

ORIGINAL RESEARCH

Identification of Influential Nodal Persons among Injecting Drug Users: - A Social Network Analysis

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Abstract

This study is concerned with Injecting Drug Users (IDUs) who weren't able to follow up with the existing HIV prevention program due to the existence of stigma. These IDUs are living in Chennai city of South India, which is a large, cosmopolitan city. Objective: The primary objective of this study was to identify the influential injecting drug user who plays an active role in carrying out different activities like buying and sharing of illicit drugs, seeking information and advising about HIV prevention, using Social Network Analysis. Methods: This quantitative cross-sectional study was conducted among 46 IDUs undergoing Opioid Substitution Therapy (OST) during the study period (April 2015- March 2016). As all the 46 IDUs were recruited as participants of this study, this network is considered as full network method, in which the existing relationships (ties) among the IDUs was studied. The open source software Node XL was used to analyze the social network data. Centrality

metrics of social network analysis like Degree, Closeness, Betweenness, Eigen Vector and Page Rank were used to identify the influential IDUs (nodal persons) within the IDU networks. Results: SNA had identified the IDU-64 as one of the influential IDUs (node) who is well known for his illicit drug dealings. He is well-connected with other IDUs in the network, because he communicates with the majority of the members for the purpose of distributing illicit drugs, directly and through other nodal persons. This analysis also identified IDU-39 as a resource person who has provided HIV-related information to the maximum number of IDUs both directly and indirectly, and IDU-67 had motivated a maximum number of IDUs in the network to engage in HIV testing and to enroll in the OST program. It is surprising to know that these three influential nodal persons had themselves had not enrolled in the OST Program and were Ex-users. Conclusion: Social network analysis of IDUs identified the key nodal individuals who could be utilized for effectively imparting essential HIV prevention information and implementing behavioral communication. The study findings highlighted the possibilities of utilizing centrality metrics of the social network as a tool for effective follow-up of IDUs for HIV prevention. Key Words: OST- Opioid Substitution Therapy, IDU- Injecting Drug User, BCC- Behavior Change Communication, IDU- Unique Identification, PE- Peer Educator and ORW- Out-Reach Worker, NACO- National AIDS Control Organization, IBBS- Integrated Biological and Behavioral Surveillance, HSS-HIV Sentinel Surveillance

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Introduction

High risk groups such as Injecting Drug Users (IDUs) are known as hidden populations, and the boundaries of these groups are unknown. As the members of these groups may want to protect their privacy, traditional methods such as survey methods cannot be used to solicit reliable information from this population (Douglas Keckathorn, 1999).[1] The limitations of the traditional methods have pushed the scholars toward innovative methods such as Social Network Analysis (SNA) to extract information. SNA is typically free from volunteer response bias as well as other bias associated with survey and observation methods (Amoy Kumar Datta, 2015) (2)

Social network analysis is the study of the social structure which connects individuals. A social network is a special type of graph that depicts relationships between actors. The actors of interest (individuals, groups, communities, etc.) are the nodes and relationships between the actors are the arcs or ties. Structural analysis of the network will also picture the presence of hidden cohesive groups. Such insights are generally not possible with traditional methods (Wasserman and Faust, 1994) (3). Moreover socio-metric techniques are more powerful in the sense that they provide a global view of the network and indicators for individual positions in that network (Morris, 2004).(4)

This analysis is developed under the assumption that individuals are influenced by the people they have contact with, and that individual positions within larger social structures can determine behavior (either through constraint or influence) (Hanneman and Mark Riddle, 2005).(5) One of the aims of this analysis is to categorize people in terms of their positions in the network. By nature of their social relations, some people are more central or popular in a group than others.

Network Analysis of Injecting Drug Users

This study is concerned with Injecting Drug Users (IDUs) who have registered with Tamil Nadu AID Society, India to participate in the Opioid Substitution Therapy program. The main aim of this study is to identify key nodal persons within this group who play an active role in carrying out different activities like buying and sharing Drugs, seeking information and advising

about HIV prevention. using Social Network Analysis (SNA).

Social network research increasingly expands our understanding of the social environment of Drug users' health risks, particularly those associated with the transmission of HIV, Hepatitis, and other sexually transmitted and blood-borne infectious diseases (Margaret, 2002).(6) Also, research studies have been establishing the existence of significant associations between social network features, on one hand, and a wide range of health-related behaviors and problems, on the other (Berkmen and Syme 1979; DiMatteo and Hays 1981; Romano et al. 1991).(7,8,9) Thus, analyzing the network of Drug users will help us to identify patterns of information sharing within the group. Also within a network, analyzing the position of members will help us to identify the nodal / key persons and provide insights into how important they are within the community (Thomas Valente, 2004).(10)

Identification of Influential Persons

Identification of influential persons in a hidden population like injecting Drug users plays a very important role in understanding their group activities. Also, these influential persons play a very important role in their day to day life. These persons, by virtue, hold senior positions in their community, and they tend to have an asymmetric influence on Drug users and, hence, on prescribing behavior and treatment guidelines. A broad and up-to-date experience with these individuals is required to identify key or influential persons among Drug users. In this modern technology the traditional approaches for identifying important persons are increasingly ineffective and exacerbate the risk of “**experience bias**”. To overcome this deficiency, Social network analysis is recommended in order to better conceptualize and measure social interactions between individuals, and an individual's influences on the behavior and attitude of others members in that network (Latkin et al., 1995).(11)

Centrality is a metric that assesses the criticality of a node's position. Node centrality as a measure of a node's importance by virtue of its central location has been commonly used by social scientists in the study of social networks for

decades. Many network centrality measures have been proposed, such as: Degree, Density, Closeness, Betweenness, Eigen vector, Page rank etc. Among many centrality measures, Eigenvalue centrality (EVC) is arguably the most successful tool for detecting the most influential node within a social graph. Thus, EVC is a widely used centrality measure in the social sciences (Freeman, 1979). (12)

Software is needed to perform social network analysis. For this study, Node XL is used to generate networks among Drug users. It offers additional features which provide easy access to social media network data streams, advanced network metrics, and text and sentimental analysis (Elizabeth M. Bonsignore, 2009 & <http://nodexl.codeplex.com>). (13)

Material

The setting of this study was Chennai City, the capital of Tamil Nadu State. The practice of injecting drugs plays a crucial role in acquiring HIV, greater than any other route of infection. A national sentinel surveillance data suggested that the highest HIV prevalence was in this state (24%) and HIV prevalence amongst IDUs in this city was estimated to range from 20 to 40 %. This study also identified that these Drug users belong to a lower socio-economic class, lack education and migrated from rural areas (NACO, 2006; Solomon, 2008; Panda, 2005; Kumar, 2000). (14,15,16 &17) Another study established that high risk behavior like needle-sharing, unsafe disposal and inappropriate cleaning of needles, as well as limited condom use, were common among Drug users (M Suresh Kumar & Suniti Solomon, et al, 2010). [18]

An earlier study on the IDUs of Chennai confirms that social networks of risky individuals are significantly associated with the HIV and HCV status of this group, and also established that minimal network support mechanisms may help them with the cessation of Drug use (Latkin). [15] The Government of this State, under its sponsored Targeted Intervention Projects, provides material and financial support to NGO's for providing prevention services to targeted groups. For this study, only the 46 injecting Drug users who have registered for the Opioid Substitution Therapy program were considered.

Measures of Centrality

Determining and analyzing centrality measures is the quantitative concept of social network analysis. One of the main uses of this analysis is to identify the most important or influencing players in a network. According to Scott (2000)[13], centrality measures help to determine the most prominent or influencing members of a network. Identification of nodes with high centrality values may help researchers to identify the influencing member in the network and plan strategic interventions. There are several measures of centrality, prominent among these being Degree, Closeness, Betweenness, Eigen Vector, and Page Rank. They are defined as follows:

Methodology

Study Design & Settings

This is an exploratory, quantitative cross sectional study. IDUs who are OST users were interviewed for this study, conducted in Chennai.

Inclusion Criteria:

The 46 IDUs using Opioid Substitution Therapy during the study period of 2015-2016 were included in the study. The forty-six IDUs were classified into three categories: i) Current users, injecting Drugs, in the last three months ii) Shadow users, switched over to oral Drug and Injecting on and Off iii) Ex -Users, not used injecting Drugs in the last six months.

Sample Selection:

As the study population is small in number, and in order to have complete information about the group, a Full Network Method was adopted for this study. A structured and well tested Questionnaire was used for data collection. The researcher himself interviewed all the participants.

Domains of this Study:

This study has used four Domains in order to identify the IDUs social networks, to indirectly measure their influential role in activities. They are as follows: Drug deals procurement and supply of illicit Drugs and act as middle men in the sharing within network. Communication identifies the prominent person who receives, communicates to and from maximum IDUs. HIV Awareness helps to identify the nodal person who creates

awareness about HIV to the maximum number of members within the group. And the last, Motivation, collects information about who and how motivates and advises the network members to go for HIV testing

Centrality Measures:

Degree, Betweenness, Closeness, Eigenvector and Page rank centrality measures were used for identifying the influencing individual IDUs within the network. Harel–Koren Fast Multiscale was used to quantify the network centrality.

Data Analysis:

The Excel-based open source soft Node XL version 1.0.1. 92 was used for analyzing the socio metric of IDU network centrality.

Ethical Consideration:

Respondents were properly briefed about the purpose of the study and informed consents were obtained. Personal information was delinked in order to maintain confidentiality and they were identified with unique code number. The Internal Review Board of School of Public Health of SRM University gave ethical clearance for this study.

Quality Control:

Pretesting of the questionnaire was carried out in order to enhance its the quality, and the entire process of obtaining data was carried out by the researcher.

Results

Characteristics of the Respondents

All the forty-six respondents were male members. Only seven percent were less than twenty-five, sixty-three percent are in the age group of 30-45 and the rest are all above forty-five. Eighty-three percent are married and HIV non-reactive. As for injecting practice, 52% belong to low volume, 26% to medium and the rest low volume and 80% are current users, 11% shadow users and 9% are ex-users.(Table.1).

Social Network Analysis of Injecting Drug Users

The different metric values and network socio-grams were provided and explained for each

of the above-mentioned activities. In each network, the nodes represent IDUs, lines between nodes represent the connection, and the arrow heads signify the directionality of connection. The different colors of the nodes denote different networks. Values of different centrality measures for each IDU and for each activity are provided in different Tables (Table 2 to Table 10) and are explained separately in the subsequent sections. For maintaining confidentiality, a Unique Identify Number (IDU) is used for representing each IDU. For making discussion simple, this study restricted its discussion to three IDUs who have secured the first three ranks.

Table 1
Shows the Socio – Demographical Details of Injecting Drug Users

(n=46)	Absolute Number	%
Gender		
Female	0	0
Male	46	100
Age		
Below 25	3	7
30-45	29	63
Above 45	14	30
Marital Status		
Married	38	83
Unmarried	8	17
HIV Status		
HIV Reactive	8	17
HIV Non-Reactive	38	83
Injecting Practice		
High Volume	24	52
Medium Volume	12	26
Low Volume	10	22
Injecting Practice		
Current User	37	80
Shadow User	5	11
Ex User	4	9

**Table:-2
Metric values buying Drugs**

IDU	Degree	In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality	PageRank
64	18	17	1	1460	0.0	0.1	8.3
28	5	4	1	348	0.0	0.0	2.5
3	4	3	1	642	0.0	0.0	1.9

**Table 3
Metric values of sharing illicit Drugs**

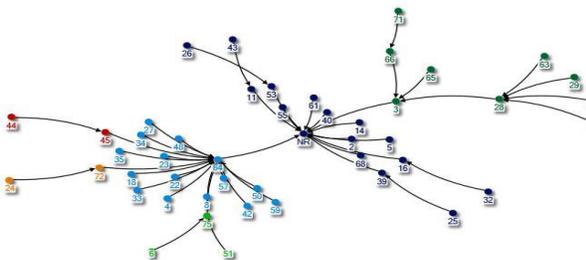
IDU	Degree	In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality	PageRank
64	9	8	1	268	0.0	0.1	4.3
3	5	5	1	60	0.1	0.0	2.5
28	5	4	1	58	0.1	0.0	2.3

Drug Domain

Table 2 Shows the social networking metrics of IDUs in relation to their purchase of Drugs. Forty-six respondents were asked **“From whom you purchase Drugs?”** Socio- Metric indicates that even though IDU-64 did not answered this question, it seems that some IDUs purchased Drug from IDU-64 only. The in-degree values of IDU-64, IDU-28 and IDU-3 are 17, 4 and 3 respectively. High in-degree value of an IDU means more members purchased Drugs from him. Also the betweenness values of these three IDUs are 1460, 348 and 642, respectively.

Pic: 1

Network structure of Buying Drug



Pic: 1 Describes the pattern of buying illicit Drug among the IDUs. Here, **Six Sub-groups** were shown in six different colors of arcs indicate that there are six different sub-networks among the forty-six IDUs. One sub-network, which consists of sixteen IDUs who had not

responded to this question. This may be due to fear of disclosing their use of illicit Drugs.

This result indicates that even though IDU-28 and IDU-3 supplied Drugs to other members, they did so only through IDU-64. These results indicate that they not only supply Drugs directly, but also indirectly, to other members. The maximum values of these two centrality measures also indicate that IDU-64 is the major supplier of illicit Drugs, as he distributes Drugs directly to sixteen IDUs and uses the IDUs 3 and 28 as bridges to connect with others. The page rank value of IDU-64 is 8.3, which shows that this IDU is well connected to already well-connected sub networks and that he supplies Drugs to others quickly in a short span of time.

Table 3 Shows the metrics of the social networking of IDUs in relation to their sharing of Drugs among themselves. Of the 46 respondents who were asked **“With whom do you share Drugs?”** The metric values indicate that majority of the IDUs shared Drugs with individual IDUs from whom they had purchased them. That is, again three IDUs - IDU-64, IDU-3, and IDU-28 - had played significant roles in sharing Drugs with others but, among the three, IDU-64 had sold and shared Drugs with majority of the network members directly, as well as indirectly. Eight network members had refused to answer this question. Overall sharing of Drugs was limited to only 21 IDU’s in the entire network.

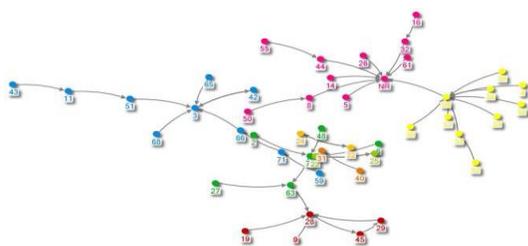
Table 4
Metric value of inward communication

IDU	Degree	In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality	PageRank
64	7	7	1	150	0.03	0.14	3.47
39	6	5	1	188	0.04	0.16	2.87
59	4	4	1	114	0.04	0.00	1.94

Table-5
Metric value of Outward communication

IDU	Degree	In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality	PageRank
64	7	7	1	312	0.0	0.1	3.3
45	5	4	1	366	0.0	0.1	2.3
51	4	4	1	18	0.2	0.0	2.3

Pic.2
Network structure of illicit Drug sharing



Pic: 2 Socio-gram shows the existence of **Eight sub groups**. The largest one is having eight members. There was also a dyad relationship in which only two members shared Drugs between themselves (IDU-24 & IDU-72) and not with others.

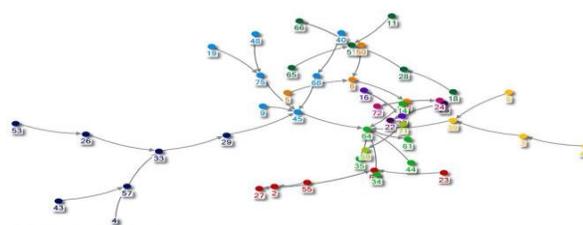
IDU-64 is the most influential nodal person as far as supplying and sharing of Drug are concerned. IDU-64 has got enrolled for OST program in the year 2013 whereas others got registered earlier in year 2008. It was identified that IDU-64 is a shadow user, whereas, IDU-28 and IDU-3 are current user. Apart from this, IDU-28 also has been working as Peer educator. If the three IDUs are motivated not to supply Drugs, then all other IDUs of this group can be easily weaned away from using illicit Drugs.

Communication Domain

To ascertain communication pattern among network members, two different questions

were posed to them. The first question is “**From whom they receive information**”? and the second one is “**To whom they contact for information**”? The former is called inward-communication and the latter is known as out-ward communication. **Table 4** shows the social networking metrics of IDUs in relation to the inward communication. The maximum values of In-Degree, Betweenness, and Page Rank indicate that IDU-64 can communicate to already well-connected maximum number of network members, but IDU-39 can do the same job quickly to smaller number of IDUs. Twenty four network members reported that they have not received any information from other network members.

Pic:-3
Networks of Inward Communication



Pic:3 Shows the existence of **Six sub groups** through which inward communication had happened among IDUs. Here, IDU-39 was centrally located and connected with other sub groups with Centrality Betweenness – 188 and Eigenvector centrality -16. Whereas, In Page Rank

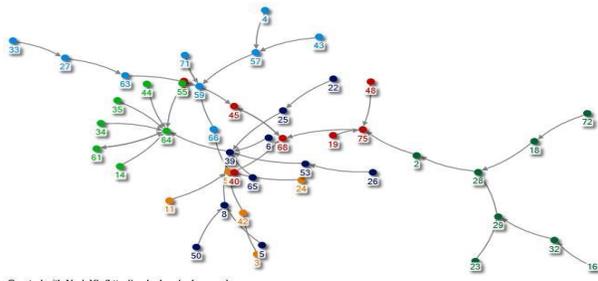
Table 6
Metric value of Received HIV Information

IDU	Degree	In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality	PageRank
39	8	7	1	578	0.01	0.10	3.71
51	4	3	1	506	0.01	0.09	1.86
57	4	3	1	168	0.01	0.07	2.02

Compare to IDU-64 shows lesser – 2.87. Thus, stands in the second influential person compare to IDU-64 though with other high values

Table 5 Shows the social networking metrics of IDUs in relation to their outward communication. The metric values indicate that 13 members approached not only IDU - 64 but also two new members: IDU-45 and IDU-51. But still, IDU-64 remains the influential nodal person as far as this activity is concerned.

Pic:-4
Networks of Outward Communication



Pic: 4 shows the existence of **Eleven subgroups** among the network members in relation to outward communication. IDU-45 had a higher brokerage capacity and finally got connected with IDU-64. This result indicates that IDU-64 had good contact with maximum number of network members, and this connection allowed him to supply Drugs and share the same with them easily. Hence, he is identified as an influential nodal person as far as the social communication domain is concerned and he is a well connected Drug dealing person. IDU-51 is a Peer Educator and current user and IDU-45 is also a current user and participates in the OST project since 2008.

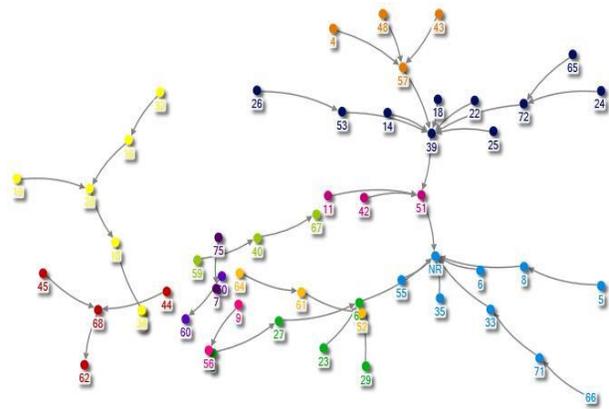
HIV Awareness Domain

The next important question is to find out whether these members are aware of the

seriousness of HIV, which was explored with the question “**How do they come to be aware of HIV**”? Table: 6 shows the social networking metrics of IDUs in relation to HIV-related information. Of the 46 respondents who were asked “**From whom they receive HIV related information**”? The In-Degree and Betweenness values indicate that three network members (IDU-39, IDU-51 & IDU-57) together were providing information about HIV to 17 other network members but among them IDU-39, who is a PLHIV, is well connected with others and does the brokerage job as well, being identified as a Good Samaritan.

It is interesting to know that both IDU-51 and IDU-39 are Peer Educators and, also, all three are ex-users. There were seven network members who did not respond to this question and 30 members replied that they didn’t receive any HIV-related information from other network members.

Pic: 5
Network structure of Received HIV Information



Pic:5 Shows the existence of **Twelve subgroups** in the network of IDUs in relation to the HIV related information they received.

Table 7
Metric value of Motivated IDUs for HIV testing

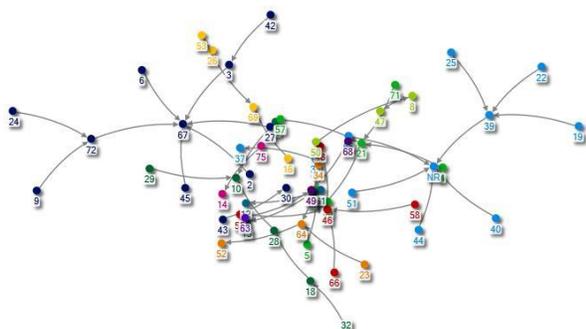
IDU	Degree	In-Degree	Out-Degree	Betweenness Centrality	Closeness Centrality	Eigenvector Centrality	PageRank
67	6	6	0	64	0.1	0.2	3.1
21	4	4	0	12	0.3	0.0	2.4
46	4	4	0	12	0.3	0.0	2.4

Motivation Domain

This section describes how network members were motivated to go for HIV testing.

Motivating to go for HIV Testing-Many members have reported that they were motivated by three members to go HIV testing for the first time, which are IDU-67, IDU-21 and IDU-46, all three of which are not in the OST program (Table.7). The metric values show that IDU-67, through his well netted connection, had motivated six members, directly, and eight members, indirectly, to go for HIV testing. Hence, he is identified as an influential person as far as this activity is concerned. He is in the formal structure of the project as a Peer Educator. Whereas IDU-67, IDU-21 & IDU-46 are not in OST program. Five network members have not responded positively to this question and there were 38 network members who reported not receiving any motivation from other network members.

Pic: 6
Network structure of Motivated for HIV testing



Pic: 6 Shows the existence of **six sub groups** regarding the HIV-test motivation factor.

Discussion:

An earlier study assessed the characteristics of network members based on attribute data sets and its relations with IDU

behaviors and other factors of interest like HIV and HCV prevalence.[15] By contrast, this study quantitatively explores the network structure of the IDUs of Chennai City and, hence, it is a pioneering study. Our study, for the first time, utilized metrics to understand IDU social networks, to identify the influential nodal persons within the IDU networks, and to explore sub-network structures in relation to various activities like selling and sharing Drugs, communicating with members, creating awareness about HIV testing and motivating members to undergo testing. Our study documents the usefulness of network analysis in the identification of influential nodal persons among network members and is similar to a study undertaken in Yunnan in China. [19]

This study established that the socio-metric network can be successfully used as one of the interventions for fostering behavioral change. In this approach, influential individuals are identified through network structures, and can be trained to be agents of change. In the case of high-risk and hard-to-reach population like IDUs, influential nodal persons may be small in number but are well connected, and they can be brought on board to spread information successfully to the greatest number of people. Moreover, as these nodal influencers are socially and emotionally connected with other members within a network, they can be trained to advise their friends to give up addiction.

Influential nodes are ranked based on centrality measures like degree, which counts the number of connections an individual has; Closeness, which measures the distances between nodes; Betweenness, which counts the number of shortest paths that go through each node' Page Rank, which identifies the node who is well connected to well-connected sub networks and, finally; Eigen vector, which quantifies the importance of a node. A node with maximum

values of Degree, Betweenness, Page Rank and Eigen vectors and with minimum value of closeness is identified as the most influential node. This study has considered the In-Degree as primary influential Centrality, followed by the other centralities.

Conclusion

This analysis identifies two influential nodal persons: IDU-64 and IDU-67. The former is well connected with other members, but he is on the wrong side- he directly and indirectly distributes and shares Drugs with the majority of members of this group. If he is corrected and motivated not to do such acts, the other members of this group can be weaned away from Drug addiction. The latter is not as well connected with other members as IDU-64, but he does the service of motivating these members to go for HIV testing. He should be recognized for his service and be rewarded.

Since the analysis of this study is based on the self-reported statements of an elusive population such as IDUs, it cannot fully explore the importance of network analysis. However, it suggests that such an analysis may help us to understand, and perhaps correct, the dynamics of existing relationships between members of the hidden IDU population. Further research studies should be undertaken on different populations in different locations to confirm the suggestions of this study.

Limitation:

The main limitation of this study is that it focused only on injecting Drug users who participate in the OST program, who have also been in the process of transitioning into non-injecting practice, and did not consider other IDUs who used private health care facilities during the study period.

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