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FINAL REPORT

ESTIMATING THE NUMBER OF PERSONS CO-INFECTED WITH HEPATITIS C VIRUS AND HUMAN IMMUNODEFICIENCY VIRUS IN CANADA

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EXECUTIVE SUMMARY

Since infection with HIV may complicate the management of patients with chronic hepatitis C virus (HCV) infection and vice versa, we wished to quantify and characterize the extent of dual HCV-HCV infection in Canada. In the first stage of the analysis, we estimated the number of persons infected with HIV according to HIV-defined exposure categories and province/region as of December 1999. Using data from published studies and unpublished reports and the results of a consensus among expert consultants, we estimated the expected HCV prevalence among HIV-infected persons in each HIV-defined exposure category for each region. Where appropriate, we adjusted for regional differences in HCV prevalence. The prevalence of HCV-HIV infection was then determined by multiplying the number of HIV-infected persons in each category times the HCV prevalence. We also estimated, specifically, the number of HCV-HIV infected Aboriginal persons and persons incarcerated in Canadian prisons. We calculated 95% confidence limits around our estimates using Monte-Carlo simulation.

As of December 1999, an estimated 11,194 persons in Canada were infected with HCV and HIV, with 95% confidence limits of 9,400 and 13,300. 87% of dually infected persons live in Quebec (34%), British Columbia (29%) or Ontario (25%). We estimate that 7,921 injection drug users (IDUs) and 1,648 men who have sex with men and also inject drugs (MSM-IDU) were dually infected, accounting for 71% and 15%, respectively, of dually infected persons in Canada. Finally, we estimated that 1,477 Aboriginal persons and 611 persons incarcerated in federal and provincial prisons had HCV-HIV infection.

Our analysis is subject to uncertainty due mostly to the lack of precise Canadian serologic data on persons with combined infection. Nevertheless, the number of persons in Canada with dual HCV-HIV infection is undoubtedly substantial. The majority of such persons are (IDU) or MSM-IDUs and are concentrated in Quebec, British Columbia and Ontario. It is unknown what proportion of these persons are aware they are infected with both viruses.

1. INTRODUCTION

1.1 Background

Co-infection with hepatitis C virus (HCV) and the human immunodeficiency virus (HIV) is of particular interest, since persons infected with both viruses may have an aggravated clinical course related to the presence of the other infection. In particular, the immune suppression caused by HIV may exacerbate the progression of hepatic disease due to HCV infection. The treatment of each infection may also be complicated by the presence of the other infection. Thus, dual infection with HCV and HIV is important due to the considerable burden of illness posed by both viruses and to the specific challenges in determining the appropriate treatment for each of these serious viral infections.

The number of HCV-HIV co-infected individuals is likely to be considerable since the modes of transmission for the two viruses overlap to a significant extent. Both HCV and HIV may be acquired through parenteral exposure, particularly related to, though not limited to, injection drug use and the receipt of blood transfusions and plasma fractionation products (in particular, clotting factors). The risk of acquisition of these viruses from blood transfusions and plasma derivatives was markedly reduced in Canada with the implementation of specific serologic screening tests. Testing for HIV was initiated in November 1985, while HCV testing began in May 1990. Nevertheless, a substantial number of persons who were infected before these measures were put in place are still alive, and injection drug users continue to become infected with HIV and HCV at a significant rate.

With respect to hepatitis C, the most important exposures in Canada are historically related to injection drug use, blood transfusions and the receipt of plasma fractionation products. Because there is more data, and more reliable data, on HIV prevalence, calculating the number of co-infections is best achieved by first estimating the number of HIV-infected persons in each HIV-defined exposure category, then multiplying this number by the prevalence of hepatitis C infection within each group based on data from Canada and comparable populations elsewhere.

We examined seven exposure categories in all: men who have sex with men (MSM), injection drug users (IDUs), MSM-IDU, persons from HIV-endemic countries, other persons infected by heterosexual contact, patients with hemophilia, and transfusion recipients. MSM (because they comprise the largest group of HIV-infected persons in Canada) and persons who inject drugs (because of the high rate of both infections) likely account for most of the HCV-HIV co-infections in Canada. Though most hemophilia patients are infected with hepatitis C, the number of surviving HIV-infected persons in this group is relatively small.

1.2 Mandate

The number of persons with HCV-HIV co-infection in Canada is currently unknown. This study is being undertaken since dually-infected persons with HCV and HIV have particular concerns relating to prognosis and antiviral treatment of each of the diseases as noted above. Therefore, we were asked to undertake a modeling analysis to estimate the number of HCV-HIV co-infected persons stratified by exposure category and region of residence. To the extent feasible, we were also asked to estimate the number of co-infections occurring specifically among Aboriginal persons and prisoners.

This study was mandated by the Hepatitis C Division, Population and Public Health Branch, Health Canada. The present report integrates the results of two previous stages of the analysis. In the first stage, we determined the number and plausible range of HIV-infected persons in Canada. In the second, we estimated the HCV prevalence among each of these groups, and then applied this prevalence to the number in each group to determine the number of HCV-HIV co-infected persons.

1.3 Study objectives

The objectives of the study were:

1) To update the estimates of the number of HIV infected-persons by exposure category and geographic region as of December 1999;

2) To review the literature to determine the likely prevalence of HCV among HIV-infected persons in each of these groups;

3) To determine the number and the plausible range of HCV-HIV co-infected persons in Canada by exposure category and geographic region; and

4) To carry out a similar analytic process as in Objective 3 for the Aboriginal population and for persons incarcerated in federal and provincial prisons in Canada.

2. METHODS

As indicated above, the exposure categories included in the analysis were: MSM, MSM-IDU, IDU, persons from HIV-endemic countries, other persons infected by heterosexual contact, patients with hemophilia, and transfusion recipients. In the analysis, we realized early that estimates of hepatitis C prevalence for each group could not be based simply on data which did not stratify on HIV status. There is a strong correlation between HIV and HCV infection due to the fact that their modes of transmission are similar. This correlation is particularly high in the case of IDUs, transfusion recipients and hemophilia patients; the situation regarding MSM is less clear. Therefore, it is not

surprising that almost all studies have shown a much higher HCV prevalence among HIV-positive persons than among HIV-negative persons. Thus, for available data on HCV prevalence not stratified on HIV infection, prevalence estimates had to be adjusted upwardly to account for this dependency.

2.1 Number of HIV-infected persons in Canada as of December 1999

Estimates of HIV prevalence to December 1999 were obtained as spreadsheet format from Dr. Chris Archibald, Chief, HIV/ AIDS Epidemiology, Centre for Infectious Disease Prevention and Control, Health Canada. These analyses had originally been carried out in 1997 and 1998 and were presented elsewhere <*1,2*>. The estimate for December 1999 was updated by Health Canada in 2000 and released in November 2000 <*3*>.

The 1999 estimate was carried out using the direct and indirect methods that were used for the 1996 estimates. In addition, the estimated HIV incidence and mortality in the period (1997-1999) were independently estimated and added and subtracted, respectively, from the 1996 estimate to ensure the plausibility of the updated estimate. The author of the present report collaborated in these analyses.

The national estimates of HIV prevalence for 1999 were provided to the author of the present report with aggregate values for several exposure categories: heterosexual and HIV-endemic categories were aggregated, as were those infected by clotting factors and blood transfusion (indicated under the category AOther@). With respect to region, estimates were aggregated for the prairie provinces and the territories. For the present analysis, we used less aggregated categories for both exposure category and region. To estimate these values for the number of HIV-infected persons, we interpolated the estimates provided by Health Canada using weights determined from an earlier, provisional estimate of national HIV infections carried out in the context of the present study.

To estimate the plausible limits of the number of HIV-infected persons by exposure category and region, we used Monte-Carlo simulation using Crystal Ball, Version 4.0c (Decisioneering Inc. Aurora, Colorado, USA). Monte-Carlo estimates were carried out using estimates of uncertainty such that the output ranges matched as closely as possible the Health Canada estimates.

2.2 Estimating HCV prevalence

2.2.1 Literature review

We reviewed published studies and available reports containing data on the prevalence of hepatitis C antibody among HIV-infected and uninfected persons for each of the above-noted exposure categories. A Medline search was carried out using the following key words: hepatitis C, HIV, homosexual,

injection drug use, hemophilia, transfusion, aboriginal and incarceration. For this purpose, we used the National Library of Medicine Medline literature search engine (PubMed) accessible on the World Wide Web. When key articles were identified, we used two techniques to locate additional articles of particular interest. First, published articles were reviewed and the relevant references cited were also obtained. Second, we used the hyperlink *Other related articles* in PubMed to extend the search to ensure a systematic and comprehensive capture of relevant published studies. Several unpublished Canadian studies available as either technical reports or abstracts of presentations were kindly provided by Marcel DuBois of the Hepatitis C Division, Health Canada. Finally, data on HCV prevalence among HIV-infected MSM derived from a study carried out in Vancouver was obtained through a personal communication with Kevin Craib of the British Columbia Centre for Excellence in HIV/AIDS.

For each value of HCV prevalence identified through the literature review, we calculated the exact 95% binomial confidence limits through the use of Epi-Info Version 6.04 (Centers for Disease Control).

2.2.2 Consultation on HCV prevalence in Canada

As noted above, only very limited data are available on HCV prevalence among HIV-infected persons in Canada. The only data in Canada on co-infection was obtained from a study conducted by Kevin Craib in Vancouver of MSM and estimates derived by the present investigator for hemophilia patients in the context of a private consultation. To compensate for the lack of data, we chose to confer with key informants to establish reasonable point estimates and plausible ranges for the prevalence of HCV among HIV-infected persons by exposure category. The four experts selected for this exercise were Kevin Craib, British Columbia Centre for Excellence in HIV/AIDS; Dr. Morris Sherman, Toronto Hospital; Dr. Shimian Zou, Division of Bloodborne Pathogens, Health Canada; and Marcel DuBois, Hepatitis C Division, Health Canada.

These experts were provided with a copy of the report from Phase I, including the tables showing the estimates and confidence limits for a large number of studies that were reviewed in this phase of the study. They were also provided with copies of selected articles that had larger and more likely representative samples and were stratified on HIV.

The consultation was conducted via teleconference. The published studies on each exposure category were briefly presented and reviewed. The likely differences between the Canadian experience (for which there was limited data) and that of countries for which data was available was also considered. On the basis of these analyses, a point estimate was derived and agreed upon by consensus. The informants also agreed upon the plausible ranges around the point estimate based on the degree of convergence of this point estimate. In general, a 10% range around the point estimate was used where the point estimate was considered to be relatively precise, 20% where intermediate, and 30% in circumstances where it was relatively uncertain. A similar procedure was carried out for all seven exposure categories for Canada as a whole.

Following this estimation procedure, we determined for each exposure category using the same consensus process whether weighting was required to take into account possible differences in HCV prevalence between the seven regions of Canada, since Abackground@ HCV prevalence rates vary from one region to another. Based mainly on data from blood donors, HCV prevalence appears to be substantially higher in British Columbia, intermediate in Ontario, and relatively lower in Manitoba, Saskatchewan and the Atlantic provinces.

For the second stage of this analysis, the estimates for HCV prevalence, taking into account regional weightings as described above, were applied to the number of HIV-infected persons for each exposure category, then summed across exposure categories and regions (the Atlantic provinces were grouped for this analysis). To determine plausible ranges, we carried out Monte-Carlo simulation for each of the cells defined by exposure category and geographic region. The Monte-Carlo simulation was carried out using Crystal Ball, Version 4.0 (Decisioneering, Aurora, Colorado, USA); 10,000 iterations were performed.

The analysis to estimate the number of co-infected persons among Aboriginal and prisoner populations was somewhat different. For this purpose, we relied on the HCV prevalences determined for each HIV-defined exposure category as described above. Preliminary work on estimates for the Aboriginal and prison populations, begun in Phase I, was refined in the context of additional information obtained during Phase II. More details about the methods used are described in Sections 2.3 and 2.4 below.

2.2.3 Estimates of HCV prevalence among hemophilia patients and transfusion recipients

To determine the prevalence of HCV among HIV-infected hemophilia patients, we based our estimates on analyses carried out for the class action settlement 1986 to 1990 in Canada <*4*>.

Studies that could be used to obtain meaningful estimates of HCV prevalence among transfusion recipients in Canada were, however, not available. Therefore, we used the HCV per unit risk for the period 1980 to 1990 and applied it to the mean number of units received by surviving HIV-infected transfusion recipients (35) derived through an earlier modeling study <*5*> using the formula $(1-[(1-p)^n])$ to calculate HCV prevalence among HIV-infected persons.

2.3 Estimates of HCV-HIV co-infection among the Aboriginal population

We obtained data on the Aboriginal population by province and by status as of 1996 from the Statistics Canada website. We then estimated the proportion of the population in each exposure category to determine the population at risk. Several available studies on the Aboriginal population suggest that injection may be more frequent among Aboriginal populations than among Canadians as a whole, and that HIV prevalence among Aboriginal injection drug users may be higher than for non-Aboriginal injection drug users. In this regard, several published studies from Vancouver were especially helpful

<*6-9*>; these observations were taken into account in the final estimates. This estimate was then multiplied by the HIV prevalence specific to each risk group.

The derived estimate of the number of HIV-infected Aboriginals was then reviewed in the light of data on recently reported AIDS cases published by the Division of HIV Epidemiology *<10>* and a personal communication from the same Division *<11>*. With respect to the former, we obtained also data on the distribution of diagnosed HIV infections by exposure category and sex and, from the latter, on the distribution of HIV infections by region.

To ensure our final number was a plausible estimate of the total number of HIV-infected Aboriginal persons, we applied the proportion of AIDS cases who were Aboriginal as a proportion of the total AIDS cases with known ethnicity to the national HIV estimate. Adjustments were made in the prevalence of risk factors and HIV prevalence to ensure that the estimate was consistent with both the distribution by exposure category and by region of reported AIDS cases. The final results for HIV distribution were also adjusted based on the proportion of reported AIDS cases diagnosed from 1996-99 comprising Aboriginals in each cell defined by exposure category and region.

Finally, the number of dually infected Aboriginal persons was determined by multiplying the HCV prevalence among HIV-infected persons defined by exposure category as determined above by the estimated number of HIV-infected Aboriginal persons in each exposure category.

The above method was used to obtain preliminary estimates of HIV infection and HCV-HIV infection among the Aboriginal population in an earlier phase of this study. More recently, the Bureau of HIV/AIDS, STD and TB estimated the number of HIV-infected Aboriginal persons in Canada as part of the national analyses referred to in Section 2.1 above. These were kindly provided to the author of the present report by exposure category and region of residence. The Health Canada estimates of the number of HIV-infected Aboriginal people was used in the final calculation, applying the HCV prevalence for the population as a whole. Where Health Canada had aggregated exposure categories and regions, the specific cells were estimated through interpolation as for the overall numbers described in Section 2.1.

2.4 Estimates of HCV-HIV co-infection among prisoners

This analysis was carried out in four stages:

2.4.1 The numbers of persons incarcerated in 1996 in federal and provincial penal institutions were obtained from the Statistics Canada website. Where individual provincial estimates were not available, they were determined by interpolation using the federal prison data.

2.4.2 To calculate the number of dually infected persons, we needed to know, most importantly, the proportion and the number of prisoners in each exposure category related to HIV infection.

For this purpose, a focused literature search was carried out to examine seroepidemiologic studies of HIV and HCV infection, as well as those on the prevalence of risk behaviours among prisoners in Canada and elsewhere <*12-23*>. The proportion of prisoners who were also injection drug users was estimated on this basis. For MSM, we used population-based estimates from the surveys carried out in Canada and elsewhere. The number of prisoners in each exposure category by region was derived by multiplying the estimated proportion of prisoners in each exposure category by the number of prisoners in each region.

2.4.3 In the next stage of the analysis, we wished to determine HIV prevalence among each HIV exposure category in the prison population. In addition, we incorporated the estimates for the denominator populations, i.e the number of persons incarcerated in Canadian prisons, to calculate HIV prevalence as a proportion. This calculation was carried out in a preliminary fashion using initial, plausible estimates, and the numbers of HIV-infected persons thus derived were then compared to the results of the identified published studies and reports as noted in Section 2.4.2 used to determine the proportion of persons having injection drug use history. We then adjusted estimates of HIV prevalence so that the overall prevalence rate was within the span of observed HIV prevalence from the approximately 10 studies so identified. For the Yukon and Northwest Territories, we used estimates midway between those for Alberta and British Columbia.

2.4.4 In the final stage of the analysis, the proportion of HIV-infected persons who are also HCV infected was derived by the same approach as that described above for each category for Canada as a whole. The estimated number of HIV-infected prisoners in each exposure category in each region was multiplied by the exposure category-specific HCV prevalence to derive the number of persons with HCV-HIV co-infection in each exposure category and geographic region. Using Monte-Carlo simulation as described above, we derived plausible limits around the point estimates for the number of dually infected prisoners.

3. RESULTS

3.1 HIV prevalence in Canada as of December 1999

Table 1 shows the estimates of HIV by exposure category for December 1999. Overall, there were an estimated 49,800 HIV-infected persons in Canada, an increase of 24% compared to 1996. The most important groups with respect to absolute numbers of HIV infections were (in descending order): MSM, IDUs and persons infected by heterosexual contact; these three groups accounted for 95% of all HIV infections. IDU and MSM alone accounted for 80% of HIV infections in Canada. The plausible ranges derived from the Monte Carlo simulation for each exposure category were: MSM 26,00-33,600, MSM-IDU 1,600-2,600, IDU 7,900-11,700, heterosexual (HIV-endemic and other heterosexual contact) 6,100-10,100, and Other (recipients of clotting factors and blood transfusion) 330-520. The plausible range for HIV prevalence in Canada as a whole was 45,200-54,600.

3.2 HCV prevalence

3.2.1 Literature search

The literature yielded many studies about HCV prevalence among HIV-infected persons, especially among IDUs and MSM. A more limited amount of information was available for hemophilia patients and multiply transfused patients. Due to lack of good data, the other HIV-related exposure categories are subject to greater uncertainty. However, due to the smaller numbers involved and the lesser importance of HCV infection, this will have limited impact on the final result.

With respect to prisoners in particular, we obtained several useful articles. We identified only one study on HCV infection among Haitans.

One consistent finding across almost all studies was the substantially higher prevalence of HCV among HIV-infected persons compared to HIV-uninfected subjects.

3.2.1.1 HCV infection among HIV-infected men who have sex with men

Approximately 15 studies of HCV infection within this population were identified and analyzed. In addition, as previously noted, an analysis of data from a study of homosexual men in Vancouver was kindly provided by Kevin Craib of the British Columbia Centre for Excellence on HIV. The results are presented below and summarized in Table 2.

The results of the review as a whole provided relatively consistent estimates of HCV among HIV-infected MSM. A large study of 1,038 homosexual men carried out in Sydney, Australia in 1984-85 <*24*> observed an HCV prevalence of 12% among HIV-infected MSM and 4.0% among those uninfected by HIV.

A study by Wormser <*25*> in New York City examined 31 HIV-infected MSM, and found none infected with HCV. However, the sample size was limited; the upper confidence interval of the HCV prevalence was 11%.

A large study of 1,058 MSM in Pittsburgh, USA by Ndimbe <*26*> examined HIV and HCV prevalence in 1984-85. The prevalence of hepatitis C markers among the 207 HIV-infected MSM was 5.8% versus 2.2% among the 851 HIV-negative subjects.

A study by Francisci in Perugi, Italy of HIV-positive MSM patients from 1985 to 1992 <*27*> observed a prevalence of HCV of 6.7%.

Particularly relevant to the present project is a study carried out by Corona <*28*> in an STD clinic in Rome, Italy in 1989. He studied several different groups of patients at risk for HIV. Among the 195 MSM examined, 4 (2.1%) were infected with HCV. HCV prevalence was a function of age: none of the 99 men under age 35 were HCV-positive, compared to the 4 (4.2%) of 96 men 35 years of age or older. Corona eliminated from these analyses any MSM who had injected drugs. None of the 24 subjects who were HIV-positive were also HCV-positive.
Sonnerborg carried out a study of 107 MSM in Stockholm, Sweden in 1988-89 <*29*>. He found an HCV prevalence of 14% among 59 HIV-infected men and 0.0% HCV prevalence among 48 HIV-negative men.

A laboratory-based study by Anand and colleagues examined sera submitted for HIV testing at a provincial laboratory in Canada <*30*>. Overall, 8 (7.9%) of the 101 specimens received from MSM were HCV-positive. Five (9.3%) of the 54 HIV-positive men were also HCV-positive, compared to 3 (6.4%) of the 47 HIV-uninfected men. The difference observed was not statistically significant.

Finally, we reviewed the preliminary results of an important study by Craib among the original Vancouver Lymphadenopathy Study (VLAS) participants enrolled from 1982 to 1984 <*31*>. HIV and HCV test results were available for 662 of 729 recruited subjects. Overall, 5.9% or 39 of the 662 men were HCV-positive. However, HCV prevalence was substantially higher among HIV-infected men compared to HIV-negative men: 31 (8.8%) of 352 HIV-infected men were HCV-infected, compared to 8 (2.6%) of 310 HIV-negative men. The 3.6 fold difference was statistically significant ($p<0.001$). Interestingly, on further examination, Craib found that a small but significant number of subjects (41) in his study admitted to injecting drugs at some time during their lifetime. Stratifying HCV prevalence by lifetime history of drug injection yielded an estimate of HCV prevalence of 3.1% among those who had never injected drugs. HIV-stratfied results among MSM who had never injected drugs were 4.3% among the 322 HIV-positive men and 1.7% of the 299 seronegative men. In contrast, among MSM who *had* injected drugs during their lifetime, HCV prevalence was 49%, 57% among the 30 HIV-positive men and 27% among the 11 HIV-negative men.

In summary, the HCV prevalence among HIV-infected MSM appears relatively consistent and, for the studies examined, is in the range 3 to 14%. The HCV prevalence among non-IDU MSM observed by Craib among the VLAS participants was somewhat lower than the results from most other studies. This may have two possible explanations: HCV prevalence may be somewhat lower in Vancouver than in the other study populations examined such as in Spain and the United States where HCV prevalence is higher than in Canada. Second, it is possible that, in many of the other studies, some MSM included in the analysis had injected drugs. Given the high HCV prevalence associated with injection of drugs, this could well have upwardly biased their results. It should also be noted that HCV prevalence in British Columbia is somewhat higher than elsewhere in Canada. Thus, a reasonable mid-point for HCV prevalence among non-injecting HIV-infected MSM in Canada would be 5%, similar to that observed by Craib in his Vancouver study.

The results of the studies of HCV infection among HIV-infected MSM we reviewed are summarized in

Table 5.

3.2.1.2 HCV infection among HIV-infected injection drug users

A large number of studies of HCV prevalence among IDUs stratified on HIV prevalence were identified. We selected 14 for presentation in this review. The results were relatively consistent across different countries and over different periods and provide relatively convergent estimates for the final estimate of number of HCV-HIV co-infections. As with MSM, HCV prevalence among HIV-infected IDUs was higher than for HIV-negative IDUs in all studies reviewed.

A review by Crofts of studies carried out from 1970 to the 1990's in Australia <*32*> revealed a range in HCV prevalence of 18% to 94%. The majority of the 14 studies cited yielded estimates in the range of 50% to 70%. Nevertheless, these studies did not stratify on HIV infection; therefore HCV prevalence among IDUs who were HIV-infected would be substantially higher than the crude HCV prevalence observed. In fact, a study by the same author among 311 IDUs in Victoria, Australia recruited through social networks in 1990-91 <*33*> observed an HCV prevalence of 79% among 14 HIV-infected IDUs, compared to 68% of 297 HIV-uninfected IDUs. It should be noted, however, that the number of HIV-infected subjects was small.

A study of a similar order of magnitude was carried out by Rodriguez <*34*> among IDUs in Spain at a drug treatment unit in 1993-94. Rodriguez found that 92% of the 26 HIV-infected IDUs studied were HCV-positive compared to 86% of the 95 HIV-negative subjects.

A small early study by Wormser in New York City <*25*> among 58 IDUs recruited beginning in 1987 found a rate of 66% among 50 HIV-infected IDUs.

Coppola studied 137 IDUs in Sardinia, Italy in 1992-93 <*35*>. He observed an HCV prevalence of 91% among the 32 HIV-infected IDUs, but only 78% among the 105 HIV-uninfected IDUs. A somewhat larger study by Francisi <*27*> of IDUs, also in Italy, examined HCV serostatus among 351 HIV-infected IDUs from 1985 to 1992. In this study, 252 (72%) of HIV-infected subjects were HCV-infected.

Sonnerborg, in the same study cited above for MSM, examined 99 IDUs in Stockholm in 1988-89 <*29*>. The prevalence of HCV was 94% among the 52 HIV-positive subjects and 79% among the 47 HIV-negative subjects.

A large study among IDUs in Baltimore, Maryland, USA was carried out by Thio in 1988-89 <*36*>. She found that 98% of 559 HIV-positive IDUs studied were HCV-infected compared to 87% of 944 HIV-negative IDUs. Overall, the prevalence of HCV in this population was 91%.

Weinstock recently published a study among a large sample of HIV-infected patients in suburban New York City <*37*>. Sera were apparently collected from 1989 to 1995. This study which included 582 IDUs found that 474 (81%) were HCV-positive.

A seroepidemiologic study among IDUs was carried out in Cape Breton Island, Nova Scotia by Health Canada in collaboration with the local and provincial health departments <*38*>. Subjects were recruited from both the community and a local correctional facility. Among 92 IDUs tested, 43 (47%) were HCV-positive, and 5 (5.4%) were HIV-positive. The joint prevalence of HCV and HIV was not specifically presented.
A similar study, also conducted by Health Canada, was carried out in Prince Albert, Saskatchewan <*39*> with similar results. Of the 188 IDUs studied, 93 (49%) were HCV-positive and two (1.1%) were infected with HIV. The joint prevalence of HCV and HIV was not presented in this study either. However, in both of these studies, the number of HIV-infected IDUs was small and would have yielded only limited information about HCV prevalence among HIV-infected IDUs.

In summary, essentially all studies identified and reviewed for the purposes of the present study observed an extremely high rate of HCV infection among injection drug users, and an even higher rate among those who were HIV-infected. Rates ranged from approximately 50% to 98%, with most results in the 70% to 95% range.

The results of the studies reviewed on HCV infection among HIV-infected IDUs are summarized in Table 3.

3.2.1.3 HCV infection among HIV-infected MSM-IDU

Few of the studies reviewed stratified MSM into those who were and were not injection drug users. Nor, conversely, did many identified studies examine sexual orientation among IDUs. However, the study by Craib <*31*> did examine HCV prevalence among the HIV-positive men who had a history of injection drug use. It must be noted that the analysis was based on a question about having *ever* injected, although such behaviours may have been sporadic and remote. Nevertheless, Craib found that 20 (49%) of the 41 persons who had ever injected were HCV positive, compared to 3.2% of those who had not. In that study, HCV prevalence among the HIV-positive MSM who had injected was 57%.

3.2.1.4 HCV infection among HIV-infected persons from HIV-endemic countries

Only one study of HCV infection was identified among persons from HIV-endemic countries. Allain <*40*> examined the prevalence of antibodies to HIV, HTLV-1 and HCV in three populations of Haitians: symptomatic outpatients, surgical patients and pregnant women. Among a subset of patients tested for HCV, HIV rates were relatively high. HIV infection was found among 39% of symptomatic

outpatients, 6.1% of surgical patients and 4.0% of pregnant women. HCV prevalence was, however, relatively low: 1.5%, 0.9% and 0.4%, respectively. Somewhat surprisingly, no association of HCV antibody was observed with HIV or HTLV seropositivity in any of the three populations. Thus, the rate of HCV in this population was in the range of 0.5% to 1.0%, similar to that among Canadians as a whole.

3.2.1.5 HCV infection among HIV-infected persons infected by heterosexual contact

This group is difficult to define and estimates from studies carried out in populations outside Canada may have limited relevance for the present study. The group is also heterogeneous in the sense that the context in which one may become HIV-infected by this route differs greatly from population to population. Consequently, HCV prevalence in this group may also vary greatly. In particular, HCV prevalence may be much higher among sexual partners of IDUs; some of these sexual partners may have injected drugs and not reported this behaviour. In spite of these reservations, results from several studies identified in this review are worth noting.

Two seroepidemiologic studies undertaken by Health Canada of IDUs in Canada also examined the seroprevalence of markers among their sexual partners. Among the 80 sexual partners studied in Cape Breton Island *<38>*, only one subject was seropositive for HIV (prevalence 1.3%) and one was HCV-positive (prevalence 1.3%). The report did not indicate whether the HCV and HIV infections were in the same person. Nevertheless, an estimate of HCV prevalence among HIV-infected sexual partners could not be derived from this study given the limited number of HIV-infected partners (i.e. one). Similarly, in an outbreak investigation carried out in Prince Albert, Saskatchewan *<39>*, none (0.0%) of 48 sexual partners had serologic evidence of HIV infection, and 3 (6.3%) were HCV-positive. The same limitations apply to this study.

Several studies carried out outside Canada are of interest. Quaranta recruited 272 patients in a French multicentre study (called SEROCO) in 1988-91 *<41>*. Among the patients studied were 82 persons infected by HIV through heterosexual contact. Fifteen (18%) were HCV-positive, with 95% confidence limits of 11 and 28%.

Dorucci analysed data from a prospective cohort of HIV seroconverters from 16 centres in Italy *<42>*. Among the 416 HIV-positive subjects were 81 persons infected through heterosexual intercourse, mainly from HIV-infected IDU sexual partners. HCV prevalence in this group was 20% (16/81), with 95% confidence limits of 12% to 30%.

Ockenga recruited HIV-infected outpatients in Hannover, Germany in 1993-94 *<43>*. Of the 33 patients infected by heterosexual transmission, three (9.1%) were also infected with HCV; the 95% confidence limits were 1.9 to 24%.

The results of the studies of HCV infection among HIV-infected persons infected by heterosexual contact are summarized in Table 4.

3.2.1.6 HCV infection among HIV-infected hemophilia patients

It has long been widely recognized that the majority of hemophilia patients treated with factor concentrates (clotting factors prepared from plasma) became infected with Anon-A non-B hepatitis@ (as hepatitis C was referred to until the viral antigens were characterized and serologic tests became available in 1989). This conclusion was based on the clinical observation of acute symptoms and laboratory signs of hepatitis following the onset of treatment with factor concentrates before HIV screening of plasma donors and viral inactivation of concentrate were implemented.

Studies carried out since the HCV antibody test became available have supported the belief that most hemophilia patients treated before 1985 became HCV-infected. Weinstock examined 35 HIV-infected hemophilia patients in suburban New York City and observed an HCV prevalence of 90% <*37*>. Similarly, Ockenga studied HIV-infected hemophilia patients in Hannover, Germany and observed an HCV prevalence of 77% <*43*>.

A study carried out by Brenner examined HCV-HIV joint marker prevalence in patients treated at two outpatient clinics in Israel <*44*>. Among the hemophilia patients, about two-thirds had received non heat-treated factor concentrates and the rest only cryoprecipitate; 33 (67%) of the patients were HCV-positive. However, 9 (88%) of the 11 HIV-infected hemophilia patients were HCV-positive compared to 24 (63%) of the 38 HIV-negative patients.

The results of the reviewed studies of HCV infection among HIV-infected hemophilia patients are summarized in Table 5.

3.2.1.7 HCV infection among HIV-infected among blood transfusion recipients

Several studies have examined HCV prevalence among HIV-infected transfusion recipients. In the period 1988-91, Quaranta tested 16 HIV-infected clinic patients in France who had been transfused and found that five (31%) were also infected with HCV <*41*>. The confidence limits for this prevalence were 11% to 59%.

The study noted in Section 3.1.6 above by Brenner <*44*> in Israel also examined 63 multiply transfused patients. He found an HCV prevalence of 21%. None of these transfusion recipients was, however, HIV-positive.

3.2.1.8 HCV infection among HIV-infected prisoners

Several studies were identified which helped to shed light on the issue of HCV infection and HCV-HIV co-infection among prisoners.

Pallas <*45*> studied prisoners in Cantabria in northern Spain in the period 1991-94 and observed an overall HCV prevalence of 41% among the 675 subjects tested. 255 (38%) prisoners reported having had injected heroin. HCV prevalence among the non-IDUs was 13% and 85% among those who had injected heroin. The prevalence of HCV infection was a function of duration of use: 70% among those who had injected heroin for five or fewer years, and 91% among prisoners who had injected for more than five years.

In a second related study conducted apparently in the same two institutions limited to prisoners who had injected drugs within the previous 12 months <*46*>, HCV prevalence was 94% among HIV-infected IDUs and 90% among HIV-uninfected IDUs.

A study of female inmates by Ford et al <*47*> in Kingston Ontario shed some light on the problem of HCV infection among prisoners in Canada. The study achieved a high participation rate. Of the 113 women examined, 45 (40%) were HCV-positive, and one (0.9%) was HIV-positive. No information on risk behaviours was available. However, it is very likely that the vast majority of HCV infections observed were in women who had injected drugs. With only one HIV-infected subject, this study cannot provide useful information specifically on HCV prevalence among HIV-infected prisoners.

A seroepidemiologic study among 415 male residents in federal correctional institutions in British Columbia was carried out in 1990 <*48*>. Of those tested, 106 (26%) were confirmed positive for HCV. No testing for HIV was done in the context of this study.

3.2.2 Consultation on HCV prevalence in Canada

Table 6 shows the best estimates and plausible ranges for the prevalence of HCV in 1999 among HIV-infected persons established by consensus during the teleconference described above.

With respect to the interprovincial weighting, we decided that the transfusion-related HCV cases should be subject to the same variation as the estimates derived from the HCV Working Group report of June 1998 <*49*>. We decided, however, that those infected by clotting factors should not be subject to interprovincial variation since the same products were distributed from a central source to all provinces. Likewise for persons from HIV-endemic countries, we did not vary the HCV prevalence among HIV-infected persons by region. For MSM, the key informants were of the opinion that a reasonable span of HCV prevalence would be 0.80 to 1.20, from the lowest to the highest HCV prevalence. For MSM, MSM-IDU, and persons infected through heterosexual contact, we decided the span should be 0.88 to 1.12 of that of the national estimated HCV prevalence.

Table 7 presents the HCV prevalence estimates among HIV-infected persons by exposure category and geographic region as used in the analysis. As seen in this table, the highest HCV prevalences are among injection drug users and persons who received clotting factors. Men who have sex with men who are also injection drug users are similar to heterosexual injection drug users. We believed that HCV prevalence among MSM should be only slightly higher than background HCV prevalence.

3.3 HCV-HIV co-infection in Canada, as of December 1999

3.3.1 HCV-HIV co-infection by exposure category and geographic region

The final results of the analysis indicating the estimated number of HCV-HIV co-infected persons in Canada are shown in Tables 8a and 8b. This was derived by multiplying the number of HIV-infected persons by the HCV prevalence among HIV-infected persons as presented in Table 7. As shown in Table 8a, we estimated that 11,194 persons were infected with both HCV and HIV in Canada as of December 1999. Of these, the vast majority (85%) were injection drug users, including those with and without same sex exposure. The 95% confidence limits for the estimates by exposure category and region are also shown in Table 8a; for the total number of HCV-HIV infections, they were 9,400 and 13,300.

Table 8b shows the distribution of HCV-HIV infected persons by geographic region. The vast majority (88%) of dually infected persons in Canada live in Quebec (34%), British Columbia (29%) or Ontario (25%).

3.3.2 HCV-HIV co-infection in the Aboriginal population

Estimating the extent of HIV infection among the Aboriginal population is somewhat challenging. To the best of our knowledge, no population-based studies of HIV prevalence among Aboriginals have been carried out in Canada. The problem of HIV infection in this population appears largely related to injection drug use though it may also be related to some extent to heterosexual transmission.

Overall, according to the Vancouver Injection Drug Use Study (VIDUS), approximately 20% of injection drug users in Vancouver are Aboriginal. There is probably an over-representation of Aboriginal persons, especially men, among IDUs in Vancouver and other major cities of western Canada, though less in Toronto and Montreal. If, overall, the Aboriginal population represents about 10% of the injection drug using population in Canada, a reasonable estimate of the number of Aboriginal injection drug users would be 8,000. Since the Aboriginal population of Canada is estimated at 800,000, this means that approximately 1% of this population are injection drug users, a plausible proportion. If HIV prevalence among Aboriginal injection drug users were estimated to be approximately 15%, the number of HIV-infected IDUs of Aboriginal ethnicity in Canada would be approximately 1,200.

Tables 9 through 11 summarize the results of the estimates of dual HCV-HIV infection for the Aboriginal population. Table 9 presents the results of the review of published studies among IDUs and MSM, including persons of Aboriginal status, indicating observed and HIV and HCV prevalences <*6-9*>. Table 10 shows the number of HIV-infected Aboriginal persons by exposure category; these estimates were provided by Health Canada as noted above.

The final results of the analysis on HCV-HIV co-infection among Aboriginal persons, as of December 1999 are shown in Tables 11a and 11b. In all, we estimate that there are 1,477 persons with HCV-HIV dual infection among the Aboriginal population, with a 95% plausible range of 1,030 to 2090. Of the 1,477 co-infected Aboriginal persons, 87% are among heterosexual injection drug users, and approximately 10% are among men who both inject and have sex with other men. These two groups together account for 97% of co-infected persons in this population. As shown in Table 11b, the largest number of dually infected Aboriginal persons resides in British Columbia, representing alone 56% of such persons in Canada.

3.3.3 HCV-HIV co-infection among prisoners

We estimated the number of HIV-infected persons in prisons in a preliminary fashion. The majority of incarcerated persons co-infected with HIV and HCV almost certainly acquired their infections through injection drug use.

According to Correctional Service Canada, the population incarcerated in federal institutions as of 1996 was approximately 13,800. Of these, approximately 30% had ever injected drugs, and 10% had injected drugs within the year previous to their incarceration. Overall, based on estimates carried out in the Consortium to characterize injection drug use in Canada (CCIC) study <50> and HIV prevalence studies, we estimate that the federal prison population infected with HIV is likely to be approximately 410 persons. This estimate was derived by multiplying 13,800 by 30% (number of IDUs) and by 10%, (the estimated HIV prevalence among injection drug users). Correctional Service Canada reports that 196 prisoners in federal institutions were known to be HIV-infected as of December 1999 *<51>*. The observation that only about 50% of HIV-infected prisoners would be known to prison authorities is plausible since not all HIV-infected persons have been diagnosed and some persons who have been diagnosed would not divulge this information to prison authorities.

The detailed analysis of HCV prevalence among prisoners in both federal and provincial institutions is presented in Tables 12 through 14. Table 12 presents the results of a review of risk factors for HIV and HCV infection and HIV and HCV infection rates summarized from published studies *<12-23, 52-4>*. The proportion of prisoners with a history of drug injection varied from 12% to 52%. Past history of injection drug use was consistently higher in female prisoners than in male prisoners. A history of injection was 50% higher in the two studies where both sexes were examined. Nevertheless, women represent a minority of prisoners in most provinces, generally in the range of 5% to 15% of prison populations.

The observed prevalence of HIV among IDU prisoners varied widely, from 1% to 15%. HIV prevalence was generally higher in women. Among non-IDUs, HIV prevalence was markedly lower, and with few exceptions, 1% or lower. The crude HIV prevalence in men or mixed populations observed in nine studies carried out in Ontario, Quebec and British Columbia from 1989 to 1998 varied from 1% to 4%.

Table 13 presents the number of prisoners by province and the proportion estimated in each exposure category by province.

Tables 14a and 14b presents the results of our analysis of dual HCV-HIV infection among prisoners. As seen in Table 14a, we estimate that, among the persons incarcerated as of December 1999, 611 persons incarcerated in Canadian prisons were co-infected with HCV and HIV. Of these, 88% were injection drug users, and 11% were male injection drug users who also had sex with other men. Together, these account for 99% of co-infections among prisoners. The 95% plausible limits for the number of co-infected prisoners were 420 to 870 persons.

As seen in Table 14b, the largest number of HCV-HIV co-infections were (in descending order) in Ontario, Quebec and British Columbia, accounting for 28%, 23% and 22%, respectively, for a combined total of 72% of co-infected prisoners in Canada.

4. DISCUSSION

The purpose of the first phase of the study was to determine the number and distribution of persons infected with HIV infection in Canada, and to establish a functional foundation for the estimate of HCV-HIV co-infection. The number of HIV-infected persons in 1999 so derived represents an increase of 24% over that estimated for three years earlier. The increase is significant from a public health perspective and is related in part to the fact that HIV incidence did not appear to decrease during this period. Among IDUs, HIV incidence remains substantial due in part to the explosive spread of HIV in Vancouver and Ottawa and the continuing high rate of transmission in Montreal. In addition, HIV incidence among MSM may be increasing, especially in Toronto. In combination with the stable or increasing HIV incidence rate, the decrease in mortality rates associated with the advent of highly active antiretroviral therapy (HAART) in 1995-96 has also been a factor in the rise of HIV prevalence over this three-year period.

To establish a plausible range of HCV infection rates among HIV-infected persons in the seven major exposure categories (namely MSM, MSM-IDU, IDU, persons from HIV-endemic countries, other persons infected by heterosexual contact, patients with hemophilia, and transfusion recipients), we reviewed studies from many industrialized countries. The results of these studies cannot be applied to the present study for Canada without taking into account several important factors:

(1) The subjects in most of these studies were not recruited using random selection from the population as a whole. Biases may have been introduced in this regard, and must be considered in the interpretation of the results.

(2) Several of the studies reviewed (especially those carried out in the early 1990s) did not use a second, confirmatory test when measuring HCV prevalence. Though the confirmation rate is

generally high in serologic testing, it is not 100%. Therefore, I have selected, where possible, only studies where confirmed results were presented.

(3) As noted above, of the studies reviewed on MSM, only one specifically indicated that IDUs had been excluded from the analysis. The results of that study yielded an HCV prevalence lower than almost all of the studies reviewed. No specific mention of injection drug use is made in most of these reports. It is possible that, at least for some, a proportion of subjects also injected drugs. Given the extremely high rate of HCV infection related to injection drug use, the inclusion of even a few persons who *had* injected drugs could have inflated the observed prevalence.

(4) Finally, HCV prevalence varies to a great extent from country to country and from region to region. This reality must be taken into consideration in the application of the results of the review in the final model. The results must be modulated in the context of observations made in Canadian populations, even where joint HCV-HIV prevalence have not been available.

There are several limitations to the modeling techniques used here to estimate HIV prevalence and HCV-HIV co-infection. As for any study of this kind, we were limited by the sparseness of data for some populations. The use of key informants is a reasonable approach in the face of limited data but the results so derived must be considered only an approximation. The results of the analysis of HIV prevalence and HCV-HIV co-infection among Aboriginal populations and prisoners must also be interpreted with caution. Nevertheless, the Monte-Carlo simulations allow for the determination of a plausible range of estimates which incorporate the uncertainties in the values of the input parameters and, in some ways, is more valid than the point estimates.

With respect to the Aboriginal population specifically, using the proportion of AIDS cases to determine the overall number of HIV-infected persons would be misleading, since the HIV epidemic began later in this population. An initial estimate of 1,245 using this approach almost certainly underestimates the true number. Obtaining the estimate based on the proportion of the AIDS cases which occurred in more recent years presents the difficulty of not being able to adjust for biases due to the differential uptake of antiretroviral therapy. In 1999, the most recent year for which data was available, AIDS cases in the Aboriginal population represented 15% of AIDS cases overall.

The method actually used also took into account the number of HIV infections diagnosed among the Aboriginal population and produced a more plausible estimate of 2,740. Nevertheless, it must be noted that the estimate of HCV-HIV co-infected persons among the Aboriginal is subject to considerable uncertainty.

With respect to prisoners incarcerated in federal and provincial prisons, we estimate that, as of December 1999, 867 persons, or 2.6% of the prison population, were infected with HIV. In December 1999, 196 HIV-infected prisoners were known to federal prison authorities, which represents a prevalence of 1.4%. Extrapolating the same proportion of persons incarcerated in the provincial prison system would yield a total number of 470 or about 54% of our estimated number.

However, it is not surprising that only 50% of HIV infections among prisoners would be known to prison authorities. Overall, in Canada, about 30% of infections are not diagnosed <*55*>, and there are likely additional reasons for resistance to HIV testing and to sharing information about HIV-positive serostatus in the prison setting.

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Table 1 Estimated HIV prevalence by exposure category
Canada, December 1999

	MSM	MSM-IDU	IDU	Hetero/ endemic	Other	Total
	29,600	2,100	9,700	8,000	400	49,800
	59.4%	4.2%	19.5%	16.1%	0.8%	100.0%
95% lower limit	26,000	1,600	7,900	6,100	330	45,200
95% upper limit	33,600	2,600	11,700	10,100	520	54,600

Source Bureau of HIV/AIDS, STD, and TB
Centre for Infectious Disease Prevention and Control
Health Canada

Table 2 Prevalence of HCV infection among HIV-infected men who have sex with men recruited in different settings and locations

Author	*Ref*	*Location*	*Year*	*Setting*	*n*	*HCV positive*	*95% CI**
Bodsworth	24	Sydney Australia	1984-85	TD clinic	478	12%	9.2-15%
Wormser	25	New York City USA	1987+	Medical service	31	0.0%	0.0-11%
Ndimbe	26	Pittsburg USA	1984-85	MACS cohort study	207	5.8%	3.0-9.9%
Francisi	27	Italy	1985-92	Infect disease clinic	30	6.7%	0.8-22%
Corona	28	Rome	1989	STD clinic	195	2.1%	0.6-5.2%
Sonnerborg	29	Stockholm Sweden	1988-89	Infect disease clinic	59	14%	6.0-25%
Anand	30	Alberta Canada	1988-89	HIV laboratory	54	9.3%	3.1-20%
Craib	31	Vancouver Canada	1982-84	General practice	322	4.3%	2.4-7.2%
Weinstock	37	New York City USA	1989-93	Hospital patients	575	14%	11-17%
Quaranta	41	France	1988-91	Clinic patients	68	2.9%	0.4-10%
Dorucci	42	Italy	NA**	Cohort study	121	12%	6.5-19%
Ockenga	43	Hannover Germany	1993-94	Outpatient clinic	122	4.9%	1.8-10%

* CI = confidence interval
** NA = not available

Table 3 Prevalence of HCV infection among HIV-infected injection drug users recruited in different settings and locations

Author	*Ref*	*Location*	*Year*	*Setting*	*n*	*positive*	*95% CI**
Crofts	32	Australia	1970+	Review article			18-94%
Crofts	33	Victoria Australia	1990-91	Social networks	14	79%	49-95%
Rodriguez	34	Gran Canaria Spain	1993-94	Drug treatment unit	26	92%	75-99%
Wormser	25	New York City	1987+	Medical service	58	65%	50-78%
Coppola	35	Sardinia, Italy	1992-93	Drug treatment unit	32	91%	75-95%
Francisi	27	Italy	1985-92	Infect disease clinic	351	72%	67-76%
Sonnerborg	29	Stockholm Sweden	1988-89	Infect disease clinic	52	94%	84-99%
Thio	36	Baltimore, USA	1988-89	Cohort study	559	98%	96-99%
Weinstock	37	New York City USA	1989-93	Hospital patients	582	81%	78-85%
Quaranta	41	France	1988-91	Special study	97	78%	69-86%
Dorucci	42	Italy	NA**	Cohort study	207	88%	83-92%
Ockenga	43	Hannover Germany	1993-94	Outpatient clinic	64	64%	51-76%
Thomas	-	Baltimore, USA	1988-89	Special study	405	93%	90-96%

* CI = confidence interval
** NA = not available

Table 4 Prevalence of HCV infection among persons HIV-infected by heterosexual contact recruited in different settings and locations

Author	*Ref*	*Location*	*Year*	*Setting*	*n*	*HCV positive*	
Quaranta	41	France	1988-91	Special study	82	18%	11-28%
Dorucci	42	Italy	NA**	Cohort study	81	20%	12-30%
Ockenga	43	Hannover Germany	1993-94	Outpatient clinic	33	9.1%	1.9-24%

* CI = confidence interval
** NA = not available

Table 5 Prevalence of HCV infection among HIV-infected hemophilia patients recruited in different settings and locations

Author	*Ref*	*Location*	*Year*	*Setting*	*n*	*HCV positive*	*95% CI**
Weinstock	37	New York City USA	1989-93	Hospital patients	35	90%	76-97%
Ockenga	43	Hannover Germany	1993-94	Outpatient clinic	13	77%	46-95%
Brenner	44	Israel	1991-92	Clinic patients	11	82%	48-98%

* CI = confidence interval

Table 6 Estimates of HCV prevalence among HIV-infected persons by exposure category established by key informants

	Best Estimate	Plausible lower limit	Plausible upper limit	Degree of weighting
Men who have sex with men	4.0%	2.0%	7.0%	0.80-1.25
Injection drug users	82%	70%	95%	0.88-1.12
Men who have sex with men who also injected drugs	80%	65%	98%	0.88-1.12
Persons born in HIV-endemic countries	1.5%	1.0%	2.3%	None
Other persons infected by hetero contact	3.0%	1.0%	6.0%	0.80-1.25
Persons infected by blood transfusion	10%	7.0%	14%	See donors
Persons infected by clotting factors	90%	86%	98%	None

Table 7 Estimate of HCV prevalence among HIV-infected persons by exposure category and geographic region, Canada, December 1999

	MSM	MSM-IDU	IDU	Endemic	Other hetero	Clotting factors	Transfus
Ontario	4.2%	82.0%	83.0%	1.5%	3.2%	90.0%	11.2%
Quebec	3.5%	73.0%	75.0%	1.5%	2.6%	90.0%	5.8%
British Columbia	4.8%	88.0%	92.0%	1.5%	3.6%	90.0%	16.2%
Alberta	4.2%	82.0%	83.0%	1.5%	3.1%	90.0%	10.8%
Prairies	3.5%	73.0%	75.0%	1.5%	2.6%	90.0%	5.8%
Atlantic	3.2%	70.0%	72.0%	1.5%	2.4%	90.0%	4.2%
Yukon / NWT	4.5%	85.0%	87.0%	1.5%	3.6%	90.0%	14.3%
Canada	4.0%	79.9%	82.4%	1.5%	3.0%	90.0%	10.0%

Table 8a Estimate of HCV-HIV-infected persons by exposure category Canada, December 1999

	MSM	MSM-IDU	IDU	Endemic	Other hetero	Clotting factors	Transfus	Total
Number	1,193	1,648	7,921	63	118	237	15	11,194
Proportion (%)	10.7%	14.7%	70.8%	0.6%	1.1%	2.1%	0.1%	100.0%
95% lower limit	760	1,200	6,300	41	56	190	11	9,400
95% upper limit	1,800	2,200	9,900	88	220	300	21	13,300

Table 8b Estimate of HCV-HIV-infected persons by geographic region Canada, December 1999

	Ontario	Quebec	British Columbia	Alberta	Prairies	Atlantic	Yukon/ NWT	Canada
Number	2,773	3,800	3,196	759	365	191	110	11,194
Proportion (%)	24.8%	33.9%	28.6%	6.8%	3.3%	1.7%	1.0%	100.0%
95% lower limit	2,300	3,200	2,600	640	310	160	91	9,400
95% upper limit	3,300	4,500	3,800	900	430	230	130	13,300

Table 9 Proportion of study population with Aboriginal status and prevalence of HIV and HCV infection among Aboriginal population, selected published studies

Author Ref. no.	Region Setting Study year Sample size	Gender	Proportion Aboriginal	HIV prevalence			HCV prevalence
				Aboriginal	Non-Aboriginal	Total	
Strathdee 7	Vancouver VIDUS (IDU) 1996-97 n = 1,006	Women and men	27.0% (272 / 1,006)	29.4% (80 / 272)	20.8% (153 / 734)	23.2% (233 / 1,006)	88.0% (440 / 500)
Heath 8	Vancouver Vanguard (MSM) 1996-98 n = 681	Women and men	8.4% (57 / 681)	3.5% (2 / 57)	1.4% (9 / 624)	1.6% (11 / 681)	

Table 10 Number of HIV-infected Aboriginal persons by exposure category Canada, 1999

	MSM	MSM-IDU	IDU	Hetero	Other	Total
	620	170	1,500	420	30	2,740
Proportion (%)	22.6%	6.2%	54.7%	15.3%	1.1%	100.0%

Source Bureau of HIV/AIDS, STD, and TB
Centre for Infectious Disease Prevention and Control
Health Canada

Table 11a HCV-HIV infections among the Aboriginal population by exposure category, Canada, 1999

	MSM	MSM-IDU	IDU	hetero	Other factors	Clotting Transfusion	Total
Number	26	145	1,284	13	6	3	1,477
Proportion	1.8%	9.8%	86.9%	0.9%	0.4%	0.2%	100%
95% lower limit	19	68	873	5	3	1	1,027
95% upper limit	35	287	1,836	28	12	5	2,094

Table 11b HCV-HIV infections among the Aboriginal population by geographic region, Canada, 1999

	Total	Proportion	95% lower limit	95% upper limit
Ontario	101	7%	49	142
Quebec	96	6%	66	136
British Columbia	820	56%	571	1,162
Alberta	196	13%	137	278
Prairies	213	14%	149	302
Atlantic	6	0%	4	8
Territories	45	3%	31	64
Canada	1,477	100%	1,027	2,094

Table 12 History of drug injection and prevalence of HIV and HCV infection among injection drug users incarcerated in Canadian federal or provincial prisons, selected published studies

Author Ref. no.	Region Setting Study year Sample size	Gender	History drug injection	HIV prevalence			HCV prevalence		
				IDU	Non-IDU	Total	IDU	Non-IDU	Total
Calzavara 12	Ontario 42 prov. prisons 1993 n = 14,284	Men	13.1% (1,316 / 10,047)	3.6% (43 / 1,184)	0.6% (45 / 7,640)	1.0% (88 / 8,824)	---	---	---
		Women	20.7% (309 / 1,492)	4.2% (11 / 262)	0.5% (5 / 1,024)	1.2% (16 / 1,286)	---	---	---
		Total	14.1% (1,625 / 11,539)	3.7% (54 / 1,446)	0.6% (50 / 8,664)	1.0% (104 / 10,110)	---	---	---
Dufour 13	Quebec City Quebec Detention Centre 1994 n = 651	Men	26.2% (129 / 492)	8.5% (11 / 129)	0.0% (0 / 363)	2.2% (11 / 492)	---	---	---
		Women	37.8% (45 / 119)	15.6% (7 / 45)	2.7% (2 / 74)	7.6% (9 / 119)	---	---	---
		Total	28.5% (174 / 611)	10.3% (18 / 174)	0.5% (2 / 437)	3.3% (20 / 611)	---	---	---
Ford 14	Kingston Federal prison 1994 n = 592	Men	12.0% (71 / 592)	1.0% (4 / 408)			27.2% (111 / 408)		

Table 12, continued

Author Ref. no.	Region Setting Study year Sample size	Gender	History drug injection	HIV prevalence			HCV prevalence		
				IDU	Non-IDU	Total	IDU	Non-IDU	Total
Ford 15	Kingston Federal prison 1994 n = 133	Women	Not given	0.9% (1 / 113)			39.8% (45 / 113)		
Ford 17	Kingston Federal prison 1998 n = 520	Men	37.4% (131 / 350)	3.8% (5 / 131)	0.5% (1 / 219)	1.7% (6 / 350)	73.3% (96 / 131)	9.6% (21 / 219)	33.4% (117 / 350)
Hankins 19	Quebec Federal prison Year unknown n = 248	Women	52.4% (130 / 248)	14.6% (19 / 130)	0.0% (0 / 118)	7.7% (19 / 248)	---	---	---
Hankins 20	Quebec 2 prov. prisons 1990 n = 588	Men	48.4% (237 / 490)	7.6% (18 / 237)	0.4% (1 / 253)	3.9% (19 / 490)	---	---	---

Table 12, continued

Author Ref. no.	Region Setting Study year Sample size	Gender	History drug injection	HIV prevalence			HCV prevalence		
				IDU	Non-IDU	Total	IDU	Non-IDU	Total
Hankins 21	Quebec Federal prison Year unknown n = 1,638	Women	48.7% (192 / 394)	13.0% (25 / 192)	1.0% (2 / 202)	6.9% (27 / 394)	---	---	---
Prefontaine 22	British Columbia Federal prisons Year unknown n = 415	Men	Not given	---			25.5% (106 / 415)		
Rothon 23	British Columbia Prov. prisons 1992 n = 2,719	Women and men	32.6% (964 / 2,953)	2.4% (18 / 744)	0.6% (10 / 1,735)	1.1% (28 / 2,479)	---	---	---

Table 13 Incarcerated population at risk for HIV, proportions, populations and numbers geographic region, Canada, 1999

	Population			Proportion at HIV risk	MSM	MSM-IDU	IDU	Endemic	Other hetero	Clotting factors	Transfusion
	Fed.	Prov.	Total		0.03	0.01	0.3	0.05	0.05	0.001	0.03
Ontario	3,554	7,778	11,332		340	113	3,400	567	567	11	340
Quebec	3,732	3,302	7,034		211	70	2,110	352	352	7	211
BC	1,902	2,517	4,419		133	44	1,326	221	221	4	133
Alberta	1,600	1,957	3,557		107	36	1,067	178	178	4	107
Manitoba	750	908	1,658		50	17	497	83	83	2	50
Saskatchewan	950	1,177	2,127		64	21	638	106	106	2	64
Atlantic	1,284	1,176	2,460		74	25	738	123	123	2	74
Yukon		79	79		2	1	24	4	4	0	2
NWT		351	351		11	4	105	18	18	0	11
Canada	13,772	19,245	33,017		991	330	9,905	1,651	1,651	33	991

Numbers of federal prisoners in Prairies are estimated by interpolation

Table 14a HCV-HIV infections among prisoners by exposure category Canada, 1999

	MSM	MSM-IDU	IDU	Endemic	Other hetero	Clotting factors	Transfus	Total
Number	4	65	536	0	0	5	0	611
Proportion (%)	0.6%	10.7%	87.7%	0.0%	0.0%	0.9%	0.0%	100.0%
95% lower limit	2	44	365	0.1	0.1	4	0	420
95% upper limit	7	93	766	0.4	0.2	7	0	870

Table 14b HCV-HIV infections among prisoners by geographic region, Canada, 1999

	Ontario	Quebec	British Columbia	Alberta	Manitoba	Sask	Atlantic	Yukon	NWT	Canada
Number	168	141	133	79	22	28	32	2	5	611
Proportion (%)	27.5%	23.2%	21.8%	13.0%	3.6%	4.7%	5.2%	0.3%	0.9%	100.0%
95% lower limit	115	96	91	54	15	19	22	1	4	420
95% upper limit	239	202	190	113	32	41	45	3	8	870