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The efficacy of a network intervention to reduce HIV risk behaviors among drug users and risk partners in Chiang Mai, Thailand and Philadelphia, US

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Abstract

Objectives—This HIV Prevention Trials Network (HPTN) study assessed the efficacy of a network oriented peer education intervention to promote HIV risk reduction among injection drug users and their drug and sexual network members in Chiang Mai, Thailand and Philadelphia, US.

Methods—We enrolled 414 networks with 1123 participants, with 204 networks randomized to the treatment condition and 210 to the control. The experimental intervention consisted of six 2-hour small group peer-educator sessions and two booster sessions. Follow-up visits occurred every six months for up to 30 months.

Results—The number of participants reporting injection risk behaviors dropped dramatically between baseline and follow-up in both sites and both arms. The networks in the experimental condition in Philadelphia sustained statistically significant reductions in high risk injection behaviors: a 46% reduction in sharing cottons, 44% reduction in sharing cookers, 47% reduction in front and back loading and 51% reduction in injecting with people not known very well. There were no significant effects associated with the intervention on risk behaviors in Thailand.

Conclusions—The study results demonstrates that not only can IDUs reduce their own injection risk behaviors, but they can also engage in the critical community role of assisting their injection network members to reduce HIV injection risk behaviors.

This HIV Prevention Trials Network study assessed the efficacy of a network-oriented peer education intervention promoting HIV risk reduction among injection drug users and their drug and sexual network members in Chiang Mai, Thailand and Philadelphia, USA. The study was designed to test impact on HIV infection, but the infection rate was low and study was terminated early. This paper reports efficacy on outcomes of self-reported HIV risk behaviors. We enrolled 414 networks with 1123 participants. The experimental intervention consisted of six small group peer-educator training sessions and two booster sessions delivered to the network index only. All participants in both arms received individual HIV counseling and testing. Follow-up visits occurred every six months for up to 30 months. There were 10 HIV seroconversions, 5 in each arm. The number of participants reporting injection risk behaviors dropped dramatically between baseline and follow-up in both arms at both sites. Index members in the intervention arm engaged in more conversations about HIV risk following the intervention compared to control indexes (OR = 1.42, p = 0.004). There was no evidence of change in sexual risk as a result of the intervention. Reductions in injection risk behaviors were observed: 37%, 20%, and 26% reduction in odds of sharing cottons, rinse water and cookers

respectively, and 24% reduction in using a syringe after someone else. Analysis of the individual sites suggested a pattern of reductions in injection risk behaviors in the Philadelphia site. In both sites, the intervention resulted in index IDUs engaging in the community role of discussing reduction in HIV injection risk behaviors. The intervention did not result in overall reductions in self reported sexual risk behaviors, and although reductions in injection risk behaviors were observed, the overall efficacy in reducing risk was not established.

Introduction

Injection drug use is a major mode of transmission of HIV in Asia, North Africa, the Middle East, Eastern and Southern Europe, and areas of North and South America,¹ with many countries reporting injection drug use as the primary mode of HIV transmission.² Increasing access to syringes has been associated with risk reduction in many settings.³⁻⁵ However, injection drug users (IDUs) often report impediments to acquiring syringes and using uncontaminated injection equipment.⁶ A significant proportion of IDUs continue to share syringes and other types of injection equipment, such as cookers (to mix and heat the drugs), cotton (to filter the solution), and rinse water (to clean syringes).⁷

Injection drug use is a social behavior and social network analysis has been used to delineate potential routes of HIV transmission.⁸⁻¹⁰ Social network characteristics have been found to be associated with HIV serostatus and with injection and sexual risk behaviors.¹¹⁻¹³ In addition to being routes of transmission, social networks may be used to diffuse risk reduction information and to promote behavior change.¹⁴

In this randomized controlled trial (RCT), active IDUs were trained in culturally appropriate methods of peer education to diffuse drug and sexual HIV risk reduction behaviors among their drug and sexual network members. It was hypothesized that IDUs trained as peer health educators would facilitate behavior change within their networks through bounded normative influence.¹⁵ The social role of peer educator was designed to garner social rewards from support and risk networks members, and hence increase the likelihood of the peer educators sustaining their HIV prevention outreach activities.¹⁶ It was also anticipated that inhabiting the role of peer educator and advocating risk reduction would lead to personal risk reduction.

The intervention was based on the theories of diffusion of innovations,¹⁷ social learning,¹⁸ social identity,¹⁹ cognitive dissonance,²⁰ social norms,²¹ and role theory²² Prior research has found that information presented by members of a referent group is likely to be viewed as credible and to be more actively processed than information received from other individuals.^{20,21} It has also been established that individuals are more likely to conform to social norms when they are salient.²³ Thus, this intervention was based, in part, on the premise that the presence of a peer educator in one's network who actively promoted risk reduction would increase the salience of risk reduction norms.

Voluntary HIV counseling and testing (VCT) was provided to all study participants. The goal of the study was to determine if a network-based intervention lead to significantly greater reduction in risk behaviors and infections as compared to high quality VCT among IDUs and their risk network members.

Methods

Recruitment

The study sites were Philadelphia, PA and Chiang Mai, Thailand. These sites were chosen based on their prior demonstration of recruiting and retaining cohorts of IDUs. IDUs in Philadelphia were recruited by outreach workers from neighborhoods with high concentrations

of drug use, drug sales, and AIDS cases. Philadelphia has a population of approximately 1.5 million. The number of injectors has been estimated to be 50,000.^{24,25} Among injectors, heroin is the primary drug of choice, though many IDUs also inject speedball and cocaine. Injection drug use has accounted for approximately 33% of all HIV and AIDS cases diagnosed since 1980.²⁶ Overall prevalence of HIV infection among IDUs has been estimated at 15%.²⁷ Philadelphia site participants, as in most urban areas in the US, can be presumed to have been exposed to numerous HIV prevention messages targeting IDUs. One study in Philadelphia found that 80% of respondents reported that new syringes were “very” easy to obtain and 77% reported using a new syringe at their last injection.²⁸

In Thailand, participants were recruited from the city of Chiang Mai and surrounding villages. The recruiters arranged community meetings to explain the project. They also provided educational and recreational activities to build a relationship with the community. Throughout the recruitment process, the recruiters held focus groups with IDUs to evaluate recruitment approaches. Many IDUs in northern Thailand were exposed to HIV prevention campaigns and community activities information about HIV during the epidemic in the late 1980s, and it is likely that many had friends die from HIV/AIDS. VCT has been available at hospitals throughout northern Thailand since 1992. The HIV prevalence rate among IDUs in Northern Thailand was reported in 2006 to be 28%, with only 36% reporting prior VCT and 59% reporting no pre and/or post-test counseling.²⁹

Recruitment in Thailand was delayed for a year due to the governmental policy known as the “war on drugs,” which commenced in February 2003 and persisted through the duration of the study. This draconian policy resulted in the extrajudicial murder of over 2,500 drug users and the incarceration of hundreds of thousands of others. Many others hid or moved. This policy had a profound effect on patterns of drug use and social dynamics among drug users,³⁰⁻³² leading to lower reported frequency of injection drug use among potential participants and greater difficulties recruiting participants. As a result, we expanded recruitment to rural sites. Participants were enrolled and followed between December 2002 and July 2006 in Philadelphia and March 2004 and November 2006 in Thailand.

Eligibility criteria

Eligibility criteria for index participants, who were the initial participants recruited and asked to identify and recruit their drug and sex network members, included: legal age to provide written informed consent, injected drugs at least 12 times in the prior three months, not in methadone maintenance in previous 3 months, HIV negative antibody test results within 60 days of randomization, and willingness to identify and attempt to recruit at least two HIV risk network members who were eligible for the study. After completing the baseline visit and returning for HIV test results, index participants were required to recruit at least one risk network member into the study. Although index participants were required to list at least two eligible network members on the network inventory, they were only required to bring in one of these network members in order to be randomized into one of the 2 study arms.

Eligibility requirements for the network members included: legal age to provide written informed consent, recruited by an eligible index participant, and injected drugs or had sex with the relevant index participant within the prior three months. Once the index member had recruited at least one eligible network member, the network (the index and at least one network member) was eligible for randomization. When sufficient eligible networks had accumulated for an intervention group at a site (at least 12 networks, ensuring a peer training group of at least 6), randomization was scheduled. Sealed envelopes containing pre-computed blocks with 1:1 randomization to control and treatment arms for groups (blocks) of size 12, 14, 16 18 and 20 were produced by the statistical center and used in sequence for each group randomization. On the day of randomization, the next block randomization envelope from the sequence

matching the group size was taken (groups of odd size were rounded up and the last assignment discarded). Randomization arm was assigned to index participants (i.e. networks) by matching ordered study ID numbers (assigned at time of screening) to the list of pre-computed assignments. The assignments were reported to the statistical center, where they were checked for consistency against the original lists.

HIV Testing and counseling

All participants, including those in the control arm, received VCT. The two-session VCT was modeled after Project RESPECT, using an interactive approach that focuses on: 1) increasing the participant's perception of personal risk, 2) supporting participant initiated protective behavioral changes, and 3) focusing on the pursuit of small, achievable steps toward reducing personal risks³³. At the pre-test session, the counselors reviewed HIV testing procedures and the meaning of the test results and helped participants plan if the test results were positive. The counselors identified and discussed sexual and injection risk behavior, reviewed basic risk reduction skills, and developed an individually tailored risk reduction plan. During post-test counseling, in addition to providing and interpreting test results, counselors reviewed and revised participants' risk reduction plans. The counselors also provided written risk reduction materials, and, if needed, risk reduction equipment such as cookers and condoms. Medical referrals were also provided including drug treatment. HIV positive participants were provided extensive health care referrals, with follow-up contacts to insure that they were able to access HIV health care providers.

Participants were tested for HIV at each six-month visit. At follow-up visits, HIV positives were provided risk reduction counseling and medical referrals. In the VCT sessions for HIV negative participants, the counselor referred to the previous risk reduction plan and worked with the participants to evaluate the efficacy of the prior strategies and help them modify their plan to set achievable risk reduction goals. On average, participants received three follow-up assessments, and hence six VCT sessions.

Intervention

The experimental intervention consisted of six two-hour, small-group, network oriented peer-educator training sessions during a four week period and two booster sessions at six and 12 months of study participation. The sessions included instruction in methods of harm reduction, developing and practicing communication skills and strategies, role-plays, and problem solving exercises. At each session, participants developed a plan about how they would discuss and encourage injection and sexual risk reduction with the specific network members that they had identified in the network inventory.

Motivational exercises were included to foster and sustain the indexes' interest in conducting peer education. A major motivational component occurred at the beginning of each session, except for the first, when participants were encouraged to talk about their peer outreach experiences. They discussed their HIV prevention conversations and the communications techniques they used. The facilitators would often praise their effective communication strategies and offer additional techniques (Copies of the intervention manual are available at www.hptn.org/research_studies/HPTN037InterventionManual.asp). In each session, participants practiced peer education skills through extensive role-plays. The injection risk reduction session included the following role-play scenarios: "Your friend rinses a used syringe once with water before injecting. What could you do to help him lower his risk?: You only have one cooker and plan to share drugs. How could you reduce the risk of becoming infected?: You see that someone's needle is jammed up and the person asks to borrow your needle, What would you say to him/her?: Your friend shares needles but always rinses 3 times with water.

How could you talk to him about reducing his risk; Your friend always wants to share cookers with you and you don't want to share.”

All intervention sessions were audiotaped and rated for fidelity by an independent research organization. Network members of index participants assigned to the intervention arm did not receive direct interventions sessions: the intervention, as designed, was delivered through their network index. For networks assigned to the control arm, no intervention beyond VCT was received.

Measures

The interviewer-administered behavioral surveys included self-reports on the frequency of the following risk behaviors: injection drug use, sharing injection equipment (needles, cookers, cotton, and rinse water, front and back loading (i.e. injecting drugs from one syringe to another)), properly disinfecting injection equipment, condom use during vaginal and anal sex with primary and casual partners, HIV prevention conversations, and the number of sex partners. Information was also collected on demographics, alcohol use, and non-injection drug use. The HIV testing protocol was based on the HPTN Central Laboratory quality assurance procedures, which included retesting a random sample of specimens and retesting all seroconverters. We followed HPTN protocol for informing seroconverters about their results, which strongly encourages them to reduce their risk behaviors and provides participants with suggestions on methods of disclosing their serostatus to their risk partners and support network members.

At screening, a social network inventory was used to enumerate the indexes' drug and sexual networks.¹⁴ The goal of the network inventory was to identify risk network members with whom the index had regular interactions for recruitment by the index. Participants were asked to list network members that they had known for at least one month.

First, they were asked to list support network members. Then asked, “Who are the people that you do drugs with?” Participants were also queried with the following probes: “Think about the places where you copped last week and the people who you were with. Do you buy or use drugs with any of those people regularly?; Think about the all the different places where you used last week. These might be friends' places, abandoned houses, your place, or galleries. Who was there and are you usually with them when you use drugs?; Sometimes people that you list are not available, they may be sick, locked up, or just not around. So can you think of anyone else that you did drugs with in the last six months?; Look at the list. Is there anyone else you can think of that you do drugs with? These may be close friends, family members, running buddies [individuals with whom IDUs acquire resources, socialize and inject] and, or acquaintances. Who else did you do drugs with last month?; In the last six months, who did you cop with?; How about three months ago, who were you doing drugs with then? How about since {Thanksgiving, Christmas, Easter, July 4th (holidays in the last 6 months)}, who have you used with since then?” After the participants delineated their drug network, the interviewer asked them about the route and type of drugs used by the network members. An injection network member was determined by the index report of injection drug use by the network member. This information was verified by the network members' self-reported drug use.

To assess the sexual network, participants were asked, “Have you had sex in the last 6 months (even if it wasn't with your primary partner)? Of the people that you listed [on the network] so far whom did you have sex with in the last six months? So think about if there are additional people who you have sex with, including people who may be casual sex partners. The people you name should be people you see regularly.”

Monitoring and oversight

All study protocols and procedures were approved by IRBs at Johns Hopkins University, University of Pennsylvania, Chiang Mai University, and the Thailand Ministry of Public Health. Each site maintained a community advisory board. An independent DSMB monitored the study outcomes, adverse events, and social harms. Independent study monitors visited the sites to verify compliance with human subjects and other research regulations, assess adherence to the study protocol and procedures manual, and confirm data quality and accuracy. All surveys and HIV test results were sent to the independent HPTN Statistical Center (SCHARP, Seattle WA) for verification and analyses. The investigators were blinded to the participants' group assignment.

Early Termination of the Study

The initial study outcome was HIV seroconversion among seronegative participants based on an anticipated annual incidence rate of 8% in Thailand and 2% in Philadelphia. At the interim study review in October 2005, the seroincidence rate was less than 1% at both sites. The DSMB and HPTN leadership concluded that the study would not achieve the required statistical power to evaluate the effect of the intervention on HIV incidence utilizing the network approach and decided to terminate the study early. Study participation ended at the next scheduled visit in Philadelphia but continued for 12 months in Thailand to allow for collection of sufficient behavioral (secondary) endpoints.

Follow-up Visits

Follow-up visits occurred every six months following randomization for up to 30 months. The eligibility window for the visits was from 14 days prior to the target date to 30 days after the target date. The maximum length of follow-up was 30 months. Due to the early termination of the study, the 24-month follow-up visit was the last possible visit for Chiang Mai participants, and not all participants at both sites were eligible for the final visit.

Analyses

This study randomized networks of injection drug users and collected risk behavior information at six month intervals. Risk behavior outcomes were assumed to be correlated both within a person with repeated measures over time and among individuals from the same network. Generalized estimating equations (GEE) models were used to assess differences at baseline, assuming a working independence correlation structure.³⁴ GEE modeling methods were used for the behavioral outcomes to accommodate the nested correlation structure when assessing the intervention effect and site differences. The network was the unit of randomization for assessing the statistical significance of the treatment effects. Participants from different networks were assumed to be uncorrelated. The models were fit using SUDAAN, specifying visits nested within subjects and subjects within networks.³⁵ Estimates of the effects and their standard error were checked for sensitivity to the assumed correlation structure using a non-parametric bootstrap over networks. Close correspondence between the asymptotic and bootstrap estimates were found.

Injection risk behaviors were assessed among participants who reported injection drug use in the last six months at enrollment. Sexual risk behaviors were assessed in the entire cohort. Corresponding to the protocol design, we first examined differences in risk behavior by treatment, pooled over sites. Subsequent examination of site specific intervention effects, conducted because of observed differences in baseline site characteristics that were likely attributable to the “war on drugs” in Thailand, revealed patterns suggestive of site specific differences. These post hoc subgroup analyses of site-specific treatment effects need to be

interpreted with caution. All follow-up visits were used in the analyses, which occurred every 6 months. Participants had different numbers of visits based on when they enrolled.

Results

Enrollment, Adherence, and Retention

The study enrolled 1123 participants, including 1027 who were injectors at baseline. These participants were comprised of 414 networks with 232 networks in Philadelphia and 182 networks in Thailand. In Philadelphia, 1249 participants completed the screening, 487 were deemed ineligible, 719 were HIV negative and returned for post-test counseling, and 232 enrolled as indexes with 464 network members. In Thailand, 326 participants completed the screening, 25 were deemed ineligible, 253 were HIV negative and returned for post-test counseling, and 182 enrolled as indexes with 245 network members. After randomization, 204 networks were assigned to the treatment arm and 210 to the control. At least one follow-up visit occurred among 90% (1008) of participants from 91% (375) of the enrolled networks.

Among the intervention index participants, in Philadelphia 85% attended at least one intervention session and 72% attended at least four sessions. In Thailand, 98% received at least one session and 96% received at least four sessions. The independent review of intervention audiotapes found that 93% of the sessions were acceptable or good, only 6% were inadequate, and 1% could not be evaluated due to the poor quality of the audiotape. The most commonly reported inadequacies were time management and failure to follow the script.

The overall percentage of participants retained was 83% at 12 months and 82% at 24 months. Among visits that were scheduled for completion, the Philadelphia site achieved a visit completion rate of 80% in visits extending out as far as 30 months, and in Thailand, 88% of visits extending to 24 month were completed. In Philadelphia, approximately 5-7% of eligible participants were incarcerated during their follow-up assessment periods.

Baseline Demographics and Risk Behaviors

Baseline demographic and risk characteristics are shown by site in Table 1. The mean and median age in Thailand was 32 and 29, respectively (range 18-69). Both mean and median age was 41 in Philadelphia (range 18-70). In the Philadelphia sample, approximately half (45%) of the participants were white and half (47%) were African American. In Thailand, half (51%) were Thai. The other largest group was Karen (38%) and 10% were members of other ethnic groups. Slightly more than half (53%) of the Thai sample was recruited from rural areas and the rest from urban areas.

There were no significant differences between arms with respect to demographics or risk characteristics. Major differences existed between sites in reports of drug treatment, incarceration, and living on the streets in the prior six months with substantially greater reports of these characteristics in Philadelphia. Types of drugs used and frequency of use were also very different, with 55% of participants in Philadelphia reporting crack smoking (none in Chiang Mai) and 41% using amphetamines (by inhalation) in Chiang Mai (1% in Philadelphia). In Philadelphia, the majority (71%) of participants injected 20 or more days per month, whereas in Chiang Mai only 16% reported injecting 20 or more days per month.

Table 1 also presents self-reported HIV risk behaviors by study site at baseline. Reports of sharing cotton were less frequent in Chiang Mai (17%) versus Philadelphia (45%), which may be due in part to greater purity of heroin in Thailand and hence less need to filter the drug solution. Although approximately half of the participants (50% in Philadelphia and 48% in Chiang Mai) reported any unprotected sex in the prior week, few participants reported unprotected sex with a non-primary partner (17% in Philadelphia and 8% in Chiang Mai).

Network Composition

The network indexes were primarily male, 80% in Philadelphia and 97% in Chiang Mai. Enrolled network size was slightly smaller on average in Chiang Mai; the average size of networks enrolled was 3.00 (standard error = 0.08) in Philadelphia and 2.35 (standard error = 0.05) in Chiang Mai. The majority (73%) of network members injected drugs with the index in both sites. In Chiang Mai, 22% were sexual contacts only and 4% had both sex and injection relationships; in Philadelphia, 10% were sexual contacts only and 17% met both sex and drug eligibility. As expected, HIV positive members were more prevalent in Chiang Mai (20%) than in Philadelphia (9%). For index members, the median network size identified on the social network inventory was 6 (range 2, 21) in Philadelphia, the median drug network size was 4 (range 0, 20). In Thailand, median index network size was 7 (range 3, 20), and median drug network size was 4 (range 1, 17).

Change in HIV risk exposure from baseline

The number of participants reporting exposure to injection and sexual risk dropped dramatically between baseline and follow-up in both sites and both arms. Table 2 shows any self-reported use of injection drugs, those with at least 14 days of injection in the last month and any sexual risk at baseline and six months - all behaviors that were not explicitly targeted for reduction by the intervention. Although there were dramatic reductions in the proportion of IDUs reporting injecting in the prior two weeks, especially in Thailand, the proportion of participants reporting a sexual partner did not change significantly from baseline at either site. Figure 1 shows the proportion reporting injection and sexual exposures through 30 months, illustrating the dramatic drops in many behaviors after baseline, and the downward trends in risk over time.

Uptake of the intervention

The peer-mentor education strategy requires that indexes engage in conversations about risk reduction with their network members. Indexes in the experimental condition from both sites were significantly more likely to report having talked to five or more people about HIV risk reduction in the prior 6 months than those in the control arm (OR = 1.39, $p = 0.004$), and having had more than 10 conversations about HIV risk reduction (OR = 1.42, $p = 0.005$).

Intervention effect

There were 10 HIV seroconversions during the trial, 5 in the treatment and 5 in the control arm (HR = 0.99, 95% CI (0.29, 3.43), $p = 0.99$). Of these, 8 occurred in Philadelphia, 3 in the treatment and 5 in the control arm, with corresponding incidence rates of 0.69 and 1.11 in treatment and control respectively. The two seroconversions in 568.4 person years in Thailand both occurred in the treatment arm.

Analysis of intervention effects for the pre-specified injection and sexual risk outcomes targeted by the intervention, found reductions in injection risk behaviors (see Table 3a), but no statistically significant differences were found: the largest observed decrease in odds was for sharing cotton (OR = 0.63, 95% CI (0.40, 0.99)), with less difference observed for sharing rinse water (OR = 0.80), sharing cookers (OR = 0.73) and using a needle after someone else (OR = 0.76). No differences in sexual risk behaviors were observed. Post-hoc examination of treatment effects by site, however, revealed different patterns for injection risk behaviors at the two sites (Table 3b). Philadelphia, a quite substantial trend is observed for reduced risk in injection behaviors. Sexual risk was similar between the arms at both sites.

The networks in Philadelphia show a pattern of reduction in high risk injection behaviors as a result of the intervention as shown in Table 3b: a 46% reduction in odds of sharing cotton (95%

CI 0.32, 0.91), and 44% reduction in odds of sharing cookers (95% CI 0.34, 0.91), 41% reduction in using a syringe after someone else (95% CI 0.35, 1.01) in Philadelphia. In addition, for two behaviors that were essentially not observed in Thailand, we found a 47% reduction in odds of front and back loading (95% CI 0.31, 0.90), and 51% reduction in odds of injecting with people not known very well (95% CI 0.29, 0.84) in Philadelphia. The networks in Thailand, on the other hand, reported slightly higher odds of injection behaviors, with odds ratios consistently close to 1.2, although with wide confidence intervals, none of which approached statistical significance.

Discussion

The most dramatic finding of the study is the reduction in injection behaviors in both sites and both arms after enrollment in the study. Regression toward the mean, selection bias, access to drugs, and social desirability bias are all possible explanations for the reduction in levels of risk from baseline. In Thailand, where the “war on drugs” reduced the willingness of individuals to report drug use, it may have been that only select types of individuals were willing to participate in the study. These individuals may have already had a propensity to reduce their drug use. Reduced drug availability may have also lead to decreased drug use. Given the age distribution of the Philadelphia sample, it also is likely that some IDUs were maturing out of drug use in Philadelphia.

In the analysis of both sites pooled, we did not find overall group differences in HIV sexual risk behaviors. Substantial baseline differences between the sites in injection risk behaviors led us to an analysis of site-specific effects. Results within the Thailand site indicate the peer-mentor intervention did not succeed in changing risk behaviors relative to the control condition possibly as a result of the war on drugs. The Thai participants had much lower rates of injection drug use at baseline than in Philadelphia. Their rates of injection drug use dropped dramatically throughout the duration of the study, therefore there was less potential to detect significant behavior change attributable to the intervention. It is plausible that both conditions had an equal impact in reducing risk behaviors. As injection drug users are a marginalized population in Thailand, the enhanced testing and counseling, received by all study participants, may have accounted for some of the pronounced levels of injection risk reduction. The “war on drugs” in Thailand may have reduced trust among IDUs, making a group intervention a less salient vehicle for HIV prevention. It is also possible that there was significant contamination between the control and intervention groups, which could have occurred by experimental index participants promoting HIV risk reduction with members of the control group. In Thailand, however, due to the small size of networks and potentially greater number of common meeting settings, indexes in the experimental setting may have interacted with a greater number of control group participants than in Philadelphia, a much larger metropolitan area.

By study design, if an individual was an index in one network they could not also participate as a network member for another index. However, there was certainly overlap among networks. This overlap may have resulted in contamination and consequently risk reduction in the control group. Individual-focused interventions may also suffer from contamination if controls interacting with experimental participants. Future network studies should measure the overlap among networks and utilize selection and training methods to reduce overlaps and contamination. One method to reduce contamination would be to choose geographically distant or structurally distinct networks.

Results within the Philadelphia site suggest that the peer mentoring intervention may have resulted in a reduction in injection risk behavior through the index members' peer mentoring role in diffusion of risk reduction messages into their drug network. These findings indicate

potential for engaging the social processes within these IDUs' networks as a route that can be capitalized on for HIV risk behavior change.

The intervention was successful at both sites in stimulating discussions about HIV by the index participants, which was hypothesized as a key component to diffuse behavior change through the increased salience of risk reduction norms and promoting other forms of social influence to reduce risk behaviors within networks, although there was no evidence of reduction in HIV risk behavior in Thailand as a result of the intervention. Future research should examine how the network structure may promote risk reduction and which network members are most amenable to risk reduction. A second important line of inquiry is the identification of the attributes of the indexes that successfully promote behavior change within their networks.

Although the number of casual sex partners decreased significantly in Philadelphia, there were no differences between the experimental and control groups in the level of sexual risk reduction. The lack of an intervention effect on sexual risks of IDUs has been noted in other studies.^{36, 37} Few IDUs reported multiple partners; the majority of sexual risk was with their primary partners. We speculate one of the reasons for the lack of intervention effect on sexual risk behaviors was that it was easier for the index participants to talk about injection risk reduction as compared to sexual risk. Moreover, the participants had, on average, more drug network members than sex network members; hence, more opportunities to discuss injection risk reduction. Future studies may want to consider a greater focus on sexual risk reduction. Dyadic interventions with partners have been found to reduce sexual risk behaviors³⁸ and may be a promising strategy for IDUs and their sexual partners.

The different trends at the two sites highlight the importance of social context in developing appropriate behavioral interventions. The intervention sessions had very high rates of fidelity, and in both sites the intervention produced changes in frequencies of HIV prevention conversations, so it is likely that the content of the intervention did not differ between sites sufficiently to produce the different outcomes.

Many of the explanations for the Thai findings, e.g., erratic injection use patterns, contamination, use of group intervention, may be a result of or were exacerbated by the "war on drugs." Our findings suggest that this behavioral intervention was either ineffective and/or unable to overcome this structural impediment, or the population enrolled exhibited such low levels of risk after testing and counseling at enrollment that the intervention effect was not measurable. This intervention was developed and adapted for Thailand before the "war on drugs" began and at that time appeared to be relevant and culturally appropriate. The dramatic decline in risk behaviors in Thailand points to the importance of insuring that the targeted behaviors is sufficiently common so that investigators do not encounter a large regression toward the mean effect.

The results of the study also suggest the importance of closely monitoring historic events that may influence study outcomes. With behavioral RCT study designs, investigators often refrain from interacting with the participants outside of the intervention sessions as to not bias study the outcomes. Consequently, the impact of historic events and contamination may be missed. As the field of HIV prevention moves toward network and community-level interventions, there is a greater likelihood that unanticipated factors in the community may influence study outcomes. With clustered and community-based RCT designs, investigators may want to enroll additional clusters or networks, which would not be included in the outcome analyses, to assess changes in the social and physical environment that may impact the study outcomes and may lead to contamination. This additional sample could be closely monitored through frequent quantitative and qualitative interviews and ethnographic observations.

An additional approach to augmenting community-based clinical trials is a phased method with alterations in the latter intervention components based on results from process analyses data of the earlier phases. For example, if the process analyses detected few conversations regarding sexual risk reduction, the investigators could add materials or additional sessions on sexual risk reduction. Although an increased or altered intervention dose may complicate statistical analyses, it may also provide a method of addressing unanticipated events within the community.

In addition to the limitations mentioned above, the study findings are limited by selection criteria and the biases inherent in conducting subgroup analyses. These data are based on self-reports, with the exception of HIV serostatus. However, the validity of self-reported data on drug use is well established.³⁹ Moreover, the self-report data were corroborated by the serological data of low HIV seroconversions in Thailand during the study period. Though socially desirable response bias is a threat to validity, data collection and intervention components of the study were carefully separated to reduce the chance of the interviewers becoming aware of treatment assignment.

In conclusion, the study results suggest that the peer network intervention may produce changes in injection drug behaviors although they showed no suggestion of effectiveness in reducing sexual risk behaviors. We did demonstrate that IDU indexes, given peer mentoring training, can engage in the critical community role of talking with their injection network members about reducing their HIV injection risk behaviors. Potentially because of the profound social impact of the “war on drugs” in Thailand, we did not find consistent effects across sites. The reduction observed in Philadelphia suggests that IDUs can reduce their own injection risk behaviors. The lack of prevention for IDUs and harsh policies toward illicit drug use may have impeded the success of the behavioral intervention in Thailand, yet the VCT provided to all participants may have been universally beneficial in these circumstances. Linking behavioral interventions to structural and policy interventions may hold promise in enhancing the next generation of HIV prevention interventions.

References

1. UNAIDS. 2006 Report on the Global AIDS Epidemic. Geneva: UNAIDS; 2006.
2. Aceijas C, Stimson GV, Hickman M, Rhodes T. Global overview of injecting drug use and HIV infection among injecting drug users. *AIDS* 2004;18(17):2295–2303. [PubMed: 15577542]
3. Committee on the Prevention of HIV Infection among Injecting Drug Users in High-Risk Countries. Preventing HIV Infection among Injecting Drug Users in High Risk Countries: An Assessment of the Evidence. Washington, DC: The National Academies Press; 2006.
4. Semaan S, Des Jarlais DC, Sogolow E, et al. A meta-analysis of the effect of HIV prevention interventions on the sex behaviors of drug users in the United States. *JAIDS* 2002;30(Suppl 1):S73–S93. [PubMed: 12107362]
5. Gibson DR, Brand R, Anderson K, Kahn JG, Perales D, Guydish J. Two- to sixfold decreased odds of HIV risk behavior associated with use of syringe exchange. *JAIDS* 2002;31(2):237–242. [PubMed: 12394803]
6. Rhodes T, Singer M, Bourgois P, Friedman SR, Strathdee SA. The social structural production of HIV risk among injecting drug user. *Soc Sci Med* 2005;61(5):1026–1044. [PubMed: 15955404]
7. Des Jarlais DC, Braine N, Yi H, Turner C. Residual injection risk behavior, HIV infection, and the evaluation of syringe exchange programs. *AIDS Educ Prev* 2007;19(2):111–23. [PubMed: 17411414]
8. Rothenberg RB, Potterat JJ, Woodhouse DE, Muth SQ, Darrow WW, Klov Dahl AS. Social network dynamics and HIV transmission. *AIDS* 1998;12:1529–1536. [PubMed: 9727575]
9. Friedman SR, Neaigus A, Jose B, et al. Sociometric risk networks and risk for HIV infection. *American Journal of Public Health* 1997;87:1289–1296. [PubMed: 9279263]

10. Morris M, Zavisca J, Dean L. Social and sexual networks: their role in the spread of HIV/AIDS among young gay men. *AIDS Education and Prevention* 1995;7:24–35. [PubMed: 8664095]
11. Miller M, Neaigus A. Networks, resources and risk among women who use drugs. *Soc Sci Med* 2001 Mar;52(6):967–78. [PubMed: 11234869]
12. Neaigus A, Friedman SR, Jose B, et al. High-risk personal networks and syringe sharing as risk factors for HIV infection among new drug injectors. *J Acquir Immune Defic Syndr Hum Retrovirol* 1996 Apr;11(5):499–509. [PubMed: 8605596]
13. Costenbader EC, Astone NM, Latkin CA. The dynamics of injection drug users' personal networks and HIV risk behaviors. *Addiction* 2006 Jul;101(7):1003–13. [PubMed: 16771892]
14. Latkin CA, Sherman S, Knowlton A. HIV prevention among drug users: outcome of a network-oriented peer outreach intervention. *Health Psychol* 2003 Jul;22(4):332–9. [PubMed: 12940388]
15. Kincaid DL. From innovation to social norm: bounded normative influence. *J Health Commun* 2004;9 (Suppl 1):37–57. [PubMed: 14960403]
16. Latkin CA, Knowlton AR. Micro-social structural approaches to HIV prevention: a social ecological perspective. *AIDS Care* 2005 Jun;17(Suppl 1):S102–13. [PubMed: 16096122]
17. Rogers, E. *Diffusion of Innovations*. Vol. 5th. New York, NY: Free Press; 2003.
18. Bandura, A. *Social Learning Theory*. Englewood Cliffs, NJ: Prentice Hall; 1977.
19. Turner JC. Social comparison and social identity: some perspectives for intergroup behavior. *Eur J Soc Psychol* 1978;5:5–34.
20. Festinger, L. *Conflict, Decision and Dissonance*. Stanford, CA: Stanford University Press; 1964.
21. Van Knippenberg, D. Group norms, prototypicality, and persuasion. In: Terry, DJ.; Hogg, MA., editors. *Attitudes, Behavior, and Social Context: The Role of Norms and Group Membership*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers; 2000. p. 157–170.
22. Jannis LL, Mann L. Effectiveness of emotional role-playing in modifying smoking habits and attitudes. *Journal of Experimental Research in Personality* 1977;1:84–90.
23. Terry, DJ.; Hogg, MA. *Attitudes, Behavior, and Social Context: The Role of Norms and Group Membership*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers; 2000.
24. Friedman SR, Tempalski B, Cooper H, Perlis T, Keem M, Friedman R, Flom PL. Estimating numbers of injecting drug users in metropolitan areas for structural analyses of community vulnerability and for assessing relative degrees of service provision for injecting drug users. *J Urban Health* 2004 Sep; 81(3):377–400. [PubMed: 15273263]
25. Brady JE, Friedman SR, Cooper HL, Flom PL, Tempalski B, Gostnell K. Estimating the prevalence of injection drug users in the U.S. and in large U.S. metropolitan areas from 1992 to 2002. *J Urban Health* 2008 May;85(3):323–51. [PubMed: 18344002]
26. Philadelphia HIV/AIDS Epidemiological Update. Philadelphia Department of Public Health AIDS Activity Coordinating Office; Philadelphia, PA: 2008.
27. Metraux S, Metzger DS, Culhane DP. Homelessness and HIV risk behaviors among injection drug users. *J Urban Health* 2004 Dec;81(4):618–29. [PubMed: 15466843]
28. MacGowan RJ, Sterk CE, Long A, Cheney R, Seeman M, Anderson JE. New needle and syringe use, and use of needle exchange programmes by street recruited injection drug users in 1993. *Int J Epidemiol* 1998 Apr;27(2):302–8. [PubMed: 9602414]
29. Kawichai S, Celentano DD, Vongchak T, Beyrer C, Suriyanon V, Razak MH, Srirak N, Rungruengthanakit K, Jittiwutikarn J. HIV voluntary counseling and testing and HIV incidence in male injecting drug users in northern Thailand: evidence of an urgent need for HIV prevention. *J Acquir Immune Defic Syndr* 2006 Feb 1;41(2):186–93. [PubMed: 16394851]
30. Vongchak T, Kawichai S, Sherman S, et al. The influence of Thailand's 2003 'war on drugs' policy on self-reported drug use among injection drug users in Chiang Mai, Thailand. *Int J Drug Policy* 2005 Mar;16(2):115–121.
31. Suwannawong P. In Thailand, drug users have to fight for their rights. *HIV AIDS Policy Law Rev* 2004 Dec;9(3):91–3. [PubMed: 15812930]
32. Poshyachinda V, Na Ayudhya AS, Aramrattana A, Kanato M, Assanangkornchai S, Jitpiromsri S. Illicit substance supply and abuse in 2000–2004: an approach to assess the outcome of the war on drug operation.

33. Kamb ML, Fishbein M, Douglas JM Jr, et al. Project RESPECT Study Group. Efficacy of risk-reduction counseling to prevent human immunodeficiency virus and sexually transmitted diseases: a randomized controlled trial. *JAMA* 1998 Oct 7;280(13):1161–7. [PubMed: 9777816]
34. Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 1986 Mar;42(1):121–30. [PubMed: 3719049]
35. Horton NJ, Lipsitz SR. Review of software to fit generalized estimating equation (GEE) regression models. *Am Stat* 1999;53:160–169.
36. Purcell DW, Latka MH, Metsch LR, et al. Results from a randomized controlled trial of a peer-mentoring intervention to reduce HIV transmission and increase access to care and adherence to HIV medications among HIV-seropositive injection drug users. *JAIDS*. In press
37. Garfein RS, Golub ET, Greenberg AE, et al. A peer-education intervention to reduce injection risk behaviors for HIV and hepatitis C virus infection in young injection drug users. *AIDS* 2007 Sep;21(14):1923–1932. [PubMed: 17721100]
38. El-Bassel N, Witte SS, Gilbert L, et al. Long-term effects of an HIV/STI sexual risk reduction intervention for heterosexual couples. *AIDS Behav* 2005 Mar;9(1):1–13. [PubMed: 15812609]
39. Darke S. Self-report among injecting drug users: a review. *Drug Alcohol Depend* 1998 Aug 1;51(3):253–63. [PubMed: 9787998]

Figure 1. Change in injection and sexual risk during the study

Table 1

Demographics and Baseline HIV Risk Behaviors

	Philadelphia	Chiang Mai	Treatment (Pooled sites)	Control (Pooled sites)
Number Enrolled	696	427	550	573
Male	479	357	411	425
	69%	84%	75%	74%
Age				
18-20	8	47	32	23
	1%	11%	6%	4%
21-30	123	189	133	179
	18%	44%	24%	31%
31-40	208	95	152	151
	30%	22%	28%	26%
40+	357	96	233	220
	51%	22%	42%	38%
Marital Status				
Single	428	177	287	318
	61%	41%	52%	55%
Married	70	158	115	113
	10%	37%	21%	20%
Living with partner	57	57	52	62
	8%	13%	9%	11%
Separated/Divorced/Widowed	141	35	96	80
	20%	8%	17%	14%
Education				
No schooling	1	112	58	55
	<1%	26%	11%	10%
Primary schooling	12	165	92	85
	2%	39%	17%	15%
Secondary schooling	222	104	142	184
	32%	24%	26%	32%
Completed secondary	314	22	176	160
	45%	5%	32%	28%
Vocational or trade schooling	14	16	9	21
	2%	4%	2%	4%
University or comm. college	133	8	73	68
	19%	2%	13%	12%
Employment				
Full time	60	267	171	156
	9%	63%	31%	27%
Part time / occasional	72	114	85	101
	10%	27%	15%	18%
Unemployed	564	46	294	316
	81%	11%	53%	55%
Non-injection drug use in last month				

	Philadelphia	Chiang Mai	Treatment (Pooled sites)	Control (Pooled sites)
Crack (smoke)	382	0/255*	198	184
Cocaine (snort or sniff)	114	1/255*	56	59
Amphetamines (inhaled)	6	1%	86	93
Opiates (smoked)	243	35%	175	142
Benzodiazepines	353	51%	176	217
Drug treatment program [^]	188	27%	78	116
Housing [^]				
Spent night on the street, car, park or abandoned building	171	25%	107	113
Spent time in jail	119	17%	67	72
Alcohol use				
Did not drink	283	41%	156	187
Never got drunk	177	25%	144	147
Sometimes got drunk	158	23%	164	154
Always got drunk	78	11%	86	85
Sexual Risk [¶]				
More than one sex partner	286	41%	179	183
Unprotected sex in last week	349	50%	262	293
Unprotected sex with non-primary partner	120	17%	72	83
Injection Drug Behaviors ^{**}				
Injection drug use in last 6 months	651	94%	504	523
Injection drug use in last month	637	98%	473	478
Heroin	603	95%	411	418
Heroin w/ Cocaine	245	38%	130	116
Heroin w/ Amphetamine	4	1%	5	4

	Philadelphia		Chiang Mai		Treatment (Pooled sites)		Control (Pooled sites)	
Cocaine	238	37%	-	-	116	28%	122	28%
Amphetamine	11	2%	64	20%	29	6%	46	10%
Number of days injected in last month								
0-5	59	9%	217	58%	131	26%	145	28%
6-14	58	9%	83	22%	69	14%	72	14%
15-29	130	20%	47	13%	103	20%	74	14%
Everyday	404	62%	29	8%	202	40%	231	44%
Equipment sharing behaviors in last month								
Shared rinse water	308	48%	149	47%	213	42%	244	47%
Shared cooker	386	61%	187	60%	278	55%	295	56%
Shared cotton	284	45%	52	17%	157	31%	179	34%
Used front or back loaded syringe	143	22%	28	9%	81	16%	90	17%
Passed a needle to someone else	330	52%	176	56%	240	48%	266	51%
Used a needle after someone else	248	39%	170	54%	202	40%	216	41%
Did not clean a syringe	87	13%	67	18%	79	16%	75	14%
Injected with someone you don't know well	134	21%	6	2%	65	13%	75	14%

& In the last month,

^a Past 6 months

* Assessment of non-injection cocaine use in Thailand was added during recruitment

** Injection drug behaviors reported only for participants reporting injection drug use in past 6 months.

Table 2
Change between baseline and six months of primary HIV risk exposure behaviors^a

Philadelphia						
	Baseline			Six Month		
	Intervention		Control	Intervention		Control
Injected in last month	310/314	98.7%	327/337	97.0%	153/246	62.2%
Injected more than 14 days in past month	261/314	83.1%	273/336	81.1%	106/246	43.1%
At least one sex partner in last month	258/336	76.8%	194/360	73.3%	153/263	58.2%
						175/292
						59.5%
						42.3%
						59.9%
Chiang Mai						
	Control			Intervention		
	Intervention		Control	Intervention		Control
Injected in last month	163/190	85.8%	151/186	81.2%	49/179	27.4%
Injected more than 14 days in past month	44/190	33.1%	32/186	17.2%	15/179	8.4%
At least one sex partner in last month	159/214	65.0%	147/213	69.0%	138/203	68.0%
						127/196
						23.1%
						5.3%
						64.8%

^a Injection risk behaviors are assessed within the cohort of injection drug users at baseline. Sexual Risk behaviors are assessed in the entire cohort.

Table 3a
Odds Ratios and 95% confidence limits of the intervention effect in reducing injection risk behaviors overall

	Pooled		
	OR	95% CI	p. values
Injection Risk behaviors (in the last month)			
Shared a cooker	0.73	(0.49, 1.09)	0.12
Shared rinse water	0.80	(0.52, 1.23)	0.31
Shared cotton	0.63	(0.40, 0.99)	0.05
Front/backed loading*	NA		
Injected with an unclean syringe	0.94	(0.70, 1.25)	0.65
Passed on a syringe	0.78	(0.53, 1.15)	0.20
Used a syringe after someone	0.76	(0.49, 1.18)	0.22
Injected with people not known well**	NA		
Injected in a shooting gallery	0.81	(0.57, 1.15)	0.24
Sexual Risk behaviors			
Multiple sex partners (last month)	1.02	(0.77, 1.35)	0.90
Any unprotected sex with non-primary partner (last week)	1.17	(0.76, 1.80)	0.46
No condom use with non-primary partner(last week)	1.03	(0.64, 1.66)	0.90
Any unprotected sex (last week)	1.03	(0.70, 1.14)	0.83
No condom use (last week)	1.06	(0.82, 1.35)	0.67
Intervention uptake (Indexes)			
Ten or more conversations about HIV risk reduction	1.42	(1.12, 1.82)	0.005
Talked with five or more people about HIV risk reduction	1.39	(1.11, 1.73)	0.004

Table 3b
Odds Ratios and 95% confidence limits of the intervention effect in reducing injection risk behaviors at each site^a

	Philadelphia				Chiang Mai			
	Prop in Control Arm	OR	95% CI	p. values	Prop in Control arm	OR	95% CI	p. values
Injection Risk behaviors (in the last month)								
Shared a cooker	18.1%	0.56	(0.34, 0.91)	0.02	8.6%	1.27	(0.63, 2.53)	0.50
Shared rinse water	12.0%	0.62	(0.36, 1.04)	0.07	7.3%	1.25	(0.59, 2.64)	0.56
Shared cotton	13.7%	0.54	(0.32, 0.91)	0.02	3.5%	1.19	(0.43, 3.28)	0.74
Front/backed loading [*]	7.3%	0.53	(0.31, 0.90)	0.02	-	-		
Injected with an unclean syringe	28.9%	0.88	(0.63, 1.21)	0.42	9.1%	1.17	(0.64, 2.14)	0.61
Passed on a syringe	16.7%	0.65	(0.40, 1.04)	0.07	7.6%	1.18	(0.58, 2.42)	0.65
Used a syringe after someone	11.1%	0.59	(0.35, 1.01)	0.05	6.1%	1.21	(0.54, 2.69)	0.64
Injected with people not known well ^{**}	8.8%	0.49	(0.29, 0.84)	0.01	-	-		
Injected in a shooting gallery	23.2%	0.72	(0.49, 1.07)	0.11	3.8%	1.51	(0.65, 3.47)	0.33
Sexual Risk behaviors								
Multiple sex partners (last month)	19.5%	0.89	(0.63, 1.27)	0.53	11.7%	1.29	(0.80, 2.10)	0.30
Any unprotected sex with non-primary partner (last week)	5.9%	1.15	(0.68, 1.95)	0.60	3.2%	1.23	(0.59, 2.53)	0.58
No condom use with non-primary partner (last week)	4.5%	1.09	(0.61, 1.94)	0.78	2.3%	0.89	(0.40, 1.99)	0.78
Any unprotected sex (last week)	34.0%	0.99	(0.72, 1.35)	0.93	35.2%	1.08	(0.74, 1.57)	0.68
No condom use (last week)	28.6%	0.99	(0.72, 1.37)	0.97	31.2%	1.14	(0.78, 1.68)	0.50
Mediators of Behavior Change (Indexes)								
Ten or more conversations about HIV risk reduction	10.8%	1.75	(0.98, 3.13)	0.06	21.4%	1.63	(1.02, 2.61)	0.04
Talked with five or more people about HIV risk reduction	13.6%	1.97	(1.12, 3.46)	0.02	30.9%	2.28	(1.47, 3.52)	0.00

^{*} Front/back loading was reported a total of only 10 times during follow-up in Chiang Mai

*** Injecting with people you didn't know well was reported by only one participant during follow-up in Chiang Mai
[^] Injection risk behaviors are assessed within the cohort of injection drug users at baseline. Sexual Risk behaviors and Mediators of change are assessed in the entire cohort.