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A systematic approach for early identification of Syphilis Infection among Men having Sex with Men in Chennai City: - A Page Rank Based Approach

Kabilan Annadurai[1], M Bagavandas[2]

[1]PhD Scholar, School of Public Health, SRM University, Chennai India, [2]Professor, School of Public Health, SRM University, Chennai India

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Corresponding Author

Address for Correspondence: Kabilan Annadurai F1, 14/355 Maduram Nagar, Periyakulathuvancherry, Chennai -600122, Tamilnadu, India
E Mail ID: kabilaaa@gmail.com

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Abstract

Background: National surveillance conducted over 12 year period (2003 -2015) indicated that though the prevalence of HIV among Men having Sex with Men (MSM) has decreased in India, it is the second highest contributor in 2015. However, the prevalence of syphilis is an increase in the past 15 years. Under reach for screening; conscious hiding or withholding information due to stigma; limited resources and difficulty in screening vulnerable. **Objective:** The primary objective of the study is to explore the feasibility of using SNA for early identification of syphilis infection among MSM. **Methodology:** All MSM with newly identified syphilis infection in Chennai City during October and December 2015 were included in the study. A total of six samples were identified from the STI clinics lead by Government Hospitals in Chennai City, India and contact tracing at two levels (exponential snow-ball sampling method) were completed by the researcher. Unlike traditional screening program, the questionnaire used had indirect questions to avoid direct confrontation that helped to reach a total of 146 MSM during Jan to Oct 2016. Overall page ranking was completed for all MSM. All were followed up and encouraged to attend RTI/STI screening clinic through peers regularly. **Results:** 24 MSMs attended syphilis RPR screening test during this 10 months study period. 12 of 13 MSM were found to be positive for syphilis had page rank value of greater than one and 1 MSM had less than one page rank value. In the case of identified negative, all (n=11) except one MSM had page rank value less than one. Statistically, correlation of page ranking with syphilis reactive value showed a strong linear positive relationship (r = 0.732) with highly significance (p-value 0.000). **Conclusion**: This study proved that contact tracing and page ranking in SNA could be an effective measure to early identify syphilis infected MSM with its high positivity rate (54.2%).

Keywords

Syphilis; Men having Sex with Men

Introduction

Different strategies have been implemented around the world to reduce the prevalence of Sexually Transmitted Infection (STI) in the past decades. India has demonstrated a steady decline in prevalence of Human Immunodeficiency Virus (HIV) in adult (15 – 49 years) population, more specifically in the last ten years. It is estimated that national level adult HIV prevalence dropped from 0.38% in 2001-03 through

0.34% in 2007 and 0.28% in 2012 to 0.26% in 2015 (1,2).

Several governmental and non-governmental based programs that were targeted on both the high-risk groups as well as the general population has contributed to this decline in prevalence (3). Men having Sex with Men (MSM), Female Sex Workers (FSW) and People with Injecting Drug (PWID) are considered as three cohorts who are at high risk for HIV/STI. In India, HIV Prevalence estimation conducted by HIV Sentinel Surveillance (HSS) and National Integrated Biological and Behavioral Surveillance (IBBS) over 12 years period (2003 -2015) indicates that prevalence of HIV among MSM positioned as second highest contributor for national prevalence in 2015 from its third position in 2003(4,5).

Though it is estimated that the prevalence of HIV among MSM in India has reduced in the past 15 years, the prevalence of syphilis is at increase (6, 7, 8, 9). Firstly, this could possibly due to under reach in identifying and screening certain cohort in conventional targeted intervention programs. This exclusion is more evident in MSM with non-feminine characteristics and their partner/spouse compared to Trans genders and MSM with feminine character population (10, 11). One of the major barriers that have been identified to contribute for increasing prevalence of syphilis among MSM is due to the stigma which contributes to conscious hiding or withholding information while self-disclosing during the screening program especially in the above mentioned group (12, 13). Secondly, screening process takes long time and resources required to complete are often limited in conventional targeted intervention programs (14). Finally, screening the spouse/partners of MSM who are highly vulnerable to infection and contribute to spreading pose a big challenge (15).

A need for a systematic approach in a rapid way to include all high-risk groups is essential. Research evidence identifies that Social Network Analysis (SNA) is an effective method to control epidemic and provide insight to long term dynamics of transmission of STI (16 17).

Social Network Analysis and Transmission of Syphilis Infection

Social networks have been used extensively from the year 1985 onwards to understand the transmission pathway and behavior pattern of infection (18). Social networks are defined by the social links between individuals that specify one or more types of relationships (19). These links represent the pathways through which information and materials can be exchanged and infections can be transmitted. Social networks can be analyzed from the perspective of individuals (ego-centric or personal) or as a collection of connected individuals and all the links between them (socio-centric). These social network analyses help in increasing the understanding of infection transmission pathway. Addressing through comprehensive approach is essential to target control efforts and prevent spread. Contact tracing, a widely used method in social network analysis helps in identifying infected cases, their recent sexual partners and in understanding the underlying transmission dynamic has been proved as a highly effective measure in the field of public health and epidemiology. (20)

The study of networks and how they relate to the propagation of infectious diseases is vital for understanding disease spread and informing disease control19. To this end, analyses of social networks of infected MSMs play an important role in understanding the syphilis infection transmission pathway among MSM and visualize their sexual MSM contacts.

This socio metric analysis allows us to predict the individual's vulnerability to infection. Prevention programs could be targeted on those individuals as early identification and appropriate treatment has been proven to contain the transmission of infection 20. Social networks can play a dual role in the spread of infection. They serve both as a route for infection transmission as well as a route for prevention through information and services exchanges (21).

Aim & Objective

To explore the feasibility of using social network analysis for early identification of syphilis infection among MSMs.

Material & Methods

Based on the Sample selection for Complete Social Network Method all MSMs who has diagnosed syphilis infection in Chennai City during three Months from October to December 2015 were taken for the study considering to focus very recent contact with other MSMs and to track early identification of infection. These has resulted with Six MSMs with Syphilis Infection from the STI clinics lead by Government Hospitals in Chennai City.

Contact tracing for those six subjects and their social network were analyzed to identify all sexual contacts and people who could influence sexual behavior. The researcher analyzed part of the structured questionnaire from a broader social network analysis that was targeted to understand syphilis infection transmission among MSM. The questionnaire had close ended indirect questions, carefully considered to avoid direct confrontation as participants are known to consciously hide their sexual activities due to stigma or delay information due to trust and confidentiality on the researcher in traditional screening programs/contact tracing method.

Only three of the domains used in the questionnaire were used for this study as they are directly related to the sexual contacts and activities. The first domain deals with Client Management (Source of referral and onward referral of clients), the second focuses on a regular sexual partner (MSM who have visitors more than once) and final domain on group sex (Engage more than 1 client at a time). The responses under the three domains of sexual activities indirectly trace the contacts, relationships, and propagation of infection within the network. Information on demographic characteristics like appearance and sexual orientation, age, marital status, residential information were also collected.

One-to-one interview with all 6 samples were conducted and exponential snow-ball sampling method was used to list out the immediate contacts, as research evidence suggests that the mentioned sampling is effective among the hidden population (22). Researcher met all six samples at several meetings to provide required assurance and developed rapport to gain trust and confidentiality. During study period from January -2016 to October-2016 the immediate contacts and referral from these six samples helped to maintain the free flow of information sharing which ensured true information are recorded. Also, each participant has identified, linked or cross referenced through his own contacts or sub-network which reassures his connectivity with the network thereby less likely to be missed during the contact tracing.

Emphasis was placed to obtain a list of MSM only and contacts other than MSM were not listed as the same is not in the scope of this study.

Overall page ranking and domain specific page ranking were completed for all MSM listed through the contact tracing. All were encouraged to attend RTI/STI screening clinic through peers regularly during this 10months study period from January-2016 to October- 2016. MSM with positive page rank value in all three domains were prioritized for screening as they could be responsible for transmission of infection within a short span of time. Hence, they were contacted more frequently i.e., three times a month compared to twice a month contact for other MSM.

The only exclusion criterion applied was MSM with no page rank value. Blood investigations (Rapid Plasma Reagin -RPR, a screening test for syphilis) were completed for those attended MSM by the Laboratory Staff in STI screening clinic (23).

Ethical considerations

Ethical approval obtained from SRM University Ethical Committee Board and study progress was reported periodically to them. The purpose of the study was clearly explained and verbal consent was obtained from all participants. The unique Identification number was allocated to all the study population in order to maintain anonymity.

Data Analysis

Data collected were entered into Node XL software (version 1.0.1. 92) for analyzing the networks of MSMs. Harel–Koren fast multi-scale was used to measure the network centrality.

In this study, page rank centrality measure was adopted to identify high priority MSM for screening and to determine the propagation of infection among MSMs. Page Rank Centrality measures the number of overall connectivity of an individual in a social network. This measure weighs combinations of centrality measures i.e., individual's direct and indirect connections (Degree); central position (Eigenvector) and proximity (Closeness) to other sub networks under each activity. Higher the weighing/page rank value, higher their connectivity with other members / sub-network. (24)

Results

Overall Domain page ranking results:

A total of 146 MSM contacts were listed following two levels of contact tracing from the initial six samples. The results of the page ranking for the study population in all three domains are given in Table 1.

85 of 146 MSM were identified to have positive page rank value. Here, Picture:2 gives a glimpse of stages and MSMs identification. Table 2 presents the baseline characteristics of study participants i.e., MSM who underwent syphilis screening. Of the 24

MSMs who underwent a syphilis RPR screening test, 13 MSMs were found positive for syphilis and 11 were non-reactive. Further, among those MSM who were identified positive 12 of them had page rank value of greater than one and 1 MSM had less than one page rank value. In the case of identified negative, all except one MSM had page rank value less than one.

Statistically, Correlation coefficient of MSM page rank with typology (r = 0.236; p-value 0.267) and age (r = -0.004; p-value 0.986) had no significant with syphilis test results. But, correlation of page ranking with syphilis reactive value (r = 0.732) showed a strong linear relationship with highly significance (p-value 0.000).

Picture:3 illustrates the socio gram of all MSM who presented with positive page rank value including the initial six samples. The color coding represents the subnetworks and the arrows indicate the networking pathway. The arrows allow us to understand the relationship and the contact source of information. The bigger circle indicate MSM with syphilis infection and their pathway. The initial six samples with whom the contact tracing was initiated are highlighted in the red box.

Similarly, all three domains were analyzed separately to understand existing sub networks, pathways of infection spread (betweenness, closeness and degree value) and to identify MSM who are vulnerable to infection.

Domain 1. Client Management

25 of the 84 MSM were identified to have page rank value of greater than one based on the referral they receive to and from their contacts. Detailed socio gram depicting contacts and the networking for MSM with page ranking less than and greater one is shown in Picture:4. A total of 12 sub-networks were identified. MSM Unique Identification Number (UID) UID-79 had high betweenness centrality value (CB932); UID-1D+ had high closeness centrality value (CC1) and UID-2J+ had high degree centrality values (CD2).

Domain 2. Regular sexual partner

Of the 96 MSM who reported to have regular sexual partner, 27% were identified to have page rank value of greater than one based on their frequency with their partner. Picture:5 illustrates the detailed socio gram of contacts and the networking for MSM with positive page ranking under this domain. A total of 10 sub-networks were identified. UID-1D+ had high betweenness centrality value (CB-2625); UID-5A+ had high closeness centrality value (CC0.250) and UID-5A+ had high degree centrality values (CD4).

Domain 3. Group Sex

21% of the total 65 MSM who reported to engage in group sex had page rank value of greater than one. Detailed socio gram depicting contacts and the networking for MSM with page ranking less than and greater one in this domain is shown in Picture:6. A total of 9 sub-networks were identified. UID-2G+ had high betweenness centrality value (CB1111); UID-E+ had high closeness centrality value (CC0.250) and UID-3E+ had high degree centrality values (CD4).

Discussion

This study has explored the feasibility of using social network analysis for early identification of syphilis infection among MSMs. Contact tracing and page rank centrality measures on three sexual activities i.e., client management, regular partner and group sex were used to identify MSM with a high risk of infection. The indirect questions posed to MSM during the contact tracing method had played a vital role to collect all possible contacts and their networks (10, 11). Hiding and delaying information is common in the conventional program as questions are focused on the MSM directly. However, in this study questions were related to third party or friends which assisted in MSMs disclosing openly and are less likely to hide. This allows enlisting almost all MSM within the network. The scope of misdirecting and wrong information is less as the listed MSM are cross referenced/listed again within their contacts/sub networks.

MSM with highest page ranking in the client management domain are the brokers who are highly influential within the network. Identification of such MSM helps in utilizing them for infection prevention activities and mobilize other MSM for screening clinics. More MSM with higher page ranking was noted under regular partner domain, which indicates that the risk and vulnerability are higher as unsafe sex activities are common with partners. Less number of MSM with higher page rank value in group sex domain is supportive of the existing research that explains the stigma to disclose group sex activities (25).

Identification and listing of 146 MSM (13 newly identified syphilis positive MSM) within a short duration and limited resource is a key achievement in this social network analysis whereas early identification of MSM is a challenge in a conventional

program. Also, those infected were identified at their early stage of infection unlike in conventional program where MSM are most likely to attend screening clinics during their secondary and tertiary stages only. (26)

Overall, 4 of the 6 initial samples in the study who were known cases of syphilis scored page rank value of greater than one. Also, 12 of the 13 MSM who were tested positive had higher page rank value. This implies that MSM with higher page ranking play a major in the transmission of infection. 11 MSM who were tested negative should not be ignored but regular follow up and education on safe sex practice to be continued to prevent infection and control transmission.

This positivity rate is extremely high compared to the previous two year period study among self-reported MSM conducted in India which resulted in positivity rate of 21.5 % only. (27,28).

MSM who are active in a sexual act through regular partners, or who engage in group sex activities and also who refer his regular partner to other MSM will have the highest connectivity within the network. They presented with higher page rank value either in each domain or in overall domain value. This information could be used to identify and predict the individual MSM who can influence the spread of infection and also visualize the transmission pathway using this analysis (29, 30).

This study highlights the advantage of using social network approach which yielded a positivity rate of 54.2%.

Conclusion

From this study, it can be concluded that the social network analysis especially contact tracing and page ranking can be used to early identify syphilis infected MSM and to understand transmission of syphilis among MSM. Page rank centrality measure used illustrated the potential routes of spread of infection and predicted the susceptible cases. Page rank value and the syphilis infection status showed strong positive linear relationship (r = 0.732) with high statistical significance (p-value 0.000). This implies that MSM with higher page rank value are at high risk of syphilis and are nodal person in the spread of infection within their network. This study had also proved to have yielded high positivity rate which indicates the effective use of resource and time.

Limitation of the study

As the study relied on self-reported information only, increasing other domains such as motivation; communication etc. could reduce any conscious hiding information that is not uncommon in this elusive study population.

Authors Contribution

Bothe authors have contributed equally.

Acknowledgement

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Tables

TABLE 1 CHARACTERISTICS OF PAGE RANK VALUE BASED ON THE THREE DOMAINS

Domain Name	Number of MSM with page rank value > 1	Number of MSM with page rank value < 1	Number of MSM with no page rank value	TOTAL
Client Management	25	59	62	146
Regular Partner	26	70	50	146
Group Sex	14	51	81	146
All domains combined	23	62	60	146

TABLE 2 BASELINE CHARACTERISTICS OF MSM WHO UNDERWENT SYPHILIS SCREENING

Description	No of MSM (n = 24)	In percentage (%)	p - value
MSM Typology			
With Feminine Characteristic (receptive)	8	33.3	0.267
With Non - Feminine (receptive & penetrative)	16	66.7	
Age			

Less than 25	10	41.7	0.986
Between 26-29	12	50	
30 and Above		8.3	
Page Rank			
Less than 1 More than 1	10 14	41.7 58.3	
Syphilis Status			
Reactive	13	45.8	
Non-Reactive	11	54.2	0.000

Figures

FIGURE 1 GLIMPSE OF STUDY FLOW FOR IDENTIFICATION OF MSMS FOR SYPHILIS SCREENING

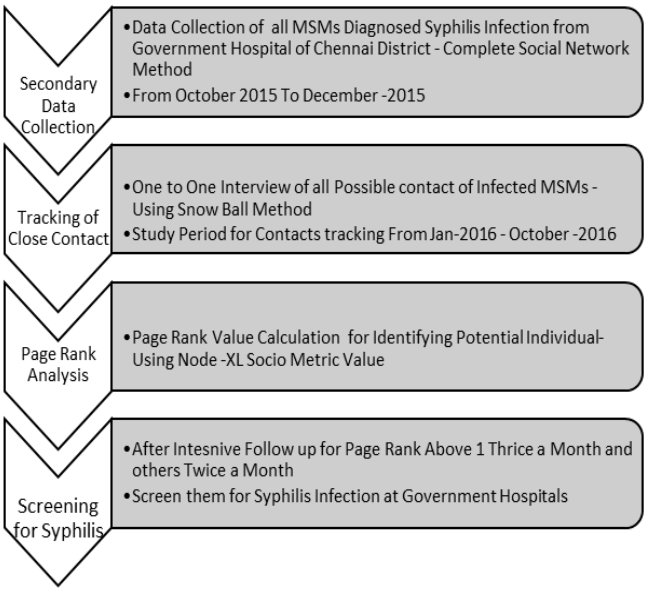

FIGURE 2 GLIMPSE OF IDENTIFICATION OF MSMS – PAGE RANK BASED

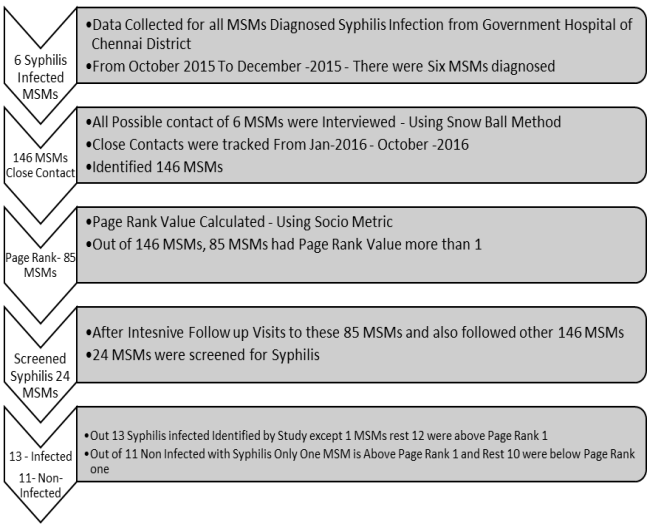

FIGURE 3 SOCIO GRAM OF MSM'S WITH PAGE RANK VALUE OVERALL NETWORKS BASED ON THREE SEXUAL ACTIVITIES

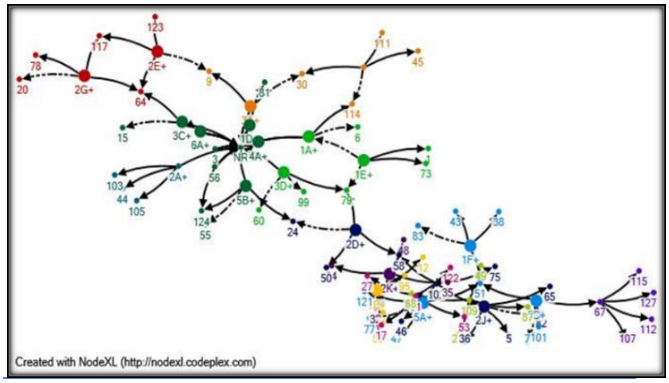

FIGURE 4 SOCIO GRAM OF MSM'S WITH POSITIVE PAGE RANK VALUE FOR THE CLIENT MANAGEMENT DOMAIN

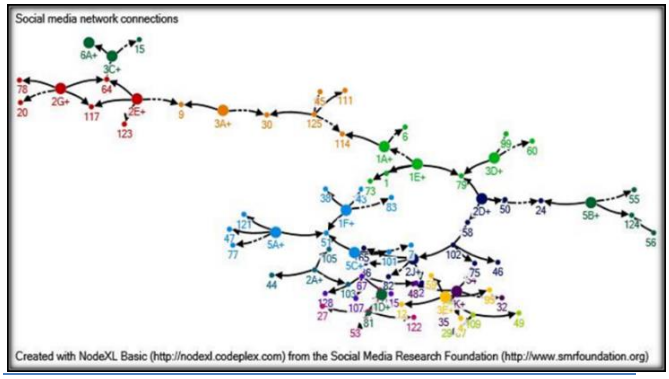

FIGURE 5 SOCIO GRAM OF MSM'S WITH POSITIVE PAGE RANK VALUE BASED ON THE FREQUENCY/REGULARITY