BRITISH COLUMBIA
CENTRE *for* EXCELLENCE
in HIV/AIDS

BC Centre for Disease Control
An agency of the Provincial Health Services Authority

HIV Monitoring Quarterly Report:
Technical Report

British Columbia Centre for Excellence in HIV/AIDS
British Columbia Centre for Disease Control

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HIV Monitoring Quarterly Report: Technical Report

This technical report describes how all HIV Indicators shown in the provincial and Health Authority (HA)-specific HIV Monitoring Quarterly Reports are defined and calculated. This report is reviewed quarterly and changes to how indicators are calculated are described here.

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Acronyms

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
BC	British Columbia
BCCDC	BC Centre for Disease Control
BC-CfE	BC Centre for Excellence in HIV/AIDS
BCPHMRL	BC Public Health Microbiology and Reference Laboratory
DTP	Drug Treatment Program
FHA	Fraser Health Authority
HA	Health Authority
HET	Heterosexual
HIV	Human Immunodeficiency Virus
HSDA	Health Service Delivery Area
IDU	Injection Drug User
IHA	Interior Health Authority
MSM	Men who have Sex with Men
MSP	Medical Service Plan
NHA	Northern Health Authority
NIR	No Identified Risk exposure
PCS	Programmatic Compliance Score
POC	Point of Care
pVL	Plasma Viral Load (in units of copies/mL)
STOP HIV/AIDS	Seek and Treat for Optimal Prevention of HIV/AIDS project
VCHA	Vancouver Coastal Health Authority
VIHA	Island Health Authority

Indicator Descriptions and Calculation Methods

Indicator 1: HIV Testing Episodes (Figures 1.1-1.3, 1.5-1.7)

Description of Measure	The number of HIV test episodes ordered, which is a measure of the volume of HIV tests performed for the province of BC by HA and by HSDA. Data includes: i) prenatal HIV tests and ii) point of care (POC) HIV tests (delivered by STOP HIV/AIDS partner agencies). The number of HIV test episodes is stratified by HA, gender, prenatal and non-prenatal testing, age category and HSDA. Stratifications by HA/HSDA include POC HIV testing; however, stratifications by prenatal, gender and age category do not include POC HIV tests.
Significance	Number of HIV test episodes ordered is a direct reflection of STOP program initiatives related to HIV screening and may lead to increased case-finding, reduced number of individuals unaware of their HIV status and reduced stigma.
Data Source	• SunQuest database at the BC Public Health Microbiology and Reference Laboratory (BCPHMRL). • Point of Care (POC) HIV testing volumes from STOP HIV/AIDS partner agencies (from 2010 Q4 forward). Note: In FHA, POC testing data are available from March 2011 forward. In IHA, POC testing data are available for May 2011 forward. For all other health authorities, POC testing data are available from the fourth quarter of 2010 forward. • Providence Health Care laboratory data (form September 2011 forward).

Calculations	• Total number of HIV tests grouped by test episodes. A test episode consists of all HIV tests conducted for an individual in a 30-day period (as follow-up or simultaneous HIV tests may be required to clarify test results within this period). • Allocation by HA/HSDA is based on address of ordering clinician or clinic, or if unknown, address of individual undergoing HIV testing. • Prenatal test episodes are determined by specific test codes within BCPHMRL laboratory data system for female specimens. Non-prenatal test episodes are calculated by subtracting prenatal test episodes from total female test episodes. • The number of HIV test episodes includes the number of POC HIV tests where the latter is available. POC HIV testing information became available in 2010 Quarter 4. • Unit of analysis is number of HIV test episodes per quarter.
Limitations	• Includes data for ~95% of all screening and all confirmatory HIV testing in BC. Does not include data for screening HIV tests conducted at Victoria General Hospital. • Where stratifications result in small numbers greater variability for this indicator will be seen, making trends more difficult to interpret.
Notes	• HIV tests ordered from outside BC or from an unknown region are excluded from these data. These tests account for ~1% of all HIV test episodes in BCPHMRL Laboratory Data.

Indicator 1: Point of Care HIV Test Episodes (Figure 1.4)

Description of Measure	The number of Point of Care (POC) HIV test episodes ordered is a measure of the volume of POC HIV tests performed in the province. The number of HIV POC test episodes is stratified by HA and HSDA (in HA-specific reports only).
Significance	Number of POC HIV test episodes ordered is a direct reflection of STOP program initiatives related to HIV screening and may lead to increased case-finding, reduced number of individuals unaware of their HIV status and reduced stigma.

Data Source	• POC HIV test volumes from STOP HIV/AIDS partner agencies (starting in 2010 Q4). Note: In FHA, POC testing data are available from March 2011 forward. In IHA, POC testing data are available for May 2011 forward. For all other health authorities, POC testing data are available from the fourth quarter of 2010 forward.
Calculations	• Each POC HIV test is counted as a test episode. • Allocation by HA/HSDA is based on address of ordering clinician or clinic. • Unit of analysis is number of HIV POC test episodes per quarter.
Limitations	• Where stratifications result in small numbers greater variability for this indicator will be seen, making trends more difficult to interpret. • A person may have multiple POC tests and each test would be counted as a test episode. • POC data cannot be stratified by prenatal tests, age category or gender.

Indicator 2: Population HIV Testing Rates (Figures 2.1-2.3)

Description of Measure	Annual population rate of unique HIV test episodes ordered per 100,000 population per year. Population HIV testing rates are stratified by HA, gender, age category and HSDA.
Significance	Rate of HIV test episodes ordered is a direct reflection of STOP HIV/AIDS program initiatives related to HIV screening and may reflect increased case-finding and reduced number of individuals unaware of their HIV status.
Data Source	SunQuest Laboratory database at the BC Public Health Microbiology and Reference Laboratory (BCPHMRL).
Calculations	• Probabilistic matching of identifiers is conducted to identify individuals having greater than one HIV test in the same year. • Denominator: Population of BC/HA/HSDA. • Numerator: Number of unique HIV test episodes ordered. • Allocation by HA is based on address of the individual undergoing HIV testing, or if unknown, ordering clinician or clinic address. • Unit of analysis is rate of HIV test episodes ordered per 100,000 population per year.
Limitations	• Repeat tests of individuals who use different identifiers (e.g., initials, pseudonyms, non-nominally) may not be identified and these individuals may be counted more than once. • Testing rates do not include POC test volumes. • **This indicator is limited to annual reporting.** If examined on a quarterly basis, one does not see big differences in the number of HIV test episodes per quarter (as repeat HIV testing is unlikely within smaller time periods). • Where stratifications result in small numbers, greater variability for this indicator will be seen, making trends more difficult to interpret.

Indicator 3: New HIV Diagnoses (Figures 3.1-3.5)

Description of Measure	Number of individuals identified with a new diagnosis of HIV (i.e., a new positive HIV test). Number of new HIV diagnoses is stratified by HA, gender, age category, exposure category (MSM, IDU, HET, NIR/Other) and HSDA.
Significance	The number of individuals identified with a new HIV diagnosis may be influenced by initiatives to expand HIV screening, resulting in increased case-finding and an increase in new diagnoses, which may be observed during initial implementation of screening initiatives. In addition, new HIV diagnosis may be influenced by decreases in HIV incidence as a result of expanded ART.
Data Source	Provincial HIV/AIDS surveillance database at BCCDC.
Calculations	• On receipt of a positive HIV test result, history of previous HIV testing is elicited from provincial databases or during public health follow-up. An individual identified with a new positive HIV test in BC is included and individuals with a previous positive HIV test inside or outside BC are excluded. • Unit of analysis is the number of new diagnoses of HIV per quarter. • Except for HIV diagnosis-Provider Address, allocation to HA/HSDA is based primarily on the address of the individual with a new HIV diagnosis, or if unknown, the address of the clinic or clinician where diagnosis occurred. • For HIV Diagnoses – Provider Address, the allocation of HA/HSDA is by the ordering clinic or physician, or if unknown, by the residence of the individual with the new HIV diagnosis.
Limitations	• This indicator is not a measure of HIV incidence (number of newly acquired HIV infections) within each time period, as an individual can be diagnosed with HIV at varying lengths of time after acquiring an infection (months to years). • May be difficult to interpret trends given influence of both HIV testing trends and HIV incidence on this variable. • Where stratifications result in small numbers greater variability for this indicator will be seen, making trends more difficult to interpret. • Ethnicity and exposure category is elicited during public health follow up and there is an expected reporting delay of 3-6 months.
Notes	• The number of new HIV diagnoses allocated by ordering physician may more accurately represent new HIV diagnoses that occur through HIV testing services within each region.

Indicator 4: Stage of HIV Infection at Diagnosis (Figures 4.1-4.4)

Description of Measure

Indicates stage of infection at HIV diagnosis, utilizing data from laboratory acuity testing, prior HIV testing history, CD4+ information, and AIDS case reports. The definition below is adapted from case definitions proposed by the U.S. Centers for Disease Control.

Classification	CD4+	Case definition
Stage 0 (Acute)	---	Laboratory criteria met for acute HIV infection, or previous negative or indeterminate HIV test within 180 days of first confirmed positive HIV test
Stage 1	CD4+ 500+	Stage 0 not met, and no AIDS case report within 12 months of diagnosis, and CD4+ ≥ 500
Stage 2a	CD4+ 350 to 500	Stage 0 not met, and no AIDS case report within 12 months of diagnosis, and CD4+ 350-499
Stage 2b	CD4+ 200 to 350	Stage 0 not met, and no AIDS case report within 12 months of diagnosis, and CD4+ 200-349
Stage 3 (Advanced)	CD4+ < 200	Stage 0 not met, and [AIDS case report within 12 months of diagnosis, or CD4+ < 200]
Stage Unknown	No CD4+ at diagnosis	Stage 0 not met, and no AIDS case report within 12 months of diagnosis, and no information available on CD4+

Number of newly HIV diagnosed individuals' stage of infection, stratified by HA, gender, age category and exposure category (MSM, IDU, HET, and Other).

Significance

Stage of infection at time of a new HIV diagnosis is directly related to the HIV Cascade of Care[1]. HIV disease staging and classification systems are critical tools for tracking and monitoring the HIV epidemic[2-8]. For the newly HIV positive individuals, early diagnoses can improve their health outcome and facilitate in the prevention of viral transmission[9]. Furthermore, a persistent undiagnosed HIV infection may impact on clinical care and may contribute to ongoing HIV transmission. Delays in diagnosis may be due to lack of awareness regarding risk of HIV or barriers to accessing HIV testing (e.g., HIV stigma).

Data Source

Provincial HIV/AIDS surveillance database at BCCDC and BCPHMRL data (SunQuest). If CD4+ data were missing in BCCDC surveillance database, Sunset (clinical database) was used.

Calculations	• Probabilistic matching of identifiers is used to link AIDS case report forms, HIV case report forms with CD4+ cell count data, and testing history. • Acute cases (Stage 0) were determined by laboratory acuity testing and by record of a previous negative test episode within 180 days of the first confirmed positive test episode. • Advanced cases (Stage 3) did not meet the criteria for an acute case and had: (1) an AIDS case reported within 12 months of first confirmed positive test episode or (2) CD4+ cell count less than 200. • Stages 1 through 2b did not meet the criteria for an acute nor advanced case and the specific stage depended on the level of CD4+ cell count. • Exposure group definitions and hierarchy are the same as followed for the BCCDC HIV annual report. • Allocation to health authority is on the basis of client's address, or if unknown, the address of the ordering clinic or clinician. • Stage of infection was stratified by health authority, exposure group, and gender. • Unit of analysis is number of newly diagnosed individuals at a particular stage of infection.
Limitations	• **This indicator is limited to annual reporting.** • Manual importing of CD4+ information from Sunset is performed at the beginning and mid-year. Due to the manual input of CD4+ information, annual updates for this indicator is available from in Q2 forward. • This indicator relies on public health follow-up and submission of AIDS case report form, which affects the timeliness of the reporting. There is an expected reporting delay of up to 12 months. While this indicator will not be lagged by a year, this AIDS case reporting delay may mean that values for previous years will change over time. • CD4+ data is sparsely populated prior to 2010. Although most of the HIV cases in 2010 had missing CD4+ count data, a manual review of those cases in Sunset system recovered many of the CD4+ count data. • The amended CDC definitions rely on data linkage to prior test history to identify seroconverters less than 180 days not captured by acute testing. While this is achievable for the most part, there are some limitations for negative test records not housed in the provincial lab system, such as point-of-care testing, HIV tests performed at Victoria General, or HIV tests performed for insurance purposes outside of the province. • Where stratifications result in small numbers, there will be greater variability making trends more difficult to interpret.

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Indicator 5: HIV Cascade of Care (Figures 5.1-5.7)

Description of Measure: There are six stages to the cascade of care: 1. HIV diagnosis, 2. Linked to HIV care, 3. Retained in HIV care, 4. On ART, 5. Adherent to ART and 6. Achieving a suppressed pVL. The cascade of care model is a histogram showing leakage points along each stage of the cascade. Cascade of care models are created for BC in the provincial report and stratified by HA (in HA-specific reports). The Cascade of Care is further stratified by HSDA in HA-specific reports. Both BC and HA reports show the cascade of care stratified by sex, age category, MSM, IDU, and MSM and age category.

Significance: The success of seek, test, treat and retain (STTR) programs like STOP are reliant on diagnosing the undiagnosed HIV population, linking them with HIV care, initiating persons on ART and ensuring excellent adherence to ART so that viral load suppression can be achieved. The cascade of care model highlights leakage points along the model. Understanding leakage points facilitates improved HIV program planning.

Interpretation: When interpreting trends in the cascade of care, we strive to see increases along each step of the cascade of care (i.e. reduced attrition) with the ultimate goal being 100% within each stage of the cascade. Cascade of care models are created for BC and stratified by HA, HSDA in HA-specific reports, sex, age category, HSDA, MSM, IDU, and MSM and age category.

Data Sources:

- BC Centre for Disease Control (BCCDC) data is used to estimate the number of identified HIV positive individuals. The BCCDC is the single provincial agency that centralizes all HIV surveillance through the BC Public Health Microbiology and Reference Laboratory (BCPHMRL), which does more than 90% of all HIV screening tests in BC and all confirmatory testing.

- The BC Centre for Excellence in HIV/AIDS (BC-CfE) DTP database provides pVL and CD4 cell count testing data, as well as ART use. All pVL measurements in BC are performed at the St Paul's Hospital virology laboratory, thus pVL data capture is 100%. An estimated 80% of all CD4 count measurements performed in the province are captured in the BC-CfE data holdings.

- Recent updates to the DTP database have allowed for more comprehensive information on HIV risk group category. As a result, 2014 Q4 data and onward may differ significantly from preceding reports in terms of total numbers ascribed to each risk group.

- The above databases were supplemented with (i) the MSP physician billing database, which captures all fee-for-service care in the province (including HIV-related physician visits and other services); (ii) the provincial Discharge Abstract Database, which captures inpatient care; (iii) the BC PharmaNet database, capturing all non-ARV medication dispensations; and (iv) the BC Vital Statistics database. Linkage and preparation of the de-identified individual-level database was facilitated by the BC Ministry of Health.

Calculation:

Table I summarizes the definitions applied to each stage of the cascade of care.

- HIV diagnosis and linkage to care are fixed classifications. Once diagnosed or linked to care, an individual is counted as such for each subsequent quarterly calculation until death.

- Individual classifications in each of the subsequent stages vary from one quarter to another. Further, the denominator in each step of the cascade is the sum of the preceding stage (ex. the number of individuals with suppressed pVLs are drawn from the sum of individuals who are adherent to therapy).

Table I. Operational Definitions for the Eight Stages of the Cascade of HIV Care

Cascade Stage	Definition
HIV-Diagnosed	Defined as the first instance of one of the following: (i) Confirmed HIV-positive test (ii) Detectable pVL (iii) HIV-related MSP billing or hospitalization (iv) Reported AIDS-defining illness (v) Antiretroviral treatment dispensation
Linked to HIV Care	Among diagnosed cases; defined as: (i) Among those with confirmed HIV test: the first instance of HIV-related service[1] following HIV diagnosis. (ii) Among those with no confirmed HIV test: the first instance of HIV-related service ≥ 30 days following derived HIV diagnosis date.

Retained in HIV Care	Among individuals linked to HIV care; defined as: (i) HIV-related physician visits OR diagnostic tests (CD4 or pVL) ≥3 months apart within the calendar year OR (ii) At least two antiretroviral drug dispensations ≥3 months apart, within the calendar year.
On ART	Among those in need of antiretroviral therapy; defined as receiving at least two antiretroviral drug dispensations ≥3 months apart, within the calendar year.
Adherent to ART	Among individuals on antiretroviral therapy; defined as having at least 80% adherence[2] in the calendar year, or from the point of antiretroviral initiation for those beginning therapy within the calendar year.
Undetectable pVL	Among individuals adherent to therapy, defined as having no detectable pVL[3] over a period ≥3 months in duration within the calendar year.

[1] pVL test OR CD4 test OR HIV-related physician visit OR antiretrovirals dispensed; [2] Refers to the number of days of medication dispensed, divided by the total number of days of follow up; [3] Based on pVL testing technology available at the time of measurement.

When calculating the Cascade of Care, we estimate the most current HIV Cascade of Care. Why and how this is done is described below:

Estimating the Current HIV Cascade of Care:

1) Background: Why do we need to estimate the current Cascade of HIV Care?

1. We are unable to get a linked dataset on a quarterly basis.
2. The time lag of receiving the linked dataset (ie. administrative data) is too long (≥1 year) to provide up to date information.

2) Objective:
To measure the Cascade of Care steps with available BC-CfE data (which has a 1 month data lag), and then estimate the proportion of the patients we should be capturing using linked data.

3) Methodology:
There are five steps to estimating the current HIV Cascade of Care. These 5 steps are executed for the province of BC, for each HA and for each HSDA in a given HA, in the

HA-specific reports. 2013 Cascade of Care is shown as an example calculation below (as of August 2013, the 2011 Cascade is the most recent measured Cascade of HIV Care).*

Step 1: For each step from the most recently measured Cascade of Care*, we estimate what proportion of people are included based on Non-BC-CfE[i] data only:

	Diagnosed	Linked	Retained	On ART	Adherent	Suppressed
Total	8308	7801	6688	5975	5172	4054
From BC-CfE data	7351	7418	6510	5975	5172	4054
From NON-BC-CfE data	957	383	178	0	0	0
Ratio NON-BC-CfE data	11.52%	4.91%	2.66%	0.00%	0.00%	0.00%

** The most recently measured Cascade of HIV Care from the linked BC-CfE dataset will always be used when calculating a given cascade of care. [i] NON-BC-CfE data comprises administrative data (Hospital admissions and physicians visits) and HIV testing information.*

Step 2: For the Diagnosed and the Linked steps of the 2011 Cascade of HIV Care, we estimate what proportion of people are excluded because they are lost to follow-up (FU) (defined as not having any administrative record in the 18 months prior to the calendar year of interest), for BC-CfE individuals and non-BC-CfE individuals.

We have to estimate the percent of lost to follow-up because the data available at the BC-CfE is not sufficiently complete to be able to capture true loss:

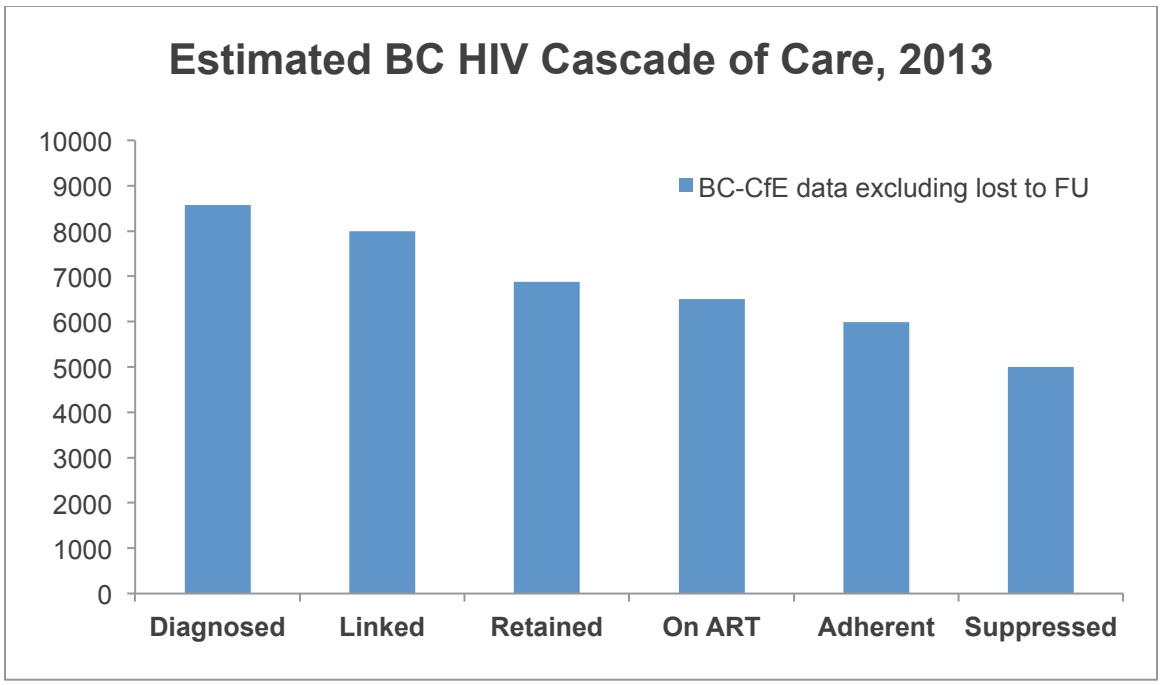
Estimation of Lost to Follow-up in Diagnosed Step

	Not lost to FU	Lost to FU	Died prior to 2011	% of Lost to FU
BC-CfE	7675	1138		12.90%
non-BC-CfE	513	420		45%

Estimation of Lost to Follow-up in Linked Step

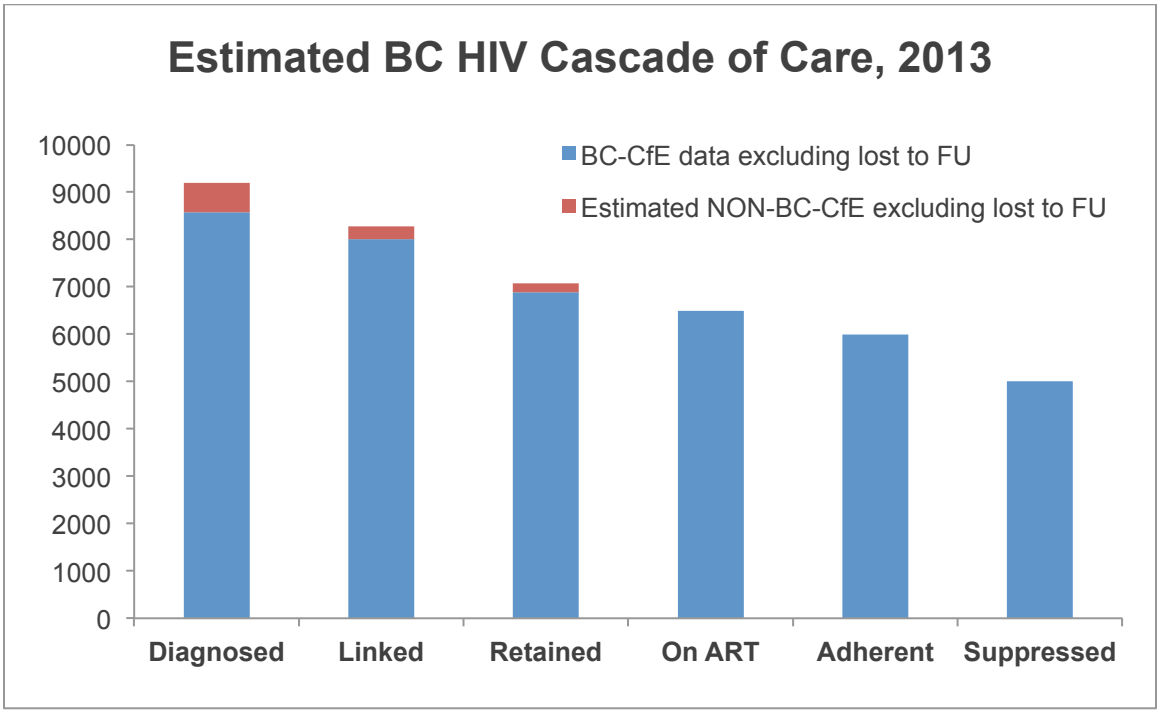
	Linked Not lost to FU	Linked Lost to FU	Unlinked or Died prior to 2011	% of Lost to FU
BC-CfE	7478	984		11.60%
non-BC-CfE	323	197		37.90%

Step 3: Given a lack of HIV testing data to define an HIV diagnosis date, we use the same definitions used in 2011 and BC-CfE data only to calculate all the steps of the current Cascade of HIV Care:



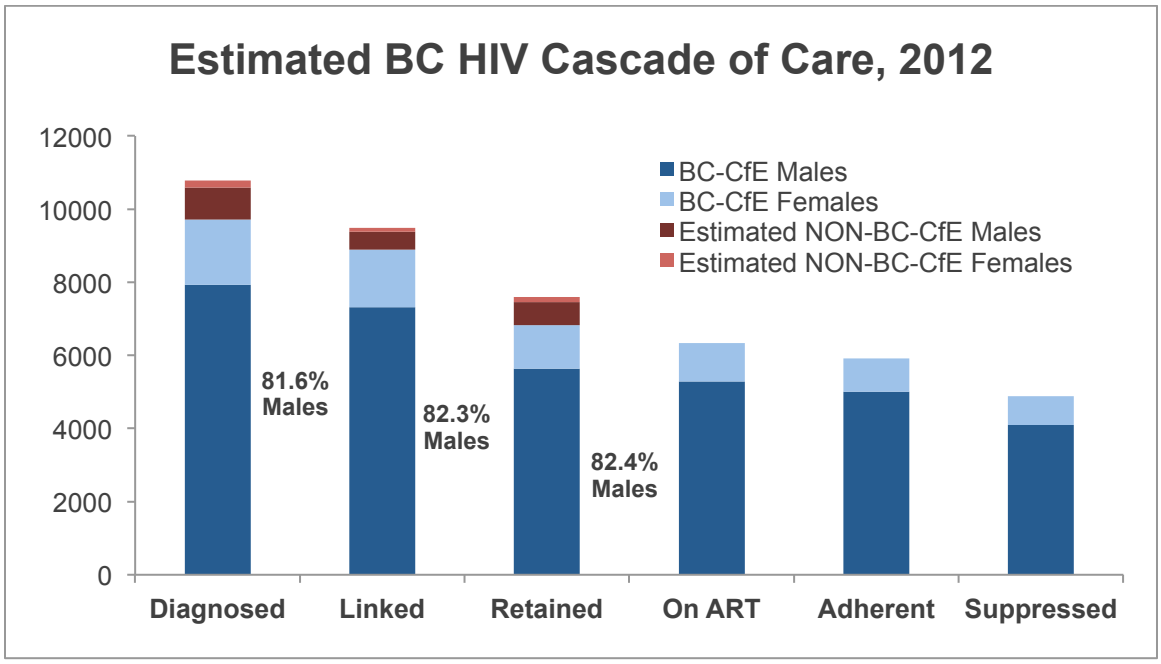
NB: Since ART use is calculated as dispensed ART at any time in a given month, adherence is slightly over-estimated.

Step 4: Inflate the 2012 Cascade of Care from BC-CfE data to account for Non- BC-CfE data, using known 2011 Non- BC-CfE / BC-CfE ratios:



Step 5: Stratify the distribution of gender, MSM, IDU and age at the end of year of interest for each step of the BC-CfE-only cascade. For each step individually, we extend the gender, MSM, IDU, age distribution to the estimated non-BC-CfE data**

	Diagnosed	Linked	Retained	On ARV	Adherent	Suppressed
From BC-CfE data:	9717	8885	6828	6339	5911	4882
BC-CfE Males	7926	7313	5630	5290	4998	4096
BC-CfE Females	1791	1572	1198	1049	913	786
Estimated NON-BC-CfE	1064	605	763	0	0	0
Estimated NON-BC-CfE Males	868	498	629	0	0	0
Estimated NON-BC-CfE Females	196	107	134	0	0	0
BC-CfE data + Estimated NON-BC-CfE	10781	9490	7591	6339	5911	4882
BC-CfE Males/Females ratio	81.57%	82.31%	82.45%	83.45%	84.55%	83.90%



Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as "Unknown". If no patient address known, then allocation by HA is based on address of patient's prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as "Unknown".

Limitations:

1. The presented cascade shows all stages of the cascade (linked to care, retained in care, on ART and suppressed viral load) as a proportion of the diagnosed population. As such, we do not show the proportion of the undiagnosed population and the leakage between the undiagnosed population and the diagnosed population. This is done because, to date, there are no reliable estimates of the undiagnosed HIV-positive population. Since cascade of care models are presented as a proportion of the diagnosed population, this improves the appearance of the cascade of care models and increases the proportion of persons retained within each stage of the cascade. Readers should take this into consideration when interpreting cascade of care results.

2. The "Unknown" groups are not shown in this analysis. This is because the BC-CfE does not capture geographical information for the individuals who do not initiate treatment; thus, it appears that they have very poor outcomes (1.3% of suppressed). Given the lack of quality information used to estimate Cascade of Care outcomes for our unknown group, our results render little meaning and utility

and are not shown. In 2013 Q2, 14% of the BC-CfE individuals are assigned into the "Unknown" HA.

3. There is a 3-6 month lag in new HIV diagnosis data from the BCCDC.

4. There is a 1-month lag in DTP data updates regarding ARV prescription data.

5. CD4 data is approximately 80% complete.

6. The IDU variable is a history of IDU. Thus, IDU may not be current. This variable is missing approximately 30% of the time.

7. The MSM variable is missing approximately 40% of the time.

8. Administrative data has a one year data lag. As such, the Cascade of Care is calculated using approximately 90% known up-to-date data and 10% estimated data. How the data is estimated to acquire a current estimate of the HIV Cascade of Care is explained in the calculation section above.

Indicator 6: Programmatic Compliance Score (PCS) (Figures 6.1 and 6.2)

Description of Measure: The Programmatic Compliance Score (PCS) assesses the impact of non-compliance to HIV treatment guidelines on mortality and clinical outcomes. Scores are categorized as 0, 1, 2, 3 and ≥4 (where a PCS=0 is the best score and a PCS of 4 or more is the worst score). The PCS and it's components are shown for the province of BC in the BC report and stratified by HA in HA-specific reports.

Significance: Compliance with HIV treatment guidelines relies on physician's following the guidelines but also a patient's cooperation with a treating physician's recommendations. The PCS is a composite measure of physician and patient-related indicators, which ultimately predicts the probability of mortality and of adverse clinical outcomes for a given PCS score.

Interpretation: Table II provides a summary of the increased risk of mortality for a given PCS. The increased risk of mortality associated with a PCS score of 1 is 3.81 compared with someone with a PCS score of 0 (best score). The increased risk of mortality associated with PCS score of 2 and 3 are 7.97 and 11.51 respectively compared with someone with a PCS score of 0. A person with a PCS score of 4 or more has 22.37 increased risk of mortality compared with someone with a PCS score of 0. Thus, HAs should be striving to see a reduction in their PCS scores over time and aiming to see their entire patient population with a score of 0.

Table II. The Probability of Mortality based on the Programmatic Compliance Score (PCS)

Programmatic Compliance Score (PSC)	Risk Ratio (95% Confidence Interval)
0 (Best Score)	1 (-)
1	3.81 (1.73–8.42)
2	7.97 (3.70–17.18)
3	11.51 (5.28–25.08)
4 or more (Worst Score)	22.37 (10.46–47.84)

Table III provides a summary of the increased risk of immunologic failure and virologic failure for a given PCS. The increased risk of immunologic failure associated with a PCS score of 4 is 9.71 compared with someone with a PCS score of 0 (best). The increased risk of virologic failure associated with a PCS score of 4 or more is 3.80 compared with someone with a PCS score of 0 (best). HAs should be striving to see a reduction in their PCS scores over time and aiming to see their entire patient population with a score of 0.

Table III. Multivariable model results for each of the two outcomes: Immunologic failure and Virologic failure.

	Adjusted Risk Ratio (95% Confidence Interval)	
	Immunologic Failure	**Virologic Failure**
List of Variables		
Programmatic Compliance Score (PCS)		
0	1 (-)	1(-)
1	1.39 (1.04-1.85)	1.32 (1.05-1.67)
2	2.17 (1.54-3.04)	1.86 (1.46-2.38)
3	2.93 (1.89-4.54)	2.98 (2.16-4.11)
4 or more	9.71 (5.72-16.47)	3.80 (2.52-5.73)
Age	NS	0.98 (0.97-0.99)
Follow-up (in years)	0.44 (0.41-0.47)	NS
Gender		
Male	1 (-)	1(-)
Female	NS	1.20 (0.96-1.50)
Injection Drug Use History		
No	1 (-)	1(-)
Yes	1.72 (1.36-2.19)	1.98 (1.65-2.38)
Adherence during First Year of ART		
>95%	1 (-)	1 (-)
≤95%	2.04 (1.60-2.62)	2.92 (2.42-3.53)
Health Region*		
VCHA-City Center	1 (-)	1 (-)
VCHA-DTES	1.21 (0.80-1.83)	0.82 (0.60-1.13)
VCHA-Other	1.50 (1.05-2.15)	1.31 (0.97-1.75)
IHA	1.04 (0.65-1.67)	0.89 (0.61-1.30)
FHA	1.24 (0.88-1.75)	1.07 (0.81-1.40)
VIHA	2.55 (1.68-3.89)	1.17 (0.85-1.61)
NHA	1.67 (0.89-3.14)	1.61 (1.01-2.57)

* DTES= Downtown Eastside, NS=Not Significant

Data Source: BC Centre for Excellence in HIV/AIDS

Calculation: Only persons ART naïve, ≥18 years of age and had one year of follow-up post ART initiation were included in the analysis. The programmatic compliance score (PCS), was obtained by adding the values for indicators 1 to 6 (listed below), which provided a range from 0 (most compliance with BC ART guidelines) to 6 (most non-

compliance with BC ART guidelines). The six performance indicators based on the appropriate International AIDS Society (IAS) USA guideline recommendations for a given year from 2000 and onwards. IAS guidelines are updated every two years on even years (ex. 2008, 2010, 2012):

(1) Having <3 (coded as 1) or ≥3 (coded as 0) CD4 cell count measurements in the first year after starting ART;

(2) Having <3 (coded as 1) or ≥3 (coded as 0) pVL measurements in the first year after starting ART;

(3) Having a genotypic resistance test performed (coded as 0) or not (coded as 1) at baseline;

(4) Initiating ART with baseline CD4 cell count with <200 cells/mm^3 (coded as 1) or ≥200 cells/mm^3 (coded as 0);

(5) Initiating ART on a combination regimen recommended by contemporary guidelines (coded as 0) or not (coded as 1); and

(6) Achieving viral suppression within 6 months of initiating ART (coded as 0) or not (coded as 1). Viral suppression was defined by two consecutive pVL <50 copies/mL.

Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as “Unknown”. If no patient address known, then allocation by HA is based on address of patient’s prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as “Unknown”.

Limitations:

1) CD4 cell count capture is not 100%, and it has been estimated as approximately 80% of all CD4 testing done in BC. CD4 cell count testing done at St. Paul’s hospital is updated automatically.

2) ART-related data has approximately a 1 month lag time to be updated in the DTP database.

Notes: For a complete description of the development of the PCS score please refer to: Lima VD, Le A, Nosyk B, Barrios R, Yip B, et al. (2012) Development and Validation of a Composite Programmatic Assessment Tool for HIV Therapy. PLoS ONE 7(11): e47859. doi:10.1371/journal.pone.0047859

Indicator 7: New Antiretroviral Therapy Starts (Figure 7)

Description	The indicator provides a count of the number of first starts (new persons actively on ART in BC) and the number of experienced starts (persons with a history of ART use reinitiating treatment) over time. The indicator provides provincial data and is stratified by HA in the HA-specific reports.
Significance	ART has transformed HIV from a fatal disease to a chronic one. Benefits of ART are well-researched and numerous. It is recommended in the BC HIV treatment guidelines that all persons ready to initiate ART should initiate ART as close to the time of HIV diagnosis as possible. The indicator provides counts of the number of persons initiating ART and is stratified by the number of first starts (new persons actively on ART in BC) and the number of experienced starts (persons with a history of ART use reinitiating treatment).
Interpretation	We would like to see the number of first starts as well as the number of persons with an experienced start increasing over time.
Data Source	BC-CfE DTP database.
Calculation	Only persons ≥18 years of age are included in this analysis. The number of new active ART participants is the sum of all persons on ART for at least one day in a given quarter, as indicated by recorded prescription length. This number is calculated for those who are “first starts” and “experienced starts”. Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as “Unknown”. If no patient address known, then allocation by HA is based on address of patient’s prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as “Unknown”. **First starts:** An ART naïve HIV-positive person prescribed their first regimen ever in the DTP (regardless of if they moved or died in the analyzed quarter). **Experienced start:** A person who was alive and residing in BC at the end of a given quarter, was previously on treatment, but not in the previous quarter, and is registered with the DTP. Also, an HIV-positive person prescribed their first regimen ever in the DTP, but was not ART naïve.

Limitations	1. The number of dispensed pills is used as a proxy for actively taking ART. It may be the case that pills have been dispensed; however, a person is not actively consuming their medication. Alternatively, a person may have a back-up of ART and is actively taking it; however, didn't refill a prescription and would be counted as not actively on ART. 2. For HA specific information, HA is designated based on the most recently provided city of residence of the HIV-positive individual. If an individual does not update this information, the attributed HA may be incorrect.

Indicator 8: CD4 Cell Count at ART Initiation (Figure 8)

Description	The absolute median CD4 cell count at ART initiation (right axis of the figure) is shown over time. The left axis shows the proportion falling into a specified CD4 cell count category at the time of initiating ART. There are five CD4 cell count at ART initiation categories: <49 cells/μL, 50-199 cells/μL, 200-349 cells/μL, 350-499 cells/μL and >500 cells/μL. Data is provided by HA only.
Significance	Evidence indicates that initiating ART early improves ART's potential benefits. Since 2012, ART guidelines in BC recommend initiating ART regardless of CD4 cell count. Thus, over time, we would like to see as many individuals as possible initiating ART at higher CD4 cell counts. This is dependent on early diagnosis of HIV and timely initiation of ART.
Interpretation	The median CD4 cell count at ART initiation of DTP participants on the right axis. The proportion of ART naïve persons initiating ART with CD4 cell counts falling into one of five categories: <49 cells/μL, 50-199 cells/μL, 200-349 cells/μL, 350-499 cells/μL and >500 cells/μL. Each calendar year refers to the year when ART was first prescribed.
Data source	BC-CfE DTP database
Calculation	Only persons ≥18 years of age and starting treatment naïve in BC were included in the analysis (regardless of if they moved or died in the analyzed quarter). CD4 cell count at ART initiation is taken as the most recent CD4 cell count prior to the two weeks after initiation of ART as indicated by ART prescriptions. CD4 cell count is categorized as either <49 cells/μL, 50-199 cells/μL, 200-349 cells/μL, 350-499 cells/μL and >500 cells/μL. The median CD4 cell count is also calculated. All persons who initiated ART for the time period shown in a given Monitoring Report were included in this analysis. Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address is available per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as "Unknown". If no patient address known, then allocation by HA is based on address of patient's prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as "Unknown".
Limitations	1. CD4 cell count data is approximately 80% complete. 2. For HA-specific information, HA is designated based on the most recently provided city of residence of the HIV-positive individual. If an individual does not update this information, the attributed HA may be incorrect.

Indicator 9: Distribution of People on ART (Table 3)

Description	Table 3 provides counts of the number of persons actively on ART in BC by HA.
Significance	In 2012, ART guidelines indicated that all persons are eligible for ART, regardless of CD4 cell count. It is expected that the number of men and women on ART increase over time.
Interpretation	The number of men and women recorded to have ever been on ART and who are considered to be actively on ART as indicated by the number of pills dispensed.
Data Source	BC-CfE DTP database.
Calculation	Only persons ≥18 years of age were included in the analysis. Sum of all persons on ART for at least one day in a given quarter, as indicated by recorded number of dispensed pills. All persons are included in the analysis regardless of if they moved or died in the analysed quarter. **On ART:** defined as being on treatment (for at least one day) in a given quarter as indicated by recorded dispensed pill counts in pharmacy records. Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as “Unknown”. If no patient address is known, then allocation by HA is based on address of patient’s prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as “Unknown”.
Limitations	1. The number of dispensed pills is used as a proxy for actively taking ART. It may be the case that pills have been dispensed; however, a person is not taking their medication. Alternatively, a person may have a back-up of ART and is actively taking it; however, didn’t refill a prescription and would be counted as not actively on ART. 2. For HA-specific information, HA is designated based on the most recently provided city of residence of the HIV-positive individual. If an individual does not update this information, the attributed HA may be incorrect.

Indicator 9: Active and Inactive DTP Participants (Figure 9)

Description	The number of persons enrolled in the DTP stratified by being active or inactive, where an active DTP participant is someone who had pills dispensed at least once in the last six months and an inactive person had no pills dispensed in the last six months. Data is shown for the province of BC in the BC report and stratified by HA in the HA-specific reports.
Significance	Treatment interruptions reduce the potential benefits of ART. This indicator provides a description of the number of persons actively taking their ART compared with those who have been prescribed ART in the past but do not have evidence of actually taking their ART. Characteristic exploration of the inactive and active groups inform which groups are experiencing treatment interruptions.
Interpretation	The indicator provides a count of the number of active and inactive DTP participants. We would like to see the number of active DTP participants increase and the number of inactive participants decrease over time.
Data Source	BC-CfE DTP database.
Calculation	Only persons ≥18 years of age were included in the analysis. Sum of all active persons and sum of all inactive DTP Participants. **Active:** Persons on ART for at least one day in a given quarter, as indicated by recorded number of dispensed pills. All persons are included in the analysis regardless of if they moved or died in the analyzed quarter. **Inactive:** Persons no longer on ART in the analyzed quarter, were previously on treatment, and were alive and residing in BC at the end of the quarter. Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as “Unknown”. If no patient address known, then allocation by HA is based on address of patient’s prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as “Unknown”.

Limitations	1. An ART prescription is used as a proxy for actively taking ART. It may be the case that pills have been dispensed; however, a person is not actively taking their medication. Alternatively, a person may have a back-up of ART and is actively taking it; however, didn't refill a prescription and would be counted as not actively on ART. 2. For HA-specific information, HA is designated based on the most recently provided city of residence of the HIV-positive individual. If an individual does not update this information, the attributed HA may be incorrect.

Indicator 10: Antiretroviral Adherence (Figure 10)

Description:	The distribution of adherence to ART over time. Adherence was measured by prescription refill compliance. There are four levels of adherence: ≥95%, 80% to <95%, 40% to <80% and <40%. Data is provided for BC in the provincial report and by HA in the HA-specific reports.
Significance:	Evidence indicates that in the presence of imperfect ART adherence benefits of ART are compromised and ART resistance mutations develop. As such, it is important to monitor adherence trends to ensure that excellent ART adherence levels are being achieved.
Interpretation	The proportion of persons enrolled in the DTP achieving one of four levels of prescription refill adherence: ≥95%, 80% to <95%, 40% to <80% and <40%. Over time, we hope to see everyone achieving prescription refill adherence of ≥95%.
Data source	BC-CfE DTP database
Calculation	Only persons ≥18 years of age, alive and residing in BC were included in the analysis. Adherence to ART measured at 12 months from antiretroviral initiation. Adherence was estimated by dividing the number of days on ART by the number of days in 12 months period. Prescription refill adherence is categorized as one of four levels ≥95%, 80% to <95%, 40% to <80% and <40%. Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as “Unknown”. If no patient address known, then allocation by HA is based on address of patient’s prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as “Unknown”.
Limitations	1. There is no gold standard to measure adherence. Prescription refill adherence is the maximum adherence to ART we can obtain. A limitation of prescription refill adherence is that an individual may have filled a prescription but is not actively taking their medication. 2. For HA-specific information, HSDA is designated based on the most recently provided city of residence of the HIV-positive individual. If an individual does not update this information, the attributed HA may be incorrect.

Indicator 11: Resistance Testing and Results (Figure 11)

Description of Measure	The measure shows cumulative resistance testing results over time. This indicator includes patients with transmitted resistance and patients who acquired ART resistance(s) during follow-up.
Significance	Resistance testing prior to ART initiation is recommended in the BC HIV treatment primary care guidelines. Tracking resistance testing trends are important for ensuring that BC ART guidelines are being adhered to. As well as monitoring trends in the types and frequency of antiretroviral treatment resistance over time.
Interpretation	Since resistance testing prior to ART initiation is recommended in the BC HIV treatment primary care guidelines, it is expected that trends in resistance testing should increase over time. Trends over time should also show an increase in the proportion of DTP participants achieving a suppressed status and an increase in resistance testing should not lead to an increase in the number of ART resistances occurring. Results are categorized as suppressed (where a genotyped person's pVL is <50 copies/mL and thus resistance testing is not possible), wild type (no HIV-drug resistances are found), never genotyped (a patient who has never had resistance testing performed), 1-Class (for a resistance test result showing resistance to one class of ART), 2-Class (for a resistance test result showing resistance to two classes of ART) and 3-Class (for a resistance test result showing resistance to three classes of ART).
Data Source	BC-CfE DTP database.

Calculation	• Only persons ≥18 were included in the analysis. • The annual denominator is the number of patients who had at least one pVL measurement in a given quarter. • DTP participants are categorized as either suppressed (where a DTP participant's pVL is too low to be genotyped); wild type (ie. no HIV treatment resistances), never genotyped, and resistances to one, two or three HIV treatment classes. • Drug resistance status was categorized by drug class (NRTI, NNRTI, PI) from all available genotype data. • In cases of multiple genotypes per patient per quarter, the genotype with the greatest resistance (worst case, most classes) was used. • Multi-class resistance was observed in a single genotyped sample • Patients remain in a resistance category until their next test (e.g. If a patient initiates therapy in 2000 and has genotypes performed in 2002 (wild type) and 2006 (1-Class), and finally suppresses in 2010. The patient would be categorized as "no genotype" in 2000-2001, wild type in 2002-2005, 1-class in 2006-2009 and suppressed in 2010-2012.) • In order to fall into the "Suppressed" category, all of a patient's pVL measurements collected in that quarter must fall below the lower assay cutoff (<50 copies/mL for 1999-2012). Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as "Unknown". If no patient address known, then allocation by HA is based on address of patient's prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as "Unknown".
Limitation	1. For HA-specific information, HA is designated based on the postal code of a patient's residence at the time of DTP enrollment. This data does not necessarily reflect a DTP participant's current postal code. 2. HA data is missing for approximately 15% of DTP participants.

Indicator 12: AIDS-Defining Illness (Figure 12)

Description	AIDS case reports are shown as an absolute number in the data table and as a rate per 100,000 in the line graph over time. Data is shown using three definitions to define AIDS cases: 1. The number of AIDS cases reported through AIDS case report forms from the BC-CfE DTP; 2. The number of AIDS cases reported through provincial surveillance at the BCCDC (including DTP cases) and; 3. The number with a CD4 cell count of <200 cells/μL at time of ART initiation using DTP data. All of the numbers were converted into rate per 100,000 of the BC population.
Significance	Improvements in ART and the expansion of ART province-wide has led to very low numbers of recorded AIDS cases across BC. As such, the prevalence of AIDS has decreased substantially over time and the number of AIDS cases is expected to decrease over time.
Interpretation	Both the number and rate of AIDS cases by 100 000 of the BC/HA population are shown: 1. The number of AIDS cases reported through AIDS case report forms from the DTP; 2. The number of AIDS cases reported through the provincial surveillance at BCCDC (including DTP cases) and; 3. The number with a CD4 cell count of <200 cells/μL at time of ART initiation using DTP data. All of the numbers were converted into rate per 100 000 of the BC population. AIDS case reporting is passive in BC, thus; AIDS case reporting is not well captured. Thus, three definitions of AIDS cases are shown, and interpreting AIDS case reports should be done with these limitations in mind.
Data Source	“DTP AIDS cases” are extracted from the DTP Database; “BCCDC AIDS cases” are extracted from i) the Provincial HIV/AIDS surveillance database at BCCDC and ii) the majority of AIDS case reports are reported by the DTP at the BC-CfE, which submits data twice yearly to BCCDC. CD4 cell count data is extracted from the DTP database.

Calculation	AIDS case reporting is passive in BC, thus; AIDS case reporting is not well captured. As such, AIDS case reporting is investigated using 3 definitions: 1. The number of AIDS cases reported through AIDS case report forms from the DTP; 2. The number of AIDS cases reported through provincial surveillance at BCCDC (including DTP cases) and 3. The number with a CD4 cell count of <200 cells/μL at time of ART initiation using DTP data. All of the numbers were converted into rate per 100,000 of the BC population. Definitions 1 and 3 only included persons ≥18 in the analysis. • The DTP sends out AIDS reporting forms to physicians annually. • Multiple AIDS case report forms may be submitted for the same individual; only the first case of each AIDS illness is included in the rate of new AIDS case reports. • The BCCDC collects AIDS data from DTP-forwarded AIDS case reports as well as physician AIDS case reports made directly to the BCCDC Provincial HIV/AIDS surveillance database at the BCCDC. • BCCDC AIDS data is extracted from the BCCDC Annual HIV report available online through the BCCDC website. • Denominator: Population of HA or BC • Numerator: Number of naïve individuals with an AIDS case report • Allocation by HA is based on patient address (DTP record) at the end of a given quarter, or if no address per DTP record, then allocation by HA is based on BC-CfE record. Known address outside BC is categorized as “Unknown”. If no patient address known, then allocation by HA is based on address of patient’s prescribing physician (most recent prescription in a given quarter). If still no address, that HA is categorized as “Unknown”. • Unit of analysis is the rate of new AIDS case reports per 100,000 population per year. • AIDS data is updated annually as very few AIDS cases reports are reported in general and trends would be difficult to notice if reported quarterly.
Limitations	1. AIDS case reporting is a passive process. Thus, it is expected that the number of reported AIDS cases to the BCCDC and DTP are underreported. 2. CD4 cell count data is approximately 80% complete. 3. BCCDC AIDS case data lags by one to two years. 4. For HA-specific information, HA is designated based on the most recently provided city of residence of the HIV-positive individual. If an individual does not update this information, the attributed HA may be incorrect.

	5. As AIDS reporting is passive in BC, it is likely that AIDS cases are under reported across all HAs. In addition to under reporting, methods of reporting AIDS cases are inconsistent across HAs and do not truly reflect the current reality of new AIDS diagnoses. 6. Where stratifications result in small numbers greater variability for this indicator will be seen, making trends more difficult to interpret.
Note	AIDS data is updated annually as very few AIDS cases reports are reported in general and trends would be difficult to notice if reported quarterly.

Indicator 13: HIV-Related Mortality (Figure 13)

Description	HIV-related mortality in BC in the BC provincial report and by HA in the HA-specific reports.
Significance	Evidence indicates that individuals who initiate treatment with recommended ART in a timely fashion may live near normal lifespans. Excess mortality among HIV positive persons is, therefore, an important measure of HIV care with a goal of minimizing HIV-related mortality in BC.
Interpretation	HIV-related mortality is shown as i) the rate per 100 in the HIV positive population along the right axis and 2) the rate per 100,000 in the BC/HA general population along the left axis. The absolute number of HIV-related death cases is summarized in the data table below the line graph. Data is provided for BC in the provincial report and by HA in the HA-specific reports.
Data source	The number of HIV-related deaths was extracted online from the Vital Statistics Annual Report. Population counts (including the HIV-positive population) were obtained online from Statistics Canada.
Calculation	**i. Calculation for the HIV-related death rate in the general population (rate per 100,000 persons)**: The number of HIV-related deaths were obtained online from the Vital Statistics Annual Report. This number was then divided by the general population (either for BC or for a specific HA, depending on the report) and multiplied by 100,000 to obtain the HIV-related mortality rate in the general population for 100,000 persons. **ii. Calculation for the HIV-related death rate in the HIV-positive population (rate per 100 persons)**: The number of HIV-related deaths was obtained online from the Vital Statistics Annual Report. This number was then divided by HIV-positive population (either for BC or for a specific HA, depending on the report) and multiplied by 100 to obtain the HIV-related mortality rate in the HIV-positive population for 100 persons. Estimates of the HIV-positive population by BC and for each HA were calculated by using known HIV diagnoses data and the Public Health Agency of Canada estimates of the undiagnosed population. Vital statistics classify deaths due to HIV disease as ICD-10 codes B20-B24.
Limitations	Limitations related to Vital Statistics data: HSDA based on usual residence.

References:

• BC Vital Statistics Agency, Annual Report: http://www.vs.gov.bc.ca/stats/annual/
• Statistics Canada: http://www.statcan.gc.ca/start-debut-eng.html