2019

Characteristics of gay, bisexual and other men who have sex with men with multiple diagnoses of infectious syphilis in British Columbia, Canada, 2005-2014

Stephanie Konrad

Donna B. Mak
The University of Notre Dame Australia, donna.mak@nd.edu.au

Troy Grennan

Bernadette Zakher

Bobbi Brownrigg

See next page for additional authors

This article was originally published as:
Konrad, S., Mak, D. B., Grennan, T., Zakher, B., Brownrigg, B., Ogilvie, G., Morshed, M., Tyndall, M., Gilbert, M., Krajden, M., & Wong, J. (2019). Characteristics of gay, bisexual and other men who have sex with men with multiple diagnoses of infectious syphilis in British Columbia, Canada, 2005-2014. *Sexually Transmitted Diseases, 46* (7), 423-428.

Original article available here:
https://doi.org/10.1097/OLQ.0000000000000995

Konrad, S., Mak, D., Grennan, T., Zakher, B., Brownrigg, B., Ogilvie, G., Morshed, M., Tyndall, M., Gilbert, M., Krajden, M., and Wong, J. (2019). Characteristics of gay, bisexual and other men who have sex with men with multiple diagnoses of infectious syphilis in British Columbia, Canada, 2005-2014. *Sexually Transmitted Diseases, 46*(7), 423-428. doi: 10.1097/OLQ.0000000000000995

Title: Characteristics of gay, bisexual and other men who have sex with men with multiple diagnoses of infectious syphilis in British Columbia, Canada, 2005 to 2014

Authors: Stephanie Konrad MSc[1], Donna B Mak MBBS MPH[2], Troy Grennan MD MSc[3,4], Bernadette Zakher MBBS MPH[5] Bobbi Brownrigg RN MBA[3], Gina Ogilvie MD MSc DrPH[3,4], Muhammad Morshed PhD[4,5], Mark Tyndall MD ScD[3,4], Mark Gilbert MD MHSc[3,4], Mel Krajden MD[4,5] , Jason Wong MD MPH[3,4]

Affiliations: [1]Canadian Field Epidemiology Program, Public Health Agency of Canada; [2]University of Notre Dame, Australia and Department of Health, Government of Western Australia; [3] British Columbia Centre for Disease Control; [4]University of British Columbia; [5]BC Centre for Disease Control Public Health Laboratory; [5]Oregon Health Sciences University, Portland VA Medical Center

Corresponding Author:

Jason Wong, BMSc MD MPH
Physician Epidemiologist, Clinical Prevention Services
BC Centre for Disease Control
655 West 12th Avenue
Vancouver, BC V5Z 4R4
Jason.Wong@bccdc.ca
Phone: 604-707-5615
Fax: 604-707-5604

Acknowledgements: The authors would like to thank the syphilis nurses, the STI team and PHL Staff at BCCDC for their contributions to this study.

Word counts: Summary (30), Abstract (250), Text (3000)

Number of references: 31 (max 30)

Number of figures: 2

Number of tables: 2

Conflict of interest: The authors declare they have no conflict of interests.

Sources of support: None

Short Summary (<30 words): A descriptive study of individuals with ≥4 syphilis diagnoses in BC, Canada, demonstrated a group of MSM living with HIV; approximately half could be linked through sexual or venue-based networks.

Abstract (max 250)

Background: Infectious syphilis has increased substantially over the past decade. Targeting limited public health resources towards subpopulations with multiple re-infections may have a large impact in reducing onward transmission within a community.

Methods: A chart review was conducted for individuals with ≥4 infectious syphilis diagnoses between 2005 and 2014 (the top 1% of all syphilis diagnoses in British Columbia, Canada). We characterized the socio-demographics, partner notification outcomes and social network.

Results: Between 2005 and 2014, there were 30 individuals with ≥4 syphilis diagnoses, accounting for 139 diagnoses. All were men who have sex with men and 29 (96%) were HIV-positive. Of the 139 diagnoses, 65% occurred in the early latent stage of infection, 22% in the secondary stage and 14% in the primary stage. The median number of sexual partners per diagnosis was five (range=1-50). Among the 838 partners reported, 79% were notifiable, 53% were notified and 23% were reported to be tested and/or treated. Sexual network mapping showed that almost half of the members of this group could be linked to one another either directly or indirectly via partners over ten years. Social network mapping demonstrated high connectivity, with four venues associated with almost two-thirds of the study population.

Conclusion: The connectivity and recurrent diagnoses in this study population suggest potential benefits of targeted interventions to individuals with multiple diagnoses and their partners. Our study highlights the need for enhanced care, increased syphilis testing frequency, and exploring alternative preventative methods among individuals with syphilis re-diagnoses to reduce syphilis incidence.

Key Words: syphilis; repeat diagnoses; gay, bisexual and other men who have sex with men; sexual network; partner notification outcomes

INTRODUCTION

Infectious syphilis rates have been increasing in many high-income countries including Canada, United States, and Europe,(1-3), driven predominantly by diagnoses among gay, bisexual, and other men who have sex with men (MSM).(1-3) In British Columbia (BC), syphilis notifications nearly doubled from 6.8 to 11.9 per 100,000 between 2005 and 2014, with MSM accounting for 71% of diagnoses.(4) Decreased condom use, changes in risk perceptions and increased testing have been suggested as contributing factors to the increasing rates.(5,6)

The increase in syphilis incidence is particularly challenging in the context of limited and even decreasing public health resources.(7,8) Thus, there is a need to target and prioritize public health services to those most likely to benefit. Studies have shown that individuals with re-infections are part of larger sexual networks, have higher transmission rates, and are at increased risk of re-infection compared to individuals with single infections.(9-11) In fact, some jurisdictions have syphilis epidemics with high proportions of syphilis re-infections.(12) Factors associated with syphilis re-infection include HIV co-infection, substance use and the stage of syphilis infection (i.e. secondary or early latent).(12-17) These findings support the notion that individuals with multiple syphilis infections may belong to densely connected high-risk sexual networks.(15,17) Interventions targeted at these networks may be an effective strategy to controlling syphilis.(18,19)

Here, we characterized the socio-demographics, partner notification (PN) outcomes and social networks of individuals with a high number of repeat syphilis diagnoses in order to inform public health interventions.

METHODS

Syphilis investigation

Current Canadian guidelines recommend risk-based syphilis screening. Specifically for MSM, those who report unprotected sex in the preceding year are recommended to be screened for syphilis and other STIs(20). Additionally in BC, people living with HIV (PLHIV)are recommended to be screened annually or every 3-6 months if they report risk behaviours or symptoms,(21) which have been in place since 2011 (personal communication, Dr. Rolando Barrios).

In BC, syphilis laboratory testing, case follow-up and counselling, and epidemiological data collection and analysis are centralized at the BC Centre for Disease Control (BCCDC), yielding a complete census of all cases. From 2005-2014, the syphilis screening algorithm consisted of rapid plasma regain (RPR) first and if reactive, a treponemal test (usually *Treponema pallidum* particle agglutination test [TPPA]). If TPPA is weakly positive, then a secondary treponemal test (e.g. line immunoassay) was used to confirm the diagnosis. Clinicians could also use dark field microscopy or submit a sample for nucleic acid amplification testing to diagnose syphilis.

All positive syphilis results are reviewed by a team of expert STI physicians who assess, diagnose, stage, and recommend treatment based on historical syphilis test results and in consultation with the testing provider and/or patient. Case definitions for infectious syphilis (i.e. primary, secondary, or early latent stages) are described in our routine surveillance report.(4)

Nurses at the BCCDC ("syphilis nurses") follow-up all syphilis cases in BC who systematically collect details on demographics, risk factors (e.g. MSM), and HIV co-infection (including HIV viral load since 2008). Syphilis nurses also perform or coordinate PN (the process of identifying, informing, testing and treating sexual partners who are potentially exposed to syphilis) to prevent transmission and minimize complications of infections.(22) Information on syphilis cases and their partners are recorded in the STI Information System (STI-IS), the provincial STI database, which includes information on all reportable STIs (i.e. chlamydia, gonorrhea, and syphilis).

The trace back period for PN is 3 and 6 months plus duration of symptoms for primary and secondary syphilis, respectively, and 12 months for early latent syphilis. PN can be completed by the case (i.e. index referral) or by a healthcare provider (such as the testing provider, syphilis nurse or other public health nurse, i.e. provider referral). If the case preferred to do his/her own PN or another provider completed the PN, the syphilis nurse follows-up with the case or provider to ensure PN occurred and records this information in the index case's and/or the partner's chart. A partner chart is created when the syphilis nurse is able to reach the partner and verify at least two personal identifiers (e.g. name and date of birth).

Data sources

Using STI-IS, all individuals in BC with infectious syphilis diagnoses between January 1, 2005 and December 31, 2014 (the study period) were identified. Data specific to each diagnosis was extracted (age, gender, ethnicity, region of residence, stage of syphilis infection, HIV status at time of diagnosis, and viral load in the three months prior to syphilis diagnosis, when available). Also, any chlamydia, gonorrhea or infectious syphilis diagnoses from inception of the database (1998) to 2014 were obtained for these individuals. STI co-infections (chlamydia or gonorrhea) were defined as a diagnosis within a one-month window of the syphilis diagnosis date. History of an STI (chlamydia, gonorrhea or syphilis) was defined as ever having had a diagnosis prior to one-month before the syphilis diagnosis date.

A chart review was conducted to determine PN outcomes and create sexual and venue based network maps for each diagnosis among individuals with four or more syphilis diagnoses during the study period. A cutoff of four was chosen as they represented the top 1% of individuals diagnosed with syphilis during our study period and may represent a core group, similar to the rationale for a study of syphilis re-infections.(12) We collected information on the total number of partners, number of notifiable partners, number of notified partners, and number of partners tested/treated. Anonymous partners were those whose identity was unknown to the case. 'Tested/treated' were combined as BCCDC guidelines recommend treating sexual partners exposed within 90 days of diagnosis and/or symptom onset regardless of test results.(23) Where possible, we assessed partner outcomes, specifically any syphilis

diagnoses and HIV status during the study period. We also collected information about venues for seeking or meeting sexual partners, including online sites.

Analyses

Descriptive statistics were used to describe individual- and diagnosis-specific characteristics. Chi-square or Fisher's exact tests were used to compare categorical variables and Kruskal-Wallis test to compare medians. Statistical significance was set at $p<0.05$. Data was analyzed using SAS 9.4 software (Cary, NC).

Two network maps were developed. A sexual network map included all sexual partners of syphilis cases (i.e. four or more syphilis infections between 2005 and 2014), including anonymous partners during the study period. In this map, a partner's unique STI-IS identifier was used to make linkages with other cases and partners. A second map focused on social networks and described reported venues for meeting sexual partners or engaging in sex**.** Social network mapping was conducted through Pajek 4.04 (Ljubljana, Slovenia).

Ethics

This work was completed to support the surveillance for the provincial syphilis epidemic response under BCCDC's public health mandate. Thus, ethics approval was not required.

RESULTS

Between 2005 and 2014, there were 3285 cases of infectious syphilis diagnoses among 2720 unique individuals. Fifteen percent (412/2720) had more than one syphilis diagnoses: 305 (11%) had two, 76 had three (3%) and 30 (1%) had four or more diagnoses which together, accounted for 30% (977/3285) of all syphilis diagnoses in BC during the study period.

Thirty individuals had four or more syphilis diagnoses during the study period (range: 4-8) for a total of 139 diagnoses. All 30 individuals were MSM, 24 (80%) self-reported as Caucasian and 28 (93%) were HIV-positive at their earliest syphilis diagnosis. One individual seroconverted between their earliest and latest syphilis diagnosis. At the time of their earliest diagnosis, all cases but one resided in the Greater Vancouver area. Mean age of cases was 41.2 years (standard deviation [SD]: 7.4) and 47.3 years (SD: 7.5) at earliest and latest diagnosis, respectively. At the time of the earliest diagnosis, 14 (47%) had at least one prior chlamydia or gonorrhea infection (Table 1).

Among the 139 diagnoses, 90 (65%) were diagnosed in the early latent stage, 30 (22%) in the secondary stage and 19 (14%) in the primary stage. The proportion of syphilis diagnosed in the primary or secondary stage generally decreased from 47% to 30% from the first to the fourth diagnoses, respectively. Eight diagnoses (6%) had a concurrent chlamydia or gonorrhea infection. HIV viral load data was available starting in 2008. Ninety-five (89%) of the 107 diagnoses among HIV-positive cases had their viral load measured at the time of syphilis diagnosis. Viral load was undetectable in 66% of the diagnoses (Table 1).

The time from one diagnosis to the subsequent diagnosis was calculated, yielding 109 intervals. Forty-two (39%) intervals were less than 365 days. The median interval between syphilis diagnoses was 452 days (interquartile range [IQR]: 288-787 days).

Partner notification outcomes

PN details were available for 111 of the 139 diagnoses (Table 2). Overall, 838 partners were reported, of which 667 (79%) were notifiable, 440 (53%) were notified and 191 (23%) were tested and/or treated. The median number of sexual partners reported per diagnosis was 5 (IQR: 2-11). The median number of sexual partners did not differ significantly among the three stages of infection (p=0.21, results not shown).

Out of all 139 diagnoses, 38 (27%) reported at least one anonymous partner, representing at least 171 anonymous partners. Multiple investigations reported "multiple" anonymous partners without a specific number and were not included in any further PN outcomes or networks.

The index cases assumed responsibility for their own PN in 35% of the investigations; this increased over the study period, from 14% (4/28) in 2005-2007 to 23% (8/35) in 2008-2010 to 47% (36/76) in 2011-2014. A higher proportion of partners were notifiable (p<0.01) by index referral when compared with provider referral. The proportion of partners notified or tested/treated did not statistically differ (Table 2).

Over these three time periods, the proportion of partners notified increased from 29% in 2005-2007 to 47% in 2008-2010 and lastly 68% in 2011-2014 (p<0.01), while the proportion of partners tested/treated remained similar.

Sexual and social networks

Figure 1 depicts the sexual network of the 30 cases and 811 unique partners (i.e. excluding duplicates or the study cases reported as partners) over the 10-year span. The largest cluster linked 390 partners and 10 cases, and represented 48% of the network. The second largest clusters linked 92 partners and 4 cases, representing 11% of the network.

Twenty-two (74%) cases and 43 (32%) diagnoses had recorded data on venues or sites where sexual encounters occurred or sexual partners were met. While the majority of venues/sites were specifically named, types of venues were also reported (e.g., bathhouse, bars). Online dating sites and bathhouses were most commonly reported, by 19 and 12 cases, respectively. Figure 2 shows a network map between 19 cases and the specifically named venues/sites. The network highlights two online dating sites (depicted as a blue triangle) reported by 7 and 5 cases, along with two physical venues (depicted as green triangles) reported by 4 cases each (Figure 2).

Partner characteristics

Of 811 unique partners reported, 123 individuals had a STI-IS identifier recorded in the index case's chart. Two STI-IS identifiers were invalid, yielding 121 partners that were included in this analysis. During

the study period, 51 (43%) partners had at least one syphilis diagnosis. These 51 partners accounted for 84 diagnoses between 2005 and 2014. Repeat diagnoses were seen for 25 (50%) of these contacts. Specifically, 17 (33%) and 8 (16%) had two and three infections within the study period, respectively. Among those with a syphilis diagnosis, all were MSM and 43 (84%) were HIV-positive. One person declined testing and 7 were HIV-negative. No differences in HIV status or STI diagnoses were identified between partners reported by cases included in the two largest sexual network clusters and those reported by cases outside these two clusters (Chi-Square, $p>0.05$, results not shown).

DISCUSSION

Our review of individuals with four or more syphilis diagnoses demonstrated a group of MSM of which the majority were HIV-positive and half had a history of another STI at their earliest diagnosis. Most were diagnosed in the early latent stage of infection and of those who were living with HIV, about two-thirds had an undetectable viral load around the time of the syphilis diagnosis. Approximately half of these individuals could be linked through sexual and venue-based networks.

One study in Belgium of individuals with five or more syphilis diagnoses over a 20-year period reported similar findings, with all individuals being MSM, HIV-positive, and on antiretroviral therapy.(12) Similarly, other studies that used varying definitions of repeat infection, including 2 or more syphilis diagnoses within a 3-,(16,24) 4-,(13) 5-,(25), or 12-year period (14), reported MSM and HIV co-infection were common among those with repeat infection.

Almost two-thirds of the diagnoses in our study population occurred in the early latent stage, similar to other studies.(12,13) The large proportion of diagnoses in this asymptomatic early latent stage of infection may suggest that this group is routinely testing for syphilis, potentially as part of HIV care.(21) However, diagnosis in the early latent stage of infection may also suggest a potentially long period of infectiousness increasing the risk of transmission. Interventions aimed at increasing the frequency of syphilis testing and raising awareness of signs and symptoms in individuals with repeat diagnoses have been suggested as a particularly effective strategy to control syphilis (26) and new testing modalities like online testing services being implemented in BC, the 'GetCheckedOnline' program, could help improve accessibility to syphilis testing.

The majority of our study population were HIV-positive, on antiretroviral therapy, and virologically suppressed. This suggests this group is engaged in routine HIV care and achieving viral suppression, reducing HIV transmission potential. However, given that most partners were similarly HIV co-infected and many had multiple syphilis diagnoses during our study period, seroadaptive behaviour (i.e. choosing partners who have the same HIV serostatus) and condomless sex may play a role in the transmission of syphilis in this network.(27,28) While enhanced counseling and education may be beneficial, re-diagnoses among our study population and their partners and history of other STIs suggest ongoing sexual behaviours putting them at risk for STIs. Therefore, other strategies like a biomedical preventative measure may be an appropriate and effective intervention to reduce subsequent STIs, as shown in a recent pilot study of doxycycline prophylaxis.(29) Two similar pilot studies of doxycycline

prophylaxis are underway in BC, led by local researchers and members of our BCCDC team. If effective, this may be an intervention that can prevent syphilis acquisition and transmission within this sexual network.

Our study population reported a median of five partners per syphilis diagnosis, compared with three in a previous study of a random sample of syphilis cases among MSM in BC,(30) suggesting this group is part of dense sexual networks. Half of partners reported by our study population were not notified, partly due to incomplete partner information and/or anonymous partners. While this finding is similar to our previous study,(30) improving engagement of this group and their partners may be a particularly important strategy to control syphilis given the infectiousness of syphilis and our finding of high connectivity in this network. Indeed, over 40% of partners whose outcomes were known were diagnosed with syphilis or almost 10% of all partners reported, higher than in our previous study.(30)

Finally, our analysis found two networks that linked almost half of the cases, despite limitations of self-reporting, recall bias, and anonymous or incomplete partner information. Several networks were linked by only a few partners who may be equally important contributors, particularly if they are not being tested and/or treated as frequently. Together, the cases and their partners accounted for 223 or 7% of all syphilis diagnoses in BC in the study period demonstrating the disproportionate burden of syphilis infections borne by a small group of individuals. Thus, enhanced public health resources towards this group and their networks can have a large impact in the overall syphilis epidemic.

Venue-based network analyses can help complement PN by identifying spaces that may be associated with higher risk of syphilis transmission.(31S) We found four venues that linked almost two-thirds of our cases in the venue-based network. Targeting these venues to communicate public health messages and access to syphilis testing, such as on-site testing, may help reach this network.

Notably, our network diagram was depicted in a compressed format over the 10-year period and does not show the dynamic and evolving nature of partnerships over time. We have begun to systematically collect partner information to better understand networks that may be driving the syphilis epidemic, such as partners who may be important bridges between high-risk individuals.

A strength of our study is that it encompasses the entire BC population over a long period of time. However, by requiring a set number of diagnoses within a set period, there is a bias towards individuals who remained in BC for a sufficient period of time to acquire infections and be diagnosed as well as those that test more frequently. Also, we may have missed individuals who moved out of BC after their initial syphilis diagnosis. Nevertheless, the persistence of the group over a long period of time suggests that this is a stable group (10) and that targeting individuals with multiple syphilis infections and their networks could have a significant influence on rates of syphilis in the community. Another concern is the potential for misclassification of treatment failure and a syphilis re-diagnosis. However, due to the centralization of syphilis data and the review of each diagnosis by a small number of syphilis physicians, this misclassification is likely minimal. Additionally, our network depictions were subject to recall bias, missing, incomplete, or anonymous partner data and thus only represented a partial network. Lastly, routine or more frequent syphilis testing could have led to the higher number of diagnoses among this

group. We have found a higher proportion of syphilis diagnosed in the early latent stage among PLHIV, which may reflect more frequent screening.

CONCLUSION

Our study found that focusing on persons with syphilis re-infection can be a useful approach to identifying networks engaged in high risk sexual behaviour. Characterizing these networks can target public health resources to individuals most likely to benefit from enhanced care and counselling, syphilis testing, and potential biomedical methods to prevent re-infection and reduce onward syphilis transmission.

REFERENCES

(1) Public Health Agency of Canada. Report on Sexually Transmitted Infections in Canada: 2012. 2015; Available at: http://www.phac-aspc.gc.ca/sti-its-surv-epi/rep-rap-2012/index-eng.php. Accessed December 18, 2016.

(2) European Centre for Disease Prevention and Control. Annual epidemiological report, 2016 - Syphilis. 2016; Available at: http://ecdc.europa.eu/en/healthtopics/Syphilis/Pages/Annual-epidemiological-report.aspx. Accessed January 5, 2017.

(3) Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance, 2015. 2016; Available at: https://www.cdc.gov/std/stats15/. Accessed December 18, 2016.

(4) BC Centre for Disease Control. STI annual report, 2014. 2015; Available at: http://www.bccdc.ca/health-professionals/data-reports/annual-surveillance-reports. Accessed December 18, 2016.

(5) Mayer K. Old pathogen, new challenges: a narrative review of the multi-level drivers of syphilis increasing in American men who have sex with men. Sex Transm Dis 2018 February 20;ePub.

(6) Savage EJ, Marsh K, Duffell S, Ison CA, Zaman A, Hughes G. Rapid increase in gonorrhoea and syphilis diagnoses in England in 2011. Euro Surveill 2012;17(29):1-4.

(7) Leichliter JS, Heyer K, Peterman TA, Habel MA, Brookmeyer KA, Arnold Pang SS, et al. US Public Sexually Transmitted Disease Clinical Services in an Era of Declining Public Health Funding: 2013-14. Sex Transm Dis 2017;44(8):505-509.

(8) Cuffe KM, Leichliter JS, Gift LT. Assessing STD Partner Services in State and Local Health Departments. Sex Transm Dis 2018;45(6):e33-e37.

(9) Gunn AR, Fitzgerald S, Aral GO. Sexually transmitted disease clinic clients at risk for subsequent gonorrhea and chlamydia infections - possible 'core' transmitters. Sex Transm Dis 2000;27(6):343-349.

(10) Richert CA, Peterman TA, Zaidi AA, Ransom RL, Wroten JE, and Witte JJ. A method for identifying persons at high risk for sexually transmitted infections: Opportunity for targeting interventions. Am J Pub Hlth 1993;83(4):520-4.

(11) Jolly AM, Wylie JL. Gonorrhoea and chlamydia core groups and sexual networks in Manitoba. Sex Transm Infect 2002;78(Suppl I):i145-51.

(12) Kenyon C, Lynen L, Florence E, Caluwaerts S, Vandenbruaene M, Apers L, et al. Syphilis reinfections pose problems for syphilis diagnosis in Antwerp, Belgium - 1992 to 2012. Euro Surveill 2014;19(45):pII=20958.

(13) Kassem AM, Bartschie J, Carter KK. Characteristics of persons with repeat syphilis - Idaho, 2011-2015. Sex Transm Dis 2018 March 14;ePub.

(14) Dolan G, Chauhan M, Foster K, Basta M, Bushby S, White C, et al. Factors associated with repeat diagnosis of syphilis in genitourinary medicine (GUM) clinic attendees in the North East of England, 2002-2014. Inter J STD & AIDS 2018;0(0):1-10.

(15) Brunham RC. Core group theory: A central concept in STD epidemiology. Venereol 1997;10:37-39.

(16) Jain J, Santos GM, Scheer S, Gibson S, Crouch PC, Kohn R, et al. Rates and correlates of syphilis reinfection in men who have sex with men. LGBT Hlth 2017;4:232-6.

(17) C. M. Schumacher. Identifying, characterizing and predicting the role of core groups in syphilis epidemics. Baltimore, Maryland: Johns Hopkins University; 2008.

(18) Juher D, Saldana J, Kohn R, Bernstein K, Scoglio C. Network-Centric Interventions to Contain the Syphilis Epidemic in San Francisco. Scientific Reports 2017;7:6464.

(19) Steen R, Elvira Wi T, Kamali A, Ndowa F. Control of sexually transmitted infections and prevention of HIV transmission: mending a fractured paradigm. Bull World Health Organ 2009;87:858-865.

(20) Canadian guidelines on sexually transmitted infections: Section 6.3 Specific populations – Men who have sex with men (MSM) / Women who have sex with women. 2013; Available at: https://www.canada.ca/en/public-health/services/infectious-diseases/sexual-health-sexually-transmitted-infections/canadian-guidelines/sexually-transmitted-infections/canadian-guidelines-sexually-transmitted-infections-40.html. Accessed Dec 15, 2018.

(21) BC Centre for Excellence in HIV/AIDS. Primary care guidelines for the management of HIV/AIDS in British Columbia. 2015; Available at: http://www.cfenet.ubc.ca/sites/default/files/uploads/primary-care-guidelines/primary-care-guidelines_015-09-15.pdf. Accessed October 2, 2017.

(22) Centers for Disease Control and Prevention. Recommendations for Partner Services Programs for HIV Infection, Syphilis, Gonorrhea, and Chlamydial Infection. MMWR 2008;57:Dec 15-1-63.

(23) BC Centre for Disease Control. British Columbia treatment guidelines. Sexually transmitted infections in adolescents and adults. 2014; Available at: http://www.bccdc.ca/resource-gallery/Documents/Communicable-Disease-Manual/Chapter%205%20-%20STI/CPS_BC_STI_Treatment_Guidelines_20112014.pdf. Accessed Dec 15, 2018.

(24) Tabidze I, Hotton A, Benbow N, Wong W. It's Back! Repeat Syphilis Infection Among Men Who Have Sex with Men, Chicago, IL, 2004-2006. Presented at: 2008 National STD Prevention Conference [P136]. 2008; Chicago, IL. Available at: https://cdc.confex.com/cdc/std2008/techprogram/P14871.HTM.

(25) Hazra A, Mayer K, Grasso C, Mimiaga M. Syphilis Re-Infection within Men At Fenway Health. Presented at: 2012 National STD Prevention Conference. 2012; Minneapolis, Minnesota. 2017; Available at: https://cdc.confex.com/cdc/std2012/webprogram/Paper29615.html.

(26) Tuite AR, Fisman DN, Mishra S. Screen more or screen more often? Using mathematical models to inform syphilis control strategies. BMC Pub Health 2013;13(606).

(27) Khosropour CM, Dombrowski JC, Swanson F, Kerani RP, Katz DA, Barbee LA, et al. Trends in serosorting and the association with HIV/STI risk over time among men who have sex with men. J Acquir Immune Defic Syndr 2016;72(2):189-197.

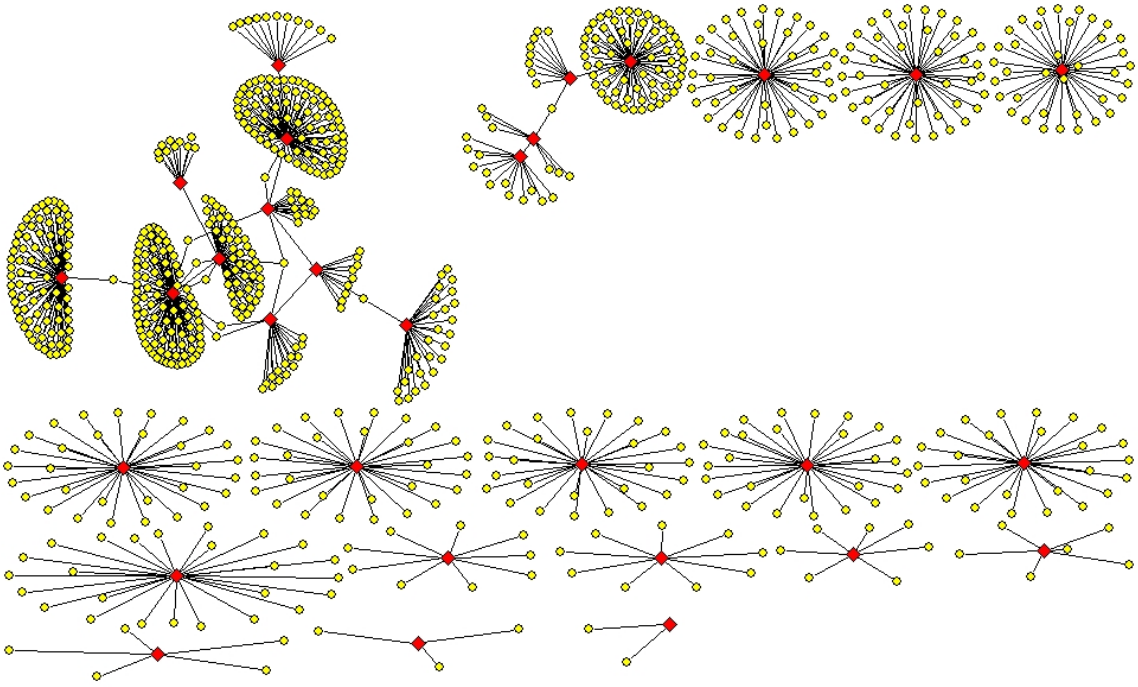
(28) Jansen K, Schmidt AJ, Drewes J, Bremer V, Marcus U. Increased incidence of syphilis in men who have sex with men and risk management strategies, Germany, 2015. Euro Surveill 2016;21(43):pII-30382.

(29) Bolan RK, Beymer MR, Weiss RE, Flynn RP, Leibowitz AA, Klausner JD. Doxycycline prophylaxis to reduce incident syphilis among HIV-infected men who have sex with men who continue to engage in high risk sex: A randomized, controlled pilot study. Sex Transm Dis 2015;42(2):98-103.

(30) Deonarine A, Ogilvie G, Montgomery C, Makaroff S, Holgerson N, Grennan T, et al. Trends in syphilis partner notification among gay, bisexual and other men who have sex with men in British Columbia, 2010 to 2013. Sex Transm Dis 2016;43(8):489-93.

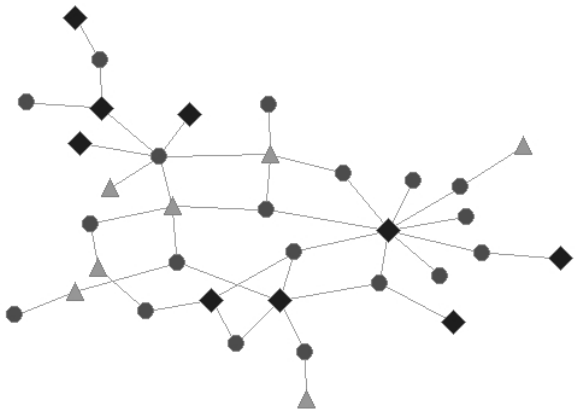
(31S) Stephens SC, Fann CK, Strona FV, Wolf W, Cohen SE, Philip SS, et al. Identifying syphilis risk networks through venue attendance in San Francisco. Sex Transm Dis 2014;41(5):333-337.

Figure 1. Compressed sexual network of individuals with ≥4 syphilis diagnoses in British Columbia, 2005 to 2014



Legend: Cases (red diamonds), partners (yellow circles)

Figure 2. Compressed social network of venues and dating sites of individuals with ≥ 4 syphilis diagnoses in British Columbia, 2005 to 2014



Legend: Cases (circles), physical venues (triangles), online sites (diamonds)

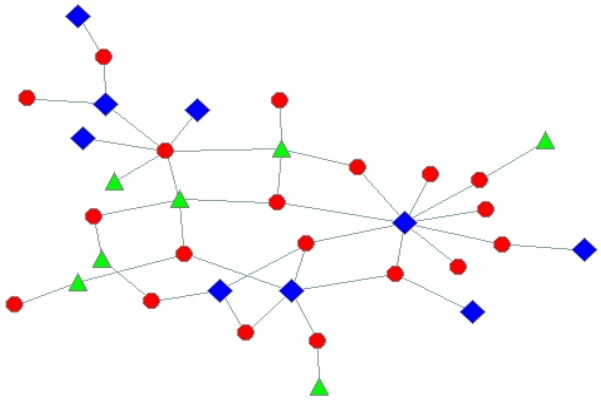


Table 1. Demographic and clinical characteristics of cases with ≥ 4 syphilis diagnoses, 2005-2014

Individual based characteristics (n=30)	
	n (%)
Age (years), Mean (IQR)	
At earliest diagnosis	41.2 (36-47)
At latest diagnosis	47.3 (43-52)
Caucasian	24 (80.0)
MSM	30 (100.0)
HIV Status – at earliest diagnosis, latest diagnosis	
HIV-positive	28 (93.3), 29 (96.7)
HIV-negative	1 (3.3), 1 (3.3)
Unknown	1 (6.7), 0 (0)
History of STI – at earliest diagnosis	
Chlamydia	5 (16.7)
Gonorrhea	9 (30.0)
Syphilis	5 (16.7)
Any STI	15 (50.0)
Diagnoses based characteristics (n=139)	
Year of diagnosis	
2005-07	28 (20.1)
2008-10	35 (25.2)
2011-14	76 (54.7)
Syphilis stage	
Primary	19 (13.7)
Secondary	30 (21.6)
Early latent	90 (64.7)
STI Co-infection	
Yes	8 (5.7)
No	131 (94.3)
Viral load (n=107)*	
Undetectable (<40 copies/mL)	71 (66.4)
41-399 copies/mL	8 (7.5)
400-999 copies/mL	5 (4.6)
1000-9999 copies/mL	2 (1.9)
≥10,000 copies/mL	9 (8.4)
Unknown	12 (11.2)

IQR=interquartile range

*Viral loads at the time of syphilis diagnoses, among HIV-positive individuals, which became available in 2008.

Table 2. Partner notification outcomes per diagnosis for individuals with four or more syphilis diagnoses in British Columbia, 2005-2014 (n=111)

	Number of Partners	Number of Notifiable Partners	Number of Partners Notified	Number of Partners Tested/Treated*
Median (IQR)	5 (2-11)	3 (1-8)	2 (1-5)	1 (0-2)
Mean	7.6	6.0	3.9	1.7
Range	1-50	0-50	0-30	0-15
PN Outcomes Over Time				
2005-2007	192	165 (86%)	55 (29%)	46 (24%)
2008-2010	254	181 (72%)	120 (47%)	53 (21%)
2011-2014	392	321 (82%)	265 (68%)	92 (23%)
PN by Referral Group				
Index Referral	385	359 (93%)	247 (64%)	46 (12%)
Provider Referral	453	308 (68%)	193 (43%)	145 (32%)
Total Number (%)	**838**	**667 (79%)**	**440 (53%)**	**191 (23%)**

*Includes self-reported outcome by contact or index case.
IQR=interquartile range, PN = partner notification