THE ASSOCIATION OF SOCIAL NETWORK FACTORS WITH HEALTHCARE USE AND OUTCOMES AMONG PERSONS WHO INJECT DRUGS IN BALTIMORE, MARYLAND

by

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ABSTRACT

Background

The prevalence of past year injection drug use has been estimated to be 15.6 million adults globally and 2.6 million in North America. Persons who inject drugs (PWID) are disproportionately burdened with a high prevalence of health and socioeconomic disparities and barriers to care. High rates of emergency department (ED) use among PWID indicate disparities in access to and use of primary care. The National Institute of Drug Abuse domestic research funding priorities include eliminating disparities in the HIV continuum of care for persons who use substances. Further, the National HIV/AIDS Strategy has set a goal to increase the number of PLWH with HIV viral suppression. While social network factors are known to influence health behaviors, it is not known how social networks may differ between PWID with current or former injection drug use and most studies do not focus on the very close ties that may be the most influential on health behaviors.

Objectives

The goal of this study is to characterize the social support available to PWID from their closest network members and determine associations of social network factors with HIV viral suppression and emergency department (ED) use.

Methods

We developed a social network survey to gather network characteristics among PWID participating in the AIDS Linked to the IntraVenous Experience (ALIVE) study in Baltimore, Maryland. The interviews were conducted from April 1, 2016 to June 30, 2017. Egocentric social network data were derived from participant report about their network members' attributes and relationship characteristics. Emotional, instrumental and informational support constructs were based on responses to seven support indicator questions. Latent class analysis was implemented with a multilevel approach based on the probabilities for each of the social support indicators. Associations with class membership were identified through multinomial logistic regression. The types of social support and the sources of support from different types of alters within ego-networks then became the primary exposures of interest in determining associations with emergency department use categorized as none, one or two or more visits in the prior six months use for the entire sample and with HIV RNA <50 at the last visit among PWID living with HIV.

Results

Data were available from 970 participants who completed the social network survey. Persons with injection drug use within the previous 12 months had smaller networks of close ties that were more likely to include a partner compared to persons with more remote injection drug use. Based on model fit statistics and in the interest of model interpretability and parsimony, the three-class model was selected: 1) *Moderate support*: probabilities of support were below 0.40; 2) *High support*: probabilities of

support ranged from 0.58 to 0.82; 3) *Very high support*: probabilities of support ranged from 0.91 to 0.99. Compared to moderate support, the odds of membership in the very high support class was greater with each increasing mean year age of alters and lower with less than three very close network members and each additional network member who ever injected drugs. Compared to the moderate class of support, greater odds of membership in the high support class were observed with each additional alter with daily contact and lower odds with each additional alter that ever used non-injection drugs. For the entire sample, compared to no ED visits in the prior six months, the odds of having one ED visit were lower for participants having informational support (AOR: 0.64; 95% CI: 0.41, 1.00) and the odds of two or more visits were lower for participants having a partner (AOR: 0.56; 95% CI: 0.35, 0.90). For PWID living with HIV, the key social network factor associated with HIV viral suppression was having at least one HIV-positive alter (AOR: 2.02; 95% CI: 1.12, 3.64).

Conclusions

There were high levels of perceived support overall from the closest network ties, while the highest level of support was less likely with current non-injection drug use by participants or ever injection drug use by network members. It is both the type of support -- informational -- and sources of support -- partners and HIV-positive alters -- that represent opportunities for network level interventions that aim to improve health outcomes and promote optimal use of healthcare resources among PWID.

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Injection drug use, including subcutaneous, intramuscular and intravenous, is distinct from other routes of administration as it has a high potential for misuse and overdose resulting from rapid drug delivery and also has a greater risk for transmission of bloodborne infections (1). Injection drug use likely began in the 1920s and rapidly diffused to become the predominant route of administration for heroin (2). Opioids, including illegal heroin and prescription pain relievers, are the most commonly injected substances, followed by stimulants, including cocaine and methamphetamine (3). More rapid injection initiation among persons who use drugs has been observed in the era of prescription opioid drug misuse (4) with frequent initiation of drug use with prescription opioids and subsequent transition to heroin use and injection (5).

Estimating the size of the population of persons who inject drugs (PWID) is challenging given the stigmatization of Injection drug use behavior (6); however, meta-analyses reveal variations by geography and sociodemographic characteristics. The prevalence of past year injection drug use has been estimated to be 0.33% (15.6 million) of adults aged 15-64 years globally and 1.06% (2.6 million) in North America (7). Lifetime injection drug use in the United States has been estimated at 2.6% (6.6 million) of persons aged 13 years and older (8). The population proportion of persons ever having used injection drugs in the United States is more than double for males (3.6%) compared to females (1.6%), highest for white males (3.8%) followed by black males (3.4%) and increased with increasing age among persons aged 18 to 49 years. The prevalence of

injection drug use in the past year is estimated to be about 774 thousand adults and adolescents. As an indication of future trends, youth in Baltimore, Maryland, experience particularly high prevalence of injection drug use, with high school students reporting one of the highest levels of ever having used injection drugs of large urban school districts in the United States (7.2%), which is almost twice that of the Maryland statewide average (3.9%) (9).

1.2. Health disparities

Persons who inject drugs are disproportionately burdened with a high prevalence of morbidity and premature mortality. The age standardized mortality rate for PWID in North America is 11.19 (3.58, 18.80) (10). From 1980 through 2012, the primary causes of death among PWID were drug overdose and AIDS. All-cause mortality is three times greater among PWID living with HIV compared to HIV-negative PWID (crude mortality ratio: 3.15). In North America, 9.0% (230,500) of PWID are living with HIV and 55.2% (1.4 million) are hepatitis C virus antibody positive (3), representing 10% and 81% population attributable fraction to injection drug use, respectively (11). In Baltimore, rates of heroin overdose deaths have more than doubled from 2014 to 2016, in part due to the prevalence of fentanyl laced heroin (12). Persons who inject drugs also have high rates of sexually transmitted infections (13), tuberculosis (14), soft tissue infections (15) and psychiatric comorbidity (16) as well as socioeconomic disparities including high rates of homelessness and incarceration (3).

1.3. Healthcare use

Active injection drug use has been associated with missed primary care visits (17), a 46% lower odds of receiving a primary care physical examination (18) and a 55% greater odds of not receiving any care compared to persons who do not use substances (19). Medicaid is the most common means of payment for healthcare services among PWID (20), and states are increasingly implementing cost controls to manage the growth in Medicaid payments, particularly to reduce preventable and inefficient use of healthcare resources (21). Persons who inject drugs at least weekly had more emergency department (ED) visits and hospitalizations and fewer outpatient clinic visits with an excess of $1,000 in healthcare costs per individual compared to persons who do not use drugs (22). Skin and soft tissue infections related to injection drug use are one of the most common reasons for an ED visit to result in a hospital admission among PWID (20) and active injection drug use among PWID living with HIV was associated with more frequent hospitalizations overall (23). With only 40% of people living with HIV infected through injection drug use regularly having had at least one HIV medical visit over a 4-month period (24), routine use of preventative services for screening, monitoring, treatment and prevention is low (25).

1.4. Policy

On the policy front, the National Institute of Drug Abuse domestic research funding priorities include eliminating disparities in the continuum of care for persons who use substances, among others, and improving HIV retention in care for difficult to reach populations, such as PWID (26). The Centers for Medicare and Medicaid Services measures ambulatory care-sensitive conditions that are potentially preventable through

appropriate use of primary care to adjust reimbursement for services (27), thereby incentivizing efforts to improve health outcomes and control costs. Further, the National HIV/AIDS Strategy has set a goal to increase the number of PLWH with HIV viral suppression and reduce HIV-related health disparities (28). With disparities in care for PWID infected with HIV and the increasingly recognized importance of retention in care both for individual health outcomes and population level HIV transmission, there is a need to understand the factors associated with viral suppression in this population. Most studies have focused on individual level predictors of health and healthcare use, some having incorporated social networks most commonly defined by HIV transmission risk behaviors. It is therefore essential to better understand the factors contributing to the inefficient use of more costly healthcare resources (29) and that also result in disease progression and ongoing transmission of HIV (30), particularly factors with the potential to strongly influence health and healthcare seeking behaviors, such as very close social network ties (31).

1.5. Social networks

Support received from social networks is known to effect decision-making about healthcare utilization (32). Social networks are composed of individuals' social relationships (ties). Different types of social support can be seen as the personal resources available from these social networks/contacts (33). Social network theory's evolution from the fields of sociology, social psychology and anthropology has been described by Scott (2004) (34). Scientists working in the Gestalt tradition posited that: groups exist in a social space determined by perceptions and experiences; individuals seek a balance of

ideas and attitudes toward people that are not in conflict; and that psychological wellbeing relates to social network structures created by patterns of relationships. Work in social anthropology supported an understanding that the content of relations and social roles, i.e., social network function, affects individuals in groups as well as the social network structure. Social learning theory suggests that individuals will model and receive social reinforcement for behaviors observed of significant others (35).

1.5.1. Constructs from the behavioral sciences

The following constructs represent the means by which social support can influence health and health behaviors (social norms, social capital and diffusion) and some of the underlying social processes that in part shape the structure and function of social networks (homophily, selection and bonding).

- Social norms: Injunctive (what others approve/disapprove) and descriptive (what others appear to do) norms are a consequence of the perception of the benefits and costs of engaging in a particular behavior, which influences one's own behavior (36). Norms are a form of social influence whereby individuals bring their behaviors and beliefs into alignment with that of their peers.
- Social capital: The quantity and quality of tangible and intangible resources, actual and perceived, available within one's social network that can be mobilized for a particular purpose (37).
- Diffusion: The process by which disease, behaviors and ideas and are adopted and transferred to and within a social network (38).

- Homophily: The differential tendency for people to affiliate with others like themselves (36). While homophily can make it difficult for new ideas and behaviors to take hold from outside the network, it can facilitate diffusion of ideas and behaviors as trust is high and interpersonal communication flows easily within networks of individuals having common attributes, attitudes and experiences.
- Selection: A mechanism underlying homophily. Selecting social contacts with similar traits will reduce cognitive dissonance resulting from differences between an individual and their close social contacts (34).
- Bonding: Benefits generated by strong close-knit ties facilitate the flow of ideas and resources. Individuals have fewer strong ties as they require energy to maintain and there are cognitive limitations to the size of a network an individual can know with meaningful, strong and stable ties (39). Social resources are more accessible with stronger ties (37).

1.5.2 Social support

Social support is the objective and subjective appraisal of an individual's contacts and the resources they provide (36). Social support represents a form of social capital that can be accessed to meet an individual's needs. Types of social support resources include: 1) emotional (cultivates feelings of comfort, caring and love); 2) instrumental (materials and aid that solve practical problems); and 3) informational (advice, guidance and knowledge to help understand situations) (40). Social support is a latent construct in that

it cannot be observed directly, but influences measurable indicators that are believed to represent the latent variable of support (41).

1.5.3. Egocentric networks

Egocentric networks are first order zones, where members, known as alters, are directly linked to a focal person, known as the ego, and to each other (39). Each member represents a network node and the relationships between each ego-alter or alter-alter dyad are referred to as ties. Egocentric networks are also hierarchical in nature, with ego-alter dyads nested within the ego-network (42). A foundational use of egocentric survey and data analysis was the General Social Survey (43), which measured close personal ties using a name generator question to identify network members: "Who do you talk to about important matters?". Responses were limited to five nominations. Other approaches to listing network members include allowing respondents to name as many as they can, then continuing the survey with the first alters named, which are posited to represent the closest and strongest ties. Egocentric data can be limited because of misperceptions of alters' attitudes and behaviors. Sociometric data methods which survey other network members beyond the ego and represent the complete set of relations in a population gets past some these issues but requires more time and resources to conduct than egocentric approaches.

1.5.4. Close network ties

Most study of the social networks of PWID has elicited a broad list of network members based on a wide range of relationship roles and often HIV transmission risk behaviors such as sexual activity and substance use. Yet, it is the closest social ties, those with the strongest social bonding, that may most strongly influence health (31, 44), including HIV risk (45) and substance use norms (46). Close relationships provide a sense that the other is responsive to one's goals, needs and desires (47, 48) and fewer supportive relationships may be required to meet one's needs if they are more highly responsive (47). On average, Americans have four to five contacts identified as close based on spending time together and discussing important issues (31).

1.5.5. Network stability and substance use

While it is likely that social networks are dynamic and change over time, it is not known whether social network structure and function differ between persons with current vs. former injection drug use. There is some evidence to suggest that an individual's substance use may be similar to that of their social network members (49) and that specific substance use behaviors are related to network composition, e.g., daily injection drug use frequency for persons with a lover/partner (50). It may be that the composition of networks differs with an individual's own drug use status, including the number of network members who use substances, with complete turnover occurring following transition from current to former use, but overall network size may remain stable regardless of drug use status (51).

1. 6. Social networks and healthcare use and outcomes

Among PWID, factors such as instrumental and emotional support (52), closeness of ties (45, 46) and norms of drug use (46) are known to influence HIV risk behaviors, greater use of syringe exchange programs is associated with greater use of primary care (53) and higher instrumental and emotional support at initiation of substance use treatment predicted greater retention in treatment programs (54). There is some evidence to suggest that emotional support, which is highly correlated with informational support (55), and instrumental support (56, 57) can deter or facilitate retention in outpatient care (56). Having network members that do not use drugs has been positively associated with seeking drug treatment (58). Outside of populations of PWID, it is also known that informational support is associated with better self-management in diabetes (59) and follow-up care for cancer (60), mental health (61) and heart failure (62).

1.6.1. Emergency department use

The total annual expenditures for emergency department (ED) care exceeds $60 billion (63), yet approximately 32% of ED patients are triaged with less than urgent needs (64). Consequently, there may be opportunities for cost savings through more appropriate ED service utilization. Appropriate ED use has been operationalized as the congruence between the emergency care setting and the level of medical care needed in addition to the frequency of visits (65). Aside from medical needs, psychosocial determinants often underlie the frequent use of emergency care (66). While social support is known to affect decision-making about health care utilization in general (32), little is known regarding the

relationship between social networks of PWID and the frequency of their use of ED services.

People rely on information from multiple sources to make decisions regarding illness prevention, self-management and use of healthcare services. Information provided by health systems is often fragmented across providers, specializations, institutions and insurers (67). Because PWID have high burden of disease, they are challenged with finding, processing and applying medically complex information for multiple comorbidities. In this regard, social network members may take on an important role for interpreting and sharing information and giving advice. Health-related informational support provided by social networks is related to diagnosis, symptom interpretation and management, medication use, treatments, medical tests and procedures, referrals and advice on interactions with healthcare providers (68). Ultimately, neither the limited information regarding the influence of the social networks of PWID on healthcare use nor individual level data can entirely explain differences in use of ED services.

1.6.2. HIV viral suppression

HIV viral suppression achieved through adherence to antiretroviral treatment (ART) maintains immune function, controls disease progression and prevents transmission. The proportion of patients with an HIV diagnosis and at least one medical visit in the last year that were virally suppressed at the last visit is a clinic-level performance measure required by the US Health Resources and Services Administration HIV/AIDS Bureau (HRSA/HAB) for Ryan White HIV/AIDS Program grantees (69). Of people living with HIV that are diagnosed and in care, having a detectable viral load has

been related to injection drug use (70). PWID have longer time to initiating ART (71) and worse indicators for virologic suppression once on treatment than those who do not use injection drugs (72). Use of stimulants, including methamphetamine (73), crack (73, 74) and cocaine (73, 75) but not heroin (75) have been associated with poorer adherence to antiretroviral treatment (ART) compared to persons who do not use substances and African-American PWID have an increased risk for missed clinic visits which can lead to virologic failure as indicated by a detectable viral load (76). HIV-positive PWID have been found to have greater levels of emotional and instrumental support compared to HIV-negative PWID (56), but little is known about how informational support in particular may influence ART adherence and ultimately HIV viral suppression.

1.7. Summary of gaps in knowledge

Prior studies have shown that PWID more frequently engage in suboptimal use of healthcare resources for illness prevention and management as indicated by high levels of ED service use. Among PWID living with HIV, this can result in inadequate viral suppression. Most of the studies have looked at individual factors or system-level barrier to accessing care and some have examined social networks defined by HIV transmission risk behaviors rather than focusing on the ties perceived to be the most important by individuals, which potentially are the most influential relationships (31, 44). However, these factors alone cannot fully explain the variability in outcomes and the closest ties within the social networks of PWID in particular may provide a point of intervention for improving the nature of health care utilization and health outcomes in this population. In addition, differences in the social networks by time since last injection drug use are not

well defined. In order to develop interventions with social networks, we need first to better understand how those networks may differ for persons with current and former injection drug use and second which social network factors may influence health care utilization and health outcomes.

1.8. Specific aims

The goal of this study is to better understand factors that can influence suboptimal use of healthcare services and viral suppression among PWID, with a focus on the role of the closest social network ties. A more comprehensive understanding of the influence of social networks in healthcare seeking behaviors and outcomes will indicate important patient, social network and community level opportunities for intervention to support viral suppression and avoid potentially preventable use of costly ED services. Results will add to the evidence regarding disparities in care and health outcomes for a difficult to reach population — persons who inject drugs and are living with or at risk for HIV.

Aim 1. Social support by injection drug use status

Characterize the latent construct of social support provided by the closest, strongest ties among PWID and identify associations of individual and social network associations with latent classes of support. Of particular interest is whether social network characteristics and classes of support differ between persons who currently and formerly injected drugs.

Aim 2: Emergency department use and social support types and sources

Determine if social network factors are associated with frequency of emergency department visits. Of special interest are the intensity, types and sources of social support that are related to greater or less use of ED services.

Aim 3: HIV viral suppression and social support types and sources

Determine if social network factors are associated with viral suppression among PWID living with HIV. Of special interest are the intensity, types and sources of social support that may address challenges to accessing care and ART adherence.

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2. Materials and methods

2.1. Study population

Participants were drawn from the AIDS Linked to the IntraVenous Experience (ALIVE) study in Baltimore, Maryland. The ALIVE study examines the epidemiology of adults 18 years of age or older with current and former injection drug use in two parallel cohorts (1). Initial recruitment began in 1988-89 followed by subsequent enrollments in 1995, 1998, 2000, 2005-2008 and 2016. Enrollment was re-opened in September 2016 with a goal of 600 persons being recruited for a full sample of 1,596. All community-dwelling, non-institutionalized ALIVE participants were eligible. Because of the potential to alter social interactions, persons residing in nursing homes, rehabilitation facilities, residential drug treatment programs or others with formalized restrictions on their social interactions were excluded.

2.2. Existing data source

ALIVE study visits occur at the Wood Clinic building, a community-based research center within the Johns Hopkins Bloomberg School of Public Health and located in east Baltimore, Maryland. Participants provide information at semiannual ALIVE study visits through a combination of Audio Computer-Assisted Self-Interview (ACASI) for drug use behaviors and an in-person standardized interview with ALIVE study interviewers for health status, healthcare use and other behaviors as well as a clinical examination for persons living with HIV. Venipuncture is performed for serum samples at each study visit and sent to laboratory to obtain HIV RNA viral load and $CD4^+$ T cell

counts. These data were obtained for the same visit as the one in which the interviews are performed for this study.

2.3. Primary data collection: social network survey

A supplemental 59-question social network module (Appendix A) was adapted from previously validated surveys eliciting types of social support (2, 3), health beliefs (4, 5) and trust in healthcare providers (6). There were 1,031 in follow up from April 1, 2016, to June 30, 2017 who were approached, of whom 970 participants (93.5%) agreed to participate in the social network survey. Study interviewers administered the social network survey at the end of the participants' regular 6-month follow-up study visits in a private room. The social network module required about 20 to 30 minutes to complete. Participants provided oral consent and were paid an additional $20.

Social networks were characterized with egocentric data comprised of a focal individual (ego) and their social contacts (alters). Information about the network is from the respondent's perspective alone. Participants reported information with the following prompt: "Looking back over the past 6 months, who are the people that have been important to you? Please think about all the people you associate with closely including friends, sexual partners, associates and family who are at least 13 years old or older." The remainder of the social network survey focused on the first five contacts listed, here after referred to as the "closest ties". We chose the first five nominations to represent the "closest ties" as prior studies indicated that the most important network members and are typically nominated first (7), the median network size among persons who use drugs has

been found to be four (8) and the impact on validity is minimal when limiting to five nominations (7).

Social network measures included alter attributes, characteristics, relationships and roles as reported by the ego. To measure three different domains of social support (emotional, informational and instrumental), we used seven social support indicator questions: (1) Having someone to talk to if down; (2) Would say is in your corner; (3) Would pitch in to help do things; (4) Would loan over $25; (5) Would let you stay if you needed a place; (6) Is someone to give situation advice, and; (7) Does help you understand health. For each of the first 5 network members listed, egos were asked to report on the frequency with which each network member provided each of the seven specified types of support over the prior six months. Responses were recorded using a five-category Likert scale (1 = never; 2 = a little; 3 = sometimes; 4 = frequently; and 5 = always) for the seven social support indicators. Egos were also asked to describe each alter named with respect to demographic and behavioral characteristics and to the relationship with each person (i.e., duration, frequency of interaction, etc.).

2.4. Social network analysis

Twenty-nine percent of participants in ALIVE followed longitudinally were found to cease injecting until censoring at four years, with the remainder having one or more transitions between use and non-use that included about one year or more of cessation (9). An individual's drug use has been related to their peers' drug use (10) and persons who quit drug use over a six-month interval had significantly greater reductions

in the proportion of their network members who used drugs compared to persons who did not quit. Given the occurrence of one-year transitions between drug use and cessation and that the proportion of peers using drugs is different between persons who quit and did not quit, we defined current injection drug use as occurring within the previous year to allow adequate time for observation of changes in key social network characteristics.

Social network analysis focuses on the nature of relationships among people and their influence on behavior and helps understand the factors associated with behavior change. The variables of interest are the characteristics of the egos and the alters as individuals as well as the ego-alter dyad relationship (tie). Summary network measures for egocentric data cover both structure (number, nature and type of relationships) and types and sources of social support provided (11). They occur at the level of the ego network (size, density, exposure) and the level of the dyad nested within the network (tie characteristics and support). Figure 1.a shows a basic egocentric network structure with the ego-alter dyads nested within a common ego. Figure 1.b shows various egocentric network configurations.

2.5. Theoretical framework

Andersen's behavioral model is a framework for examining factors leading to healthcare behaviors and health outcomes (12-14). It has been used to examine healthcare utilization among PWID and persons living with HIV (14-16). It organizes individual, social and health system level factors into predisposing characteristics and enabling resources and needs (Figure 2). Individual characteristics that are predisposing to service

utilization include substance use and sociodemographic characteristics that exist before the occurrence of illness. Enabling tangible and intangible resources are a form of social capital which can be accessed through one's social network. Structural level factors include community level barriers to care, such as housing and transportation, and clinic level variables such access to the same provider, among others (15, 17, 18).

2.5. References

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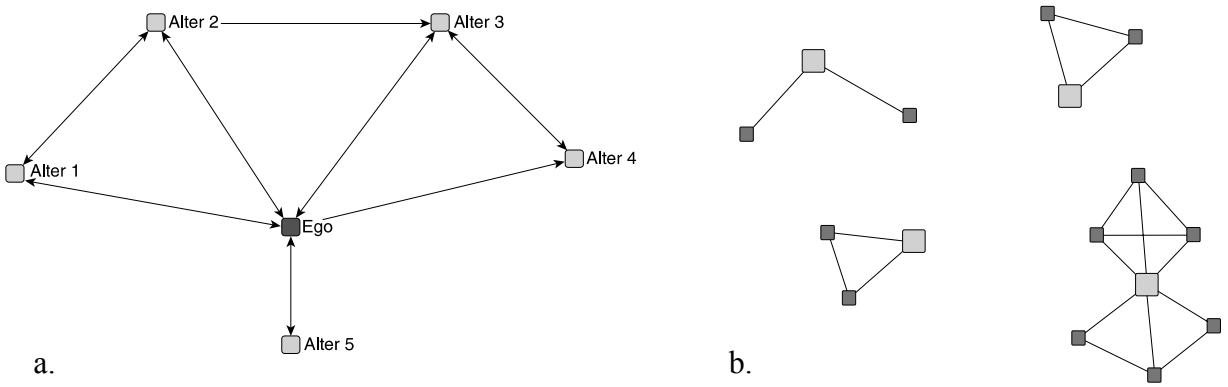

Figure 1. Egocentric networks.
a) Ties nested with an ego-network; b) Various network configurations. Adapted from Crossley et al, 2015 (19).

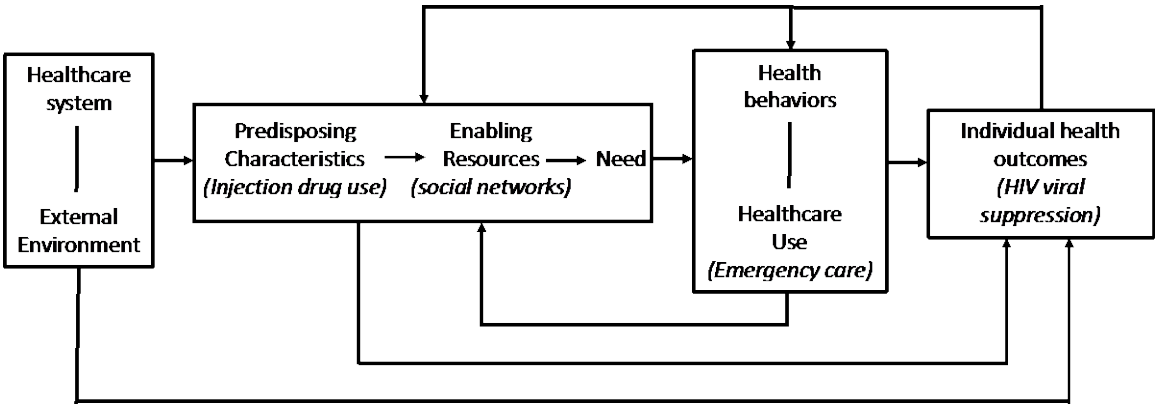

Figure 2. Andersen's behavioral model of health care use.
With key exposures (injection drug use and social networks) and outcomes (emergency service use and HIV viral suppression). Adapted from Andersen, 1995 (12).

3. Social networks and latent classes of social support comparing persons with current to former injection drug use

3.1. Abstract

Little is known about the differences in the composition of social networks and types of social support available to persons who currently inject drugs compared to those with remote injection drug use. A better understanding of how support networks may change as individual patterns of injection drug use change may help tailor more effective social network interventions to promote health. The aim of this study is to examine social support provided by close network ties among persons who inject drugs and identify differences in support by time since last injection drug use.

Information was obtained from a sample of AIDS Linked to the IntraVenous Experience study participants at their six-month study visit from April 1, 2016 through June 30, 2017. A multilevel latent class analysis clustered on individual ego-networks was performed to identify underlying latent constructs of social support using seven support indicators. Multinomial logistic regression was used to examine the associations of the ego and network variables with latent class membership.

Of the 970 ALIVE participants who completed the supplemental social support survey, 34.1% reported that they last injected drugs in the previous twelve months. Persons with injection drug use in the previous 12 months were more likely to have smaller networks of close ties that included a partner. Based on model fit statistics and in the interest of model interpretability and parsimony, the three-class model was selected: 1) *Moderate support*: probabilities of support were below 0.40; 2) *High support*:

probabilities of support ranged from 0.58 to 0.82; 3) *Very high support*: probabilities of support ranged from 0.91 to 0.99.

In adjusted analysis, compared to the moderate support class, greater odds of membership in the high support class was associated with each increasing mean year age of alters (AOR: 1.03; 95% CI: 1.01, 1.05) and each additional alter with daily contact (AOR: 1.33; 95% CI: 1.14, 1.56). Lower odds of membership in the high support class was associated with each additional alter that ever used non-injection drugs (AOR: 0.81; 95% CI: 0.69, 0.95). Compared to the moderate support class, greater odds of membership in the very high support class was associated with each increasing mean year age of alters (AOR: 1.03; 95% CI: 1.01, 1.05) and each additional alter with daily contact (AOR: 1.54; 95% CI: 1.30, 1.83). Lower odds of membership in the very high support class was associated with non-injection drug use in the past year (AOR: 0.58; 95% CI: 0.37, 0.92), less than three very close network members (AOR: 0.50; 95% CI: 0.29, 0.85) and each additional network member who ever injected drugs (AOR: 0.75; 95% 0.56, 1.00) and always argued with (AOR: 0.59; 95% CI: 0.44, 0.78).

Results showing high levels of perceived closeness and support overall suggest a potentially impactful resource for positively influencing health through social network interventions. Given that network members are able to influence social norms and the closest relationships are potentially the most influential, health promotion interventions that focus on the small core of long-standing and very close ties, particularly relatives and partners, may be most effective.

3.2. Background

The social networks of persons who inject drugs (PWID) are known to influence drug use and sexual risk behavior norms, including exchanging sex for drugs (1), sharing needles (2) and frequency of injection (3) among others. Because injection and other drug use is associated with high rates of sexually transmitted infections, viral hepatitis, HIV (4, 5), tuberculosis (6), soft tissue infections (7) and depression (8, 9), PWID must navigate healthcare systems to meet multiple complex health needs. There is evidence to suggest that emotional support, which is highly correlated with informational support (10), financial and instrumental support can facilitate retention in outpatient care for PWID living with HIV (11, 12). Conversely, it has also been found that network members may be less likely to provide emotional and more likely to provide material support for PWID living with HIV or hepatitis C (13).

A substantial proportion of PWID have been found to cease injecting or have multiple transitions between use and non-use over time (14, 15), but little is known about differences in the composition of social support networks and the domains of social support provided between these groups. A better understanding of how support networks may change as individual patterns and frequency of drug use change may be relevant for both maintaining drug use cessation as well as other positive health behaviors. There is some evidence of complete turnover of network members occurring when people transition from current to former use, but overall network size may remain stable regardless of drug use status (16). Substance use by social contacts may be related to an individual's own substance use (17), and having network members that do not use drugs has been positively associated with seeking treatment (18). While higher instrumental and

emotional support at initiation of substance use treatment predicted greater retention in care, it was not protective against stressful conditions that increase the risk of relapse over the long term (19).

There is limited understanding of how social networks differ for persons who are currently injecting and those who have stopped injecting. In addition, studies typically define support networks broadly grouping together persons who provide different domains of social support and at varying levels of influence. Consequently, interventions leveraging social support may be missing opportunities to promote optimal health behaviors and outcomes by not focusing on the smaller set of very close ties that are more likely to influence health behaviors (20) and without consideration of the differences in the social networks of current and former injection drug users.

This study aims to address these gaps by (1) examining social support as a latent construct provided by closer/stronger relationships among persons who inject drugs (PWID) and (2) determining whether social support networks differ between persons who currently and formerly injected drugs. The latent types of social support from the most important personal network ties are described with respect to different domains of social support. We hypothesized that the highest level of social support would be found among those not currently injecting drugs, with chronic health conditions and a greater number of very close ties with network members. A better understanding of how support networks may change as individual patterns and frequency of drug use change may be relevant for both maintaining drug use cessation as well as other positive health behaviors.

3.3. Methods

This study was an analysis of cross-sectional survey data from the AIDS Linked to the IntraVenous Experience (ALIVE) study. The ALIVE study is a longitudinal cohort which examines the epidemiology of injection drug use and associated health factors among adults 18 years of age or older with a history of injection drug use (21). ALIVE participants completed standardized questionnaires, Audio Computer-Assisted Self-Interview (ACASI), in-person interviews and provided bio-specimens for behavioral, socioeconomic and clinical parameters at 6-month visits. As described previously, a supplemental 59-question social network survey module was developed and used to gather information from participants about the attributes of their social network members, the nature of their relationships and the support they are available to provide. Data in this study are from 970 ALIVE participants who completed the supplemental social support survey in the from April 1, 2016, to June 30, 2017.

3.3.1. Variables

Social network measures included characterization of participant and network member relationship ties. The Likert scale responses for frequency that each network member provided emotional, informational and instrumental support (1 = never; 2 = a little; 3 = sometimes; 4 = frequently; and 5 = always) over the prior six months for seven social support indicators were collapsed from five to three by combining ‘never’ with ‘a little’ and ‘sometimes’ with ‘frequently’. This approach had several advantages for the interpretation and analysis of our data. First, the proportion of ‘always’ responses was high, ranging from 62% to 76%. Second, the Likert data are assumed to be nonparametric, the scale items do not represent equal intervals and collapsing these items

may minimize ambiguity due to participants misjudging the intensity of an inherently subjective response. Third, keeping all five items on the scale resulted in a large number of parameters and a sparse distribution of some item rating scores.

Additional variables were generated to describe network structure and function. A binary variable for frequency of interaction at least daily compared to less than daily was created from responses for talking with network members daily, weekly, monthly or greater than monthly. Binary variables for relationship quality were created for: trust with life based on a scale from 1) no trust to 5) trust with life; very close vs not very close based on a scale from a 1) not very close to 5) very close; and frequently to always vs less than frequently argue from a scale of 1) never to 5) always argue. Network density was defined as the number of social ties within a network that know each other as a proportion of all possible ties. Multiplexity was defined by the number of different social support roles, represented by the seven indicators, provided by network members. Homophily between ego and network member characteristics was determined for the same: race; gender; 10-year age category; 6-month and ever injection drug use; non-injection drug use; and HIV status.

Variables for health status were defined through self-report for medical comorbidities including diabetes mellitus, hypertension, heart disease, cardiovascular disease, stroke, and renal disease. Depression was confirmed through administration of the Center for Epidemiological Studies-Depression (CESD) with cut off of 22 selected given that persons with history of opioid misuse score higher than the general population (22). HIV status was confirmed through enzyme-linked immunosorbent assay and confirmed through Western blot. Chronic hepatitis C infection was defined as ever

having had a positive anti-hepatitis C virus antibody test and detectable hepatitis C viral RNA measured through a study visit.

3.3.2. Statistical analysis

Descriptive statistics were used to compare participant demographics, substance use and social networks across a binary variable of most recent injection drug use by participants within or greater than the last 12 months prior to the study visit using T tests for continuous and chi-square tests for categorical measures. The tests of significance for comparisons of social network characteristics were adjusted for correlations within individual networks by clustering on network members. Based on the literature on drug use social networks, we defined current injection drug use as occurring within the previous year to allow adequate time for observation of changes in key social network characteristics.

Egocentric networks can be conceptualized at multiple levels: the tie or relationship between the ego and network member, referred to as level 1 variables, and attributes aggregated across the personal network for a particular ego, referred to as level 2 variables (23). We used information about support from the network member-ego dyad relationship level to identify latent classes of social support rather than relying on a summary variable that aggregates support at the level of the individual.

A key analysis concern was to determine if the latent construct of social support occurred within personal networks at the level of the participant-network member tie or the level between participants' personal networks. To answer this question, we examined

the intra class coefficient (ICC) to determine the proportion of total variance in social support that can be attributed to ego-network member dyads without regard for clustering on the individual ego network compared to the variance in social support between ego-networks that accounts for the nesting of network members within the social network of the same ego. The ICC was calculated as between variance divided by total variance: $\rho = \sigma^2\text{between} / (\sigma^2\text{between} + \sigma^2\text{within})$. We found that the social support received from network members who shared the same ego was more similar than those who did not. Therefore, the latent class analysis (LCA) was implemented with a multilevel approach that used social support indicators from the level of each ego-network member tie to identify latent classes of social support received at the level of the participant.

A multilevel latent class analysis clustered on individual ego-networks was performed to identify the underlying, unobservable constructs of social support to take into account the level of social support between egos, the influence of each network member and the interdependence of social support measures nested within personal networks. Latent class analysis is a person-centered, data reduction approach that clusters individuals who are more similar to each other based on observed patterns of categorical indicators (24). Latent class analysis has been used to identify subgroups with different levels and types of perceived informational, instrumental and emotional support provided by network members (25). Among PWID, LCA has been used to identify latent groups of substance use and other health risk behaviors (26-31).

A series of models with increasing number of latent classes were run to compare solutions and identify the number of classes that best described the data using the collapsed 3-item responses for each of the seven social support indicators. The model

with the optimal number of classes was determined by iteratively specifying an additional class starting with two and comparing measures of fit for: Akaike's Information Criteria; sample size adjusted Bayesian Information Criteria; the Lo-Mendell Rubin adjusted likelihood ratio test for n versus n-1 classes; entropy, which indicates the separation of the latent classes; and interpretability of the results. Latent class analysis was executed using MPlus version 8.0 (Muthèn and Muthèn) and class assignment was based on the most likely class. The classes in the final model were regressed on a number of individual and social network variables using multinomial regression to examine the associations of the ego and network variables. Social network variables used the count of network members with a given attribute. Variables with significant associations with class membership ($p \leq 0.05$) were included in the final multivariable model. Latent class membership and regression analysis were performed using Stata version 15.0 (StataCorp, College Station, TX).

3.4. Results

Of the 970 ALIVE participants who completed the supplemental social support survey (Table 3.1.), 596 reported that they last injected drugs more than 12 months prior to the study (61.4% defined as former PWID) and 374 reported injecting within 12 months (38.6% defined as current PWID). Of those injecting in the last 12 months, 287 (76.7%) had injected in the previous 6 months. Compared to persons without recent injection drug use, those who have used injection drugs in the last 12 months were younger (median age 53 yrs. vs. 57 yrs.; $p<0.001$) and were less likely to identify as black (76.5% vs. 91.9%; $p<0.001$) or be HIV-positive (24.3% vs. 34.1%; $p=0.001$). They were

more likely to: report homelessness in the prior 6 months (19.0% vs. 5.0%; p<0.001); have 6-month income <$5,000 (74.9% vs. 58.9%; p<0.001); be hepatitis C positive with confirmed hepatitis C RNA (61.9% vs. 52.1%; p=0.003); have depressive symptoms (38.0% vs. 17.3%; p<0.001); and live alone (34.0% vs. 40.8%; p=0.036). Persons with 12-month injection drug use were significantly more likely (p<0.001) to use non-injection drugs and to be active in a substance use support group in the prior 6 months (49.5% vs. 40.7%; p=0.007).

Persons with 12-month injection drug use had a smaller median network size (3 vs 4; p=0.015), were less likely to have a least one black network member (81.8% vs. 94.4%; p<0.001) and more likely to have a spouse/partner (47.1% vs. 39.5%; p=0.024) (Table 3.2.). Although the difference in having one or more network members reported as very close did not vary by current injection drug use status, the mean score of closeness with social ties was significantly lower for networks with 4-5 vs 1-3 members (4.59 vs. 4.70; p=0.005). Measures of homophily among the total 3,388 participant-network member ties indicated that for persons with injection drug use in the previous 12 months compared to greater than 12-months, characteristics were more dissimilar between egos and alters for sex, race, six-month inject drug use and ever street drug and more similar for 10-year age, HIV status and ever injection drug use (Supplemental Table S.3.1.). For injection drug use in the previous 12 months compared to greater than 12 months, the highest homophily was seen for race (94.1% vs. 96.1%; p=0.006) and the lowest for ever injection drug use (20.9% vs. 13.7%; p<0.001).

Social support across the three collapsed levels for each indicator are stratified by participant network size and time since last injection drug use for the 3,388 participant-

network member ties (Table 3.3.). For smaller networks (0-3 alters), persons with 12-month compared to greater than 12-month injection drug use had a smaller proportion of network members that always provided emotional support (in your corner: 72.3% vs. 80.7%, p=0.018); instrumental support (pitch in: 63.3% vs. 73.6%, p=0.026; loan money: 55.0% vs. 71.6%, p=0.002; place to stay: 64.6% vs. 75.5%, p=0.005). For larger networks (4-5 alters), persons with 12-month injection drug use similarly had a smaller proportion always providing emotional support (in your corner: 68.2% vs. 78.8%; p=0.001); instrumental support (pitch in: 57.0 vs. 69.8%, p=0.001; loan money: 51.6% vs. 65.7%, p<0.001; place to stay: 60.3% vs. 72.4%, p=0.001) and informational support (situational advice: 58.4% vs. 67.5%, p=0.013).

Multiplexity for network members always providing support for all seven of the support indicators was smaller for persons with 12-month compared to greater than 12-month injection drug use (29.4% vs. 37.3%) and greater for providing no support (14.3% vs. 9%) (Supplemental Table S.3.2). Overall, provision of six to seven indicators of support was highest for partners (63%) followed by women (52.6%), relatives (51.4%), men (44.3%) and least for friends (36.8%).

3.4.1. Latent classes of social support

Results of the latent class analysis model comparing results from two to five class models is reported in Table 3.4. Entropy was good for all solutions, with higher values indicating clear separation of classes. While the AIC and sample size adjusted BIC were lowest for the five-class model, the Lo-Mendell Rubin adjusted likelihood ratio test (LMR) showed no insignificant improvement in model fit going from a three to four class

solution. Based on the LMR and in the interest of model interpretability and parsimony, the three-class model was selected.

Figures 3.1. to 3.3. illustrate the conditional probabilities of participant class membership and the class prevalence based on the estimated posterior probabilities of response level for each of the seven indicators of social support. We defined these three groups as moderate, high and very high with the middle level of high support being the reference for subsequent analyses.

Moderate support: The probabilities of network members always providing any social support was below 0.40 for all indicators. However, the probabilities of providing a moderate level of support, denoted as sometimes-frequently, was over 0.50 for having someone to talk to, always being in your corner, pitching in and giving general advice.

High support: The probability of network members always providing support for each of the seven indicators ranged from 0.58 to 0.82, followed by sometimes-frequently from 0.158 to 0.31 and none-a little from 0.02 to 0.11.

Very high support: The probabilities for alters always providing support for each of the seven indicators was very high, ranging from 0.91 to 0.99. Probabilities for sometimes-frequently and none-a little were below 0.05 for both.

3.4.2. Associations with social support class membership

Table 3.5. shows results of the multinomial regression of the associations with latent class membership using the middle class of support, labeled high, as the base for comparisons with the moderate and very high support classes. In multivariable analysis,

compared to the moderate support class, greater odds of membership in the high support class was associated with each increasing mean year age of alters (AOR: 1.03; 95% CI: 1.01, 1.05), each additional alter with daily contact (AOR: 1.33; 95% CI: 1.14, 1.56) and having someone to do something enjoyable with (AOR: 3.24; 95% CI: 2.20, 4.78). Compared to moderate support, lower odds of membership in the high support class was associated with each additional alter that ever used non-injection drugs (AOR: 0.81; 95% CI: 0.69, 0.95). Compared to the moderate support class, greater odds of membership in the very high support class was associated with each increasing mean year age of alters (AOR: 1.03; 95% CI: 1.01, 1.05) and having someone to do something enjoyable with (AOR: 7.74; 95% CI: 4.87, 12.30). Compared to the moderate support class, lower odds of membership in the very high support class was associated with non-injection drug use in the past year (AOR: 0.58; 95% CI: 0.37, 0.92), less than 3 very close network members (AOR: 0.50; 95% CI: 0.29, 0.85) and each additional network member who ever injected drugs (AOR: 0.75; 95% CI: 0.56, 1.00) or used non-injection drugs (AOR: 0.60; 95% 0.49, 0.73) and always argued with (AOR: 0.59; 95% CI: 0.44, 0.78).

3.5. Discussion

This study describes three latent classes of social support and associations with participant and social network attributes among a cohort of persons with current and former injection drug use. The overall study population characteristics are similar to national data indicating that persons with 12-month injection drug use are younger, more often white and experience a range of socioeconomic and health disparities including homelessness, low income, chronic hepatitis C and HIV (32-34). We also found persons

with 12-month injection drug use to be more likely to live alone, have smaller networks and be more likely to have a partner/spouse. However, density, age, gender, HIV or HCV status, frequency of contact, trust, closeness and conflict were not significantly different by injection drug use status. While there were differences between individual indicators of support and injection drug use by alters was associated with lower likelihood of having very high support, participant injection drug use in the past 12 months was not associated with latent classes of support.

As expected, the highest level of support was associated with having a greater number of close ties with network members. Participants in the very high support group were significantly less likely to use non-injection drugs or have network members that ever-used non-injection drugs. Differential association theory suggests that peers are likely to share similar substance use behaviors (35), and we did find that a large proportion of former injectors shared similar non-injection substance use behaviors with their network members; however, homophily of injection drug use was low for current or former injectors and their network members. Substance use by friends has been associated with low or no support in communities with a high prevalence of substance use (36). For a population of PWID, having close network members that do not use drugs might be considered a form of social capital and promote adoption of norms that discourage substance use (35) and HIV and hepatitis C infection risk behaviors such as needle sharing and condomless sex (1, 37).

In the very high support group, there was strong separation between network members always providing support for each indicator compared to none to a little or sometimes to frequently providing support. For the high class of support, the probabilities

of network members always providing support were highest for emotional and lowest for financial support and health advice. This class can be further described as high support with an emphasis on emotional support. The lowest levels of support were observed in the moderate class, where the greatest probabilities were for network members providing help with a situation by pitching in, with low probabilities of emotional support and situational advice. This class might be described as moderate support with an emphasis on instrumental help.

All three latent classes represented relatively high levels of support, which coincides with our focus on the closest social ties when eliciting network members rather than characterization across a broad range of relationship roles. This level of high support is in agreement with a similar approach used to delineate social networks for up to five of the most important people spoken to in the prior month and measures of the quantity (number of alters providing support) and quality (frequency of contact and proximity) to identify latent classes of support that found most (59%) were classified in the high support group and most had at least one person available to provide emotional, instrumental and informational support (38).

Although perceived closeness was high regardless of network size, it was lower in larger networks, with members of smaller networks more likely to always provide emotional, instrumental and informational support, similar to findings that average closeness decreases with increasing numbers of close contacts and an increasing total number of social ties weakens the average strength of those ties overall (20). The capacity for close, responsive relationships may be a finite resource that limits the number of very close relationships possible within personal networks. Further supporting

the generally high closeness with network members is the long median relationship duration, which agrees with the high proportion of network members that are relatives and partners and suggests that these well-established relationships remain important across networks of current and former PWID. Relatives are particularly important in the social networks of African-Americans, indicated by greater contact with family members compared to whites who are more likely to receive support from friends (39). We found a greater proportion of partners, women and relatives always provided six to seven domains of support compared to men and friends. There may be overlap of the high level of support from women and partners as over two-thirds of partners were women.

A high degree of social connection and interaction is indicated by the large proportion of participants with high levels of trust and closeness and the associations of daily contact, shared leisure activities and conflict with levels of social support. Participants in the very high support group had a lower likelihood of conflict with their social ties. Negative social interactions include criticism, invading privacy, interfering in affairs among others (40), and have been associated with lower health-related quality of life (41). Some individuals have a negative orientation toward accessing their social resources when experiencing health problems, which may be mediated by negative social interactions with peers (42). Cohesive, non-conflictive family relationships and instrumental and emotional support have been highly correlated with medical treatment adherence (43), which may be particularly important for this population with a high degree of multi-comorbidity. It was not surprising that having someone to do something enjoyable with was associated with greater odds of membership in the very high and lower odds of membership in the moderate support group. It has been suggested that one

means by which social support is positively associated with better health is through lower loneliness, which can result from participation in leisure and recreational activities (44).

3.6. Limitations

Although our study was limited to the most important five network members, keeping the network to five may not be a substantial limitation given that previous work in a similar population found the mean size of the social support network to be about 5 (45) and the number of network members providing health advice was 2.9 and financial support 2.7 (46). Social desirability may have resulted in participants reporting greater levels of support than actually exist. This is a cross sectional study and we were unable to determine the effect of cessation of injection drug use on social network composition and support. While there was limited variability of social support across the five-level Likert scale, the predominance of network members 'always' providing support is not surprising given the name generator aimed to elicit the most important, closest network ties and indicates that respondents in general perceived a clear distinction between 'always' and the remaining options.

3.7. Conclusion

These findings shed light on the nature of the core social support network among PWID. It was encouraging that this sometimes-disenfranchised population had relatively high levels of support across the seven support indicators for informational, instrumental and emotional support among a network of the closest most important ties. Results showing high levels of perceived closeness and support overall suggest a potentially

impactful resource for positively influencing health through social network interventions. Given that network members are able to influence social norms, for example, by discussing or modeling particular health behaviors (47), and the closest relationships are potentially the most influential (20, 48), health promotion interventions that focus on the small core of long-standing and very close ties, particularly relatives and partners, may be most effective.

3.8. References

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Table 3.1. Participant characteristics by time since last injection drug use.

Characteristic	Total N=970 N (%)	IDU>1 yr. N=596 N (%)	IDU≤1 yr. N=374 N (%)	p value
Age, median (IQR)	56 (50-60)	57 (52-61)	53 (45-58)	**<0.001**
Female	315 (32.5)	201 (33.7)	114 (30.5)	0.29
Black	834 (86.0)	548 (91.9)	286 (76.5)	**<0.001**
Any homelessness [1]	101 (10.4)	30 (5.0)	71 (19.0)	**<0.001**
Income <$5, 000[1]	626 (65.1)	346 (58.9)	280 (74.9)	**<0.001**
HIV-positive	294 (30.3)	203 (34.1)	91 (24.3)	**0.001**
Hepatitis C positive [2]	535 (55.9)	306 (52.1)	229 (61.9)	**0.003**
Number of comorbidities [3]				
0	311 (32.1)	165 (27.7)	146 (39.0)	**<0.001**
1	286 (29.5)	171 (28.7)	115 (30.7)	
≥2	373 (38.5)	260 (43.6)	113 (30.2)	
CESD>22[4]	245 (25.3)	103 (17.3)	142 (38.0)	**<0.001**
Live alone [1]	370 (38.2)	243 (40.8)	127 (34.0)	**0.036**
<u>Substance use</u>				
6 mo. injection drug use [1]				
Inject heroin	176 (18.1)	--	176 (47.1)	**--**
Inject cocaine	100 (10.3)	--	100 (26.7)	**--**
Inject speedball	139 (14.3)	--	139 (37.2)	**--**
Inject other	10 (1.0)	--	10 (2.7)	**--**
Injection freq. (1 mo.)				
None	681 (70.4)	--	86 (23.1)	
<Daily	158 (16.3)	--	158 (42.4)	
Daily	129 (13.3)	--	129 (34.6)	
Crack cocaine [1]	243 (25.1)	81 (13.6)	162 (43.3)	**<0.001**
Opioid replacement therapy [1]	478 (49.3)	229 (38.4)	249 (66.6)	**<0.001**
Sedative/tranq., street [1]	85 (8.8)	25 (4.2)	60 (16.0)	**<0.001**
Painkiller, street [1]	61 (6.3)	14 (2.3)	47 (12.6)	**<0.001**
Marijuana [1]	155 (16.0)	65 (10.9)	90 (24.1)	**<0.001**
Alcohol, daily [1]	36 (3.7)	13 (2.2)	23 (6.1)	**<0.001**
Substance use support grp. [1]	426 (44.1)	242 (40.7)	184 (49.5)	**0.007**

IDU=injection drug use; IQR=interquartile range

[1] Last 6 months

[2] Detectable Hepatitis C RNA

[3] HIV, diabetes mellitus, hypertension, heart disease, cardiovascular disease, stroke, renal disease, respiratory disease, seizure disorder, dyslipidemia

[4] Center for Epidemiological Studies-Depression score greater than 22

Table 3.2. Social network characteristics by participant time since last injection drug use.

Characteristic	Total N=970 N (%)	IDU>1 yr. N=596 N (%)	IDU≤1 yr. N=374 N (%)	p value
Network size, median (IQR)	4 (2-5)	4 (2-5)	3 (2-5)	**0.015**
Density, mean (SD)	0.99 (0.08)	0.98 (0.09)	0.99 (0.08)	0.94
Age, median (IQR)	54 (42-63)	54 (43-63)	54 (41-62)	0.70
Female [1]	891 (92.7)	548 (92.9)	343 (92.5)	0.80
Black [1]	867 (89.6)	561 (94.4)	306 (81.8)	**<0.001**
HIV-positive [1]	122 (12.8)	71 (12.1)	51 (13.8)	0.46
Hepatitis C positive [1]	210 (22.4)	117 (20.4)	93 (25.5)	0.066
Relational				
Partner/spouse [1]	409 (42.2)	232 (38.9)	177 (47.3)	**0.010**
Friend [1]	453 (46.7)	275 (46.1)	178 (47.6)	0.66
Relative[1]	848 (87.4)	523 (87.8)	325 (86.9)	0.70
Professional [1]	23 (2.4)	15 (2.5)	8 (2.1)	0.71
Years known, median (IQR)	32 (23-42)	34 (24-43)	31 (20-41)	**0.009**
Frequency of contact [1, 2]	850 (87.6)	531 (89.1)	319 (85.3)	0.080
Trust [1, 3]	913 (94.2)	567 (95.3)	346 (92.5)	0.071
Closeness [1, 4]	894 (93.3)	560 (94.6)	334 (91.3)	**0.044**
Do you argue with [1, 5]	283 (29.2)	175 (29.4)	108 (29.0)	0.91

IDU=injection drug use; IQR=interquartile range

[1] One or more network members

[2] At least daily

[3] Trust with life, on a scale from 1=Don't trust to 5=Trust with life

[4] Very close, on a scale from 1=Not very close to 5=Very close

[5] Frequently-always, on a scale from 1=Never to 5=Always

Table 3.3. Social support indicators by time since last injection drug use stratified by network size for ego-alter dyad.

		0-3 alters			4-5 alters		
	Total N=3,388	IDU>1 yr N=610	IDU≤1 yr N=444		IDU>1 yr N=1521	IDU≤1 yr N=813	
Support indicator	N (%)	N (%)	N (%)	p-value	N (%)	N (%)	p-value
Emotional							
Could talk to if down							
Never-a little	291 (8.6)	36 (5.9)	28 (6.3)	0.176	139 (9.1)	88 (10.8)	0.095
Sometimes-frequently	923 (27.3)	149 (24.6)	136 (30.6)		390 (25.6)	248 (30.5)	
Always	2170 (64.1)	421 (69.5)	280 (63.1)		992 (65.2)	477 (58.7)	
Would say is in your corner							
Never-a little	127 (3.8)	16 (2.6)	19 (4.3)	**0.018**	49 (3.2)	43 (5.3)	**0.001**
Sometimes-frequently	690 (20.5)	101 (16.7)	103 (23.4)		272 (18.0)	214 (26.5)	
Always	2550 (75.7)	489 (80.7)	319 (72.3)		1190 (78.8)	552 (68.2)	
Instrumental							
Would pitch in to help do things							
Never-a little	198 (5.9)	27 (4.4)	22 (5.0)	**0.026**	76 (5.0)	73 (9.0)	**<0.001**
Sometimes-frequently	931 (27.6)	134 (22.0)	141 (31.8)		381 (25.2)	275 (34.0)	
Always	2245 (66.5)	448 (73.6)	281 (63.3)		1055 (69.8)	461 (57.0)	
Would loan over $25							
Never-a little	407 (12.0)	62 (10.2)	51 (11.5)	**0.002**	150 (9.9)	144 (17.8)	**<0.001**
Sometimes-frequently	878 (26.0)	110 (18.2)	148 (33.5)		372 (24.5)	248 (30.6)	
Always	2093 (62.0)	434 (71.6)	243 (55.0)		998 (65.7)	418 (51.6)	
Would let stay if needed a place							
Never-a little	409 (12.1)	60 (9.9)	65 (14.7)	**0.005**	159 (10.5)	125 (15.4)	**0.001**
Sometimes-frequently	638 (18.9)	89 (14.6)	92 (20.8)		260 (17.1)	197 (24.3)	
Always	2337 (69.1)	460 (75.5)	286 (64.6)		1101 (72.4)	490 (60.3)	

Table 3.3. continued.

Support indicator	Total N=3,388 N (%)	0-3 alters IDU>1 yr N=610 N (%)	4-5 alters IDU≤1 yr N=444 N (%)	p-value	IDU>1 yr N=1521 N (%)	IDU≤1 yr N=813 N (%)	p-value
Informational							
Someone to give situation advice							
Never-a little	232 (6.8)	27 (4.4)	19 (4.3)	0.193	107 (7.0)	79 (9.7)	**<0.013**
Sometimes-frequently	920 (27.2)	142 (23.3)	132 (29.7)		387 (25.4)	259 (31.9)	
Always	2236 (66.0)	441 (72.3)	293 (66.0)		1027 (67.5)	475 (58.4)	
Does help understand health							
Never-a little	510 (15.2)	82 (13.5)	70 (15.8)	0.141	213 (14.1)	145 (18.1)	0.066
Sometimes-frequently	907 (27.0)	140 (23.1)	122 (27.6)		406 (26.9)	239 (29.8)	
Always	1943 (57.8)	385 (63.4)	250 (56.6)		889 (59.0)	419 (52.2)	

IDU=injection drug use
p-values adjusted for clustering of network members within participant social networks

Table 3.4. Model fit and selection criteria for latent classes of social support.

Criteria	Class 2	**Class 3**	Class 4	Class 5
Parameters	29	**44**	59	74
AIC	32687.306	**31301.778**	30665.369	30210.899
BIC [1]	32772.872	**31431.602**	30839.451	30429.238
LMR(p) [2]	<0.0001	**<0.0001**	0.1241	--
Entropy	0.945	**0.921**	0.920	0.900

[1] Sample size adjusted BIC

[2] Lo-Mendell Rubin adjusted likelihood ratio test for n versus n-1 classes

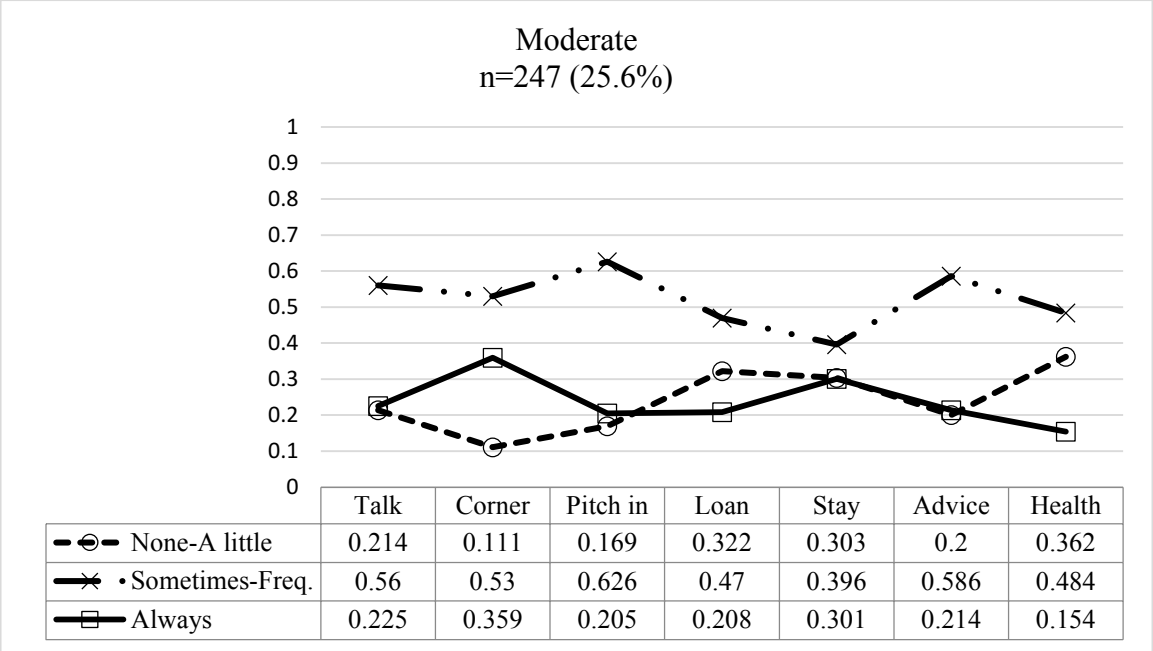
Table 3.5. Correlates of latent class membership for high and very high support compared to moderate support.

	Bivariate		Multivariable	
	High	Very high	High	Very high
Predictors	OR (95 CI)	OR (95 CI)	AOR (95 CI)	AOR (95 CI)
Participant				
Female	1.12 (0.79, 1.59)	1.3 (0.92, 1.85)		
Age, years	1.01 (1.00, 1.03)	1.02 (1.00, 1.04)*	0.99 (0.96, 1.01)	0.99 (0.96, 1.01)
Injected last 12 mos.	0.69 (0.49, 0.95)*	0.52 (0.37, 0.73)*	0.80 (0.52, 1.23)	0.85 (0.53, 1.36)
Street drugs (not IDU)	0.63 (0.46, 0.88)*	0.43 (0.31, 0.60)*	0.82 (0.54, 1.24)	0.58 (0.37, 0.92)*
Homelessness	0.55 (0.34, 0.89)*	0.31 (0.18, 0.53)*	0.86 (0.48, 1.51)	0.57 (0.28, 1.16)
HIV-positive	0.94 (0.65, 1.34)	1.36 (0.96, 1.94)		
Depressive symptoms	0.65 (0.46, 0.92)*	0.36 (0.25, 0.53)*	0.93 (0.61, 1.43)	0.65 (0.39, 1.06)
Network size=4-5	1.18 (0.85, 1.64)	0.63 (0.46, 0.88)*	0.97 (0.60, 1.56)	0.50 (0.29, 0.85)*
Network member				
Female[1]	1.17 (1.02, 1.35)*	1.06 (0.92, 1.22)	1.08 (0.89, 1.30)	1.13 (0.91, 1.40)
Age, mean years	1.02 (1.01, 1.04)*	1.03 (1.01, 1.05)*	1.03 (1.01, 1.05)*	1.03 (1.01, 1.05)*
Injected drugs ever [1]	0.93 (0.78, 1.11)	0.58 (0.46, 0.72)*	0.99 (0.79, 1.25)	0.75 (0.56, 1.00)*
Street drugs ever [1]	0.85 (0.75, 0.96)*	0.54 (0.47, 0.63)*	0.81 (0.69, 0.95)*	0.60 (0.49, 0.73)*
Talk to daily[1]	1.39 (1.23, 1.58)*	1.43 (1.26, 1.63)*	1.33 (1.14, 1.56)*	1.54 (1.30, 1.83)*
Do something enjoyable with	3.44 (2.45, 4.84)*	7.93 (5.36, 11.72)*	3.24 (2.20, 4.78)*	7.74 (4.87, 12.30)*
Argue with always [1]	0.92 (0.76, 1.12)	0.59 (0.46, 0.74)*	0.81 (0.64, 1.02)	0.59 (0.44, 0.78)*

OR=odds ratio; AOR=adjusted odds ratio; CI=confidence interval; IDU=injection drug use

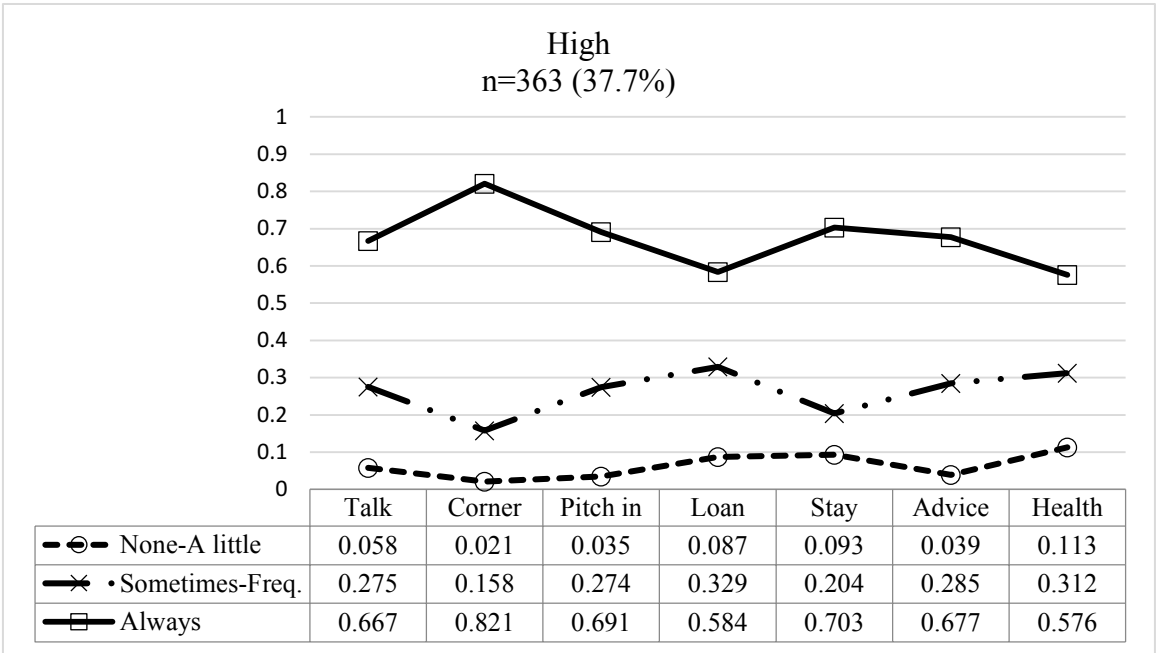
[1] Number of network members from 0 to 5

* Significant $p<0.05$



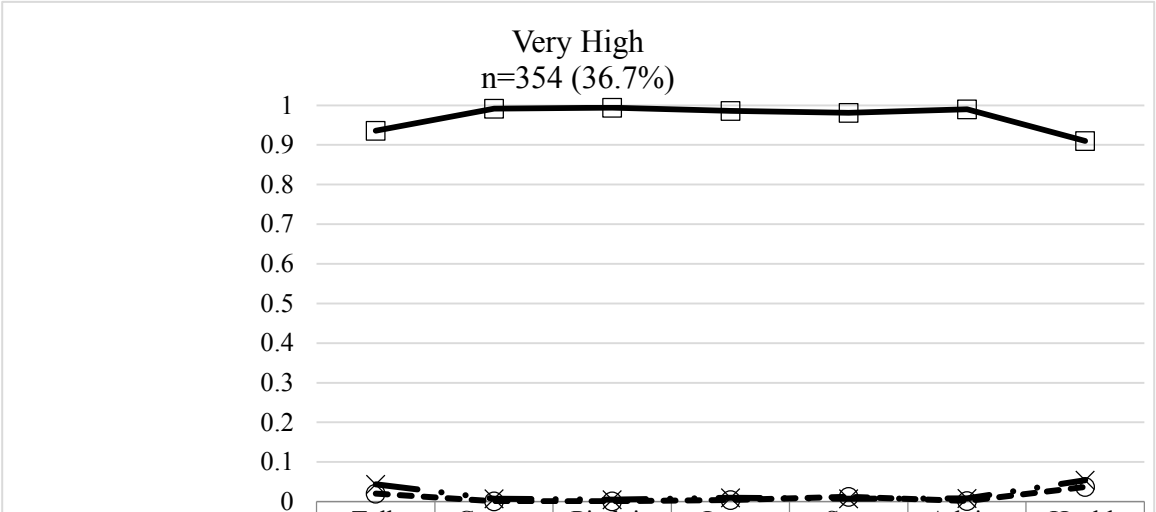
	Talk	Corner	Pitch in	Loan	Stay	Advice	Health
None-A little	0.214	0.111	0.169	0.322	0.303	0.2	0.362
•Sometimes-Freq.	0.56	0.53	0.626	0.47	0.396	0.586	0.484
Always	0.225	0.359	0.205	0.208	0.301	0.214	0.154

Figure 3.1. Moderate support class with social support indicator response probabilities.



	Talk	Corner	Pitch in	Loan	Stay	Advice	Health
None-A little	0.058	0.021	0.035	0.087	0.093	0.039	0.113
•Sometimes-Freq.	0.275	0.158	0.274	0.329	0.204	0.285	0.312
Always	0.667	0.821	0.691	0.584	0.703	0.677	0.576

Figure 3.2. High support class with social support indicator response probabilities.



	Talk	Corner	Pitch in	Loan	Stay	Advice	Health
None-A little	0.02	0.001	0.001	0.004	0.012	0.002	0.037
Sometimes-Freq.	0.044	0.007	0.005	0.01	0.007	0.008	0.054
Always	0.936	0.992	0.994	0.986	0.981	0.99	0.91

Figure 3.3. Very high support class with social support indicator response probabilities.

Supplemental Table S.3.1. Homophily of ego-alter characteristics.

Same ego-alter Characteristic	Total N=3388 N (%)	IDU>1 yr. N=2131 N (%)	IDU≤1 yr. N=1257 N (%)	p value
Sex	1604 (47.8)	1046 (49.5)	558 (44.8)	**0.008**
Race	3228 (95.4)	2046 (96.1)	1182 (94.1)	**0.006**
Age within 10 yrs.	1597 (47.2)	971 (45.6)	626 (49.8)	**0.018**
HIV status	2359 (72.8)	1416 (69.7)	943 (78.1)	**<0.001**
Inject drugs, ever	505 (16.3)	268 (13.7)	237 (20.9)	**<0.001**
Inject drugs, 6 mos.	2256 (73.2)	1923 (98.7)	333 (29.4)	**<0.001**
Street drugs, ever	1887 (62.7)	1398 (73.6)	489 (44.1)	**<0.001**

IDU=injection drug use

Supplemental Table S.3.2. Multiplexity of alter roles.

Number of different roles [1]	Total N=3388 N (%)	IDU>1 yr. N=2131 N (%)	IDU≤1 yr. N=1257 N (%)	p value
				<0.001
0	371 (11.0)	191 9.0)	180 (14.3)	
1	227 6.7)	121 5.7)	106 (8.4)	
2	212 6.3)	113 5.3)	99 (7.9)	
3	256 7.6)	162 7.6)	94 (7.5)	
4	288 8.5)	173 8.1)	115 (9.1)	
5	365 (10.8)	215 (10.1)	150 (11.9)	
6	505 (14.9)	362 (17.0)	143 (11.4)	
7	1164 (34.4)	794 (37.3)	370 (29.4)	

IDU=injection drug use

[1] Represented by the seven social support indicators

4. Frequency of emergency department visits among persons with a history of injection drug use with a focus on social network correlates

4.1. Abstract

Persons who inject drugs (PWID) have more frequent emergency department (ED) visits than the general population. Frequent ED visits can indicate inappropriate and inefficient use of healthcare resources. This study examines associations of ED visit frequency among a cohort of PWID with characteristics of their close social relationships including different types of social support from different types of social network members.

Information was obtained from a sample of AIDS Linked to the IntraVenous Experience study participants at their six-month study visit from April 1, 2016 through June 30, 2017. Andersen's behavioral model of healthcare use was used as a framework for the analysis. Multinomial logistic regression was used to determine odds ratios for the outcome of ED visit frequency (0, 1, ≥2 visits in the prior six months).

Of 970 participants who completed a social network survey, the prevalence of having one ED visit in the prior six months was 15.7%, having two or more was 10.6% with 73.7% having no ED visits. Lack of transportation was the most prevalent barrier, increasing with increasing ED visit frequency from 31.4% of those with no ED visit to 57.3% of those with two or more visits. In multivariable analysis, compared to no ED use, having one visit was significantly more common among participants with the predisposing characteristic of past year injection drug use (AOR: 1.53; 95% CI: 1.03, 2.28) and less common for those with the enabling factor of informational support (AOR:

0.64; 95% CI: 0.41, 1.00). Compared to no ED use, having two or more visits was significantly more common among participants who had the predisposing characteristics of past year injection drug use (AOR: 1.69; 95% CI: 1.07, 2.67) and homelessness in the past six months (AOR: 3.32; 95% CI: 1.81, 6.07); the need factor of three or more non-psychiatric/non-infectious comorbidities (AOR: 3.77; 95% CI: 2.25, 6.31) and the environmental factor of lacking transportation (AOR: 1.95; 95% CI: 1.22, 3.12). Two or more ED visits were significantly less common among participants with the enabling factor of having a partner (AOR: 0.56; 95% CI: 0.35, 0.90).

Findings indicate that social networks of PWID represent a resource that may enable more optimal use of healthcare services and may be a valuable place to intervene to strengthen support systems that can potentially prevent vulnerabilities that lead to poor health and barriers to care, particularly for informational support from social network members and with partners.

4.2. Background

Appropriate ED use has been operationalized as the congruence between the emergency care setting and the level of medical care needed in addition to the frequency of visits (1). High frequency ED use indicates disparities in use of primary care that can lead to health conditions that could have been prevented in the ambulatory care setting (2). These ambulatory care-sensitive conditions include complications from diabetes, chronic obstructive pulmonary disease and heart failure and are used to lower government reimbursement for healthcare services (3). Injection drug use has been

implicated in suboptimal healthcare use, e.g., lower engagement in outpatient care and greater use of the ED or hospitalization (4, 5). Persons who inject drugs (PWID) have been estimated to have three times greater ED visits than the general population (6). Among persons who use substances, factors associated with greater likelihood of ED visits include co-occurring psychiatric comorbidity (4, 7-9), more frequent injection (10) and HIV-positive status (4, 10), more primary care utilization (10, 11), unstable housing (12, 13) and having more female social network members (14). A lower likelihood of ED visits has been found for persons having a regular healthcare provider, being on methadone treatment (4) or reporting good to excellent health (14). Among HIV-positive PWID, those with higher quality of engagement with their healthcare provider had lower odds of using the ED as a usual source of care (15).

Andersen's behavioral model of healthcare use provides a framework to organize individual, social and health system level factors that influence health behaviors and outcomes (16). It has been used to examine ED use among groups impacted by infectious disease (17), mental illness (18) and PWID (15). It organizes predictors of healthcare use into predisposing factors that indicate a predisposition to use healthcare existing prior to illness; enabling factors that facilitate use of healthcare; actual and perceived health needs; as well as environmental factors that include facilitators and barriers to care at the clinic and community level. The use of Andersen's health behavior model to explain the association of social networks with ED use among PWID is limited.

Support from social network members is also known to affect healthcare utilization behaviors (19). One's social network is often characterized by the nature and composition of one's relationships (i.e., relationship type and quality, types of social

resources available from their network contacts, etc.) (20). These resources can be categorized as the provision of informational (advice or guidance), emotional (comfort or encouragement) and instrumental support (tangible help). Some studies have found that for patients visiting EDs that serve urban and poor populations, having more network members providing social support or consulting a family member or friend before visiting the ED (8) reduces the likelihood of having two or more ED visits per year (8, 21). Conversely, frequent visitors to the ED report lower levels of social support overall (22). Having network members that use drugs has been shown to increase the likelihood of suboptimal ED use, defined as visits without a subsequent hospital admission (23). However, the contribution of social network factors to ED use among PWID is not well-understood. For example, it is not known if ED use varies by both type of support and the source of support, i.e., which network member is being supportive in what way.

The present study aims to identify factors associated with high frequency ED use among PWID and evaluate the role of individual and social network characteristics in patterns of ED utilization within the framework of Andersen's behavioral model of healthcare use. Results can enhance our understanding about ED use among PWID and point to opportunities for interventions to reduce suboptimal healthcare utilization.

4.3. Methods

This study was an analysis of cross-sectional survey data from the AIDS Linked to the IntraVenous Experience (ALIVE) study. The ALIVE study is a longitudinal cohort which examines the epidemiology of injection drug use and associated health factors among adults 18 years of age or older with a history of injection drug use (24). ALIVE participants completed standardized questionnaires, Audio Computer-Assisted Self-

Interview (ACASI), in-person interviews and provided bio-specimens for behavioral, socioeconomic and clinical parameters at 6-month visits. As described previously, a supplemental 59-question social network survey module was developed and used to gather information from participants about the attributes of their social network members, the nature of their relationships and the support they are available to provide. Data in this study are from 970 ALIVE participants who completed the supplemental social support survey in the from April 1, 2016, to June 30, 2017.

4.3.1. Variables

The healthcare use outcome of interest was frequency of ED visits in the prior six months. Frequent users defined as having four or more ED visits per year accounted for only 4%-8% of ED patients, but 21%-28% of ED visits (25). Therefore, for the six-month study period we categorized ED visit frequency as none, one or two or more to distinguish participants with very high use (≥2/6 months) from those with single visit, which is not as clearly high use given the short period of time.

The primary exposure of interest, social support, was considered an enabling resource and was operationalized in three ways: 1) classes of social support intensity (moderate, high, very high) determined through multilevel latent class analysis using social support indicators from the level of ego-alter ties nested within participant social networks; 2) each of the seven social support indicators individually; and 3) the seven indicators aggregated by the constructs of informational, emotional and instrumental support. The Likert scale response categories for seven indicators of emotional, instrumental and informational social support were dichotomized to generate binary

variables indicating support was always or not always provided by the alter. We used this dichotomy because the proportion of 'always' responses was high, ranging from 62% to 76%, while none of the other four options rose above 16% across all seven social support indicators. Variables for social support were defined as having one or more network member available to always provide the given support.

The role of social support was further evaluated through stratifying each support construct by alter characteristics that may modify the association of social support with ED use: 1) partners; 2) female gender; and 3) injection drug use. Other social network enabling factors were network member demographics, quality and nature of relationship with participants, substance use behaviors and healthcare use. All alter characteristics were reported by the ego.

Variables were examined within the framework of Andersen's Behavioral Model. Need variables were self-reported health status, the number of comorbid health conditions other than infectious or behavioral health needs, HIV, hepatitis C and depressive symptoms. General health status was categorized as excellent to very good, good and fair to poor. Composite measures of comorbidities reduce the number of specific disease variables needed (26) and a large proportion of persons with ED visits have three or more comorbidities (27). Therefore, we created a binary variable was generated representing three or more comorbid chronic health conditions (diabetes mellitus, hypertension, heart disease, cardiovascular disease, stroke and renal disease). However, comorbidities of depressive symptoms, HIV and hepatitis C infection were examined separately given the strong associations with ED use shown for these conditions. Depressive symptoms were confirmed through administration of the Center

for Epidemiological Studies-Depression (CESD) with a cut off of 22 selected given that persons with history of opioid misuse score higher than the general population (28). HIV status was diagnosed through enzyme-linked immunosorbent assay and confirmed through Western blot. Chronic hepatitis C infection was defined as ever having had a positive anti-hepatitis C virus antibody test and detectable hepatitis C viral RNA measured through a study visit. Predisposing factors were general demographics as well as injection and non-injection drug use behaviors and treatment. Additional enabling factors beyond the social network factors described above were income, having a usual source of care and health insurance. Environmental factors were clinic wait times, transportation barriers and clarity of provider communication.

4.3.2. Statistical analysis

Descriptive statistics were used to compare participant demographics, substance use and social networks roles and characteristics using T tests for continuous and chi-square tests for categorical measures. A prior study found that over 96% of persons living with HIV in this cohort were engaged in outpatient care in the previous six months. As outpatient care is highly correlated with ED use, we first compared participant characteristics by HIV-status to describe differences that may play a role in ED use. The tests of significance for comparisons of social network characteristics at the level of the participant-alter dyad were adjusted for correlations within individual networks by clustering on egos. Because of the potential for a high degree of correlation among variables within each domain of Andersen's behavioral model, we tested tetrachoric correlations for substance use, comorbidity, environmental and social support binary

variables. Selection of highly correlated variables for modeling was based on the understanding their relationship, relative importance and role in healthcare behaviors.

To explore the role of sources of support within ego networks on ED visit frequency, we used contingency tables comparing informational, emotional and instrumental support available within networks from combinations of alters that were female or male, partners or non-partners and those with a history of injection drug use or no injection drug use history. For example, ED visit frequency was compared across ego networks having: 1) a partner as the only source of support; 2) only from a non-partner; 3) from both a partner and a non-partner; and 4) from neither a partner or non-partner.

Multinomial logistic regression was used to determine associations with levels of ED visit frequency. Variables with significant associations ($p \leq 0.05$) were included in the final multivariable model. Participant age was included regardless of bivariate significance in the unadjusted analyses because of the well-established relationship of age with health status. We used contingency tables to further explore predisposing characteristics significantly associated with ED visit frequency by key enabling, need and environmental factors. Analyses were performed using Stata version 15.0 (StataCorp, College Station, TX).

4.4. Results

Table 4.1. stratifies characteristics of participants by their HIV serostatus. For predisposing factors, a greater proportion of participants living with HIV compared to those HIV-negative were black (91.8% vs. 83.4%; $p<0.001$) and were less likely to have

experienced homelessness in the prior six months (5.8% vs. 12.4%; p=0.002). They were less likely to use injection drugs (31.1% vs. 41.9%; p=0.002) and when they did report injection drug use they were less likely to report daily injection (10.6% vs. 14.5%; p=0.035). The only statistically significant difference among enabling resources was having a usual source of care, which was high for both but greater for persons living with HIV (97.6% vs. 86.1%; p<0.001). For need factors, persons living with HIV were significantly more likely to be co-infected with hepatitis C (62.3% vs. 53.1%; p=0.008). For environmental factors, persons living with HIV were more likely to report clear communication from providers (67.9% vs. 45.1%; p<0.001) and less likely to report that clinic wait times were too long (7.1% vs. 18.2%; p<0.001). In terms of health care use overall, the median number of ED visits was zero (range=0-7) with 715 (73.7%) having no ED visits, 152 (15.7%) having one and 103 (10.6%) having two or more ED visits in the prior six months, with no significant differences by HIV status.

The proportion reporting barriers to care increased with increasing number of ED visits in the past six months (Table 4.2.). The most prevalent barriers were not having reliable transportation, (36.2%), followed by inability to afford care (21.1%), unstable housing (15.2%) and waiting too long at the clinic (14.8%) or too long to schedule appointments (14.6%).

The proportion reporting three or more comorbidities increased as the number of ED visits increased (Supplemental table S.4.1.). The most common was hypertension (52.2%) followed by psychiatric comorbidities of depression (45.9%), anxiety/pain (25.7%) and bipolar (24.0%). The prevalence of lung disease (p<0.001), diabetes

p=0.011), heart problems (p<0.001), stroke (p<0.001) and renal disease (p=0.002) increased with increasing ED visit frequency as did all psychiatric conditions.

4.4.1. Social network characteristics

Most social network characteristics were similar across categories of ED visit frequency (Table 4.3.). Participants reported knowing their network members 32 years on average and daily interaction was common (87.6%). Ninety-two percent reported having at least one female alter and 38.7% had an alter with a history of injection drug use. Compared to those who reported no ED use, those who reported two or more visits to the ED were significantly less likely to have a partner (32.0% vs. 44.9%; p=0.013). Persons with no ED visits in the past six months were least likely to have an alter with at least one health condition (p=0.038).

Most reported having at least one alter always available for emotional (92.1%) and instrumental (92.3%) support and there were no significant differences in the overall provision of support by frequency of ED use (Table 4.4.). However, compared to those with no ED visits, those with two or more were significantly less likely to report they had a partner who provided instrumental support (32% vs. 39.9%; p=0.029). There were no differences in ED use by persons who had instrumental or emotional support provided by female alters or those who use injection drugs.

Most reported having at least one alter who was always available for informational support (84.6%). Compared to those who reported one ED visit, those with no or two or more visits were significantly more likely to report informational support

from any alter (86.0% and 86.3%, respectively, vs. 77.0%; p=0.017) or specifically from a partner (36.4% and 28.2%, respectively, vs. 24.3%; p=0.008). The most common source of all types of support was from female alters and the lowest from alters with a history of injection drug use. The pattern was similar for the seven individual social support indicators (Supplemental table S.4.2.).

Comparing the composition of ego networks by combinations of a given alter trait (e.g. networks where a type of support is reported only from a partner, only from non-partners, from both partners and non-partners or from neither partners or non-partners) revealed significant differences by ED use frequency for informational support provided by partners and female alters, but not emotional or instrumental support from any alter type (Supplemental Table S.4.3.). Participants with networks having a partner as the only source of informational support were more likely to have no ED visits (5.6%) compared to one (5.3%) and two or more visits (2.0%) and if the only source of informational support was from a non-partner they were less likely to have no ED visits (49.6%) compared to one (52.6%) and two or more visits (57.8). Participants networks having female alters as the only source of informational support were more likely to have one ED visit (30.3%) compared to no (26.3%) and two or more visits (20.4%) and if the only source of informational support in their network was from a male alter they were more likely to have no ED visits (9.6%) compared to one (7.9%) and two or more visits (6.8%).

4.4.2. Associations with ED visit frequency

Table 4.5. shows the results of multinomial logistic regression of the associations with ED visit frequency. Because there were no differences by HIV status for the key

domains of healthcare use and access and need that were hypothesized to differentiate HIV-positive from HIV-negative, it was evaluated as a potential confounder of the relationship between social support and ED visit frequency rather than through separate models stratified by HIV status. In the adjusted model compared to no ED use, having one visit was significantly more common among participants who had injected drugs in the past year (AOR: 1.53; 95% CI: 1.03, 2.28) and less common for those always informational support available from an alter (AOR: 0.64; 95% CI: 0.41, 1.00). Because the latent classes of intensity of social support were highly correlated with each of the three types of support, we chose to keep the specific construct for informational support in the adjusted model as it would be more explanatory of the role of a specific support type. Compared to no ED use, having two or more visits was significantly more common among participants who had injected drugs in the past year (AOR: 1.69; 95% CI: 1.07, 2.67), been homeless in the past six months (AOR: 3.32; 95% CI: 1.81, 6.07), had three or more non-psychiatric/non-infectious comorbidities (AOR: 3.77; 95% CI: 2.25, 6.31) and lacked transportation (AOR: 1.95; 95% CI: 1.22, 3.12)) and significantly less common among participants having a partner (AOR: 056; 95% CI: 0.35, 0.90).

Comparing predisposing characteristics significant in the adjusted model by key enabling, need and environmental factors, we found that participants that were female were more likely to have a usual source of care, three or more comorbidities and report having to wait too long at the clinic (Supplemental Table S.5.4). Participants who injected drugs in the prior year were more likely to be homeless, have a partner, lack transportation and report long clinic wait times and less likely to have a usual source of care, have informational support or three or more comorbidities. Participants that

reported homelessness in the prior six months were more likely to report injection drug use, lack transportation and identify long clinic wait times as a barrier to care, and less likely to have a usual source of care, have informational and three or more comorbidities.

4.5. Discussion

In this sample of PWID, most were living below the national poverty level and had substantial barriers to care and chronic medical and psychiatric comorbidities, but also had high levels of enabling resources including health insurance, having a usual source of care and social support. About 27% of our study sample experienced at least one ED visit in the prior six months, lower than the 33% rate previously found among PWID in Baltimore (5) and lower than the national rate of about 35% annually for adults with Medicaid (29). About half of the participants had been to their primary care provider two or more times in the prior six months, which is consistent with national level data indicating that almost half of persons with ED visits attempted to contact an outpatient provider first (30).

Social network attributes that were associated with less frequent ED use in our sample were having a partner and the availability of informational support. Fear of finding out about a new illness diagnosis can be a barrier to accessing care (31), while greater understanding of illness has been associated with reduced ED visit frequency (32). Additionally, persons who are actively using opioids and in pain may have a fear of withdrawal symptoms if their pain is not adequately treated by healthcare providers (33), which may factor into their healthcare seeking decisions.

Persons who use substances also experience barriers to care related to stigma and discrimination, difficulty communicating with medical providers and lack of knowledge about how and where to access care and consequently turn to their substance using peers for information (34). It may be that PWID in our study had gained enhanced understanding of their illness, help deciding if the acuity of an illness warranted a visit to the ED or support with medication adherence for their chronic health conditions by mobilizing the social resources within their networks for informational support, particularly from partners. These peers may provide an essential form of informational support that counterbalances the difficulty in communication they experience when interacting with healthcare providers and decision making about seeking care in general.

Given perceptions around substance use and mental illness, service providers must be trained to recognize stigma and discrimination as a barrier to engaging in preventative outpatient care and engage in non-judging communication with persons with injection drug use that promote trusting relationships. Providers can screen patients for sources and types of social support to identify opportunities for encouraging interaction with supportive network members, such as having partners attend clinic visits or referring patients to social support groups if they lack support resources.

We found that having a partner was protective of experiencing two or more ED visit and that persons receiving instrumental and informational support from their partners were less likely to have any ED visits. It has been shown that married couples experience better health than unmarried persons (35), and persons with a partner in our study, regardless of marital status and including partners, did have somewhat lower prevalence of multi-comorbidity. We found that a lower proportion of persons with a

partner reported having a transportation barrier than those without a partner, which may indicate that a partner can assist in meeting transportation needs. Given the positive influence of one partner's adoption of health promoting behaviors on the other (36), partners represent an opportunity for influencing norms of engaging in outpatient care that may in turn avoid potentially preventable ED visits. Our findings indicate that intervening with partners and alters with a history of injection drug use may be one means for promoting diffusion of health behaviors that promote efficient use of healthcare resources.

HIV seropositivity was not associated with ED visit frequency, despite a greater prevalence of hospitalization and hepatitis C co-infection among those living with HIV compared with HIV-negative participants. This may be related to the high level of engagement in outpatient care shown by the large proportion having a usual source of care, recent clinic visits, perceptions of clear communication with providers as well as lower levels of injection drug use. While participants living with HIV may have greater need for healthcare services, they have access to comprehensive essential services and community interventions supported through federally funded Ryan White HIV/AIDS Program HIV clinics (37) that are not available to HIV-negative PWID.

Not having reliable transportation was an important barrier to accessing care and was found to be associated with greater ED visit frequency in the adjusted model. Nationally, over 50% of those having an ED visit in the past year reported not having transportation, and those without transportation had an 88% greater likelihood of having an ED visit (38). Despite high levels of engagement in outpatient care in our study, having a usual source of care may be necessary but may not sufficient to reduce ED visit

frequency when significant structural barriers to care exist. These barriers could potentially be addressed through locating clinics closer to populations in need and without effective means of public or personal transportation or providing clinic-based patient shuttle services and travel expense reimbursement. Presumably, having others in the social network to drive one to the clinic would address this barrier as well, although we did not find instrumental support in general to be associated with ED visit frequency.

Potentially preventable ED visits and hospitalizations are defined in part by the presence of ambulatory care-sensitive conditions for which primary or other preventative care can reduce the need for more intensive services (39). Greater use of the ED has been related to a number ambulatory care-sensitive conditions, including heart disorders, diabetes, respiratory problems (26). A previous study of emergency medical service use in Baltimore found that chronic conditions, including diabetes, HIV and asthma were related to more frequent ED use (40). Our findings are similar, with three or more comorbidities associated with ED visits and differences found for prevalence of chronic lung disease, diabetes and heart disease. These are all health conditions that are most effectively managed by primary care and specialty providers in the outpatient setting, avoiding the need for emergency services. Additionally, linkage to harm reduction resources such as needle exchange programs have been shown to reduce ED visits (41), which may in part be a consequence of reduced skin infections related to injection drug use, one of the most common reasons for ED use among PWID (10, 42).

As with previous studies (43, 44), we found high ED use to be associated with homelessness. While persons experiencing homelessness reported fewer comorbidities, they had a higher prevalence of injection drug use and transportation barriers and a lower

prevalence of available informational support or having a usual source of care, all of which were independently associated with ED use. Chronic illness along with substance use and homelessness represent a syndemic of interacting health problems (45). The prevalence of multi-comorbidity including mental illness and homelessness among this group of PWID confirms the need for comprehensive approaches to care and multidisciplinary teams that integrate medical with psychosocial and case management services.

4.6. Limitations

Limitations of the study include the lack of the diagnosis for ED visits to evaluate if use was preventable and whether an ED visit directly led to hospitalization. Consequently, while many health conditions can be treated in the primary care setting, others do require emergency services and we were not able to determine the appropriateness of ED use. However, we were able to look separately at persons who had more than 1 ED visit as a marker of potentially inappropriate use. We did not look at the primary mode of transportation or proximity of residence to healthcare services, which would be important to asses in the future given the level of perceived transportation barriers. With 96% of persons living with HIV in this cohort having had an outpatient care visit in prior six months, this cohort may not be representative of other populations with much lower levels engagement in care. Additionally, this analysis used cross-sectional data from a single study visit and does not allow examination of the lag that may exist between an individual and social network exposures and ED use, limiting the ability to draw causal inferences from these results.

4.7. Conclusion

Understanding factors associated with more frequent use of emergency services and implementing programs to reduce inappropriate use continues to be a priority of health systems and governments seeking to encourage preventive care, improve health outcomes and reduce health care spending. This study shows that certain modifiable social network and individual factors are associated with higher emergency care utilization. Social networks may thus be a valuable place to intervene and connect people with more effective and appropriate health care services, as well as to strengthen support systems that can prevent vulnerabilities that lead to poor health and barriers to care. Still, more research is needed to understand the process by which different types support from different types of network members may play a positive role in health and health-care seeking behaviors. Such research can inform the design of interventions to encourage social ties and peer support to educate and encourage more use of preventive care services.

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Table 4.1. Participant characteristics by HIV status.

Characteristic	Total n=970 N (%)	HIV-negative n=676 N (%)	HIV-positive n=294 N (%)	p-value
Predisposing				
Age, median (IQR)	56 (50-60)	55 (49-60)	56 (51-60)	0.099
Female	315 (32.5)	216 (32.0)	99 (33.7)	0.6
Black, non-Hispanic	834 (86.0)	564 (83.4)	270 (91.8)	**<0.001**
Homelessness [1]	101 (10.4)	84 (12.4)	17 (5.8)	0.002
Injection drug use, any [2]	374 (38.6)	283 (41.9)	91 (31.1)	**0.002**
Inject heroin alone [1]	176 (18.1)	141 (20.9)	35 (11.9)	**<0.001**
Inject cocaine alone [1]	100 (10.3)	75 (11.1)	25 (8.5)	0.22
Inject speedball [1]	139 (14.3)	96 (14.2)	43 (14.6)	0.86
Frequency of injection [1]				**0.035**
None	681 (70.4)	458 (67.9)	223 (76.1)	
<Daily	158 (16.3)	119 (17.6)	39 (13.3)	
Daily	129 (13.3)	98 (14.5)	31 (10.6)	
Crack cocaine [1]	243 (25.1)	167 (24.7)	76 (25.9)	0.7
Drug misuse, non-injection [1]	382 (39.4)	271 (40.1)	111 (37.8)	0.49
Opioid replacement therapy [1]	478 (49.3)	343 (50.7)	135 (45.9)	0.17
Enabling				
Income <5,000 [1]	626 (65.1)	430 (64.4)	196 (66.9)	0.45
Health insurance [1]	945 (97.6)	655 (97.2)	290 (98.6)	0.17
Have usual source of care	868 (89.6)	581 (86.1)	287 (97.6)	**<0.001**
Need				
≥3 comorbidities (not HIV) [3]	178 (18.4)	123 (18.2)	55 (18.7)	0.85
Hepatitis C infection [4]	535 (55.9)	353 (53.1)	182 (62.3)	**0.008**
CESD>22 [1,5]	245 (25.3)	178 (26.3)	67 (22.8)	0.24
Perceived health status				0.51
Excellent-very good	328 (33.8)	222 (32.8)	106 (36.1)	
Good	327 (33.7)	235 (34.8)	92 (31.3)	
Fair-poor	315 (32.5)	219 (32.4)	96 (32.7)	
Environment				
Doctors explain things clearly	502 (52.0)	303 (45.1)	199 (67.9)	**<0.001**
No reliable transportation	351 (36.2)	246 (36.4)	105 (35.7)	0.83
Wait too long at clinic	144 (14.8)	123 (18.2)	21 (7.1)	**<0.001**

Table 4.1. continued.

Characteristic	Total n=970 N (%)	HIV-negative n=676 N (%)	HIV-positive n=294 N (%)	p-value
Healthcare use				
≥1 hospital admission [1]	140 (14.4)	82 (12.1)	58 (19.7)	**0.002**
≥1 outpatient visit [1]	764 (78.8)	499 (73.8)	265 (90.4)	**<0.001**
Emergency department visit [1]				0.18
None	715 (73.7)	509 (75.3)	206 (70.1)	
1	152 (15.7)	97 (14.3)	55 (18.7)	
≥2	103 (10.6)	70 (10.4)	33 (11.2)	

[1] Over prior 6 months
[2] Over prior 12 months
[3] Diabetes mellitus, hypertension, heart disease, stroke, renal disease, respiratory disease, seizure disorder, dyslipidemia
[4] Detectable Hepatitis C RNA
[5] Center for Epidemiological Studies-Depression score greater than 22

Table 4.2. Barriers to healthcare by frequency of ED visits over the prior six months.

Barrier to care [1,2]	Total n=970 N (%)	No ED visit n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
No reliable transportation	351 (36.2)	224 (31.4)	68 (44.7)	59 (57.3)	**<0.001**
Can't afford care	204 (21.1)	132 (18.6)	43 (28.3)	29 (28.2)	**0.005**
Unstable housing	147 (15.2)	89 (12.4)	34 (22.4)	24 (23.3)	**<0.001**
Wait too long at clinic	144 (14.8)	90 (12.6)	27 (17.8)	27 (26.2)	**<0.001**
Wait too long for appointments	141 (14.6)	89 (12.4)	30 (19.9)	22 (21.4)	**0.007**
Inconvenient appointments	120 (12.4)	72 (10.1)	24 (15.8)	24 (23.3)	**<0.001**
Don't want to disclose drug use	93 (9.6)	56 (7.9)	24 (15.8)	13 (12.6)	**0.006**
Active drug use makes it hard	90 (9.3)	54 (7.6)	17 (11.2)	19 (18.4)	**0.001**
Don't trust medical system	80 (8.2)	51 (7.1)	16 (10.5)	13 (12.6)	0.090
Don't like doctors	74 (7.6)	45 (6.3)	19 (12.5)	10 (9.7)	**0.023**
Provider does not care	73 (7.5)	42 (5.9)	17 (11.2)	14 (13.6)	**0.004**
Don't understand instructions	45 (4.6)	26 (3.6)	11 (7.2)	8 (7.8)	**0.045**

ED=emergency department

[1] Over the prior six months

[2] Not a problem vs. somewhat-major problem

Table 4.3. Social network characteristics by frequency of ED visits in the prior six months.

Characteristic	Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Network size, median (IQR)	3.5 (1.4)	3.5 (1.4)	3.5 (1.4)	3.6 (1.3)	0.79
Years known, mean (SD)	32 (14)	33 (14)	32 (13)	31 (12)	0.50
Age, median (IQR)	50 (42-57)	51 (42-57)	49 (41-55)	48(40-56)	0.079
One or more network members					
Female	891 (92.7)	653 (92.4)	143 (94.7)	95 (92.2)	0.59
Ever used injection drugs	351 (38.7)	267 (40.2)	51 (35.7)	33 (33.0)	0.28
Ever used street drugs, not IDU	521 (57.6)	379 (57.1)	87 (61.7)	55 (55.6)	0.54
Substance use self-help group	149 (18.0)	108 (17.8)	26 (19.3)	15 (17.2)	0.91
HIV-positive	122 (12.8)	89 (12.7)	22 (14.6)	11 (10.8)	0.67
Hepatitis C-positive	210 (22.4)	150 (21.7)	35 (24.0)	25 (25.0)	0.67
Partner/spouse	409 (42.2)	321 (44.9)	55 (36.2)	33 (32.0)	**0.013**
Relative	848 (87.4)	628 (87.8)	128 (84.2)	92 (89.3)	0.39
Talk with daily	850 (87.6)	634 (88.7)	128 (84.2)	88 (85.4)	0.25
Frequently-always argue	283 (29.2)	209 (29.3)	44 (28.9)	30 (29.1)	1.00
≥1 health condition	629 (66.8)	450 (64.5)	109 (74.1)	70 (72.2)	**0.038**
Regularly goes to outpatient clinic [1]	607 (97.1)	434 (96.9)	105 (97.2)	68 (98.6)	0.74

ED=emergency department

[1] If alter has a chronic health condition

Table 4.4. Availability of at least one source of three types of support by frequency of ED visits over the prior six months.

Social support	Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Emotional support [1]					
Any alter	892 (92.1)	660 (92.3)	137 (90.7)	95 (92.2)	0.81
Partner	346 (35.7)	269 (37.6)	45 (29.6)	32 (31.1)	0.10
Female	795 (82.5)	586 (82.7)	124 (81.6)	85 (82.5)	0.95
Ever used injection drugs	279 (30.1)	215 (31.7)	37 (25.3)	27 (26.7)	0.23
Instrumental support [1]					
Any alter	895 (92.3)	665 (93.0)	135 (88.8)	95 (92.2)	0.21
Partner	363 (37.4)	285 (39.9)	45 (29.6)	33 (32.0)	**0.029**
Female	802 (83.2)	593 (83.5)	121 (80.1)	88 (85.4)	0.49
Ever used injection drugs	279 (30.2)	213 (31.5)	39 (26.4)	27 (26.7)	0.34
Informational support [1]					
Any alter	820 (84.6)	615 (86.0)	117 (77.0)	88 (86.3)	**0.017**
Partner	326 (33.6)	260 (36.4)	37 (24.3)	29 (28.2)	**0.008**
Female	727 (75.3)	541 (76.2)	105 (69.1)	81 (78.6)	0.13
Ever used injection drugs	262 (28.1)	202 (29.6)	33 (22.4)	27 (26.5)	0.20

ED=emergency department

[1] ≥1 network member always provides support for at least one indicator by support construct

Table 4.5. Associations with one and two or more ED visits compared to no ED visits over the prior six months.

	Bivariate		Multivariable	
Factor	1 vs. no ED visits OR (CI)	≥ 2 vs. no ED visits OR (CI)	1 vs. no ED visits AOR (CI)	≥ 2 vs. no ED visits AOR (CI)
Predisposing				
Age, years	1.00 (0.98, 1.02)	0.99 (0.97, 1.01)	1.00 (0.98, 1.03)	1.00 (0.97, 1.02)
Female	1.08 (0.74, 1.58)	1.99 (1.31, 3.02)*	1.11 (0.75, 1.65)	1.69 (1.07, 2.67)*
Income < $5, 000 [1]	1.20 (0.82, 1.75)	1.03 (0.67, 1.58)		
Homelessness [1]	1.78 (1.04, 3.07)*	3.77 (2.23, 6.39)*	1.52 (0.85, 2.73)	3.32 (1.81, 6.07)*
Injection drug use [2]	1.60 (1.12, 2.28)*	1.96 (1.29, 2.97)*	1.53 (1.03, 2.28)*	1.65 (1.00, 2.70)*
Enabling				
Network size>3	0.94 (0.66, 1.33)	1.12 (0.74, 1.69)		
Alter age, mean years	0.99 (0.97, 1.00)	0.98 (0.96, 1.00)		
Partner/spouse [3]	0.70 (0.48, 1.00)*	0.58 (0.37, 0.90)*	0.73 (0.50, 1.06)	0.56 (0.35, 0.90)*
Female alters, number	1.01 (0.87, 1.18)	0.97 (0.81, 1.16)		
Alter ever used injection drugs [3]	0.82 (0.57,1.20)	0.73 (0.47,1.14)		
Social support constructs [1, 4]				
Emotional	0.82 (0.44, 1.51)	0.99 (0.46, 2.14)		
Instrumental	0.60 (0.33, 1.07)	0.89 (0.41, 1.94)		
Informational	0.54 (0.35, 0.84)*	1.02 (0.56, 1.87)	0.64 (0.41, 1.00)*	1.50 (0.79, 2.87)
All constructs	1.11 (0.55, 2.24)	1.27 (0.53, 3.03)		
Intensity of support				
Moderate	1	1		
High	0.77 (0.50, 1.18)	0.85 (0.50, 1.45)		
Very high	0.58 (0.37, 0.92)*	0.94 (0.56, 1.59)		

Table 4.5. continued.

Factor	Bivariate 1 vs. no ED visits OR (CI)	Bivariate ≥ 2 vs. no ED visits OR (CI)	Multivariable 1 vs. no ED visits AOR (CI)	Multivariable ≥ 2 vs. no ED visits AOR (CI)
Need				
HIV-positive	1.40 (0.97, 2.02)	1.16 (0.75, 1.82)		
Hepatitis C infection	1.12 (0.79, 1.60)	1.28 (0.84, 1.95)		
≥3 comorbidities (not including HIV) [5]	1.58 (1.02, 2.44)*	3.32 (2.12, 5.21)*	1.52 (0.96, 2.43)	3.77 (2.25, 6.31)*
Depressive symptoms [6]	1.25 (0.84, 1.86)	2.24 (1.45, 3.45)*	0.85 (0.55, 1.33)	1.37 (0.83, 2.26)
Perceived general health status				
Excellent-very good	1	1	1	1
Good	1.08 (0.69, 1.70)	1.23 (0.71, 2.13)	0.93 (0.59, 1.49)	0.85 (0.47, 1.53)
Fair-poor	1.88 (1.23, 2.88)*	2.24 (1.34, 3.74)*	1.51 (0.96, 2.39)	1.30 (0.73, 2.30)
Environment				
Lack transportation	1.77 (1.24, 2.53)*	2.93 (1.92, 4.47)*	1.41 (0.95, 2.07)	1.95 (1.22, 3.12)*
Wait too long at clinic	1.50 (0.94, 2.40)	2.47 (1.51, 4.03)*	1.09 (0.65, 1.82)	1.22 (0.69, 2.16)
≥1 outpatient visit	1.44 (0.91, 2.28)	1.73 (0.97, 3.07)		

ED=emergency department; OR=odds ratio; AOR=adjusted odds ratio; CI=confidence interval

* p≤ 0.05; OR=odds ratio

[1] Over the prior six months

[2] Over prior 12 months

[3] ≥1 network members with given characteristic

[4] Network member always provides at least one indicator for each construct

[5] Diabetes mellitus, hypertension, heart disease, stroke, renal disease, respiratory disease, seizure disorder, dyslipidemia

[6] Center for Epidemiological Studies-Depression score greater than 22

Table S.4.1. Self-reported ever having had chronic comorbidities by frequency of ED visits over the prior six months.

Comorbidity	Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Number comorbidities [1]					**<0.001**
0	311 (32.1)	248 (34.7)	42 (27.6)	21 (20.4)	
1	286 (29.5)	225 (31.5)	43 (28.3)	18 (17.5)	
2	195 (20.1)	135 (18.9)	34 (22.4)	26 (25.2)	
≥3	178 (18.4)	107 (15.0)	33 (21.7)	38 (36.9)	
Hypertension	506 (52.2)	359 (50.2)	83 (54.6)	64 (62.1)	0.062
Chronic lung disease [2]	209 (21.5)	128 (17.9)	38 (25.0)	43 (41.7)	**<0.001**
High cholesterol	200 (20.6)	139 (19.4)	35 (23.0)	26 (25.2)	0.29
Diabetes (high blood sugar)	155 (16.0)	101 (14.1)	28 (18.4)	26 (25.2)	**0.011**
Heart problem [3]	82 (8.5)	50 (7.0)	13 (8.6)	19 (18.4)	**<0.001**
Seizures [4]	56 (5.8)	39 (5.5)	6 (3.9)	11 (10.7)	0.060
Stroke	56 (5.8)	33 (4.6)	9 (5.9)	14 (13.6)	**0.001**
Renal disease or failure	42 (4.3)	23 (3.2)	8 (5.3)	11 (10.7)	**0.002**
<u>Psychiatric comorbidities</u>					
Depression	445 (45.9)	298 (41.7)	87 (57.2)	60 (58.3)	**<0.001**
Anxiety/panic	249 (25.7)	167 (23.4)	44 (28.9)	38 (36.9)	**0.008**
Bipolar (manic depression)	233 (24.0)	148 (20.7)	50 (32.9)	35 (34.0)	**<0.001**
Schizophrenia [5]	45 (4.6)	29 (4.1)	6 (3.9)	10 (9.7)	**0.035**

ED=emergency department

[1] Non-psychiatric and non-communicable

[2] Asthma, Chronic obstructive pulmonary disease, emphysema, not pneumonia

[3] Angina, heart attack, congestive heart failure

[4] Epilepsy, convulsions

[5] Schizophrenia / Schizoaffective disorder

Table S.4.2. Social support available from types of alters by frequency of ED visits over the prior six months.

Social support	Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Intensity of support					0.21
Moderate	247 (25.6)	172 (24.2)	48 (32.0)	27 (26.2)	
High	363 (37.7)	269 (37.8)	58 (38.7)	36 (35.0)	
Very High	354 (36.7)	270 (38.0)	44 (29.3)	40 (38.8)	
Emotional support [1]					
Could talk to if down					
Any alter	780 (80.5)	574 (80.3)	124 (82.1)	82 (79.6)	0.85
Partner	304 (31.3)	239 (33.4)	36 (23.7)	29 (28.2)	**0.048**
Female	685 (71.1)	502 (70.8)	110 (72.4)	73 (70.9)	0.93
Ever used injection drugs	234 (25.0)	180 (26.2)	33 (22.0)	21 (20.8)	0.33
Would say is in your corner					
Any alter	859 (89.0)	641 (90.3)	127 (83.6)	91 (88.3)	0.054
Partner	324 (33.4)	254 (35.5)	41 (27.0)	29 (28.2)	0.062
Female	759 (78.9)	563 (79.6)	115 (75.7)	81 (78.6)	0.55
Ever used injection drugs	258 (27.7)	200 (29.3)	33 (22.4)	25 (24.8)	0.19
Instrumental support [1]					
Would pitch in to help do things					
Any alter	800 (82.7)	600 (84.0)	117 (77.0)	83 (82.2)	0.11
Partner	306 (31.5)	243 (34.0)	35 (23.0)	28 (27.2)	**0.018**
Female	705 (73.2)	527 (74.2)	103 (68.2)	75 (73.5)	0.32
Ever used injection drugs	226 (24.1)	176 (25.7)	32 (21.5)	18 (17.6)	0.15

Table S.4.2 continued.

Social support	Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Would loan over $25					
Any alter	767 (79.2)	577 (80.8)	111 (73.5)	79 (76.7)	0.11
Partner	308 (31.8)	246 (34.4)	37 (24.3)	25 (24.3)	**0.012**
Female	660 (68.5)	492 (69.3)	99 (66.0)	69 (67.0)	0.69
Ever used injection drugs	211 (22.4)	164 (23.9)	28 (18.4)	19 (18.6)	0.22
Would let stay if needed a place					
Any alter	827 (85.3)	617 (86.3)	127 (83.6)	83 (80.6)	0.25
Partner	334 (34.4)	263 (36.8)	42 (27.6)	29 (28.2)	**0.036**
Female	732 (75.9)	544 (76.6)	113 (74.3)	75 (72.8)	0.63
Ever used injection drugs	238 (25.4)	180 (26.2)	33 (22.3)	25 (24.8)	0.61
Informational support [1]					
Someone to give situation advice					
Any alter	785 (80.9)	592 (82.8)	112 (73.7)	81 (78.6)	**0.028**
Partner	304 (31.3)	245 (34.3)	34 (22.4)	25 (24.3)	**0.004**
Female	686 (71.1)	512 (72.1)	100 (65.8)	74 (71.8)	0.29
Ever used injection drugs	243 (26.0)	189 (27.6)	33 (22.3)	21 (20.6)	0.17
Does help understand health					
Any alter	702 (72.9)	521 (73.3)	106 (70.7)	75 (73.5)	0.80
Partner	278 (28.7)	217 (30.3)	34 (22.4)	27 (26.2)	0.12
Female	621 (64.4)	457 (64.3)	95 (62.9)	69 (67.0)	0.80
Ever used injection drugs	206 (21.8)	155 (22.4)	29 (19.2)	22 (21.6)	0.68

ED=emergency department

[1] Network member always provides support for indicator

Table S.4.3. Social support available from at least one type of alter by frequency of ED visits over the prior six months.

Social support construct [1]		Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Emotional						
Partner	Non-partner					0.44
Yes	Yes	305 (31.5)	237 (33.1)	38 (25.2)	30 (29.1)	
Yes	No	41 (4.2)	32 (4.5)	7 (4.6)	2 (1.9)	
No	Yes	546 (56.3)	391 (54.7)	92 (60.9)	63 (61.2)	
No	No	77 (7.9)	55 (7.7)	14 (9.3)	8 (7.8)	
Female	Male					0.75
Yes	Yes	549 (57.0)	407 (57.4)	79 (52.0)	63 (61.2)	
Yes	No	246 (25.5)	179 (25.2)	45 (29.6)	22 (21.4)	
No	Yes	90 (9.3)	67 (9.4)	13 (8.6)	10 (9.7)	
No	No	79 (8.2)	56 (7.9)	15 (9.9)	8 (7.8)	
Ever inject	Never inject					0.44
Yes	Yes	224 (24.2)	177 (26.1)	27 (18.5)	20 (19.8)	
Yes	No	55 (5.9)	38 (5.6)	10 (6.8)	7 (6.9)	
No	Yes	552 (59.6)	396 (58.3)	91 (62.3)	65 (64.4)	
No	No	95 (10.3)	68 (10.0)	18 (12.3)	9 (8.9)	

Table S.4.3. continued.

Social support construct [1]		Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Instrumental						
Partner	Non-partner					0.14
Yes	Yes	317 (32.7)	251 (35.2)	37 (24.3)	29 (28.2)	
Yes	No	46 (4.7)	34 (4.8)	8 (5.3)	4 (3.9)	
No	Yes	531 (54.8)	379 (53.1)	90 (59.2)	62 (60.2)	
No	No	75 (7.7)	50 (7.0)	17 (11.2)	8 (7.8)	
Female	Male					0.47
Yes	Yes	547 (56.7)	404 (56.9)	78 (51.7)	65 (63.1)	
Yes	No	255 (26.5)	189 (26.6)	43 (28.5)	23 (22.3)	
No	Yes	86 (8.9)	66 (9.3)	13 (8.6)	7 (6.8)	
No	No	76 (7.9)	51 (7.2)	17 (11.3)	8 (7.8)	
Ever inject	Never inject					0.12
Yes	Yes	226 (24.4)	178 (26.3)	28 (18.9)	20 (19.8)	
Yes	No	53 (5.7)	35 (5.2)	11 (7.4)	7 (6.9)	
No	Yes	556 (60.1)	404 (59.8)	87 (58.8)	65 (64.4)	
No	No	90 (9.7)	59 (8.7)	22 (14.9)	9 (8.9)	

Table S.4.3. continued.

Social support construct [1]		Total n=970 N (%)	No ED visits n=715 N (%)	1 ED visit n=152 N (%)	≥2 ED visits n=103 N (%)	p-value
Informational						
Partner	Non-partner					**0.011**
Yes	Yes	276 (28.5)	220 (30.8)	29 (19.1)	27 (26.5)	
Yes	No	50 (5.2)	40 (5.6)	8 (5.3)	2 (2.0)	
No	Yes	493 (50.9)	354 (49.6)	80 (52.6)	59 (57.8)	
No	No	149 (15.4)	100 (14.0)	35 (23.0)	14 (13.7)	
Female	Male					**0.023**
Yes	Yes	473 (49.0)	354 (49.9)	59 (38.8)	60 (58.3)	
Yes	No	254 (26.3)	187 (26.3)	46 (30.3)	21 (20.4)	
No	Yes	87 (9.0)	68 (9.6)	12 (7.9)	7 (6.8)	
No	No	151 (15.6)	101 (14.2)	35 (23.0)	15 (14.6)	
Ever inject	Never inject					0.079
Yes	Yes	205 (22.0)	160 (23.4)	24 (16.3)	21 (20.6)	
Yes	No	57 (6.1)	42 (6.1)	9 (6.1)	6 (5.9)	
No	Yes	506 (54.3)	372 (54.5)	75 (51.0)	59 (57.8)	
No	No	164 (17.6)	109 (16.0)	39 (26.5)	16 (15.7)	

ED=emergency department

[1] ≥1 alters always available to provide support for each support construct derived by aggregating seven individual indicators into emotional, instrumental and informational support

Table S.4.4. Associations of sources of support with predisposing, enabling, need and environmental factors.

Factor	Total N=970 N (%)	Female [1] No n=655 N (%)	Female [1] Yes n=315 N (%)	p-value	Total N=969 N (%)	Injection drug use [1] No n=595 N (%)	Injection drug use [1] Yes n=374 N (%)	p-value
Predisposing								
Female	--	--	--	--	315 (32.5)	201 (33.8)	114 (30.5)	0.29
Homelessness [1]	101 (10.4)	66 (10.1)	35 (11.1)	0.62	101 (10.4)	30 (5.0)	71 (19.0)	**<0.001**
Injection drug use [2]	374 (38.6)	260 (39.8)	114 (36.2)	0.29	--	--	--	--
Enabling								
Usual source of care	868 (89.6)	577 (88.2)	291 (92.4)	**0.047**	867 (89.6)	545 (91.6)	322 (86.3)	**0.009**
Partner/spouse	409 (42.2)	276 (42.1)	133 (42.2)	0.98	409 (42.2)	232 (39.0)	177 (47.3)	**0.011**
Informational support [1]	820 (84.6)	546 (83.4)	274 (87.3)	0.12	819 (84.6)	517 (87.0)	302 (80.7)	**0.008**
Need								
≥3 comorbidities [3]	178 (18.4)	103 (15.7)	75 (23.8)	**0.002**	178 (18.4)	127 (21.3)	51 (13.6)	**0.003**
Environmental								
Lack transportation	351 (36.2)	227 (34.7)	124 (39.4)	0.16	350 (36.2)	164 (27.6)	186 (49.9)	**<0.001**
Wait too long at clinic	144 (14.8)	75 (11.5)	69 (21.9)	**<0.001**	144 (14.9)	57 (9.6)	87 (23.3)	**<0.001**

[1] Over prior 6 months

[2] Over prior 12 months

[3] Diabetes mellitus, hypertension, heart disease, stroke, renal disease, respiratory disease, seizure disorder, dyslipidemia

Table S.4.4. continued.

Factor	Total N=970 N (%)	Homeless [1] No n=869 N (%)	Homeless [1] Yes n=101 N (%)	p-value
Predisposing				
Female	315 (32.5)	280 (32.2)	35 (34.7)	0.62
Homelessness [1]	--	--	--	--
Injection drug use [2]	374 (38.6)	303 (34.9)	71 (70.3)	**<0.001**
Enabling				
Usual source of care	868 (89.6)	789 (90.8)	79 (79.0)	**<0.001**
Partner/spouse	409 (42.2)	370 (42.6)	39 (38.6)	0.45
Informational support [1]	820 (84.6)	744 (85.7)	76 (75.2)	**0.006**
Need				
≥3 comorbidities [3]	178 (18.4)	168 (19.3)	10 (9.9)	**0.020**
Environmental				
Lack transportation	351 (36.2)	290 (33.4)	61 (61.0)	**<0.001**
Wait too long at clinic	144 (14.8)	75 (11.5)	69 (21.9)	**<0.001**

[1] Over prior 6 months

[2] Over prior 12 months

[3] Diabetes mellitus, hypertension, heart disease, stroke, renal disease, respiratory disease, seizure disorder, dyslipidemia

5. The role of social support in promoting viral suppression among persons with a history of injection drug use and living with HIV

5.1. Abstract

HIV viral suppression is essential to prevent disease progression and population level HIV transmission. Persons who inject drugs (PWID) are often less likely to achieve HIV viral suppression than those who do not inject drugs. Because injection drug use is a stigmatized behavior and PWID often have many health needs, the social networks of PWID may have an important influence on health behaviors and outcomes. The aim of this study is to understand the social network factors associated with suboptimal viral suppression among PWID.

Information was obtained from a sample of AIDS Linked to the IntraVenous Experience study participants at their six-month study visit from April 1, 2016 through June 30, 2017. Networks were described using egocentric network analysis and odds ratios for the outcome of viral suppression <50 HIV RNA were determined with logistic regression.

Of 293 participants with confirmed HIV seropositive status and a documented HIV RNA viral load who completed the supplemental social support survey, 49.5% were virally suppressed at their last visit. Engagement in care indicated by a visit with an HIV provider (96.4%) and antiretroviral use (84.6%) in the last six months were high and similar regardless of viral suppression status. Compared to those with a detectable viral load, a greater proportion of those with viral suppression were female (40.7% vs. 26.4%; p=0.009) and reported that their wishes were considered by their HIV care provider

(69.0% vs. 66.7%; p=0.013). Compared to those with a detectable viral load, a greater proportion of persons who were virally suppressed had at least one HIV-positive alter (32.2% vs. 19.4%; p=0.014), a partner (42.8% vs. 30.4%; p=0.028) and an HIV-positive partner (17.2% vs. 4.1%; p<0.001) within their social network. In multivariable analysis, there were greater odds of viral suppression with each increasing year of age (AOR: 1.04; 95% CI: 1.01, 1.08), female sex (AOR: 2.44; 95% CI: 1.42, 4.23), reporting that their wishes were considered by their HIV provider (AOR: 1.86; 95% CI: 1.10, 3.14) and having at least one HIV-positive alter (AOR: 2.02; 95% CI: 1.12, 3.64).

Findings indicate that having network members who are HIV-positive may be supportive of viral suppression, which may be related to the positive influence of disclosure of HIV status to a peer and receiving support from persons who share the experience of living with HIV. In addition, healthcare providers promoting shared decision making with their patients living with HIV and a history of injection drug use may be help PWID acheive viral suppression.

5.2. Background

In the United States, of the people living with HIV (PLWH) who received any HIV care, 80% achieved viral suppression at their last viral load test (1). Among persons who inject drugs (PWID) the proportion virally suppressed is lower, 74.9% to 77.6% among female and male PWID, respectively. Historically, PWID have experienced lower rates of engagement in care, prescription of antiretroviral treatment (ART) and viral suppression (2-4) compared to all other transmission categories, although these

disparities have diminished overtime in some clinic cohorts (5, 6). With the importance of viral suppression to individual health outcomes and population level HIV transmission, there is a need to understand the factors associated with suboptimal viral suppression among PWID in the modern ART era.

People living with HIV require access to care for lifelong treatment of HIV infection with ART. The goal of ART is to suppress HIV RNA viral load to below detectable limits and maintain immune function as indicated by $CD4^+$ T cell over time, which requires consistent ART medication adherence (7). Among PWID, about 85% achieved viral suppression if they had 95% or greater adherence to medication (8). A number of structural and individual level factors have been related to retention in care and medication adherence. Barriers to care include lack of transportation and unstable housing (9). Antiretroviral medication non-adherence has been associated with drug use (8, 10), poor treatment by healthcare providers and stigma among healthcare providers towards PWID (10). However, differences in viral suppression by injection drug use are not always observed when measured longitudinally with continued retention in care and ART adherence (11). While these factors have a role in achieving HIV viral suppression, they do not fully explain the variability in viral suppression among PWID.

In addition to the barriers to care and treatment PWID living with HIV can experience, they also have considerable need for healthcare services given the high prevalence of comorbidities associated with aging among PLWH (12) and high rates of infectious diseases among PWID (13-15). Thus, their social networks may have an important influence on health behaviors and outcomes. Social networks can influence health-related behaviors through social norms, injunctive (what others

approve/disapprove) and descriptive (what others appear to do) and social capital--the quantity and quality of tangible and intangible resources available within one's social network (16). Most work with social networks factors and PWID have focused on HIV risk behaviors and their relationship with norms of safe sex (17) and drug use (18), but their role in healthcare use and treatment behaviors is not well-understood in this population.

Social networks are often defined as an individuals' social ties with their network members, referred to as their alters, and the resources available through these relationships (19). Among persons living with HIV, social support (20) and disclosure of HIV-positive status to more social network members (21) has been associated with retention in care. Among PWID living with HIV, there is some evidence to suggest that retention in care is related to emotional support (22, 23). However, knowledge of the types and sources of social support that best promote health outcomes like viral suppression is limited.

The purpose of this study is to examine associations with viral suppression among PWID living with HIV with a focus on the types and sources of social support that may address challenges to accessing care and ART adherence. Study findings can inform efforts to support PWID in achieving viral suppression and downstream public health benefits of reduced transmission and burden of HIV at the population level.

5.3. Methods

This study was an analysis of cross-sectional survey data from the AIDS Linked to the IntraVenous Experience (ALIVE) study. The ALIVE study is a longitudinal cohort which examines the epidemiology of injection drug use and associated health factors among adults 18 years of age or older with a history of injection drug use (24). ALIVE participants completed standardized questionnaires, Audio Computer-Assisted Self-Interview (ACASI), in-person interviews and provided bio-specimens for behavioral, socioeconomic and clinical parameters at 6-month visits. As described previously, a supplemental 59-question social network survey module was developed and used to gather information from participants about the attributes of their social network members, the nature of their relationships and the support they are available to provide. Data in this study are from 970 ALIVE participants who completed the supplemental social support survey in the from April 1, 2016, to June 30, 2017.

5.3.1. Variables

The outcome of interest was HIV RNA viral suppression. HIV status was diagnosed through enzyme-linked immunosorbent assay and confirmed through Western blot. The limit of detection on all viral load tests was 50 HIV RNA copies/ml of blood. Participants experiencing 'blips' in detectable viral load, defined as an isolated detectable HIV RNA below 200 copies preceded by viral suppression and returning to below detectable limits at the next laboratory measure (25) were considered virally suppressed. The upper limit of a blip was set at 200 copies as HIV RNA above 200 may indicate

virologic failure. Various viral load cutoffs were tested to evaluate sensitivity of model outcomes to different definitions of viral suppression.

The primary exposure of interest, social support, was considered an enabling resource and was operationalized in three ways: 1) classes of social support intensity (moderate, high, very high) determined through multilevel latent class analysis using social support indicators from the level of ego-alter ties nested within participant social networks; 2) each of the seven social support indicators individually; and 3) the seven indicators aggregated by the constructs of informational, emotional and instrumental support. The Likert scale response categories for seven indicators of emotional, instrumental and informational social support were dichotomized to generate binary variables indicating support was always or not always provided by the alter. We used this dichotomy because the proportion of 'always' responses was high, ranging from 62% to 76%, while none of the other four options rose above 16% across all seven social support indicators. Variables for social support were defined as having one or more network member available to always provide the given support. Other social network enabling factors were network member demographics, quality and nature of relationship with participants, substance use behaviors and healthcare use. All alter characteristics are reported by the ego.

Variables for health status were defined through self-report of ever having medical comorbidities including diabetes mellitus, hypertension, heart disease, cardiovascular disease, stroke and renal disease. Depressive symptoms was confirmed through administration of the Center for Epidemiological Studies-Depression (CESD) with cut off of 22 selected given that persons with history of opioid misuse score higher

than the general population (26). Chronic hepatitis C infection was defined as ever having had a positive anti-hepatitis C virus antibody test and detectable hepatitis C viral RNA measured at a study visit. Antiretroviral treatment regimens were identified based on participant self-report of medications taken in the previous six months with assistance by visual depictions of medications. and the reason reported for stopping any ART medication. The reasons reported for stopping ART in the previous six months were categorized at the level of the patient (non-adherence; side effects; pill burden) and provider initiated (drug interactions; virologic failure-drug resistance; immunologic failure/no recovery in low CD4 T cell counts; viral suppression).

5.3.2. Statistical analysis

Descriptive statistics were used to compare participant demographics, substance use and social network characteristics and roles by viral load suppression using t-tests for continuous and chi-square tests for categorical measures. The association of social support indicators and constructs with viral suppression was first examined for differences in the distribution of support stratified by alters with key characteristics across personal networks: 1) HIV-positive alters; 2) alters that are partners; 3) alters who had ever injected drugs; and 4) female alters. Because these attributes can overlap, we further evaluated the joint distribution of social support available from alters with characteristics found to be individually statistically significant. To explore the role of sources of support within ego networks on viral suppression, we used contingency tables comparing informational, emotional and instrumental support available within networks from combinations of alters that were female or male, partners or non-partners and those

with a history of injection drug use or no injection drug use history. For example, viral suppression was compared across ego networks having: 1) a partner as the only source of support; 2) only from a non-partner; 3) from both a partner and a non-partner; and 4) from neither a partner or non-partner. The variance inflation factor was calculated to identify multicollinear independent variables.

Logistic regression was used to determine associations with viral suppression. Non-collinear variables with statistically significant associations ($p \leq 0.05$) were included in the final multivariable model. Participant age and gender were included regardless of significance because of their well-established relationship with health behaviors and outcomes. Analyses were performed using Stata version 15.0 (StataCorp, College Station, TX).

5.4. Results

There were 293 ALIVE participants with confirmed HIV seropositive status and a documented HIV viral load who completed the supplemental social support survey. Overall, 145/293 (49.5%) were virally suppressed (Table 5.1.). Among persons that were virally suppressed at the visit of interest for this analysis, 83.0% and 87.1% were also suppressed at the previous and next 6-month study visits, respectively. A smaller proportion of persons with viral suppression had at least one hospital admission in the prior six months (14.5% vs. 24.3%; p=0.033). Engagement in care indicated by a visit with an HIV provider (96.4%) and ART use (85.6%) in the last six months were high

regardless of viral suppression status. There were no statistically significant differences in viral suppression by substance use, health status or health-related knowledge.

The most prevalent barrier to accessing health care was not having reliable transportation (35.8%), followed by inability to afford care (18.5%), although there were no statistically significant differences by viral suppression stratus for any barriers (Table 5.2.). The most common reasons for stopping any ART medication were having too many pills (30.9%), with no difference by viral suppression, while 27% of persons reporting being on ART in the previous six months were on a single pill regimen. Of those reporting ART use, about half (53.4%) were taking one of the recommended initial regimens (Supplemental Table S.5.1.).

About 19% reported more than three comorbidities (Supplemental Table S.5.2.). The most common were hypertension (49.1%) and depression (49.5%), followed by bipolar (25.6%) and lung disease (23.9%), with no differences for any comorbidities by viral suppression status.

There were differences in viral suppression observed for a number of social network factors (Table 5.3.). Persons who were virally suppressed had slightly larger median social network size (4 vs. 3; p=0.010) and a greater proportion had at least one HIV-positive alter (32.2% vs. 19.4%; p=0.014), partner (42.8% vs. 30.4%; p=0.028) and HIV-positive partner (17.2% vs. 4.1%; p<0.001). Person who were virally suppressed were more likely to have at least one HIV-positive alter available for emotional (28.5% vs. 16.4%; p=0.014), instrumental (27.8% vs. 16.4%; p=0.20) and informational support (27.1% vs. 15.0%; p=0.011) (Table 5.4.). Similarly, a greater proportion of the virally suppressed had a partner available for emotional (40.0% vs. 26.4%; p=0.013),

instrumental (40.7% vs. 27.7%; p=0.019) and informational support (37.2% vs. 23.6%; p=0.011) irrespective of the presence or lack of support from other alters in the social network. The pattern was similar for the seven individual social support indicators (Supplemental Table S.5.3.).

Comparing the composition of ego networks by combinations of a given alter trait (e.g. networks where a type of support is reported only from a partner, only from non-partners, from both partners and non-partners or from neither partners or non-partners) revealed significant differences by viral suppression for emotional and informational support (Supplemental Table S.5.4.). Comparing HIV status of alters, viral suppression was more likely for participants with networks having only HIV-positive alters as the source of emotional support (8.3% vs. 4.1%; p=0.05) and less likely if emotional support was only available from HIV-negative alters (66.0% vs. 72.6%; p= 0.05). Similarly, viral suppression was more likely for participants with network's having informational support from only an HIV-positive alters (9.7% vs. 4.8%; p=0.029) and less likely if informational support was only available from HIV-negative alters (59.0% vs. 61.2%; p=0.029). Comparing partner status of alters, viral suppression was more likely for participants with networks having only a partner as the source of emotional support (4.8% vs. 2.0%, p=0.037) and less likely if non-partners were the only source of emotional support (55.9% vs. 634.2%; p=0.37). Similarly, viral suppression was more likely for participants with networks having informational support from only partners (3.4% vs. 2.0; p=0.039) and less likely if non-partners were the only source of informational support (50.3% vs. 54.7%; p=0.039). In general, social support was more likely available from female compared to male alters and partners compared to non-

partners, but less so from HIV-positive compared to HIV-negative alters (Supplemental Table S.5.5.).

Since viral suppression was associated with both having an HIV-positive alter and partner, we considered these factors jointly. Across all 1004 ego-alter dyads, the prevalence of HIV-positive partners was greater among those virally suppressed (5.1% vs. 1.6%; p=0.007) and HIV-negative non-partners were marginally more prevalent among those with a detectable viral load (Supplemental Table S.5.6.). This pattern was also seen at the social network level, viral suppression was more likely among participants having an HIV-positive partner and all HIV-negative non-partners (9.7% vs. 3.4%; p=0.029) or non-partners of any HIV status (17.4% vs. 4.1%; p<0.001) (Supplemental Table S.5.7.). In the adjusted model Table 5.5.), there was greater odds of viral suppression with each increasing year of age (AOR: 1.04; 95% CI: 1.01, 1.08), female sex (AOR: 2.44; 95% CI: 1.42, 4.23) having providers consider patient wishes (AOR: 1.86; 95% CI: 1.10, 3.14) and having at least one HIV-positive alter (AOR: 2.02; 95% CI: 1.12, 3.64).

5.5. Discussion

This study examined associations with HIV viral suppression among persons living with HIV and a history of injection drug use with a focus on the types and sources of social support available from their closest network members. Understanding such relationships may indicate areas for interventions that focus on individuals and their supportive social relations to achieve and maintain viral suppression.

The proportion of PWID that were virally suppressed was similar to the overall US average (49.5 % vs. 48.4%) (1). We found that having at least one HIV-positive alter was associated with viral suppression in the adjusted model. While a greater proportion of the virally suppressed had an HIV-positive alter that provided each social support indicator or construct, HIV-positive and HIV-negative alters did not differ significantly with respect to types of support they were available to provide. Therefore, it may be that the source of social support has more impact than the quality of support. Persons living with HIV can experience social isolation and little or no social support due to not disclosing HIV status out of fear of HIV-related stigma and rejection (27). Unexpectedly, our study sample had relatively high levels of social support for a disenfranchised group. However, having an HIV-positive alter may provide a trusted and safe source of non-judgmental support. As an indication of disclosure and support, people living with HIV that were comfortable taking their medication in the presence of close friends and with emotional and instrumental support available have been found to have higher odds of medication adherence (28). Additionally, methadone-maintained persons living with HIV having a network member who was aware of their HIV status were nearly three times more likely to engage in primary care (29).

We considered that the HIV positive alters who are most supportive may also be partners. Although the HIV-positive alter association may be driven by the HIV-positive partner association, it is hard to conclude that there is an effect of having an HIV-positive alter who is not a partner because the number in this group was so small. One study found that for PWID living with HIV, having a partner in the support network was associated

with lower odds of having access to care, measured as seeing the same provider most of the time (22).

Persons who use drugs and are living with HIV face stigma from substance misuse and HIV-status jointly (9, 20). Substance use stigma is closely associated with the willingness to disclose and fear of social rejection due in part to socially unacceptable modes of transmission, particularly among racial minorities (30). Substance use stigma is exacerbated by perceptions from providers that persons who use drugs use healthcare inefficiently (31). PWID perceiving discrimination from healthcare providers may turn to their substance using peers for information about HIV care (32). Although substance use was common in this cohort, it was not found to be associated with viral suppression, suggesting that patients using substances can be adherent and bias against offering treatment due to substance use behaviors should be avoided. However, we did not consider the association of the frequency of injection drug use with viral suppression among those with current injection drug use. Additionally, there is a need for risk reduction interventions given we found that participants with a detectable viral load were sharing injection equipment and more likely to engage in condomless sex than persons who were virally suppressed.

Social networks are a resource of social capital that can be mobilized to affect positive change on behavior and health (33). Interventions at the network level draw upon a number of mechanisms to affect behavior change through social influence (34). Norms for medication adherence among PLWH that lead to viral suppression may be influenced through peers endorsing and engaging in treatment adherence themselves. Identifying and training informal opinion leaders is one means to promote diffusion of such health

behaviors (35). More formally trained peer and community health workers have a particularly important role in reaching hidden and stigmatized communities, such as persons with substance use disorders (36), helping to bridge the cultural divide between patients and providers that can result from mistrust of the health care profession among disenfranchised groups (Eiser & Ellis, 2007). Our findings indicate that there is an opportunity to intervene with HIV-positive peers and partners to promote behaviors that support medication adherence and ultimately viral suppression.

Viral suppression was positively associated with having wishes considered by the provider. Persons who use drugs experience barriers to care related to difficulty communicating with medical providers and lack of knowledge about how and where to access care (32). However, patient-provider relationships that include information sharing, shared decision making and respect for patients' decisions have been associated with greater odds of medication adherence (37) and clinic attendance has been associated with the quality of provider communication (27), patient-provider relationships (20) and clarity of medical instructions (38).

5.6. Limitations

Limitations of the study include cross-sectional data from a single study visit that does not allow examination of the lag that may exist between social network exposures and viral suppression outcomes over time, limiting the ability to draw causal associations from these results. Because most exposures evaluated were self-reported, social desirability and recall bias may be a factor, particularly for ART use and reasons for

stopping ART medication. We did not have the data to examine concerns for medication adherence in depth. Because social support was high overall, there may be associations with types of social support and viral suppression that might be identified in networks more broadly defined beyond the most important members. Given the high level of engagement in HIV care in this population, results may not extrapolate to groups with a lower prevalence of retention in care typical of PWID in general.

5.7. Conclusions

Having network members who are HIV-positive was associated with viral suppression. Although additional data are needed to understand the reason for this association, it may be related to the positive influence of disclosure of HIV status to a peer and receiving support from persons who share the experience of living with HIV. Future research should explore the role of having an HIV-positive partner in particular and the ability of partner-focused interventions to improve health outcomes among PWID. The greater prevalence of condomless vaginal sex among persons with a detectable viral load is a concern and warrants further investigation. In addition, findings suggest the importance of healthcare providers promoting shared decision making with their patients living with HIV and a history of injection drug use in order to achieve a goal of ART, continuous viral suppression.

5.8. References

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Table 5.1. Participant characteristics by viral suppression.

Characteristic	Total N=293 N (%)	HIV viral load≥50 N=148 N (%)	HIV viral load<50 N=145 N (%)	p-value
Age, median (IQR)	56 (51-60)	56 (50-60)	56 (52-61)	0.11
Female	98 (33.4)	39 (26.4)	59 (40.7)	**0.009**
Men who have sex with men	31 (10.7)	16 (11.0)	15 (10.4)	0.87
Health insurance [1]	289 (98.6)	145 (98.0)	144 (99.3)	0.32
Homelessness [1]	17 (5.8)	11 (7.4)	6 (4.1)	0.23
Income <5,000 [1]	195 (66.8)	97 (66.0)	98 (67.6)	0.77
Substance use				
Injection drug use, any [2]	91 (31.1)	49 (33.1)	42 (29.0)	0.44
Inject heroin alone [1]	35 (11.9)	21 (14.2)	14 (9.7)	0.23
Inject cocaine alone [1]	25 (8.5)	14 (9.5)	11 (7.6)	0.57
Inject speedball [1]	43 (14.7)	23 (15.5)	20 (13.8)	0.67
Frequency of injection				0.49
None	222 (76.0)	108 (73.5)	114 (78.6)	
<Daily	39 (13.4)	23 (15.6)	16 (11.0)	
Daily	31 (10.6)	16 (10.9)	15 (10.3)	
Crack cocaine [1]	76 (25.9)	44 (29.7)	32 (22.1)	0.13
Non-injection drug misuse [1]	111 (37.9)	63 (42.6)	48 (33.1)	0.095
Opioid replacement therapy [1]	135 (46.1)	72 (48.6)	63 (43.4)	0.37
Substance use support group [1]	141 (48.1)	65 (43.9)	76 (52.4)	0.15
Transmission risk [3]				
Shared injection equipment [1]	16 (23)	10 (26)	6 (19)	0.53
Condomless anal sex [1]	9 (43)	4 (57)	5 (36)	0.35
Condomless vaginal sex [1]	73 (64.0)	40 (72.7)	33 (55.9)	0.062
Health status				
≥3 comorbidities (not HIV) [4]	55 (18.8)	25 (16.9)	30 (20.7)	0.41
Hepatitis C infection [5]	181 (62.2)	92 (62.6)	89 (61.8)	0.89
CESD>22 [1,6]	67 (22.9)	35 (23.6)	32 (22.1)	0.75
Ever psychiatric diagnosis	150 (51.2)	74 (50.0)	76 (52.4)	0.68
CD4 T-Cells [1]				0.74
<200	21 (14.9)	9 (14.8)	12 (15.0)	
200-499	46 (32.6)	22 (36.1)	24 (30.0)	
≥500	74 (52.5)	30 (49.2)	44 (55.0)	
HIV viral load<50 prior visit	197 (69.6)	80 (56.3)	117 (83.0)	**<0.001**
HIV viral load<50 next visit	166 (63.4)	51 (39.2)	115 (87.1)	**<0.001**
HIV knowledge				
Goal: viral load to go down	208 (71.5)	103 (70.5)	105 (72.4)	0.72
Goal: CD4 to go down	71 (24.4)	34 (23.3)	37 (25.5)	0.66

Table 5.1. continued

Characteristic	Total N=293 N (%)	HIV viral load≥50 N=148 N (%)	HIV viral load<50 N=145 N (%)	p-value
Healthcare use				
Antiretroviral treatment [1]	247 (84.6)	125 (85.0)	122 (84.1)	0.83
HIV provider visit/6 months	266 (96.4)	131 (95.6)	135 (97.1)	0.50
Know HIV provider ≥2 years	186 (67.6)	90 (66.2)	96 (69.1)	0.61
≥1 ED visit [1]	86 (29.5)	47 (32.0)	39 (26.9)	0.34
≥1 hospital admission [1]	57 (19.5)	36 (24.3)	21 (14.5)	**0.033**
Provider considers wishes	187 (64.5)	84 (57.5)	103 (71.5)	**0.013**
Doctors explain clearly	198 (67.8)	98 (66.7)	100 (69.0)	0.67

IQR=interquartile range

[1] Over prior 6 months

[2] Over prior 12 months

[3] 21 responded to the question about condom use and anal sex and 114 about condom use and vaginal sex.

[4] Diabetes mellitus, hypertension, heart disease, stroke, renal disease, respiratory disease, seizure disorder, dyslipidemia

[5] Detectable Hepatitis C RNA

[6] Center for Epidemiological Studies-Depression score greater than 22

Table 5.2. Barriers to healthcare and antiretroviral medication use by viral suppression.

	Total N=293 N (%)	HIV viral load≥50 N=148 N (%)	HIV viral load<50 N=145 N (%)	p-value
Barrier to care [1]				
No reliable transportation	105 (35.8)	57 (38.5)	48 (33.1)	0.33
Unstable housing	54 (18.5)	26 (17.6)	28 (19.4)	0.68
Can't afford care	35 (11.9)	17 (11.5)	18 (12.4)	0.81
Drug use makes it hard	25 (8.5)	14 (9.5)	11 (7.6)	0.57
Don't want to disclose drug use	21 (7.2)	8 (5.4)	13 (9.0)	0.24
Don't trust medical system	14 (4.8)	7 (4.7)	7 (4.8)	0.97
Wait too long for appointments	15 (5.1)	8 (5.4)	7 (4.8)	0.82
Wait too long at clinic	20 (6.8)	10 (6.8)	10 (6.9)	0.96
Inconvenient appointments	22 (7.5)	13 (8.8)	9 (6.2)	0.40
Reason for stopping ART [2]				
Too many pills	34 (30.9)	17 (32.7)	17 (29.3)	0.70
Don't know why	26 (23.6)	8 (15.4)	18 (31.0)	0.054
Other reason	22 (20.0)	11 (21.2)	11 (19.0)	0.77
Side effects	15 (13.6)	7 (13.5)	8 (13.8)	0.96
Nonadherence	10 (9.1)	6 (11.5)	4 (6.9)	0.40
Viral resistance/treatment failure	6 (5.5)	2 (3.8)	4 (6.9)	0.48
Drug interactions	5 (4.5)	1 (1.9)	4 (6.9)	0.21

ART=Antiretroviral treatment

[1] Not a problem vs. somewhat-major problem

[2] Any single antiretroviral medication

Table 5.3. Social network characteristics by viral suppression.

Characteristic	Total N=293 N (%)	HIV viral load≥50 N=148 N (%)	HIV viral load<50 N=145 N (%)	p-value
Network size, median (IQR)	3 (2-5)	3 (2-5)	4 (3-5)	**0.010**
Age, median (IQR)	51 (44-57)	50 (44-57)	52 (46-57)	0.19
<u>One or more alters</u>				
Female	276 (94.5)	139 (94.6)	137 (94.5)	0.98
Ever IDU	97 (36.3)	49 (36.8)	48 (35.8)	0.86
HIV-positive	74 (25.8)	28 (19.4)	46 (32.2)	**0.014**
Partner/spouse	107 (36.5)	45 (30.4)	62 (42.8)	**0.028**
HIV-positive partner	31 (10.6)	6 (4.1)	25 (17.2)	**<0.001**
Relative	257 (87.7)	132 (89.2)	125 (86.2)	0.44
Years known, median (IQR)	34 (24-43)	34 (25-43)	33 (23-44)	0.70
Talk with daily	250 (85.3)	124 (83.8)	126 (86.9)	0.45
Frequently-always argue	90 (30.7)	46 (31.1)	44 (30.3)	0.89
Regularly goes to clinic [1]	178 (97.3)	79 (96.3)	99 (98.0)	0.49
Helps you understand HIV	189 (69.7)	94 (69.1)	95 (70.4)	0.82
HIV-positive in HIV care [2]	71 (99)	26 (100)	45 (98)	0.45
HIV-positive talk about HIV care [2]	53 (74)	17 (65)	36 (78)	0.23

IQR=interquartile range

[1] If alter has a chronic health condition

[2] Out of the total 74 participants with ≥1 HIV-positive alters

Table 5.4. Availability of at least one source of support by viral suppression.

Social support	Total n=293 N (%)	HIV viral load≥50 n=148 N (%)	HIV viral load<50 n=145 N (%)	p-value
Emotional [1]				
Any alter	273 (93.2)	134 (90.5)	139 (95.9)	0.071
HIV-positive	65 (22.4)	24 (16.4)	41 (28.5)	**0.014**
Partner	97 (33.1)	39 (26.4)	58 (40.0)	**0.013**
Female	249 (85.3)	124 (84.4)	125 (86.2)	0.66
Injection drug use, ever	81 (29.7)	37 (27.2)	44 (32.1)	0.37
Instrumental [1]				
Any alter	266 (90.8)	130 (87.8)	136 (93.8)	0.078
HIV-positive	64 (22.1)	24 (16.4)	40 (27.8)	**0.020**
Partner	100 (34.1)	41 (27.7)	59 (40.7)	**0.019**
Female	248 (84.6)	122 (82.4)	126 (86.9)	0.29
Injection drug use, ever	80 (28.9)	38 (27.5)	42 (30.2)	0.62
Informational [1]				
Any alter	243 (82.9)	116 (78.4)	127 (87.6)	**0.036**
HIV-positive	61 (21.0)	22 (15.0)	39 (27.1)	**0.011**
Partner	89 (30.4)	35 (23.6)	54 (37.2)	**0.011**
Female	225 (76.8)	109 (73.6)	116 (80.0)	0.20
Injection drug use, ever	78 (28.2)	37 (26.6)	41 (29.7)	0.57

[1] ≥1 network members with given characteristic available to always provide given support

Table 5.5. Correlates of viral suppression.

	Bivariate HIV viral load<50 OR (CI)	p-value	Multivariable HIV viral load<50 AOR (CI)	p-value
Ego characteristic				
Age, years	1.03 (0.99, 1.06)	0.125	1.04 (1.01, 1.08)	**0.025**
Female	1.92 (1.17, 3.14)	**0.010**	2.44 (1.42, 4.23)	**0.001**
Homelessness	0.54 (0.19, 1.49)	0.234		
Injection drug use	0.82 (0.50, 1.35)	0.444		
Crack use	0.67 (0.39, 1.13)	0.136		
Street drugs, non-injection	0.67 (0.42, 1.07)	0.096		
Substance/alcohol support group	1.43 (0.90, 2.26)	0.129		
CESD>22	0.91 (0.53, 1.58)	0.748		
Ever any psychiatric diagnosis	1.10 (0.70, 1.74)	0.679		
Hepatitis C infection	0.97 (0.60, 1.55)	0.891		
≥3 comorbidities (not HIV)	1.28 (0.71, 2.31)	0.406		
≥1 ED visit	0.78 (0.47, 1.30)	0.342		
My wishes are considered by my provider	1.85 (1.14, 3.02)	**0.013**	1.86 (1.10, 3.14)	**0.021**
Doctors explain things in a clear way	1.04 (0.81, 1.34)	0.750		
Lack transportation	0.79 (0.49, 1.28)	0.335		
Wait too long at clinic	1.02 (0.41, 2.53)	0.962		
Social network				
Network size>3	1.41 (0.89, 2.23)	0.145		
Alter age, mean years	1.01 (0.99, 1.04)	0.322		
Female alters, number	1.20 (0.98, 1.48)	0.078		
Partner/spouse [1]	1.71 (1.06, 2.76)	**0.029**	1.48 (0.88, 2.50)	0.137
Relatives, number	1.06 (0.90, 1.23)	0.489		
HIV-positive [1]	1.96 (1.14, 3.38)	**0.015**	2.02 (1.12, 3.64)	**0.019**
Social support constructs [1, 2]				
Emotional support	2.42 (0.90, 6.48)	0.079		
Instrumental support	2.09 (0.91, 4.82)	0.083		
Informational support	1.95 (1.04, 3.65)	**0.038**	1.48 (0.74, 2.95)	0.265
All support constructs	2.61 (0.98, 6.93)	0.054		
Intensity of support				
Moderate	1			
High	1.66 (0.89, 3.10)	0.109		
Very high	1.65 (0.92, 2.99)	0.097		

OR=odds ratio; AOR=adjusted odds ratio; CI=confidence interval

[1] ≥1 network members with given characteristic

[2] Network member always provides at least one indicator for each construct

Table S.5.1. Self-reported antiretroviral medications used in the prior six months.

Medication [1]	Class	N (%)
Regimen [1]		
Recommended initial regimen	INSTI + 2 NRTIs	71 (26.9)
Recommended in certain clinical situations	Boosted PI + 2 NRTIs	44 (16.7)
	NNRTI + 2 NRTIs	32 (12.1)
	INSTI + 2 NRTIs	26 (9.8)
Other combinations of antiretroviral medications	Various	91 (34.5)
Individual medication formulations		
Ritonavir	PI	97 (14.2)
Emtricitabine / Tenofovir DF	NRTI	85 (12.4)
Darunavir	PI	74 (10.8)
Dolutegravir	INSTI	51 (7.5)
Raltegravir	INSTI	42 (6.1)
Abacavir / Dolutegravir / Lamivudine [2]	NRTI / INSTI	36 (5.3)
Abacavir / Lamivudine	NRTI	33 (4.8)
Unknown	NA	32 (4.7)
Efavirenz / Emtricitabine / Tenofovir DF [2]	NNRTI / NRTI	30 (4.4)
Atazanavir	PI	29 (4.2)
Elvitegravir / Cobi / Emtricitabine / Tenofovir DF [2]	INSTI / NRTI	19 (2.8)
Elvitegravir / Cobi / Emtricitabine / Tenofovir AF [2]	INSTI / NRTI	19 (2.8)
Lipinavir / ritonavir	PI	17 (2.5)
Darunavir / Cobicistat	PI / booster	17 (2.5)
Lamivudine	NRTI	15 (2.2)
Emtricitabine / Tenofovir AF	NRTI	13 (1.9)
Etravirine	NNRTI	12 (1.8)
Rilpiverine / Emtricitabine / Tenofovir DF [2]	NNRTI / NRTI	10 (1.5)
Other	Various	54 (7.9)

Data from 264 of 268 participants reporting ART use.
PI= Protease Inhibitor; NRTI= Nucleoside Reverse Transcriptase Inhibitors; Non-Nucleoside Reverse Transcriptase Inhibitors; INSTI=Integrase Strand Transfer Inhibitor
Antiretroviral treatment reported by 264 participants
[1] Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents Living with HIV
[2] Single pill regimen only=74/268 (27.6%): Atripla=24; Triumeq=24; Stribild=10; Genvoya=9; Complera=7

Table S.5.2. Self-reported chronic comorbidities by viral suppression.

Comorbidity	Total n=293 N (%)	HIV viral load≥50 n=148 N (%)	HIV viral load<50 n=145 N (%)	p-value
Number of comorbidities [1]				0.66
0	83 (28.3)	40 (27.0)	43 (29.7)	
1	89 (30.4)	46 (31.1)	43 (29.7)	
2	66 (22.5)	37 (25.0)	29 (20.0)	
≥3	55 (18.8)	25 (16.9)	30 (20.7)	
Hypertension	144 (49.1)	73 (49.3)	71 (49.0)	0.95
Chronic lung disease (asthma, COPD, emphysema, not pneumonia)	70 (23.9)	34 (23.0)	36 (24.8)	0.71
High cholesterol	67 (22.9)	34 (23.0)	33 (22.8)	0.97
Diabetes (high blood sugar)	43 (14.7)	19 (12.8)	24 (16.6)	0.37
Heart problem (angina, heart attack, CHF)	34 (11.6)	18 (12.2)	16 (11.0)	0.76
Stroke (CVA)	28 (9.6)	12 (8.1)	16 (11.0)	0.39
Renal disease or failure	19 (6.5)	10 (6.8)	9 (6.2)	0.85
Seizures (epilepsy, convulsions)	15 (5.1)	8 (5.4)	7 (4.8)	0.82
Psychiatric comorbidities				
Depression	145 (49.5)	72 (48.6)	73 (50.3)	0.77
Bipolar (manic depression)	75 (25.6)	34 (23.0)	41 (28.3)	0.30
Anxiety/panic	58 (19.8)	31 (20.9)	27 (18.6)	0.62
Schizophrenia/ Schizoaffective disorder	11 (3.8)	3 (2.0)	8 (5.5)	0.12

COPD= Chronic obstructive pulmonary disease; CHF=Congestive heart failure; CVA=Cerebrovascular accident

[1] Non-psychiatric and non-communicable

Table S.5.3. Frequency of support available from sources of support by viral suppression.

Social support [1]	Total N=293 N (%)	HIV viral load≥50 N=148 N (%)	HIV viral load<50 N=145 N (%)	p-value
Intensity of support				0.19
Moderate	70 (24.1)	42 (28.6)	28 (19.4)	
High	97 (33.3)	46 (31.3)	51 (35.4)	
Very High	124 (42.6)	59 (40.1)	65 (45.1)	
Emotional support				
Could talk to if down				
Any alter	239 (81.6)	119 (80.4)	120 (82.8)	0.60
HIV-positive	53 (18.2)	17 (11.6)	36 (24.8)	**0.004**
Partner	85 (29.0)	35 (23.6)	50 (34.5)	**0.041**
Female	213 (72.9)	107 (72.8)	106 (73.1)	0.95
Injection drug use, ever	69 (24.7)	32 (23.0)	37 (26.4)	0.51
Would say is in your corner				
Any alter	260 (89.3)	125 (85.6)	135 (93.1)	**0.038**
HIV-positive	61 (21.0)	22 (15.1)	39 (27.1)	**0.012**
Partner	90 (30.7)	36 (24.3)	54 (37.2)	**0.017**
Female	234 (80.4)	115 (78.8)	119 (82.1)	0.48
Injection drug use, ever	76 (27.5)	34 (24.5)	42 (30.7)	0.25
Instrumental support				
Would pitch in to help do things				
Any	246 (84.2)	119 (81.0)	127 (87.6)	0.12
HIV-positive	57 (19.6)	21 (14.3)	36 (25.0)	**0.021**
Partner	88 (30.0)	36 (24.3)	52 (35.9)	**0.031**
Female	226 (77.1)	111 (75.0)	115 (79.3)	0.38
Injection drug use, ever	69 (24.7)	32 (22.9)	37 (26.6)	0.47
Would loan over $25				
Any alter	236 (80.8)	112 (76.2)	124 (85.5)	**0.043**
HIV-positive	59 (20.2)	22 (15.0)	37 (25.5)	**0.025**
Partner	85 (29.0)	34 (23.0)	51 (35.2)	**0.021**
Female	214 (73.3)	104 (70.7)	110 (75.9)	0.32
Injection drug use, ever	64 (22.5)	28 (19.4)	36 (25.7)	0.21

Table S.5.3. continued.

Social support [1]	Total N=293 N (%)	HIV viral load≥50 N=148 N (%)	HIV viral load<50 N=145 N (%)	p-value
Would let stay if needed a place				
Any alter	245 (83.6)	120 (81.1)	125 (86.2)	0.24
HIV-positive	59 (20.3)	21 (14.4)	38 (26.2)	**0.012**
Partner	90 (30.7)	35 (23.6)	55 (37.9)	**0.008**
Female	226 (77.1)	112 (75.7)	114 (78.6)	0.55
Injection drug use, ever	69 (24.6)	32 (22.5)	37 (26.6)	0.43
Informational support				
Someone to give situation advice				
Any alter	233 (79.5)	111 (75.0)	122 (84.1)	0.053
HIV-positive	56 (19.2)	20 (13.6)	36 (25.0)	**0.014**
Partner	85 (29.0)	32 (21.6)	53 (36.6)	**0.005**
Female	213 (72.7)	104 (70.3)	109 (75.2)	0.35
Injection drug use, ever	71 (25.5)	33 (23.6)	38 (27.5)	0.45
Does help understand health				
Any alter	204 (69.6)	98 (66.2)	106 (73.1)	0.20
HIV-positive	53 (18.2)	18 (12.2)	35 (24.1)	**0.008**
Partner	74 (25.3)	27 (18.2)	47 (32.4)	**0.005**
Female	184 (62.8)	89 (60.1)	95 (65.5)	0.34
Injection drug use, ever	63 (22.1)	29 (20.3)	34 (23.9)	0.46

[1] Network member always provides support for at least one indicator by support construct

Table S.5.4. Frequency of support available within networks having at least one type of alter by viral suppression.

Social support construct		Total n=293 N (%)	HIV viral load≥50 n=148 N (%)	HIV viral load<50 n=145 N (%)	p-value
Emotional					
HIV-positive	HIV-negative				**0.050**
Yes	Yes	47 (16.2)	18 (12.3)	29 (20.1)	
Yes	No	18 (6.2)	6 (4.1)	12 (8.3)	
No	Yes	201 (69.3)	106 (72.6)	95 (66.0)	
No	No	24 (8.3)	16 (11.0)	8 (5.6)	
Partner	Non-partner				**0.037**
Yes	Yes	87 (29.7)	36 (24.3)	51 (35.2)	
Yes	No	10 (3.4)	3 (2.0)	7 (4.8)	
No	Yes	176 (60.1)	95 (64.2)	81 (55.9)	
No	No	20 (6.8)	14 (9.5)	6 (4.1)	
Female	Male				0.17
Yes	Yes	169 (57.9)	81 (55.1)	88 (60.7)	
Yes	No	80 (27.4)	43 (29.3)	37 (25.5)	
No	Yes	23 (7.9)	9 (6.1)	14 (9.7)	
No	No	20 (6.8)	14 (9.5)	6 (4.1)	
Ever inject	Never inject				0.17
Yes	Yes	68 (24.9)	30 (22.1)	38 (27.7)	
Yes	No	13 (4.8)	7 (5.1)	6 (4.4)	
No	Yes	166 (60.8)	81 (59.6)	85 (62.0)	
No	No	26 (9.5)	18 (13.2)	8 (5.8)	
Instrumental					
HIV-positive	HIV-negative				0.061
Yes	Yes	46 (15.9)	18 (12.3)	28 (19.4)	
Yes	No	18 (6.2)	6 (4.1)	12 (8.3)	
No	Yes	197 (67.9)	103 (70.5)	94 (65.3)	
No	No	29 (10.0)	19 (13.0)	10 (6.9)	
Partner	Non-partner				0.069
Yes	Yes	93 (31.7)	38 (25.7)	55 (37.9)	
Yes	No	7 (2.4)	3 (2.0)	4 (2.8)	
No	Yes	166 (56.7)	89 (60.1)	77 (53.1)	
No	No	27 (9.2)	18 (12.2)	9 (6.2)	
Female	Male				0.24
Yes	Yes	168 (57.3)	79 (53.4)	89 (61.4)	
Yes	No	80 (27.3)	43 (29.1)	37 (25.5)	
No	Yes	18 (6.1)	8 (5.4)	10 (6.9)	
No	No	27 (9.2)	18 (12.2)	9 (6.2)	

Table S.5.4. continued

Social support construct		Total n=293 N (%)	HIV viral load≥50 n=148 N (%)	HIV viral load<50 n=145 N (%)	p-value
Instrumental					
Ever inject	Never inject				0.13
Yes	Yes	70 (25.3)	32 (23.2)	38 (27.3)	
Yes	No	10 (3.6)	6 (4.3)	4 (2.9)	
No	Yes	163 (58.8)	77 (55.8)	86 (61.9)	
No	No	34 (12.3)	23 (16.7)	11 (7.9)	
Informational					
HIV-positive	HIV-negative				**0.029**
Yes	Yes	40 (13.7)	15 (10.2)	25 (17.4)	
Yes	No	21 (7.2)	7 (4.8)	14 (9.7)	
No	Yes	175 (60.1)	90 (61.2)	85 (59.0)	
No	No	55 (18.9)	35 (23.8)	20 (13.9)	
Partner	Non-partner				**0.039**
Yes	Yes	81 (27.6)	32 (21.6)	49 (33.8)	
Yes	No	8 (2.7)	3 (2.0)	5 (3.4)	
No	Yes	154 (52.6)	81 (54.7)	73 (50.3)	
No	No	50 (17.1)	32 (21.6)	18 (12.4)	
Female	Male				0.094
Yes	Yes	143 (48.8)	65 (43.9)	78 (53.8)	
Yes	No	82 (28.0)	44 (29.7)	38 (26.2)	
No	Yes	18 (6.1)	7 (4.7)	11 (7.6)	
No	No	50 (17.1)	32 (21.6)	18 (12.4)	
Ever inject	Never inject				0.12
Yes	Yes	65 (23.5)	30 (21.6)	35 (25.4)	
Yes	No	13 (4.7)	7 (5.0)	6 (4.3)	
No	Yes	143 (51.6)	66 (47.5)	77 (55.8)	
No	No	56 (20.2)	36 (25.9)	20 (14.5)	

[1] ≥1 alters always available to provide support for each support construct derived by aggregating seven individual indicators into emotional, instrumental and informational support

Table S.5.5. Frequency of support available from sources of support for all dyads.

	HIV-positive [1]			Partner [1]		
	No n=826	Yes n=106		No n=894	Yes n=110	
Social support	N (%)	N (%)	p-value	N (%)	N (%)	p-value
Indicators [1]						
Could talk to if down	580 (70.2)	64 (60.4)	**0.039**	597 (66.8)	87 (79.1)	**0.009**
Would say is in your corner	664 (81.3)	79 (74.5)	0.099	698 (78.9)	92 (83.6)	0.24
Would pitch in to help do things	604 (73.6)	70 (66.0)	0.10	625 (70.3)	91 (82.7)	**0.006**
Would loan more than $25	568 (68.9)	74 (69.8)	0.85	588 (65.9)	88 (80.0)	**0.003**
Would let stay if needed a place	609 (73.7)	78 (73.6)	0.97	633 (70.8)	93 (84.5)	**0.002**
Someone to give situation advice	579 (70.1)	74 (69.8)	0.95	606 (67.8)	88 (80.0)	**0.009**
Does help understand health	475 (57.6)	69 (65.1)	0.14	490 (54.9)	77 (70.0)	**0.003**
Constructs [2]						
Emotional	704 (85.7)	84 (79.2)	0.078	744 (83.7)	99 (90.0)	0.085
Informational	702 (85.0)	87 (82.1)	0.43	735 (82.2)	103 (93.6)	**0.002**
Instrumental	613 (74.3)	82 (77.4)	0.50	646 (72.3)	92 (83.6)	**0.011**

p values adjusted for clustering on ego

Non-missing data: 932 for HIV status; 1004 for partner status

[1] Alter always provides support for given indicator

[2] Alter always provides support for at least one indicator by support construct

Table S.5.5. continued.

Social support	Female [1] No n=396 N (%)	Female [1] Yes n=606 N (%)	p-value	Injection drug use [1] No n=737 N (%)	Injection drug use [1] Yes n=139 N (%)	p-value
Indicators [2]						
Could talk to if down	245 (61.9)	438 (72.3)	**<0.001**	514 (69.7)	91 (65.5)	0.32
Would say is in your corner	304 (77.6)	485 (80.7)	0.23	596 (81.3)	99 (73.3)	**0.033**
Would pitch in to help do things	261 (66.2)	455 (75.5)	**0.002**	539 (73.6)	96 (69.1)	0.27
Would loan more than $25	256 (64.6)	420 (69.5)	0.11	520 (70.7)	89 (64.0)	0.11
Would let stay if needed a place	265 (66.9)	461 (76.1)	**0.002**	561 (76.1)	92 (66.2)	**0.014**
Someone to give situation advice	259 (65.4)	435 (71.8)	**0.032**	513 (69.6)	96 (69.1)	0.90
Does help understand health	201 (50.8)	366 (60.5)	**0.002**	415 (56.3)	85 (61.2)	0.29
Constructs [3]						
Emotional	321 (81.9)	521 (86.1)	0.072	630 (85.7)	108 (78.8)	**0.040**
Informational	315 (79.5)	523 (86.3)	**0.005**	634 (86.0)	111 (79.9)	0.061
Instrumental	274 (69.2)	464 (76.7)	**0.008**	540 (73.3)	107 (77.0)	0.36

p values adjusted for clustering on ego

[1] Non-missing data: 1,002 for gender; 876 for IDU status

[2] Alter always provides support for given indicator

[3] Alter always provides support for at least one indicator by support construct

Table S.5.6. Frequency of types of alters by viral suppression for all dyads.

Dyad level	Total N=1004	HIV viral load>=50 N=479	HIV viral load <50 N=525	p-value
Non-partner, HIV-negative	752 (80.7)	372 (83.4)	380 (78.2)	**0.007**
Partner, HIV-positive	32 (3.4)	7 (1.6)	25 (5.1)	
Partner, HIV-negative	74 (7.9)	38 (8.5)	36 (7.4)	
Non-partner, HIV-positive	74 (7.9)	29 (6.5)	45 (9.3)	

p-value adjusted for clustering on ego

Table S.5.7. Network composition for combinations of alter HIV and partner status by viral suppression.

Effect	Partner	Non-partner	Total N=293 N (%)	VL>=50 N=148 N (%)	VL<50 N=145 N (%)	p-value
HIV-pos. alter	Any positive*		74 (25.8)	28 (19.4)	46 (32.2)	**0.014**
	All negative		211 (74.0)	115 (80.4)	96 (67.6)	
Partner	Any partner		107 (36.5)	45 (30.4)	62 (42.8)	**0.028**
	No partners		184 (63.2)	102 (69.4)	82 (56.9)	
HIV-pos. partner	+	all –	19 (6.5)	5 (3.4)	14 (9.7)	**0.029**
	+	+/–	31 (10.6)	6 (4.1)	25 (17.2)	**<0.001**
HIV-pos. non-partner	–	any +	43 (14.8)	22 (15.0)	21 (14.6)	0.93
	+/–	any +	55 (18.8)	23 (15.5)	32 (22.1)	0.15
HIV-neg. partner	–	all –	67 (23.4)	36 (25.0)	31 (21.8)	0.55
	+/–	all –	219 (78.8)	116 (83.5)	103 (74.1)	0.057

– HIV-negative; + HIV-positive

*HIV-negative partner with either HIV-positive/-negative non-partner is similar given that there is only one network that consists of only one alter and that alter is an HIV-positive partner; therefore, all networks that have at least one HIV-positive alter include cases where partners are HIV-negative.

6. Conclusion

6.1. Summary of findings

Persons who inject drugs experience a number of health-related disparities, including greater risk for HIV infection and barriers in accessing preventative care (1, 2). At the national level, research funding priorities include eliminating disparities in the continuum of care for persons who use substances (3), policies to increase the number of persons living with HIV that are virally suppressed (4) and incentives to promote more optimal use of healthcare resources (5). While social networks are known to influence healthcare seeking and health outcomes (6), most studies of the social networks of PWID have not examined the most important, closest ties, which may be the most influential for behavior change (7, 8).

The goal of this study was to increase our understanding of the factors that can influence suboptimal use of healthcare services and HIV viral suppression among PWID by examining the closest social network ties. A more comprehensive understanding of the influence of social networks in healthcare seeking behaviors and outcomes can help to identify important patient, social network and community level opportunities for intervention to support HIV viral suppression and avoid potentially preventable use of costly ED services. Results add to the evidence regarding social network factors related to disparities in care and health outcomes for a difficult to reach population — persons who inject drugs and are living with or at risk for HIV.

The thread that links findings of the three analyses in this sample of PWID with high levels of social support regardless of current or former injection drug use, is that both the source and quality of support is associated with healthcare utilization and health outcomes. For example, partners were more likely to be perceived as always available for six to seven domains of support, the greatest of any relationship type, and having high frequency ED visits was less likely for participants who had a partner. In addition, persons having HIV-positive alters, including HIV-positive partners, were more likely to be virally suppressed, despite no differences with respect to the level of support available from HIV-positive and HIV-negative alters having been identified. In terms of the quality of support, informational support was found to be associated with a lower likelihood of having an ED visit, the only support type to be associated with either outcome examined in this study. Thus, peers living with HIV, partners and the availability of informational support from close social ties represent opportunities for interventions aimed to address health disparities among PWID.

In aim 1 we developed and implemented a social network survey to determine types of support and differences by time since last injection drug use. There were high levels of support overall: 1) *Moderate support*; 2) *High support*; and 3) *Very high support*. The odds of membership in the very high class was lower compared to the moderate support class for participants with non-injection drug use in the past year. The key social network factor associated with latent support was a lower odds of very high support compared to moderate support with each additional network member who ever injected drugs, demonstrating that a lower intensity of social support is available from peers with a history of injection drug use.

In aim 2, we determined social network factors associated with frequent emergency department use. Compared to no ED visits in the prior six months, the odds of having one visit were lower for participants having informational support and the odds of two or more visits were lower for participants having a partner. This finding suggests that information from peers may play a role in decisions about seeking emergency services and that partners may provide support that addresses the barriers to care experienced by PWID.

In aim 3, we determined social network factors associated with HIV viral suppression. For the 293 PWID living with HIV, the odds of HIV viral suppression were greater for participants having at least one HIV-positive alter. This finding indicates that homophily between individuals and their network members of an often-stigmatized health condition may be supportive of health-related behaviors. We additionally confirmed the importance of shared decision-making between HIV care providers and their patients.

6.2. Strengths and limitations

These findings can provide insight into the role of social networks on HIV care and clinical outcomes as well as optimizing use of health care resources to avoid potentially preventable ED visits. Our focus on the very closest and potentially most influential networks ties is unique and suggests opportunities to intervene with peers of individuals that face barriers to care related to the stigmatized nature of injection drug use as well as HIV infection.

Limitations include misperceptions or lack of awareness regarding alter attitudes and behaviors, differential recall bias, social desirability bias and confounding by unknown variables. ALIVE participants may be subject to the Hawthorne effect, where study participants benefit from increased care and follow up and exhibit behavior change from being under observation (9). Additionally, persons agreeing to participate in the ALIVE study may have higher levels of retention in care than is typical for PWID. Consequently, they may not be similar to other groups of PWID. Missing information or misclassification may occur due to respondent fatigue, forgetting or refusal to respond out of privacy concerns for their network members. Despite these limitations, study findings contribute to the literature regarding the social networks of PWID with our focus on the closest social ties and also suggest directions for future research in addressing disparities in health experienced by PWID.

6.3. Public health implications and recommendations for future research

Finding more effective means of promoting the health and optimal use of healthcare services among PWID outside of the clinical setting is critical given the structural and psychosocial barriers that hinder health promoting and healthcare seeking behaviors. Interventions that leverage the social resources available to PWID to achieve and maintain viral suppression can not only prevent disease progression, but also population level HIV transmission. Given the concerns about the increasing cost of healthcare and limited resources, the social networks of PWID also represent an opportunity to encourage use of preventative care that can potentially avoid costly and inefficient use of emergency services.

Further investigation of social network factors associated with health outcomes and healthcare use is warranted. In particular, it is essential to understand how social support may influence retention in HIV care and adherence to antiretroviral medication. Given the association of HIV-positive alters with viral suppression among PWID in this sample, it would be helpful to understand what aspect of their relationships may be influential, particularly focusing on the roles of social influence through modeling self-care and the potential for support from someone with a shared experience to mediate community-level HIV stigma and individual shame regarding their diagnosis. To better understand how peers may influence use of healthcare resources, research should focus on what health-related information is being communicated and which healthcare seeking behaviors are being modeled by peers. While having a partner is not a universal social asset, it is important to explore what partner traits and behaviors promote optimal healthcare seeking, both for prevention and emergency care, and which barriers partners may be mitigating, such as lack of transportation.

6.4. References

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Appendix A: Social network survey

THE ALIVE STUDY

SOCIAL NETWORK SURVEY QUESTIONNAIRE

A. GENERAL INFORMATION

A1.	SUBJECT ID:	____ ____ ____ ____ ____	1
A2.	VISIT #:	____ ____ ____	6
A5.	FORM VERSION:	2.1	9
A6.	DATE OF INTERVIEW:	____ ____ /____ ____ /____ ____	12
A7.	INTERVIEWER'S INITIALS:	____ ____ ____	18
A8.	TIME MODULE BEGUN:	____ ____ : ____ ____	21

INTERVIEWER INSTRUCTION:

For your own reference with later questions, confirm here if client is:

	No	Yes	
HIV-positive	0	1	25
HCV-positive	0	1	26

SECTION 1
SOCIAL NETWORK MEMBERS

READ TO THE PARTICIPANT:

I would like to get an idea of the people who are important to you in a number of different ways.

1. Looking back over the past 6 months, who are the people that have been important to you? Please think about all the people you associate with closely including friends, sexual partners, associates and family who are at least 13 years old or older. Just tell me their initials.

RECORD INITIALS BELOW

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

IF LESS THAN 4 PEOPLE, PROBE, ANYONE ELSE? RECORD INITIALS ABOVE

[Interviewer check: How many initials were mentioned in questions 1? ___ ___] 27

INTERVIEWER INSTRUCTION:

List up to the first 5 initials in order along the side of the matrix on the facing page. Then write initials 2-5 across the top.

0 **(38)**

2. We are going to talk about the first 5 people you mentioned. How close are you to these people on a scale from 1 to 5, with 1 being not very close and 5 being very close? How close are you to **[initials]**

	Not very close				Very close	
Initials 1 _____	1	2	3	4	5	29
Initials 2 _____	1	2	3	4	5	30
Initials 3 _____	1	2	3	4	5	31
Initials 4 _____	1	2	3	4	5	32
Initials 5 _____	1	2	3	4	5	33

INTERVIEWER INSTRUCTION:

If only 1 person listed, go to 4. Refer to matrix below for question 3. Fill in unshaded boxes for question 3.A. and 3.B. for each pair of network members. For 3.B. record closeness as:

Not very close				Very close
1	2	3	4	5

3. I would like you to think about the relations between the people you just mentioned. Some of them may be total strangers in the sense that they wouldn't recognize each other if they bumped into each other on the street. Others may be especially close, as close to each other as they are to you.

A. First, think about **[Initials]** and **[Initials].** Do _____ and _____ know each other?

B. On a scale of 1 to 5, how close are **[Initials]** and **[Initials]**? One is not close at all and 5 is very close.

THEN ASK 3.A FOR NEXT PAIR DOWN

	INITIALS 2		INITIALS 3		INITIALS 4		INITIALS 5		
		No Yes		No Yes		No Yes		No Yes	
INITIALS 1	A. B.	0 1 ____	A. B.	0 1 ____	A. B.	0 1 ____	A. B.	0 1 ____	34 38
INITIALS 2			A. B.	0 1 ____	A. B.	0 1 ____	A. B.	0 1 ____	42 45
INITIALS 3					A. B.	0 1 ____	A. B.	0 1 ____	48 50
INITIALS 4							A. B.	0 1 ____	52 53
INITIAL 5									

	Initials:							
4.	Is [**initials**] male or female?							54
	1 = Male	2 = Female						
	8 = Refused	9 = Don't know						
5.	How long have you known [**him/her**]? Years							59
	88 = Refused	99 = Don't know						
6.	How old is [**he/she**]? Years							69
	88 = Refused	99 = Don't know						
7.	What is [**his/her**]'s race?							79
	1 = White	2 = Black	3 = Other					
	8 = Refused	9 = Don't know						
8.	As far as you know, what is [**initials**]'s highest level of education?							84
	1 = < 12 yrs.	2 = HS/GED	3 = Any college					
	8 = Refused	9 = Don't know						
9.	How often do you usually talk with [**him/her**] over the last six months, almost every day, at least weekly, at least monthly or less than monthly?							89
	1 = Daily	2 = Weekly	3 = Monthly					
	4 > Monthly	8 = Refused	9 = Don't know					
10.	On a scale from 1 to 5, how much do you trust [**him/her**], with 1 meaning "don't trust at all" and 5 meaning "trust with my life"?							94
	1 = Don't trust	2	3	4	5 = Trust with life			
	8 = Refused	9 = Don't know						
11.	How is [**initials**] connected with you?							99
	1 = Sex Partner/Spouse	2 = Relative	3 = Friend					
	4 = Professional	8 = Refused	9 = Don't know					
12.	Is [**he/she**] (age 12 or over) currently working?							104
	0 = No	1 = Yes	7 = N/A					
	8 = Refused	9 = Don't know						

INTERVIEWER INSTRUCTIONS FOR Q13 – Q20:

Never	A little	Sometimes	Frequently	Always
1	2	3	4	5

	Initials:	__ __	__ __	__ __	__ __	__ __	
	How often…..						
13.	do you argue with [**him/her**]?						109
14.	could you talk to [**him/her**] if you were feeling stressed or down?						114
15.	would you say [**he/she**] is "In your corner"?						119
16.	would [**he/she**] pitch in to help you do things that you needed some help with?						124
17.	would [**he/she**] loan you some money over $25?						129
18.	would [**he/she**] let you stay at their place, if you needed a place to stay?						134
19.	would you say [**he/she**] is someone to give you advice or help you understand a situation?						139
20.	does [**he/she**] help you to understand information about your health?						144

INTERVIEWER INSTRUCTION FOR Q21 – Q31 :

NO	YES	RF	DK	N/A
0	1	7	8	9

	Initials:	__ __	__ __	__ __	__ __	__ __	
21. **[25]**	Does [**he/she**] have any health conditions, like diabetes, high blood pressure, kidney disease, liver disease, heart disease or any other chronic health problem?						149
22.	Does [**initials**] regularly go to a clinic or see a doctor for one of these chronic conditions? [**not an ER visit or hospitalization**]						154
23.	Does [**he/she**] seem confident in their ability to manage their chronic health problems?						159
24.	Does [**he/she**] seem discouraged or frustrated by their chronic health problems?						164
25. **[28]**	Does [**he/she**] have HIV or AIDS?						169
26. **[28]**	Do you know if **[he/she]** is receiving care or treatment for HIV?						174
27.	Does [**he/she**] regularly talk to you about seeing their doctor for HIV?						179

INTERVIEWER INSTRUCTION FOR Q21 – Q31 :

NO	YES	RF	DK	N/A
0	1	7	8	9

		Initials:					
28. **[33]**	Does [**he/she**] have hepatitis C?						184
29.	Is [**he/she**] receiving care for hepatitis C?						189
30.	Has [**he/she**] been treated for hepatitis C?						194
31.	If yes, what was he/she treated for hepatitis C with:						199
	a. Pills only (Harvoni)?						204
	b. Pills and interferon injections?						209
	c. Other						
32.	Is he/she cured of hepatitis C?						214
	Q33 is for HIV positives only – for others skip to Q34						
33.	Does [**he/she**] help you to understand **your** HIV, such as your labs or medications?						219
	Q34 is for HCV positives only – for others skip to Q35						
34.	Does [**he/she**] help you to understand care of or go the clinic for **your** hepatitis C?						224

INTERVIEWER INSTRUCTION FOR QUESTIONS Q35 – Q37:

NEVER	6 MOS	More than 6 MOS	RF	DK	N/A
1	2	3	7	8	9

	Initials:						
35.	Has [**he/she**]:						
	a. Injected drugs						229
	b. Used any "illicit"/"illegal"/"street" drugs not by injection						234
	c. Used alcohol						239
36.	Have you shared needles, cookers or other injection paraphernalia with [**him/her**]? **INTERVIEWER: If 35a and 35b are never then code as 9.**						244
37.	Has [**he/she**] been enrolled in a drug treatment or attended narcotics anonymous or other self-help group? **INTERVIEWER: If 35a-c are never then code as 9**						249

SECTION 2
HEALTH BELIEFS

READ TO THE PARTICIPANT:

Now I'm going to ask you some general questions about yourself, what you think about your health and healthcare.

		Strongly Disagree	Somewhat Disagree	Neither agree or disagree	Some what Agree	Strongly Agree	
38.	Seeing the doctor or nurse is a good way to stay healthy.	1	2	3	4	5	254
39.	I do not think the doctor can help me too much when I am sick	1	2	3	4	5	
40.	The treatment my doctor prescribes is generally the right one.	1	2	3	4	5	
41.	I do not get very worried when I get sick.	1	2	3	4	5	
42.	I am worried about getting sick.	1	2	3	4	5	
43.	When I am sick I generally do the same things as when I am healthy	1	2	3	4	5	
44.	I seem to get a little sicker than other people.	1	2	3	4	5	
45.	I am as healthy as anyone I know.	1	2	3	4	5	
46.	I expect my health to get worse.	1	2	3	4	5	262

SECTION 3
QUALITY OF PROVIDER INFORMATION

READ TO THE PARTICIPANT:

Now I'm going to ask you about the information you get from you doctor, nurse or other healthcare providers.

[RESPONSE CARD 1]

47. Doctors explain everything in a clear and understandable way.

Strongly Disagree	1	263
Disagree	2	
Neither agree or disagree	3	
Agree	4	
Strongly Agree	5	

INTERVIEWER INSTRUCTION:

QUESTIONS 48 -53 ARE FOR HIV POSITIVES ONLY. FOR HIV NEGATIVES, GO TO READ INSTRUCTIONS BEFORE Q54

48. My wishes are taken into account during treatment for my HIV.

Strongly Disagree	1	264
Disagree	2	
Neither agree or disagree	3	
Agree	4	
Strongly Agree	5	

SECTION 4
HIV HEALTH-RELATED KNOWLEDGE

READ TO THE PARTICIPANT:

We would like to know if clients are familiar with some terms related to HIV care and a few of your labs.

49. What is your last CD4 count?

____ ____ ____ ____ 9997 Refused 9998 Don't know 265

50. What is your last viral load?

____ ____ ____ ____ ____ ____ 999997 Refused 999998 Don't know 269

0 Non-detectable

		Up	Down	RF	DK	
51.	Is the goal of treatment to make the CD4 count go up or down?	0	1	7	8	275
52.	Is the goal of treatment to make the viral load go up or down?	0	1	7	8	276

READ TO THE PARTICIPANT:

Now I'm going to ask you to answer in your own words the following question. Please say whatever comes to your mind.

53. Can you tell me what would make it easier for you to start or stay in care for HIV? **[Probe. If nothing write NOTHING]**

__ __ __ __ __ __ 277

SECTION 5
HCV HEALTH-RELATED KNOWLEDGE

READ TO THE PARTICIPANT:

Now we want to ask you some questions about your beliefs related to hepatitis C and its treatment.

		No	Yes	Don't know	Refused	
54.	The new treatments for hepatitis C cure most people of hepatitis C	0	1	7	8	283
55.	The new treatments for hepatitis C have a lot of side effects	0	1	7	8	
56.	If you are successfully cured of hepatitis C, you can never catch it again	0	1	7	8	
57.	Hepatitis C is a major health concern for me	0	1	7	8	286

INTERVIEWER INSTRUCTION:

Q 58 is an open-ended question for **HCV positives**. Please write down in the space below as close to the exact words of the client as possible. **FOR HCV NEGATIVES, GO TO QUESTION 59.**

READ TO THE PARTICIPANT:

Now I'm going to ask you to answer in your own words the following question. Please say whatever comes to your mind.

58. Can you tell me what would make it easier for you to start or stay in care for hepatitis C? **[Probe. If nothing write NOTHING]**

__ __ __ __ __ __ 287

	Do you feel supported by other things in your life?	No	Yes	RF	DK	
59.	a. Support group	0	1	7	8	293
	b. Religious/faith organization such as a church	0	1	7	8	
	c. Recovery program	0	1	7	8	
	d. Other	0	1	7	8	296
	Specify _____ ___ ___					297

READ TO THE PARTICIPANT:

That's the end of the survey. Thank you for participating.

60.	END TIME:	____ ____ : ____ ____		299

INTERVIEWER REFERENCE FOR QUESTION 11

Sex Partner
Spouse
Boy/girlfriend/fiancé/partner
Sex partner

Kin
Grandparent
Parent – biological
Parent – step/foster/adoptive
Child – biological
Child – step/foster/adoptive
Partner's child
Grandchild
Sibling – biological
Sibling – step/foster/adoptive
Uncle/aunt
Nephew/niece
Cousin
Brother/sister in-law
Mother/father in-law
Son/daughter in-law
Partner's relative
Child/grandchild's partner
Relative's partner

Non-kin
Friend
Associate/acquaintance
Running partner/drug buddy
Child/grandchild's relative
Child/grandchild's friend
Relative's friend
Partner/s friend
Friend's partner, relative or friend
Neighbor
Someone at work/supervisor/boss
NA/AA program sponsor
Landlord
House/room mate
Someone inject(ed) with
Ex-partner

Professional
Case manager/social worker
Doctor/nurse
House manager/director
Counselor/therapist
Research staff
Minister/pastor/spiritual advisor
Parole or law office
Other

CARD 1: AGREEMENT

Strongly Disagree	Somewhat Disagree	Neither agree or disagree	Somewhat Agree	Strongly Agree
1	2	3	4	5

Appendix B: Curriculum vitae

Curriculum Vitae

PAUL LOUIS SACAMANO NP-C, MPH, ACRN

EDUCATION

Johns Hopkins University Bloomberg School of Public Health, Baltimore
Ph.D. candidate in Epidemiology — Summer 2018
Dissertation: Social support and healthcare use among persons who inject drugs

Master of Public Health — December 2012
Capstone: 30-day hospital readmissions in an HIV+ community clinic cohort

Johns Hopkins University School of Nursing, Baltimore
Master of Science Nursing — December 2012
Adult nurse practitioner track

Bachelor of Science Nursing — July 2010

University of Arizona School of Natural Resources, Tucson
Master of Landscape Architecture — August 1991
Thesis: Structure and function of two neighborhood community forests

Bachelor of Science Agriculture — May 1988

WORK EXPERIENCE

El Rio Health Special Immunology Associates, Tucson
Nurse Practitioner — July 2018 – present
- Provide outpatient HIV primary care

Johns Hopkins School of Medicine, Baltimore
Nurse Practitioner — December 2017 – June 2018
- Provide outpatient HIV primary and PrEP care

Johns Hopkins School of Nursing, Baltimore
Nurse Practitioner — May 2016 – December 2017
- Led peer navigator community outreach, organized outreach events and coordinated healthcare working training for PrEP
- Developed and implemented Massive Open Online Course for PrEP
- Developed training on cultural humility with stigmatized populations
- Applied for and managed medical, nursing and other continuing education credits for healthcare worker training programs
- Developed patient and provider HIV and sexual health educational material
- Provided outpatient HIV primary and PrEP care

Johns Hopkins University Bloomberg School of Public Health, Baltimore — September 2013 – March 2016
Teaching Assistant
- Epidemiology and Public Health Impact of HIV and AIDS
- Epidemiology Methods I and III
- Sexual Orientation, Gender Identity and Public Health

Johns Hopkins Medical Management Corp, Baltimore
Registered Nurse — August 2013 – August 2014
- Provided patient care on infectious disease telemetry medical-surgical unit

Johns Hopkins University School of Nursing, Baltimore
Teaching Assistant — September – December 2013
- Global Tuberculosis Clinical Management and Research

University of Maryland Medical Center, Baltimore
Clinical Nurse II — September 2010 – August 2013
- Provided patient care on infectious disease telemetry medical-surgical unit
- Coordinated patient discharge
- Precepted and mentored new nursing graduates

University of Maryland School of Nursing, Baltimore — September 2010
Consultant
- Assisted with focus group for study of coping strategies in older adults living with HIV and chronic comorbidities

Environmental Health Experience

City and County of San Francisco, San Francisco
Superintendent and Assistant Superintendent Bureau of Urban Forestry — July 2002 – January 2008
- Directed tree planting and care, landscaping, and sidewalk repair operations
- Developed $14 million annual budget and wrote successful grants
- Administered contracts and reported service measures to oversight agencies
- Oversaw hiring, training, and other personal matters for 110+ workforce
- Initiated street-side greening legislation and consulted on other legislation

Urban Forester
- Provided representation at public hearings and neighborhood meetings
- Led development of legislation for San Francisco's Urban Forestry Council — November 1999 – June 2002
- Developed budgets and wrote successful grants to state and local agencies
- Led multidisciplinary teams of non-profits and governmental agencies
- Supervised staff, evaluated performance and handled personnel issues

Davey Resource Group, The Davey Tree Expert Co., Livermore
Manager of Technical Services Western. U.S. — November 1993 – October 1999
- Responsible for urban forestry consulting
- Wrote successful grant proposals to government agencies and corporations
- Developed resource plans for agency, corporate and community partners
- Provided outreach and technology transfer
- Led development of inventory protocol, software and training manual

Northeastern Forest Experiment Station, USDA Forest Service, Chicago — August 1991 – November 1993
Landscape Architect
- Advised agencies and community groups regarding tree benefits and costs
- Assisted technology transfer and writing up project findings
- Assisted modeling environmental and economic benefits and costs of trees
- Evaluated remotely sensed imagery for natural resource assessment

University of Arizona, School of Renewable Natural Resources, Tucson
Research Assistant — August 1988 – August 1991
- Assisted in study of vegetation effects on climate and building energy use

TEACHING: INVITED LECTURES

Johns Hopkins University School of Nursing, Baltimore — June 2012 to present
Primary Care Expectations for the HIV-positive Patient
Nursing Care of the Adult Patient Living with HIV
Graduate pathophysiology: clinical immunology
Pathogenesis of HIV Infection

NHANES, Hyattsville — November 2017
Pre-Exposure Prophylaxis Epidemiology and Clinic Care

STD/HIV Prevention Training Center, Baltimore — November 2017
STI's in Vulnerable Populations

Johns Hopkins Broadway Center for Addiction, Baltimore — October 2017
Pre-Exposure Prophylaxis and Substance Misuse

University of Southern California School of Nursing, Los Angeles — March 2017
Primary Care of the Patient with HIV

CONFERENCE PRESENTATIONS

Association of Nurses in AIDS Care Conference, Dallas — November 2017
PrEP Community Outreach Program

National HIV PrEP Summit, San Francisco — December 2016
Growing the Capacity for PrEP Services in Baltimore

Association of Nurses in AIDS Care Conference, Chicago — October 2015
Associations of sexual and Drug Use Behaviors with Viral Load

Association of Nurses in AIDS Care Conference, Atlanta — November 2013
Predictors of 30-day Hospital Readmissions in HIV-infected Patients

University of Maryland Medical Center Practice Summit, Baltimore — September 2012
Transitional Care Reduces Readmissions & Improves Patient Experiences

Utility Arborists Association Conference, St. Petersburg Beach — Winter 1998
PG&E's Comprehensive Tree Inventory

Texas Urban Forestry Conference, Texoma — Winter 1997
Benefit & Cost Analysis to Manage an Urban Forest

Arizona State Lands Conference, Phoenix — Winter 1996
Tree Inventories for Urban Forest Management

PROFESSIONAL ORGANIZATION INVOLVEMENT

Association of Nurses in AIDS Care, Baltimore — January 2014 – 2017
Chesapeake Chapter President and Director at Large

University of Maryland Medical Center, Baltimore — June 2012 – August 2013
Nursing Research Council

City and County of San Francisco, San Francisco — June 2004 – June 2007
Chair, Urban Forest Council; Chair Planning and Policy Committee

VOLUNTEER EXPERIENCE

Baltimore City Health Department, Baltimore — June 2012 – November
Reproductive Health Mobile Van Volunteer
- Assessed reproductive needs, provided pregnancy testing and birth control
- Referred for STI testing as well as reproductive, acute and primary care

Jacques Initiative, Institute of Human Virology, Baltimore — June 2012
City Uprising HIV Tester
- Assessed and counseled regarding behavioral risk reduction
- Provided rapid testing for HIV and referred for treatment and support

San Francisco AIDS Foundation, San Francisco — May 2007 – May 2009
Tenderloin Needle Exchange Volunteer
- Provided clean supplies and risk reduction counseling
- Screened and made referrals for testing and care

California HIV/STD Hotline Counselor
- Assessed risks and educated regarding risk reduction
- Made referrals for testing and treatment, offered emotional support

2008 International AIDS Society Conference, Mexico City — August 2008
Attendee Support
- Provided programmatic information and support to international delegates

Project Homeless Connect, SFDPH, San Francisco — Summer 2007 & Winter 2008
Homeless Client Triage & Service Guide
- Assessed homeless clients' needs and guided to on-site service providers

AWARDS, GRANTS & HONORS

Johns Hopkins University School of Public Health, Baltimore
NIH T32 Drug Dependence Epidemiology Training Grant — September 2013 – May 2016
NIH T32 HIV Epidemiology Training Grant

Johns Hopkins University School of Public Health, Baltimore
Cele & Pete Borcuk Endowment — July 2010 – June 2011
Lillian Hiss-Ethel Crosby Scholarship

University of Maryland Medical Center, Baltimore — May 2012
Living Excellence in Nursing

Johns Hopkins University School of Nursing, Baltimore — July 2010
Alumni Leadership Award
The Honor Society of Nursing, Sigma Theta Tau International

City and County of San Francisco, San Francisco — June 2007
Professional Commendation

University of Arizona, Tucson — August 1991
The National Honor Society of Landscape Architecture

LICENSURES, TRAINING & MEMBERSHIPS

Adult Primary Care Nurse Practitioner — April 2013–April 2023
American Association of Nurse Practitioners

Registered Nurse — May 2018 – April 2022
Arizona Board of Nursing

AIDS Certified Registered Nurse — April 2011 – April 2019
Association of Nurses in AIDS Care

Certified HIV Counseling, Testing & Referral — June 2012 – present
Maryland Department Health

Buprenorphine Waiver Training
American Association Nurse Practitioners/American Society Addiction Medicine — February 2018

PUBLICATIONS

Sacamano, P., Krawczyk, N., & Latkin, C. (2018). Emergency Department Visits in a Cohort of Persons with Substance Use: Incorporating the Role of Social Networks. *Substance Use & Misuse*, 1-5. doi:10.1080/10826084.2018.1461225

Maulsby C, **Sacamano P**, Jain KM, Enobun B, Brantley ML, Kim HY, Riordan M, Werner M; A2C Implementation Team, Holtgrave DR. Barriers and Facilitators to the Implementation of a National HIV Linkage, Re-Engagement, and Retention in Care Program. AIDS Educ Prev. 2017 Oct;29(5):443-456.

Sacamano PL, Farley JE. Behavioral and Other Characteristics Associated with HIV Viral Load in an Outpatient Clinic. PLoS One. 2016 Nov 2;11(11).

Sacamano P, Mark H. Sexually Transmitted Infections. In: Brucker MC, King TL, editors. Pharmacology for Women's Health. Second ed. Burlington, Ma: Jones & Bartlett Learning; 2015. p. 651-78.

Farley JE, Hayat MJ, **Sacamano PL**, Ross T, Carroll K. Prevalence and risk factors for methicillin-resistant Staphylococcus aureus in an HIV-positive cohort. American journal of infection control. 2015;43(4):329-35

Sacamano, P., & Aschenbrenner, D. S. (2011). Drugs Treating Severe Pain. In D. S. Aschenbrenner & S. J. Venable (Eds.), *Drug Therapy in Nursing* (pp. 404-430). Philadelphia, PA: Wolters Kluwer Health | Lippincott Williams & Wilkins.

Sacamano, P., McPherson, E. G., Myhre, R., Stankovich, M., & Weih, R. (1995). *Describing Urban Forest Cover: An Evaluation of Airborne Videography*. Journal of Forestry, 93(5), 43-48.

McPherson, E. G., Nowak, D. J., **Sacamano, P.** L., Prichard, S. E., & Makra, E. (1992). *Chicago's evolving urgan forest; an initial report of the Chicago Urban Forest Climate Project.* (General technical report NE-169). Radnor, PA: U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.