Comparison of late HIV diagnosis as a marker of care for Aboriginal versus non-Aboriginal people living with HIV in Ontario

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BACKGROUND: Studies have found that Aboriginal people living with HIV/AIDS (APHAs) are more likely than non-APHAs to receive suboptimal HIV care, yet achieve similar clinical outcomes with proper care.

OBJECTIVE: To compare the proportions of individuals diagnosed late with HIV between APHAs and non-APHAs within the Ontario HIV Treatment Network Cohort Study (OCS).

METHODS: The analysis included OCS participants who completed the baseline visit by November 2009. Two definitions of the outcome of late HIV diagnosis were used: the proportion of participants with an AIDS-defining illness (ADI) before or within three months of HIV diagnosis; and the proportion of participants with a CD4+ count <200 cells/mL at diagnosis. Logistic regression analysis was used to assess the association between Aboriginal ethnicity and late HIV diagnosis.

RESULTS: APHAs were more likely to be female and have lower income, education and employment. No statistically significant differences were noted in the proportions receiving a late HIV diagnosis defined by ADI (Aboriginal 5.2% versus non-Aboriginal 6.3%; P=0.40). Multivariate logistic regression analysis revealed a significant association between Aboriginal ethnicity and late HIV diagnosis defined by CD4+ count <200 cells/mL at diagnosis. Logistic regression analysis was used to assess the association between Aboriginal ethnicity and late HIV diagnosis.

DISCUSSION: APHAs were more likely to have a CD4+ count <200 cells/mL at diagnosis but had similar clinical outcomes from late diagnosis when defined by ADI. However, differences may be underestimated due to recruitment limitations and selection bias.

CONCLUSION: Additional work is needed to address the socioeconomic and health care needs of APHAs.

Key Words: Aboriginal peoples; Access to care; Cohort study; HIV; HIV diagnosis; Quality of care

Despite increases in HIV research and advances in care and support programs in Canada, the Aboriginal population remains both over-represented in the Canadian HIV epidemic and under-represented in research. In 2006, 27.3% of positive HIV test reports were attributable to Aboriginal peoples in Canadian provinces and territories that reported ethnicity data for HIV testing. In these provinces and territories, Aboriginal peoples represent 6.0% of the total population; therefore, Aboriginal people are over-represented by approximately 4.6 times in the HIV epidemic in Canada (1).

Studies have found that certain subpopulations of Aboriginal peoples have more HIV risk factors (2) and a higher incidence of seroconversion given these risk factors (3). In 2005, the proportion of new HIV diagnoses among Aboriginal peoples attributable to injection drug use (IDU) was 53%, while the proportion among all Canadians was 14% (1), suggesting that Aboriginal peoples have a different set of risk factors and that HIV-positive Aboriginal peoples represent a marginalized population with limited access to care and support services in Canada.

HISTORIQUE: Les études ont démontré que les Autochtones qui vivent avec le VIH ou le sida (AVVS) sont plus susceptibles que les non-Autochtones qui vivent avec le VIH ou le sida (NAVVS) de recevoir des soins sous-optimaux, mais présentent des issues cliniques similaires lorsqu’ils reçoivent des soins convenables.

OBJECTIF: Comparer la proportion d’AVVS et de non-AVVS de la cohorte OCS du réseau thérapeutique du VIH qui reçoivent un diagnostic tardif de VIH en l’Ontario.

MÉTHODOLOGIE: L’analyse incluait les participants de l’OCS qui avaient eu leur première visite avant novembre 2009. Deux définitions de l’issue de diagnostic tardif du VIH ont été utilisées : la proportion de participants ayant une maladie symptomatique du sida (MSS) avant ou dans les trois mois suivant le diagnostic du VIH, et la proportion de participants ayant une numération de CD4 inférieure à 200 cellules/mL au diagnostic. Les chercheurs ont utilisé l’analyse de régression logistique pour évaluer l’association entre l’ethnie autochtone et le diagnostic tardif de VIH.

RÉSULTATS: Les AVVS étaient plus susceptibles d’être des femmes et d’avoir un revenu et une scolarisation plus faibles ainsi qu’un emploi moins bien rémunéré. Les chercheurs n’ont pas fait une différence statistiquement significative dans la proportion qui avait reçu un diagnostic tardif de VIH défini par une MSS (Autochtones 52,2 %, non-Autochtones 63,3 %; P=0,40). L’analyse de régression logistique multivariée a révélé une association significative entre l’ethnie autochtone et un diagnostic tardif de VIH défini par la numération de CD4+ après rajustement compte tenu de l’âge et du facteur de risque de VIH (RRR=1,55; P=0,04).

EXPOSÉ: Les AVVS étaient plus susceptibles de présenter une numération de CD4+ inférieure à 200 cellules/mL au diagnostic, mais avaient des issues cliniques similaires de diagnostic tardif lorsqu’on le définissait par une MSS. Cependant, les différences sont peut-être sous-estimées en raison des limites de recrutement et du biais de sélection.

CONCLUSION: D’autres travaux s’imposent pour connaître les besoins socioéconomiques et en soins de santé des AVVS.
Limited access to primary health care services among Aboriginal populations in Ontario has been reported based on higher hospital admission rates for conditions that could effectively be managed in an ambulatory care setting when compared with the general population (4). For example, in Ontario, individuals from Aboriginal communities, rural communities and remote communities have been found to be diagnosed with diabetes at a later stage, and to be more likely to visit an emergency department or be admitted to hospital for diabetes management than individuals from urban and non-Aboriginal communities (5). Such a finding may apply to the HIV field, such that Aboriginal people may similarly experience a trend of late diagnosis for HIV. The high concentration of Canadian Aboriginal peoples in rural areas may also contribute to their limited access to health care. In 2004, 21.1% of the Canadian population, but only 9.4% of Canadian physicians, were located in rural areas (6). Additional barriers to accessing health care among Aboriginal populations include perceived racism, differences in cultural beliefs and values, and a shortage of Aboriginal physicians (7). Nearly all of the Aboriginal people living with HIV/AIDS (APHAs) in Canada have either been directly subjected to or had a family member who was subjected to the residential school system. Accordingly, access to health care services and the trust placed in health care providers by Aboriginal peoples is profoundly impacted by historical factors and the repercussions of the residential school system (8).

Late diagnosis of HIV has important consequences for clinical outcomes as well as on health care costs. For example, late diagnosis of HIV (CD4+ count <200 cells/mL) is associated with higher mortality despite earlier initiation of therapy (9,10). In Alberta, individuals diagnosed with HIV with a CD4+ count <200 cells/mL were found to incur medical care costs twice as high as those of patients diagnosed with a CD4+ count >200 cells/mL in the year following diagnosis. In addition, HIV-related hospital care costs were 15 times higher for those diagnosed late (11). Furthermore, earlier HIV diagnosis creates opportunities to reduce the risk of subsequent transmissions by offering earlier treatment and thorough behavioural modifications (12,13).

Several studies have identified predictors of late HIV diagnosis. In a Texan cohort, female sex and illicit drug use were associated with a higher CD4+ count at diagnosis, potentially from perceived increased risk in this population (14). In other studies, heterosexual contact and an absence of reported risk factors were often associated with late HIV diagnosis (15-17). In a study of 219 Aboriginal British Columbia residents, participants with an HIV risk factor, such as a previous positive test result for a sexually transmitted infection or needle sharing, were more likely to undergo HIV testing (18).

Factors such as cultural appropriateness of services may influence the acceptance of HIV testing within a community. An exploratory, qualitative analysis of the experiences of seven Aboriginal Canadian women identified fear of unfair judgment as a barrier to HIV testing, and this was linked to a lack of familiarity with the context of the lives of Aboriginal women. In addition, these women perceived HIV testing to infringe on the cultural norm of not disclosing problems to non-community members (19).

In addition to being at risk for late diagnosis of HIV, Aboriginal peoples may receive poorer quality of care once an HIV diagnosis is established. A study conducted in northern Alberta found that Aboriginal ethnicity was associated with a longer median time to accessing care after HIV diagnosis (20). A study conducted in British Columbia found that Aboriginal peoples are more likely to receive double versus triple antiretroviral therapy (ART), to be less adherent in the first year of treatment and to have a physician less experienced in treating HIV compared with non-Aboriginal peoples. However, when controlling for these factors, Aboriginal peoples were mortal to have comparable virological response to ART (21). Accordingly, there is a need for additional information regarding ART use among Aboriginal peoples in Ontario. In addition, a cohort study of HIV-positive pregnant women in Ontario, Manitoba and Saskatchewan found that Aboriginal women were more likely to experience delayed start of ART when compared with other ethnicities (22).

In the present study, we investigated the difference in the proportion of individuals diagnosed late with HIV between APHAs and non-APHAs within the Ontario HIV Treatment Network Cohort Study (OCS).

Late diagnosis of HIV was defined in two ways: an AIDS-defining illness (ADI) before or within three months of their HIV diagnosis; and a CD4+ count <200 cells/mL at diagnosis. Differences between female and male APHAs were also assessed.

METHODS

Study population and design: OCS

The OCS is a multisite, prospective, observational cohort of individuals living with HIV who, since 1997, have been recruited from primary and tertiary care sites throughout Ontario. Information is collected on demographics, HIV-related laboratory values, HIV- and AIDS-related illnesses, comorbidities, drug adverse events, HIV genotypes and sociobehavioural measures. Data are collected from multiple sources including electronic medical records, chart abstraction and linkages to other laboratory databases. Data are collected on each participant every six months.

For the present analysis, the inclusion criteria were: enrollment in the OCS; completed information on self-reported ethnicity; and completed data on date of HIV diagnosis. In the analysis of ADI before or within three months of HIV diagnosis, participants who did not have an ADI were excluded if their follow-up in the cohort was less than three months. The data included cross-sectional data from the baseline visit on participants who were enrolled until November 2009.

Study predictors and outcomes

One outcome of interest was an ADI before or within three months of the first HIV diagnosis. Another outcome was defined as a CD4+ count <200 cells/mL at the time of the first HIV diagnosis. Because CD4+ measurement is not routinely performed with HIV testing, the CD4+ count at diagnosis was defined as the first CD4+ count recorded within the first six months after HIV diagnosis. The primary and secondary outcomes were compared between Aboriginal and non-Aboriginal participants, and between male and female Aboriginal participants.

Participants were classified as Aboriginal participants if they indicated Aboriginal ancestry in response to any of the following questions: How do you characterize your racial background? If Canadian Aboriginal, to which Canadian Aboriginal group do you belong? If First Nations, are you: status / non-status / don’t know / refused? To which ethnic or cultural group(s) did your ancestors belong?

Statistical analysis

Baseline demographic and clinical characteristics were tabulated according to ethnicity (Aboriginal versus non-Aboriginal) and sex for the Aboriginal population (male versus female). Categorical variables were summarized with frequencies and proportions and compared between groups using χ² tests. Continuous variables were summarized with medians and interquartile ranges (IQR) and compared between groups using Wilcoxon rank sum tests. Logistic regression models were used to determine the association between Aboriginal ethnicity and late diagnosis. Separate analyses were conducted for each late HIV diagnosis outcome. Logistic regression models were also used to assess the association between sex and late diagnosis within the Aboriginal population. Data were analyzed using SAS statistical software version 9.2 (SAS Institute Inc., USA).

Ethical considerations

Written informed consent was obtained from all participants of the OCS. The present study was approved by the University of Toronto (Toronto, Ontario) Research Ethics Board and the OCS Governance Committee (the latter comprised of a majority of people living with HIV). Because the present study pertains to Aboriginal people in Canada, Ownership, Control, Access, and Possession (OCAP) principles were adhered to.
RESULTS
As of November 2009, 5044 participants were enrolled in the OCS. Of these, 4862 had a known date of HIV diagnosis. Of participants with a known date of diagnosis, 350 were Aboriginal peoples, 4235 were non-Aboriginal peoples and 227 had missing ethnicity data. Twelve non-Aboriginal and one Aboriginal participant had follow-up of less than three months or incomplete information for both the time of diagnosis and onset of an ADI that were in the same year and, therefore, it was not possible to determine the timing of the ADI relative to HIV diagnosis. Accordingly, the analysis according to ADI included 349 Aboriginal and 4223 non-Aboriginal participants. The analysis of CD4+ count <200 cells/mL at diagnosis included 114 Aboriginal and 1626 non-Aboriginal participants because CD4+ data at the time of HIV diagnosis were missing for all other participants.

Baseline characteristics
The demographic and clinical characteristics for APHAs versus non-APHAs are summarized in Table 1. When compared with non-Aboriginal participants, Aboriginal participants were younger, more likely to engage in IDU and heterosexual transmission as HIV risk factors, and were more likely to be living in northern Ontario. With regard to socioeconomic factors, Aboriginal participants were less likely to be employed, more likely to have a level of education less than a high school diploma and more likely to have a household annual income <$20,000. Aboriginal participants were also more likely to be coinfected with hepatitis C.

Table 2 describes the demographic and clinical characteristics of Aboriginal participants according to sex (male versus female). Among Aboriginal participants, women were younger and more likely to live in northern Ontario. Women were more likely to have IDU and heterosexual transmission as HIV risk factors. Women were less likely to be employed, more likely to have a level of education less than a high school diploma and more likely to have a household annual income <$20,000. In addition, female Aboriginal participants were more likely to be hepatitis C coinfected than male Aboriginal participants (42% versus 24% [P<0.01]). Female Aboriginal participants were less likely to have ever been on ART (73% versus 89% [P<0.01]) and the Kaplan-Meier estimate for median duration from HIV diagnosis to ART initiation for female and male Aboriginal participants were 3.0 years (95% CI 2.1 to 4.7) and 3.6 years (95% CI 2.9 to 4.0), respectively (log rank P=0.73).

Analysis of ADI before or within three months of HIV diagnosis
In the univariate analyses, the proportions of APHAs and non-APHAs who had an ADI before or within three months of their first HIV diagnosis were 5.2% and 6.3%, respectively (P=0.40). After adjusting for age and HIV risk factors in the logistic regression analysis, the analysis according to ADI before or within three months of HIV diagnosis (OR 0.89 [95% CI 0.54 to 1.47]; P=0.65) (Table 3).

Analysis of CD4+ count <200 cells/mL at HIV diagnosis
There were more non-APHAs (n=1626 [38%]) with available data on a CD4+ count within six months of HIV diagnosis compared with APHAs (n=114 [33%]) (P=0.03). The proportions of APHAs and non-APHAs who had a CD4+ count <200 cells/mL at the time of their HIV diagnosis were 35% and 29%, respectively (P=0.18). Median CD4+ counts at the time of HIV diagnosis for Aboriginal and non-Aboriginal participants were 299 cells/mL (IQR 111 cells/mL to 520 cells/mL) and 341 cells/mL (IQR 156 cells/mL to 518 cells/mL), respectively (P=0.24). After adjusting for age and HIV risk factors in the logistic regression model, Aboriginal ethnicity was significantly associated with having a CD4+ count <200 cells/mL at the time of HIV diagnosis (OR 1.55 [95% CI 1.03 to 2.33]; P=0.04) (Table 3).

Analyses of Aboriginal population according to sex
Analyses were performed comparing proportions of Aboriginal participants receiving a late diagnosis of HIV according to sex. Fifty-nine female Aboriginal participants and 290 male Aboriginal participants were included in a comparison of the proportions of individuals who had an ADI before or within three months of their HIV diagnosis. Many participants were missing data on CD4+ counts, resulting in only 20 female Aboriginal participants and 94 male Aboriginal

### Table 1

| Age, years, median (interquartile range ) | 45.0 | 48.0 | <0.0001 |
|-----------------------------------------|------|------|---------|
| Ever on antiretroviral treatment | 302 (86) | 3784 (89) | 0.07 |
| AIDS defining illness | 116 (33) | 1505 (36) | 0.36 |
| CD4+ risk factor | <0.0001 |
| MSM | 175 (50) | 2718 (64) |
| IDU/MSM-IDI | 104 (30) | 483 (11) |
| Heterosexual transmission | 52 (15) | 428 (10) |
| From country with high HIV prevalence | 0 (0) | 369 (9) |
| Other | 19 (5) | 237 (6) |
| Employment status | <0.0001 |
| Employed full or part time | 93 (34) | 1194 (50) |
| Student | 6 (2) | 62 (3) |
| Retired | 15 (6) | 198 (8) |
| Disability | 121 (45) | 739 (31) |
| Unemployed | 35 (13) | 210 (9) |
| Missing data | 80 (23) | 1832 (43) |
| Highest education level | <0.0001 |
| Some high school | 73 (27) | 299 (12) |
| Completed high school | 49 (18) | 426 (18) |
| Some college/university | 63 (23) | 546 (23) |
| Completed college/university | 70 (26) | 908 (38) |
| Postgraduate education | 16 (6) | 233 (10) |
| Missing data | 79 (23) | 1823 (43) |
| Marital status | 0.59 |
| Married, living common-law | 104 (38) | 947 (39) |
| Separated/divorced | 17 (6) | 195 (8) |
| Widowed | 9 (3) | 60 (2) |
| Single | 141 (52) | 1205 (50) |
| Missing data | 79 (23) | 1828 (43) |
| Household income/year, $ | <0.0001 |
| <20,000 | 104 (43) | 568 (26) |
| 20,000 to <40,000 | 41 (17) | 462 (21) |
| 40,000 to <60,000 | 28 (12) | 334 (15) |
| 60,000 to <80,000 | 24 (10) | 249 (11) |
| 80,000 to <100,000 | 20 (8) | 183 (8) |
| ≥100,000 | 26 (11) | 410 (19) |
| Missing data | 107 (31) | 2029 (48) |
| Hepatitis B coinfection | 32 (9) | 449 (11) | 0.40 |
| Hepatitis C coinfection | 94 (27) | 666 (16) | <0.0001 |

Data presented as n (%) unless otherwise indicated. IDU Injection drug use; MSM Men who have sex with men.
Late HIV diagnosis in Aboriginal peoples in Ontario

TABLE 2
Aboriginal participants' demographic and clinical characteristics according to sex

| Characteristic                          | Male (n=290) | Female (n=60) | P   |
|----------------------------------------|-------------|---------------|-----|
| Age, years, median (interquartile range) | 46.0 (39.0–51.0) | 40.5 (35.5–48.5) | <0.01 |
| Ever on antiretroviral treatment       | 258 (89)    | 44 (73)       | <0.01 |
| AIDS-defining illness                  | 99 (34)     | 17 (28)       | 0.38 |
| HIV risk factor                        |             |               | <0.0001 |
| MSM                                    | 175 (60)    | 0 (0)         |       |
| IDU/MSM-IDU                            | 78 (27)     | 26 (43)       |       |
| Heterosexual transmission              | 23 (8)      | 29 (48)       |       |
| Other                                   | 14 (5)      | 5 (8)         |       |
| Geographical location in Ontario       |             |               | <0.01 |
| Metropolitan Toronto                   | 112 (41)    | 11 (21)       |       |
| Central                                 | 27 (10)     | 9 (17)        |       |
| Eastern                                 | 57 (21)     | 11 (21)       |       |
| Southwestern                           | 33 (12)     | 4 (8)         |       |
| Northern                               | 39 (14)     | 17 (32)       |       |
| Other                                   | 2 (1)       | 1 (2)         |       |
| Employment status                      |             |               | <0.01 |
| Employed full- or part-time            | 87 (39)     | 6 (13)        |       |
| Student                                 | 5 (2)       | 1 (2)         |       |
| Retired                                 | 13 (6)      | 2 (4)         |       |
| Disability                              | 96 (43)     | 25 (54)       |       |
| Unemployed                              | 23 (10)     | 12 (26)       |       |
| Missing data                            | 66 (23)     | 14 (23)       |       |
| Highest education level                |             |               | <0.001 |
| Some high school                       | 48 (21)     | 25 (53)       |       |
| Completed high school                  | 41 (18)     | 8 (17)        |       |
| Some college/university                | 56 (25)     | 7 (15)        |       |
| Completed college/university           | 63 (28)     | 7 (15)        |       |
| Postgraduate education                 | 16 (7)      | 0 (0)         |       |
| Missing                                 | 66 (23)     | 13 (22)       |       |
| Marital status                         |             |               | 0.59  |
| Married, living common-law             | 88 (39)     | 16 (34)       |       |
| Separated/divorced                     | 14 (6)      | 3 (6)         |       |
| Widowed                                 | 6 (3)       | 3 (6)         |       |
| Single                                 | 116 (52)    | 25 (53)       |       |
| Missing                                 | 66 (23)     | 13 (22)       |       |
| Household income/year, $               |             |               | 0.02  |
| <20,000                                 | 80 (39)     | 24 (62)       |       |
| 20,000 to <40,000                      | 32 (16)     | 9 (23)        |       |
| 40,000 to <60,000                      | 25 (12)     | 3 (8)         |       |
| 60,000 to <80,000                      | 22 (11)     | 2 (5)         |       |
| 80,000 to <100,000                     | 20 (10)     | 0 (0)         |       |
| ≥100,000                               | 25 (12)     | 1 (3)         |       |
| Missing                                 | 86 (30)     | 21 (35)       |       |
| Hepatitis B coinfection                | 28 (10)     | 4 (7)         | 0.46  |
| Hepatitis C coinfection                | 69 (24)     | 25 (42)       | <0.01 |

Data presented as n (%) unless otherwise indicated. IDU injection drug use; MSM Men who have sex with men

In unadjusted logistic regression models, male sex was not associated with either late diagnosis of HIV as defined according to timing of ADI (OR 1.02 [95% CI 0.29 to 3.63]; P=0.98) or according to CD4+ count <200 cells/mL (OR 1.00, [95% CI, 0.37, 2.76]; P=0.99) (Table 4). Logistic regression models, after adjusting for other covariates, showed no significant effect of sex on either definition of late HIV diagnosis.

DISCUSSION

In the present study, APHAs were more likely to have a CD4+ count <200 cells/mL at the time of HIV diagnosis than non-APHAs, suggesting potential late diagnosis within the Aboriginal population. However, data from these analyses failed to demonstrate a difference in late HIV diagnosis as defined according to ADI between Aboriginal and non-Aboriginal participants. The discrepancy in these findings may suggest that CD4+ count is a more sensitive marker for late HIV diagnosis. Also, in populations where access to care is an issue, including diagnosis of HIV, the diagnosis of ADIs may also be limited.

Significant differences in demographic and socioeconomic factors existed between Aboriginal and non-Aboriginal participants, and between male and female Aboriginal participants. Aboriginal participants were more likely to have lower levels of income, education and employment than male Aboriginal participants. It is imperative to address these gross discrepancies in socioeconomic factors and the structural factors that make certain populations, such as Aboriginal women, more vulnerable to poorer health outcomes.
Although female Aboriginal participants tended to have higher CD4+ counts at HIV diagnosis and shorter durations from HIV diagnosis to ART start than male Aboriginal participants, these differences were not statistically significant, due at least, in part, to the small numbers of Aboriginal participants and, as a result, low statistical power. In a Vietnamese study, male sex was associated with delayed HIV diagnosis (25). A Canadian study found that among Aboriginal people living off reserve, female sex was associated with an increased likelihood of undergoing an HIV test within the previous year (26). These trends may reflect the impact of prenatal HIV testing because pregnant women may be more likely to be diagnosed at an earlier stage of disease. However, female Aboriginal participants involved in the present study were significantly less likely to have ever been on ART, and this finding is concerning in the context of the prevention of vertical transmission of HIV. The data on ART use were limited in the present analysis, and additional analyses should take duration of ART, indications for ART initiation and reasons for discontinuation into consideration. In addition, female Aboriginal participants were nearly twice as likely to be hepatitis C coinfected than male Aboriginal participants. This likely represents differences in the rates of IDU and highlights the importance of prevention efforts targeted at addressing the structural, social and historical factors that place Aboriginal women at risk of HIV and hepatitis C.

The findings from the present study have significant policy implications. They call attention to the need for interventions to increase HIV testing uptake among Aboriginal populations. A combination of public health and community-driven programs are needed to help make HIV testing more accessible and acceptable among Aboriginal populations, and to reduce barriers to testing, such as HIV-related stigma. Physicians should be more proactive in offering HIV counseling and testing, coupled with primary prevention efforts, to at-risk populations. Strategies that could lead to more timely HIV diagnoses include professional development and training for physicians and allied health care workers (27,28), as well as increasing access to alternative or newer HIV testing services such as anonymous (29,30), rapid point-of-care (31-33), home-based (34,35) or mobile (36) testing. The goal for increasing HIV testing in Aboriginal populations is to enable earlier diagnoses, which would lead to this population accessing care and ART at higher CD4+ counts and preventing ADIs. In addition, improving testing and diagnosis of HIV can also have prevention implications. Individuals diagnosed with HIV can be presented with information that will help them to reduce the risk of HIV transmission and HIV superinfection. Initiating individuals on ART may also have a role in the reduction of HIV transmission (37).

Our study has several limitations, one of which was the small sample size of Aboriginal participants. Despite over-representation in the Canadian and Ontario HIV epidemic, Aboriginal peoples are under-represented in the OCS, accounting for only 7.5% of all OCS participants. Over the past decade, Aboriginal peoples have comprised approximately 20% of new HIV-positive test results annually in Canada (1). Another limitation is that the OCS only recruits from primary and tertiary health care sites and, thus, only individuals receiving HIV care are included in the study. The individuals who are most at risk for late HIV diagnosis and poor quality of HIV care are likely those who are not accessing services at all and, as a result, are not captured in the study cohort. Because many AHPAs are not receiving care, this cohort fails to include some of the most vulnerable AHPAs in Ontario. This limitation leads to a likely underestimation of the true difference in the proportion of late HIV diagnosis in AHPAs versus non-AHPAs. In addition, the study participants may not accurately represent the geographical distribution of Aboriginal peoples in Ontario. Recruitment methods that focus on increasing the number of Aboriginal participants in the OCS are greatly needed and the OCS has included Aboriginal participants as a priority population for future recruitment efforts. Strategies could include expanding recruitment sites to community agencies and traditional healers, increasing the number of recruitment sites in northern Ontario and involving Aboriginal peoples as research team members to advise on recruitment strategies for Aboriginal peoples. Aboriginal peoples and community leaders should be engaged as key partners in all research efforts involving Aboriginal peoples.

Another limitation was that less than one-half of all participants had a documented CD4+ count within six months of HIV diagnosis. Many participants are enrolled in the OCS through tertiary care clinics that do not usually have a complete history of CD4+ counts dating back to the time of HIV diagnosis, and this likely contributed to the missing data. The missing data limited the power of our analyses and also may have introduced a respondent bias to the sample. Factors associated with having no documented CD4+ count within six months of HIV diagnosis include history of an ADI, hepatitis C coinfection, receiving disability support and low income. In addition, data regarding employment, education and income were only available for participants enrolled after 2007, and it was not possible to adequately adjust for these factors in multivariate logistic regression analysis of the participants with a documented CD4+ count within six months of HIV diagnosis. These missing data represent a significant limitation, because a previous study (38) found low educational level to be associated with late diagnosis of HIV. Our study was a preliminary analysis and found significant differences in the late diagnosis of HIV between Aboriginal and non-Aboriginal OCS participants when late diagnosis was defined according to CD4+ count <200 cells/mL at diagnosis. However, numerous study limitations have been noted. Data limitations can be addressed by targeted recruitment of AAPHAs, and Aboriginal women living with HIV in particular, in cohorts such as the OCS. Furthermore, the present analysis should be repeated using Canada-wide data, and efforts should be made to collect data on AAPHAs who are not receiving appropriate health care or for transient populations of Aboriginal peoples who are not often captured in longitudinal cohort studies. More research is also needed on the context of HIV diagnosis and ART among Aboriginal women. Finally, the present study highlights some of the many socioeconomic inequities between AAPHAs and non-AAPHAs, and between Aboriginal women and men living with HIV. Future research efforts should address the link between socioeconomic factors and vulnerability to HIV and hepatitis C among Aboriginal peoples.

### Table 4

| Covariate | Onset of an AIDS-defining illness within three months of HIV diagnosis (n=290 men, 59 women) | CD4+ count <200 cells/mL at time of HIV diagnosis (n=94 men, 20 women) |
|-----------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Male sex  | 1.02 (0.29–3.63)                                                                         | 1.00 (0.37–2.76)                                                   |
| Age (per 10 years) | 1.51 (0.90–2.53)                                                                         | 1.25 (0.87–1.79)                                                   |
| HIV risk factor: |                                                    |                                                                  |
| MSM | 1                                                                 |                                                                 |
| IDU/MSM-IDU | 0.75 (0.22–2.48)                                                                         | 0.99 (0.38–2.58)                                                   |
| Heterosexual transmission | 1.13 (0.29–4.33)                                                                         | 1.00 (0.35–2.88)                                                   |
| HIV-endemic | –                                                                 | –                                                                  |
| Other | 2.17 (0.43–10.87)                                                                         | 1.24 (0.19–8.00)                                                   |
| Toronto | 0.44 (0.14–1.38)                                                                         | 1.33 (0.59–2.98)                                                   |
| Hepatitis B coinfection | 0.57 (0.07–4.42)                                                                         | 0.34 (0.07–1.62)                                                   |
| Hepatitis C coinfection | 0.78 (0.25–2.42)                                                                         | 0.64 (0.23–1.79)                                                   |

Data presented as OR (95% CI). IDU Injection drug use; MSM Men who have sex with men.
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