Candidate change agent identification among men at risk for HIV infection

John A. Schneider[a,b], **Rachel B. McFadden**[a], **Edward O. Laumann**[c], **SG Prem Kumar**[d], **Sabitha R. Gandham**[e], and **Ganesh Oruganti**[e]

[a]Department of Medicine, University of Chicago, 5841 S. Maryland Ave. MC 5065, Chicago, IL 60637, USA

[b]Department of Health Studies, University of Chicago, 5841 South Maryland Ave. MC 2007, Chicago, IL USA

[c]Department of Sociology, University of Chicago,1126 East 59th Street, Chicago, IL 60637, USA

[d]Public Health Foundation of India, ISID Campus, 4 Institutional Area, Vasant Kunj, New Delhi 110070, India

[e]SHARE-India, 6-1-126&127/4 Padmarao Nagar, Secunderabad, Andhra Pradesh, 500025, India

Abstract

Despite limited HIV prevention potency, peer-based programs have become one of the most often used HIV prevention approaches internationally. These programs demonstrate a need for greater specificity in peer change agent (PCA) recruitment and social network evaluation. In the present three-phase study based in India (2009–2010), we first explored the nature of friendship among truck-drivers, a group of men at high risk for HIV infection, in order to develop a thorough understanding of the social forces that contribute to and maintain their personal networks. This was accomplished in the first two study phases, through a combination of focus group discussions (n=5 groups), in-depth qualitative interviews (n=20), and personal network analyses (n=25) of truck-drivers to define friendship and deepen our understanding of friendship across geographic spaces. Measures collected in phases I and II included friend typologies, discussion topics, social network influences, advice-giving, and risk reduction. Outcomes were assessed through an iterative process of qualitative textual analysis and social network analysis. The networks of truck-drivers were found to comprise three typologies: close friends, parking lot friends, and other friends. From these data, we developed an algorithmic approach to the identification of a candidate PCA within a high-risk man's personal network. In stage III we piloted field-use of this approach to identify and recruit PCAs, and further evaluated their potential for intervention through preliminary analysis of the PCA's own personal networks. An instrument was developed to translate what social network theory and analysis has taught us about egocentric network dynamics into a real-world methodology for identifying intervention-appropriate peers within an

Corresponding Author: John A. Schneider, Department of Medicine, University of Chicago, 5841 S. Maryland Ave. MC 5065, Chicago, IL 60637, Ph: +1-773.702.8349, Fax. +1-773.702.8998, jschnei1@medicine.bsd.uchicago.edu.

individual's personal network. Our approach can be tailored to the specifications of any high-risk population, and may serve to enhance current peer-based HIV interventions.

Introduction

In this paper we describe a new approach to increase the potency of social network-based interventions, and the formative work behind its conception. Our goal was to develop an instrument that could increase the potency of one of the most common models for behavior-change and HIV prevention internationally: the peer-change agent model (Medley et al., 2009; Simoni et al., 2011). Our approach is based upon the condition that within a target high-risk individual's (ego's) personal network, there exist peers (the peer-change agent [PCA]) who have potential to motivate behavior change in the high-risk individual (ego). This PCA can be rapidly identified and recruited to become a vehicle for personalized intervention on the target ego. The strength of this model lies in its capacity to harness naturally existing influences within a social network, making it a resource-efficient model for sustainable HIV prevention.

Our strategy is grounded in social network theory and differs from most interventions employing the PCA framework which (1) utilize variable PCA selection criteria; and (2) do not directly account for a candidate PCA's position within the network of the target high-risk ego. The instrument developed from our approach, which we call the Rapid Alter Assessment Instrument (RAAI), extracts specific information about the characteristics and network position of both a high-risk ego and his network members. This information affords a more precise view of overall network structure including ties between network members. Having this "pre-view" of a network advances the ability of researchers and health workers to (1) efficiently select network members who are most likely to affect the ego; and (2) to understand the network forces behind an outcome of interest (e.g., change in ego's behavior). This work joins a growing movement towards personalized interventions, which may be especially crucial in settings where the HIV epidemic has stabilized and is concentrated in specific high-risk populations. To introduce the rationale behind and significance of our approach we first highlight the importance of social networks in the prevention of HIV. We then describe existing PCA-based HIV prevention interventions, their limitations, and how our instrument employs social network theory to potentially enhance these interventions.

Social Networks and HIV Prevention

The goal of network analysis is to explain the behavior of a network as a whole as well as its individual elements through careful study of the interconnections among those elements (E.O. Laumann, 1979). Social network "elements" represent individual persons and the relationships between them are signified by links. In any social setting, relationships often influence an element's behavior above and beyond the influence of his or her individual attributes (Blau, 1994) and thus play a critical role in mediating the adoption and spread of behaviors (T. W. Valente & Pumpuang, 2007). Smoking, eating and sex are all examples of socially mediated behaviors that are critical to health (Alexander et al., 2001; Christakis & Fowler, 2007; Davey-Rothwell et al., 2011; Ennett & Bauman, 1993, 1994; Romer et al., 1994).

Network-derived influences also shape the transmission of infectious diseases such as HIV (Morris & International Union for the Scientific Study of, 2004; Rothenberg et al., 1998), and the analysis of networks around disease transmission can yield valuable models not only for their spread (Gorbach et al., 2009) but also for the diffusion of HIV prevention behaviors (Friedman et al., 2004). For example, there is evidence that groups at high risk for HIV infection receive and transmit information primarily through large informal social networks (E. O. Laumann et al., 1994). Most network evaluations, however, limit their investigation to one or two elements or ties within a high-risk person's network, and fail to probe features of the larger social structure that mediate and modify those relationships (E.O. Laumann et al., 2004). Deeper characterization of the local structure of a high-risk ego's network can be used to identify potent, network-specific PCAs *and* to predict the direction and magnitude of their influence (T. W. Valente & Fosados, 2006).

Peer-change agent approaches

The PCA model is one of the most frequently used conceptual frameworks for HIV prevention interventions internationally (Medley et al., 2009). These interventions generally utilize similar strategies for training candidate PCAs to effectively communicate HIV risk reduction messages with targeted peers (Kelly, 2004; Kelly et al., 1991; Latkin et al., 2003). The PCA selection process, however, is quite heterogeneous across studies. For example, PCAs may be selected because they share common conditions or behaviors with the target population (e.g., race, drug-use) (Colon et al., 2010; Fritz et al., 2011; Miller et al., 1998; Outlaw et al., 2010), they may have superior communication skills (Kelly, 2004; NIMH, 2010), are considered popular or leaders within a community (Kelly, 2004), are charismatic (Cupples et al., 2010) or attractive (Starkey et al., 2009), or are particularly motivated to impact their community (Kegeles et al., 1996). These attributes are sought independently or in combination, though the rationale behind each approach is often poorly characterized. In addition, PCA recruitment is operationalized via a heterogeneous assembly of methods: self-selection, peer-nomination, key informants, ethnographic observation, surveys, and other approaches (T. W. Valente & Pumpuang, 2007). Yet to our knowledge, no study has attempted the identification or recruitment of PCAs based on analysis of a high-risk ego's social network – the ego network.

The most extensively studied example of the PCA model in the context of HIV is Latkin's peer outreach intervention (Latkin et al., 2003). In Latkin's intervention, high-risk egos are recruited through a convenience sample and trained to communicate risk reduction techniques to their drug and sex partners. The primary goal of this approach is to change the behavior of the high-risk ego and secondarily that of their at-risk peers. Both goals are accomplished by focusing intervention efforts within the personal network of the ego, which increases message credibility and reinforces uptake. This intervention has demonstrated success in the United States in improving HIV knowledge and reducing drug-related risk behaviors among injection drug using (IDU) egos (Latkin et al., 2003). However, only modest reductions in sexual risk behavior such as unprotected intercourse were reported by the sex partners of IDU egos in the United States (Latkin et al., 2003; Tobin et al., 2011). Further, efficacy has been mixed among diverse international populations (Latkin et al., 2009). A more recent implementation of Latkin's peer outreach intervention introduced dyadic intervention sessions, designated opportunities for ego IDUs and their recruited sex and drug partners to discuss risk reduction in the research clinic. This study reported a greater reduction of sexual risk among female peers than previous trials (Tobin et al., 2011), suggesting that increasing the structure of communication between the ego and his/her network peers may strengthen the intervention's outcomes. Yet scheduled, environment-controlled sessions are not representative of organic social interactions, and thereby forego an essential objective (and strength) of peer and network-based interventions.

Challenges to Existing PCA-based Approaches

Existing peer-based interventions lack an effective strategy for the selection of peers who are most likely to affect change in the ego. For instance, the ego may hesitate recruiting their closest friends or partners - the most influential members of their network - in order to protect the privacy of these individuals or to prevent possible conflict; in the initial Latkin study, neither primary drug nor sex partners were significant recipients of prevention messages from the ego compared to casual or secondary partners (Latkin et al., 2003). Thus ego-driven peer selection potentially supplies network members who are socially distant from the ego. Social distance can be measured in various ways including degree and tie strength, where degree measures the number of people a network member knows (or who know a member, i.e., "popularity") and tie strength quantifies the influence of a relationship on the individuals involved. Both factors affect dyadic control (E.O. Laumann et al., 2004) and, subsequently, behavior change (Thomas W. Valente, 2010). Parallel to ego selection bias, peers of a lower social stratum than the ego may be prone to tailor their participation according to social norms (Afifi et al., 2009; Scott, 2008; Semaan et al., 2010; Semaan et al., 2009). In the presence of the more "popular" ego, such a peer may be less willing to divulge personal information including sexual behaviors that deviate from social norms, even in the intervention context (Davis et al., 2010; Dohrenwend et al., 1968).

A further concern is the overlap of an ego's personal network with that of the recruited peer (i.e., peer-peer connections). A central postulate behind social network-based interventions is that an individual's social network may be more influential than their personal resolve regarding behavior change; the recruited peer is no exception. The ways in which ego-peer networks overlap and interact may predict how and if intervention messages are delivered. For example, the perceived threat that shared information could circulate to a mutual third party, termed "triadic closure" (E.O. Laumann et al., 2004), thwarts the progress of a network-based intervention by obstructing communication. Figure 1 illustrates two scenarios which may inhibit disclosure of sex behavior information between an ego and peer in an intervention promoting dual sex and drug risk reduction communication. In the first situation, the ego avoids discussing his/her behavior with a peer, and in the second, the peer is restrained from sharing this information with the index. Similar findings have been described previously; for example, infidelity is less common among married men when he and his spouse know their neighbors (E.O. Laumann et al., 2004), and older men share less with their female spouse when she is strongly connected to mutual male friend (Cornwall & Laumann, 2011). Rigorous analysis of existing network qualities and interactions (e.g., directionality of influence, tie strength) could appreciably strengthen the potency of PCA interventions by predicting conditions such as these. In light of this, we propose a method of PCA selection based on a comprehensive assessment of the relationships between a targeted ego and his peers *and* the relationships between various peers in the network.

Improving Potency and Analysis of Peer-Based Outreach HIV Interventions

We developed the Rapid Alter Assessment Instrument (RAAI) to address two interrelated limitations in the conduct of existing PCA-based interventions: (1) existing interventions do not select PCAs based on their organic social influence on a target high-risk ego (i.e., influence and tie strength); and (2) existing interventions select PCAs with little understanding of their personal network structure, within which the intervention takes place. These shortfalls in current peer-based studies highlight the need for newer, social network-based approaches. To address the first limitation, we devised a method for recruiting network peers based on relationship factors such as influence and tie strength that can directly affect the prevention outcome of choice for both the ego and peer. As to the second limitation, we sought to accurately locate the network peer in relation both to the target ego and to other peers within the ego's network for analytic purposes.

The RAAI was devised as a tool to translate what social network analysis and theory has taught us about egocentric network dynamics into a real-world methodology that can identify intervention-appropriate peers within an individual's personal network. It works as an algorithm, taking specific information about many of an ego recruit's network members and selecting for desirable peers according to a pre-specified criterion. Dyad characteristics such as closeness, type of relationship, frequency and discussion content, etc., are considered in the algorithm. Used appropriately, the RAAI can predict critical pathways of communication and behavior change diffusion, and thus filter for the most ideal peer candidate(s) to receive and relay HIV prevention messages (T.W. Valente, 1995).

In the present three-phase study, we first explored the nature of friendship among a group of men at high risk for HIV infection in order to develop an understanding of the social forces that contribute to and maintain their personal friendship networks. This was accomplished in the first two study phases through a combination of focus group discussions, in-depth qualitative interviews, and network visualization and analysis. From these data, we then developed an algorithmic approach to the identification of a candidate PCA within the high-risk man's personal network, which we call the RAAI. We then piloted field-use of the RAAI in order to identify and recruit PCAs, and to further determine their potential for intervention through preliminary analysis of the PCA's own personal networks.

Methods

Setting and participants

All three phases of this study included truck-drivers at a large transport depot center and from four associated parking lots on the outskirts of Hyderabad, the capital of Andhra Pradesh (AP) India, between 2009 and 2010. This population was selected as AP has the highest rate of heterosexually-transmitted HIV infection in the country, and truck-drivers have one of the highest male HIV prevalence rates (Chandrasekaran et al., 2006). Since initial characterization of transmission routes in India, there has been disappointingly little HIV prevention research or program implementation for this highly mobile and marginalized population (Cornman et al., 2007; Schneider et al., 2010; Schneider et al., 2009).

For phases I and II of the study, candidate participants were referred to study staff from a government-funded peer educator HIV prevention program for truck-drivers. Drivers in these programs are approached in parking lots by program peer educators or outreach workers for behavior change communication (Kumar et al., 2009; NACO, 2007). Candidate participants were referred if they reported a history of at least one of four risk factors in the previous six months: sex with a male or female sex worker; health care worker-diagnosed sexually transmitted infection; concurrent sexual partners; and alcohol use before sex. Truck-drivers with any of these risk factors were eligible for participation if they were between the ages of 18–45, fluent in Hindi or Telugu, and reported being HIV negative or unaware of their status. Phase III involved pilot testing the guided recruitment of participant truck-drivers' friends using the RAAI.

Data collection procedures

Data collection included three iterative phases: Phase I (focus groups); Phase II (qualitative interviews); Phase III (RAAI pilot). Informed consent was obtained from participants, followed by basic socio-demographic data and the interview. Digital recordings of each session were professionally transcribed verbatim into Telugu or Hindi, and these transcripts were then translated into English. Participants of phases II and III were guided through a network visualization exercise (Hogan et al., 2007), a highly engaging supplement to

traditional network name generators that produce a visual representation of ego-peer and peer-peer ties within a personal network.

Phase I – Focus group discussions

Five focus groups of five to seven respondents (total N = 26) were conducted using a semi-structured outline of questions. The questions were designed to prompt discussion on the meaning of friendship and characteristics of friends in order to illuminate the specific language used by drivers when speaking about friends and the varying roles played by friends in their social lives.

Phase II – Qualitative Interviews and Personal Network Mapping

Preliminary qualitative analysis of the focus group discussions revealed general themes of friendship, closeness, influence and communication pathways that were used to structure the individual qualitative interviews. The phase II interview (n=20) was designed to elicit details regarding relationships and social-strata-specific trends and themes within individual networks. Research assistants prompted participants to describe different friendship types, to provide demographic and behavioral information for specific friends, discuss the nature of their relationship with these friends, as well as conversation content, location and frequency.

Respondent-directed visualization of personal networks has been demonstrated to improve quality of participation, accelerate name generation, and provide reliable checks for various network measures (Hogan et al., 2007). Both driver and interviewer could refer to this sociogram as needed during the interview. Each sociogram included ties between the driver and friends (ego-alter ties), as well as known ties between his friends (alter-alter ties). Data were entered into social network software (Borgatti, 2002) to construct a structured display of each truck-driver's friend network. Based upon findings from Phase I, each sociogram was organized according to three friend types (close, other and casual) and four geographic spaces (local parking lot, destination lot, hometown, and other places). The network map of secondarily RAAI-recruited participants was merged with that of the truck-driver through whom he was recruited, to discern network overlap.

Phase III – The Rapid Alter Assessment Instrument (RAAI)

Phase III of this study was focused on the construction and implementation of the RAAI as a tool to guide recruitment of participants' network members. The instrument was developed based upon findings from phases I and II and is described in detail in Appendix 1. It consists of a rapid survey-algorithm (requires less than 10 minutes) which is structured to identify and select for alter attributes in a hierarchical manner that emphasizes peer-to-peer discussion of personal matters while maximizing dyadic control. The RAAI was administered to participants following Phase II interviews and network mapping.

Qualitative Analysis for Phases I–III

Interview transcripts were analyzed by employing an iterative process of qualitative textual analysis. For the focus group transcripts (Phase I), open coding (Strauss & Corbin, 1998) was utilized to identify and label discrete units of text which generated themes related to friendship and friend characteristics. Following this process, the individual interviews (Phases II–III) were coded using an analytic induction technique (Taylor & Bogdan, 1998) that referred to one or more sub-themes, or domains, relevant to relationship dynamics between truck-drivers and their friends. Three members of the study team met to cooperatively define appropriate labels and content for different concepts and to formulate a working codebook of primary friendship domains and other emerging themes. Codebook domains are shown in Figure 2. After the first few iterations of this process, and when the

codebook developed some stability, qualitative data analysis software (NVivo qualitative data analysis software; QSR International Pty Ltd. Version 8, 2008) was employed to recode all prior and subsequent interviews according to the codebook formulations. At various points throughout the analysis, an inductive approach was employed to recognize emergent themes and to identify relationships and patterns between domains. The codebook was amended when new ideas and themes emerged. Following the principle of constant comparison (Janesick, 2000), each new transcript was considered in relation to the prior ones to ensure that the codebook and our evolving interpretations remained faithful to the data. Evaluation of the RAAI was limited to its general usability in the field and ability to identify a candidate PCA since the primary goal of this study was to generate the instrument.

Ethics Statement

Procedures and protocols were approved by institutional review boards in India and the United States, and all study participants provided written informed consent.

Results

A total of 52 respondents were recruited. Five focus groups including a total of 27 truck-drivers were conducted, followed by in-depth individual interviews with 20 truck-drivers. The RAAI was employed to recruit peer-network members during the last five of the 20 in-depth qualitative interviews, and these peers were also interviewed.

Relationships and Social Norms

Friend Typologies—Initial analysis from the focus groups revealed three general friend typologies: *close friends*, *parking lot friends*, and *other friends*. These groups were primarily differentiated by degree of trust and reliability, and frequency of contact. The qualitative interviews were structured to provide further details concerning the typical conditions under which these friendships were forged and the characteristics of individuals within each typology.

A *close friend* was described as one who could lend a hand in times of need and help the driver solve day-to-day or emergency issues relating to work, finances, and family affairs. Drivers often referred to close friends as "brothers," indicating family-like intimacy. The relationship was further described as one of mutual benefit in terms of reliance and trust; help is exchanged, and each will do for the other what is done for them. Financial help was frequently emphasized, in addition to help with work matters, emergencies, and day-to-day problems. Close friends were nearly always known from childhood, and several drivers described the intimacy of growing up together using phrases such as "*we ate from the same plate.*" These years of shared experience were used to explain the strong mutual trust between close friends. In the words of one driver:

> From childhood, if I have any problem he will help me, if he has some problem I will help him. That is the reason why he is my closest friend.

Childhood friendships were without exception associated with the driver's home town. All drivers interviewed reported a closest friend from their "native place" (term used by drivers for their hometown), and many of these close friends continued to reside there. This physical propinquity is important beyond facilitating the longevity of these friendships: drivers are frequently away for long periods of time and require a person they can trust to watch over their home and family. One driver aptly describes these friends as his "*home people*" because they "*take care of my home, parents, and children.*" The vast majority of respondents reported that at least one and more often all of their close friends were acquainted with nuclear family members including parents, spouses, and children. Drivers

asserted that regular meetings in the native place upon returning home negated the need to maintain these friendships (by phone or other line of communication) while away.

Typically, drivers acquired many *parking lot friends* through their work engagements. Most respondents, however, did not know these individuals well and they were described as friends of convenience. The primary role of a friend in the parking lot was to provide temporary companionship for drivers while at resting points. Drivers would share meals, drink, play cards or gamble, and otherwise socialize with these individuals, but rarely was contact sustained outside of the parking lot. Although most drivers claimed to have a large circle of parking lot friends (upwards of five, sometimes ten or twenty), they could usually recall the names of just a handful. Conversation was limited and for the most part revolved around work issues; no driver acknowledged speaking about personal topics with their friends at the parking lots.

Although the general description of these relationships was consistent, it is noteworthy that not all drivers considered their relationships with these individuals as "friendship" *per se*. Just over half of interviewees specified having meaningful friendships in the parking lots; this was related to frequency of contact and solidarity on the roads. These drivers often described mutual professional benefit of befriending fellow drivers or others such as mechanics and shop owners in the lot. As one younger driver described:

> It is good to make friends in driving line, because we get good help on the road. If there is any problem and if I have a friend, he will ask me what happened and help me.

The other half of respondents reported that friendship with these individuals was not possible due to the brevity time spent together leading to a lack of trust in these individuals.

Other friends, despite the indistinctiveness of the term, were identified by respondents as a distinct category. The group was heterogeneous, comprising qualities of both close and parking lot friend groups: many belonged to the drivers' village, were also drivers, knew the drivers' families, etc. This heterogeneity defies characterizing the group as a whole, yet the interviews did reveal several unique features of this group. For instance, we found that encounters with parking lot friends were largely restricted to the work environment (i.e. parking lots), while meetings with close friends mostly occurred in the respondents' native place; in both cases, very little communication occurred outside of these spaces. However respondents *did* correspond with their other friends via cell phone to coordinate meetings while crossing through the same city or truck stop. These arrangements with other friends differ considerably from the location-constrained interactions with close and parking lot friends. These friendships are maintained out of choice, and the effort required to do so may be indicative of some perceived benefit that warrants the investment. Another unique feature of other friends was that drivers often credited this group with offering and exchanging advice about sex and sexual health – more so than the other two friend categories. Studies have shown that advice-sharing within a social context can be ascribed emotional value in addition to informative value, as it predicts a degree of concern and closeness (Goldsmith & Fitch, 1997). At the same time, these friends are not so close as to inhibit open disclosure of (in this case) sexual behavior, a subject which may be more sensitive around individuals who know the respondents' families. Other friends were less intimately embedded in drivers' personal lives than close friends, yet unlike parking lot friends they offer sound and stable companionship.

Discussion Topics—Respondents were asked to describe common topics of conversation among their different groups of friends. We coded conversation topics into three primary domains: personal, casual, and sex-related. The personal domain included emotions, family,

and financial matters, and problems, while the casual entailed work-related conversation, joking, and "chatting", and the sex-related domain involved discussions about sexual health, behaviors, and sex advice.

Personal conversation was common between close friends, less so between other friends, and did not occur between parking lot friends. Nearly every respondent specified that personal topics were discussed primarily or solely within close friendships. Casual conversation was prevalent within all groups, but accounted for the majority of conversation among parking lot friends. The dearth of personal conversation with parking lot friends was often attributed to a lack of trust in these individuals and their alienation from the rest of the driver's personal network. For instance, as one driver described:

> He is an outsider so we talk outside talks only. These are all motor line friends, those are different from those who live in the village and know my wife.

This driver points to the divide between people who know his family and those who do not, and the close association between family, close friends, and personal discussions.

Discussions about sex were of special interest during the interviews and analyses, and several trends emerged that helped to further develop the RAAI algorithm. According to respondents, the content and quality of these conversations differed considerably between friend groups. First, "outside sex" was a term used by respondents to describe sexual relations with a non-spouse either preceding or concurrent with marriage. Among close friends, outside sex was largely discouraged based on the potential conflict with family values or health concerns. With parking lot friends these discussions included sharing details about the quality of sexual encounters, locations along driving routes where sex workers could be found, prices paid for sex, and recommendations for specific sex workers. One respondent recounted how such a conversation might unfold between a group of parking lot friends:

> When we talk about such things, someone from the group says, you will get lots of girls in this area. Second person says… even we can get girls at this place also. Third person says, when I was in Dhaba hotel, I found one girl and I paid Rs. 50 or Rs. 100 and she had sex with me.

Thus the candor and content of sex-related conversations differed markedly depending on the friend with whom the driver was engaging. Engagement in the kind of "story telling" as just described may be avoided with close friends due to a perceived threat of third party disclosure involving the driver's family. This approach seems to both predicate and fuel the dual existence a driver typically leads between the parking lot and his native place, and his censorship with close friends may be largely related to their social and physical closeness to family.

A second trend we observed was the frequency of sex-related advice-giving with other friends. While the majority of respondents asserted they would take advice from their close friends and their other friends because it was honest and "good," only half as many admitted exchanging advice about sex with their close friends. Again, we attribute this to other friends' position within the participants' network. Other friends are able to establish trust with the driver through both the protection of sensitive disclosures and the ability to give valuable advice. This role may at first seem more appropriate for a close friend, but other friends have the advantage of being less connected to a driver's personal life (e.g. few ties to family). Parking lot friends may assume a similar position in this regard, yet they are generally less trusted and rarely did respondents seek meaningful advice from parking lot friends. On the other hand, many respondents openly discuss sexual habits, behaviors, or

problems with other friends and expect meaningful feedback without worry that this information will diffuse to others within their close network.

Social Influences

Advice—A predictor of the acceptance and value of advice from a friend was similarity in life experiences. Most drivers described their close friends as the people who knew them best and would provide honest advice even if the respondents may not want to hear it. Additionally, respondents were more likely to claim that they always or unquestioningly took advice from close friends than from parking lot or other friends. Many drivers referred to instances of a close friend inciting positive change in their lives, such as a favorable career move and encouragement to reduce drinking, smoking, or visiting sex workers. As previously described, however, close friends were not sought for advice on sex-related matters. This was especially true concerning "outside" sex; the drivers reported that *if* such behavior was discussed with close friends, these individuals would advise against it. While discouraging outside sex may be well-intentioned advice from close friends, it could also be a source of cognitive dissonance for the respondents given their self-reported sexual behavior when away from home. Avoidance of this tension was evidenced in our results, for nearly every respondent listed other friends as those whom they would approach for advice on sexual related matters.

Risk Reduction—Risk reduction was approached very differently within the separate friend groups. These differences may reflect the different geographic spaces within which these groups are embedded. Parking lot friends frequently offered reminders to use protection when talking about buying sex, an occurrence respondents attributed to the presence of HIV prevention programs available in some parking lots. According to our respondents, risk-prevention messages in the form of signs, truck decorations and company sponsored education meetings were common at truck stops, along with parking lot-based condom distribution and HIV testing. As one respondent described:

> We got [condoms] and kept them in the first aid box, you can get them in every lorry… All the drivers know, it was told to all the drivers how to save themselves from HIV… on every truck there are slogans.

Such high visibility reflects national and international efforts to reduce HIV transmission among truck-drivers in India, and HIV prevention has become increasingly normalized HIV prevention in their work environment. Conversely, there was little display of HIV prevention knowledge in respondents' native places, and this dearth is reflected by the lack of HIV prevention conversations among close friends:

> Wherever I go [in the parking lots] I can see awareness on how to do sex with condom, that is good; but in the village no one will talk about this.

Close friends generally discouraged buying sex, a practice nonetheless very common among our sample. If respondents were to bring home risk reduction messages from the work place, friends and family who are not regularly exposed to such messages may be less receptive to them.

Rapid Alter Assessment Instrument (RAAI)

A peer-profile was constructed based upon findings from Phase I and II interviews and served as a framework for the RAAI, which was in turn used to identify candidate PCAs within the personal network of respondents (n=5). Candidate PCAs were algorithmically selected according to category of friendship, potential for influence, connection to respondent's family or native place, and discussion about sexual matters. The RAAI algorithm was carried out in three stages (Appendix 1 shows the instrument in full). Stage

one of the RAAI algorithm prioritized alters who were categorized as "other friend" by the respondent, did not know the respondent's wife or family, and were not from the respondent's native place. Stage two selected for alters with whom the respondent discussed sex and alcohol use or other risk-related behaviors. This phase eliminated alters with whom the respondent did not communicate with frequently or who were likely to disapprove of risk-related behaviors. Finally, stage three of the algorithm sought alters who supplied the ego with meaningful advice about sex and life in general. Secondary recruits were identified based upon RAAI results from the final five study respondents; and were successfully contacted for interviews.

Sociograms

Sociograms of each respondent's network were used to identify patterns of inter- and intra-group relationships. Figure 3 illustrates three prototypical truck-driver networks, also known as *ego networks*. Panels A–C illustrate several network patterns we identified above, including the compartmentalization of friend groups and triadic closure. **Panel A** shows the friend network of a single respondent and exemplifies the isolation or compartmentalization of friend groups within a single driver's personal network. In fact, the ego network shown in Panel A has no inter-group relationships. This pattern is replicated in most other respondent networks, leading to the general conclusion that any given friend of the ego is more likely to know others of their same type than those of the other two types. The highly mobile lifestyle of truck-drivers could allow for (or enforce) the rigid geographical compartmentalization of their associates, and supports existing evidence that geography is a significant factor leading to compartmentalization within small networks (Onnela et al., 2011). In the case of a truck-driver, this means friends who live in his native place are unlikely to meet his parking lot friends who reside hundreds of kilometers away.

That being said, not all ego networks are composed of perfectly isolated friend groups. **Panel B** shows the ego network of a second respondent in which inter-group friendships do exist, and how these ties may lead to a series of triadic closures. One of the ego's other friends (labeled "O") knows one of his close friends (labeled "C"), who helps care for the ego's family while he is away. Any information or behavior practices the ego driver does not wish reaching his family (e.g., visiting sex workers) he may avoid discussing with this other friend as the information could be passed to his close friend back home and, in turn, his family. As discussed previously, triadic closure describes a natural process by which tension within a network triad is relieved: if A has a strong tie to B and to C, B and C must also have a strong tie or else one will be forged to alleviate psychosocial tension. Similarly, if strong ties exist between A, B and C, and important information is known to only A and B, it is likely that this information will be passed to C. Additionally, Heider's social balance theory proposes that a triad will naturally move towards a balanced state even if this requires changes in ideas or behaviors (Heider, 1958). Once again, this alleviates psychosocial tension and in the sociogram example above, would predict the communication of personal information from both the other friend to the close friend, and from the close friend to the ego's family. This hypothetical example of triadic closure and balance theory illustrates the possible obstacle to interventions posed by ties between alters, and thus the necessity of knowing and characterizing these ties.

Finally, **Panel C** depicts the ego network shown in Panel B combined with that of the ego's RAAI-recruited friend – or the *recruit network*. The initial respondent is labeled "Ego 1", and the recruited alter is labeled "Ego 2". The recruited alter shown in Panel C is an other friend, one of four other friends in the respondent's network. In the context of inter-group relationships, it is important to note ties not only within the respondent and alter networks separately, but also the connections *between* the two networks. In the sociogram one can see

that the recruited peer's friend network is quite exclusive from the respondent's network. For instance, he has no ties to the respondent's close friends; no such ties were reported by Ego 1, and this was confirmed during the interview with Ego 2. Thus the risk of triadic closure as illustrated in Panel B is minimized with the recruited peer. Interestingly, the recruited peer has ties to several parking lot friends, which may portend more candid discussions about sexual behavior (as is typical among parking lot friends). This open sharing of behavior combined with the advice-giving associated with other friends would seem to make this recruited individual a valuable change agent according to our model.

While the above is only a visual interpretation of a sociogram generated in this study, the fact that each of the five recruited peers passed through our RAAI indicates that they met most if not all of the criterion we assembled to define our ideal change agent. Our sociograms demonstrate that the RAAI, based on network theory, can recruit an appropriate peer-change agent from among a truck-driver's entire friend network. Presumably, these individuals could be recruited for further intervention and positively impact the target truck-drivers' behavior while causing minimal tension within their personal network.

Discussion

In this study we developed and pilot tested a social network informed instrument called the Rapid Alter Assessment Instrument (RAAI). The RAAI serves as a guide through an individual's social network, leading to the identification of candidate peers who best fit a desired set of criteria. In the present case we sought the peer within a truck-driver's network who would likely be most influential on that driver's HIV risk-taking behavior; that is, the peer having the greatest potential to serve as a change agent. Our criteria, or peer-profile, for this candidate peer change agent was based on the peer's structural position within the respective driver's network. Before formulating the peer-profile, we conducted an exploratory evaluation of truck-drivers' friend networks to identify the distribution and clustering of peers, their attributes and influences.

A clear pattern of compartmentalization emerged during interviews with the truck-drivers. This pattern led to the formal distinction between close friends, parking lot friends, and other friends. Compartmentalization was driven by geographical spacing, stemming from the mobility inherent to the profession, and was reinforced by social norms and influences. The associates of truck-drivers naturally fall within foundational geographic boundaries, yielding the described categories of friends. For example, close friends are associated with a driver's native place while parking lot relationships are confined to specific and predictable rest points at the beginning and end of a given route. This group-wise segregation, however, may be enforced by the driver out of respect for the different social norms within each group. Location-based influences dictate pronounced differences in lifestyle and behavioral practices between each group and space: close friends are characterized as having a more traditional, family-oriented perspective; friends in the parking lot endorse more socially deviant behaviors such as drinking, visiting sex workers, and condom use.

The differences between close friends and parking lot friends reflect the discrete social roles of truck-drivers within these different contexts. For most drivers, again, these roles are bounded by geography but reinforced by social and psychological tension. First is the family role set and enforced by local traditions, in which the adult male is head of his home and provider for his family (Francoeur et al., 2004). Many respondents indicated that the pressure to maintain respectability with close friends and family was a common stressor in this context. The second role is that of a truck-driver whose work revolves around parking lots; during our interviews many drivers expressed their awareness of the stereotyped behaviors and concomitant reputation associated with this line work. These two roles

polarize around sexual matters, and the dissonance created within the driver may deeply complicate his decision-making around this subject. For example, risky sex behaviors are incongruous with the traditional, family-based role, however, are quite normal and encouraged in the parking lot context. One way to manage this dissonance is through careful censorship of what is shared with whom. For instance, a friend from home will be less likely to know of a driver's risky behaviors which he shares openly with parking lot friends, while a friend from the parking lot will be kept ignorant of the driver's emotional and personal needs which he brings to his close friends instead.

As described, other friends share qualities with both close and parking lot friends without strongly resembling either. Interestingly, just as the truck-drivers bridge two different social roles within their own lives, other friends often bridge the truck-drivers' personal and work lives. The qualities they do comprise make them an appropriate fit with our change agent peer. Other friends are relatively isolated within a driver's network, and often lack ties to a driver's close friends or parking lot friends. Moreover, they are trusted with some personal information, as evidenced by the truck-drivers' willingness to seek sex-related advice from them.

With respect to HIV prevention, we found that prevention efforts may be largely confined within one geo-social space in the same way that some high-risk behaviors are. Many participants described regular exposure to HIV prevention messages in various parking lots including education meetings, condom distribution, and testing clinics. Condom use was often encouraged by parking lot friends, while this kind of discussion rarely occurred between close friends. Close friends were more likely to endorse abstaining from sex workers completely as a matter of respectability, which may be effective for HIV prevention but does not reflect the actual lifestyle and work environment of many drivers. Close friends represent a significant and indispensable portion of respondents' support network, and the absence of prevention discussions within this context is troubling. Yet we find this consistent with network theory, given that most close friends are quite intimate with the drivers' families. In Granovetter's "forbidden triad," if person A is strongly tied to person B and to person C, then B and C must share a tie; if they do not, the resulting tension will eventually resolve through formation of the third B–C tie (Granovetter, 1973). In this context, the driver shares strong ties with close friends and family, making these two groups also likely to share a tie and thus communication. Psychological tension could develop, for example, if friends are close with ego's family and are made aware of ego's contact with sex-workers. This scenario could work to destabilize the driver's social relations.

Bio-behavioral HIV prevention interventions are likely to be most successful when the effect on target behavior minimizes psychosocial tension and network destabilization. We sought a candidate change from within a driver's compartmentalized network who did not have very strong ties to either parking lot or close friends, and who was able to speak openly with drivers about sensitive matters. Other friends most closely resembled this ideal peer change agent. After further developing our peer-profile, we succeeded in recruiting candidate PCAs from the final five truck-drivers' social networks. These individuals shared several important traits: they (1) were not closely tied to the driver's family members; (2) frequently discussed personal and sex-related issues with the respondent; (3) were unlikely to disapprove of respondents for using alcohol, drugs or having unprotected sex, and (4) offered valuable advice on the respondents' personal and sex life.

Significant resources continue to be spent on the implementation and evaluation of peer-based interventions internationally; however little can be concluded from these studies due to heterogeneity in methodology and a failure to trace outcome pathways (Webel et al., 2010). Process evaluation of peer studies remains largely absent from the literature, and

existing methodologies can be laborious and of limited in scope (Sarafian, 2011). Two recent high-profile international multi-center peer-based interventions have illustrated how an absence of in-depth network data and analysis may appreciably limit the interpretation of study findings. In both the C-POL and peer outreach programs, HIV-related outcomes among the intervention groups were not significantly different from those in the control condition (Latkin et al., 2009; NIMH, 2010). Both programs were tested using randomized trials, thus accounting for baseline differences in tie qualities and structures across condition and control groups. Because the control conditions performed remarkably well despite minimal prevention efforts, concerns for contamination between conditions has been raised as a potential factor (Schneider & Laumann, 2011). Formal social network analysis has a proven ability to elucidate the network dynamics that drive different outcomes, and could provide the appropriate analytical supplement to these current peer-based studies.

Our study does have limitations. For the purposes of this pilot study, however, the limited number of focus groups and individual interviews were likely sufficient to make conclusions about the friend networks of this population of truck-drivers. Although the RAAI was only used with five of the interviewed participants, our primary goal was to evaluate it for feasibility. Future work will likely need to compare different selection algorithms, perhaps randomizing whether a close or other friend is selected as the change agent. Research staff were able to contact all five of the RAAI-selected peers to conduct interviews and network evaluations, however, formal analysis of ability to recruit and retain candidate PCAs following the RAAI is required prior to implementation. Inclusion bias may have also affected our outcomes, and truck-drivers who were unwilling to participate in this study may occupy a different sphere of social influences. Further studies with larger sample sizes and including other high-risk populations will be necessary to validate our findings.

The RAAI utilizes positional analysis in the form of an algorithm to strategically recruit desired network members. Parallel to investigations into underlying network mechanisms (e.g., triadic closure), this instrument could explain curious findings observed in other peer-based programs and render their interventions more potent and replicable in diverse settings. We devised the RAAI in part to strengthen the capacity for process evaluation within peer-based interventions. This tool enables identification of specific network-based structural attributes in a peer, allowing for a systematic breakdown of network, peer influence and action components. Specific successes or failures of the intervention may then be ascribed to distinct components, enabling evaluators to isolate points of weakness and improve methodologies. An additional strength of the RAAI is its adaptability. Following an assessment of social networks within a specific population, a researcher may customize a peer-profile to seek network members with a set of characteristics that make them valuable to a specific intervention within a particular context. Regardless of the desired peer-profile, this instrument allows for the direct selection of network members who may enhance behavioral and biomedical interventions targeting the high-risk individual through which they were identified. Development of social network informed algorithms for specific populations is very feasible, and implementation may be automated through digital formats such as computer-assisted participant interviewing. In resource restricted settings, pen and paper forms can be used complementing standard intake and documentation required by many government backed HIV prevention programming. Future studies that adapt and assess the use of this instrument for peer-based interventions among other populations may further validate its utility.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Research Highlights

- Reviews the usefulness of peer-based and network-based approaches for HIV prevention

- Analyses the friendship networks of Indian truck-drivers to identify candidate peer change agents

- Unique friend typologies were socially and geographically bounded; "bridging" alters were identified as ideal change agents

- A novel instrument was used to identify alters who may affect drivers' behavior according to social network theory
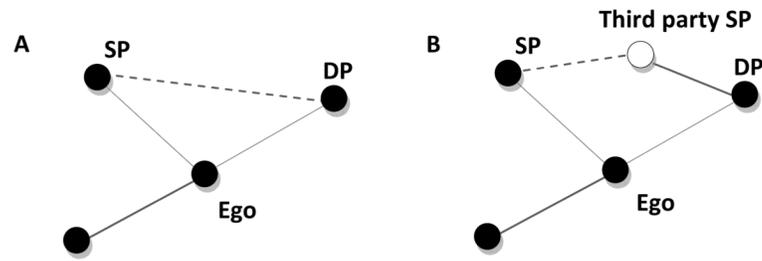
Figure 1. Possible obstruction of dual messaging due to network overlap within the personal network of an IDU ego

(A) In this example of an egocentric network, the sex partner and drug partner of ego are sex partners and may withhold information about their sexual behavior from ego so as not to disclose their relationship. **(B)** Here, the sex partner and drug partner of ego have a mutual, third party sex partner; index's sex partner withholds information to prevent knowledge of this relationship from spreading from index to the drug partner.
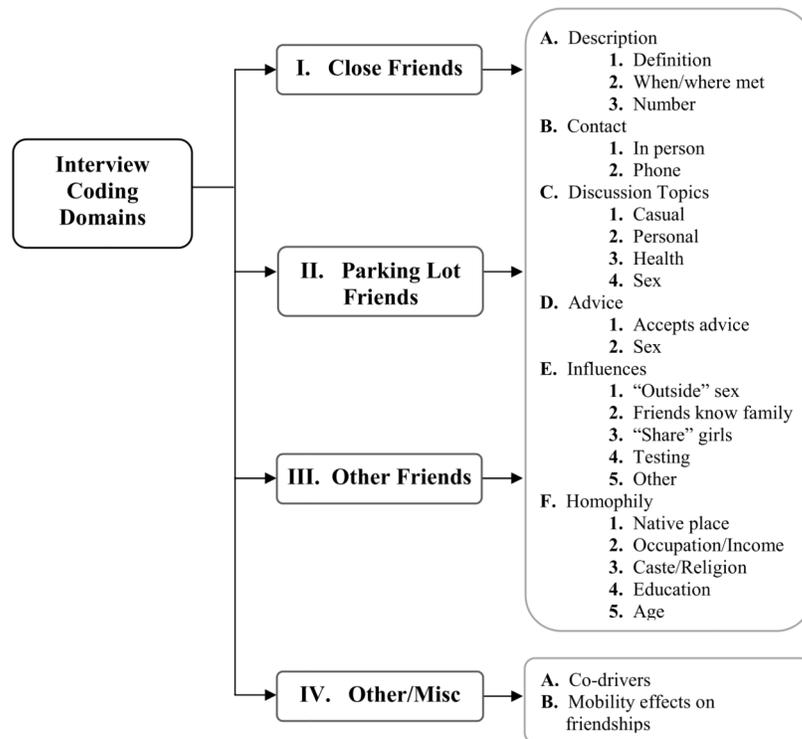
Figure 2.
Coding used for qualitative analysis of focus groups and interviews. Each numbered or lettered heading represents a distinct coding domain, by which interview content was coded.
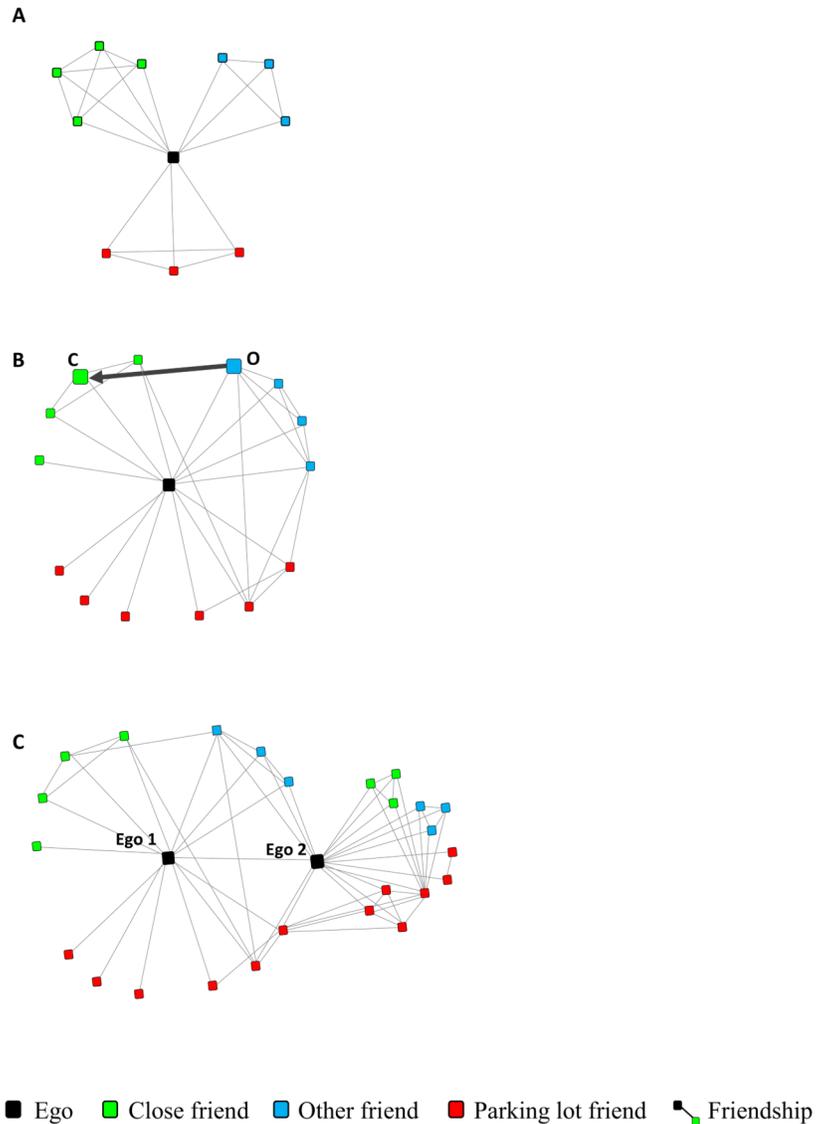
Figure 3. Egocentric social network maps for three truck-drivers interviewed in Hyderabad, India

Panel A depicts a typical truck-driver egocentric network. The three friend groups are perfectly compartmentalized such that no friend of one type is tied to a friend of either other type. **Panel B** shows the ego network of a second respondent in which some inter-group ties exist. The highlighted tie could potentially limit open discussion of sexual behavior between the respondent and this other friend, to prevent the information from being communicated to the respondent's family through the close friend. **Panel C** illustrates the same network featured in Panel B (respondent labeled "Ego 1") in addition to the respondent's RAAI recruited friend (labeled "Ego 2") and his network. The recruited friend exemplifies a peer who could be an effective change agent.