



National Collaborating Centre  
for Infectious Diseases

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# Reaching Underserved Populations: Leveraging Point-of-Care Tests for Sexually Transmitted and Blood-Borne Infections to Explore New Program Options in Canada

## *Review of the Evidence*

March, 2018

Prepared by Megan Smallwood, MSc

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This is NCCID Project number 382

Production of this document has been made possible through a financial contribution from the Public Health Agency of Canada through funding for the National Collaborating Centre for Infectious Diseases. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada.

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# Reaching Underserved Populations: Leveraging Point-of-Care Tests for Sexually Transmitted and Blood-Borne Infections to Explore New Program Options in Canada

## *Review of the Evidence*

### Introduction

#### **Sexually Transmitted and Blood-borne Infections (STBBIs) in Canada**

In Canada, sexually transmitted and blood-borne infections (STBBIs), which include HIV, hepatitis C, human papilloma virus (HPV), hepatitis B, *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (GC), syphilis, and *Trichomonas Vaginalis* (TV), continue to be important public health concerns, despite various public health interventions designed to prevent, diagnose and treat these infections (2).

Reported rates of sexually transmitted infections have been on the rise for the last decade, increasing by 16.7% for Chlamydia, 65.4% for gonorrhoea and by 85.6% for infectious syphilis between 2010 and 2015, representing 139,665 cases of diagnosed infections in Canada in 2015 (3-5). This trend is mirrored in countries such as the United States (US), Australia, and the United Kingdom (UK), and may be explained by factors such as improved tests used to diagnose infections (e.g. improved case finding), changing sexual behaviours and practices, and increasingly drug resistant microorganisms which complicate treatment regimens (2).

STBBIs are particularly challenging to control due to stigma and discrimination associated with these types of infections. In Canada, infections are largely concentrated in young and marginalized populations such as men who have sex with men (MSM), sex workers, First Nations, Métis and Inuit populations, and people who inject drugs (PWID) (2, 6). Left untreated, STBBIs may have important consequences on sexual and reproductive health of Canadians, with complications disproportionately affecting women.

Globally, international health organizations have called to act on eliminating HIV, hepatitis C and other STBBIs as public health threats by 2030, and achieve the 2030 Agenda for Sustainable Development goals, and Canada has endorsed the targets established by UNAIDS and WHO in 2015 (7-9). By 2020,

90% of people living with HIV will be diagnosed, of those, 90% will be treated, and of those 90% will be virally suppressed (9). For hepatitis C, WHO Health sector strategy targets are a reduction by 30% of new chronic infections, and a reduction of 10% in mortality (7). For STBBIs, milestones to achieve are the screening and treatment of all pregnant women for syphilis to eliminate congenital syphilis, for which Canada still has cases (4), and 70% of key populations having access to a full range of STBBI services.

Despite these goals, at the end of 2014 an estimated of 65,040 persons were living with HIV in Canada, among whom 20% were unaware of their infection (10). As many as 245,987 Canadians were living with hepatitis C at the end of 2011 in Canada, of whom 44% remained unaware of their status (11). A comprehensive portrait of the number of people in need for STBBI diagnosis and treatment is still lacking in Canada. As testing is the gateway to the continuum of care and treatment, elimination can be achieved by reaching the undiagnosed through the implementation of new and innovative strategies that ensure timely and equitable access to quality diagnosis, care, and treatment.

## Point-of-Care Diagnostics

Diagnostic tests are needed for control, prevention, surveillance and elimination of STBBIs. Timely and accurate diagnosis of STBBIs is essential for ensuring patients receive appropriate treatment and care, preventing adverse outcomes and limiting the spread and transmission of infection (12). Many infected individuals do not display any symptoms, meaning they may unknowingly pass on an infection. Timely diagnosis can be achieved by screening, which is detecting an infection early in asymptomatic individual because of targeted intervention, or by diagnosis when investigating for cause of symptoms. While much progress has been made in advancing diagnostic technologies, the challenge of making STBBI testing comfortable and available for all persists in Canada (2, 13).

Point-of-care testing (POCT) is one solution for rethinking diagnostic testing. POCT can be defined as, “medical diagnostic testing performed outside the clinical laboratory in close proximity to where the patient is receiving care. POCT is typically performed by non-laboratory personnel and the results are used for clinical decision making” (14). It can be performed in a variety of settings including hospitals, clinics, physician’s offices, pharmacies, ambulances, nursing and long-term care facilities, or the patient’s residence (15), bringing diagnostics closer to people, especially to populations who are not currently using health services for many different reasons including, stigma, discrimination, criminalization, and geographic isolation, to name a few. That is, POCT can be done near the patient to increase convenience and expedite clinical decisions, as completion of testing, communication of results and follow-up action can be done in the same clinical encounter (16).

POCT has become particularly useful in low and middle income countries (17-22), where laboratory infrastructure is underdeveloped, public health systems are stretched or the costs of quality care is prohibitive and diagnostics are typically under-used, for syndromic management has been the norm (12). However, POCT also has an important role to play in high income countries such as Canada, where POCT has the potential to expand mobility, availability and acceptability of testing in remote and rural

communities, and reduce turnaround time, expedite clinical management and decision-making, and provide additional non-traditional testing options for marginalized groups who are often failed by health systems (15).

To exert their full potential and improve equitable access to quality STBBI screening and diagnosis, POCT need to be fully integrated into existing healthcare systems as a way to strengthen and complement current approaches and infrastructures. New diagnostic technologies cannot exist independently of health systems and practitioners (23) and their integration into public health programs need to be supported by strong laboratory structures that have the capacity to ensure quality-assured diagnostic services (24).

Accurate and reliable POC tests for HIV have led the way for POCT for STBBIs, and are well established globally (18). In Canada, there is one HIV rapid test licensed for use at point-of-care, the INSTI HIV-1/HIV-2 antibody test kit (bioLytical Laboratories, Inc., in BC, Canada), licensed in 2005 (25). In addition to the INSTI HIV test, there is only one rapid tests for other STBBIs licensed by Health Canada, the OraQuick HCV Antibody rapid test (Orasure Technologies) approved in January 2017 (26).

In Canada, use of POCT varies among provinces and territories (15), and therefore devices such as the INSTI HIV POC test that was approved in 2005 are still not in use in all provinces and territories of Canada, with little or no availability in the Northern Territories (Yukon, Northwest Territories and Nunavut) and in any of the four Atlantic Provinces (27). Additionally, there is a lack of availability of POCT in rural and remote communities, many of which are home to First Nations, Métis, and Inuit communities (27).

Overall, Canada's use of POC testing remains low compared to the United States or the European Union (5.9% in Canada, compare to 58% of all HIV tests in US in 2011) ([Reaching the Undiagnosed Webinar Series](#)). In the US, about 12 HIV POCTs are available, in addition to HCV, and syphilis rapid tests being made available ([access to FDA approved test](#)). This highlights a major issue in Canada: while new POC technologies become increasingly advanced and accessible globally, they still have limited uptake in Canada. The benefits of POCT in Canada have been demonstrated through the example of the INSTI rapid test for HIV (27, 28), and include being preferred by users, greater flexibility, immediate results, reached first testers and key populations, reduced delay to result and higher proportion of people receiving results.

While there is interest in expanding POCT in Canada (15), translating research and evidence into POCT policies and programs remains a challenge. As recognized by many groups and organizations in Canada, including the Canadian Agency for Drugs and Technologies in Health (CADTH) (15), and the CIHR Centre for REACH in HIV/AIDS (REACH 2.0) (27), there remains a gap between research and actual scale-up and implementation of POCT in Canada.

In order to effectively incorporate POCT into the Canadian health care system and achieve greater equity in national HIV testing response, the *HIV POCT in Canada: Action Plan 2015-2020* was released, in

2015, recommending key actions to increase awareness, access to and uptake of HIV POCT in Canada (29).

### **Aim of this Evidence Review**

To support national efforts to improve STBBIs screening and support awareness building for equitable access to and uptake of new diagnostic technologies for STBBIs, the National Collaborating Centre for Infectious Diseases (NCCID) commissioned this evidence review on POCT as it relates to the Canadian context. This review is the first of several projects NCCID is conducting, and is intended to summarize POC technologies and devices that are currently used, on the market, approved or available in Canada, or in the pipeline.

Future project will include a review of evidence on performance, acceptability, feasibility and impact of POCT that are relevant to the Canadian context, and the opportunities and challenges to their implementation in Canada, particularly in rural and remote communities and key populations, as well as.

## Methods

A comprehensive search of the literature was conducted in September 2017. PubMed, and Medline (via Ovid) were searched for MeSH terms related to sexually transmitted infections, hepatitis B and C, AND terms related to point-of-care (see Supplementary material for complete search string). The search was limited to records published in English in the past 15 years (January 2002 through September 2017).

Sociological Abstracts was searched using the terms ((sexually transmitted) OR (sexually transmitted infections) OR (sexually transmitted diseases) AND pd(>20020101)) AND (diagnostics OR diagnosis OR point-of-care OR (point-of-care testing));

Duplicate records were removed using Endnote software. Grey literature was searched to identify any reports or guidelines on POCT for sexually transmitted and blood borne infections in Canada and from international organizations, which would not have been published through traditional peer-reviewed journals.

The references of relevant articles were hand-searched, as well as websites for the following organizations: WHO, CDC, World Bank, Unitaaid, USAID, UN Women, Global Fund, Gates Foundation, and the International Diagnostics Centre.

## Eligibility Criteria

Titles and abstracts of all records were screened for eligibility (see Figure 1 for PRISMA flow diagram). Articles were included if they described POCT for any sexually transmitted infection, hepatitis B, or hepatitis C. Articles were grouped in three different categories: technologies/devices for POCT for STBBI's (including evaluations of devices, and reviews of current devices available and in the pipeline), implementation of POCT strategies and barriers to POCT (including original research articles, reviews, commentaries, and editorials), and finally, reports and guidelines to POCT published by government and non-governmental organizations (e.g. WHO, CDC, Health Canada).

Articles were excluded from title/abstract screening if they described technology that was not yet commercialized in any country. Due to the widespread availability of accurate POC tests for detecting HIV and the overwhelming number of articles evaluating HIV tests, articles evaluating rapid POC tests for HIV unless they described new technologies within the past 3 years (such as rapid tests for acute HIV infection, or multiplex tests) were excluded. This allowed for prioritizing the search on new, upcoming technologies for other STBBIs which are not as well established as HIV POCT. Additionally, articles on viral load or CD4+ testing were excluded to focus on screening/diagnosis of HIV. Articles were excluded if they were not available in English.

## Final Selection of Articles

Articles were selected for inclusion in the final report based on their priority and relevance in the Canadian context for POCT. They were prioritized if they evaluated implementation of POCT strategies and policies in high income countries as well as articles which evaluated strategies in key populations (e.g. MSM, First Nations, Métis and Inuit populations, women, youth, people who use drugs, and indigenous populations in Australia and Brazil). Additionally, the focus was made on articles which described technologies for POCT which are already licensed by Health Canada, or most likely to be of interest to Canadian populations.

## Chapter 1: POC technologies for STBBI screening: Performance and Availability

POC devices can be found in an array of technologies, from a simple test strip to a more sophisticated portable apparatus. The technology itself does not define POC testing, but rather the successful integration of this technology into a near-patient diagnostic process with rapid turnaround time to results (16). Rapid turnaround of results can range between few minutes (e.g. lateral flow immunoassay – strip) to few hours, while patients wait (e.g. NAAT on a GeneXpert platform). While some simpler technologies can be used across settings (home, communities, clinics, peripheral laboratories, and hospitals) with a wide range of users (peers, community workers, nurses, physicians, laboratory specialists), other technologies may require a certain level of infrastructure and be used in clinical settings or mobile van with a trained technician. Depending on the device and end-user, some technologies can only be used for screening and future referrals, while others can be used for diagnosis, prescription of treatment and monitoring. Understanding the technologies for POCT, their usage, the barriers to their integration and in what context they are beneficial will support public health managers in identifying the most impactful delivery models (16, 31).

**Table 1. Definitions of Terms Concerning Diagnostic Technology and Accuracy (30)**

<b>Diagnostic Term</b>	<b>Definition</b>
Sensitivity	The ability of the test to correctly identify those who have the infection
Specificity	The ability of the test to correctly identify those who do not have the infection
True positives	People with the infection who are correctly identified as positive by the test
True negatives	People without the infection who are correctly identified as negative by the test
False positives	People who do not have the infection but are erroneously identified as positive by the test
False negatives	People who have the infection, but are erroneously identified as negative by the test
RDT	Rapid Diagnostic Tests
NAAT	Nucleic acid amplification test
Immunoassay	Detection of host antibodies (Ab) directed against pathogen antigens (Ag), or direct recognition of pathogen antigens – biomarker-based single or multiplexed tests

## What is on the Market and Approved in Canada?

### Human immunodeficiency Virus (HIV)

As noted above, the INSTI HIV-1/HIV-2 antibody test is the only HIV rapid test currently available in Canada. Recently, USAID compiled a list of all rapid tests for HIV which have been approved by the FDA (or USAID), with a total of 49 tests identified (32). The majority of these tests detect antibodies to HIV-1 or HIV-2 (or both) and are generally accepted to be highly sensitive and specific. The main limitation of these types of tests is that they cannot detect infection during the acute stage, and the focus of rapid diagnostics for HIV has now shifted to combination rapid tests which can detect p24 antigen in addition to HIV antibodies, or molecular-based platforms (33-39). At present, HIV antigen/antibody rapid tests have not shown sufficient sensitivity for detecting acute infections, and the molecular-based platforms for HIV that can overcome this challenge have focused on early infant diagnosis and have not been validated for use in adults.

Additionally, self-tests for HIV allow users to purchase a testing kit, perform the self-test in the comfort of their home (via oral fluid sample or finger prick), and receive a preliminary rapid test result. HIV self-tests have shown comparable accuracy to other antibody-based HIV rapid tests (40), and are approved for use in countries such as the United States, the United Kingdom, France, and several other countries in Europe (41).

However, the opportunity for HIV self-testing in Canada still faces uncertainty from Canadian stakeholders, largely due to concerns regarding test accuracy, users coping with results, linkage to care, and affordability (42). There are several HIV self-tests available (oral fluid and blood-based) plus several in the pipeline which are planned to submit for WHO prequalification or CE-marking (43).

**Key points:** The Health Canada-approved INSTI HIV test performs well for detecting HIV. While there are countless POC devices on the market for HIV, only one is currently accepted in Canada. New POC devices for detecting acute and early infections should take priority when considering new devices for Health Canada licensing.

### Syphilis

There are no POC tests for syphilis currently licensed by Health Canada, according to the Canadian Public Health Laboratory Network (44). Globally, there have been many POC tests developed for diagnosing syphilis, most of which detect antibodies directed against *Treponema pallidum* (TP). A summary of these tests can be seen in Table 1. These tests have been found to perform comparably to laboratory TP tests for syphilis, as demonstrated through a systematic review and meta-analysis published in 2013 (45), and have been valuable for detecting syphilis in resource-limited settings and hard-to-reach populations (46). However, because TP antibodies can persist long after the infection has been cured, individuals with a past syphilis infection can still test positive. This means that in high prevalence populations such

as MSM, the rate of false positives may reach unacceptable levels. TP-based syphilis tests must be followed up with non-TP laboratory confirmation (47), which can be a challenge in resource limited settings.

Recently, the first dual TP and non-TP POC test has been commercialized: the Dual Path Platform (DPP) Syphilis Screen and Confirm assay (Chembio Diagnostics Systems, Medford, NY, USA). Evaluations of this device have shown favourable performance against laboratory reference tests (48-55).

**Key points:** There are multiple POC tests for syphilis which are accurate and may be useful for diagnosing marginalized or isolated populations in Canada; however no such tests are currently licensed by Health Canada. Dual TP and Non-TP tests for syphilis are promising, but further independent evaluations on their diagnostic performance are needed.

### Syphilis-HIV dual tests

Adding to the list of available POC diagnostics for HIV and syphilis are dual/combo tests which can simultaneously detect HIV and syphilis (currently, treponemal only). Three of these HIV-syphilis dual-tests have been independently evaluated for accuracy (SD Bioline HIV/Syphilis Duo test, MedMira Multiplo Rapid TP/HIV antibody test, and the Chembio DPP HIV/Syphilis Assay), as summarized in a recent systematic review and meta-analysis (56). These evaluations for HIV-syphilis tests have shown high accuracy for detecting HIV, with the SD Bioline and Chembio DPP tests performing with the highest accuracy. The SD Bioline test had the best performance for syphilis out of the three assays, with comparable sensitivity and specificity to single syphilis TP POC tests (56). However, an additional evaluation of the SD Bioline test published later in 2017 found lower sensitivity for syphilis than previous evaluations (57). A summary of the dual HIV-syphilis tests can be seen in Table 2. There are additional devices which are available but have limited independent evaluations (Table 2), therefore further research will be needed to understand their performance.

In 2018, we are expecting to see the launch of the mChip dual assay for HIV/Syphilis, which uses a smartphone for powering the test, as well as reading results (47). No dual HIV-syphilis devices are currently licensed by Health Canada.

**Key points:** The SD Bioline HIV/Syphilis Duo test is currently the highest performing dual test that has been evaluated, however the sensitivity of the syphilis component requires further investigation.

### *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoea* (NG) tests

The gold standard for detecting both CT and NG is nucleic acid amplification testing (NAAT), of which there are multiple available platforms that are laboratory-based. Numerous POC assays for CT and NG

have been developed, however the majority are non-NAAT based (e.g. antigen/antibody reactions) and have fallen short in achieving adequate sensitivity and specificity (58-69).

A systematic review published in 2016 evaluated the performance of rapid, POC tests for CT and NG (beginning in 2010) and found the sensitivities of most CT rapid POC tests were below 70%, with many below 50%, when compared to NAAT, indicating that POC devices produce a substantial number of false-negative results (70). One notable exception to the poorly performing devices for CT is the aQcare Chlamydia TRF kit (Medisensor, Korea) which has shown superior performance to currently available POC tests, however further research is still needed (71). For NG, the list of available devices is much smaller, and included Gram stain smears. Gram stain smearing is a diagnostic procedure that uses endocervical, urethral, oropharyngeal, and rectal specimens, to dye certain types of bacteria (e.g. *Neisseria gonorrhoea*) which can be identified via microscopy. The sensitivity of Gram stain smears for NG was much higher in male urethral smears (>95%) than female cervical smears (<35%) (70).

With the potential exceptions of the aQcare CT test, and BioStar NG test, the most promising technologies for CT/NG detection at POC are NAAT platforms. One platform which is currently available is the GeneXpert system (Cepheid, Sunnyvale, USA), which is a platform widely used for TB diagnosis, but also has assays for CT and combined CT/NG detection (Xpert CT and Xpert CT/NG). The Xpert CT/NG test has demonstrated excellent performance for detection of both CT and NG, compared to gold standard NAAT-based laboratory tests (69, 70, 72-76).

In the pipeline for POC assays for CT and NG is the iO Platform by Atlas Genetics, which has developed a CT assay, and assays for CT/NG and NG antibiotic resistance (47). Cepheid has a more portable version of its GeneXpert platform in the pipeline, and several other NAAT platforms are in development.

Health Canada has licensed two POC assays for detection of Chlamydia: the Chlamydia Rapid Test CRT (Diagnostics for the Real World, Sunnyvale, CA, USA), which has shown inadequate sensitivity for detecting CT (sensitivity 73% to 85% for vaginal swab, 59% to 89% for first void urine)(66), and the Xpert CT/NG (Cepheid) described above.

**Key points:** While antibody-based POC tests for Chlamydia and gonorrhoea have demonstrated inadequate performance, NAAT-based tests such as the GeneXpert system for CT/NG have been optimized for POC use. The Xpert CT/NG assay has been licensed by Health Canada.

## Hepatitis B (HBV) and hepatitis C (HCV)

Several systematic reviews and meta-analyses have been conducted on rapid POC tests for hepatitis B (HBV), which have highlighted the sheer quantity of tests available for detecting HBV infection (77-79). While overall pooled accuracy was found to be high, there was wide variation in accuracy between tests, and even between evaluations of the same test (78). The Determine test offered acceptable performance (80). The WHO recently released guidelines this year which recommended the use of laboratory-based enzyme immunoassays (EIAs) over rapid diagnostic tests (RDTs) where existing

laboratory tests are already available and accessible (81). Part of the reasoning behind this recommendation was due to the high variability between different tests for Hepatitis B surface antigen (HBsAg) with some tests performing poorly (81). There are currently no POC tests for HBV approved by Health Canada.

Similarly to HBV, systematic reviews and meta-analyses of POC tests for HCV have identified dozens of available tests, with varying degrees of accuracy (82-84). Based on pooled analyses grouped by device, the authors of one systematic review were able to identify the OraQuick HCV Rapid Antibody Test (OraSure Technologies) as the highest performing test (82), which is in line with WHO guidelines (81). The OraQuick HCV Rapid Antibody Test has been approved by Health Canada in 2017.

The WHO has recommended the use of RDTs for hepatitis C over EIAs due to their acceptable sensitivity and specificity, in settings where laboratory services are limited, and in particular for outreach settings (e.g. prisons and substance abuse programs) (81). As of 2017, there is now an Xpert HCV Viral Load test (for use on the GeneXpert platform) for HCV RNA detection available which has shown very high sensitivity and specificity in one evaluation (85), and good analytical performance in another (86).

**Key points:** Select POC tests for HBV have adequate sensitivity and specificity; however none are yet available for use in Canada. The OraQuick HCV Rapid Antibody Test has high sensitivity and specificity for detecting HCV, and has been approved by Health Canada.

### Other sexually transmitted infections

In addition to STBBIs mentioned above, rapid POC tests are available globally and in the Canadian pipeline which can detect infections such as *Trichomonas Vaginalis* (TV) and human papillomavirus (HPV). Three POC tests for TV are licensed by Health Canada: the OSOM Trichomonas test (Sekisui Diagnostics), which is a more traditional immuno assay POC rapid test, and two NAAT POC assays: the AmpliVue test (Quidel corporation), and the Solana Trichomonas Assay (Quidel Corporation) (Table 4). All of these assays have shown excellent sensitivity and specificity (87). In addition to these assays, for TV there is also available (however not approved for use in Canada) the Affirm VPIII (Becton Dickinson) which does not perform as well as the other POC tests mentioned, and the GeneXpert TV test which has very high sensitivity and specificity (87, 88). In the pipeline are two more assays, the iO platform (Atlas Genetics) and the TrueLab real Time quantitative micro PCR system (Molbio Diagnostics), both of which are NAAT-based POC assays (47).

For HPV, the only independently reviewed device on the market is the GeneXpert system: the Xpert HPV test (Cepheid) which is licensed by Health Canada and shows promising sensitivity and specificity (89), however evaluations on the performance of this device are currently limited. Other HPV molecular POC tests in the pipeline are the careHPV test (Qiagen) which is a DNA test not commercially available yet,

the NEDxA (GENOMICA) which has not yet been peer evaluated, and the Omni platform (Cepheid) which is expected to be on the market in 2018 (47).

### Multiplex Tests

In addition to dual assays which can detect two different infections in one test (e.g. HIV and syphilis, or CT and NG) there are also various multiplex devices available which can detect three or more infections simultaneously. Multiplex tests are particularly useful in individuals with HIV related co-infections, and can save time and resources in testing high-risk individuals. One such device is the Miriad Rapid TP/HBV/HIV/HCV Antibody Test (MedMira Inc., Halifax, Canada), which simultaneously detects four infections. However, accuracy for each of the different infections of the Miriad multiplex test are variable, even in the improved version of the device, with HCV having a lower sensitivity and specificity (80.4% and 85.3%, respectively) than HIV or syphilis (90). Hepatitis B accuracy could not be evaluated in this sample due to high vaccination rates in Canada (90).

The FilmArray (BioFire Diagnostics, LLC, Salt Lake City, Utah) device is a multiplex PCR (molecular or NAAT) system capable of detecting up to 50 infections, however a first generation version of this device was developed for detection of nine STI-related organisms: CT, NG, TV, TP, Mycoplasma genitalium (MG), Ureaplasma urealyticum (UU), Haemophilus ducreyi (HD), and herpes simplex virus (HSV) types 1 and 2 (HSV1, HSV2) (91). While sensitivities and specificities for this device were not calculated, the performance of the device for detecting CT and NG was found to be comparable to standard NAAT. The FilmArray produced substantial numbers of false positives for the other infections in the panel (91).

The DPP HIV-HCV-Syphilis Assay (Chembio Diagnostic Systems, Inc., Medford, NY) was evaluated and found high sensitivity and specificity for both HIV and HCV, however syphilis did not perform well (sensitivity for TP 44%) compared gold-standard laboratory tests (non-treponemal syphilis test RPR, HCV and HIV enzyme immunoassay) (92). Specificity was high for all three infections (>99%) (92).

**Key points :** Multiplex devices have the potential to simultaneously screen for multiple STBBIs, HIV and related co-infections, however developing devices to have high accuracy for all infections is still challenging. The decision of using multiplexed tests should be made with consideration of the underlying burden of disease in specific populations, and combinations of biomarkers should be chosen accordingly (1) .

A summary of POC devices for STBBIs which are licensed by Health Canada can be seen in Table 5. Despite the fact that few tests have been licensed in Canada, some unlicensed tests have been used for research with an IVD (Investigational device) Health Canada approval for research purpose only or with a special authorization obtained through Health Canada Special Access Program.

The [Special Access Program](#) (SAP) allows doctors to obtain medical devices that have not yet been approved for sale in Canada, and require special authorization.

The funding of POC devices in Canada often depend on the province or territory, sometimes from provincial health care budgets, health care facilities' operational and global budgets, vendor funding, laboratory services budgets, fee-for service models, and patients paying out-of-pocket, which creates ambiguity regarding who is responsible for paying for POCT as reported in an Environmental Scan on POCT conducted in Canada (15).

Test name	Company	Detects	Specimen Type	Time to result	Test type	Sensitivity	Specificity	Approved in Canada?
Determine	Alere Inc	TP (Ab/Ag)	Whole blood (fingerstick), plasma, or serum	15 minutes (up to 24 hours)	lateral flow immuno-chromatographic assay	59.6-100%	95.7-100%	No
SD Bioline Syphilis 3.0	Alere/Standard Diagnostics (South Korea)	TP (Ab/Ag)	Whole blood (venous or fingerstick), plasma, or serum	5-20 minutes	lateral flow immuno-chromatographic assay	85.7-100%	95.5-99.4%	No
Syphicheck - WB	The Tulip Group/WB	TP (Ab/Ag)	Whole blood (venous or fingerstick), plasma, or serum	15 minutes	lateral flow immuno-chromatographic assay	64.0-97.6%	98.4-99.7%	No
Visitect Syphilis	Omega Diagnostics	TP (Ab/Ag)	Whole blood (venous or fingerstick), plasma, or serum	30 minutes	lateral flow immuno-chromatographic assay	72.7-98.2%	98.1-100%	No
OnSite Syphilis AB Combo Rapid Test	CTK Biotech Inc (USA)	TP (Ab/Ag)	Whole blood (venous or fingerstick)	15 minutes	lateral flow immuno-chromatographic assay	NA	NA	No
Syphilis Health Check	Trinity Biotech (Ireland)	TP (Ab/Ag)	Whole blood (fingerstick), plasma, or serum	10 minutes	lateral flow immuno-chromatographic assay	NA	NA	No
Uni-Gold Syphilis treponemal	Trinity Biotech (Ireland)	TP (Ab/Ag)	Whole blood (fingerstick), plasma, or serum	15 minutes	lateral flow immuno-chromatographic assay	NA	NA	No
DPP Syphilis Screen and Confirm Assay	ChemBio Diagnostics Systems	Dual TP and non-TP (Ab/Ag)	Treponemal antibody, non-treponemal antibody	15-20 minutes	lateral flow immuno-chromatographic assay	90.1-98.2% (TP antibody); 80.6-98.2% (non-TP antibody)	91.2-98.0% (TP antibody); 89.4%(non-TP antibody)	No
Crystal TP Syphilis test	Span Divergent (Surat, India)	TP (Ab/Ag)	Whole blood, plasma or serum			NA	NA	No

Test name	Company	Detects:	Specimen Type	Time to result	Test type	Sensitivity	Specificity	Approved in Canada?
SD Bioline HIV/Syphilis Duo Rapid Test	Alere Inc/Standard Diagnostics	TP, HIV (Ab/Ag)	Whole blood, plasma or serum	15-20 mins	lateral flow immuno-chromatographic assay	HIV: 97.9-99.0% Syphilis: 93.0-99.6%	HIV: 99.0-100%; Syphilis: 99.1-100%	No
DPP HIV-Syphilis Assay	ChemBio Diagnostics Systems	TP, HIV (Ab/Ag)	Whole blood, plasma or serum;	10 mins	Immunofiltration (flow through)	HIV: 98.9%; Syphilis: 95.3%	HIV: 97.9-99.6%; Syphilis: 97.0-99.6%	No
Multiplo TP/HIV Antibody test	MedMira Inc	TP, HIV (Ab/Ag)	Whole blood, plasma or serum	3 minute test procedure, results must be read immediately	Rapid vertical flow (RVF)	HIV: 97.9%; Syphilis: 94.1%	HIV: 94.2-99.5%; Syphilis: 94.2-99.1%	No
INSTI HIV/Syphilis Multiplex test	Biolytical laboratories Inc, Canada	TP, HIV (Ab/Ag)	Whole blood (fingerstick or venous), plasma or serum	60 seconds (from addition of sample to sample diluent)	Immunofiltration (flow through)	NA	NA	No
OnSite HIV/Syphilis Ab Combo Rapid test	CTK Biotech Inc	TP, HIV (Ab/Ag)	Whole blood (fingerstick or venous), plasma or serum	15 mins from addition of sample diluent	Lateral flow immuno-chromatographic assay	NA	NA	No

Test Name	Company	Detects	Features
First Response HIV/Syphilis Combo Card Test	Premier medical corporation	TP, HIV (Ab/Ag)	
DPP HIV-HCV-Syphilis	ChemBio Diagnostics Systems	TP, HIV, HCV (Ab/Ag)	
mChip Assay	Junco Labs and Columbia University, OPKO Health	TP and non-TP, HIV	Time to result: 15 minutes
ChipCare platform	ChipCare corporation		

Test name	Manufacturer	Detects	Specimen Type	Time to result	Test type	Sensitivity	Specificity	Approved in Canada?
GeneXpert CT	Cepheid , Sunnyvale, USA	CT (nucleic acids)	Female and male urine, endocervical swab, patient collected vaginal swab (in clinical setting)	90 minutes	in vitro real time PCR (cartridge and platform)	NA	NA	No
aQcare Chlamydia TRF kit	Medisensor, Inc., Daegu, Korea	CT (Ab/Ag)	Endocervical and urethral swabs; urine	15 minutes	Lateral flow immune-chromatographic assay	93.8%; 88.2%	96.8%; 94.7%	No
BioStar Optical ImmunoAssay (OIA)	Biostar, Boulder, CO, USA	CT (Ab/Ag)	Endocervical swabs	30 minutes	Optical immunoassay	59.4-73.8%	98.4 - 100%	No
Clearview Chlamydia MF	Alere, Watham, MA, USA	CT (Ab/Ag)	Endocervical; vaginal swabs	15 minutes	Lateral flow immune-chromatographic assay	49.7%, 32.8%	97.9%, 99.2%	No
QuickVue Chlamydia Rapid Test	Quidel corporation, San Diego, USA	CT (Ab/Ag)	Endocervical; vaginal swabs	12 minutes	Lateral flow immune-chromatographic assay	25.0-65.0%; 83.5%	100% - 98.9%	No
ACON Plate CT Rapid Test	ACON laboratories, San Diego	CT (Ab/Ag)	Vaginal swabs; endocervical swabs; male urine			66.7%; 22.7-30.5%; 43.8%	91.3%; 99.8-100%; 98.3%	No
Chlamydial Rapid Test (CRT)	Diagnostics for the Real World, Sunnyvale, USA	CT (Ab/Ag)	Male urine; vaginal swabs	30 minutes	Lateral flow immune-chromatographic assay	41.4%, 39.4-74.2%	89.0%; 94.4-96.8%	Yes, licensed by Health Canada
GeneXpert CT/NG (sn/sp for CT/NG)	Cepheid, Sunnyvale, USA	CT/NG (nucleic acids)	Endocervical swabs,; vaginal swabs; female urine; male urine	90 minutes	in vitro real time PCR (cartridge and platform)	CT: 97.4%, 98.7%; 97.6%; 97.8% NG: 100%; 100%; 95.6%; 98.9%	CT: 99.6%; 99.4%; 99.8%; 99.9% NG: 100%, 99.9%; 99.9%; 99.9%	Yes, licensed by Health Canada
ACON NG and CT Duo test combo	ACON laboratories, San Diego	CT/NG (Ab/Ag)	Endocervical swabs			12.50%	99.80%	No
BioStar Optical ImmunoAssay (OIA)	Biostar, Boulder, CO, USA	NG (Ab/Ag)	Endocervical swabs			60%; 100%	89.9%; 93.0-98.0%	No

<b>Test name</b>	<b>Company</b>	<b>Detects</b>	<b>Features</b>
Atlas Genetics io Platform	Atlas Genetics	CT (nucleic acids)	Cartridge NAAT, 30 mins to result
Atlas Genetics io Platform	Atlas Genetics	CT/NG (nucleic acids)	Cartridge NAAT, 30 mins to result
Atlas Genetics io Platform	Atlas Genetics	NG antibiotic resistance (nucleic acids)	Cartridge NAAT
Atlas Genetics io Platform	Atlas Genetics	CT/NG/TV (nucleic acids)	Cartridge NAAT
GeneXpert Omni	Cepheid	CT/NG (nucleic acids)	Cartridge, but battery operated and highly portable
RT Cross-priming amplification (CPA)-CT test	Ustar Biotechnologies	CT (nucleic acids)	Cross-priming amplification cartridge
TrueLab Real Time micro PCR System	Molbio Diagnostics	CT, NG (nucleic acids)	RT PCR platform
Alere-I platform	Alere Inc	CT/NG (nucleic acids)	iNAAT
MAMEF	University of Maryland and Baltimore Country and Johns Hopkins	CT (nucleic acids)	Cartridge NAAT
MAMEF	University of Maryland and Baltimore Country and Johns Hopkins	NG (nucleic acids)	Cartridge NAAT
MobiNAAT	Johns Hopkins and BioMEMS	CT (nucleic acids)	Cartridge NAAT

<b>Test name</b>	<b>Company</b>	<b>Specimen Type</b>	<b>Time to result</b>	<b>Test/Detection type</b>	<b>Sensitivity</b>	<b>Specificity</b>	<b>Approved in Canada?</b>
OSOM Trichomonas Test	Sekisui Diagnostics	Vaginal swab	10 mins	TV (Ab/Ag), RDT	83.3-90.0%	98.8-100%	Yes, licensed by Health Canada
AmpliVue	Quidel Corporation	Vaginal swabs	45 mins	Platform (nucleic acids)	NA	NA	Yes, licensed by Health Canada
Solana	Quidel Corporation	Vaginal swabs, female urine	35 mins	Platform (nucleic acids)	NA	NA	Yes, licensed by HC for use with urine specimens and vaginal swabs
Xpert TV	Cepheid	Female and male urine, endocervical swab/patient collected vaginal swab	60 mins	Platform (nucleic acids)	NA	NA	No
Affirm VPIII	Becton Dickinson	Vaginal swabs	-	DNA probe molecular test (nucleic acids)	46.30%	100%	No

Table 5. Point-of-Care tests for STBBIs currently licensed by Health Canada (Active License Listing for Medical Devices)					
Device Name	Manufacturer	Infection	Device first issue date	License #	Link
GeneXpert CT/NG	Cepheid	CT/NG	2012-10-31	89992	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>
Chlamydial Rapid Test (CRT)	Diagnostics for the Real World	CT	2011-07-25	86727	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>
OSOM Trichomonas Test	Sekisui Diagnostics	TV	2006-09-20	72370	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>
AmpliVue	Quidel Corporation	TV	2017-04-12* <i>No longer authorized for sale in Canada</i>	98932	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?lang=en&amp;type=archived_archive">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?lang=en&amp;type=archived_archive</a>
Solana Trichomonas Assay		TV	2017-04-03	98899	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>
Xpert HPV	Cepheid	HPV	2015-03-26	94932	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>
OraQuick HCV Rapid Antibody Test	Orasure Technologies	Hepatitis C	2017-01-17	98356	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>
Reveal Rapid HIV Antibody Test (Laboratory Use Only)	Medmira Laboratories	HIV	1999-06-14	5140	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>
INSTI HIV-1/HIV-2 ANTIBODY TEST KIT	Biolytical Laboratories	HIV	2005-10-25	69580	<a href="https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active">https://health-products.canada.ca/mdall-limh/dispatch-repartition.do?type=active</a>

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