus, many participants have the misperception (despite detailed informed consent forms and instructions) that someone will notify them if they are infected. This assumption that "no news is good news" may generate a false sense of security. If testing is performed, local reporting requirements must be clearly stated in the informed consent.

INFORMED CONSENT

It has been said that informed consent is a moral prerequisite to enrollment of research subjects. For research funded by DHHS, it is also a legal prerequisite. Federal guidelines specify the basic elements of informed consent: a statement of the research purpose, reasonably foreseeable risks, reasonably expected benefits, alternate procedures, a statement concerning confidentiality of records, whom to contact for additional information, and a statement that participation is voluntary and that consent may be revoked at any time without penalty (45 CFR 46).

In medicine, the general rule is that adults (over 18 years of age) or emancipated minors who are conscious, competent, and uncoerced can consent to (or refuse) medical care, and this also applies to participation in research. Unfortunately, the people of greatest interest to AIDS researchers often fail to meet these criteria simultaneously. Studies of the etiology of substance abuse, adolescent prostitution, and the manner in which adolescent users connect to adult networks may necessitate recruiting people below the age of 18. Can they legally consent? The authors reviewed Colorado law, which permits minors (whether emancipated or not) to consent to diagnosis and treatment for sexually transmitted diseases, substance abuse treatment, and birth control counseling; they concluded that those who could legally consent to such treatment could also consent to participate in related research. Similar conclusions have been reached by other researchers.

The issue of competence is more challenging: Does a chronic substance abuser who is rarely, if ever, sober have capacity to consent? To provide informed consent, subjects must have the mental ability to make choices and understand their consequences. Researchers studying drug users, the homeless, or similar populations must consider the extent to which intoxication, mental illness, or long-term substance abuse affect their subjects' capacity to consent. They must determine on a case-by-case basis whether these conditions interfere with a potential subject's ability to comprehend the information provided and to decide whether to participate.

Consent should be obtained under circumstances that provide the prospective subject with sufficient opportunity to consider whether or not to participate, as well as minimize the possibility for coercion or undue influence. Federal guidelines expressly limit research conducted in prisons and similar settings where subjects are especially vulnerable. Opportunities for coercion in prison are obvious, and respondents may perceive (correctly or incorrectly) that some benefit might accrue from participation. Incarceration is a fact of life, however, for many of the people studied (such as prostitutes and drug users), and jails are often good settings for locating and interviewing these people. While incarcerated, subjects are free from the influence of alcohol or drugs, and there are few interruptions. For these reasons, the authors reconducted some interviews in jails, but recruitment from jails was not undertaken.

The prospective nature of the present study made it difficult to locate people for annual followup; by reviewing jail rosters, the authors often found people with no fixed address who had otherwise disappeared. When conducting interviews in jail, they explained that researchers had no connection with the jailers, that participation conveyed no benefits, and that the jailers had no access to study notes. Every detained subject was offered the opportunity to be interviewed after release.

Another potential source of coercion involves paying subjects for participating. Payment of research participants is common and, for many potential subjects from low-income populations, may constitute a powerful incentive. Ideal ethnographic research requires establishing trust and rapport between researcher and subject over a long period of time. Few researchers have this luxury, and payment may be a convenient substitute: subjects share some aspects of their lives with observers simply because the price is right. While it is appropriate to reimburse subjects for actual expenses and inconvenience, there is a fine

line between reasonable reimbursement and payment for participation. To the extent that payment is a monetary incentive, it may compromise the integrity of the research (Feinleib 1991).

Subjects may believe that participation increases their chances for obtaining treatment or that they will be denied treatment or access to services if they refuse. In such cases, consent is not voluntary. Researchers must also evaluate the extent to which their own tenacity, and the means they use to persuade or "convert" subjects who initially refuse, may constitute coercion.

What about subjects who cannot read a consent form or who choose not to? The authors attempted to ascertain whether subjects could read (few who could not volunteered this information), and when necessary the investigators read the form verbatim or paraphrased it. Some participants elected not to read the two-page, Institutional Review Board (IRB)-approved consent form, so the authors designed a "checklist" containing the essential elements. When interviews were conducted in homes, cars, bars, parks, or places of employment, this checklist was used, and the researchers offered individuals a copy of the full form. Research participants can waive rights to fully informed consent just as medical patients can. In such instances, however, it is important to document that the information was offered and that the patient declined to read it. Participants *cannot*, however, waive any legal rights or release investigators from negligence.

DISCLOSURE

The greatest potential threat to participants in network research may be disclosure of the information they provide. Information about their drug use, sexual behavior, and illegal activities can harm respondents and their partners, and may be of interest to police and others. Because confidentiality can never be guaranteed, consent forms should not mislead respondents. To obtain truly informed consent, as well as to minimize their own liability, researchers must accurately inform subjects of potential risks of disclosure. Even if disclosure is compelled, investigators might incur liability under a variety of legal theories, including invasion of privacy, breach of contract, or misrepresentation (Teitelbaum 1983, pp. 11-47). Threats to confidentiality include inadvertent disclosure, public health laws, subpoenas, and criminal reporting laws.

INADVERTENT DISCLOSURE

Inadvertent disclosure can result from negligence or accidents. An investigator injured in an accident, for example, could lose control of interview records. Precautions involve minimizing the amount of information carried by investigators, requirements for prompt return of data collection instruments to secure settings, limiting personal identifiers on instruments, and using codes to link records. Other forms of "inadvertent" disclosure may take place due to program audits and evaluations, secondary analyses, selection of data entry clerks, and access to records by computer technicians.

PUBLIC HEALTH LAWS

Many States require HIV reporting; if serology results are obtained, researchers may be required, in the absence of a "research exception" (see, for example, Colorado Revised Statute 25-4-1402.5), to report infected people to local or State health authorities. While these people may already be known to health authorities, or are likely to be reported by other entities, the consent form should nevertheless describe reporting requirements.

SUBPOENAS

Another threat to confidentiality is subpoena power. Information collected by network researchers is of potential interest to police. The trend in both criminal and civil cases is to make sweeping requests for documents, and subpoenas may be issued for reasons unrelated to the subject of the research or simply for prosecutorial "fishing expeditions" (see In re Grand Jury Subpoena, 750 F.2d 223 [2nd Cir. 1984]). While the most obvious threats involve criminal prosecution of respondents themselves, investigations of agency improprieties, fiscal mismanagement, or alleged illegal acts by researchers could result in subpoenas for "any and all records" or, if a Government agency, in a request under the Freedom of Information Act. Similarly, participants in civil actions (such as divorce) might believe research data to be of value and attempt to obtain it.

CRIMINAL REPORTING

One of the thorniest problems facing those who work with drug users, sex workers, street gangs, and similar populations are the legal and ethical duties concerning observed criminal behavior. Ethnographic research frequently entails observation of illegal drug activity, ranging from individual use to the manufacture and sale of drugs. Generally, private citizens have no duty to report criminal activity they observe, so long as they neither assist nor encourage it.' There are statutory exceptions, however. Law enforcement officers, for example, must report observed criminal activity, and a much wider range of people are mandated to report known or suspected child abuse.

CHILD ABUSE REPORTING

Researchers who observe drug users in private homes, "crack houses," or "shooting galleries" frequently see instances of child abuse or neglect. State laws vary in their delineation of those required to report, ranging from physicians and nurses to, in some jurisdictions, anyone with knowledge or suspicion that abuse is occurring. Employees of local or State agencies (including universities) are often included among those mandated to report. A duty to report may even exist where the subjects themselves confide that they have been victims or perpetrators of child abuse. Some studies of adolescents include an express warning that, if the subjects reveal themselves to be victims of ongoing abuse, the researcher must report this information.

Even in the absence of formal legal requirements, researchers clearly have ethical obligations to prevent harm to children. These obligations can and do conflict with research goals of learning about "hidden" activities and gaining the trust and cooperation of subjects. At minimum, field investigators must be trained about what constitutes reportable abuse or neglect in their jurisdiction, as well as their legal responsibilities when abuse is observed. If these include reporting any observed or suspected abuse, potential participants must be so informed.

DUTY TO WARN

A more complex problem is the researcher's "duty to warn." By virtue of the information most valuable to a network researcher-the identity of

sexual or needle partners-investigators are likely to learn of people directly at risk of infection from an HIV-infected subject. What is the researcher's responsibility to those people? Can someone bring an action against a researcher who knew that a subject was infected, and that the subject failed to inform partners, if one of those partners subsequently became infected?

Current case law generally limits liability to those in a therapeutic relationship, primarily medical providers or mental health therapists. Even for physicians, the duty is less than clear; many believe that their sole obligation is to the patient, that the sanctity of the physician-patient relationship is inviolate, and that any breach undermines the therapeutic relationship. Others maintain that privacy is not an absolute right: Potentially fatal harm to third parties overrides the physician-patient privilege (Bayer and Toomey 1992).

Most (but not all) cases impose a duty where the third parties at risk are "identifiable." In the case of infected prostitutes or injectors who patronize "shooting galleries," it may be impossible to identify specific "partners." Yet the circumstances may be such that potential transmission to *someone* is high. With identifiable partners, physicians and others apply various standards, often considering the extent to which partners "should" be aware of their risk. Those who work exclusively with gay men, for example, might conclude that every gay man in this era knows of AIDS and knows how to protect himself from it, and the corresponding need to intervene may be small or nonexistent. Research with "heterosexual" populations, on the other hand, could uncover bisexual men whose female partners are ignorant of their risk, or men who patronize prostitutes unbeknownst to their wives. In such cases, or in the case of a secretly bisexual man whose wife is pregnant, a higher level of duty might be found (to prevent eventual infection of the wife, for example, or, if already infected, to permit consideration of terminating the pregnancy).

Confidentiality commitments to subjects must be weighed against the magnitude of harm which could result and the extent to which third parties are likely to be aware of their risk. Researchers should, at minimum, counsel HIV-infected subjects about how to prevent transmission of the virus and strongly encourage them to inform past, present, and prospective partners.

SAFEGUARDS

A variety of mechanisms exist to protect research subjects from unauthorized disclosures and other forms of harm. These mechanisms are statutory, procedural, and technical in nature.

Statutory

Although several States have considered "researcher shield statutes," not one has enacted them (Melton and Gray 1988). Neither do any States recognize a "researcher-subject" privilege analogous to physician-patient privilege (although the existence of such a privilege might be successfully argued in response to a subpoena).

The Public Health Service does, however, offer some advance protection for research records (42 U.S.C. 242). "Certificates of confidentiality," which originally applied only to studies involving substance abuse or mental health, now cover more varied research. They provide protection from subpoenas but must be applied for on a case-by-case basis (i.e., they do not automatically cover all federally funded research).

Procedural

Federally funded research involving human subjects must be reviewed by an IRB to ensure that subjects are not exposed to unreasonable harm (45 CFR 46). IRBs vary in composition and sophistication. While most members are capable of judging the ethical propriety of research, they may lack the expertise to evaluate the potential benefits of sophisticated research such as social network analysis. IRB members may have little insight into the practical problems of conducting "street" research with drug users or other alienated populations. Some IRBs are much more sensitive than others to the issues of privacy and confidentiality that arise in network research.

Technical

Technical protections include common-sense limitations on transporting and storing sensitive data, as well as sophisticated measures such as randomized responses or "error inoculation" to limit the value of data to others (Steinberg 1983, pp. 249-26 1). Consent forms and data collection

instruments may explicitly instruct participants *not* to reveal information about crimes they participated in for which they have not been arrested or prosecuted.

Ideally, personal identifiers should be removed as soon as possible and before data are shared with others. In longitudinal studies, however, where identifying and linking data are collected over time, this may be impossible. In such cases, data encryption and the use of linking files are recommended. Some commentators go so far as to suggest that such files be physically stored beyond the control of the researchers, perhaps in a foreign country. Careful consideration should be given to the ultimate disposition or destruction of data containing personal identifiers.

CONCLUSION

All research occurs within a social context (Hurley and Pinder 1992). Research involving human subjects entails some ethical and legal obligations. Network research, which requires identifying the participants and elucidating connections between them, poses special problems that are compounded when the subjects are drug users and the focus is on AIDS.

Legal guidelines and ethical principles provide a framework for designing such research but rarely provide prescriptive solutions to the complex and subtle problems that arise in conducting it. Awareness of these principles, however, and ongoing concern for the dignity and well-being of subjects are essential to resolving the inevitable ethical dilemmas that arise. Informed consent, respect for subjects' privacy, data confidentiality, sound and valid research methodology (to ensure research results are of genuine benefit to society), and a cognizance of the researchers' own values are all essential to the design and implementation of social network studies. Greater attention must be focused on the practical problems of studying high-risk populations, both to guide investigators and to inform future research.

NOTE

1. A number of researchers report subjects who express willingness to allow their drug use to be observed but who request payment in advance. When the researcher knows that the purpose of the advance

payment is to permit the subject to "cop" the drugs he or she will use, does this constitute "assisting or encouraging"? Are researchers who provide sterile injection equipment to injectors they are observing "assisting"?

REFERENCES

Avins, A.L., and Lo, B. To tell or not to tell: The ethical dilemmas of HIV test notification in epidemiological research. *Am J Public Health* 79(11):1544-1548, 1989.

Bayer, R., and Toomey, K.E. Health law and ethics: HIV prevention and the two faces of partner notification. *Am J Public Health* 82(8):1158-1164, 1992.

Department of Health and Human Services, Office of the Secretary. Title 45 *Code of Federal Regulations* Part 46.

Department of Health, Education, and Welfare. "The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Biomedical and Behavioral Research." *Federal Register* April 18, 1979.

Feinleib, M. The epidemiologist's responsibilities to study participants. Supplement 1. *J Clin Epidemiol* 44:735-795, 1991.

Hurley, P., and Pinder, G. Ethics, social forces, and politics in AIDS-related research: Experience in planning and implementing a household HIV seroprevalence survey. *Milbank Q* 70(4):605-628, 1992.

Melton, G., and Gray, J.N. Ethical dilemmas in AIDS research. *Am Psychol* 43(1):60-64, 1988.

Mulvey, E.P., and Phelps, P. Ethical balances in juvenile justice research and practice. *Am Psychol* 43(1):65-69, 1988.

Potterat, J.J.; Spencer, N.E.; Woodhouse, D.E.; and Muth, J.B. Partner notification in the control of human immunodeficiency virus infection. *Am J Public Health* 79:874-876, *1989.*

Steinberg, J. Social research use of archival records: Procedural solutions to privacy problems. In: Boruch, R.F., and Cecil, J.S., eds. *Solutions to Ethical and Legal Problems in Social Research.* New York: Academic Press, 1983.

Teitelbaum, L. A positivist approach to law and social science research. In: Boruch, R.F., and Cecil, J.S., eds. *Solutions to Ethical and Legal Problems in Social Research.* New York: Academic Press, 1983.

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Network Models for HIV Outreach and Prevention Programs for Drug Users

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INTRODUCTION

Most drug abuse and human immunodeficiency virus (HIV) prevention programs rely on individually oriented models of change, or they are conducted at the mass media level. The media approach assumes that the mass transmission of information, embedded in emotionally sculptured scenarios, will spur individual behavioral change through social diffusion theory effects. Prevention programs focused on the individual are constructed around competing or complementary assumptions about individual behavior. They assume that people lack accurate knowledge about the targeted problem (health beliefs model), that the problem occurs because situational intensity interferes with the individual's ability to negotiate a favorable situation (self-efficacy model), that the individual lacks the decision-making models necessary to protect oneself (theory of reasoned action), that individuals are not at an appropriate state of readiness to change their behavior (stages of change theory), or that people are in need of motivational support for change (motivational counseling approach) (Bandura 1986, 1990, pp. 128-141; LaFromboise and Rowe 1983; Tyler and Holsinger 1975).

Both individual and mass media programs attempt to strengthen the probability that individuals will overcome risks through increased knowledge, improved self-efficacy, and modeling alternative or resistance behaviors (May 1992). These approaches have had an important impact on HIV and drug prevention programs, but their cumulative effect falls short of a complete elimination of risk-taking behavior.

The most significant element missing from these prevention efforts is an accommodation of the effects of basic units of human interaction: the networks of family, friends, work environments, and the other small human groups that produce the key social contexts for people's daily lives. This chapter describes a model that combines social network considerations with psychosocial approaches to HIV-risk reduction.

The authors propose that the conditions found in group contexts directly affect HIV transmission and drug use. These conditions demand the use of specific social interventions (change in group norms, consensus-based problem solving, improved social dynamics) in prevention programs. This new paradigm should be added to individually targeted culturally competent interventions in order to successfully reduce the overall risk of HIV infection and drug abuse in the United States.

The model being promoted has been constructed from three types of network analytical approaches, used in a complementary fashion. The first is an ethnographic exploration of drug-using networks. The authors employ open-ended questions and conduct direct observations of drug group activities in order to acquire descriptive and typological data on drug networks. The second approach is an ego-centered (i.e., single person-oriented) attributional data collection process that relies on a standardized questionnaire to determine the characteristics of individuals' networks. The final strategy is a network relationship analytical approach that includes both qualitative and quantitative elements for analysis and interpretation.

This multicultural acquired immunodeficiency syndrome (AIDS)-risk reduction program, still ongoing, is focused on the development and testing of culturally sensitive outreach interventions for injecting drug users (IDUs) and crack smokers in small towns and rural areas.' Efforts focus on the use of both network and individually based interventions in four cultural groups: African Americans, Anglo Americans, Hispanics, and Native Americans in the Southwest. The authors' objective is to demonstrate the effectiveness of two prevention approaches: a standard approach used at 20 cooperating sites and an enhanced intervention developed locally. The aims are: (1) to define the cultural and psychosocial parameters of HIV/AIDS-risk behaviors in medium-sized multiethnic towns; (2) to develop models for understanding and preventing risk behavior cross-culturally; and (3) to develop relevant network and individual approaches to HIV/AIDS prevention for each cultural group.

The project is being conducted in Strip Town', a town of approximately 45,000 people. It resembles other Southwestern towns that stretch along the railroad tracks that bisect them, forming neighborhoods on "both sides of the track." Strip Town is slightly more than 100 years old and contains considerable cultural diversity. The largest population is the Anglo-American community (29,647). The second largest population is

Hispanic (6,972), and the third group is Native American (4,210). (There are several federally recognized Native-American reservations within 100 miles of the town.) The fourth Strip Town cultural community is African American (1,135). The community residents feel that the town is relatively isolated. However, the community is linked to numerous metropolitan areas by more than 3 million tourists who travel through the town annually. These individuals are a potential source of HIV infection, as are local visits to metropolitan areas.

ETHNOGRAPHIC OVERVIEW OF DRUG USE IN SMALL TOWNS

In contrast to urban areas, drug use is rarely visible on the streets of Strip Town. However, ethnographic research has determined that the town is not exempt from any of the drugs found in urban centers in the United States. Heroin, cocaine, methamphetamines, marijuana, hallucinogens, and a variety of prescription drugs are all readily available for illegal consumption. Some drugs are grown or manufactured within the community, but more often drugs are obtained from metropolitan areas within 3 to 5 hours of driving time from Strip Town.

The drug-purchasing sites are bars and individual homes or apartments, complemented by a home delivery service available to some drug networks. Drug users utilize motel rooms scattered around town for occasional drug deals. The program has identified a number of “party houses” where people go to use drugs. These are not commercial enterprises but are a part the social aspect of existing drug networks. Finally, a number of sites called “rock houses” were identified. They are “mom and pop” operations for relatively small drug networks. They appear to be different from crack houses in urban settings and do not involve a significant sex-for-drugs trade. “Shooting galleries” do not exist in town.

Locally Produced Drugs

The most common locally grown drug is marijuana. Respondents have reported that psilocybin mushrooms, jimson weed (Datura), and poppy bulbs grow in the area, although these are drugs that are more often used by “drug experimenters” rather than the drug users who are the focus of this project. Peyote is locally legally used by members of the Native-American Church in religious ceremonies, but it is illegally used as a

recreational drug by some Native Americans, Anglo Americans, African Americans, and Hispanics. Peyote must be imported from other locations since it does not grow locally. Marijuana is grown both in and out of doors, with the most successful production systems being elaborate indoor operations that provide controlled lighting, moisture, and fertilization.

Drugs that require a modest degree of processing, such as crack cocaine and crystal meth, are produced locally. These operations are small enterprises that can be set up in homes or apartments without being highly visible. "Cooking" methamphetamine to produce "crystal meth" is done locally. Another common local production involves "rocking cocaine." This is carried out in multiple rock houses. A rock house will typically serve one or two drug networks of 10 to 15 users. The process utilizes baking soda in place of ether and can be easily and safely done in most settings. People who belong to these rock house circles use the drug in the home of the supplier or carry it away to use elsewhere.

Importing Drugs From Urban Areas

The most sophisticated processes for creating drugs from raw products are beyond the expertise of local groups and occur in urban or international locations that have access to raw materials and necessary production facilities. Crack and powder cocaine (cocaine hydrochloride), heroin, and methamphetamine are usually imported from urban areas. Crack "rocks," or the "tar" form of heroin, are acquired by small-town middlemen who break or cut the drugs into locally usable sizes. The street value of these larger purchases is normally $2,000 to $3,000, which is within the economic range of small operators. The sale of "eight balls" is also common. This amount of money will provide about a week's worth of drugs for the buyer and provide cash for another buy when the part that is not personally used is sold.

The local price of drugs varies in terms of available supply but also varies according to the buyer's social relationship with the seller. If a drug user has a strong social relationship with a dealer, the dealer will sell drugs for a lower price than is charged to people with a more casual relationship with the dealer. Kinsmen tend to get the best price, friends next, long-term buyers, and so on down the line.

The main local crack supply is obtained by dealers purchasing it in an urban area and bringing it back to town. Some drugs are also brought in

by traveling dealers who follow regular routes through the State or through several States. They are the modem-day equivalent of the rural pack peddlers of the past. Crack is commonly distributed by a home delivery system or an individual "pickup" system. Once a dealer is known to have a renewed supply of a drug, regular customers contact him or her; the dealer then takes it to customers' homes, or they come to his or her home and purchase it. There is also at least one "opportunistic scoring location" in town. If someone wants drugs, they go to this location and hang around. Dealers drive by on an irregular basis, and if they recognize the person standing there, they will ask the person if they are "looking," "buying," or "scratching," code words for wanting to buy drugs. These "drive-by" dealers will not normally sell to individuals who they do not recognize in order to avoid local law enforcement undercover agents.

Heroin is imported in two different forms, the traditional white powder called "china white" and a substance locally called "Mexican tar." The tar, or "tootsie roll," form is the most common. At the present time, heroin and cocaine are similar in price. Smalltown heroin-using groups often pool their money and send one of their members to an urban area to score their heroin. This generates a considerable need for trust on the part of group members since the purchases tend to be infrequent and to involve large sums of money in relation to the wealth of the group.

In some cases, one of the network members is a local primary supplier of drugs on a permanent basis. Drug suppliers make trips to urban centers as entrepreneurs. A project respondent who has assumed this supplier position displayed his products recently. They included an "eight ball" of heroin "tar," a small bag of powdered cocaine, a baseball-size crack rock, and several boxes of prescription drugs. This individual is primarily a heroin user but supplies other users a wide range of drugs he obtains in urban areas.

Smalltown HIV Intervention

The U.S. national AIDS effort concentrates on urban systems in which the HIV prevalence is very high. Recently, the Centers for Disease Control and Prevention (1992) has identified a growing HIV risk for nonmetropolitan areas, where there is more limited knowledge of beliefs and attitudes toward AIDS (Estrada, unpublished data; Estrada et al. 1989) and far fewer intervention and education programs. The recent HIV infection surveillance report for the State[3] in which Strip Town is

located indicates a total of 1,900 AIDS cases (52.19 per 100,000) and 3,285 HIV-infected individuals (121 per 100,000). The AIDS infection rate for the predominantly rural county of which Strip Town is a part is 10.35 per 100,000, and the HIV infection rate is 20.71 per 100,000. However, the local drug-using population has an HIV prevalence rate of 3 percent (3,000 per 100,000), based on 470 active local cocaine, heroin, and other IDUs tested by the project in the past 22 months. This differential in HIV rates indicates that the project is targeting many if not most of the highest risk individuals in the area.

Some of the locations where activities that present HIV risks occur in urban areas are missing in Strip Town; others are not. The town does not have prostitution strolls where street-based sex workers are available. It lacks abandoned buildings with crack houses and has no shooting galleries for sharing needles. Most of the HIV high-risk locations for drug users are in homes or bars, and the risks come primarily from sex and needle sharing in defined drug networks. In one park, there is a male homosexual "pickup" area, unobserved by most of the people who take their children there to play. The majority of the activity initiated in the park is not prostitution; it is casual sex for bisexual males in town who are married and want to make homosexual contacts. In addition, a number of bars have been identified where there are drugs available for sale, as well as a high rate of sexual pickups and a high level of sexually transmitted disease contact referrals.

The primary objective of this project is to reduce HIV risks in drug-using networks. The characteristics of local drug use must be taken into account in the intervention, since the size of the town impacts on peoples' attitudes toward AIDS. Some of the conditions ethnographers are investigating act to reduce HIV risk-taking behavior; others create an environment that will support rapid spread of the disease from any node where it enters the community. The protection derives from the fact that it is difficult to hide persistent behaviors in a small town. The anonymity of urban settings is lacking for anyone who has lived in the area for any length of time. This condition helps to reduce behaviors that place people at risk, especially sexually related risks, because the people in the town have a generally conservative orientation toward sexual activities with strangers. On the other hand, the density of the social networks sets up a condition in which the disease, once it penetrates a network, is likely to spread rapidly to a significant portion of the population.

The perceived isolation of the town has an effect on the local population's assessment of their risk of HIV infection. Some people believe that isolation provides immunity; they believe that AIDS is an urban problem. However, since the drugs must at some point be procured from an urban center, someone must take risks in an urban environment. These "drug runs" carry primary risks for rural drug users. The buyers travel to poorly known territory where they must negotiate as outsiders. Respondents report numerous risk-taking activities on these trips, including testing drugs with borrowed "works" (drug paraphernalia) and casual sexual activities. When asked how they try to reduce these risks, the first response is usually "I never share needles when I go to score." However, with further inquiry, most will report that there was "that one time" for either sharing works or casual sex. When enough of these "one time" events are aggregated, the risk becomes significant.

ETHNOGRAPHIC NETWORK APPROACHES TO HIV- AND DRUG-RISK REDUCTION

The project collects baseline and ongoing ethnographic data (Bernard 1986; Trotter 1991) in conjunction with quantitative data collection on psychosocial variables (Bandura 1986; Mays et al. 1990, pp. 128-141; Prochaska et al. 1992). The ethnographic data collected has two purposes: It is used to define the sociocultural elements of drug use and HIV risks in small towns and to develop models for preventing HIV and drug risks cross-culturally. The general ethnographic data and the qualitative network analysis is complemented by quantitative forms of network analysis (Fraser and Hawkins 1984; Klovdahl 1985; Knoke and Kuklinski 1982), as well as other systematic data collection procedures.

Ethnographic Network Data

> A network can be defined as "a specific type of relation linking a defined set of persons" (Knoke and Kuklinski 1982, p. 12).

The authors began exploring rural drug networks at a community level by conducting ethnographic interviews with in-treatment and active drug users. The questions asked included how long the respondent had used drugs, what drugs they used, why they use drugs, which drugs they prefer and why they prefer them, how they get their drugs, how many people they know use drugs, and the characteristics of their own drug-using

network. The purpose of these questions was to establish baseline data and to provide a preliminary overview of the local drug networks. Heroin addicts reported that there were only a few users in the area shooting heroin, often estimating that they knew of 10 to 15 people in this situation. The same was true of most cocaine users, crystal meth injectors, and others. However, it became clear that these individuals, for the most part, did not know each other. They were describing a potentially large number of strongly bounded and mutually exclusive groups. This information was supported by a noticeable lack of consensus between these users on where and how they scored and on the type of membership (family, friends, strangers) in their drug network.

Discovering numerous small drug networks that do not have knowledge of one another appears somewhat counterintuitive given the smalltown nature of Strip Town, where *everyone* feels they know everyone else. It would be reasonable to assume that most drug users would have common social connections, scoring locations, or long-term associations from grade school and high school. However, a countervailing problem exists that changes the local ecology of drug networks. Drug arrests commonly take place at the user (not dealer) level. Using drugs with anyone but a small circle of well-known acquaintances is hazardous. Therefore, the authors have repeatedly confirmed that there are many more drug networks in town than are assumed by the drug users themselves and that these networks only minimally overlap, being linked by one or two people at the most.

Developing a Rural Typology of Drug Networks. The authors felt that using an ethnographic approach to developing a drug network classification was an important first step for this intervention. Ethnographers found there was no clear local "folk" typology of drug-using groups. People do not have clear labels or descriptions for networks. Yet, the actual networks that have been observed form and maintain stable social relationships. In the absence of a preexisting classification, the authors decided to create a typology that emphasizes the social and cultural variables that appear to be the most promising for the development of the intervention strategies. These variables define differences in risk taking and risk protection for the groups, which would subsequently assist in improving the efficacy of the authors' network intervention programs.

Ethnographic interviews indicated there are three major variables that permit construction of a typology of drug groups in small towns. The

first is the relative degree of openness of the network, measured by the level of recruitment of new members over time. An open network is one that has a high percentage of newly recruited members, and a closed network is one that does not allow the recruitment of new members to any significant degree. This is a continuous variable, from networks that are completely open to new membership at any time (a risky situation given the illegal nature of drug use), to those that never recruit new members after their initial formation. There is nothing, other than mutual agreement, that prevents networks from changing from open to closed and back again over time, depending on internal and external circumstances. However, these networks have not been observed long enough to determine whether or not these cyclical changes occur.

The second set of classification variables includes the types and the number of social bonds that predominate in the group. At present, there are four conditions associated with this set of variables in the project classification system: (1) kinship relationships, (2) long-term friendships, (3) shorter term acquaintanceships, and (4) weak or virtually anonymous relationships. All or only a few of each type of relationship may occur in a single drug-using group. Among the long-term and well-established drug networks, kinship and very long-term friendship are the core structural elements. One particular drug network the project is studying consists of a three-generation family of more than 10 IDUs. At the other extreme, acquaintance based on convenience and almost random association may predominate in a network.

The third variable used to construct this classification is the type and level of social activities or interactions that exist within the drug network, such as group drug use, joint recreational activities, or work-related associations. Joint drug use, in particular, is a key variable. One anchor for this variable is the absence of any of these activities for the group as a whole. The next observable level is face-to-face activities limited to dyads or triads in the group. The other end of this activity spectrum includes a high level of social interaction (e.g., parties, participation in softball leagues, other recreational activities) involving the entire group. These activities are generally associated with the social structure that exists in a network but are not correlated to them in a one-to-one relationship. Even a family-based network may decide not to engage in face-to-face activities due to hostility or conflict in the group. There is some covariation between levels and types of activities in a group and the types of social bonds that predominate in that network, but it is not a perfect relationship.

Another variable was considered in creating this drug network typology: the type of drug used. This variable did not produce a significant improvement in the identification of network types. Most groups prefer a single drug or specific drug combinations. Most groups also use other drugs, especially marijuana and alcohol, when the primary drug is not available. However, there are networks of each type that use each of the drugs available. So, while networks tend to be single drug-oriented, the other relationships (openness, types of relationships, and social activities) determine the actual network structure.

Analyzing the ethnographic network data produced a typology with four distinct (i.e., internally consistent, externally divergent) classes of drug networks. They have been labeled Types A, B, C, and D. Type A (mature injector networks) is a closed system in which members allow virtually no new recruitment. Group size ranges from approximately 5 to 10 individuals. Type A networks often include individuals from a variety of social, economic, and ethnic backgrounds. The most commonly encountered drug of use for this type of group is heroin, although other drug preferences were found in Type A groups. The primary purpose of the group is to pool resources for the acquisition of drugs. Joint drug use activities do not extend beyond scoring for the most part. The group has social bonds based on kinship and very long-term friendship that help to maintain the group, but they socialize less than the other groups. The socialization occurs as dyads or triads and does not involve the whole group. A respondent described scoring, the group's primary activity:

> Somebody in the group will get a hold of the others when they want to score or when they are going to score. Who ever wants some will put their money together and someone will go to . . . (major city) . . . usually, and get the stuff and bring it back and call the others. The others will come and get their part and go home and use.

Type A drug use tends to be very secretive. Most of the members are married or in monogamous relationships. They are employed at various economic levels. They may use on a maintenance level during the week and get "loaded" on weekends or special occasions. The major area of risk for HIV transmission is from contact with persons outside the group (weak ties), for example, when they come in contact with outsiders whose HIV status is unknown. For the most part, this type of network does not

involve sex for drugs, although it is not completely avoided. A respondent belonging to a Type A group states:

> A couple of girls I know up here wanted to work something out for some chiva [heroin] . . . but I didn't. . . coke users do more of that.

Type B drug networks (kin-based groups) are semi-closed and are predominantly kinship groups (family, in-laws, or fictive kinship such as *compadrazgo* relationships in the Hispanic community). One is either born into these groups, marries in, or has a steady sexual partner in the group (with rare exceptions). The members have gone to school together and were often raised together. The groups tend to be homogeneous in terms of socioeconomic status (SES) and ethnic identification. Drug use within these groups could be considered a family tradition, a special case of peer pressure. The individual has very strong pressures to conform to group norms. The nonuser is considered to be sending a message condemning the group's behavior. An example of this was reported by a Navajo respondent who was attempting to abstain from drug use:

> They called me names, they said that I was too good for them.. . I fought with them. . . I beat two of them up but I still had to go to the hospital.

These groups form a contrast with Type A groups, where the social relationships surrounding drug abuse are minimal. The HIV-risk areas for this group include the sharing of works between family and friends. This activity is often not even labeled sharing and may actually be a part of the bonding process that occurs within the group; refusal to share can be considered a distancing from the group's social norms. For the most part, these networks involve individuals with longstanding monogamous partnerships, and there is not a significant amount of exchange of sex for drugs, although there is co-use of sex and drugs in some of the partnerships. These groups can have any one of several drugs as the drug of choice for the group, with the most common being cocaine, crack, rock, crystal meth, marijuana, and alcohol.

Type C networks (friendship-based networks) are semi-open systems whose members score together and are socially bonded by drug use. The majority of these networks are relatively homogeneous in terms of SES and ethnicity, but they are more mixed than Type B groups. The predominant social bonds in the group are long-term friendships,

although some kinship relationships normally are present. Individuals in these networks involve one another in both drug use and in other types of social activities. The members are often connected through work as well as their social activities. These groups are somewhat open to recruitment of new members, although it takes time. "Good friends" may be invited to "party" (to use drugs) with the group, but it is very common for the group to take from 12 to 18 months of feeling people out before they are recruited. Multiple drugs are used in this type of group, including heroine, cocaine, crack, speed, and alcohol. The groups also tend to include both injectors and noninjectors in the same network. A respondent describes a night of mixed drugs:

> People will be drinking or doing coke and those who want to shoot up go in the other room.

The risk areas for this group include the sharing of works "among friends." Sexual activity may also be present within the group, with multiple sexual partners a possibility, and with some changing sexual relationships within the group over time. There appears to be some exchange of sex for drugs, although this seems to involve ongoing social relationships rather than commercial transactions.

Type D (acquaintance) networks are the most open of the four types. They often include polydrug users who bridge or skip from group to group. The most common drug used is crack cocaine. The crack dealers operate more openly than most of the other suppliers, and profit is a major condition for establishing a relationship with recruits. Introduction into the group can be accelerated if an individual has become a known buyer. Others will introduce that person to the group's dealer, saying "He's OK, he's buying." This indicates that the existing group member has seen and has been with the new person when they were scoring. Having a known supply of money is a significant credential for entry into these networks and can expedite the process of acceptance. Individuals in these groups regularly exchange sex for drugs, and there are far more "impersonal" exchanges of this type than in the other groups, including a considerable power differential between the person giving the sex for the drug and the person in control of the drug (and consequently in control of the sexual activity).

A long-time drug user derogatorily referred to members of this type of group as "trash can addicts. " They will use anything. These groups are normally heterogeneous in terms of ethnicity. The SES of group

members can also vary to a considerable degree. These networks tend to consist of users who are new in the area and are looking for contacts, people who have progressed to a drug use stage that makes them unattractive to members of the more closed groups, users in transition between groups, or young drug users who have not been recruited to a stable network. As a respondent indicated:

> I was here chipping, running back and forth to [nearby metropolitan area] for a year before I finally ran into one person and from them I met about 10 others.

This person then moved into a more stable and less visible Type C network once he gained acceptance. The Type D groups appear to be at the highest risk for HIV infection, due to a full range of sex-for-drug activities (commercial and noncommercial) and needle sharing with strangers. These groups also include numerous individuals who are highly mobile and who are likely to move back and forth to nearby urban areas during the year, increasing local risks due to contact with higher HIV prevalence sites.

The majority of the networks tend toward the closed end of the spectrum. Of the 23 networks the authors currently have data on in Strip Town, five are Type A, five are Type B, eight are Type C, and five are Type D. This creates a 4: 1 ratio of closed to relatively more open networks.

In order to confirm the validity of this general network typology, a small cross-validation study was conducted using the quantitative data collected on the drug use and HIV-risk patterns of project clients. Each client is assigned membership in an existing or a new drug network when they are identified as meeting three of seven assignment criteria. Individuals who do not meet those criteria are considered isolates, peripheral members, or unassigned. Each identified network is classified, using the qualitative criteria described above. The authors then used one-way analysis of variance to compare selected drug- and HIV-risk variables from the Risk Behavior Assessment questionnaire, with the variable identifying the type of network membership (A, B, C, D, or none) for each client.

It was hypothesized that there would be differences in intravenous drug use across the groups, but not general drug use, following the use patterns found in the community. Significant differences were seen for days using intravenous drugs in the last 30 days ($F(4,171) = 9.16$, $p = 0.0000$), with the Type A network reporting most frequent use in the last 30 days

(M = 13.85, standard deviation [SD] = 16.63), and the remaining four networks seldom using intravenous drugs (isolates, M = 2.04, SD = 6.67; Type B, M = 2.52, SD = 6.9; Type C, M = 4.57, SD = 6.90; Type D, M = 1.79, SD 6.09). Post-hoc Tukey-HSD multiple range significance tests indicated that members of Type A networks used drugs significantly more than any of the other four networks. There were no differences across the network types in days using nonintravenous (non-IV) drugs during the previous 30 days ($F(4,171) = 0.78$, $p = 0.54$). This result was expected since the measure of non-IV drugs combines alcohol, marijuana, and cocaine. Almost all subjects report alcohol use, and many report crack use in addition to other IV drugs. The range of use was so large that differences would be difficult to detect.

Sexual risk and HIV testing were also examined across the five groups. Frequency of unprotected sex was expected to differ among the groups. This hypothesis was supported for males ($F(4,90) = 3.93$, $p = 0.006$) but not females ($F(4,49) = .16$ $p = 0.95$) with the kinship network (M = 1.00, SD = 0.00 and the isolates (M = 0.96, SD = 0.12) engaging in the most frequent unprotected sex with Type A (M = 0.70, SD = 0.44) and Type C (M = 0.76, SD = 0.41) less frequent and the type D the least frequent (M = 0.5 1, SD = 0.46). The family-based network members have many socially negative connotations associated with using condoms with regular partners. These results match well with the ethnographic data, including the lack of difference for females. The rate of unprotected sex was uniformly high across all five groups for females, although the smaller group sizes collected for them may obscure some actual differences. Alternatively, insisting on condom use may be a more complicated behavior for women than men, and the power differentials associated with it may be unrelated to the criteria used to assess membership in this social network typology.

Intercourse with IV drug users was also expected to vary across the groups, with Type B networks engaging in the least amount of “safe sex” (intercourse with non-IDUs). This hypothesis was supported ($F(4,139) = 3.06$, $p < 0.02$), with the Type A networks engaging in significantly less safe sex (M = 0.54, SD = 0.48) than the younger, Type D networks (M = 0.87. SD = 0.31). The remaining three groups were between these two in frequency of safe sex (isolates, M = 0.83, SD = 0.36; Type B, M = 0.73, SD = 0.40; Type C, M = 0.74, SD = 0.41).

The frequency of HIV testing was not significantly different ($F(4,172) = 1.96$, $p = 0.10$) across the five groups. Although this was not

significant, there was a trend in the data for network Type B to be tested more often with an average of 1.22 (SD = 1.62) tests per person, with Type C (M = 0.70, SD = 0.95) and D (M = 0.73, SD = 1.3) slightly less. Network Type A (M = 0.38, SD = 0.67) and the isolates (M = 0.36, SD = 0.79) had been tested the least. The finding that Type B networks have been tested most frequently may be related to social norms about the need to protect other family members, a consistent theme in the ethnographic interviews conducted with these individuals. The low rate of testing for isolates again may reflect either the social ecology of being an isolate, including a differential access to resources, or may be related to psychosocial conditions of isolation.

Finally, two variables that were identified were not expected to vary across the groups: income in the last 30 days and amount of time spent in jail. Neither days in jail [$(F(4,169) = 1.30, p = 0.27)$] nor income in the last month [$(F(4,172) = 1.23, p = 0.30)$] were found to be significantly different across the groups. The lack of variation in income may be due to that targeted sampling strategy. The lack of variation in jail time may or may not be an important condition for network-based interventions. Since the authors hypothesize that the local networks may provide several forms of social protection, it would be interesting to have comparable data for networks in metropolitan areas to determine whether the size and composition of smalltown networks provide a differential amount of protection from jail time when compared to other locations.

These data are useful for targeting intervention and education activities for the highest risk group, IDUs, based on multiple-risk criteria. They also contain important information about the subepidemics that are likely to be part of HIV transmission in rural areas. The authors believe that the overall effort of their ethnographic network data collection is well justified in terms of the advantages it provides in prevention and intervention efforts. It also creates a mechanism to help validate the utility of their network approach beyond its ability to describe drug use in a small town.

Using Ethnographic Network-Based HIV Intervention in Small Towns

The present network typology meets several needs for understanding important social relationships among drug users. One primary use of this ethnographic network approach is to create an effective outreach system for contacting high-risk individuals. Network-associated outreach

follows existing social relationships, and recruitment can be initiated within the context of the same unit that will either reinforce or act as a barrier to program objectives. Once the first few individuals in the network have been recruited, the group itself can provide impetus for other members to participate. Rather than relying on individual-by-individual recruitment, group dynamics are in force beyond individual motivations. Once the group is assessed, the prevention or intervention program can be transmitted to a central individual in the network, with a good chance that it will subsequently be transmitted to part or all of the rest of the network. This makes the prevention effort more effective. For example, there is now one woman, the central person in a kinship-based network, who uses her kin relationships to assure that all of her children, nieces, and nephews have condoms and clean needles before they go out to party on the weekends. The typology also makes it possible to engage in interventions that focus on both group and individual behavior or that pursue only individual-level intervention for isolates and type D network members. The majority of the authors' smalltown drug-using networks show a strong tendency for tight communication and reinforcement of the group's norms. This means that if the network is currently "clean" of HIV infection, the group itself can become an excellent focal point for developing social norms that promote remaining HIV free. Prevention or intervention efforts are enhanced by knowing the variables that cause these differences.

Network-informed outreach has additional advantages. Keeping track of network members is a natural, ongoing function of the gatekeepers of the network. This condition can greatly assist the followup phase of any project. If the core or most influential members of the network can be identified and tracked, then they can act as primary links to the other members of the group 6 months, 12 months, or even longer into the future, reducing the disadvantages of followup that must track every single individual.

An additional benefit to network interventions is related to the condition that drug users in small towns rarely receive positive services from the community. Many programs available in cities do not exist in rural areas or are not accessible to the drug-using population. Drug users are a stigmatized population, and they do not want to become more visible than they already are. Drug users often feel that it is unlikely that anyone outside their group would be concerned about their well-being. This causes them to reject participation in programs if they are approached anonymously or through normal communication channels. Outreach

workers are often confronted with questions like "Who are you really working for?" Participants have expressed fears of being "busted" following interviews. These problems are greatly reduced by network-based recruitment since the first person to participate tests out the system to see if the researchers are doing what they say they will do and to see if they get busted. These drug users tend to become strong advocates of the program when they discover it has value to them. These individuals then help recruit the rest of the network, short-circuiting the suspicion that would be caused by a one-to-one "cold" contact by outreach workers. The need to remain hidden, due to the illegality of drug-related behavior, can be accommodated by normal networked entry into these groups.

EGO-CENTERED NETWORK DATA

The second component of this network approach to risk reduction is also informed by ego-centered network analysis. An ego-centered network consists of a single individual and all of the persons that he or she recognizes as being connected in terms of some specified social relation. The attributional data associated with ego networks (i.e., size, gender and ethnic composition, retrospective conditions) can be identified and described as a "typical" network profile. These data can be further compared with other variables of interest, such as level of HIV risk, choice of drugs, unprotected sex, or any other variable potentially associated with network social relationships. This approach has both advantages and disadvantages for constructing intervention programs. The basic data collection instrument can be administered as a standardized questionnaire, using sampling approaches that provide a reliable communitywide view of ego-centered networks. This allows for much larger samples of networks than other approaches, and the results can be subjected to the same types of analytical procedures as any questionnaire. This is an excellent method for gaining a rapid overview of the networks in a large population.

The disadvantages of this approach stem from the lack of ability to determine connections or overlaps between networks and the missing reciprocal data from the individual's ego discusses, especially, relationships that may be directional (i.e., stronger in one direction than in the other, such as the level of trust between two people). The data are collected from ego's perspective but are not checked by asking the individuals named by the ego to comment on the relationships to the ego or to each other.

The quantitative baseline data for the authors' AIDS prevention project is an attributional survey of HIV and drug risks, using a form called the Risk Behavior Assessment (RBA). Collecting ego-centered network data from informants was managed as a cost effective add-on and provided additional variables that can be analyzed in conjunction with the survey data. The ego-centered network instrument was developed as part of the National Institute on Drug Abuse's (NIDA's) Cooperative Agreement Project and has been tested in five sites. The primary purpose of the instrument is to describe the ego-centered networks of active drug users not in treatment and their risk-taking behavior in relation to possible HIV infection. The primary questions in the instrument ask about the size, composition (age, sex, ethnicity), drug use, and sexual relationships of the ego's network.

The authors collected ego-centered network data from 52 active drug users to provide a statistical overview of the drug networks. The data include general information about the ego networks, information about ego network drug activities in the last 30 days, and information about the ego's last episode of drug use. Table 1 illustrates the gender, age, and ethnic distributions of respondents.

The number of people each ego reports "spending time with" ranges from 0 to more than 25, with 76.3 percent responding that they spend time with 0 to 10 other people. The composition of these networks includes between 1 and 10 family members for all but 16 of the respondents. These findings support other network data indicating that the majority of these individuals belong to relatively small drug-using networks that commonly include both users and nonusers, some kin relations, and close friends. Only 25 percent responded that all of the people they "spend time with" use drugs, and 13 percent reported that *none* of the people they "spend time with" use drugs. Of those alters who used drugs, 25 percent injected drugs, 69 percent smoked crack, and the rest used some other drug and method of administration.

Respondents were asked to think about and list (first names only) up to six people they had used drugs with in the last 30 days. They reported the size of these networks as follows: 25 percent denied injecting drugs or smoking crack with anyone else; 17 percent identified one person; 11 percent identified two people; 13 percent identified three people; 11 percent identified four people; 9 percent identified five people; and 11 percent identified six people. There were a maximum of six slots available on the questionnaire; some respondents would have added more

TABLE 1. *Gender, age, and ethnic distributions of respondents, and respondents' 30-day and recent-use networks.*

	Respondent N=52 (%)	Alters in 30-Day Network N=127 (%)	Alters in Most Recent Use N=90 (%)
Gender			
Male	34 (67)	81 (63)	62 (68)
Female	18 (33)	46 (37)	28 (31)
Age			
10-19[5]	12 (23)	36 (28)	28 (31)
20-29	14 (26)	38 (29)	25 (27)
30-39	23 (44)	43 (33)	30 (33)
40-49	3 (5)	9 (7)	7 (7)
50-59	0 (0)	1 (1)	0 (0)
Ethnicity			
African American	10 (19)	22 (17)	16 (17)
Hispanic	19 (36)	64 (50)	42 (46)
Anglo	18 (34)	35 (27)	27 (30)
Native American	5 (9)	6 (4)	5 (5)

people if they had been allowed. Examination of the ethnic mixture of these 52 networks showed that 48.8 percent were confined to a single ethnic group, 46.5 percent included representatives from two ethnic groups, and two networks (3.8 percent) included three ethnic groups.

The risk factors assessed by the questionnaire included needle sharing and sexual relations with network members. Table 2 illustrates drug use and HIV-risk patterns for the respondents' 30-day alter network and for their most recent drug use episode.

TABLE 2. *HIV- and drug-risk patterns for 30-day and most recent use networks.*

	30-Day Network N (%)	Most Recent Use Network N (%)
Drug Use		
Crack	66 (76)	n/a[6]
IV	9 (10)	19 (26)
Crack and IV	21 (24)	n/a
Frequency		
Daily	6 (6)	n/a
Weekly	34 (39)	n/a
Monthly	21 (24)	n/a
<1x/mo	24 (27)	n/a
Missing	1 (1)	n/a
Needle Sharing		
Gave needles	16	4
Got needles	11	6
Sexual Activity		
Sexual relationship	20	15
Sex with drugs	16	n/a

Needle-sharing episodes occurred between 12 egos and 30 alters who injected drugs. These included 11 mentions of needles obtained by the egos from alters and 16 given to alters by egos. Most needles were shared between the ego and the first person identified in his or her matrix. Sexual activity was reported with 20 of the possible 127 alters (15 percent). Sixteen of the relationships were with the first person identified on the ego's list, and 14 of these included sex with drugs. All four of the sexual relationships with other alters included sex during drug use, probably with casual partners.

The authors have identified a number of additional risks that were present in the 30-day ego-centered networks, using a linked network question-

naire and RBA data set. The numbers of respondents were insufficient to look at trends in this sample, but the following risks were listed by at least one individual as occurring in the past 30 days: not cleaning shared needles with bleach, using the same cooker as someone else, using the same rinse water, and having sex during drug use. A larger sample would be required to determine how these risks were distributed through the various networks, but their presence indicates that the egos are definitely at risk for HIV infection from drug use or sexual activities associated with drug use.

The networks for the latest drug use episode show similar results. Thirty-five respondents (67.3 percent) reported using drugs with between 1 and 11 people, for a total of 116 alters. The most frequent was use with 2 others (10 respondents), with 3 others a close second (9 respondents). The egos' perception of their relationship with the alters was assessed. For the people named in the first position, 35 percent were relatives or in the husband-wife-lover category; 48 percent were considered very good friends; 12 percent were friends; and only 3 percent were acquaintances. Of the 26 people in the second position in the matrix, 15 percent were identified as acquaintances or friends of friends. These data support the drug network descriptions and typologies created through this ethnographic research and provide risk-related data for comparison with the full network data below.

The drug use- and sexual-risk factors assessed for these individuals included needle sharing and sexual relations with network members. Nineteen alters were identified as using intravenous drugs during the most recent drug-using episode. Needle sharing between the egos and alters included six mentions of needles obtained by the egos from the alters and four given to alters by egos. All needles were shared between the ego and the first or second person identified in the matrix. Sexual activity was fairly limited, with relationships reported with 15 of the possible 90 alters. Eleven of the relationships were with the first person identified on the ego's list, three with the second person and one with the sixth person on his/her list. Sex during drug use was not assessed for this episode.

The demographic composition of the 30-day network and the "last use" networks are similar, supporting the validity of the ego's responses. The gender and age distributions are representative of the larger sample of drug users in the project, as well as the hypothesized gender breakdown for the drug-using community as a whole. The ethnic distribution is

skewed toward Hispanics more than would be predicted by the total project client population. This is an artifact that is primarily due to the composition of the networks that were being interviewed at that time.[7] Drug-related risks in the form of both needle sharing and sexual activity during drug use occur relatively frequently. Due to the questionnaire's construction of ego-centered instruments, it was impossible to assess the needle sharing and sexual activity of the alters. If their rate of activity is similar to that reported by the egos, the level of network risk could increase exponentially. The finding that most of the sexual activity occurs between close friends, spouses, or lovers can be taken as an indicator of potentially heightened risk. Research findings from within this study and others (Prochaska et al., unpublished data) suggests that the use of condoms with "main" partners is very low and difficult to initiate. As a result, risk of infection from sexual activity may be very high if anyone in the group becomes infected.

These ego-centered data both confirm and advance the present ethnographic data. The data demonstrate that the majority of drug networks in Strip Town are small (2 to 10 individuals), are based on close friendship or kinship ties, and are relatively stable in their composition. The data also indicate that the majority of needle-sharing activities occur with the first three people named by the ego as members of their network and that sexual activities occur predominantly with the first person named by the ego. This finding has potential importance in targeting prevention information using parts of the ego-centered data. A smaller portion of the needle sharing and sexual encounters occur with people outside of the ego's network, but the data also indicate that it is exactly these encounters, called "weak ties," that are the highest risk contacts for the majority of drug users. Based on these data, part of the present HIV prevention and education effort has been directed at making recommendations that would help these individuals break, reduce, or decrease the risks associated with "weak tie" types of relationships.

FULL NETWORK (RELATIONAL) DATA

The ethnographic and ego-centered network approaches described here are providing valuable baseline data for the authors' intervention strategies, but they do not provide all of the information needed about the actual type, strength, or direction of the relationships within drug networks. Nor do they allow comparison of differences in relationships based on diverse kinds of interactions, such as drug use, social activities,

or intimate topics. Therefore, the authors decided to conduct full network analysis on a subsample of the local drug networks in order to collect information about the interactive affiliations of each individual in the network.

The authors currently are working with 23 clearly defined groups of active drug users in Strip Town, as well as a number of individuals who have no known network connections (isolates). The size of these groups varies from 2 (usually couples) to 42 or more. Full network relationship data have been obtained on a total of 10 of the active networks in this study. During the full network data collection process, the group is brought together and asked to rate their relationship to each member of the network based on a structured set of questions about their social relationships, their drug use patterns, and communication about intimate subjects such as sex. The authors also record focus group discussions about the ways in which new members are recruited and the norms the group holds in relation to HIV risks.

These network group interviews identify the perspectives that members have on the social and drug-using characteristics of the group. They provide information on how the group perceives its need to protect itself from HIV risks by either reinforcing or changing group norms about needle sharing or unprotected sexual relations with main and casual partners. The process also includes a network problem-solving intervention that allows the group to identify risks to the group as a whole (without blaming or identifying members). Feedback from these sessions indicates that the sessions are successful in initiating communication within the group on topics that were not formerly discussed. The analysis of the relational network data collected in these sessions provides the opportunity to identify network characteristics that exist in these drug networks (Glover 1989, 1990; Kilworth and Bernard 1974; Knoke and Kuklinski 1982; Panning 1982; Scott 1991). Knowledge of the communication patterns of networks allows a much more focused approach for carrying out the educational and intervention objectives of this project.

One network has been chosen to illustrate the types of information used to analyze relational aspects of the AIDS risk reduction program. This network, labeled “N1” was chosen as an example of a multigeneration, family-based drug network. There also are networks with virtually no family ties or centralized leadership, which demand different intervention approaches. Network Nl contains members from two Hispanic kinship

groups, one of which includes an Anglo-American spouse. The group has both male and female membership, as can be seen from the following kinship diagrams (see figure 1).

The drugs of choice for the group are cocaine and crystal meth, and the group includes both IDUs and non-IDUs. The members of the group are "in the system," living in local project housing. Three undocumented individuals from Mexico are members of the group. The core group has been using drugs together since high school; some of the members are now in their forties. The network is relatively closed, with membership being restricted to kin and sexual partners of kin.

The structural relationships identified in this network (or any network) include different types of connections between actors, the centrality or influence of individual actors as subgroups within the larger group, and as roles or "positions" within the network (Knoke and Kuklinski 1982). The authors are currently studying both the connections and the substructures of the networks. They are analyzing the patterns of

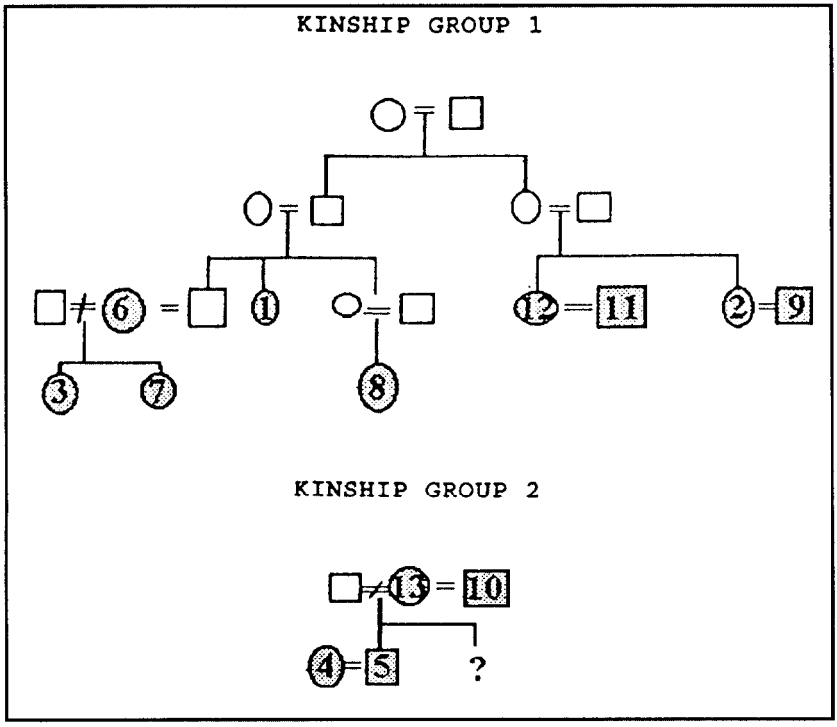

FIGURE 1. *Network N1 kinship charts.*

information flow within networks, sometimes called connectivity (Doreian 1974). This flow can be characterized by several measures, including the amount of information that passes through a particular individual, the length of time it takes information to reach each person in the network, identification of the people who are gatekeepers of the information flow, measures of differential influence in the group, and measures of the probability that someone can or cannot receive information that is injected into the network (Ford and Fulkerson 1956; Gomory and Hu 1964; Katz 1953; Taylor 1969). Issues of subgroups and positions in the networks are also being investigated. Network researchers have created two methods of identifying key structural elements of groups. One is based on the idea of social cohesion, where cliques or circles of social actors are identified by the aggregate bonds that link them together (Bron and Kerbosch 1973; Mokken 1979). The other is based on the idea of structural equivalence, where people who are similarly connected (have the same types of links to others) are thought to be more similar to each other than people in the same subset who have different types of links to others (Kilworth and Bernard 1974). Both the structural and connection data provide information that can increase the effectiveness of HIV education and prevention efforts directed either at individuals or the whole group by identifying the most effective targets for the messages and skills training.

The authors' full network questionnaire is a matrix consisting of 27 questions that allow each individual to define his or her relationships to the other members of their network. The questionnaire includes social relationship questions (e.g., How much do you hang out with X?); drug relationship questions (e.g., How willing are you to share needles with X?), and HIV- or intimacy-related questions (e.g., How willing would you be to tell X you have AIDS?). These are aggregated and analyzed to provide a picture of the social, drug, and other intimate communication relationships in the network. The following diagram provides a sociogram model of the relationships in network N1 , derived from the social relationship questions on the matrix (figure 2).

The connecting lines between individuals (identified by a number) indicate the existence of a strong connection between two people. All individuals in this group have some weak interactions with each other, but the influence or communication between some is minimal; the diagram concentrates on the strong ties. Females are represented by a number in a circle and males by a number in a square. An arrowhead

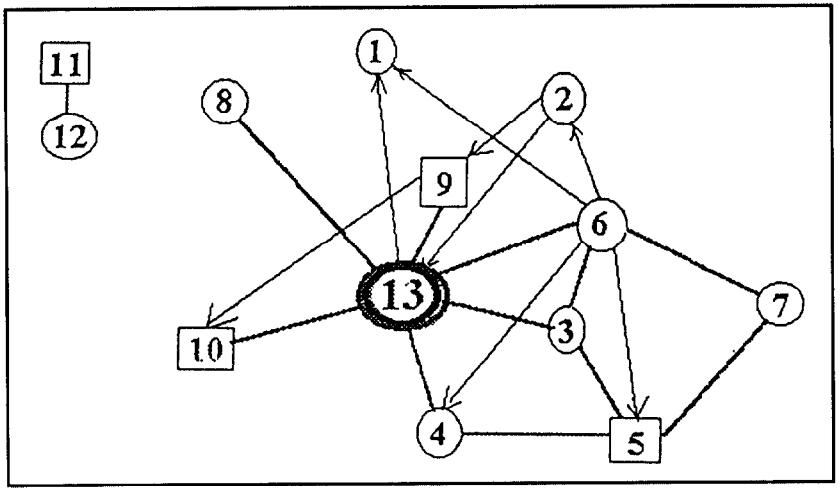

FIGURE 2. *Network N1 sociogram of social relations.*

indicates a one-way connection between two people, while a solid line indicates a two-way connection. The width of the line indicates the strength of the connection. The larger, lighter circle around Anita, #13, indicates she is the central person in terms of influence measures. She is also the most central communication node in the network. The core of the network is comprised of Anita (#13), Lydia (#6), Adelita (#4), Marcos (#5), Jaime (#9), and Josepha (#3). All of these individuals have close kinship ties, and communication between them is strong. Miguel (#11) and Dolores (#12) are living as married, and Miguel is the first cousin of Maria (#1) and Lydia (#6). Aida (#7) is Lydia's (#6) niece and Josepha's (#3) first cousin.

The drug network characteristics (derived from analysis of the drug questions on the network matrix) are an interesting contrast to the social relationships. Several people change position, from peripheral to more strongly connected, or vice versa, as can be seen in the following diagram (figure 3).

There is a change in the information flow and influence patterns of the network in relation to drug issues. Aida (#7) is a nonuser, which is clearly represented in her lack of connections on the drug questions. Anita (#13) shares the influence on drug relationships with her son, Marcos (#5), and with Jaime (#9), who is a central member because he is a bilingual communication bridge between the Spanish (only) and English (only) speakers in the network. Marcos (#5) scores drugs for this

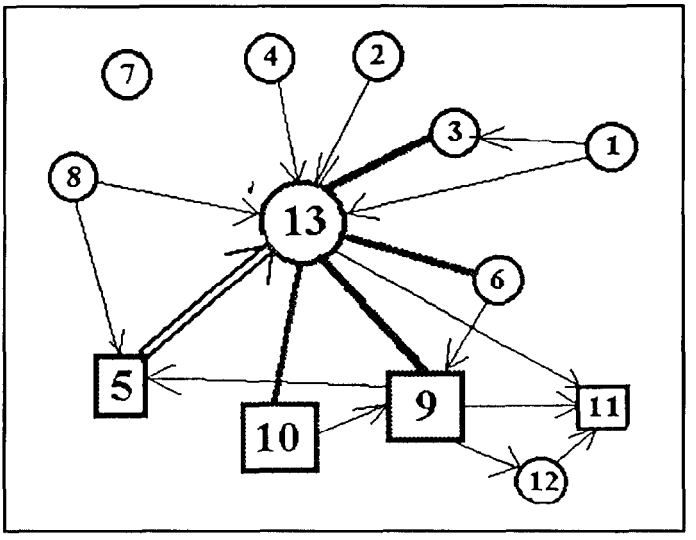

FIGURE 3. *Network N1 sociogram of drug relations.*

network, keeps track of drug-related conditions, and influences the network through his mother's close connections with everyone else.

Some of the individuals who were strongly connected by social relationships are connected by weak ties or are no longer directly connected in terms of their drug relations. For example, Adelita (#4) and Marcos (#5), who are married to each other, are strongly tied in the diagram on social relationships, but Adelita (#4) does not communicate much about drugs with her husband, only with her mother-in-law, Anita (#I 3). The kinship ties between Jaime (#9) and Maria Elena (#2) (living as married) are not visible in the drug relationship diagram, nor is the aunt-niece connection between Lydia (#6) and Aida (#7). This indicates that some people are reachable for the HIV/drug-risk reduction information but are less accessible to the social-risk-reduction information, such as sexual risk, unless the information is brokered by different individual connections.

As a final note on the relationships displayed by these three representations, the shape of the drug relations network diagram is similar to a classic problem-solving configuration for networks. It is called a star pattern, in which one person acts as a center in direct communication with the rest of the network through dyadic relationships, with relatively few interconnections. This allows rapid input on any issue and facilitates problem solving for the group as a whole. The social network diagram is

a classic communication configuration where there are multiplex ties within the group. This structure ensures that communication will not break down with the loss of one member of the network since everyone in the core group is tied to multiple individuals.

These findings are parallel to those for other networks this project has investigated. The majority of drug-using networks in Strip Town, like N1 , are small and relatively tight. They depend on kinship and long-term friendship for entry, and they show a strong tendency for tight communication and reinforcement of the group's norms. This means that if the network is currently "clean" of HIV infection, the group can become an excellent focal point for developing or reinforcing social norms that promote remaining HIV free. These norms can support the elimination of risks through the elimination of ties that produce HIV risks, such as needle sharing with strangers or unprotected sex with casual partners. In addition, the existing boundaries can be reinforced, and some assessment of HIV risk can be added to the trust issues that already affect new recruitment into the group. New recruits could be sought only from low-risk categories of drug abuse or sexual behavior.

The authors have also analyzed several other classic measures of network connections and network structure' in the 10 networks for which they have collected relational data in order to inform their education and prevention efforts. These can be taken as a general model of the measures found to be useful for these purposes. The *geodesic distance* measures for the network show that information flow is tight: The general distances between individuals are small even though there are quite a few people in the group (Doreian 1974). A second network measure, Freeman Betweenness Centrality (Freeman 1979), indicates that there are two persons who are the most central in the social relationships, Anita and Jaime. They act as brokers for information flowing through the network for the social relations. Most social information (such as sexual education information) must flow through one or both of these individuals if it is to reach everyone in the network. In contrast, there are three brokers for the drug relations: Marcos, Jaime, and Anita, in that order. Marcos is Anita's son, which decreases his social centrality. In both sets of relationships, Jaime holds a central position in the network and is a critical person to recruit for both information exchange and behavioral change.

A further analysis of the network structures, of factions and cliques, (Borgatti et al. 1990; Bron and Kerbosch 1973; Seidman and Foster

1978) indicates there are only a small number of people who are marginal to the core of the group. The factions within the group change significantly when the drug relation questions are analyzed. These data divide the core drug group into two subsystems. This information has been used to identify boundaries where information may be blocked if at least one individual from each subgroup is not involved in the intervention. If a network is badly fissured, information must be provided to multiple individuals. Centralized networks like this one, with few marginals, can be provided education through fewer contacts and through a smaller number of individuals than in diffuse, less tightly constructed networks.

STRATEGIES FOR NETWORK-BASED DRUG AND HIV INTERVENTION

Current evaluations indicate there are numerous advantages in using a multiple-method network approach in HIV- and drug-risk reduction programs. Ego-centered data collection, especially early in the program cycle, provides excellent baseline data for understanding the general network characteristics in a population. Ethnographic network data collection combined with relational data can provide critical information throughout the project by identifying the most effective recipients of prevention and intervention actions; this type of data collection can also act as an effective evaluation tool to determine the impact of interventions at a level above individual measures of change.

Network-based outreach is an effective mechanism for establishing the contacts and relationships necessary to conduct effective HIV prevention programs in hidden or hard-to-reach populations. The most difficult part of the process is often the initial contact or entry into a new network. Network-based outreach follows existing social relationships. Finding the first individual who will provide access is challenging. However, with the sponsorship of that person, the remainder of the network can be contacted without violating social taboos surrounding the necessary secrecy of the group's membership. Any gatekeeper is a natural go-between who can reduce barriers to participation by endorsing the program to others in the network. Recruitment of individuals into programs can be made within the context of the same social group that will reinforce program objectives or oppose them. Once the network has been recruited, the group itself can provide the impetus to participate rather than having to rely on individual-by-individual motivational

techniques. Group dynamics are in force that can reduce barriers to prevention and education.

Network-based intervention has additional advantages. Keeping track of network members is a natural function of the gatekeepers of the network. Doing this can greatly assist the followup phase of any project. If the core or most influential members of the network are identified and tracked, they can act as primary links to the other members of the group, reducing the disadvantages of individually based followup by providing assistance to outreach workers who cannot spend as much time following the whereabouts of network members as the gatekeepers can.

Once effective outreach is established, networks with strong group norms can be approached differently from those with predominantly weak ties and variable norms. Strong group norms can be helped to adopt or maintain norms that reduce HIV risks with strangers or outsiders and reinforce protective behavior (needle cleaning, safe sex) as appropriate behaviors within the group. The intervention can also support increased communication between members of these groups. If the initial prevention or intervention message is successfully transmitted to a central or core individual in the network, there is a good chance that person will subsequently transmit it to part or all of the rest of the network.

The network approach can also identify individuals who are peripheral to the network, those people intervention will reach only if they are individually educated. It can identify differences in the ease of communication across various topics. The network members may speak openly about cleaning needles but restrict conversations on intimate subjects. Using network techniques to identify these areas of low or nonexistent communication can lead to a more clearly targeted intervention directed toward lifting communication taboos.

In the case of drug networks where members interact as short-term acquaintances and operate in a loosely structured group, the intervention may have to be conducted on an individual, dyadic, or triadic basis. The network structure prevents a synergistic effect beyond anything more than small segments of the group. The intervention is also most likely to consist of reducing the risks associated with sexual and drug interactions among ties that create high risks within the group; it does so by encouraging people to break those ties and reduce their risk or to become associated with a group that has more protective boundary mechanisms. The standard intervention employed by the project described in this

chapter assumes clients are capable of interacting assertively within their peer group and with sexual partners. Since this may not be the case, the enhanced intervention adds the opportunity for the whole network to discuss these issues and to establish group norms that may protect the less powerful group members and reduce the chance of HIV infection for the group as a whole.

Data collected during this project also explain some of the failures of the classic strategy used in both drug rehabilitation and in HIV-risk reduction, which is to move an individual away from high-risk personal social networks into lower risk relationships (peer cluster theory). Smalltown drug networks are frequently kinship based or based on long-term friendship. There are relatively few choices for making friends in a small town; for example, there is a restricted pool to choose from, compared with an urban area with more groups and associations. In a small town, if a person does not like someone in his or her Narcotics Anonymous (NA) group, "that's tough," because it is the only one in town. People might have to leave town or even leave the State to accomplish the classic goal of changing friends and networks. Data show this is an unlikely event for most of the people interviewed. On the other hand, these network data indicate it is possible to change the norms and risk-taking patterns of networks, as a whole, by reinforcing positive risk reduction behaviors. For this reason, natural network-based approaches to risk reduction are a highly desirable adjunct to individual intervention strategies.

Beyond these basics, a number of approaches could be introduced to enhance network-based HIV interventions. Ethnographic network analysis has identified individuals who could become key players at the between-network intervention and outreach levels. These individuals act as a bridge for HIV infection entering or leaving a network through their drug or sexual activities outside of the core group. Once identified, these individuals could be recruited for a number of intervention-related roles. They could become key players by reducing the chances of HIV bridges being activated. These bridge individuals could also potentially be assembled into a grassroots organization to assist in forming a drug community effort to confront the spread of HIV infections. Since they are already backed by social groups, they could form the nucleus for "street-level" community development efforts. This type of organizational intervention provides some opportunity for creating a self-help structure that will last beyond the end of the Federal funding of HIV prevention projects, allowing the effects to continue on their own.

FUTURE DIRECTIONS FOR NETWORK-BASED PREVENTION

The authors' approach to risk reduction in smalltown drug networks has proven to be valuable in the identification, location, and recruitment of hidden or difficult-to-access populations. Ethnographic network analysis has led to a series of suggestions combining qualitative and quantitative approaches to increasing knowledge about HIV and drug intervention in "not-in-treatment" drug users. At the simplest level, network data identify the presence or absence of communication between individuals and between sets of individuals on particular topics. At the next level, network information data can identify the central person or persons who exhibit the most influence on the group, the nodes in the network that act as gatekeepers for interaction, or the subsets of individuals who interact more among themselves than they do with others in the larger network. Each of these conditions can suggest processes for direct and indirect intervention and provide outcome measures of the efficacy of both preventions and interventions.

The authors hypothesize that they will be able to measure both the individual effects of interventions and the cumulative network effects using combined analytical tools. Ethnographic findings demonstrate that qualitative descriptions of network conditions can be used as a direct adjunct to this prevention program. The ethnographic data can also act as an important theory generation bridge into quantitative measures of the impact of social networks on HIV and drug risk-taking processes.

The next step in the present research will be to look at the relationships among aggregated variables associated with individuals in each network in order to test hypotheses on the information obtained about the various groups. , For example, there should be additional linkages between network types and the presence or absence of risky conditions. The presence of HIV infection (or percentage of infected individuals) should vary among the networks. The size of the network should have some impact on the ease or difficulty of changing norms that will protect members from risks in the community. The authors should be able to measure differential effects, if there are any, on HIV risk and the type of drug used, holding the type of network constant. They should also be able to measure differences in the overall risk to individuals and to the group as a whole, based on the ratio of kin to nonkin membership, or the ratio of strong to weak ties, or on the basis of group norms that favor or that interfere with positive attitudes toward drug treatment programs.

Knowing the network membership of participants should allow measurement of peer influence on attempts to enter or avoid drug rehabilitation programs.

The authors are hypothesizing that both individual effects of interventions and cumulative network effects using network analysis tools can be measured. For example, those conditions that require increased communication can be measured by increased information flow within the network (Hubbell 1965; Taylor 1969). They are also measurable in terms of reduced geodesic distances among all network members or some portions of the network (Doreian 1974). It should be possible to identify risk reduction in the network, between time 1 and time 2 if high-risk elements of the network have been segmented off and the interactions with those cliques are reduced or eliminated (Glover 1989, 1990). Factions within the network should show either risk reduction or risk concentration with increased distance to the risky parts of the network. Centralization is a measure of the way that information is being controlled by individuals (Stephenson and Zelen 1991), and for some networks, a reduction of centralization should correlate with risk reduction through the creation of more communication linkages between noncentral individuals.

The authors also should be able to detect changes in influence, both in drug and socially related issues, where individuals take on new roles within the group to reinforce protective behaviors and reduce risks (Bonacich 1987). When these data are correlated with qualitative and attributional data sets, it provides an important set of tools to measure HIV-risk reduction in a high-risk population. In sum, network analysis in its various forms appears to be a highly desirable and productive tool for the reduction of HIV hazards in hard-to-reach populations.

The authors have also hypothesized that network relational and structural analysis can identify individuals who should become key players in network-level intervention and outreach, as adjuncts to project staff for a particular network. Once identified, these individuals can be recruited specifically for intervention-related roles. Central individuals from different groups could also be assembled into a grassroots organization to assist in forming a drug community effort to confront the spread of HIV infection. Since these leaders are already backed by social groups, they could form the nucleus for street-level community development efforts. This type of organizational intervention provides some opportunity for

creating a self-help structure that will last beyond the end of the Federal funding for this project, allowing the effects to continue on their own.

An individual's potential for treatment success may be directly related to network variables that can then be converted to a group "willingness to change" measure. The authors should also be able to measure the impact of splits in the group, as well as differences in within-group associations on risk taking and the effects of those risks on both individuals and the groups. They may also be able to detect changes in influence, both in drug and socially related issues, where individuals take on new roles within the group to reinforce protective behaviors and reduce risks. The authors believe there are numerous other qualitative and quantitative measures that will allow identification of the effects of this program beyond the individual level. Many are yet to be discovered, but efforts at the network level appear to be invaluable in helping researchers address the key HIV and drug risks of hidden populations.

NOTES

1. This is a 5-year project funded by the National Institute on Drug Abuse (NIDA) grant #U01-DA07295. It is part of the NIDA Community Research Branch's Cooperative Agreement program. The project principal investigator is Robert T. Trotter II, and the co-principal investigators are Laurie J. Price and Anne M. Bowen.

2. Following the general ethical guidelines for projects like this one, the names of the communities involved in the project have been replaced by pseudonyms or generic terms to meet privacy and confidentiality conditions.

3. The citation for this report has been omitted to protect the anonymity of the community.

4. The instrument *Assessment of Drug Use Social Networks* was developed by Dr. Mark Williams, Dr. Richard Needle, and Dr. Harvey Siegal in cooperation with other researchers from Cooperative Agreement sites. Correspondence should be directed to Dr. Williams, Affiliated Systems Corporation, 3104 Edloe, Suite 330, Houston, TX 77027-6022.

5. In order to participate, respondents must be 18 years of age or older, must not have been in treatment for at least the past 12 months, and must have a positive urine test for either cocaine or heroine use (or have fresh needle tracks and test positive for other injectable drugs) at the time of the RBA interview. Therefore, this category for the clients includes only 18- and 19-year-olds. The nonclient (alter) categories may include younger individuals since no age restrictions were placed on naming the people in these categories.

6. The n/a designation indicates that this variable was not assessed for the designated group.

7. Recruitment is conducted on a network-by-network basis, with an overall targeted sampling plan in effect over a 12-month period. For any given shorter length of time, subsections of the targeted sample may be overrepresented.

8. All of the calculations were conducted using the program UCINET 4.0.

REFERENCES

Bandura, A. Perceived self-efficacy in the exercise of control over AIDS infection. In: Mays, V.; Albee, G.W.; and Schneider, S.F., eds. *Primary Prevention of AIDS: Psychological Approaches.* Vol. XIII. Newbury Park: Sage Publications, 1990.

Bandura, A. *Social Foundations of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice Hall, 1986.

Bernard, H.R. *Research Methods in Cultural Anthropology.* Beverly Hills, CA: Sage, 1986.

Bonacich, P. Power and centrality: A family of measures. *Am J Sociol* 92:1170-1182, 1987.

Borgatti, S.P.; Everett, M.G.; and Shirey, P.R. LS sets, lambda sets, and other cohesive subsets. *Soc Netw* 12:337-357, 1990.

Bron C., and Kerbosch, J. Finding all cliques of an undirected graph. *Commun ACM* 16:575-577, 1973.

Centers for Disease Control and Prevention. *HIV/AIDS Surveillance.* U.S. Department of Health and Human Services, Atlanta, GA, July 1992.

Doreian, P. On the connectivity of social networks. *J Math Social* 3:245-258, 1974.

Estrada, A.; Erickson, J.R.; Femandez, M.E.; and Stevens, S. "AIDS Risk Behaviors Among Native American IVDU's: A Preliminary Report." Paper presented at the National Institute on Drug Abuse/National Institute of Mental Health Technical Review on AIDS Risks in Minority Groups, Albuquerque, NM, November 1989.

Fraser M., and Hawkins, D. Social network analysis and drug misuse. *Soc Sew Rev* University of Chicago, 1984.

Freeman, L. Centrality in social networks: Conceptual clarification. *Soc Netw* 1:215-239, 1979.

Ford, L.R., and Fulkerson, D.R. Maximum flow through a network. *Can J Math* 8:399-404, 1956.

Glover, F. Tabu Search-Part I. *URSA J Comput* 1: 190-206, 1989.

Glover, F. Tabu Search-Part II. *ORSA J Comput* 2:4-32, 1990.

Gomory, R.E., and Hu, T.C. Synthesis of a communication network. *J SIAM (Appl Math)* 12:348, 1964.

Hubbell, C.H. An input-output approach to clique identification. *Sociometry* 28:377-399, 1965.

Katz, L. A new status index derived from sociometric data analysis. *Psychometrika* 18:34-43, 1953.

Kilworth, P., and Bernard, H.R. CATIJ: A new sociometric and its application to a prison living unit. *Hum Organ* 33:335-350, 1974.

Klovdahl, A. Social Networks and the spread of infectious diseases: The AIDS example. *Soc Sci Med* 21(11):87-93, 1985.

Knoke, D., and Kuklinski, J.H. *Network Analysis.* Newbury Park, CA: Sage Publications, 1982.

LaFromboise, T., and Rowe, W. Skills training for bicultural competence: Rationale and application. *J Couns Psychol* 30(4):589-595, 1983.

May, P.A. "The Prevention of Alcohol and Other Substance Abuse among American Indians: A Review and Analysis of the Literature." Paper presented to the National Institute on Alcohol Abuse and Alcoholism Prevention Research Branch, Rockville, MD, June 1992.

Mays, V.; Albee, G.W.; and Schneider, S.F., eds. *Primary Prevention of AIDS: Psychological Approaches.* Vol. XIII. Newbury Park, CA: Sage Publications, 1990.

Mokken, R. Cliques, clubs and clans. *Qual Quant* 13:161-173, 1979.

Panning, W. Fitting block models to data. *Soc Netw* 4:81-101, 1982.

Scott, J. *Social Network Analysis: A Handbook.* Newbury Park, CA: Sage Publications, 1991.

Seidman, S., and Foster, B. A graph theoretic generalization of the clique concept. *J Math Social* 6:139-154, 1978.

Stephenson, K., and Zelen, M. Rethinking centrality. *Soc Netw* 13:81-101, 1991.

Taylor, M. Influence structures. *Sociometry* 32:490-502, 1969.
Trotter, R.T.II. Ethnographic research methods for applied medical anthropology. In: Hill, C.H., ed. *Training Manual in Applied Medical Anthropology*. American Anthropological Association Special Publication No. 27. Washington, DC: American Anthropological Association, 1991.
Tyler, J., and Holsinger, D. Focus of control differences between rural American Indian and White children. *J Soc Psychol* 95:149-155, 1975.

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A Personal Network Approach to AIDS Prevention: An Experimental Peer Group Intervention for Street-Injecting Drug Users: The SAFE Study

Carl A. Latkin

INTRODUCTION

The Stop AIDS For Everyone (SAFE) study is a social network-oriented experimental intervention designed to reduce the human immunodeficiency virus (HIV)-risk behaviors in injecting drug users (IDUs). The outcome of the study has been presented elsewhere (see Latkin et al., in press; Mandell et al., submitted).

In a 3-month followup survey in the initial phase of the study, significant differences were found between the experimental group and the control group regarding changes in the self-reported HIV-risk behaviors of needle sharing, attending shooting galleries, cleaning injection equipment with bleach, and carrying bleach. Although at baseline the experimental group reported higher levels of injection-related HIV-risk behaviors, at the 5-month followup study the experimental group reported significantly greater risk reduction. Individuals in the experimental condition who reported lower levels of risk behavior at baseline demonstrated significantly greater risk reduction, as compared with the control group, suggesting that these results are likely to be a product of a regression to the mean phenomenon. At baseline, personal network characteristics of size of drug network and density of network predicted at followup the risk behavior of needle sharing, and a smaller material aid subnetwork predicted attendance in shooting galleries.

This chapter will first describe the intervention; second, examine evidence of strengths of a social network approach for IDUs not in treatment; and third, examine evidence of the social influence of drug-sharing subnetworks on the HIV-risk behaviors of their members.

The strategy of using naturally occurring drug-sharing subnetworks as a vehicle for behavior change is based on theories of social influence. Several studies have indicated that perceived peer norms and peer pressure are determinants of HIV-related risky injection practices and unprotected sexual activity (Des Jarlais et al. 1985; Friedman et al. 1986, 1987; Magura 1989; Mandell et al., in press; Murphy 1987). Ethnographic studies have identified social pressures associated with greater involvement in drug-using social groups as promoting needle-sharing behavior (Des Jarlais et al. 1985; Murphy 1987).

One method of studying social influence is through social and personal network analysis. Analysis of networks allows for the study of both individuals' behaviors and their social environments. Investigators have used social and personal network analysis to examine socialization, diffusion of innovation, and norm formation (Marsden 1990). Social networks are theorized to influence members' behaviors through social comparison processes, fear of social sanctions, information exchange, and socialization of new members (Fisher 1988; Fisher and Fisher 1992; Hall and Wellman 1985). Previous research indicates that social network characteristics are associated with adoption of health behaviors (Gottlieb 1985; Hunter et al. 1991), buffer against psychological stress, and differentiate drug use behaviors (Fraser and Hawkins 1984; Hunter et al. 1991).

There is little systematic information on the role of social influence in adopting or maintaining acquired immunodeficiency syndrome (AIDS)-related behaviors among IDUs. In the present study, IDUs' drug-sharing subnetworks were the focus of intervention and analysis. The study design included random assignment to an intervention or control group.

METHODS

Recruitment

Respondents were recruited from the AIDS Linked to Intravenous Experiences (ALIVE) study, a longitudinal study of the natural history of HIV infection and disease. Approximately 3,000 IDUs in Baltimore enrolled in ALIVE (Vlahov et al. 1991a, 1991b). The majority of participants (85 percent) were recruited by word of mouth, which in itself is a network recruitment technique. At the ALIVE clinic, participants who were 18 years old and at their regular 6-month followup visit

reported that they had shared drugs in the preceding 6 months and had shared needles were asked to participate in the SAFE study. At the SAFE clinic, potential participants were again screened for eligibility. Those who were eligible were interviewed for 1 to 1½ hours on their background, HIV-risk behaviors, and personal networks.

Before entering the SAFE study, ALIVE participants were given information on risk reduction and were counseled and tested for HIV. Many of the ALIVE study participants had already reported HIV-risk reduction related to injecting practices, yet many injectors continued to report risky injection practices (Vlahov et al. 1991 c). After the baseline interview, participants were randomly assigned to a control or experimental condition. Criteria for enrollment included injecting within the last 6 months, sharing injection equipment, having a drug-sharing subnetwork, and willingness to bring network members into the clinic and participate in six group sessions. Individuals who were a member of the index's drug network or were isolates or dyads were not eligible for the intervention.

Participants who were assigned to the experimental condition (called indexes) were asked to bring in their drug-sharing subnetwork for the intervention. The individuals with whom they reported that they "did drugs" and were brought into the clinic were called members of the index's drug network. After the random assignment, the indexes met with one of the group facilitators, who were former drug-dependent individuals, to receive information about the study and to discuss ways the indexes could talk to members of their drug-sharing networks about the intervention and encourage them to participate.

All potential participants were invited to the study on a fully informed consent basis. They were told that the research staff would provide study participants with information and the opportunity to practice skills to prevent contracting and transmitting HIV. The indexes were given a financial incentive ($25) for bringing at least two members of their drug-sharing subnetwork into the clinic.

Measures

All participants were administered a personal network interview, a demographic survey, and a survey on drug use and HIV-risk behaviors. The personal network survey asked participants to list, by giving the first name and the first letter of the last name or nickname, members of their

social network. They were first asked to list individuals who could provide support in the domains of intimate interactions, material assistance, socializing, physical assistance, positive feedback, and health information (Mitchell 1982; Mitchell and Trickett 1980). Participants also were asked to list individuals with whom, in the last 6 months, they have had sex and shared drugs.

Criteria for Completion

For a discussion session to occur, the index and the majority of the group members needed to be present. If they did not meet these conditions, the session was rescheduled. Indexes who attended three or more sessions were considered to have completed the program. The followup interview occurred 3 months after completion of the final intervention session. Participants in the control group were reinterviewed within the same timeframe.

Intervention

The experimental groups received up to six sessions. Each session was 1% hours in length. The group intervention utilized the self-help peer-led group techniques and cognitive-behavioral approaches to behavior change. A primary goal of the intervention was to provide a social context for the members of drug-sharing networks to choose methods of reducing their HIV-related drug-injecting and sexual practices and increase their health-promoting behaviors. The group facilitator emphasized that each group was to decide how it would address the issues of HIV and AIDS and how it would support individual members' decisions to alter their risk behaviors.

The intervention strategy was focused on all network members, identifying the risk of HIV to the drug network as a whole and to each member. The facilitators, who were former drug users, helped the groups to identify risky behaviors and make decisions to protect their health. Seven impediments to HIV/AIDS-risk behavior change were identified: (1) denial of risk, (2) belief that safe partners can be identified, (3) inadequate information about risk reduction techniques, (4) inadequate decision-making procedures, (5) lack of detailed behavior-planning skills, (6) failures in managing relapse, and (7) failure of social network responses to risky behaviors.

The first group session began with a 15-minute videotaped discussion of HIV/AIDS and the risk of becoming infected from contaminated needles, followed by a video segment of an IDU with AIDS describing the illness symptoms. Personal risk information was communicated using strategies suggested by Slovic (1987) for enhancing meaningfulness and a sense of personal identification. The sessions were structured to lead from recognition of the general risk of HIV/AIDS to recognition of personal risk of infection. The network was then involved in a group decision process about reducing behavior and preventing relapses for those risky behaviors that they had already reduced or eliminated. This was followed by step-by-step planning of safer behaviors and identifying methods by which the group could monitor and reinforce safer behaviors of each member.

At each session, the facilitator employed cognitive and/or behavioral techniques related to drug use and HIV. Role playing of problem situations was also used. Topics for session discussions included:

1. Cognitive distortions (e.g., denial, avoidance, hopelessness) regarding use of unhygienic needles;

2. Communication skills, in particular rejecting high-risk injection practices in a socially acceptable manner;

3. Degree of identity and self-esteem attached to needle sharing;

4. Alternative activities to visiting shooting galleries;

5. Control and management of emotions through cognitive-behavioral techniques; and

6. Methods of relapse control,

Group members were then asked to list target situations that they felt might be most likely to interfere with their achieving safer drug use. They were asked to make a commitment to risk reduction in front of their peers. Different techniques were discussed for assuring the availability of hygienic needles, such as purchase of sterile needles or proper use of alcohol and bleach as disinfectants, and their relative advantages in different situations. The participants were asked to identify strategies they would use in different settings. Groups would then discuss potential impediments to altering the identified risky behaviors and methods of

addressing these impediments. Several portions of the counseling sessions were devoted to assisting participants in developing the skills to implement their decisions. On completion of the six sessions, participants were given a certificate of completion.

Analyses

The unit of analysis was the drug-sharing subnetworks, and the number of "subjects" in the trial was the number of indexes.

RESULTS

Social Networks as a Method of Recruitment

In the first set of analyses the overlap between participants in the ALIVE and SAFE was examined. Out of 348 network members recruited, 16 percent reported that they were in the ALIVE study. Few network members reported recent participation in drug treatment programs. Only 10 percent reported that in the last 6 months they had been in a methadone maintenance program; 15 percent reported that within the prior 6 months they had been in a detoxification program, and 5 percent reported involvement in both types of programs.

In the next analyses, the feasibility of using personal networks as a method of recruitment was assessed. Of the 189 individuals who had been randomly assigned as indexes, 70 individuals did not return with drug network members (table 1). Another 12 indexes brought in only one member of their drug-sharing network to be interviewed. Thus, of the 189 assigned indexes, 107 returned with two or more members of their drug-sharing network, bringing in a total of 348 network members (table 1).

Drug-Sharing Personal Networks as an Intervention Target

The next analyses examined the study attrition rate. Out of the 189 potential indexes, 78 (41 percent) indexes completed at least one session, and 66 indexes and 192 network members completed three or more sessions. The mean and median number of network members in groups who attended the sessions was three.

TABLE 1. *Number of drug subnetwork members brought into the clinic by probands in the SAFE study, Baltimore, MD, 1990-1992.*

Frequency of Drug Subnetwork Members	Frequency of Probands	Number of Subnetwork Members
0	70	0
1	12	12
2	40	80
3	36	108
4	19	76
5	6	30
6	1	6
7	4	28
8	1	8
	Total Probands = 189	Network Members = 348

The followup interview occurred 3 months after the completion of the sessions. The followup rate was 94 percent for the indexes who had completed the program and 88 percent for the controls. There was a significant difference in average size of drug networks between indexes who completed the program and those who did not (mean of 6.4 versus 5.2, respectively; $t = 2.31$, $df = 1,186$, $p < 0.05$).

Description of Participants

The respondents were predominantly low-income, African-American males (table 2). The majority had received public assistance within the last 6 months and were unemployed. Within the last 6 months, approximately one-third had been homeless. Injectable cocaine and heroin were the drugs of choice in this sample (table 3).

TABLE 2. *Demographic characteristics and life events at baseline of IDUs enrolled in the SAFE study, Baltimore, MD, 1991-1992.*

Variables	Network Members		Probands	
	(%)	N	(%)	N
Gender: Male	75.3	348	85.7	189
Race: African-American	98.3	348	97.4	189
Education: > 12th grade	45.0	347	42.6	188
Married	4.6	347	4.8	187
Currently employed	11.8	339	10.8	185
Arrested within last 6 months	30.0	320	29.4	163
Homeless within last 6 months	29.1	320	41.5	164
On public assistance now	62.5	347	60.6	188
Mean and median year of birth	1953		1953	

Indexes' and Drug Subnetwork Members' Risk Behaviors

To assess the relationship between indexes' and their drug-sharing subnetwork's HIV-risk behaviors, the associations between the index's risk behaviors and those of the drug-sharing subnetwork's were examined. A network risk level was defined as the group mean, excluding the index, on each of the risk variables. Each group's risk score was then correlated with the index's score on the five HIV-risk variables of frequency of injecting cocaine, attending shooting galleries, always cleaning injection equipment with bleach, frequency of sharing injection equipment, and number of sharing partners. There were 12 drug-sharing networks that only had 2 members (i.e., the index and 1 network member). As these 12 were dyads, not groups, they were removed from the analyses. As presented in table 4, there was a strong

association between indexes' risk behaviors and the mean of the drug-sharing network. Four out of the five Spearman's correlation coefficients were statistically significant.

TABLE 3. *Self-reported drug use for the last 6 months at baseline interview of 189 probands and 348 networks members in the SAFE study, Baltimore, MD, 1990-1992. **

Variables	Probands (%)	Controls (%)
Any use of cocaine	93.1	93.5
Injecting cocaine once a day or more	47.6	48.1
Any use of heroin	87.3	86.5
Injecting heroin once a day or more	47.1	53.9
Use of crack more than once a month	14.3	17.7
Always clean used needles	34.9	54.8
Injected in a shooting gallery	29.6	27.6
Frequency of sharing needles		
Not at all	19.8	43.8
Less than once a month	24.1	18.3
Once a month or more	56.1	47.9

KEY: * Missing data on four participants,

TABLE 4. *The association between the probands' risk behavior and the mean of the probands' drug-sharing network on five HIV-risk behaviors among 107 drag-sharing networks, Baltimore, MD, 1990-1992.*

	Spearman's Correlation Coefficient	Number of Drug-Sharing Subnetworks	P
Attending shooting gallery in prior 6 months	0.24	107	0.007
Frequency of injecting cocaine	0.25	107	0.004
Always clean used needles	0.21	107	0.014
Frequency of sharing injection equipment	0.06	106	0.273
Number of individuals with whom share injection equipment	0.18	102	0.039

DISCUSSION

In this preventive intervention aimed at drug-sharing subnetworks, significant differences between the control group and the experimental group in the HIV-related injecting behaviors were found at a 3-month followup. Differences were found in the HIV-risk behaviors of cleaning used needles, always carrying bleach, frequency of needle-sharing partners, and use of shooting galleries (see Latkin et al., in press; Mandell et al., submitted).

As the ALIVE study, from which indexes and controls were recruited, obtained the majority of their participants by word of mouth, the indexes' network members were examined to see if they were also ALIVE participants. The social network approach to recruitment brought into the clinic a group of 348 IDU network members, few of whom had been in the ALIVE study. The low percentage of overlap among SAFE and ALIVE participants suggests that such a social network approach to recruitment may reach individuals who have not been involved or exposed to other public health programs. The lack of overlap between participants in these two studies also may be partially explained by the turnover rate in drug-sharing subnetworks. Cochran and colleagues (1990) found a 3-year turnover rate of 23 percent among network ties of two-parent mothers in Syracuse, NY. The rate of turnover was much higher (39 percent) for single mothers. The authors suggest that single mothers in their study were often subject to stressful changes and abrupt moves that disrupted their social relations. The lives of IDUs are also subject to numerous stresses that disrupt their social ties, and therefore IDUs also may have high rates of network turnover.

The network approach to recruitment of IDUs may also have other applications. By examining the overlap among drug-sharing networks within and between samples, network analysis could be used to estimate the number of IDUs in a given geographic area.

The results from this study demonstrate that a social network approach is a viable method for recruiting and imparting skills relevant to HIV prevention in IDUs, and perhaps the approach may facilitate enrollment in treatment programs. The significant statistical association between the indexes' levels of risk behavior and the mean risk behavior of the indexes' drug-sharing network suggests that high-risk groups of IDUs may be recruited into preventive interventions by first identifying high-risk individuals and then using these individuals to recruit their drug-sharing networks into treatment and prevention programs.

There are several explanations for the significant association between the groups' behaviors and the behaviors of the indexes. One explanation is that of differential association; that is, those who engage in high risk may associate with other high-risk individuals, or low-risk groups may shun high-risk individuals. Among adolescents, research on drug use patterns has verified the relationship between drug usage and the use pattern of friends (Brooks et al. 1989; Elliott et al. 1985). Several social factors have been identified as influencing HIV-risk behaviors. Friedman and

colleagues (1987) found that perceptions of friends' HIV-related risky behaviors were the strongest predictors of behavioral change in IDUs. Perceptions of friends' risk behaviors were a stronger determinant of risk reduction than was knowledge about AIDS, education level, or personal knowledge of somebody with AIDS. Magura and colleagues (1989) also report that friends' attitudes are a strong determinant of needle sharing. Friedman and colleagues (1986), reporting on an IDU subculture in New York City, describe the existence of small friendship groups that work together in pairs or small groups to obtain money, drugs, and protection against assault. In Baltimore the organized group of IDUs known as Street Voice, which publishes a monthly newsletter, has emphasized the importance of a "walking partner" for help and protection on the street (Street Voice 1993).

Group norms for IDUs are hypothesized to include sharing of injection equipment. Group norms have been shown to influence members' behaviors (Myers and Bishop 1970; Newcomb 1958). Group norms have been characterized as conservative factors, working against the initiation of new behaviors and may account for the resistance of many IDUs to adopt HIV-risk protection (Nadler and Fisher, unpublished manuscript). However, if groups do adopt new norms, it is theorized that the new norms will maintain themselves and reward members who comply with the new norms (Zucker 1977).

The authors found that most members of drug-sharing networks returned as a group to the clinic and completed the program as long as the clinic was sufficiently flexible in operating hours and rescheduling appointments. The greatest impediment to participation was an index's inability to bring in his or her drug-sharing network. However, once the groups attended the first session, it was highly probable that they would return.

The generalizability of the findings may be limited. Explicit criteria for enrollment included injecting drugs within the last 6 months and having a drug-sharing network; implicit criteria were the ability and motivation to bring members of one's drug-sharing network into the clinic and to participate in at least three intervention sessions. This was primarily a sample of unemployed individuals who were or had been on public assistance and had a history of incarceration. The cohort was comprised of volunteers from the ALIVE study. It is plausible that volunteers differ from those who did not volunteer or those who withdrew from the study. Type of drug use, age, and duration of acquaintances with drug-sharing network members also may be factors in the generalizability of these

results. As the intervention was intended to capitalize on the social influence factors occurring in groups, isolates and dyads were not included in the intervention, further limiting the generalizability of the results.

In summary, the findings from this study suggest that a personal network approach may be a powerful method for recruiting IDUs into preventive interventions and other treatment programs, that drug-sharing personal networks vary by their level of risk behavior, and that a personal network approach may be used to alter high-risk behaviors through methods of social influence. Future research may examine how personal networks link to form social networks and how social networks could be used for augmenting HIV prevention.

REFERENCES

Brooks, J.S.; Nomura, C.; and Cohen, P. A network of influences on adolescent drug involvement: Neighborhood, school, peer, and family. *Genet Soc Gen Psychol Monogr* 115:125-145,1989.

Cochran, M.; Lamer, M.; Riley, D.; Gunnarsson, L.; and Henderson, C.R. *Extending Families: The Social Networks of Parents and Their Children.* New York: Cambridge University Press, 1990.

Des Jarlais, D.C.; Friedman, S.R.; and Hopkins, W. Risk reduction for AIDS among intravenous drug users. *Ann Intern Med* 103:755-759, 1985.

Elliott, D.S.; Huizinga, D.; and Ageton, *S.S. Explaining Delinquency and Drug Use.* Beverly Hills, CA: Sage, 1985.

Fisher, J. Possible effects of reference group-based social influence on AIDS risk behavior and AIDS prevention. *Am Psychol* 43:914-920, 1988.

Fisher, J.D., and Fisher, W.A. Changing AIDS risk behavior. *Psychol Bull* 111:455-474, 1992.

Fraser, M.W., and Hawkins, D.J. The social networks of opioid abusers. *Int J Addict* 19:903-917, 1984.

Friedman, S.R.; Des Jarlais, D.C.; and Sotheran, J.L. AIDS health education for IVDUs. *Health Educ Q* 13:383-393, 1986.

Friedman S.R.; Des Jarlais, D.C.; Sotheran, J.L.; Garber, J.; Cohen, H.; and Smith, D. AIDS and self-organization among intravenous drug users. *Int J Addict* 23:201-219, 1987.

Gottlieb, B.H. Social support and community mental health. In: Cohen, S., and Syme, L., eds. *Social Support and Health. New* York: Academic Press, 1985. pp. 303-326.

Hall, A., and Wellman, B. Social networks and social support. In: Cohen, S., and Syme, L., eds. *Social Support and Health. New* York: Academic Press, 1985. pp. 23-41.

Hunter, SM.; Vizalberg, I.A.; and Berenson, G.S. Identifying mechanisms of adoption of tobacco and alcohol use among youth: The Bogalusa heart study. *Soc Net* 13:91-104, 1991.

Latkin, C.A.; Mandell, W.; Oziemkowska, M.; Celentano, D.D.; Vlahov, D.; and Ensminger, M. Family, friends, and partners: The relationship between structural characteristics of social networks and frequency of injecting in urban drug abusers. *J Drug Alcohol Depend*, in press.

Magura, S.; Grossman, J.I.; Lipton, D.S.; Qudsia, S.; Shapiro, J.; Marion, I.; and Amann, K.R. Determinants of needle sharing among intravenous drug users. *Am J Public Health* 79:459-462, 1989.

Magura, S.; Qudsia, S.; Shapiro, J.; Grossman, J.I.; Lipton, D.S.; Marion, I.; Weisenfeld, L.; Amann, K.R.; and Koger, J. Outcomes of an AIDS prevention program for methadone patients. *Int J Addict* 26:629-655, 1991.

Mandell, W.; Latkin, C.A.; Oziemkowska, M.; Celentano, D.D.; and Vlahov, D. "Impact of Social Network Intervention on HIV Risk Behaviors in Injecting Drug Users." Manuscript submitted for publication.

Mandell, W.; Vlahov, D.; Cohn, S.; Latkin, C.A.; and Oziemkowska, M. Correlates of needle sharing among intravenous drug users. *Am J Public Health*, in press.

Marsden, P.V. Network data and measurement. *Annu Rev Social* 16:435-463, 1990.

Mitchell, R.E. Social networks and psychiatric clients: The personal and environmental context. *Am J Community Psychol* 10:387-401, 1982.

Mitchell, R.E., and Trickett, E.J. Task force report: Social networks as mediators of social support: An analysis of the effects and determinants of social networks. *Community Ment Health J* 16:27-44, 1980.

Murphy, S. Intravenous drug use and AIDS: Notes on the social economy of needle sharing. *Contemp Drug Probl* 14:373-395, 1987.

Myers, D.G., and Bishop, P.J. Discussion effects on racial attitudes. *Science* 169:778-789, 1970.

Nadler, A., and Fisher, J.D. "Personal Change: An Interpersonal Perspective." Unpublished manuscript, 1988.

Newcomb, T.M. Attitude development as a function of reference groups: The Bennington study. In: Maccoby, E.E.; Newcomb, T.M.; and Hartly, E.L., eds. *Readings in Social Psychology. New* York: Holt, 1958.

Slovic, P. Perception of risk. *Science* 236:280-285, 1987.

Street Voice. *Street Voice: an Outreach Tool for Education and Survival.* Vol. 3 1. Baltimore: Street Voice, 1993.

Vlahov, D.; Anthony, J.C.; Celentano, D.D.; Solomon, L.; and Chowdhury, N. Trends of HIV-1 risk reduction among initiates into intravenous drug use, 1982-1987. *Am J Drug Alcohol Abuse* 17:39-48, 1991c.

Vlahov, D.; Anthony, J.C.; Muñoz, A.; Margolick, J.; Nelson, K.E.; Celentano, D.D.; Solomon, L.; and Polk, B.F. The ALIVE Study: A longitudinal study of HIV- 1 infection among intravenous drug users: Description of methods. *J Drug Issues* 21:759-776, 1991a.

Vlahov, D.; Muñoz, A.; Celentano, D.D.; Cohn, S.; Anthony, J.C.; Chilcoat, H.; and Nelson, K.E. HIV seroconversion and disinfection of injection equipment among intravenous drug users in Baltimore. *Epidemiology* 2:444-446, 1991 *b.*

Zucker, L.G. The role of institutionalization in cultural persistence. *Am Social Rev* 42:726-743, 1977.

ACKNOWLEDGMENTS

This research was supported by grants DA06326 and DA04334 from the National Institute on Drug Abuse.

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Promising Social Network Research Results and Suggestions for a Research Agenda

Samuel R. Friedman

INTRODUCTION

Previous research indicates that social network characteristics and processes affect human immunodeficiency virus (HIV) risk and protective behaviors. In a comparison of a "standard" education and HIV-testing intervention with a social network intervention, which promoted mutual concern about risk reduction through peer-led group exercises and discussions among members of drug injector networks, Latkin and colleagues (1994) have provided preliminary evidence that those in the social network intervention, compared to the standard intervention control group, were more likely to have reduced their frequency of sharing needles and injecting in shooting galleries as well as always carrying bleach and cleaning their needles before injecting. Zapka and colleagues (1993) reported that, in an intervention targeting clients in a short-term residential detoxification program, decrease in the level of drug use-related HIV-risk behavior was related to reducing the number of drug-injecting friends in subjects' social networks. Neaigus and colleagues (1994) found that the relative proportion of interaction with drug injectors and with noninjectors in drug injectors' egocentric networks was related to syringe sharing, shooting gallery use, renting syringes, borrowing syringes, and sharing cookers.

The spread of HIV is shaped by the networks of those engaging in risk behaviors. Klovdahl (1985) has argued that the "structure of a network has consequences for its individual members and for the network as a whole, over and above effects of characteristics and behavior of the individuals involved" (p. 1204). Auerbach and colleagues (1984), in a study of HIV infection among homosexual men during the early 1980s, found that a cluster of 40 patients with acquired immunodeficiency syndrome in 10 cities were linked directly or indirectly (via index patient 0) through sexual contact. In New York City, HIV and hepatitis

B core antibody seroprevalence vary by sociometric network location (Friedman et al., in press).

The *importance* of research into the social networks of drug injectors flows from the above discussion. HIV and other blood-borne pathogens are, in many cases, transmitted among drug injectors who are acquainted with each other-that is, through their social networks-and social influence that affects the extent of risk behavior and of deliberate risk reduction is exerted by individual or group processes through social networks.

The chapters in this monograph, as well as the discussions at the Technical Review on "Social Networks, Drug Abuse, and HIV Transmission" (August 19-20, 1993), support this initial research conducted on HIV and social networks. Social network research is a promising approach for understanding HIV-risk behaviors and epidemiology among drug injectors. Social network approaches also offer fruitful lines of research for understanding the spread of other infectious agents that are transmitted sexually or parenterally. In addition, social network research may offer important insights into how to design more effective interventions to reduce the spread of infectious diseases and, as well, to assist drug users to stop using drugs.

This chapter reviews evidence from prior studies and from the studies in this volume indicating that social networks are important in the lives and fates of drug injectors. This chapter also presents some ideas (based on the work in this volume and on the discussions at the Technical Review) about some of the research that is needed for: (1) improving the methodology of research on the social networks and risk networks of drug users and (2) understanding these networks, their implications, and the interventions that can be based on them.

EVIDENCE THAT SOCIAL NETWORKS MATTER

More specifically, the chapters presented in this volume provide prima facie evidence that the social networks to which drug users belong have a wide variety of impacts on their behaviors and on their likelihood of becoming infected with HIV, although the evidence here might also be explained in terms of differential association. As the research on which these chapters are based matures, the author strongly suspects that the positive promise of the (mainly) preliminary results reported here will be

confirmed. The data presented here suggest but do not prove that drug injectors' social networks have effects on a number of key variables, as discussed in the three following sections.

Who Gets Infected

Rothenberg and colleagues (this volume) show that the seropositive drug users in Colorado Springs are not members of the core of their large connected component. Instead, seropositives who are members of this component are comparatively weakly connected to the rest of the component, and other seropositive drug injectors are members of smaller components. They suggest that the low seroprevalence in Colorado Springs might result from the failure of HIV to be introduced into the core of the large component. Price and colleagues (this volume), on the other hand, present egocentric data that suggest that HIV is concentrated in St. Louis among drug injectors whose close social connections are exclusively with other drug injectors; they suggest that this concentration of virus among this "isolated" group of injectors may have reduced viral spread. The egocentric data available in the St. Louis study do not allow determination of the sociometric structure of the "isolated" group of drug injectors, and thus it cannot be ascertained whether the network structure of this group would be conducive to rapid epidemic spread *among this isolated group*. Recent analyses from the New York City group have shown that (1) members of the Seidman 2-core of a large connected component are more likely to be infected with HIV and to have hepatitis B core antibody than are peripheral members of the large connected component, members of smaller components, or unlinked subjects (Friedman et al., in press), and (2) that an ethnographically defined core (whose members interact frequently with each other and who often refer to each other in conversations as being insiders) has higher HIV seroprevalence than either those injecting drug users (IDUs) with links to core members (an inner periphery) or an outer periphery who lack such ties (Curtis et al., in press). The New York City and Colorado Springs findings at least suggest that the early entry of HIV into the cores of large components might be an important part of the process whereby HIV spreads rapidly in some cities.

Williams and colleagues (this volume) study egocentric networks in three cities-Rio Piedras (Puerto Rico), which has a high seroprevalence rate, and Houston and Dayton/Columbus, which have low seroprevalence. They find that network turnover is considerably higher in Rio Piedras, as is the frequency of drug injecting with network members. The networks

in Rio Piedras are more homogeneous, including gender and race/ethnicity membership. They suggest that homogeneous networks may be more prone to involve short-term relationships, which seems to be somewhat at variance with the analysis in Williams and Johnson (1993, p. 83) and that this higher turnover, in combination with the higher frequency of reported injections with network members, could lead to rapid HIV spread among the drug-injecting population.

Neaigus and colleagues (this volume) study risk factors for HIV infection at an individual level among new injectors. Their findings indicate that new drug injectors who engage in frequent *behavioral* risk (such as injecting speedball more than once a day or injecting in outdoor settings) and have high-risk egocentric networks are more likely to be infected, as are new women injectors who have older drug injectors in their networks.

Brunswick and colleagues (this volume) study one particular form of network tie-sibling relationships. They find that HIV infection is more likely among subjects who have a sibling who is infected than among those who do not have an infected sibling. These findings suggest that perhaps the siblings of infected persons should receive HIV counseling and testing and other prevention efforts and that family-targeted interventions might be developed. Sets of siblings who were concordantly seropositive differed both in social background and in (non-HIV-related) health markers from other sets of siblings, which suggests that contextual social factors need to be taken into account both in epidemiologic research and in prevention efforts.

Individual Risk Behaviors

A number of the studies reported in this volume report that network variables are related to risk behaviors cross-sectionally. In some cases, regression techniques have been used to study whether these relationships meet cross-sectional tests for potential causality. Such techniques, of course, can provide only provisional evidence about causation.

One behavior of considerable importance for HIV spread is injecting with a syringe others have used. Frey and colleagues (this volume) present data on 20 African-American male IDUs in methadone treatment and on 85 of 106 of the "most important" persons in their lives. They find that the drug-using behaviors of methadone clients' egocentric network members are predictors of the drug-using behaviors of the client, including syringe sharing. Neaigus and colleagues (this volume) find that the

characteristics of subjects' dyadic relationships with alters are related to the probability that the subject will inject with a syringe that the alter has used. Closer relationships (such as those in which ego and alter have daily contact, have injected together for more than a year, have a "very close" relationship, or have a sexual relationship) are most likely to involve such receptive syringe sharing. On the other hand, Williams and colleagues (this volume) find that in data from three citiesreceptive syringe sharing is not related to duration of the injection relationship (although it is more common in relationships that are also sexual relationships). Latkin (this volume) finds that subjects' frequency of sharing injection equipment is not associated with that of their egocentric network members, but that there were significant relationships between the ego's scores and the mean scores of his or her network members for (1) the number of persons they share injection equipment with, (2) shooting gallery use, (3) cocaine injection frequency, and (4) always cleaning used needles. Frey and colleagues (this volume), similarly, found that subjects' drug use behaviors are associated with those of their egocentric network members.

Trotter and colleagues (this volume) used ethnography to define four types of networks: (1) closed long-term groups whose interaction is focused almost solely on drugs; (2) semiclosed kin networks; (3) semi-open networks based on long-term friendships and sexual partnerships, with recreational drug use as one of several important foci for group activities; and (4) open networks where membership is based on acquaintance or willingness to purchase drugs. Network type was significantly related to the number of days per month the subject injected, the proportion of sex acts using condoms (for men-but not for women), and the proportion of sex acts with drug injectors.

Price and colleagues (this volume) find that the nature of egocentric networks is associated with a number of sexual risk behaviors, including the number of sex partners, soliciting sex from commercial sex workers, working as a commercial sex worker, and ever using condoms. Neaigus and colleagues (this volume) report that condom use in dyadic relationships is associated with relationship characteristics such as closeness and with peer norms (see also Friedman et al. 1994).

Intervention Efficacy

In addition, these chapters provide preliminary evidence that interventions that target social networks may be effective in reducing risk

behavior. Latkin (this volume) indicates that having drug injectors recruit their network members to come together in groups for sessions aimed at furthering risk reduction may be more effective in encouraging needle cleaning and the carrying of bleach and in discouraging sharing needles and attending shooting galleries than risk reduction sessions that are aimed at individual drug injectors in isolation from their networks. Their network intervention also reached "new people" who had not been reached by another project in Baltimore from which the index subjects had been recruited-which suggests that network recruitment for interventions might be a valuable supplement to other approaches. Wiebel and colleagues (1993) used ethnographic research techniques to study networks and to implement an intervention in the streets; this was associated with declines in both high-risk behavior and in HIV seroconversion. Moreover, those individuals who stopped "sharing dirty" due to this network-based intervention were less likely to seroconvert than those who continued to inject with syringes that others had used without bleaching them in between.

SETTING A RESEARCH AGENDA: METHODOLOGICAL ISSUES THAT NEED TO BE STUDIED

As a relatively new framework for investigation, social network research still poses a wide range of different kinds of methodological issues. Some of these involve basic issues of how networks should be conceived of and how research on networks should be integrated with other frameworks; other issues are far more specific.

Networks as Formal Linkage Structures, as Sociocultural Communities, and as Historically Embedded

Both the conceptions of networks and their operationalization vary between studies. One notable difference is that the more quantitatively oriented investigators seem to focus on networks as formal structures of dyadic linkages among people, whereas the ethnographers see networks more as groups of persons who interact together in a cultural context. A third perspective looks at networks as historically embedded and thus as both changing over time in their own right and being shaped (and helping to shape) larger scale changes in neighborhoods or even cities. Further conceptual and methodological development is needed to clarify these differences, how the different perspectives can strengthen each other, and how to develop research designs that fruitfully combine the different

perspectives. In addition, it will be useful, as studies accumulate, to commission review articles that attempt to update categorizations of what kinds of conceptions of "networks" have been developed and which of these conceptions seems to be most useful for research on problems of different kinds.

Several studies have combined ethnographic field observation with survey techniques to study networks (Curtis et al., in press; Neaigus et al., this volume; Trotter et al., this volume; Vera et al. 1993). These seem to offer several possible suggestions for how to combine different perspectives on networks. First, preliminary ethnography helps in winning community acceptance and cooperation, in understanding the social environment so as to be able to plan sampling processes, and in writing a meaningful interview instrument. Later, ethnographic data provide cultural and social contexts for the network data, and continuing ethnography allows understanding of how the drug scene, its environment, and its networks change during the course of the study. In addition, the ethnography provides the opportunity for direct observation of interactions between network members. Neaigus and colleagues (this volume) and Trotter and colleagues (this volume), for example, discuss how one project attempted to use such field observations to confirm and to supplement the survey-derived data on which subjects were linked to each other. Further research is needed on how to systematize such field observation to make it more compatible with survey network assumptions and also to test out how best to use such field links in modeling networks.

Network Population Dynamics

Surveys of networks among drug users can be viewed as gathering information about networks that may be "fuzzy" since they contain many short-term associations that are hard to conceptualize, much less to measure-although a comparison of the Neaigus and colleagues (this volume) and Trotter and colleagues (this volume) chapters suggests that the extent of such short-term associations varies between localities, with it being possible that there are fewer short-term associations among drug injectors in small cities than in large ones. In addition, the data that are gathered about these networks tend to be somewhat "fluffy" (i.e., to involve only partial reporting of links) due to a combination of reticence on the part of some subjects to name their associates, subjects' difficulty in recalling whom they have interacted with, and the problems resulting from still-being-developed name-elicitation techniques. A situation of

"fluffy" data about "fuzzy" networks poses a number of difficult issues for analysis:

1. Many links among subjects will not be ascertained. It is possible that missing data in network studies may make analysis much more difficult than it does in studies of individual attributes. Some questions that need to be resolved include: What are the effects of "missing links" on the ability to understand social influence within networks? Disease transmission? How are various measures of distance among specific network members affected by missing links? One potentially serious problem that needs to be studied is whether missing links pose the threat of sizable discontinuities in estimates of key parameters. That is, under what circumstances can one missing link lead to large-scale errors in parameter estimates rather than small errors?

   A related issue is how to develop techniques that either minimize the number of missing links or that at least increase the probability that missing links will have only minimal impacts on parameter estimates.

2. Methods need to be developed and tested to ascertain the validity and reliability of network data. Goldstein and colleagues (1993) have compared what different members of a network say about each other and their mutual behaviors-which, to some extent, provides some understanding of the validity of data about the *content* of network ties. They conclude that network data about other persons' demographic characteristics and behaviors-and about mutual behaviors transacted by a subject and another network member-are reasonably accurate. Further research is needed to confirm this finding and, in addition, to further quantify the degree of error in different kinds of such data.

3. A related issue that needs research is the validity and biases of data about the existence or lack of ties among specific network members. What are the impacts of such error on measures of network properties? Similarly, to what extent are the links that are established (as compared to those that are missed) socially or statistically distinct? That is, to what extent is the observed sample of links a biased one? If it is biased, how do these biases affect results? How can biases be minimized, or else estimated, and thus controlled for?

4. The changing nature of networks means that several kinds of modeling issues need development beyond that incorporated in the chapter in this volume. Modeling techniques are needed that can incorporate data about the time duration of linkages among members or about changes in the content of such linkages (as, for example, when persons who inject drugs together start-or stop-having sex together). Such models should be able to help develop understanding of a number of social processes, including:

   (a) the population dynamics of the system of networks as individuals move across networks. For example, researchers need to be able to model how the volume of movement across networks affects the rate of viral spread and also the diffusion of risk reduction norms and practices. Here, of course, the models need to be able to incorporate the ways in which movement of persons among networks is not random but will more normally involve selective mixing (Morris 1993); and

   (b) biographical patterns of movement of drug users and their nonusing associates as they age and as the drug users become more experienced users. One issue raised by Neaigus and colleagues (this volume), for example, is whether women who begin to inject drugs may enter into the networks of long-term drug injectors earlier in their drug careers than men do-and whether they may thus get infected with HIV sooner (see also Friedman et al. 1993).

Social Settings as Supra-Personal Nodes

Drug users' networks often include several kinds of social "nodes" that may be crucial in the transmission of infectious agents (Neaigus et al. 1994). Shooting galleries and other locations in which persons from different networks may use "anonymous paraphernalia" can provide settings for the transmission of HIV and other pathogens across networks without direct face-to-face contact among any of their members. Network studies should include ways to measure the potential for such anonymous transmission, a task which is complicated by the following facts: (1) shooting galleries form and dissolve quite frequently in many neighborhoods, as do anonymous "outside settings"; and (2) attempts to elicit precise and unambiguous specifications about the settings at which a drug user injects involve considerable measurement error due to a combination of reticence to disclose some locations as well as the

inherent difficulties of describing social settings that may move in space on a daily basis.

Sampling

Further research is needed on how to sample the networks of drug users. Issues include the relative utility of targeted sampling, snowball, and random walk designs-which may well vary depending both on the research question and on the city or other location where the study is being conducted-and the representativeness of data about drug users' networks. In terms of representativeness, network studies share a problem that bedevils all research on drug users: the impossibility of developing a method to draw a random sample of drug users in the first place. Thus, given present research methods, researchers are unable to draw a random sample of "initial index cases." To understate the problem considerably, this poses difficulty for the statistical characterization of the nominees of the index cases, and then of the nominees of the nominees; likewise, this poses difficulty for the extent to which the measured characteristics of large-scale drug-user networks can be said to be representative of those in a neighborhood or city drug scene. On the other hand, the author suggests that the concern expressed by Price and colleagues (this volume) about the need for special statistical treatment in using dyadic relationships obtained from egocentric data might lead researchers to needlessly eschew important analyses. Given the lack of probability sampling of index cases in network studies, the reasons to be concerned about nonrandom selection of alters may be of secondary importance.

Boundaries-Who Should Be Studied?

A related issue is how to study network boundaries. Drug injectors and other drug users have social ties with nonusers, and these ties can have important influences on all parties. For what kinds of studies should researchers concentrate on the characteristics of the networks of drug users with each other, with their sexual partners, or both-that is, with persons likely to be in their risk networks-and for what kinds of studies should researchers investigate their total social networks (including, therefore, the nature and implications of ties between drug users and other persons)? Most of the studies discussed in this volume have focused on samples of drug users alone. In a study of the social networks of young adolescents in high-risk neighborhoods, on the other hand, Lovely and colleagues (1993) took a different approach. Starting with census tract-

delimited area probability samples of youth (aged 11-15) in Atlanta and San Juan, Puerto Rico, additional subjects (11-29 years of age) were sampled by random selection from lists they provided of their social contacts, including those with whom they had sex or engaged in drug use. The random walk continued with these additional subjects ("second nodes") being asked similar questions, a random selection being made among their contacts to pick a third subject; and, then, a fourth node was similarly selected and interviewed. Data were collected about their relationships and behaviors together. These data were collected, in part, in order to assess whether the structure of subjects' sociometric networks was related to their risk behaviors, with an underlying perspective that social networks are vehicles for social influence that can shape and change both peer norms and individual beliefs, values, and behaviors (Fischer et al. 1992). For prevention purposes, they suggest that studying social networks in high-risk neighborhoods provides data on how to shape risk behaviors by understanding and changing social influences.

There are benefits and disadvantages to studying risk networks without broader social networks. The benefits inhere largely in being able to concentrate on the dyadic relationships in which HIV and other blood-borne or sexually transmitted infectious agents can be transmitted. The disadvantage to this approach is that patterns of social influence are not fully ascertained and that risk networks are by and large only a subset of the total web of relationships in which their members are enmeshed. Focusing on social networks will capture most of what is studied by focusing on risk networks[1], but unless the sampling design ensures that risk network members are selected for interview, important epidemiologic data may be lost.

Issues of Categorization in Analysis

Turning now to methods of analysis, network data pose additional questions for methodological research. One of these involves methods of categorization of networks, ways of separating out sections of networks in useful ways, and ways of describing individual locations in sociometric networks (Friedman et al., in press; Klovdahl 1985; Knoke and Kuklinski 1982; Rothenberg et al., this volume; Scott 1991; Seidman 1983; Seidman and Foster 1978; Stephenson and Zelen 1989; Trotter et al., this volume). Examples of ways to define subsets of networks include both those relying on formal network properties (e.g., groups composed of members, all of whom name each other as contacts) and others that are based on more substantive grounds (e.g., women as a subset, or drug

users who inject with anonymous works at a particular shooting gallery). The issue, then, is to find typologies that help researchers to detect and explain differences in viral transit times within sections of networks, across sections of networks, and among separate networks; to determine the relative risks of persons in different sections and in different categories of networks; and to determine which categorizations allow most meaningfully the study of differences in beliefs, behaviors, peer cultures, multiplexity of ties, and solidarity among drug users.

Statistical Issues

Network data also pose questions for statistical modeling. First, if data on large-scale network structures are developed from data provided by subjects about their nominees and then nominees are interviewed (or perhaps multiple levels of nominees), it is clear that the set of persons studied cannot in any meaningful way be viewed as statistically independent. Furthermore, there are several levels of analysis, and researchers have to develop ways to model the influence of these different levels upon each other. To mention some relatively easy examples, how do researchers model data about subjects as functions of data about the set of their nominees? Or as functions of data about the sections of large-scale networks to which they belong? How do researchers model the relationships of egocentric network properties to sociometric network properties-particularly since egocentric data often are available for all the alters whom the ego names (and about the characteristics of their social and risk relationships)-whereas sociometric data in community-based studies typically are available only (Friedman et al., in press) or primarily (Klovdahl et al. 1994; Rothenberg et al., this volume) for egos and alters who are interviewed.

Human Subjects Issues

Woodhouse and colleagues (this volume) raise a number of issues important to network researchers. They start with a fundamental point: All research designs in HIV epidemiologic research require compromise among ethical principles. In network research, these difficulties may be magnified by the existence of conflicting potential threats and benefits to different social entities: (1) the individual research participant; (2) the persons whom participants name as “alters” who are not themselves (yet) participants; (3) the social groups whose activities, interrelationships, and other interests might be enhanced or hurt by the research (even though the ethical rights of such social groups-particularly among drug

injectors-might not be recognized by current human subjects laws); and (4) those individuals and groups who might benefit or lose from the new scientific knowledge generated by the project.

One of the issues Woodhouse and colleagues (this volume) discuss is the ethical and legal "duty to warn." Given the uncertainty about how courts will rule in this evolving area of case law, the authors are somewhat limited in what they conclude. "Duty to warn" issues pose a serious dilemma for network research in which data on HIV or other infectious agents are collected, since this research simultaneously provides information about which participants are likely to be infectious and about with whom they engage in high-risk drug injection and sex. It may be useful to ruminate briefly about the implications of this fact for several kinds of network research.

If the research team retains identifiers for a given participant (the ego), then they are likely to know: (1) certain egos are infectious; (2) certain alters are uninfected; and (3) which seronegative alters a given seropositive ego engages in high-risk behaviors with. Thus, the researcher is confronted with a situation in which failure to warn such alters of their specific threats from having unprotected sex with a named ego, or from sharing injection equipment with that ego, might put the alter's life in danger. (Although this situation can be mitigated by general warnings to both ego and alter to avoid high-risk activity and may be ambiguous because the alter may engage in high-risk behaviors with other potentially infected persons, there may nonetheless be a legal or ethical liability from failure to warn.)

On the other hand, specific disclosure is also dangerous. The alter may blame the ego if both are seropositive, and seronegative alters may blame seropositive egos for endangering their lives. This may disrupt marriages, friendships, or other valuable social relationships. In a group context, it may lead to splits or feuds; such feuds might lead to potentially fatal violence (particularly, perhaps, if splits disrupt existing drug-dealing organizations or if some members of the network are either emotionally unstable or become so as a result of the interaction of stress and drug-taking patterns.) Thus, disclosure could lead to fatal consequences.

Considerable discussion occurred at the Technical Review meeting on which this monograph is based about the implications of the evolving case law on "duty to warn." Proponents of contact notification argued that if researchers know that somebody is infected and that they have

relationships with others that might transmit HIV to these others, the investigator should ensure that these others are notified that they are at risk. Other participants argued that confidentiality guarantees around HIV testing at least provided considerable public-health benefit that would be lost if subjects knew that their contacts would learn that they are infected. Several other research issues were raised:

1. Whether the knowledge that contacts would be notified might lead some potential participants to refuse to take part (sample bias), lead some subjects to reduce the extent to which they would name their contacts, or lead subjects to name some kinds of contacts but not others (linkage bias). This could lead both to major underestimation of the size and density of networks and perhaps to serious biases in these data. For example, if drug injectors were to be more concerned about the repercussions of such contact notification than other subjects in a study of persons at risk of HIV through different modes of transmission, researchers might be led to methodologically induced "findings" that drug injectors are of low centrality and have small egocentric network sizes and that their networks are sparse rather than dense, even if this is not the case in reality.

2. In addition, such duty to warn might make the cost of network studies prohibitive in locales such as New York and Puerto Rico where a considerable proportion of drug injectors are HIV infected. For example, if a study samples 500 drug injectors, 250 of whom are HIV-seropositive, these 250 persons might nominate 1,000 or more other persons as people with whom they have injected drugs or had sex in the last 30 days (and many more if the naming prompt is for 6 months or longer). The resources required to locate these persons, confirm that they are indeed the persons nominated, and then to provide them with appropriate contact notification messages (and, presumably, with HIV counseling and testing if they want it) would probably surpass the costs of gathering study data many times over.

Clearly, social and risk network research on HIV poses many difficult issues about the interactions of ethics, legal requirements, and research. At the present time, researchers do not yet know enough about how different network research designs affect the different levels of social entities that are involved in research to provide fully adequate guidance about the necessary tradeoffs. Thus, one priority for the National Institutes of Health should be to fund research that addresses the consequences for human subjects of different network research designs.

SETTING A RESEARCH AGENDA: SUBSTANTIVE QUESTIONS TO BE RESEARCHED

The chapters in this volume present data that indicate that the fate of a drug injector is shaped in many ways by the network to which she or he belongs. This monograph, however, just begins what may well become an extensive body of research. The chapters open up areas for research that need considerable further development before researchers can answer with assurance any of the following key questions:

1. One set of key questions concerns further specification of the effects of networks in terms of how the structure or content of drug injectors' networks of or their links to non-IDUs in a city or neighborhood, perhaps in interaction with, or mediated by, their personal characteristics or neighborhood characteristics, affect:

   (a) The rate and patterns of spread of HIV and other parenterally and sexually transmitted infectious agents.

   (b) The rate and patterns of spread of tuberculosis.

   (c) The extent to which these agents spread outside of the immediate neighborhood; for example, how do the network structures of IDUs in New York City affect the patterns of HIV seroprevalence among youth in the suburbs?

   (d) The kinds and extent of risk reduction efforts by individual IDUs.

   (e) The lives of drug injectors who become infected with HIV. Do networks affect their overall quality of life? The extent and kind of social or material support they receive from other drug injectors or other persons? As their disease progresses, do the characteristics of their network affect whether the network abandons them or becomes an increasing source of support? How do the processes discussed in this paragraph affect the extent to which they can resist or avoid opportunistic infections and death?

   (f) The ability of IDUs to work together collectively in drug users' organizations to prevent or retard the spread of HIV or to care for those who become infected. Here, network characteristics

parallel the kinds of variables that resource mobilization theory suggests are important determinants of the extent to which people can mobilize for collective action around shared needs (Gamson 1975; Lo 1992; Morris 1984; Tilly 1978), although efforts to establish such organizations also need to incorporate theories that make solidarity, strategy, and micromobilization problematic (Friedman and Des Jarlais 1993; Gamson 1992).

(g) The extent to which IDUs know about, seek, and use medical services to obtain treatment for HIV-related or other medical problems.

(h) The extent to which drug users know about, seek, and enter drug abuse treatment.

(i) The success rates of drug abuse treatment (as networks provide support or opposition to clients' efforts to stop using drugs, or as networks differ in their hold on clients' loyalties).

(j) The recruitment of new persons to use drugs and to inject drugs.

(k) The degree of stability in the drugs that are used in a local area. That is, are some network patterns more prone to take up new drug fads and others more resistant?

2. Networks can also be investigated as dependent variables. Several major areas for research in this regard include:

(a) How do the networks of men and women who inject drugs differ? Of new and long-term injectors? Of drug-injecting members of different racial/ethnic groups? To what extent do these different networks overlap?

(b) How does knowledge of a drug injector's HIV serostatus affect his or her network?

(c) What variables affect the rate of formation and disappearance of drug injector networks in a neighborhood or city? The rate at which individuals move between networks?

(d) How are the various formal and substantive characteristics of network structure or content associated with each other?

3. To the extent that networks affect behaviors or the probability that a given level of taking risks leads to infection by a pathogen, interventions that target networks may have positive effects. Latkin (this volume) and Wiebel and colleagues (1993) present evidence that such interventions can be efficacious. Network interventions might target networks at the level of the personal networks of individuals, neighborhood network structures, or city network structures. Further research and development are needed to design and evaluate network-based interventions to:

   (a) Decrease individual risk.

   (b) Change network structures or population dynamics in ways that should reduce viral transmission.

   (c) Change the cultures of networks. Ways to do this might include: introducing positive role models from outside the network; promoting communication and normative reinforcement for risk reduction within a network; or encouraging the formation of formal organizations of some or all network members (perhaps with memberships that cross network boundaries) that could try to change their beliefs, norms, and practices in ways that would reduce risks.

Research should also consider what level of network or social processes that embed the network should be the target of intervention. That is, for each of the three kinds of outcomes just discussed, is the appropriate target for the intervention the individual? The individual's risk network? The individual's social network? The neighborhood network? The local drug culture? Large-scale characteristics of local urban development or policy (such as police patterns or gentrification that disrupt existing drug users' networks-and therefore, perhaps, lead pathogens to be spread to new neighborhoods or weaken the strength of preexisting network controls over drug injectors' behavior)? Further discussion of network intervention issues appears in Friedman and colleagues (in press).

4. Very little is currently known about the extent of variation in drug injectors' networks across cities or about how these affect the rates of spread of HIV and other agents. Egocentric data could be collected

in conjunction with other research projects and, perhaps, in a relatively routine way by drug abuse treatment clinics. Data on larger scale network structures might require more resources. If they can be obtained, baseline and followup data on large-scale and egocentric network structures, peer cultures, and larger social contexts in a large number of cities could be useful for understanding both the spread of pathogens among drug injectors and from them to other persons, as well as how local drug scenes respond to the threat of HIV and, indeed, why patterns of drug use and drug treatment outcomes vary across cities. The payoff for such research is hard to calculate at this time, but clearly there is sufficient potential for fundamentally new interventions to make it well worth considering.

NOTE

1. One complication should be mentioned: To the extent to which infectious agents are transmitted through injecting with syringes or other anonymous equipment at shooting galleries or other multiperson settings, probes to elicit social network members may well fail to elicit parts of the risk networks. The complexities of "anonymous settings" such as these (or locations where anonymous sex may occur, whether in crack houses, commercial sex work, or bathhouses) require further study and the development of additional research techniques. See Neaigus and colleagues (1994) for further discussion.

REFERENCES

Auerbach, D.M.; Darrow, W.W.; Jaffe, H. W.; and Curran, J.W. Cluster of cases of the acquired immune deficiency syndrome: Patients linked by sexual contact. *Am J Med* 76:487-492, 1984.

Curtis, R.; Friedman, S.R.; Neaigus, A.; Jose, B.; Goldstein, M.; and Ildefonso, G. Street-level drug market structure and HIV risk. *Soc Netw*, in press.

Fischer, J.D.; Miscovich, S.J.; and Fisher, W.A. Impact of perceived social norms on adolescents' AIDS-risk behavior and prevention. In: DiClimente, R.J., ed. *Adolescents and AIDS.* Newbury Park: Sage, 1992. pp. 117-136.

Friedman, S.R., and Des Jarlais, 'D.C. Going beyond education to mobilizing subcultural change. *Int J Drug Policy* 4(2):91-95, 1993.

Friedman, S.R.; Jose, B.; Neaigus, A.; Goldstein, M.; Curtis, R.; and Des Jarlais, D.C. "Female Injecting Drug Users Get Infected Sooner Than Males." Paper presented at the Ninth International Conference on AIDS, Berlin, June 6-11, 1993.

Friedman, S.R.; Jose, B.; Neaigus, A.; Goldstein, M.; Curtis, R.; Ildefonso, G.; Mota, P.; and Des Jarlais, D.C. Consistent condom use in relationships between seropositive injecting drug users and sex partners who do not inject drugs. *AIDS* 8:357-361, 1994.

Friedman, S.R.; Neaigus, A.; Jose, B.; Curtis, R.; Goldstein, M.; Latkin, C.A.; and Des Jarlais, D.C. Network and sociohistorical approaches to the HIV epidemic among drug injectors. *AIDS Cure,* in press.

Gamson, W.A. *The Strategy of Social Protest.* Homewood, IL: Dorsey, 1975.

Gamson, W.A. The social psychology of collective action. In: Morris, A.D., and Mueller, CM., eds. *Frontiers in Social Movement Theory.* New Haven: Yale, 1992. pp. 53-76.

Goldstein, M.; Neaigus, A.; Ildefonso, G.; Jose, B.; Mota, P.; and Friedman, S.R. "Quality of Data Provided by IDUs about HIV Risk Network Members." Paper presented at the American Public Health Association Annual Meeting, San Francisco, October 28, 1993.

Klovdahl, A.S. Social networks and the spread of infectious diseases: The AIDS example. *Soc Sci Med* 21:1203-1216, 1985.

Klovdahl, A.S.; Potterat, J.J.; Woodhouse, D.E.; Muth, J.B.; Muth, S.Q.; and Darrow, W.W. Social networks and infectious disease: The Colorado Springs study. *Soc Sci Med* 38:79-88, 1994.

Knoke, D., and Kuklinski, J.H. *Network Analysis.* Beverly Hills, CA: Sage, 1982.

Latkin, C.A.; Mandell, W.; Oziemkowska, M.; Celentano, D.; Vlahov, D.; and Ensminger, M. "Using Social Network Analysis To Study Patterns of Drug Use Among Urban Drug Users at High Risk for HIV/AIDS." Paper presented at Sunbelt 14, International Social Network Conference, New Orleans, February 17-24, 1994.

Lo, C. Communities of challengers in social movement theory. In: Morris, A.D., and Mueller, C.M., eds. *Frontiers in Social Movement Theory.* New Haven: Yale, 1992. pp. 224-248.

Lovely, R.H.; Liebow, E.B.; Vera, M.; McGrady, G.A.; Mann, E.; and Mueller, C. "Feasibility of Studying the Social Networks of Ethnic Youth at Risk for HIV/AIDS." Paper presented at the Ninth International Conference on AIDS, Berlin, June 6-11, 1993.

Morris, A.D. *The Origins of the Civil Rights Movement. New* York: Free Press, 1984.

Morris, M. Epidemiology and social networks: Modeling structured diffusion. *Social Meth Res* 22(1):99-126, 1993.

Neaigus, A.; Friedman, S.R.; Curtis, R.; Des Jarlais, D.C.; Furst, R.T.; Jose, B.; Mota, P.; Stepherson, B.; Sufian, M.; Ward, T.P.; and Wright, J.W. The relevance of drug injectors' social networks and risk networks for understanding and preventing HIV infection. *Soc Sci Med* 38:67-78, 1994.

Scott, J. *Social Network Analysis.* Beverly Hills, CA: Sage, 1991.

Seidman, S.B. Network structure and minimum degree. *Soc Netw* 5:269-287, 1983.

Seidman, S.B., and Foster, B. A note on the potential for genuine cross-fertilisation between anthropology and mathematics. *Soc Netw* 1:65-72, 1978.

Stephenson, K., and Zelen, M. Rethinking centrality: Methods and examples. *Soc Netw* 11:1-37, 1989.

Tilly, *C. From Mobilization to Revolution.* Reading, MA: Addison-Wesley, 1978.

Vera, M.; Alegría, M.; Lovely, R.H.; Liebow, E.B.; McGrady, G.A.; Mueller, C.; Mann, E.; and Klovdahl, A.S. "The Role of Ethnography in Social Network Research." Paper presented at National Institute on Drug Abuse Technical Review Meeting on Social Networks, Drug Abuse, and HIV Transmission, Bethesda, MD, August 19-20, 1993.

Wiebel, W.W.; O'Brien, M.U.; and Murray, J. "Social Networks as Targets for Intervention and Intervention Impact." Paper presented at National Institute on Drug Abuse Technical Review Meeting on Social Networks, Drug Abuse, and HIV Transmission, Bethesda, MD, August 19-20, 1993.

Williams, M.L., and Johnson, J. Social network structures: An ethnographic analysis of intravenous drug use in Houston, Texas. In: Fisher, D.G., and Needle, R.H., eds. *AIDS and Community-Based Drug Intervention Programs: Evaluation and Outreach.* Binghamton, NY: Harrington Park Press, 1993.

Zapka, J.G.; Stoddard, A.; and McCusker, J. Social network, support and influence: Relationships with drug use and protective AIDS behavior. *AIDS Educ Prev* 5:352-366, 1993.

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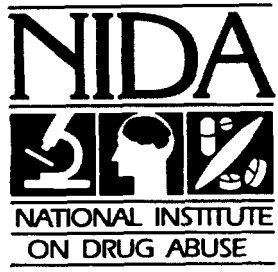
*U-S. GOVERNMENT PRINTING OFFICE: 1995 386-912/00017



NIH Publication No. 95-3889
Printed 1995