

## Suicide mortality among people accessing highly active antiretroviral therapy for HIV/AIDS in British Columbia: a retrospective analysis

Jasmine Gurm BBA, Hasina Samji PhD, Adriana Nophal MSc, Erin Ding MSc, Verena Strehlau MD, Julia Zhu MEng, Julio S.G. Montaner MD, Robert S. Hogg PhD, Silvia Guillemi MD

### Abstract

**Background:** Suicide rates have been reported at elevated levels among people living with HIV/AIDS. We sought to characterize longitudinal suicide rates among people living with HIV/AIDS who are accessing free highly active antiretroviral treatment (HAART) in British Columbia and evaluate the sociodemographic, clinical and behavioural factors associated with suicide in this population.

**Methods:** Retrospective analysis of all patients in the HAART Observational Medical Evaluation and Research (HOMER) cohort who were 19 years of age and older who started treatment between August 1996 and June 2012. The primary outcome variable was death due to suicide. Data on deaths were obtained monthly through a linkage with the British Columbia Ministry of Health Vital Statistics Agency. Logistic regression and Cox proportional hazards models were used to identify factors independently associated with suicide mortality.

**Results:** A total of 993 deaths among 5229 patients accessing treatment were recorded, of which 82 (8.2%) were caused by suicide. Death from suicide peaked at 961 deaths per 100 000 person-years in 1998 and declined to 28 deaths per 100 000 person-years in 2010. Cox regression analysis showed that a history of injection drug use (adjusted hazard ratio [AHR] = 3.95, 95% confidence interval [CI] 1.99–7.86) or having no experience with an AIDS-defining illness (AHR = 4.45, 95% CI 1.62–12.25) were factors independently associated with suicide. This model showed a 51% reduction (AHR = 0.49, 95% CI 0.45–0.54) in the suicide rate per calendar year.

**Interpretation:** Deaths from suicide declined substantially over time, and factors other than progression of HIV disease, such as injection drug use, may be important targets for intervention to reduce suicide risk.

In general, patients with chronic illnesses, and HIV in particular, are at an increased risk of suicide.<sup>1,2</sup> The sense of hopelessness that can accompany the life-long implications of being HIV positive can contribute to compromised quality of life and substantial mental distress.<sup>3–8</sup> The prevalence of mental health disorders, particularly depression, have been reported at elevated levels among people living with HIV/AIDS compared with the general population, and historical suicide rates within this population are also elevated.<sup>2,3,9</sup>

However, the advent of highly active antiretroviral therapy (HAART) transformed HIV from a terminal illness to a manageable chronic condition.<sup>3</sup> HAART has effectively reduced the risk of developing AIDS-defining illnesses and opportunistic infections, providing the potential for enhanced quality and longevity of life for people living with HIV/AIDS.<sup>3,5,9–14</sup> In light of these widespread benefits, it was anticipated that rates of suicide among people living with HIV/AIDS could be reduced.<sup>9,15,16</sup>

Two recent studies have reported declines in suicide risk among people living with HIV/AIDS between the pre-HAART era (before 1996) and the HAART era (1996

onwards); however, the studies concluded that suicide risk<sup>5</sup> and suicide rates<sup>16</sup> remain substantially elevated among people living with HIV/AIDS at about 9 times and 2–3 times that of the general population, respectively.<sup>5,16</sup> This implies that despite effective HIV treatment, an elevated propensity toward suicide persists, perhaps indicating that there are factors, other than issues directly related to HIV infection,<sup>7,16</sup> that predispose people living with HIV/AIDS to suicidality.<sup>16–18</sup>

Identifying these factors is essential to deriving meaningful targets for interventions that can effectively mitigate suicide risk in

**Competing interests:** Julio Montaner is supported by grants from the US National Institutes of Health (R01DA036307), AbbVie, Bristol-Myers Squibb, Gilead Sciences, Janssen, Merck and ViiV Healthcare. No other competing interests were declared.

This article has been peer reviewed.

**Correspondence to:** Silvia Guillemi, sguillemi@cfenet.ubc.ca

**CMAJ Open 2015. DOI:10.9778/cmajo.20140101**

this population.<sup>1</sup> Therefore, we conducted this analysis to characterize longitudinal suicide rates and ascertain factors associated with suicide among people living with HIV/AIDS who have accessed free HAART in the province of British Columbia.

## Methods

### Setting

HAART has been provided free-of-charge to people living with HIV/AIDS in BC since its introduction in 1996 through the provincially funded drug treatment program at the British Columbia Centre for Excellence in HIV/AIDS (BC-CfE). The BC-CfE is the centralized distributor of antiretroviral therapy for all patients accessing HIV treatment in BC.

### Design

The HAART Observational Medical and Evaluation (HOMER) cohort includes all patients aged 19 years and older who were enrolled at the BC-CfE from 1996 onwards and who began HAART between August 1996 and June 2012.<sup>19</sup>

The HOMER protocol was granted ethics approval by the University of British Columbia Research Ethics Board, which approved the retrospective use of anonymous administrative data without requiring consent; an information sheet for participants was provided in lieu of a consent form.

### Sources of data

Sociodemographic and clinical data for these patients, including HAART history and immunologic and virologic markers, were available through the BC-CfE treatment registry. Cause and date of death were obtained through an ongoing monthly link between the BC-CfE registry and the British Columbia Ministry of Health Vital Statistics Agency up to June 2012. This link minimizes loss to follow-up to less than 4% and allows all deaths that occurred in the cohort to be included.

### Variable selection

Our primary outcome variable was suicide, as listed as the underlying cause of death on the death record from the Vital Statistics Agency. The definition of suicide used in this study was adapted from the Manitoba Centre for Health Policy and includes several poisoning codes, such as “accidental poisoning” that account for International Classification of Disease (ICD)-10 codes suspected of capturing a significant proportion of suicides.<sup>20</sup> The ICD-10 codes from the Vital Statistics Agency used in this definition are listed in Appendix 1 (available at [www.cmajopen.ca/content/3/2/E140/suppl/DC1](http://www.cmajopen.ca/content/3/2/E140/suppl/DC1)).

The sociodemographic variables evaluated included sex, Aboriginal identity (extracted from several sources, e.g., surveys, physicians’ reports and death information), median income (the median income recorded in census data for each patient’s postal code was taken as the patient’s median income), whether patients were from urban or rural neighbourhoods (determined by postal code information held at the drug treatment program), age at death and year of death. Clinical variables evaluated included diagnosis of an AIDS-defining illness (a condition that, in the setting of an HIV

infection, confirms the diagnosis of AIDS. This includes a list of serious and life-threatening diseases such as cancers and infections), a diagnosis of hepatitis C virus (HCV) infection, adherence to HAART treatment in the last year before death, calculated by the number of days undergoing treatment (based on the number of days of coverage provided by a given prescription) divided by the number of days the patient was alive in the last year, the last or most recent HAART regimen, efavirenz as part of the last or most recent regimen, number of years on HAART, most recent and nadir CD4 cell counts and latest viral load. History of injection drug use was the only sociobehavioural variable assessed.

### Statistical analysis

Two main analyses were conducted in this study. The first analysis examined the predictors of suicide among all patients in the HOMER cohort who died from suicide or remained alive over the study period, whereas the second analysis was limited to all deaths (suicides and nonsuicides). Statistical comparisons were conducted using the Pearson  $\chi^2$  test or Fisher exact test for dichotomous variables and the Wilcoxon rank sum test for continuous variables.

A Cox proportional hazards regression model was used to identify the independent predictors of suicide among patients in the HOMER cohort who remained alive or died from suicide during the study period. Logistic regression was used to identify independent predictors of suicide among suicides and nonsuicides. Variables for inclusion in both models were selected using exploratory model selection process based on Akaike information criterion and type III *p* values.

Suicide rates and general mortality data in the HOMER cohort were compared with suicide rates and general mortality data in the general population of BC to contextualize findings. These calculations were restricted to 1997–2011 to ensure full-year comparisons. Person-years of risk in the HOMER cohort were based on time under observation of the patient and on annual population estimates in the general population of BC.<sup>21,22</sup> The number of deaths from suicide in the general population, by year, were obtained from reports of the Vital Statistics Agency.<sup>15</sup> Crude rates were expressed as deaths per 100 000 person-years. The Somers D asymptotic test of trend was used to analyze the change in suicide rates over time because of the small number of deaths due to suicide.

## Results

Our analysis involved 5229 people living with HIV/AIDS in the HOMER cohort who began HAART between August 1996 and June 2012 in BC. A total of 82 deaths from suicide were observed. Figure 1 shows the decline in suicide rates during our study period from 961 deaths per 100 000 person-years in 1998 to 28 deaths per 100 000 person-years in 2010 (the last year any suicides were recorded in this cohort). A test for trend showed this decline was statistically significant ( $p < 0.001$ ). A relatively constant suicide rate in the general population of BC was observed; similarly, the proportion of suicide deaths among all-cause mortality deaths was

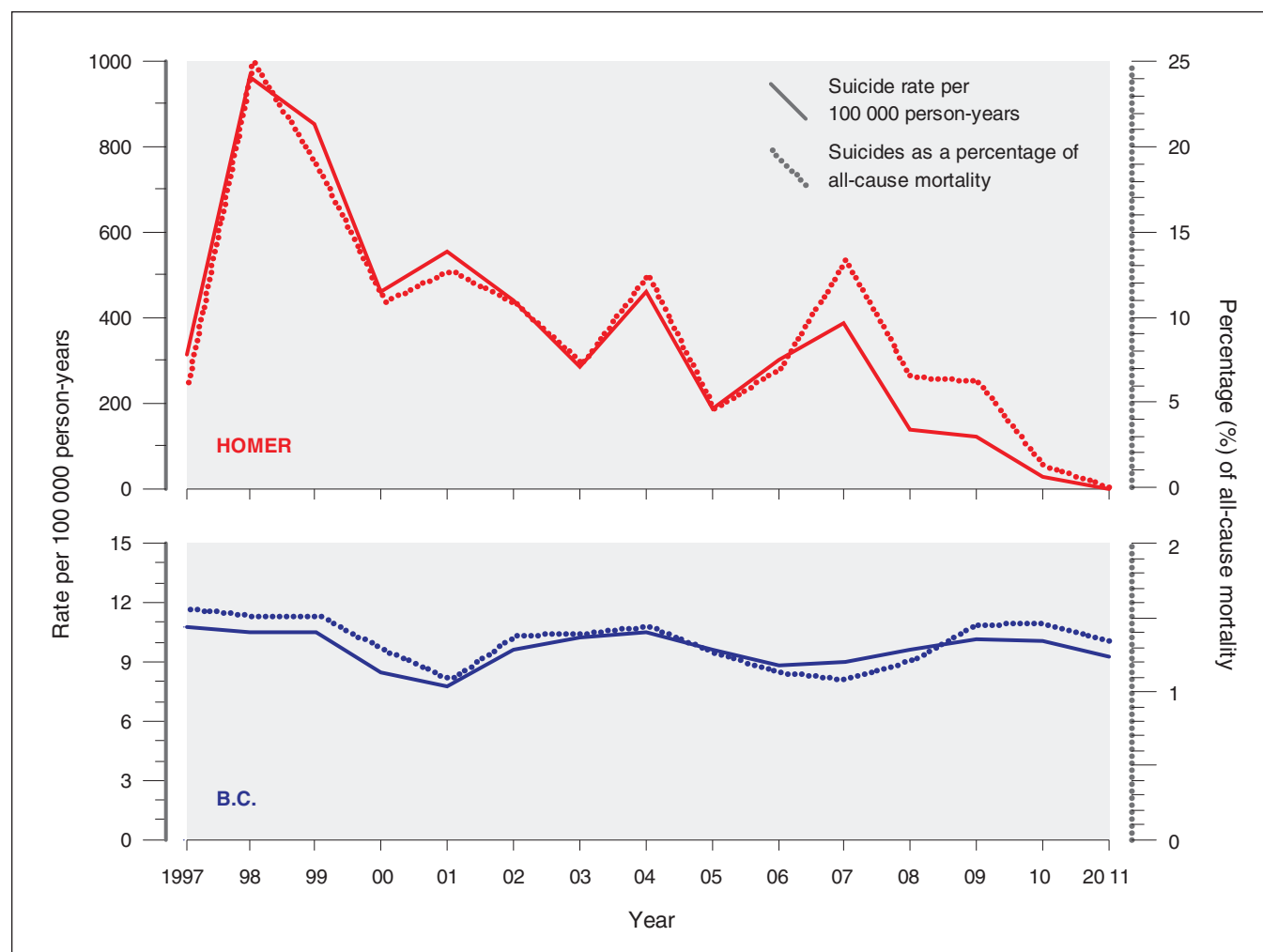
constant over time. Table 1 provides the ICD-10 codes for the deaths due to suicide ( $n = 82$ ).

The bivariate analysis in Table 2 describes the characteristics of all study participants who died from suicide ( $n = 82$ ) compared with those who remained alive ( $n = 4236$ ), but excludes those patients who died of causes other than suicide ( $n = 911$ ). Seventy-eight percent of individuals who died from suicide were male, the median age was 42 years and the median number of years on HAART was 3. Ethnicity ( $p = 0.013$ ), annual income ( $p = 0.012$ ), injection drug use ( $p < 0.001$ ), HCV status ( $p < 0.001$ ), most recent HAART regimen or last HAART regimen before death ( $p = 0.002$ ), efavirenz included in the last or most recent HAART regimen ( $p = 0.002$ ), and never having had an AIDS-defining illness ( $p = 0.0011$ ) were associated with suicide. Younger age ( $p < 0.001$ ), poor treatment adherence in the last or most recent year preceding death ( $p < 0.001$ ), higher baseline CD4 cell count ( $p = 0.001$ ), lower last or most recent CD4 cell count ( $p < 0.001$ ), and higher last or most recent viral load ( $p < 0.001$ ) were also significantly associated with suicide.

A second bivariate analysis (Table 3) was performed to compare suicide deaths ( $n = 82$ ) to nonsuicide deaths ( $n = 911$ ). Younger age of death ( $p < 0.001$ ), death in an earlier calendar period (earlier in the HAART era) ( $p < 0.001$ ), and higher nadir, baseline and most recent CD4 cell counts before death ( $p < 0.001$ ) were associated with suicide. Never having had an AIDS-defining illness ( $p < 0.001$ ) and HCV status ( $p = 0.013$ ) were also significantly associated with suicide.

Table 4 highlights the results of the Cox proportional hazards model. In this analysis, those patients who died from non-suicide deaths were censored, and never having had an AIDS-defining illness (adjusted hazard ratio [AHR] 4.45, 95% confidence interval [CI] 1.62–12.25) or having a history of injection drug use (AHR 3.95, 95% CI 1.99–7.86) were independently associated with an increased rate of suicide mortality. Each additional calendar year was associated with a 51% decrease in suicide rate (AHR 0.49, 95% CI 0.45–0.54).

Table 5 highlights results from the logistic regression model comparing suicide with nonsuicide deaths. Never having an AIDS-defining illness was associated with nearly a 7-fold



**Figure 1:** Comparison of suicide rates in the HOMER cohort with suicide rates in the general population of British Columbia and as a proportion of all-cause mortality from 1997 to 2011. To ensure full-year comparisons, data starting from 1997 to 2011 were used in the graph. HOMER = HAART Observational Medical Evaluation and Research.

increase in the odds of suicide v. nonsuicide death (adjusted odds ratio [AOR] 6.63, 95% CI 2.34–18.83), whereas having a history of injection drug use was associated with a 2-fold increase in the odds of suicide v. nonsuicide death (AOR 1.92, 95% CI 0.87–4.28). Death at an older age (AOR 0.96, 95% CI 0.94–0.99) or in a later calendar year (AOR 0.85, 95% CI 0.79–0.91) was associated with decreased odds of suicide. A higher last CD4 cell count was associated with an increased likelihood of suicide v. nonsuicide death (AOR 1.21, 95% CI 1.06–1.38)

## Interpretation

Our results show that suicide rates among patients using HAART have declined substantially since the start of the HAART era. However, suicide rates remained elevated compared with the general population. Suicide mortality decreased with each calendar year during the HAART era and was greater among those patients who never experienced advanced HIV disease in the form of an AIDS-defining illness.

Several factors may have contributed to such a dramatic decline within this cohort. First, as the HAART era progressed, treatment regimens became simpler, more effective, less toxic and better tolerated,<sup>18,23</sup> thereby reducing treatment burden and impact on quality of life. Second, HIV was initially characterized as a terminal illness, and therefore inherently associated with an elevated risk of suicide,<sup>18,24</sup> but HAART transformed HIV into a chronic manageable condition.<sup>9,23</sup> Third, public perception of HIV has evolved over time, leading to greater social acceptance of people living with HIV/AIDS and potentially contributing to reduced suicide rates in this population. People living with HIV/AIDS in BC may now be less exposed to established correlates of suicidality, such as stigma, marginalization and social exclusion,<sup>9,15,17–21</sup> than at the start of the epidemic. Finally, improved access to facilities (e.g., the supervised injection site) may have reduced the number of accidental poisonings and improved access to psychiatric care may have helped to mitigate suicide behaviour, including suicidal thoughts, ideation and attempts, and prevent escalation to the most severe end of the spectrum, death by suicide.

Consistent with previous research, injection drug use was independently associated with higher rates of suicide mortality.<sup>17,25,26</sup> Within the HOMER cohort, over a third of participants had a history of injection drug use, a behaviour known to often occur in the presence of concomitant mental illness,<sup>27,28</sup> and psychosocial and socioeconomic disparities.<sup>25,29</sup> It may be that compromised mental health becomes neglected in the face of injection drug use, HIV infection and more visibly apparent health concerns, therefore contributing to the exacerbation of suicide risk or suicidality.<sup>16,18,30</sup>

Moreover, even though mental health services have always been offered free of charge in BC as part of the public health care system, the need for specialized services for patients with HIV infection was recognized early on in the epidemic. Designated psychiatrists have provided care at the John Ruedy Immunodeficiency Clinic at St. Paul's Hospital, Vancouver,

since 2003. This clinic provides outpatient care for patients with HIV infection who have significant comorbidities; subsequently, the mental health services team expanded to include psychiatric nurses, social workers, counsellors and psychologists. There are other outpatient psychiatric services throughout the province that are free-of-charge for BC residents, but they are not exclusively for patients with HIV infection. These services may help mitigate suicide behaviour, including suicidal thoughts, ideation, and attempts, and prevent escalation to the most severe end of the spectrum, death by suicide. Recent research reported an association between regimens containing efavirenz and an increased risk of suicidality.<sup>31</sup> Our analysis only detected an association between suicide and efavirenz in univariate results comparing those patients who died of suicide to those who remained alive. However, the small number of suicides in our sample and the small number of these patients who were prescribed efavirenz in their most recent regimen limited our statistical power. Moreover, most of the suicides in the HOMER cohort occurred earlier in the HAART era (between 1996 and 2004), a time when nevirapine was the primary non-nucleoside reverse-transcriptase inhibitor prescribed.

Conflicting results have been reported with respect to the relationship between disease stage and suicide.<sup>5,16,17,24,32,33</sup> Several

**Table 1: Number of suicides by method and ICD-10 code (n = 82)**

Method	ICD-10 code	No. of deaths
Accidental poisoning by and exposure to antiepileptic, sedative–hypnotic, antiparkinsonism and psychotropic drugs	X41	1
Accidental poisoning by and exposure to narcotic and psychodysleptic drugs	X42	60
Accidental poisoning by and exposure to other gases and vapours	X47	1
Suicide by antiepileptic, sedative–hypnotic, antiparkinsonism and psychotropic drugs	X61	4
Suicide by drowning and submersion	X71	1
Suicide by hanging, strangulation and suffocation	X70	6
Suicide by jumping from a high place	X80	4
Suicide by nonopioid analgesic, antipyretic and antirheumatic drugs	X60	1
Suicide by other and unspecified drugs, medicaments and biological substances	X64	2
Suicide by other and unspecified firearm discharge	X74	1
Suicide by other specified means	X83	1

Note: ICD = International Classification of Disease.

studies reported that advanced HIV disease is associated with a greater likelihood of suicide,<sup>6,18,34</sup> whereas others reported that disease progression or symptomatic disease is not associated with an increased risk of suicide.<sup>17,18,35–37</sup> Our results showed that those patients who never had an AIDS-defining illness

were more likely to die by suicide, which is consistent with a previous finding that 70% of the autopsies in patients with HIV infection who died by suicide showed no signs of AIDS-related disease.<sup>17</sup> This suggests that people living with HIV/AIDS with less graduated disease are at greater risk of suicide. Within our

**Table 2: Participant characteristics, death by suicide v. those alive at the end of the study**

Variable	No. of patients (%) <sup>*</sup>		<i>p</i> value
	Died by suicide n = 82	Alive n = 4 236	
Sex			
Female	18 (22)	773 (18)	0.4
Male	64 (78)	3 463 (82)	
Ethnicity			
Aboriginal	16 (20)	473 (11)	0.01
Non-Aboriginal	24 (29)	1 805 (43)	
Unknown	42 (51)	1 958 (46)	
Geographic region			
Rural	2 (2)	162 (4)	0.8
Urban	64 (78)	3 327 (79)	
Unknown	16 (20)	747 (18)	
History of injection drug use			
Yes	47 (57)	1 535 (36)	< 0.001
No	10 (12)	1 973 (47)	
Unknown	25 (30)	728 (17)	
AIDS-defining illness			
Yes	4 (5)	758 (18)	0.001
No	78 (95)	3 478 (82)	
Hepatitis C			
Yes	63 (77)	1 582 (37)	< 0.001
No	13 (16)	2 355 (56)	
Unknown	6 (7)	299 (7)	
Last or most recent HAART regimen			
Single PI	47 (57)	2 131 (50)	0.002
Single NNRTI	30 (37)	1 717 (41)	
Any IIN		299 (7)	
Other	5 (6)	89 (2)	
Efavirenz included in last or latest regimen			
Yes	7 (9)	1 086 (26)	< 0.001
No	75 (91)	3 150 (74)	
Adherence			
≥ 95%	19 (23)	2 685 (63)	< 0.001
< 95%	63 (77)	1 551 (37)	
Age at the end of follow-up, † yr; median (IQR)	42 (38–49)	47 (41–54)	< 0.001
Year of death, median (IQR)	2003 (2000–2006)		< 0.001
Median income, CAD (IQR)	21 015 (14 750–27 799)‡	23 406 (18 258.5–29 901)§	0.01
Baseline CD4+ cell count, × 10 <sup>9</sup> /L; median (IQR)	0.29 (0.17–0.4)	0.22 (0.325–0.67)	0.001
Most recent CD4+ cell count before the end of follow-up, † × 10 <sup>9</sup> /L; median (IQR)	0.355 (0.2–0.5)	0.49 (0.325–0.67)	< 0.001
Nadir CD4+ cell count, × 10 <sup>9</sup> /L; median (IQR)	0.17 (0.07–0.29)	0.16 (0.06–0.25)	0.2
Most recent viral load before the end of follow-up, † log <sub>10</sub> copies/mL; median (IQR)	5.0 (2.69–5.0)	2.69 (2.69–2.69)	< 0.001
No. of years of treatment with HAART, yr; median (IQR)	3 (2–6)	6 (3–10)	< 0.001

Note: HAART = highly active antiretroviral therapy, IIN = integrase inhibitor, IQR = interquartile range, NNRTI = non-nucleoside reverse-transcriptase inhibitor, PI = protease inhibitor.  
<sup>\*</sup>Unless otherwise specified.  
<sup>†</sup>End of follow-up can be the date of death, the date of last contact, date of last contact before moving out of British Columbia or to participation in antiretroviral blinded trials.  
<sup>‡</sup>Some values for income were missing. Median income was calculated using *n* = 65.  
<sup>§</sup>Some values for income were missing. Median income was calculated using *n* = 3308.

**Table 3: Participant characteristics, death by suicide v. nonsuicide death**

Variable	No. of patients (%)		p value
	Suicide death n = 82	Nonsuicide death n = 911	
<b>Sex</b>			
Female	18 (22)	194 (21)	0.9
Male	64 (78)	717 (79)	
<b>Ethnicity</b>			
Aboriginal	16 (20)	195 (21)	0.9
Non-Aboriginal	24 (29)	267 (29)	
Unknown	42 (51)	449 (49)	
<b>Geographic region</b>			
Rural	2 (2)	42 (5)	0.75
Urban	64 (78)	699 (77)	
Unknown	16 (20)	170 (19)	
<b>History of injection drug use</b>			
Yes	47 (57)	449 (49)	0.1
No	10 (12)	196 (22)	
Unknown	25 (30)	266 (29)	
<b>AIDS-defining illness</b>			
Yes	4 (5)	296 (32)	< 0.001
No	78 (95)	615 (68)	
<b>Hepatitis C</b>			
Yes	63 (77)	548 (60)	0.01
No	13 (16)	250 (27)	
Unknown	6 (7)	113 (12)	
<b>Last or most recent HAART regimen</b>			
Single PI	47 (57)	537 (59)	0.4
Single NNRTI	30 (37)	281 (31)	
Any IIN	0 (0)	25 (3)	
Other	5 (6)	68 (7)	
<b>Efavirenz included in last or latest regimen</b>			
Yes	7 (9)	142 (16)	0.1
No	75 (91)	769 (84)	
<b>Adherence</b>			
≥ 95%	19 (23)	197 (22)	0.8
< 95%	63 (77)	714 (78)	
<b>Age at death, yr; median (IQR)</b>			
	42 (38–49)	46 (39–54)	< 0.001
<b>Year of death, median (IQR)</b>			
	2003 (2000–2006)	2006 (2002–2009)	< 0.001
<b>Median income, CAD (IQR)</b>			
	21 015 (14 750–27 799)†	19 346.5 (14 518–26 073)‡	0.7
<b>Baseline CD4+ cell count, × 10<sup>9</sup>/L; median (IQR)</b>			
	0.29 (0.17–0.4)	0.15 (0.05–0.27)	< 0.001
<b>Last or most recent CD4+ cell count before the end of follow-up, × 10<sup>9</sup>/L; median (IQR)</b>			
	0.355 (0.2–0.5)	0.14 (0.03–0.31)	< 0.001
<b>Nadir CD4+ cell count, × 10<sup>9</sup>/L; median (IQR)</b>			
	0.17 (0.07–0.29)	0.05 (0.01–0.14)	< 0.001
<b>Last or most recent viral load before the end of follow-up,* log<sub>10</sub> copies/mL; median (IQR)</b>			
	5.0 (2.69–5.0)	5 (2.69–5.0)	0.5
<b>No. of years of treatment with HAART, yr; median (IQR)</b>			
	3 (2–6)	3 (1–6)	0.5

Note: HAART = highly active antiretroviral therapy, IIN = integrase inhibitor, IQR = interquartile range, NNRTI = non-nucleoside reverse-transcriptase inhibitor, PI = protease inhibitor.  
\*End of follow-up can be the date of death, the last date of contact, last date of contact date before moving out of British Columbia or to participation in antiretroviral blinded trials.  
†Some values for income were missing. Median income was calculated using n = 65.  
‡Some values for income were missing. Median income was calculated using n = 700.

**Table 4: Factors associated with suicide among patients who died from suicide or who were alive at the end of the study (n = 4318)**

Variable	Unadjusted HR (95% CI)	p value	AHR (95% CI)	p value
AIDS-defining illness		0.002		0.004
Yes	1.00 (ref)		1.00 (ref)	
No	4.90 (1.79–13.39)		4.45 (1.62–12.25)	
History of injection drug use		< 0.001		< 0.001
No	1.00 (ref)		1.00 (ref)	
Yes	5.86 (2.96–11.60)		3.95 (1.99–7.86)	
Unknown	9.13 (4.38–19.03)		2.59 (1.21–5.56)	
Adherence in the last year before death		< 0.001		
< 95%	1.00 (ref)			
≥ 95%	0.16 (0.10–0.27)			
Age at the end of follow-up*	0.93 (0.90–0.95)	< 0.001	Not selected	
Year of the end of follow-up*	0.49 (0.44–0.53)	< 0.001	0.49 (0.45–0.54)	< 0.001
Last CD4+ cell count before the end of follow-up*	0.77 (0.70–0.85)	< 0.001	Not selected	
Last viral load before the end of follow-up*	3.14 (2.54–3.87)	< 0.001	Not selected	
Efavirenz included in last drug regimen			Not selected	
No	1.00 (ref)			
Yes	3.01 (1.37–6.54)	0.005		

Note: AHR = adjusted hazards ratio, HR = hazards ratio, ref = reference category.  
\*End of follow-up can be the date of death, the last date of contact, the last date of contact before leaving British Columbia or to participation in antiretroviral blinded trials.

**Table 5: Factors associated with suicide among patients who started HAART and died from suicide or from causes other than suicide (n = 993)**

Variable	Unadjusted OR (95% CI)	p value	AOR (95% CI)	p value
AIDS-defining illness		< 0.001		< 0.001
Yes	1.00 (ref)		1.00 (ref)	
No	9.39 (3.40–25.88)		6.63 (2.34–18.83)	
History of injection drug use		0.1		0.02
No	1.00 (ref)		1.00 (ref)	
Yes	2.02 (1.02–4.14)		1.92 (0.87–4.28)	
Unknown	1.84 (0.86–3.92)		0.89 (0.37–2.14)	
Age at the end of follow-up*	0.96 (0.93–0.98)	< 0.001	0.96 (0.94–0.99)	0.006
Year of death*	0.87 (0.82–0.92)	< 0.001	0.85 (0.79–0.91)	< 0.001
Nadir CD4 cell count (per $0.1 \times 10^9/L$ )	1.71 (1.47–1.99)	< 0.001	1.23 (0.97–1.56)	0.09
Last CD4+ cell count before death (per $0.1 \times 10^9/L$ )	1.24 (1.15–1.34)	< 0.001	1.21 (1.06–1.38)	0.004

Note: AOR = adjusted odds ratio, CI = confidence interval, HAART = highly active antiretroviral therapy, OR = odds ratio, ref = reference category.  
\*End of follow-up can be the date of death, the last date of contact, the last date of contact before leaving British Columbia or to participation in antiretroviral blinded trials.

cohort, 76.8% of individuals who died of suicide did not adhere to treatment in the year preceding their death. Compromised mental health is a widely recognized mediator of nonadherence to treatment among people living with HIV/AIDS,<sup>38-40</sup> therefore, this trend toward nonadherence could be indicative of underlying, and possibly undiagnosed and untreated, mental illness.

Readers should be cautious when interpreting our results. First, in the cross-sectional analysis, we were able to highlight associations, but unable to show or infer causality or direction of the associations. Second, our data pertained to a very specific population of people living with HIV/AIDS who have started HAART in BC, which is a universal health care setting with free access to treatment and HIV-related care. Third, the lack of accepted methodology within this field of research, suicidal-ity in HIV-positive populations, limits the comparability and generalizability of results across studies.<sup>1,9,11,41,42</sup> Fourth, suicides may be underestimated as those that occur as a result of self-administered withdrawal of care or similar indirect ways often cannot be distinguished as such; however, given the definition of suicide used in this study includes accidental poisoning it may also be possible that the number of suicides was overestimated and that some instances of overdose death are, in fact, not suicides. Fifth, our sample size, information on certain variables such as injection drug use and sex distribution is limited; in addition, we had no access to clinical information regarding previous psychiatric history, particularly depression, or any mental health-related treatments. Lastly, suicide itself can be seen as the severest outcome of a spectrum. We did not collect data for other suicidal or self-harming behaviours, but we acknowledge that they are closely related because they represent the array of suicidal behaviours that exist.

## Conclusion

Suicide rates among patients with HIV infection who access antiretroviral therapy have declined substantially since 1996. Our results reflect a large decline in the number of suicides compared with other recent studies, such as those reported by the national registries of Switzerland and Denmark. This difference is likely partially due to differences in methodological design — HOMER is a distinct cohort of patients living with HIV who are receiving treatment — and we have a centralized distribution site in which all patients who are receiving treatment in BC are enrolled. However, despite substantial declines, suicide rates in our cohort remained at nearly 3 times the rate of the general population in the most recent comparison. Thus, our results reinforce the need for further integration of care, and proactive mental health screening and treatment in patients with HIV infection, particularly for those with histories of injection drug use, to identify suicidal risk.

## References

- Catalan J, Harding R, Sibley E, et al. HIV infection and mental health: suicidal behaviour—systematic review. *Psychol Health Med* 2011;16:588-611.
- Marzuk PM, Tierney H, Tardiff K, et al. Increased risk of suicide in persons with AIDS. *JAMA* 1988;259:1333-7.
- Do AN, Rosenberg ES, Sullivan PS, et al. Excess burden of depression among HIV-infected persons receiving medical care in the United States: data from the Medical Monitoring Project and the Behavioral Risk Factor Surveillance System. *PLoS ONE* 2014;9:e92842.
- Quintana-Ortiz RA, Gomez MA, Baez Feliciano DV, et al. Suicide attempts among Puerto Rican men and women with HIV/AIDS: a study of prevalence and risk factors. *Ethnicity & Disease*. Spring 2008;18(2 Suppl 2):S219-24.
- Jia CX, Mehlum L, Qin P. AIDS/HIV infection, comorbid psychiatric illness, and risk for subsequent suicide: a nationwide register linkage study. *J Clin Psychiatry* 2012;73:1315-21.
- Kalichman SC, Heckman T, Kochman A, et al. Depression and thoughts of suicide among middle-aged and older persons living with HIV/AIDS. *Psychiatr Serv* 2000;51:903-7.
- Cooperman NA, Simoni JM. Suicidal ideation and attempted suicide among women living with HIV/AIDS. *J Behav Med* 2005;28:149-56.
- Schneider SG, Taylor SE, Hammen C, et al. Factor influencing suicide intent in gay and bisexual suicide ideators: differing models for men with and without human immunodeficiency virus. *J Pers Soc Psychol* 1991;61:776-88.
- Carrico AW. Elevated suicide rate among HIV-positive persons despite benefits of antiretroviral therapy: implications for a stress and coping model of suicide. *Am J Psychiatry* 2010;167:117-9.
- Samji H, Cescon A, Hogg RS, et al. Closing the gap: increases in life expectancy among treated HIV-positive individuals in the United States and Canada. *PLoS ONE* 2013;8:e81355.
- Aldaz P, Moreno-Iribas C, Egues N, et al. Mortality by causes in HIV-infected adults: comparison with the general population. *BMC Public Health* 2011;11:300.
- Côté TR, Biggar RJ, Dannenberg AL. Risk of suicide among persons with AIDS. A national assessment. *JAMA* 1992;268:2066-8.
- Mocroft A, Brettle R, Kirk O, et al. Changes in the cause of death among HIV positive subjects across Europe: results from the EuroSIDA study. *AIDS* 2002;16:1663-71.
- Montaner JS, Lima VD, Harrigan PR, et al. Expansion of HAART coverage is associated with sustained decreases in HIV/AIDS morbidity, mortality and HIV transmission: the “HIV Treatment as Prevention” experience in a Canadian setting. *PLoS One*. 2014;9:e87872.
- Sherr L, Lampe F, Fisher M, et al. Suicidal ideation in UK HIV clinic attenders. *AIDS* 2008;22:1651-8.
- Keiser O, Spoerri A, Brinkhof MW, et al. Suicide in HIV-infected individuals and the general population in Switzerland, 1988–2008. *Am J Psychiatry* 2010;167:143-50.
- Marzuk PM, Tardiff K, Leon AC, et al. HIV seroprevalence among suicide victims in New York City, 1991–1993. *Am J Psychiatry* 1997;154:1720-5.
- Komiti A, Judd F, Grech P, et al. Suicidal behaviour in people with HIV/AIDS: a review. *Aust N Z J Psychiatry* 2001;35:747-57.
- Patterson S CA, Samji H, Cui Z, et al. Cohort profile: HAART Observational Medical Evaluation and Research (HOMER). *Int J Epidemiol* 2014;44:58-67.
- Concept suicide and attempted suicide (intentional self-inflicted injury). Winnipeg: University of Manitoba; 2010. Available: <http://mchp-appserv.cpe.umanitoba.ca/viewConcept.php?conceptID=1183> (accessed 2015 Feb. 6).
- British Columbia Ministry of Health Vital Statistics Agency. Quarterly Digest, 1997–2011. Available: [www.vs.gov.bc.ca/stats/quarter/](http://www.vs.gov.bc.ca/stats/quarter/) (accessed 2015 Mar. 11)
- BCStats. BC Quarterly Population Estimates, 1997–2012. Available: [www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx](http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx) (accessed 2015 Mar. 11).
- Montaner JS, Wood E, Kerr T, et al. Expanded highly active antiretroviral therapy coverage among HIV-positive drug users to improve individual and public health outcomes. *J Acquir Immune Defic Syndr* 2010;55(Suppl 1):S5-9.
- Pugh K, O'Donnell I, Catalan J. Suicide and HIV disease. *AIDS Care* 1993; 5:391-400.
- Havens JR, Strathdee SA, Fuller CM, et al. Correlates of attempted suicide among young injection drug users in a multi-site cohort. *Drug Alcohol Depend* 2004;75:261-9.
- Sarin E, Singh B, Samson L, et al. Suicidal ideation and HIV risk behaviors among a cohort of injecting drug users in New Delhi, India. *Subst Abuse Treat Prev Policy* 2013;8:2.
- Kelly B, Raphael B, Judd F, et al. Suicidal ideation, suicide attempts, and HIV infection. *Psychosomatics* 1998;39:405-15.
- Gallego L, Barreiro P, Lopez-Ibor JJ. Diagnosis and clinical features of major neuropsychiatric disorders in HIV infection. *AIDS Rev* 2011;13:171-9.
- Roy A. Characteristics of HIV patients who attempt suicide. *Acta Psychiatr Scand* 2003;107:41-4.
- Pompili M, Pennica A, Serafini G, et al. Depression and affective temperaments are associated with poor health-related quality of life in patients with HIV infection. *J Psychiatr Pract* 2013;19:109-17.
- Mollan K, Smurzynski M, Na L, et al. Hazard of suicidality in patients randomly assigned to efavirenz for initial treatment of HIV-1: a cross-study analysis conducted by the AIDS Clinical Trials Group (ACTG) [abstract]. IDWeek 2013 conference; 2013 Oct 2-6; San Francisco. Available: <https://idsa.confex.com/idsa/2013/webprogram/Paper40032.html> (accessed 2015 Mar. 11).
- Gala C, Pergami A, Catalan J, et al. Risk of deliberate self-harm and factors associated with suicidal behaviour among asymptomatic individuals with human immunodeficiency virus infection. *Acta Psychiatr Scand* 1992;86:70-5.
- Préau M, Bouhnik AD, Peretti-Watel P, et al. Suicide attempts among people living with HIV in France. *AIDS Care* 2008;20:917-24.
- Carvajal MJ, Vicioso C, Santamaria JM, et al. AIDS and suicide issues in Spain. *AIDS Care* 1995;7(Suppl 2):S135-8.



35. Sherr L. Suicide and AIDS: lessons from a case note audit in London. *AIDS Care* 1995;7(Suppl 2):S109-16.
36. McKegney FP, O'Dowd MA. Suicidality and HIV status. *Am J Psychiatry* 1992;149:396-8.
37. O'Dowd MA, Biderman DJ, McKegney FP. Incidence of suicidality in AIDS and HIV-positive patients attending a psychiatry outpatient program. *Psychosomatics* 1993;34:33-40.
38. Chander G, Himelhoch S, Moore RD. Substance abuse and psychiatric disorders in HIV-positive patients: epidemiology and impact on antiretroviral therapy. *Drugs* 2006;66:769-89.
39. Horberg MA, Silverberg MJ, Hurley LB, et al. Effects of depression and selective serotonin reuptake inhibitor use on adherence to highly active antiretroviral therapy and on clinical outcomes in HIV-infected patients. *J Acquir Immune Defic Syndr* 2008;47:384-90.
40. Yun LW, Maravi M, Kobayashi JS, et al. Antidepressant treatment improves adherence to antiretroviral therapy among depressed HIV-infected patients. *J Acquir Immune Defic Syndr* 2005;38:432-8.
41. Badiee J, Moore DJ, Atkinson JH, et al. Lifetime suicidal ideation and attempt are common among HIV+ individuals. *J Affect Disord* 2012;136:993-9.
42. Bellini M. HIV Infection and suicidality. *J Affect Disord* 1996;38:153-64.

**Affiliations:** BC Centre for Excellence in HIV/AIDS (Gurm, Samji, Nophal, Ding, Zhu, Montaner, Hogg, Guillemi), St. Paul's Hospital, Vancouver, BC; The University of British Columbia (Montaner, Guillemi), Faculty of Medicine, Vancouver, BC; The University of British Columbia (Strehlau), Department of Psychiatry, Vancouver, BC; Simon

Fraser University (Guillemi), Faculty of Health Sciences, Burnaby, BC

**Contributors:** Erin Ding, Adriana Nophal and Julia Zhu conducted the statistical modeling and data analysis for this study. Robert Hogg and Silvia Guillemi had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Jamine Gurm wrote the first draft of the manuscript. Verena Strehlau, Silvia Guillemi and Julio Montaner conceptualized the paper. All of the authors critically revised the manuscript for important intellectual content, approved the final version submitted for publication and agreed to act as guarantors of the work.

**Funding:** Julio Montaner is supported by a grant from the British Columbia Ministry of Health through the STOP HIV/AIDS Initiative.

**Acknowledgements:** We would like to thank James Nakagawa, Communications Assistant at the BC-CfE, for designing the figures presented in this paper. We would also like to acknowledge all the participants from the HOMER cohort who have enabled this research to take place by allowing their data to be collected and used for the purposes of advancing HIV/AIDS research.

**Supplemental information:** For reviewer comments and the original submission of this manuscript, please see [www.cmajopen.ca/content/3/2/E140/suppl/DC1](http://www.cmajopen.ca/content/3/2/E140/suppl/DC1)