

**NETWORKING FOR DRUG INJECTION AS A SOCIAL PROCESS:
A SUBSTANTIVE AND METHODOLOGICAL ANALYSIS**

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KEY WORDS: social network, cohesion, betweenness, brokerage, block modeling, drug use, injection.

INTRODUCTION

Substance abuse is regarded as the nation's number one health problem (Robert Wood Johnson Foundation, 2001), and HIV/AIDS risks are known more prone among drug injectors and disproportionately more concentrated among African American drug injectors (Friedman, Jarlais, and Ward, 1993; CDC, 1996). According to the Center for Disease Control (1998), 217,000 injecting drug users (IDU) had been diagnosed with AIDS as of 1998, and 87,000 had died of the disease. Clearly, drug injection practice must be a major focus of HIV prevention efforts. What has been less clear is whether members of networked IDU groups with different connections among them have similar level of higher risks of HIV/AIDS. Although most injecting drug users do not use alone, it remains largely unknown what kind of network ties would signify, and for what kind of drug behavior. Comparatively little attention has been devoted to quantitatively assessing network structure and its etiological factors driving the formation and maintenance of cohesive subgroups as well as roles and positions within networks. The objective of this study is twofold: first, to examine what and how specific positions and roles held by drug injectors would be conducive to higher HIV/AIDS risk; second, to examine whether there exists potential systematic self-motivated social selection in terms of social networked ties.

The research questions of this study are: (1) what personal and behavioral characteristics contribute to the drug injectors' *relational* settings in their web of connections? (2) what personal and behavioral characteristics contribute to the drug injectors' *positional* settings in their web of connections? and (3) what are the structural network covariates of the IDU's chance to be infected with HIV?

LINKING IDU NETWORK TIES TO BEHAVIOR

Network is a set of actors with specific type of relations linking them (e.g., Knoke and Kuklinski, 1982; Wasserman and Faust, 1994). Despite substantial progress in slowing the epidemic among substance-abusing populations, new cases of HIV increasingly can be attributed directly to injecting drug use through contaminated needles or indirectly through sexual

transmission (Levy, 1998; CDC, 2000). Considering that grouped injection and paired sexual intercourse constitute personal interactions entailing identical potential pharmacological consequences in terms of acquiring HIV/AIDS, no distinction is made between drug use connection or sexual behavior connection in this study. The drug use network was defined as a web of drug injectors with each linkage marked as having injected drugs together and/or had sexual intercourse in the 6 months prior to the survey. That is, as long as a drug user named another drug user with whom he/she had ever had injected drugs together or had sexual intercourse in the past 6 months, then a connected tie is regarded as existing between these two drug users.

Most drug use network research to date has focused on dyadic ties, despite of the possibility that the ties between two persons may shape, or be shaped by, the presence of link(s) involving a third drug user. To better understand the relational and positional settings among the networked IDUs, social cohesion and brokerage status are examined as two key network characteristics on their relationships with IDUs' drug acquisition and injecting behaviors. I argue, as is illustrated in table 1, that in the drug injection field, cohesion and brokerage of network ties distinguish from each other in terms of their nature, model of capital involved, and medium of exchange, which in turn condition different drug injection related events.

Table 1. Characterizing drug injection network ties

		<i>Nature</i>	<i>Mode of capital</i>	<i>Medium of exchange</i>	<i>Drug injection behavior</i>
network ties	<i>cohesion</i>	personalize -- matter of collegiate	social	convenience, common good, trust, duty	sharing equipment
	<i>brokerage</i>	depersonalize -- matter of business	financial	money, control	pooling money to buy drugs, selling drug, sex

Social theorists have suggested that social ties between individuals that extend across different contexts will lead to particularly high levels of social cohesion (Emirbayer and Goodwin, 1994). It follows that people tied together for one type of activity are very likely to engage in other activities together, especially when these activities are centering around drug injection as studied

here. I hypothesize,

HYPOTHESIS 1: *Social cohesion is positively associated with IDUs' chances of engaging in risky behavior such as sharing injection equipment.*

As quantitative study of drug injector roles has barely begun (Friedman et al, 1998), it should be quite important to study the role of network brokers and what attributes are associated with it. Few research up to date in the illicit drug injection field explicitly evaluate the role of a network broker or a "middle man" (Whitmeyer, 1997). Researchers, i.e., in economic sociology, usually look at how people make use of their location in social networks to mobilize resources in order to achieve their economic goals (Granovetter, 1990). In contrast with organizational studies which emphasize "broker" as a centralized location for performing key activities of the network, brokerage status, in the field of networking for illicit drug injection, is probably a measure representing a passive, rather than deliberate broker-role-seeking, position. An IDU broker, unlike a salesperson or a stock broker at a trading floor, is a loosely defined, informal, undeclared, and probably secretive position. On the one hand, the receptive role of this entity may not necessarily help coordinate or even manage the associated activities; on the other hand, it provides a basis for the formation of weak ties and whether the so-called "weak-tie" theory would provide a foundation to explain the HIV diffusion on this matter is worthwhile to be investigated.

HYPOTHESIS 2: *IDU who has high brokerage status is more likely to be associated with drug injection "business" such as seeking or being sought after drug dealing, sex trading, or resource grouping activities.*

METHOD

Sample. The data used come from a multi-wave longitudinal survey which was designed mainly to monitor how drug injectors would change risky behavior over time. The data were collected by NORC from the street subpopulation through a combination of target sampling (with 2 seed observations in each of the 6 targeted communities) and a subsequent snowball sampling with 4 stages (seed ÷ tier 1 ÷ tier 2 ÷ tier 3 ÷ tier 4). The sample was exclusively limited to African American drug injectors living in Washington, D.C. and the sample size was 516. Demographic, drug use, injection, and sex behavior histories for the six months prior to interview were collected in confidential one-to-one sessions. Only 2 out of whole sample reported having had sex with a partner with the same sex, so this sample can be regarded as reflecting mainly a heterosexual rather than homosexual or bisexual drug use population. The current analysis uses the data at intake only. To facilitate the particular requirement of this study, both ego-centric and sociometric data matrixes were

constructed based on raw data recorded in the QuatroPro format.

Symmetrizing data. In the survey, networked drug injectors were asked with whom they knew personally and injected drugs or had sex in the past 6 month. That who named whom was documented in the survey answering sheets and then transformed into a multi-tier and hierarchical Quatra-Pro data file. Based on this relationship recorded in the raw form, I first constructed 11 directed ego-centric network data matrixes at the first stage representing eleven seed-derived neighborhood networks. The directed sociomatrixes were then symmetrized to reflect the reciprocity of the relationships since I defined that a tie existed as long as one of the dyad pair named the other person.

Community-specific sociometric data. Having carefully examined the extent of the overlapping of respondents injecting drugs in multiple ego-centric networks and considering that two seeds came from the same neighborhood and that separate analysis showed the paired seed networks overlapped, the ego-centric networks in the same community were combined to form the community specific sociometric data matrixes. Two small community sociometric data matrixes were further merged together since they were closed geographically to the same neighborhood. As a result, 10 seed-driven egocentric networks were merged into 4 community based social networks consisted of drug injection and/or sexual intercourse ties. With the retainment of an additional network that started from just one seed, over all there were 5 communities included in the subsequent analyses. The network sizes were 63, 114, 112, 159, and 52. In each of the 5 networks, more than two thirds of the IDUs were more than 40 years old and females accounted for one fourth to nearly one half in these networks. About one fifth (20.6%) to two fifth (44.6%) of the network members injected drugs most frequently in public places.

Dependent variables

The relationship between a pair of, or among multi-pairs of, drug injectors is a property of the pair(s) and not inherently a characteristic of the individual drug injector. Individuals, however, may possibly influence or be influenced the pair connections. Given the cross-sectional data used in this study, it is recognized that the causal directions of the associations examined can go in both ways. Nevertheless, to better understand the network process, it is important to treat network measurements as central. The dependent variables examined here are social cohesion, brokerage status, and membership of the structural equivalence block with lower level HIV/AIDS infections.

Social cohesion. I measure the cohesion of the

drug injectors' substance use and sexual relationships through "cliques". Substantively, clique measures the interpersonal relationships among three or more persons. It indicates the extent of the cohesiveness of the inter-relationships. In a clique, everybody knows and connects to each other. To many, clique may be largely a pattern of relationships which is hypothetically defined and mathematically derived. Cliques imply a very tight definition of cohesive subgroups, that does not hold very often in practice, because subgraphs may be very close to being a clique but lack a few connections (Wasserman & Faust, 1994). As a first step to evaluate the level of the cohesion for the IDU drug networks in the selected communities in Washington, D.C., I performed subgroup analyses to find the cliques in each network. To classify IDUs and facilitate multivariate analysis, a binary variable was created with 0 indicating that "no clique" was associated with an observation and 1 indicating that "1 or more cliques" was associated with an observation.

Brokerage. I use Freeman Betweenness Index (FBI) in the analysis. Although it has not been utilized in prior drug use studies, the FBI, an indicator of centrality in the network analysis, represents an important brokerage type of role that some IDUs may assume. I constructed FBI by calculating the extent to which actors fall between pairs of other actors on the shortest paths (geodesics) connecting them (Freeman 1977). If person A and C were connected only through B, B would fall 'between' A and C and would mediate the flow of any resources between A and C. The actor betweenness index

for n_i is defined as:

$$C_B(n_i) = \sum_{j < k} \frac{g_{jk}(n_i)}{g_{jk}}$$

Where g_{jk} is the number of geodesics linking two actors j and k . And $g_{jk}(n_i)$ is the number of geodesics linking the two actors j and k that contains actor i . A dichotomized betweenness variable is set up using the median value as the threshold to indicate "low" and "high" betweenness of each drug users in the local social networks.

Membership of structural equivalent block with lower level of HIV/AIDS. Equivalence models group actors together if they have similar relations with other actors in the network, even though they may not be directly linked to each other. The equivalence derives from being tied to the "same" individual actors. In this study, I define equivalence as having similarity of relational ties with approximate equivalent actors. In this analysis of the IDU drug networks, I use the correlation method. Correlations are defined as the Pearson product-moment correlation of rows and columns corresponding to two different actors. UCINET 5 (Borgatti, Everett, & Freeman, 1999) was used to implement permutations. Consequently, the whole network was partitioned into blocks of actors that shared equivalent positions in the

drug injection and sexual behavior network.

Independent variables

Sharing injection equipment, representing an important dimension of HIV related risk behavior (Chitwood et al., 1990; Needle, et al., 1998), was measured by a summed index based on three survey questions. Respondents were asked that in the past 6 months, how often did they (1) draw up from a cooker after or at the same time it was used by someone; (2) use rinse water after or at the same time it was used by someone; and (3) inject drugs with a needle or syringe after someone squirted drugs into it from his or her syringe. The distribution of the responding values for each item ranged from 0 to 10. The Cronbach coefficient alpha of this summed index was .77.

Grouping resources to engage in drug use is a network activity for the common advantage of participants. This activity was measured by IDU's response to the question that in the past 6 months, "how frequently have you pooled money with someone else to buy drugs?"

Status of selling drugs, syringes, and/or trading sex for drugs was measured by whether an IDU's major sources of income include selling drug or syringes or trading sex for drugs.

HIV serostatus. The drug injectors' HIV status was coded in two ways -- subjective and objective. Both respondents' self reported HIV status and a scientific laboratory oral HIV testing using the OraSurer oral specimen collection device were used in the analysis. Self-reported diagnose and objective measure showed quite similar results, which enhanced indirectly the validity of, and our confidence about, other responses regarding drug and sexual behaviors. Only the objective measure of HIV status, however, was used in the analytic results presented.

Control variables include gender, age, personal income, whether major income sources were HIV/AIDS risky behavior related (i.e. via selling drugs, trading sex for drugs, etc.), and whether respondent injected drug most frequently in a public place such as a shooting gallery, a park, a public facility, or an abandoned building rather than a private place such as one's own or other's home.

ANALYSIS

I used UCINET-- a social network analysis program, and the LOGISTIC procedure in SAS to examine three social network attributes among networked drug injectors -- cohesion, brokerage, and structural equivalence and their associations with HIV/AIDS risks.

Table 2. Odds Ratios of the Logistic Regression Model of Injecting Drug User's Social Cohesion and Betweenness

	Social Cohesion		Betweenness	
	Odds Ratio	Adjusted Odds Ratio	Odds Ratio	Adjusted Odds Ratio
<i>Frequency of Pooling Money to Buy Drugs</i>				
monthly to <daily (vs. < monthly)	n.s.	n.s.	0.41 (0.20 – 0.83) ¹	0.40 (0.20 – 0.83)
Once a day or more (vs. < monthly)	n.s.	n.s.	n.s.	n.s.
<i>Sharing Injection Equipment</i>				
Sometime (vs. none)	n.s.	n.s.	2.28 (1.06 – 4.90)	2.29 (1.06 – 4.96)
Frequently (vs. none)	2.58 (1.25 – 5.33)	2.65 (1.28 – 5.49)	2.76 (1.25 – 6.08)	2.77 (1.26 – 6.11)
<i>Selling Drugs, Syringes, and Sex</i>				
Yes (vs. no)	n.s.	n.s.	1.89 (1.10 – 3.24)	1.87 (1.08 – 3.24)
Controlled Variables ²				
Male (vs. Female)	–	n.s.	–	n.s.
Age Over 40 (vs. 40 years old or younger)	–	n.s.	–	n.s.
Personal Income > \$500/mon. (vs. other)	–	n.s.	–	n.s.
Injecting at Public place (vs. Private place)	–	n.s.	–	n.s.
Adjusted R-square	0.093	0.10	0.10	0.11
-2 log L.	323.65	321.88	314.94	314.26

Note: 1. 95% Wald confidence limits are in the parentheses. 2. Adding two additional control variables – “frequency of injecting drugs given by others” and “peak month frequency of drug injection” does not change the result in both models.

RESULTS

The level of network subgroup cohesion is significantly related to IDUs' sharing injection equipment. No significant relationships are found between cohesion level and either the frequency of pooling money to buy drugs, or IDUs' status of selling drugs, syringes, or having sex to trade for drugs.

Drug injectors who also sell drugs, syringes, or have sex as personal favors to obtain drugs are 1.9 times more likely (OR=1.89, $P < .05$; Adjusted OR=1.87, $P < .05$) than other IDUs to have a brokerage status with higher level of betweenness within the network. Those who share drug injection equipment sometimes or frequently are 2~3 times more likely (OR=2.28~2.76, $P < .05$; Adjusted OR=2.29~2.77, $P < .05$) to have a higher brokerage role than those who do not share injection equipment. The results, as shown in table 2, are significant both before and after the statistical control of other demographic characteristics and injection environmental context.

After identifying the blocks in which IDUs share equivalent positions, a set of bivariate analyses are performed to establish profiles on a dozen of relevant IDU attributes and behavioral measures. Without exception, each block in each community have about 1/3 to 1/2 members acting as certain brokers to be drug, and/or

syringe, and/or, sex sellers. The existence of these brokers helps to maintain the supply side of the drug injection subgroups with members having similar ties.

The most important differences come from the HIV test result differences among blocks. In the sociometric drug injection network, there is one identified block in which members have the lowest HIV infection prevalence compared to the rest three blocks, i.e., these lowest rates are: 10% in one blocked subgroup vs. at least 33.3% in all other blocked subgroups in the “O street community”, 7.7% in one blocked subgroup vs. at least 23.1% in all other blocked subgroups in the “Petworth” community, and 13.6% in one blocked subgroup vs. at least 34.8% in all other blocked subgroups in the “H street” community. Given the small number of communities, it is difficult to draw definitive conclusion from this analysis, however, two points are notable: first, these HIV test results were not self reported, but rather, tested directly, therefore, the possibility that the variation may be caused by the selectivity of the self-reporting tendency can be ruled out; second, what is striking here is that there seems existing a deep cleavages on HIV infection between different subgroups in which members were structurally similar.

Table 3 presents the logistic regression coefficients with the membership of the above identified

Table 3. Modeling the Likelihood of IDUs' Falling Into the Low HIV-risk Blocks – Logistic Regression Coefficients.

	Unadjusted	Adjusted
Betweenness	-0.73**	-0.94**
Cohesion	0.54*	0.56
Male	-	-0.26
Age>40	-	-0.63
Personal Income	-	-0.12
Injecting at Public Places	-	-0.67
Share Equipment	-	-0.06
Major Income Sources Include Selling Drug, Syringe, or Sex.	-	-0.18
Pooling Money to Buy Drugs	-	0.13
Adjusted R-square	0.031	0.089
-2 Log. L.	281.7	241.9

Note: * Associated odds ratio falls into 95% confidence interval; ** Associated odds ratio falls into 99% confidence interval.

low HIV-risk blocks as the outcome variable. In the first model where the dichotomous measures of the betweenness and the cohesion are entered, the Freeman betweenness index demonstrates a significant negative relationship with the IDUs' chances to fall into the low HIV risk blocks, whereas social cohesion is positively associated with the chance of falling into the low HIV risk blocks. After controlling the personal characteristics (age, gender, income) and other relevant or potential confounding variables, the betweenness index measure remains to be negatively associated with the likelihood to be in the low HIV risk blocks.

CONCLUSION AND DISCUSSION

Consistent with the conceptual framework proposed in Table 1, my analysis of Washington, D.C. drug injectors shows that drug injectors in the network who have close social adjacency and reachability are significantly more likely to share injection equipment, but not necessarily more likely to sell drugs or pool money to buy drugs, which suggests that social ties characterized by cohesive cliques are likely to be discretionary, reflecting a certain bonded interpersonal trust. Also, drug injectors having brokerage type of status in the network have significantly higher odds of pooling money to buy drug, engaging in drug selling and promiscuous sexual behavior, and sharing injection equipment. These patterns persist net of a set of demographic and socioeconomic controls.

When the similarities embedded in networks of

relations are identified after permutation process based on Pearson product correlations of rows and columns in the adjacency matrixes, it turns out that members in the blocks emerged do not cluster together based on similarity in terms of age, gender, or educational background. Drug injectors who have brokerage status in terms of higher betweenness are significantly more likely to be associated with the high HIV/AIDS risk subgroups. The existing pattern of ties facilitates IDUs' drug use, and unfortunately also advances the chances of some to be with an even higher risk subgroup in the high risk network.

There is no clear cut age-, gender-, education- or other demographic profile differentiated differences in terms of the ways how drug use/sexual intercourse ties prevail within the local social networks of drug injectors. In contrast with the conjecture, as the homophily literature on mainstream activities suggests, perceived similarity, which is enhanced by third-party ties, should tend to increase mutual trust (Kanter, 1977; Lincoln and Miller, 1979), black drug injectors tend to form their ties not necessarily based on similarities of their personal characteristics. Perhaps, the common activity of drug injection overshadows the differences of personal attributes and ties them together for the same personal favors and preferences. The relative influence of predictors versus control variables is like "structuralism versus individualism" (Mayhew, 1980), it suggests that the drug use networking mechanism is function-oriented instead of person-centered. Within the illicit drug use and HIV/AIDS risk research field, in certain respects, my analyses substantiate claims by network structuralists (White, Boorman, and Breiger, 1976; Mayhew, 1980) that the pattern or structure of social relations is a meaningful determinant of an individual's fate, suggesting that how an IDU stitches his/her behavioral fabric matters.

This study has several limitations. First, potential bias in the sample may compromise the representativeness of the data and cause "partial system fallacy" (Laumann, Marsden, & Prensky, 1989). The chain-referred naming could not be recorded without limits and a boundary had to be set up. In this study, the snow ball sample was collected up to the fourth tier beyond the seed. Persons mentioned in later tiers would be thus more likely to be dropped and were not interviewed. However, the extend of negative impact, if any, should be limited in itself because the ego-centric networks had 4 tiers and the sociometric networks were rationally large. The larger the network, the more heterogeneous the recorded network IDUs were, and thus the more likely that the boundary bias became less severe. According to Rothenburg (1995), ethnographic and recruitment methods, which are used in ascending

data gathering, have fundamental analogies with sequential analysis, and thus the method of the probability sampling. Although chain-referral violates the assumption of statistical independence, resulting in considerable limitations in many drug injection related studies (Friedman et al. 1998), the dependence, however, in particular the extent of interdependence in terms of cohesion and equivalence, is a focus of the study and is thus examined explicitly. Second, the study is limited in that only the presence versus absence of the drug use or sexual intercourse relationships is analyzed as the ties in the network analysis. A further examination of the relationship attributes, such as frequency, duration, priority, and intensity would demand intense programming work on setting up value-laden ties in the sociometrics, but should help our understanding of how strength of ties would influence the configuration of block memberships.

Notwithstanding these limitations, this study, with substantive research questions and relational and positional network analytic methodologies, is able to demonstrate several important points: First, by focusing on identifying measures that capture some key aspect of a complicated network structure, this paper has developed and tested measures of the importance structural characteristics. Both brokerage and cohesion are important and relevant measures in illicit drug injection research, which helps to capture some of the key component of the social process parallel to the inner-city drug injection behaviors and/or drug injection induced sexual behaviors. The Freeman Betweenness Index (FBI) proves to be a powerful analytic instrument to the network research on injecting drug users. This seems particular important given the infectious nature, i.e., via connections and contact, of HIV/AIDS risk. Second, block modeling identifies subgrouped injecting drug users with similar pattern of ties which would otherwise escape from our radar screen if the method of regular equivalence is not used. Finally, the equivalence analysis using the sociometric matrixes adds non-trivial value to traditional approaches. Each of the communities, as is studied here, contains subgrouped IDU members with relatively low HIV/AIDS risks. IDUs who engage in similar level of HIV/AIDS related risky behavior, but have different configurations of ties, are exposed to quite different level of HIV/AIDS risks.

In closing, this study provides a starting point from which further study can proceed to investigate the underlying mechanism of the web of ties, which in turn should offer a promising opportunity to inform our national policy on illegal drugs and make it more effective at the local community level.

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