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Sexually transmitted infections in British Columbia: An update

Though the rate of HIV diagnosis in BC has been declining, physicians should be aware of rising rates of gonorrhea, chlamydia, and syphilis to ensure their patients receive adequate screening, treatment, and follow-up.

ABSTRACT: Sexually transmitted infections remain a public health concern in BC. Rates of gonorrhea and chlamydia have been increasing over the past decade. Similarly, the incidence of syphilis in BC has been increasing, particularly in men who have sex with men, but also in women aged 15 to 49 years. This rise has prompted new recommendations to repeat syphilis testing in pregnancy around the time of delivery, in addition to routine syphilis screening in the first trimester. In contrast, the rate of HIV diagnosis in BC has been declining. This has occurred as more individuals at high risk for HIV acquisition have been enrolled in the pre-exposure prophylaxis program and more HIV-infected patients maintain undetectable viral loads, which reduces transmission. Despite the lack of incidence data on human papillomavirus infection as a nonreportable sexually transmitted infection, the rate of human papillomavirus-associated complications, namely anogenital warts and cervical intraepithelial neoplasia, has been declining in BC since the introduction of human papillomavirus vaccination programs.

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This article has been peer reviewed.

Sexually transmitted infections (STIs) in British Columbia are a public health concern, particularly the increasing rates of chlamydia and syphilis. In the spring of 2020, during the initial phase of the COVID-19 pandemic, STI screening rates declined, probably due to both changes in sexual behavior and reduced access to sexual health services.[1] However, in 2021, screening rates began to normalize.[2] STI clinics have resumed services and continue to provide online STI testing to help overcome barriers in accessing clinic-based assessment.[3]

In this review, we discuss the current epidemiology, testing, management, and prevention of STIs in BC. We focus on those pathogens tested in routine screening, including gonorrhea, chlamydia, syphilis, and HIV. In addition to screening, routine vaccinations are available to prevent sexual transmission of hepatitis B and human papillomavirus (HPV). Hepatitis B vaccination has been part of the immunization schedule in BC since 1992, whereas HPV vaccination was introduced in 2008 for girls and was expanded to include boys in 2017.[4] We review BC's HPV vaccination and screening programs and their impact on prevalence.

Gonorrhea

Twice as many new gonorrhea cases are diagnosed in men as in women, and rates have been increasing over the past decade. A large proportion of females with gonorrhea infection can be asymptomatic; in those who are symptomatic, particularly with lower genital tract infection, the clinical manifestations are often limited to mild irritation and vaginal discharge, which may be interpreted as regular vaginal discharge.[5] Males, however, are more likely than females to have symptoms that may drive them to get tested. In addition to sexual behaviors, reasons for increased rates may include frequency of testing, improved sensitivity and specificity of testing methods, or changes in gonorrhea strains.[6,7]

Testing for gonorrhea and chlamydia is indicated for patients who have symptoms of urethritis/cervicitis or reported contact with a sexual partner who has either infection, and anyone who has tested positive or is being screened for another STI.[7] Symptoms of gonorrhea and chlamydia are quite similar and may include purulent urethral discharge, painful or difficult urination, new mucopurulent vaginal discharge, lower abdominal pain, dyspareunia, testicular swelling or pain, sore throat, or rectal pain or discharge.[7] Sites for screening should be based on symptoms and on type of recent sexual activity according to the patient's sexual health history. Active urethral, cervical, or abnormal vaginal discharge should be swabbed for both

gonorrhea culture and susceptibility, as well as for a nucleic acid amplification test (NAAT) for gonorrhea and chlamydia **[Table 1]**. The swab recommended for gonorrhea and chlamydia NAAT is shown in the **Figure**. Similarly, patients with throat and/or rectal symptoms should have swabs of the symptomatic site(s) collected for both gonorrhea culture and susceptibility, as well as gonorrhea and chlamydia NAAT. Screening of asymptomatic patients should consist of gonorrhea and chlamydia NAAT on first-catch urine, ideally without having voided in the preceding 1 to 2 hours, as well as on swabs of the cervix, vagina, throat, and/or rectum **[Table 1]**.

Unless chlamydia has been ruled out, patients with confirmed or suspected gonorrhea are treated for both infections. In BC, the recommended treatment for gonorrhea is a single dose of either cefixime 800 mg orally or ceftriaxone 250 mg intramuscularly, along with a single dose of oral azithromycin 1000 mg to cover chlamydia **[Table 2]**. With rising antibiotic resistance in gonorrhea strains, however, other national agencies such as the United States Centers for Disease Control are currently recommending a 500 mg dose of ceftriaxone intramuscularly. This increased dose of ceftriaxone has not yet been incorporated into Canadian guidelines.[8,9] However, the BC STI treatment guidelines are currently under review, and based on local antimicrobial susceptibility patterns and epidemiology, the gonorrhea treatment recommendations will be reassessed, including the ceftriaxone dose, the need for concurrent azithromycin, and whether cefixime will still be a first-line option. Patients should be counseled to abstain from condomless intercourse until 7 days posttreatment.[7] Repeat screening is recommended 6 months after successful treatment due to the high risk of reinfection.

Chlamydia

Chlamydia is the most common STI in BC, and its rate of infection continues to increase.[6,10] Females have approximately 1.5 times the diagnosis rate compared with males, who remain asymptomatic in half the cases of chlamydia infection.[11] Rates of chlamydia, as well as gonorrhea and syphilis, have also increased in seniors, which highlights the importance of extending preventive and screening measures for STIs to include older adults.[12] The reason for increased rates of chlamydia is likely multifactorial. Contributing factors may include increased screening in asymptomatic young adults, the use of NAAT on urine samples, which are less invasive for patients, and possibly, changes in sexual practices.[10,13]

The recommended treatment of chlamydia is doxycycline 100 mg orally twice daily for 7 days, or azithromycin 1000 mg orally in a single dose **[Table 2]**. Test of cure is recommended 3 to 4 weeks after initial treatment for pregnant and breastfeeding patients or if symptoms persist following treatment; retesting less than 3 weeks after treatment may be associated with

TABLE 1. Diagnostic work-up for gonorrhea, chlamydia, and syphilis.[7,13]

Site	Asymptomatic (screening)	Symptomatic
Cervix	GC/CT NAAT* on vaginal swab (preferred), cervical swab, or urine† (If hysterectomy or vaginoplasty, collect urine† for GC/CT NAAT)	1. GC C&S* from cervical swab (preferred) or vaginal swab 2. GC/CT NAAT for GC/CT on vaginal swab (preferred), cervical swab, or urine†
Penile; urethra	Urine† for GC/CT NAAT	1. GC C&S of visible discharge at meatus (insertion not required) 2. Urine† for GC/CT NAAT
Throat	Throat swab for GC/CT NAAT if receptive oral sex on a penis	Throat swab for: 1. GC C&S 2. GC/CT NAAT
Rectum	Rectal swab for GC/CT NAAT if receptive anal sex	Rectal swab for: 1. GC C&S 2. GC/CT NAAT
Genital or oral ulcers	Venipuncture for syphilis enzyme immunoassay serology	1. Syphilis polymerase chain reaction‡ 2. Venipuncture for syphilis enzyme immunoassay serology

* GC = gonorrhea; CT = chlamydia; NAAT = nucleic acid amplification test; C&S = culture and susceptibility testing

† patient should not have voided in the previous 1–2 hours; send first-void urine (first 10–20 mL)

‡ If a NAAT swab (similar to GC/CT collection) is used for syphilis polymerase chain reaction (PCR) and is not accessioned via the BC Centre for Disease Control Public Health Laboratory (BCCDC PHL), write on the laboratory requisition, "Lesion swabbed for syphilis PCR testing. Send to BCCDC PHL, attn: Dr Morshed."

FIGURE. Swab for gonorrhea and chlamydia nucleic acid amplification test. PHOTO: BONNE SYDORA, RN

a false-positive NAAT.[13] Repeat testing is recommended 6 months after treatment.

Syphilis

The number of new syphilis infections in BC has been increasing. Although most diagnoses are in men who have sex with men (MSM), infections are also increasing among women. From 2017 to 2018, there was a nearly 40% increase in infectious syphilis among women aged 15 to 49 years.[6,10] Because of the increase recorded in women, a change has been made to syphilis screening during pregnancy. Routinely, pregnant women are screened for syphilis in the first trimester.[14] It is now recommended to repeat syphilis testing around the time of delivery. The goal of testing twice during pregnancy is to prevent infection being passed from mother to baby. In 2019, two cases of congenital syphilis were identified in BC, after no cases had been identified in previous years.[14]

Testing for syphilis is indicated for patients who have symptoms of syphilis, such as a painless chancre at the site of inoculation, diffuse rash, or new visual symptoms; people with reported contact to syphilis; or pregnant patients in the first trimester and at the time of delivery. Patients with genital lesions suspicious for syphilis should be swabbed for a syphilis NAAT, which has replaced the previous method of dark field microscopy. All patients should be assessed with syphilis serology, which involves both treponemal and nontreponemal tests, which in BC are performed according to a validated algorithm.

Treatment of syphilis depends on the stage of the infection, which is determined based on symptomatology, timing of potential sexual exposure, serology results, and the results and timing of any previous testing. In BC, if there is ambiguity in interpreting syphilis test results or determining the stage of infection, support is available from the physicians and nurses at BC Centre for Disease Control sexually transmitted infections clinics.[15] Early syphilis, which includes primary, secondary, and latent infections within 1 year of infection, is treated with 2.4 million units of penicillin G benzathine (Bicillin L-A) given as two simultaneous intramuscular injections **[Table 2]**. Late syphilis, which is usually in the late latent stage, is treated with 2.4 million units of intramuscular penicillin G benzathine (Bicillin L-A) weekly for a total of three sets of injections. Patients with a true allergy to penicillin are treated with doxycycline 100 mg orally twice daily for 14 days in early syphilis and 28 days in late syphilis. Following treatment, all patients should have repeat syphilis serology; patients with early syphilis should generally be monitored with serology every 3 months to assess for the expected decline in titer of the rapid plasma reagin. The BC Centre for Disease Control provincial sexually transmitted infections clinics syphilis team can advise on this monitoring for different patient populations.[15]

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HIV

The rate of new HIV diagnoses in BC has been declining over the past decade, even with an increase in testing. This is due in part to treatment as prevention, with more HIV-infected individuals maintaining undetectable viral loads.[16] During the initial phase of the COVID-19 pandemic, rates of both testing and new HIV

TABLE 2. Treatment for gonorrhea, chlamydia, and syphilis.[7,11]

Infection	First-line	Second-line	Additional	Follow-up
Gonorrhea	Cefixime 800 mg orally in a single dose and azithromycin 1000 mg orally in a single dose; or ceftriaxone 250 mg intramuscularly in a single dose and azithromycin 1000 mg orally in a single dose	Cefixime 800 mg orally in a single dose and doxycycline 100 mg orally twice a day for 7 days; or ceftriaxone 250 mg intramuscularly in a single dose and doxycycline 100 mg orally twice a day for 7 days	Abstain from sexual activity for 7 days from the start of treatment. Test and treat last sexual contact AND any sexual contacts within the last 60 days.	Repeat testing at 6 months
Chlamydia	Doxycycline 100 mg orally twice a day for 7 days; or azithromycin 1000 mg orally in a single dose	—	Abstain from sexual activity for 7 days from the start of treatment. Test and treat last sexual contact AND any sexual contacts within the last 60 days.	Repeat testing at 6 months
Early syphilis	2.4 million units of penicillin G benzathine (Bicillin L-A) given as two simultaneous intramuscular injections	If penicillin allergic: doxycycline 100 mg orally twice a day for 14 days	Abstain from sexual activity for 14 days from the start of treatment. Test and treat sexual contacts within the past 3 months.	Repeat syphilis serology every 6 months until satisfactory drop in rapid plasma reagin titer

diagnoses declined. The greatest number of new HIV diagnoses is in MSM, which the pre-exposure prophylaxis (PrEP) program aims to address.[6,17]

HIV PrEP addresses HIV prevention in HIV-negative individuals at high risk of acquiring HIV infection. Those individuals are offered an antiretroviral combination pill (emtricitabine/tenofovir disoproxil fumarate) to prevent infection with HIV. There are two approaches to administering PrEP: daily and on demand. In on-demand PrEP, patients take one emtricitabine/tenofovir disoproxil fumarate combination pill 2 hours prior to sexual intercourse, a second pill 24 hours later, and a third pill 48 hours after the first dose. PrEP has been shown to be highly effective in preventing HIV transmission.[18] In BC, the PrEP program is publicly funded and open to any HIV-negative individual who meets the criteria for being at high risk of HIV acquisition.[19] Currently, approximately 4000 individuals are actively enrolled in the PrEP program, most of whom identify as MSM. Transgender women and MSM who are newly diagnosed with syphilis or a rectal bacterial STI, and who report having condomless anal sex, should be informed of the PrEP program. Further information regarding enrolment can be found at the BC Centre for Excellence in HIV/AIDS website.[19]

Human papillomavirus

Screening

Human papillomavirus (HPV) infection causes anogenital warts, as well as multiple genital tract malignancies, including cervical, vaginal, vulvar, and anal cancers. Consequently, HPV screening is based on screening for genital tract cancer, primarily cervical cancer.

The current BC guidelines for HPV screening recommend cervical cytology obtained through the conventional Papanicolaou smear test (Pap test) as the only screening method in asymptomatic females.[20] However, implementation of HPV DNA testing has been identified as a priority by the Canadian Partnership Against Cancer, and provincial health systems are moving toward this goal.[21]

The BC Cancer Agency recommends screening for cervical cancer with a Pap test in 25- to 69-year-old female and transgender patients who have a cervix. The recommendations explicitly state that Pap test screening should be continued in patients who have been through menopause, who have ever been sexually active at any point in their lifetime, who have received the HPV vaccine, and who are in a same-sex relationship.[22] Patients who do not require Pap test screening include those who have had their cervix removed for any reason, including total hysterectomy and gender-affirming surgery, and have no history of precancerous lesions or previous cervical cancer, and those who have never had any sexual contact (including penetrative, digital, or oral sexual contact).[20,22]

In BC, the PrEP program is publicly funded and open to any HIV-negative individual who meets the criteria for being at high risk of HIV acquisition.

Regarding anal cancer screening, the 2012 BC Cancer Agency guidelines recommend digital rectal exam to be included on annual physical exams at primary care.[23] Patients who are identified to be in a higher-risk group for anal cancer, particularly HIV-positive MSM, could be considered for anal cytology and high-resolution anoscopy at the St. Paul's Hospital Anal Dysplasia Clinic.[23]

Vaccination

HPV vaccination is now part of the school-based program for all children. In grade 6, two doses of the 9-valent HPV vaccine (HPV9) are given 6 months apart. Individuals who start the vaccine series at 15 years or older receive three doses at months 0, 2, and 6.[20]

For those who missed the school-based program, the current BC guideline for HPV vaccination recommends HPV9 (Gardasil 9), which provides protection against cervical, vulvar, vaginal, and anal cancers, as well as anogenital warts.[24] Compared with the previously used quadrivalent HPV vaccine (HPV4), HPV9 provides similar protection against anogenital warts but may also provide up to 15% additional protection against anogenital cancers.[24] It is available through the publicly funded program for individuals who start the vaccine series before their 19th birthday and those between 9 and 26 years who are transgender, HIV positive, MSM, or males who are street-involved or in the care of the Ministry of Children and Family Development.[24,25] Individuals who do not qualify for publicly funded HPV vaccination include MSM older than 27 years, women aged 19 to 45 years, and males aged 9 to 26 years.[25] For those individuals, HPV vaccination is recommended and is available by prescription. The cost is approximately $500 for the three-dose vaccine series and may be covered by third-party insurance plans.[20]

Individuals who have completed an HPV vaccination series with one of the older vaccines (HPV2 or HPV4) may choose to purchase an HPV9 vaccine series in order to ensure protection against the additional HPV strains. A minimum interval of 6 months between completion of an HPV2 or HPV4 series and initiation of an HPV9 series is recommended.[24]

Prevalence

HPV is not a reportable disease in BC, nor is it part of routine STI screening; therefore, the annual incidence and prevalence of HPV in the province is not well documented. A 2016 trial reported 8.2% HPV positivity at baseline screening of more than 15 000 women.[26] Furthermore, given that HPV infection with strains 6 and 11 is associated with 90% of anogenital warts, the prevalence rate of anogenital warts in the province can provide valuable information on the prevalence of HPV infection. In a study that examined the impact of BC's quadrivalent HPV immunization program on rates of anogenital warts, clinical exam diagnosis of anogenital warts in BC clinic visits from 2000 to 2017 were analyzed: 8.15% of the 85 158 individuals screened were diagnosed with anogenital warts.[27]

The incidence of HPV infection appears to be influenced primarily by HPV immunization. The above-mentioned study analyzed anogenital wart rates across different birth cohorts to assess the impact of BC's HPV immunization programs. The study reported a

56% overall decline in rates of anogenital warts in the younger birth cohort that is eligible for public HPV4 immunization when compared with older birth cohorts.[27] Additionally, a more than 50% decline in the rates of cervical intraepithelial neoplasia has been reported in the province since the introduction of the publicly funded HPV vaccination program.[28,29]

Summary

Physicians should be aware of rising rates of STIs in BC to ensure adequate screening, treatment, and follow-up of their patients. HPV vaccination has significantly reduced the rates of anogenital warts and precancerous genital lesions, and should be encouraged in eligible groups. ■

Competing interests

None declared.

Physicians should be aware of rising rates of STIs in BC to ensure adequate screening, treatment, and follow-up of their patients.

References

1. Ablona A, Chang H-J, Grace D, et al. Sex in the time of COVID-19: Preliminary results from a recent survey. BC Centre for Disease Control, Smart Sex Resource. 2020. Accessed 10 April 2021. https://smartsexresource.com/health-providers/blog/202011/sex-time-covid-19-preliminary-results-recent-survey.
2. BC Centre for Disease Control. Clinical Prevention Services (CPS): Monthly surveillance report, March 2021. Accessed 10 April 2021. www.llbc.leg.bc.ca/public/pubdocs/bcdocs2021/721593/721593_2021_03_CPS_Monthly_Surveillance_Report.pdf.
3. BC Centre for Disease Control. GetCheckedOnline. Accessed 10 April 2021. www.bccdc.ca/our-services/programs/getcheckedonline.
4. BC Centre for Disease Control. Immunization manual. 2021. Accessed 10 April 2021. www.bccdc.ca/health-professionals/clinical-resources/communicable-disease-control-manual/immunization.
5. Walker CK, Sweet RL. Gonorrhea infection in women: Prevalence, effects, screening, and management. Int J Womens Health 2011;3:197-206.
6. BC Centre for Disease Control. Reportable diseases data dashboard. n.d. Accessed 10 April 2021. www.bccdc.ca/health-professionals/data-reports/reportable-diseases-data-dashboard.
7. Public Health Agency of Canada. Section 2: Canadian guidelines on sexually transmitted infections–primary care and sexually transmitted infections. 2013. Accessed 10 April 2021. www.canada.ca/en/public-health/services/infectious-diseases/sexual-health-sexually-transmitted-infections/canadian-guidelines/sexually-transmitted-infections.html.
8. Centers for Disease Control and Prevention. Gonorrhea treatment and care. 2020. Accessed 22 May 2021. www.cdc.gov/std/gonorrhea/treatment.htm.
9. Public Health Ontario. Ontario gonorrhea testing and treatment guide, 2nd edition. 2018. Accessed 22 May 2021. www.publichealthontario.ca/-/media/documents/G/2018/guide-gonorrhea-testing-treatment.pdf.
10. Plotogea A, Wong J. In the news! Commonly asked questions about STIs. BC Centre for Disease Control, Smart Sex Resource. 2018. Accessed 10 April 2021. https://smartsexresource.com/health-providers/blog/201810/news-commonly-asked-questions-about-stis.
11. Wong T, Singh A, Mann J, et al. Gender differences in bacterial STIs in Canada. BMC Womens Health 2004;4(Suppl 1):S26.
12. Abeykoon H, Lucyk K. Sex and seniors: A perspective. Canadian Public Health Association. 2016. Accessed 10 April 2021. www.cpha.ca/sex-and-seniors-perspective.
13. BC Centre for Disease Control. British Columbia treatment guidelines: Sexually transmitted infections in adolescents and adults 2014. Accessed 10 April 2021. www.bccdc.ca/resource-gallery/Documents/Communicable-Disease-Manual/Chapter%205%20-%20STI/CPS_BC_STI_Treatment_Guidelines_20112014.pdf.
14. BC Centre for Disease Control. BC experiencing highest rates of infectious syphilis in the last 30 years. 2019. Accessed 10 April 2021. www.bccdc.ca/about/news-stories/stories/bc-experiencing-highest-rates-of-infectious-syphilis-in-the-last-30-years.
15. BC Centre for Disease Control. Sexually transmitted infections clinics. n.d. Accessed 10 April 2021. www.bccdc.ca/our-services/our-clinics/sexually-transmitted-infections-clinics.
16. Lima VD, Brumme ZL, Brumme C, et al. The impact of treatment as prevention on the HIV epidemic in British Columbia, Canada. Curr HIV/AIDS Rep 2020;17:77-87.
17. BC Centre for Excellence in HIV/AIDS. HIV monitoring semi-annual report for British Columbia: Fourth quarter 2020. Accessed 10 April 2021. http://stophivaids.ca/qmr/2020-Q4/#/bc.
18. Molina J-M, Capitant C, Spire B, et al. On-demand preexposure prophylaxis in men at high risk for HIV-1 infection. N Engl J Med 2015;373:2237-2246.
19. BC Centre for Excellence in HIV/AIDS. HIV pre-exposure prophylaxis (PrEP): Quarterly report. 2020. Accessed 10 April 2021. http://bccfe.ca/sites/default/files/uploads/publications/centredocs/prep_q2_2020_report-final.pdf.
20. BCGuidelines.ca Guidelines & Protocols Advisory Committee. Genital tract cancers in females: Human papillomavirus related cancers (cervical, vaginal & vulvar). 2016. Accessed 2 April 2021. www2.gov.bc.ca/assets/gov/health/practitioner-pro/bc-guidelines/fgt_hpv.pdf.
21. Canadian Partnership Against Cancer. Action plan for the elimination of cervical cancer in Canada 2020–2030. 2020. Accessed 10 April 2021. https://s22438.pcdn.co/wp-content/uploads/2020/11/Elimination-cervical-cancer-action-plan-EN.pdf.
22. BC Cancer Agency. BC Cancer cervix screening program overview. 2022. Accessed 20 Mar 2022. www.bccancer.bc.ca/screening/Documents/Cervix-Program-Overview.pdf.
23. BC Cancer. Gastrointestinal cancer: Anus. In: Cancer management manual. Last updated 2012. Accessed 2 April 2021. www.bccancer.bc.ca/health-professionals/clinical-resources/cancer-management-manual/gastrointestinal/anus.
24. BC Centre for Disease Control. Updates to the human papillomavirus (HPV) immunization program: Question and answer document. 2017. Accessed 10 April 2021. www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Immunization/Vaccine%20Info/Archived_HPV9_QandA_August_17_2017.pdf.
25. BC Centre for Disease Control. Communicable disease control manual: Chapter 2 immunization. 2017. Accessed 20 Mar 2022. www.bccdc.ca/health-professionals/clinical-resources/communicable-disease-control-manual/immunization.
26. Ogilvie GS, Krajden M, van Niekerk D, et al. HPV for cervical cancer screening (HPV FOCAL): Complete round 1 results of a randomized trial comparing HPV-based primary screening to liquid-based cytology for cervical cancer. Int J Cancer 2017;140:440-448.
27. Lukac CD, Donken R, Otterstatter M, et al. Impacts of human papillomavirus immunization programs on rates of anogenital warts in British Columbia, Canada, 2000 to 2017. Sex Transm Dis 2020;47:691-697.
28. Donken R, van Niekerk D, Hamm J, et al. Declining rates of cervical intraepithelial neoplasia in British Columbia, Canada: An ecological analysis on the effects of the school-based human papillomavirus vaccination program. Int J Cancer 2021;149:191-199.
29. Racey CS, Albert A, Donken R, et al. Cervical intraepithelial neoplasia rates in British Columbia women: A population-level data linkage evaluation of the school-based HPV immunization program. J Infect Dis 2020;221:81-90.