REPORT ON THE HIV/AIDS EPIDEMIC IN ONTARIO

1981 to 1996

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FOREWORD

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This report was made possible by funding from the AIDS Bureau of the Ministry of Health which allowed researchers at the University of Toronto (Dr. Robert Remis, Marian Vermeulen) to dedicate their time to a review of the HIV/AIDS epidemic in Ontario.

It is our intention to produce an updated report every year. The report is being disseminated to public health units, community groups involved in HIV prevention and in the care of those affected by HIV/AIDS and to HIV researchers. We hope it will serve as an important resource for these groups, as well as for others, including the media, students, persons in other provinces and countries, etc. As this is the first version, we would appreciate your critical comments and suggestions for future reports.

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EXECUTIVE SUMMARY

This report characterizes the HIV/AIDS epidemic in Ontario from 1981 to 1996. The report presents data on diagnosed HIV infection, AIDS incidence, AIDS-associated mortality, as well as providing estimates of HIV infection in Ontario obtained and through statistical modelling. Using a number of sources and methodologic approaches, we assess the impact of HIV/AIDS on the Ontario population.

Data from several sources were used in the analyses, including HIV serodiagnostic results from the HIV Laboratory, Central Public Health Laboratory (CPHL) of the Ontario Ministry of Health, 1985 to 1996; AIDS case reports from the Public Health Branch, Ontario Ministry of Health, 1981 to 1996; AIDS mortality data from the Vital Statistics database, Ontario Registrar-General, 1987 to 1996; and cases included in the Ontario HIV Pediatric Network, 1984 to 1997. Data from each of the above sources, as well as from seroepidemiologic studies, were also used to model the prevalence and incidence of HIV infection.

We analyzed first-time HIV diagnoses and AIDS cases according to sex, age at diagnosis, source of exposure, health region and year of diagnosis. Analysis of AIDS mortality data included sex, age at death, health region and year of death. In addition, the distribution of deaths according to country of birth (HIV-endemic and non-HIV-endemic) was calculated. The number and proportion of children born to HIV-infected mothers was analyzed according year of birth, clinical status of the infant, source of exposure of the mother and city in which the infant was diagnosed. Statistical modelling included estimation of the incidence, cumulative incidence and prevalence of HIV infection and AIDS from 1980 to 1996. Annual and cumulative deaths due to AIDS were also estimated for the same time period.

In all, 17,491 persons in Ontario have been diagnosed with HIV infection and 6,069 persons have been reported with AIDS to December 31, 1996. According to our statistical model, 21,600 persons have been infected with HIV and approximately 15,800 persons are currently living with HIV infection in Ontario. Within Canada, Ontario has the most AIDS cases (40%) of any province and the third highest cumulative incidence rate (59.8 per 100,000). From 1987 to 1996, 4,634 persons were known to have died of AIDS in Ontario. Correcting for incomplete ascertainment of deaths and including those persons who died before 1987, we estimate that approximately 6,000 persons have died from AIDS in Ontario since the beginning of the epidemic.

Women comprise a growing proportion of persons affected by the HIV/AIDS epidemic in Ontario. Among first-time HIV diagnoses, the proportion of women rose from 1.8% in 1985 to 18% in 1996. The proportion of AIDS cases diagnosed among women has also increased: among cases diagnosed in 1986 or earlier, women comprised 1.6% compared to 9.0% of cases in 1996. The number of AIDS cases peaked in 1992 for men, while the number of cases in women continued to grow until 1995.

We observed several notable trends in the distribution of HIV diagnoses and AIDS cases according to exposure category. Although men who have sex with men (MSM) continued to be the group most affected by the epidemic to date, the proportion of first-time HIV diagnoses and reported AIDS cases associated with MSM has declined. While MSM comprised 75% of AIDS cases during the period 1981-96, only 62% of cases diagnosed in 1996 were among MSM.

Similarly, 56% of first-time HIV diagnoses were among MSM in 1996, compared to 75% in 1985-96.

HIV diagnoses and AIDS cases increased among those reporting injection drug use (IDU), HIV-endemic country of origin and heterosexual contact.

Approximately 9% of reported AIDS cases diagnosed in 1996 were among persons born in an HIV-endemic country, compared with 2.8% during 1981-96. Similarly, 12% of AIDS cases in 1996 were in persons reporting heterosexual contact (compared to 7.2% in 1981-96) and 5.9% were among IDU (compared to 3.3% in 1981-96).

A substantial proportion of HIV infections diagnosed in 1985-96 were among persons reporting IDU, particularly in the Northern (25%), Eastern other (21%) and Ottawa-Carleton (19%) regions. HIV-positivity rates in IDU were especially high in the Northern (3.3%) and Ottawa-Carleton (2.6%) regions in 1996. In the Ottawa-Carleton region, HIV-positivity rates among female IDU were particularly high (3.0% in 1996). This corresponds to recent findings of a study conducted in the Ottawa-Carleton region, which suggest that HIV prevalence among IDU was 19.2% in 1997 (Leonard, 1997).

Infection among persons from HIV-endemic regions, including Africa and the Caribbean, have become an important component of the HIV epidemic in Ontario in recent years, particularly in the Ottawa-Carleton and Metro Toronto regions. Almost 10% of AIDS cases diagnosed in 1996 were among persons born in these countries, compared to less than 3% of AIDS cases diagnosed previously. According to our statistical model, approximately 1,500 to 2,000 Ontario residents from HIV-endemic countries are HIV-infected, comprising 10% of the persons living with HIV in the province and approximately 200 new HIV infections occur each year. Persons born in HIV-endemic countries constituted a growing proportion of AIDS deaths in the period 1987-96. This was particularly evident among women born in HIV-endemic countries, who represented 32% of AIDS deaths in women in 1996. This population also had a substantially higher AIDS-associated mortality rate than the Ontario population as a whole (14.0 compared to 4.2 per 100,000 in 1996). In addition, a significant proportion of maternal-infant transmission of HIV infection has occurred among persons from HIV-endemic countries (70% in 1994-97).

Further data is required to better understand the growing number of first-time HIV diagnoses and AIDS cases related to heterosexual transmission. Little is known about the risk factors for HIV propagation among partners of such cases. For example, it is uncertain whether HIV infection is being spread significantly through heterosexual contact with the growing number of HIV-infected IDUs.

Trends in perinatal transmission of HIV infection are not well reflected by HIV serodiagnostic and AIDS incidence data. Nevertheless, an increasing number of infants born to HIV-infected mothers have been ascertained through the HIV Pediatric Network in Ontario. Since 1984, 233 HIV-infected mothers and 102 HIV-infected infants were identified. In recent years, most of the identified HIV-infected infants have been born to mothers from HIV-endemic countries (70% in 1994-97). Estimates based on statistical modelling indicate that approximately 142 infants were infected through mother-infant transmission from 1984 to 1997. In 1997 alone, an estimated 93 HIV-infected women gave birth to 19 HIV-infected infants.

We found little evidence of trends in age at diagnosis according to exposure category. Although analyses conducted by Health Canada using national data have found a relative shift of HIV infection to younger MSM, the complexity of factors which influence age at diagnosis make it difficult to determine whether the incidence of HIV and AIDS is increasing among young MSM in Ontario.

A significant decrease in the number of AIDS-associated deaths was observed in 1996. This is most likely due to important advances in the treatment of HIV infection, including combination therapy and viral load determination. Mortality declined overall by 31% from 1995 to 1996; for men it declined by 32% and for women, 22%. The decrease in AIDS-associated mortality varied according to region, with generally greater decreases in regions with higher mortality rates in 1995 (Metro Toronto, Ottawa-Carleton and Southwest) and more modest decreases in regions with lower mortality rates in 1995 (Eastern other, Northern and Central West). The only exception to this pattern was the Central East other region, which had a relatively low mortality rate in 1995 and declined substantially in 1996. Mortality in the three regions with a higher mortality rate in 1995 examined together decreased by 38% in 1996. The mortality rate declined by only 7.1% in the three other regions with a lower mortality rate in 1995. In the Central East other region, the mortality rate decreased by 27% from 1995 to 1996.

In summary, our review has shown that, although the number of AIDS cases and new HIV diagnoses in Ontario are beginning to decline, new and important patterns of transmission are emerging, particularly among injection drug users and persons born in HIV-endemic countries. This is especially evident in certain sub-groups and regions of the province, such as IDU in Ottawa-Carleton and the Northern health regions. Although there are encouraging trends concerning HIV infection among MSM, there remains a large number of HIV-infected persons in this population and available evidence suggests that HIV transmission continues to occur.

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1. INTRODUCTION

This report summarizes the HIV/AIDS epidemic in Ontario as of December 1996 using several indicators. It includes data on HIV serodiagnoses from Ontario's voluntary HIV testing system, AIDS incidence data obtained through the Ontario AIDS case reporting system, AIDS mortality data from the Vital Statistics Division and data on mother-infant HIV infection from the Ontario HIV Pediatric Network. Finally, estimates of HIV infection in Ontario based on statistical modelling are presented.

Surveillance of HIV/AIDS must respond to changes in the clinical course and survival of HIV-infected persons brought about by new therapies. Efforts to monitor the spread of HIV through existing sources, particularly AIDS surveillance and mortality, may become more challenging as rates of progression to AIDS slow and survival improves in response to advances in medical treatment (CDC, 1997; CDC, 1996). Therefore, we have included HIV serodiagnostic data in this report and hope to include additional HIV epidemiologic data collected by public health units in future reports. Data on reported cases of HIV are not available at the Ministry - they are collected only at the public health unit level and not provided to the Ministry - and therefore are not included in the report.

This report was produced in the context of a special project to enhance the monitoring of the HIV/AIDS epidemics in Ontario. This project was initiated in January 1997 by the AIDS Bureau, Ontario Ministry of Health, in collaboration with the Department of Public Health Sciences, University of Toronto. The current document is a first attempt to review and summarize what is known to date about the patterns of HIV transmission and infection. It complements the annual reportable disease report produced by the Public Health Branch, Ontario Ministry of Health, which presents descriptive data on AIDS and approximately 50 other reportable infectious diseases.

2. METHODS

Population estimates by year, sex, age group and public health unit were obtained from census data (Statistics Canada, 1996) for the calculation of annual incidence and mortality rates. Cumulative incidence rates were calculated using the 1991 population as the denominator. All annual incidence rates were calculated using the actual or interpolated population for the year of interest.

Where appropriate, statistical testing was carried out using the chi-square or Fisher's exact test to compare proportions and the chi-square for trend to test for trends over time (EpiInfo v. 6.04b, 1997, Centers for Disease Control and Prevention, Atlanta, USA and World Health Organization, Geneva, Switzerland).

2.1 HIV serodiagnoses

2.1.1 Data source

HIV serodiagnostic data were obtained from the HIV Laboratory, Central Public Health Laboratory (CPHL) of the Ontario Ministry of Health for the years 1985 to 1996.

All HIV diagnostic tests in the Province of Ontario are performed through the Public Health Laboratory System, Ontario Ministry of Health. However, HIV testing is carried out by other laboratories for the purposes of establishing eligibility for life insurance, obtaining visas for international travel, and screening organ and tissue donors. Ontario blood donors are tested at the Canadian Red Cross Blood Transfusion Service. Finally, Ontario residents may be tested in other provinces (persons may either have tested elsewhere before establishing residence in Ontario or travelled out of province expressly for the purposes of an HIV test).

In Ontario, persons requesting a test from their physician or at any one of the specialized clinics established for this purpose (anonymous testing sites) are tested at no charge. Specimens are transported to the Public Health Laboratory system where the HIV testing is carried out. Specimens are first tested by enzyme immunoassay (EIA) and, if repeatedly reactive, by supplemental and confirmatory testing, including Western blot. Only rarely does this approach not provide a definitive result. In such a case, follow-up testing (e.g., polymerase chain reaction [PCR], p24 antigen) involving the collection of additional blood specimens is required. Since 1992, 200,000 to 300,000 HIV tests have been conducted annually and less than 0.5% have been indeterminate. Fewer than 10 tests per year remain indeterminate. For the purpose of the analysis, specimens are classified as: negative or indeterminate; seroconverter, i.e., positive after a negative test or window-positive; first-time positive; or repeat positive.

2.1.2 Data analysis

To the extent possible, subsequent HIV-positive tests from the same person were eliminated to avoid duplicate counting. This was carried out by (1) removal of HIV-positive tests from persons who indicated that they had had a previous positive test whenever possible and (2) matching HIV-positive tests to earlier HIV-positive tests in the database (using identifying information, e.g., names, initials, dates of birth, clinic where HIV test was carried out, etc.).

We calculated the number and proportion of first-time HIV diagnoses according to sex, age at time of first HIV-positive test (under 1, 1-14, 15-19, 20-29, 30-39, 40-49, 50-59 and 60+), exposure category and year of diagnosis. Analyses were carried out according to major health regions; these were slightly modified to better represent the heterogeneity of the epidemic in Ontario and highlight the differences between the larger urban centres and other parts of the province. The following regional categories were used: Northern, Ottawa-Carleton, Eastern other than Ottawa-Carleton (Eastern other), Metropolitan Toronto (Metro Toronto), Central East other than Metropolitan Toronto (Central East other), Central West and Southwest. The mean age at diagnosis was also calculated. We used 1991 population estimates by health region obtained through Statistics Canada to calculate and map rates of HIV infection. Annual population estimates were used to calculate rates of HIV testing according to health region (modified) from 1992 to 1996.

To attempt to estimate the true distribution of cases by exposure category and region, we reassigned cases with missing data for several analyses. Cases with unknown sex and/or region of residence were allocated to these categories based on the distribution among cases for which the data were available. Cases for which exposure category was unknown were assigned to a category using the results of a call-back study conducted by the CPHL in 1994-95. In this study, physicians of HIV-positive cases without risk information or with risk information indicating heterosexual contact as the only source of exposure were contacted by letter and a follow-up telephone call to determine exposure category. Approximately 20% of cases were reassigned, ranging from 4.0% in the Northern region to 43.3% in the Southwest. Data from the call-back study indicated that, except for under-representation of persons from HIV-endemic countries and a slight over-representation of MSM and blood product recipients, there were no significant differences in the exposure category distributions between those who had an indicated source of exposure and those who did not.

To illustrate various combinations of exposure categories where more than one was reported, we presented first-time HIV diagnoses according to single and multiple sources of exposure.

We calculated “HIV-positivity rates” for cases diagnosed from 1992 to 1996, since data on negative tests have only been collected since 1992. To calculate these rates, persons receiving an HIV test for the first time were included in the numerator and HIV tests conducted in the same calendar year, excluding repeat tests, were included in the denominator. To minimize instability where numbers were small, moving averages were used to calculate and graph HIV-positivity rates by health region (modified) and year of diagnosis within each major exposure category.

2.1.3 Classification by exposure category

Where more than one exposure (i.e., presumed route of HIV infection) was indicated for a patient, the case was classified according to a mutually exclusive hierarchy which assigns the case to the risk category most likely to represent the source of HIV infection, as follows:

- Men who have sex with men (MSM)
- MSM and injection drug use (IDU)
- IDU
- Perinatal transmission
- Blood product recipient prior to November 1985
- Blood transfusion recipient prior to November 1985
- Origin/residence in an HIV-endemic area
- Heterosexual transmission
  - High-risk heterosexual
  - Low-risk heterosexual
- Unknown (not indicated)

The high risk category among heterosexual transmissions includes those with a history of sexual contact with a person known to be HIV-infected or with someone at high risk of HIV infection (e.g., bisexual male [women only], IDU, clotting factor recipient, person from an HIV-endemic region). The low risk category includes all other persons who have had sex with persons of the opposite sex, none of whom were known to be HIV-infected or at increased risk of being HIV-infected.

In the design of the requisition, blood product recipients were meant to indicate persons who received fractionated blood products. Blood transfusion, on the other hand, was meant to indicate persons who received whole blood or components of fresh blood. However, it later became evident that some physicians prescribing tests used the blood product category to indicate the receipt of blood components. Since more detailed data about these cases were not available, we were not able to reclassify them.

2.2 AIDS incidence

2.2.1 Data source

Data on AIDS cases diagnosed to December 31, 1996 and reported to September 23, 1997 were obtained from the Public Health Branch, Ontario Ministry of Health.

AIDS cases in Ontario are reported to local public health units and forwarded to the Public Health Branch, Ontario Ministry of Health. Reporting of AIDS cases was initiated informally in 1982 and expanded into the official surveillance system (the Ontario AIDS Surveillance Program [OASP]) when AIDS became reportable in August 1983. Currently, AIDS data is managed through the Ministry's Reportable Disease Information System (RDIS) implemented in 1990. This system provides for the organization of data on reportable diseases at the local health unit level and for electronic transfer to the Ministry of Health. All reported cases, including those ascertained retrospectively (i.e., prior to the institution of official reporting), were included in our analyses.

AIDS cases in Ontario are classified according to criteria used for epidemiologic surveillance as recommended by the Laboratory Centre for Disease Control (Health Canada, 1987). The Laboratory Centre for Disease Control defines a case of AIDS as a person who has an illness characterized by the following: (1) one of more of the specified indicator diseases, and (2) either a positive test for HIV infection or absence of specified causes of underlying immunodeficiency. From 1983 to 1987, approximately 20 indicator conditions, including opportunistic infections and malignancies, were used. In 1987, the list was expanded to include two syndromes (HIV wasting and HIV encephalopathy) and "presumptive diagnoses" for several of the indicator conditions (Health Canada, 1987; CDC, 1987). Finally, in 1993, three new indicator conditions were added, namely, pulmonary tuberculosis, cervical cancer (in women), and recurrent bacterial pneumonia (Health Canada, 1993; Castro et al., 1992).

2.2.2 Data analysis

Cumulative incidence rates (1981 to 1996) were calculated using the 1991 population as denominator.

The number of AIDS cases and cumulative incidence rate per 100,000 were calculated according to sex, age at diagnosis (under 15, five-year age categories from 15 to 59, and 60+), exposure category, health region (modified) (Northern, Ottawa-Carleton, Eastern other, Metro Toronto, Central East other, Central West and Southwest) (see Section 2.1.2) and year of diagnosis. In addition, we calculated the mean age at diagnosis. The date of diagnosis was defined as the date of the earliest AIDS-defining illness, if available, or the reported date of diagnosis otherwise.

We carried out analyses of trends by sex and exposure category using five mutually exclusive time intervals selected to maximize homogeneity within each interval and display trends most effectively.

We also compared the Ontario experience with AIDS to that of other Canadian provinces according to sex and exposure category using data published by Health Canada, Laboratory Centre for Disease Control (LCDC) (Health Canada, 1997). This data included cases diagnosed to the end of June 30, 1997 and received by LCDC by July 15, 1997. (It was not possible to obtain data limited to cases diagnosed to December 31, 1996 for the purposes of the interprovincial comparisons.)

2.2.3 Classification by exposure category

Exposure categories were defined according to Appendices C1-3 of the Guidelines for the Surveillance of AIDS in Canada (Health Canada, 1995). Where more than one exposure category was given, a hierarchy was used to determine the most likely source of infection for final classification (see Appendix A). This was done according to our best understanding of the patterns of HIV incidence and prevalence in Ontario. The underlying principle was that, for persons with multiple exposures, we assumed that the most likely source of infection was that associated with the highest HIV incidence and prevalence.

We analyzed AIDS cases according to single and multiple sources of exposure to evaluate combinations of exposure categories which are not reflected in the hierarchical exposure classification. In this analysis, persons who received clotting factor prior to November 1985 or of unknown date were grouped and classified as clotting factor recipients. Persons who received a transfusion prior to November 1985 were considered as transfusion recipients. Those who received clotting factor or a transfusion after November 1985 or received a transfusion of unknown date were attributed to the “no identified risk” (NIR) category. In this analysis, therefore, the numbers in the clotting factor, heterosexual other and transfusion categories do not necessarily reflect those in the hierarchical classification tables.

2.2.4 Adjustment for reporting delays

Due to delays between the date of diagnosis and date of report to the Ontario Ministry of Health, the actual number of AIDS cases is likely to be underestimated, particularly in the most recent years. Therefore, delay adjustments were carried out for each major exposure category to present a more accurate picture of the annual number of diagnosed cases. These adjustments were carried out by Dr. Ping Yan at the Laboratory Centre for Disease Control (LCDC), Health Canada.

Dates of report for AIDS cases were available at the Ontario Ministry of Health only from the inception of RDIS (i.e., mid-1990). Therefore, the reporting delay analysis was carried out using dates of report provided by LCDC for AIDS cases reported from January 1, 1983 to December 31, 1990. In addition, the LCDC date of report was used for cases reported between January 1, 1991 and December 31, 1996 in which the LCDC date of report was earlier than the Ontario date of report. The RDIS date of report was used for the remaining AIDS cases with dates of report between January 1, 1991 and December 31, 1996. An adjustment factor of -2 months was applied to LCDC dates of report when they were used, based on the median difference in RDIS and LCDC dates of report among cases with both dates.

The following cases were excluded from the calculation of reporting delay adjustments: (1) cases in which the date of report was earlier than the date of diagnosis; (2) cases diagnosed prior to January 1, 1997 but reported in 1997; and (3) cases in the NIR and occupational exposure categories. The adjustment factors were applied to all AIDS cases in each of the exposure categories with the most cases (i.e., MSM, MSM-IDU, IDU, HIV-endemic, other heterosexual).

2.3 AIDS-associated mortality

2.3.1 Data source

AIDS mortality data were obtained from the Ontario Vital Statistics office, Registrar-General. Deaths occurring during the period 1987 to 1996 for which the ICD-9 code was 042, 043 or 044 (HIV-related death) were selected.

2.3.2 Data analysis

The number of deaths and mortality rate per 100 000 were calculated according to sex, age group (under 15, five-year age groups from 15 to 69, and 70+) and year of death. Annual mortality rates were calculated for each of the health regions (modified) (Northern, Ottawa-Carleton, Eastern other, City of Toronto, Metro Toronto, Central East other, Central West and Southwest) (see Section 2.1.2).

We also examined the distribution of deaths according to country of birth (HIV-endemic and non-HIV-endemic). The 1996 mortality rate in this population was calculated using the 1996 immigrant population of persons from HIV-endemic countries as the denominator (Statistics Canada, 1996). Countries considered to be HIV-endemic for the purposes of these analyses are shown in Appendix B.

We calculated potential years of life lost (PYLL) as the difference between age 75 and the age of the decedent and summed the individual cases according to year and sex.

2.4 HIV infection due to mother-infant transmission

2.4.1 Data source

Data were obtained from the Ontario HIV Pediatric Network on infants born to HIV-infected mothers from 1984 to 1997.

The Ontario HIV Pediatric Network was initiated in 1992 to collect information on children born to HIV-infected mothers and receiving specialized care at four hospitals in Ontario. Data is collected by staff at each participating institution from medical charts. The Ontario Network is coordinated by Dr. Susan King at the Hospital for Sick Children in Toronto and is part of the larger Canadian HIV Pediatric Network. The following hospitals have contributed cases to the Network to date: Hospital for Sick Children, Toronto; Children's Hospital in Eastern Ontario, Ottawa-Carleton; McMaster University Medical Centre, Hamilton; and St. Joseph's Health Centre, London.

Solicitation for new cases and an update on the clinical status of previously reported cases is carried out once a year, usually in December or January. Until now, the database has been maintained using spreadsheet software (Microsoft Excel). Information is collected on date of birth and sex of the infant, country of birth of the mother, risk factor for HIV infection in the mother, whether the mother received zidovudine prophylaxis during pregnancy and the clinical status of the infant (confirmed infected, confirmed not infected, pending/unknown/lost to follow-up). Pending cases are, for the most part, infants for whom a final decision on infection status cannot yet be made on the basis of laboratory analysis, including HIV antibody tests, polymerase chain reaction (PCR) and viral culture.

2.4.2 Data analysis

The number and proportion of children born to HIV-infected mothers was calculated according to: (1) the year of birth and clinical status of the infant; (2) location of the institution (hospital) and exposure category; and (3) the year of birth of the infant and the presumed source of exposure of the mother among HIV-infected infants.

In addition to the descriptive analyses, we carried out statistical modelling to estimate the true number of HIV-infected women delivering infants in Ontario from 1984 to 1997 and the number of HIV-infected infants born each year. (These numbers, of course, exceeded the number of HIV-infected women and infants identified to date in Ontario.) The methods used in this analysis incorporate to some extent the methods used for the Ontario HIV model presented in Section 2.5 below. Further details on these methods have been presented elsewhere (Remis et al., 1998).

2.5 Ontario HIV model

We wished to estimate with the greatest precision possible the incidence, cumulative incidence and prevalence of HIV infection and AIDS from 1978 to December 1996. We also wished to assess annual and cumulative deaths due to AIDS during the same time period. To accomplish this, we used data from a variety of sources, including (with source) HIV serodiagnoses (Central Public Health Laboratory), AIDS incidence (Ontario AIDS Surveillance Program), AIDS mortality (Vital Statistics, Registrar-General) and HIV infections among women who delivered a live infant (Ontario HIV Pediatric Network). Data from seroepidemiologic studies were also used.

Initial estimates for HIV incidence, AIDS incidence and AIDS deaths were entered into a spreadsheet and the values of the above indicators were progressively refined in an iterative fashion so as to be consistent with the collected data, taking into account the direction and strength of biases. The initial results were compared to results from techniques used elsewhere (e.g. back-calculation) to verify the credibility of the estimates. Further details concerning the techniques used are included in Appendix C of the present report.

To determine the rates and numbers of HIV infections by health region, the estimated number of prevalent HIV infections among adults were interpolated to each of the 42 public health units in Ontario using reported AIDS cases as weights. The absolute number of HIV infections was then divided by the adult population (?15 years of age) for each of the public health units (estimated at 75% of the population for each health unit) to obtain the HIV prevalence per 1000. Finally, the number of persons diagnosed with HIV were compared (the number of serodiagnosed persons being distributed by the location of the physician who ordered the HIV test) to the results of the modelling method to determine whether there were regional differences in the comparison of HIV diagnoses to HIV infections.

3. RESULTS

3.1 HIV serodiagnoses

A total of 17,491 persons (15,121 males and 805 females) were diagnosed with HIV infection from 1985 to 1996 (Table 1.1 and Figure 1.1). Except for 1985 (which was a partial year since HIV testing began in about November), approximately 1,000 to 2,000 first-time HIV diagnoses each year were made in Ontario, with a mean of 1,590 new diagnoses annually. The number of diagnoses rose from about 1,400 in 1986 to a peak of 2,100 in 1990 and decreased almost linearly afterward. In the most recent year for which data is presented (1996), approximately 1,100 persons were newly diagnosed with HIV infection.

Overall, the majority (90.6%) of HIV diagnoses with known sex were among men. However, the proportion of new diagnoses comprised by women increased steadily over the years, from approximately 1.8% in 1985 to 18% in 1996. This increase was statistically significant (chi-square for trend, $p<0.0001$). In absolute numbers, the number of newly diagnosed men peaked in 1990 and decreased consistently thereafter. Among women, the number of new HIV diagnoses continued to increase steadily and appeared to have plateaued in 1994 and 1995 at about 220 new diagnoses per year. In 1996, the number of cases decreased by 16%; it remains to be seen whether this decrease will be sustained.

Table 1.2 shows cumulative HIV diagnoses by exposure category and sex. The proportions shown are for exposure categories among men, women and total cases for which exposure information was available. Among men, 82% of cases had had sex with other men, 5.5% injected drugs and 3.1% had received clotting factor. In women, the distribution among risk categories was different, with 30% being high-risk heterosexual, 21% injection drug users, 16% low-risk heterosexual, 9.4% from HIV-endemic countries and 8.0% infected through blood transfusion.

Table 1.3 shows similar data to that in Table 1.2, except that cases with unknown sex or exposure category or both were reassigned according to the distribution of cases with known sex and according to exposure category data obtained from a call-back study conducted at the CPHL (see Section 2.1.2 for method used). This analysis revealed that approximately 11,500 MSM, 1,500 injection drug users, 1,200 persons from HIV-endemic countries, 900 MSM-IDU, 800 persons reporting low-risk heterosexual contact, 700 persons reporting high-risk heterosexual contact, 360 blood transfusion recipients and 330 blood product recipients have been diagnosed with HIV.

Table 1.4 indicates the distribution of first-time HIV diagnoses by age and sex among cases with known age at diagnosis. Those aged 20-49 years represented the vast majority of HIV diagnoses (90.2% of cases in men and 81.3% in women), though there was a somewhat lower proportion in the 40-49 year age group, especially among women. A significantly greater proportion of women were diagnosed prior to the age of 30 (48%) compared to men (31%) (chi-square, $p<0.0001$). Age at diagnosis varied from 0 to 76 years for women and 0 to 93 years of age for men. In first-time HIV diagnoses of unknown sex, the age distribution most resembled the age distribution of males, though the proportion among those aged 60+ was similar to that seen in females.

Table 1.5 presents first-time HIV diagnoses by age and exposure category. The majority (99.2%) of cases diagnosed prior to the age of 1 year were related to perinatal transmission. Among those aged 1-14, 58% of cases were blood product recipients and 36% were perinatally acquired. In the 15-19 age group, 37% were MSM, 25% blood product recipients, 12% IDU and 9.1% high risk heterosexual. The vast majority of cases (77%) in those aged 20-59 occurred among MSM. IDU represented 9.2% of infections in those aged 20-29 and 8.0% of those aged 30-39. A larger proportion of HIV infections among those aged 60 or greater were associated with receipt of transfusion (19%) or blood products (11%).

Tables 1.6 and 1.7 show the mean age at first-time HIV diagnosis according to year of diagnosis and exposure category for males and females, respectively. Except in the years in which there were very few cases, the mean age at first-time HIV diagnosis did not differ markedly over time. There were no notable trends in the mean age at diagnosis by exposure category, with the exception of male IDUs, among whom the mean age increased from 28.0 in 1987 to 33.8 in 1996. Overall, among men, the mean age at time of first-time HIV diagnosis was 34.5 years, with 73% of persons being younger than 40 years of age (data not shown). The age at diagnosis was somewhat younger for women, who had a mean of 30.0 years at time of diagnosis with 88% of women diagnosed for the first time being younger than 40 years of age.

Trends in the distribution of first-time HIV diagnoses by exposure category are shown in Table 1.8. The proportion of cases in the MSM category declined from 88% in 1985 to 56% in 1996 (chi-square for trend, $p<0.0001$). The proportion of cases comprised by IDU increased from less than 1% in 1985 to 12% in 1996 (chi-square for trend, $p<0.0001$). Persons from HIV-endemic country of origin, who represented less than 1% of first-time HIV diagnoses in 1986, comprised 4.5% of those in 1996 (chi-square for trend, $p<0.0001$). An increasing proportion of first-time HIV diagnoses indicated high risk and low risk heterosexual exposure, representing 4.5% and 13% of cases, respectively, in 1996 (chi-square for trend, $p<0.0001$).

Table 1.9 shows the number of first-time HIV diagnoses by exposure category and health region (modified). The proportion of HIV-positive persons with no risk factor indicated was 51% overall. The proportion with missing information varied according to region, with a lower proportion observed in the Northern region (38%); moderate levels in the Eastern other (45%), Ottawa-Carleton (46%) and Metro Toronto (49%) regions; and higher proportions in the Southwest (59%) and Central East other (61%) regions. Among first-time HIV diagnoses with a risk factor indicated, Metro Toronto had the highest proportion (83%) associated with MSM. The Northern and Eastern other regions had a large proportion of cases in the IDU category (33 and 28%, respectively). Ottawa-Carleton had the greatest proportion of cases associated with HIV-endemic country of origin (7.5%), while the Central East other region had the highest proportion in the low risk heterosexual category (11%).

As with Table 1.3, the results of an analysis of data obtained through a call-back study conducted at the CPHL were used to assign cases with missing data on region and exposure category, and are shown in Table 1.10. Metro Toronto had a significantly higher proportion of cases (72%) in the MSM category than the rest of the province (chi-square, $p<0.0001$). The proportion of cases attributed to injection drug use were highest in the Northern (25%), Eastern other (21%) and Ottawa-Carleton (19%) regions. The Ottawa-Carleton region had the highest proportion (13%) of cases associated with HIV-endemic country of origin. Proportions in the high risk heterosexual category were highest in the Central East other (11%), Central West (10%) and Southwest (9.8%) regions.

The cumulative incidence rate per 100,000 of first-time HIV diagnoses according to health region (modified) are mapped in Figure 1.2. The highest rates were found in Metro Toronto (508 per 100,000) and Ottawa-Carleton (253); the lowest rates were observed in the Northern (31.6) and Central West (25.1) regions.

Table 1.11 (on two pages) indicates the number of HIV-positive tests, the number of persons tested and first-time HIV-positivity rates by sex, exposure category and health region (modified) for the period 1992-96. The highest rates of HIV-positivity overall were observed in MSM (6.5%), MSM-IDU (5.2%), persons from HIV-endemic countries (2.3%) and IDU (1.5%). Among MSM, the highest HIV-positivity rate was observed in Metro Toronto (6.7%). In MSM-IDU, positivity rates were highest in Metro Toronto (9.4%) and Ottawa-Carleton (7.8%). A high rate of HIV-positivity was also observed among IDU in Ottawa-Carleton (3.2%) and among persons from HIV-endemic countries in Metro Toronto (3.1%).

The same analyses are shown in Table 1.12 for 1996 alone. Overall, HIV-positivity rates were 0.73% among males and 0.13% among females. The highest positivity rates were found in MSM, MSM-IDU, persons from HIV-endemic countries and IDU. HIV-positivity rates among persons from HIV-endemic countries were particularly high in the Metro Toronto (5.5%) and Central East other (4.6%) regions. Rates among IDUs were highest in the Northern (3.3%) and Ottawa-Carleton (2.6%) regions. Although overall HIV-positivity rates among IDUs were similar in males and females, the rate among female IDUs in Ottawa-Carleton was higher than in males (3.0% compared to 2.2%).

Trends in HIV-positivity rates using moving averages by exposure category and region are presented in Figure 1.3. (The discussion in this paragraph cites observed rates rather than moving averages which are displayed in the figure.) Overall, HIV-positivity rates were stable or decreased for most exposure categories and regions over the five-year period of study. There were, however, notable exceptions. For MSM, rates appeared to decrease in most regions; the rates were highest in Metro Toronto and followed a similar, lower trend in the other six regions. In MSM-IDU, there was considerable variation from region to region. Rates were highest in Metro Toronto, but appeared to decrease over the five-year period. Rates increased in the Southwest region and possibly in the Central East other region. Among IDU, rates were distinctly higher in Ottawa-Carleton than the other six regions. Although the rate among tested IDU in the Northern region was similar to that in other regions in 1992-94, it increased slightly in 1995 and in 1996 it was 3.3%, the highest of any region in Ontario.

Among persons from HIV-endemic countries, HIV-positivity rates increased significantly in 1995 and 1996 in the Metro Toronto (5.5% in 1996), Central East other (4.6% in 1996) and Eastern other (3.0% in 1996) regions. Overall positivity rates were lower in both heterosexual categories than in the other four categories. In the high risk heterosexual category, rates were higher in the Metro Toronto and Central East other regions and appeared to decrease from 1992 to 1996. In the other regions with lower rates, there were no clear trends. Finally, for persons reporting low risk heterosexual contact, rates in Metro Toronto increased gradually over the five year period.

Combinations of risk factors among persons newly diagnosed with HIV infection were also examined; the results are shown in Table 1.13. Of those with a risk factor indicated, 640 (7.4%) reported both MSM and IDU, 365 (4.2%) reported both MSM and HIV-endemic country of origin, 131 (1.5%) were both MSM and bisexual, and 77 (0.89%) reported both IDU and heterosexual contact.

Table 1.14 indicates trends in HIV testing patterns according to sex in the period 1992-96. The number of HIV tests increased between 1992 and 1996, and women comprised a growing proportion of persons tested (chi-square for trend, p<0.0001). Both the total number of tests and the proportion comprised by women appeared to increase in stages, with the numbers and proportions increasing from 1992 to 1993, remaining relatively stable between 1993 and 1995 and increasing again in 1996. In 1996, the number of HIV tests per 1000 population was 21.8 in males and 26.1 in females (data not shown).

Changes over time according to exposure category were also noted. Table 1.15 shows that whereas MSM constituted 14.0% of testers in 1992, they constituted only 8.4% of testers in 1996 (chi-square for trend, p<0.0001). A growing number of persons reporting low risk or high risk heterosexual contact (chi-square for trend, p<0.0001) were tested for HIV. In 1996, 71,606 (68%) reported low risk heterosexual contact, 9,266 (8.8%) reported high risk heterosexual contact and 5,728 (5.4%) reported IDU.

The number of HIV tests per 1,000 population in Ontario was 25.0 per 1,000 in 1996. In 1996, the number of HIV tests per 1,000 was highest in Ottawa-Carleton (44.8 per 1,000) and Metro Toronto (43.4), intermediate in the Eastern other region (26.1) and lowest (between 10 and 20) in the remaining four regions of the province (Table 1.16). Most of the HIV tests were conducted in the Metro Toronto region (39%), followed by the Central East other (18%), Ottawa-Carleton (12%), Southwest (10%), Central West (9.5%), Eastern other (6.6%) and Northern (5.1%) regions (data not shown).

3.2 AIDS incidence

A total of 6,069 cases of AIDS diagnosed between 1981 and 1996 were reported in Ontario. Of these, 5,760 (94.9%) were among males and 308 (5.1%) in females (1 case had missing data on sex). Figure 2.1 and Table 2.1 indicate the distribution of AIDS cases by year of diagnosis and sex. The proportion of female AIDS cases (using periods of diagnosis over which the proportion was constant) increased significantly over time: 1981-86: 1.6%; 1987-90: 4.0%; 1991-93: 5.3%; 1994-95: 7.1%; 1996: 9.0% (chi-square for trend, p=0.0001).

The number and distribution of AIDS cases by exposure category and sex during the period 1981-96 are shown in Table 2.2. Among males, MSM comprised the largest proportion of AIDS cases (79%), followed by heterosexual transmission (5.5%) and MSM-IDU (4.3%). Among females, heterosexual transmission predominated (40%), followed by HIV-endemic country of origin (18%), blood transfusion (14%) and injection drug use (13%).

Figure 2.2 shows reported and delay-adjusted AIDS incidence by year of diagnosis for each major exposure category. Two hundred sixty-five cases reported in 1997 and 192 cases in which the date of report preceded the date of diagnosis were excluded from the calculation of reporting delay adjustments. The median reporting delay for all AIDS cases was approximately 12 months following diagnosis. Among MSM, incidence peaked in 1992-93, followed by steady declines from 1993 to 1995 and a significant drop in 1995-96. The incidence among MSM-IDU peaked in 1992 and did not decline substantially until 1995-96. In IDU, AIDS incidence increased between 1993 and 1995 and dropped slightly in 1995-96. Although the number of AIDS cases attributed to heterosexual contact increased substantially from 1986 to 1990, the degree of variability in the following years makes it difficult to discern a clear trend. An increase in the number of cases in persons from HIV-endemic countries was observed between 1982 and 1992, followed by a decline in 1994 and substantial increases in 1995 and 1996.

Table 2.3 shows that, among males, the incidence of AIDS was greatest for those between the ages of 30 and 39. The peak ages of incidence in females were 25 to 34. The male-to-female (M:F) ratio was 19.2 overall. The M:F ratios were greater than 25 for the four five-year age categories from 35 to 54 years, with the highest (41) among those aged 45-49. A significantly higher proportion of women than men were diagnosed before the age of 30 (33% versus 15%, respectively; chi-square, $p<0.0001$).

In 1996, the mean age at diagnosis was 39.6 years in men and 35.1 in women. The mean age at diagnosis increased slightly over time in men (from 38.4 in 1981-93 to 39.4 in 1994-96) and decreased in women (from 35.9 in 1981-93 to 33.8 in 1994-96) (data not shown). Tables 2.4 and 2.5 present mean age at AIDS diagnosis by exposure category for males and females, respectively. Except in the years in which there were very few cases, the mean age at AIDS diagnosis was not remarkably different over time, with the exception of MSM. In this group, the mean age at diagnosis increased slightly, from 38.4 years during the period 1981-93 to 39.6 in 1994-96.

Trends in the distribution of AIDS cases by exposure category are shown in Table 2.6. While the proportion of cases associated with MSM declined steadily over time from 84% in 1981-86 to a low of 62% in 1996 (chi-square for trend, $p<0.0001$), increases were observed in the following exposure categories: heterosexual transmission (12% in 1996 compared to 6.9% in 1981-95), HIV-endemic country of origin (9.0% in 1996 compared 2.5% in 1981-95) and injection drug use (5.9% in 1996 compared to 3.2% in 1981-95). Each of these increases was statistically significant (chi-square for trend, $p<0.0001$). These trends are illustrated according to sex in Figures 2.3 and 2.4. Among males, a growing proportion of cases were associated with injection drug use, HIV-endemic country of origin and heterosexual transmission. Among females, the greatest increases were in cases infected through heterosexual transmission and women from HIV-endemic countries of origin.

The distribution of single and multiple sources of exposure among AIDS cases is shown in Table 2.7. A mean of approximately 1.3 potential sources of exposure per case was observed. A total of 620 (10%) reported both MSM and bisexual contact, 112 (1.9%) reported both injection drug use and heterosexual contact, 51 (0.84%) reported both MSM and occupational exposure, and 37 (0.61%) reported both MSM and HIV-endemic country of origin.

Table 2.8 presents the number of AIDS cases and cumulative incidence rate per 100,000 by health unit and sex. The highest rates were observed in the City of Toronto (454 per 100,000), East York (110), Ottawa-Carleton (68.9) and the City of York (68.2). The greatest number of cases were reported among residents of the City of Toronto (3,002, or 50%) and Ottawa-Carleton (485, or 8%).

The majority of AIDS cases have consistently been among residents of Metro Toronto (62% in the period 1981-96), followed by the Central East other (9.0%), Central West (8.4%), Ottawa-Carleton (8.0%), Southwest (7.6%), Eastern other (2.7%) and Northern (2.2%) regions (data not shown).

Table 2.9 shows the number of AIDS cases and cumulative incidence rates according to health region (modified) and sex. The highest cumulative incidence rates among males were observed in Metro Toronto (314.2 per 100,000), followed by Ottawa-Carleton (129.5) and the Southwest region (63.8). Similarly, cumulative incidence rates in females were 10.7 per 100,000 in Metro Toronto, 10.3 in Ottawa-Carleton and 4.5 in both the Southwest and Central East other regions. A higher proportion of female cases was observed in the Central East other (10%) and Eastern other (9.1%) regions, whereas a relatively low proportion (3.4%) of female cases was observed in Metro Toronto.

The number and proportion of AIDS cases by exposure category and health region (modified) are presented in Table 2.10. Metro Toronto had the highest proportion of cases in the MSM category (82%). The proportion of cases attributed to injection drug use was highest in the Eastern other (15%) and Northern (6.7%) regions. The Central East other and Central West regions had the highest proportion of cases associated with heterosexual transmission (16% and 9.0%, respectively) and Ottawa-Carleton had the highest proportion of cases associated with HIV-endemic country of origin (7.4%).

Table 2.11 shows the distribution of AIDS cases in Canada according to province/region and sex. Ontario had the greatest number (6,034, or 40.2%) of AIDS cases and the third highest cumulative incidence rate (59.8 per 100,000) reported to June 30, 1997 in Canada. Fewer cases in Ontario have occurred among women (5.1%) as compared to Quebec (11%), the Prairies/Territories (8.4%) and the Atlantic provinces (9.6%). The number and proportion of AIDS cases in Canada by exposure category and province/ region are presented in Table 2.12. Ontario has a relatively high proportion of cases associated with MSM (third highest among the regions listed, 75%), heterosexual transmission (third highest, 7.0%) and HIV-endemic country of origin (second highest, 2.4%).

3.3 AIDS-associated mortality

A total of 4,634 persons who died of AIDS from 1987 to 1996 in Ontario were identified; 4,408 (95.1%) were male and 226 (4.9%) female. Mortality rates increased steadily from 1987 to 1995, apart from a slight decrease in 1994, and dropped 31% from 1995 to 1996 (from 6.2 to 4.2 per 100,000) (Figure 3.1). The number of AIDS deaths peaked in the third quarter of 1995 at 187, decreasing to 146 in the first quarter of 1996 and to 106 in the final quarter of 1996, representing a decline of 22% and 43%, respectively, compared to the third quarter of 1995. The dramatic decrease from 1995 to 1996 varied according to the variables examined; further details on this analysis are provided in the paragraphs below.

The mortality rate in males was lowest in 1987 (4.3 per 100,000) and highest in 1995 (11.9 per 100,000); among females, the rate varied from 0.16 per 100,000 in 1988 to 0.72 in 1994 (see Table 3.1). The distribution according to sex shifted significantly in recent years: 6.0% of AIDS deaths in 1994-96 were in females, compared to 4.2% in 1987-93 (chi-square, p=0.01). The marked decline in the number of AIDS-associated deaths from 1995 to 1996 was greater in males, in whom AIDS deaths decreased by 32%, from 653 in 1995 to 446 in 1996. The decline in females was 22%, from 37 in 1995 to 29 in 1996.

The majority of AIDS-associated deaths in 1996 (67%) occurred among those 25-44 years of age (see Table 3.2 and Figure 3.2). In males, 66% of deaths in 1996 were among those aged 25-44; in females, 83% of deaths occurred in this age group. The mean age at death in 1996 was 40.9 for males and 35.6 for females (data not shown). In males, the greatest decrease in the number of deaths from 1995 to 1996 occurred in 30-34 age group (40%), followed by those aged 40-44 (37%) and 35-39 (33%). However, no statistically significant differences in the distribution of deaths were observed between 1995 and 1996. (The number of deaths by age group among females was too small for trend analysis.)

A small proportion of cases (2.2%, or 102) were missing data on region of residence and were excluded from regional analyses. Table 3.3 shows that mortality rates varied considerably by region. In 1996, a high mortality rate was observed in Metro Toronto (11.3), moderate rates in the Ottawa-Carleton (3.5), Eastern other (2.8), and Southwest (2.4) regions, and lower rates in the Central West (2.0), Central East other (1.6) and Northern (1.5) regions.

Trends in AIDS-associated mortality varied considerably according to region (see Figure 3.3). Greater decreases were observed in the three regions with higher mortality rates in 1995: Metro Toronto (which declined from 17.1 per 100,000 in 1995 to 11.3 per 100,000 in 1996, a decrease of 34%), Ottawa-Carleton (from 6.4 to 3.5, 45%) and the Southwest region (from 5.2 to 2.4, 53%). With the exception of the Central East other region, more modest decreases were observed in the regions with lower mortality rates in 1995: Eastern other (from 2.9 to 2.8, 5.2%), Central West (from 2.2 to 2.0, 8.1%) and Northern (from 1.6 to 1.5, 7.0%). The mortality rate in the Central East other region, which was 2.2 per 100,000 in 1995, declined substantially to 1.6 in 1996 (27%). Overall, mortality in the three regions with a higher mortality rate in 1995 decreased by 38% in 1996 and by 7.1% in the three other regions with a lower mortality rate in 1995. The mortality rate declined by 27% from 1995 to 1996 in the Central East other region. The decrease in mortality rates from 1995 to 1996 in the three regions with a higher mortality rate in 1995 was statistically significant (chi-square, $p<10^{-6}$), while the 15% decrease in the four other regions (including Central East other) was not significant.

A substantial number of AIDS deaths were among those born in an HIV-endemic country, totalling 246 in men and 48 in women in 1987-96 (see Table 3.4). The AIDS-associated mortality rate in 1996 in this population was 14.0 per 100,000 overall, 20.6 in males and 4.7 in females. Women from HIV-endemic countries represented a sizable proportion (21%) of AIDS deaths in females. Although the proportion of deaths in these women dropped to 10% in 1994, it has otherwise been consistently high, increasing again to 22% in 1995 and 32% in 1996. A similar pattern was noted among men from HIV-endemic countries, who represented 2.8% of all AIDS-related deaths in men in 1988 and 7.4% in 1996.

The number and proportion of AIDS deaths by country of birth (Caribbean, sub-Saharan Africa and non-HIV-endemic) are shown in Table 3.5. From 1987 to 1996, 4.6% of all AIDS deaths occurred among persons born in the Caribbean and 1.8% among those born in sub-Saharan Africa. The proportion of AIDS deaths among persons born in the Caribbean and sub-Saharan Africa has increased over time, comprising 5.7% and 3.2%, respectively, of all AIDS deaths in 1996. Among those born in sub-Saharan Africa, the mortality rate in 1996 was 25.2 per 100,000 in males and 6.5 in females (data not shown). Among those born in the Caribbean region, the rates were 18.6 per 100,000 in males and 4.2 in females.

Table 3.6 indicates that AIDS was a growing cause of potential years of life lost (PYLL) during the period studied. From 1987 to 1996, a total of 163,873 PYLL were attributable to AIDS. PYLL due to AIDS increased from 7,706 in 1987 to 24,164 in 1995 and declined markedly in 1996 to 16,388. Among men, AIDS-associated PYLL declined from 22,807 in 1995 to 15,246 in 1996; in women, PYLL decreased from 1,357 to 1,142 over this period. The proportion of PYLL comprised by women increased significantly over time (chi-square for trend, $p<0.0001$).

3.4 HIV infection due to mother-infant transmission

Two hundred forty-two infants born to HIV-infected mothers between 1984 and 1997 were identified (see Table 4.1). Of the 228 cases in which infection status was known, 102 (45%) were confirmed to be infected and 126 (55%) were confirmed not to be infected. The number of infants born to HIV-infected mothers increased from a low of 3 in 1985 to a peak of 36 in 1994, followed by modest declines in 1995 (33) and 1996 (27). Only 9 infants born in 1997 had been identified to December 1997. The proportion who were confirmed as infected (among infants whose infection status was known) declined from 61% in 1984-92 to 32% in 1993-97.

We examined the distribution of children born to HIV-infected mothers according to treating institution and exposure category of the mother (see Table 4.2). All cases associated with injection drug use were identified by hospitals in Ottawa and Toronto. Hamilton and London, on the other hand, had a greater proportion of cases associated with other heterosexual transmission (Fisher's exact test, $p=0.02$). The proportion of HIV-infected mothers from an HIV-endemic country was highest in Toronto (42%) and Hamilton (40%), followed by Ottawa-Carleton (37%) and London (23%).

The most important source of exposure among the mothers of HIV-infected infants in the period 1994-97 was HIV-endemic country of origin (70%), followed by other heterosexual transmission (22%) and IDU (4.9%) (see Table 4.3). The proportion of HIV-infected infants born to mothers from an HIV-endemic country followed a u-shaped distribution, comprising a large proportion of identified cases in 1984-87, a smaller proportion in 1988-89 and an increasing proportion from 1990-97.

According to the results of our statistical model (see Table 4.4), an estimated 618 HIV-infected women delivered in Ontario from 1984 to 1997. We estimated that 142 infants were infected through mother-infant transmission during the same period. According to the model, an estimated 93 HIV-infected women gave birth to 19 HIV-infected infants in 1997.

3.5 Ontario HIV model

Table 5.1 shows the model output for HIV, AIDS and AIDS-associated mortality for Ontario for the years 1978 through 1996. Overall, we estimate that 21,640 persons have been infected with HIV during this period, with 15,800 living as of December 1996. A total of 17,850 persons were diagnosed with HIV to the same date; this data is based on the number of unique persons diagnosed with HIV at the provincial HIV Laboratory.

Correcting for under-reporting and delayed reporting, we estimated that approximately 8,400 persons have been diagnosed with AIDS since the beginning of the epidemic, of whom 2,550 are currently alive. A cumulative total of 5,840 persons died of AIDS, with 650 having died in 1996. Figure 5.1 graphically depicts the cumulative HIV incidence and prevalence, as well as cumulative deaths. Figure 5.2 shows the annual HIV incidence, prevalence and annual deaths in the period from 1978 to 1996.

Table 5.2 presents the modelled prevalence of HIV in Ontario by sex, region of residence and exposure category as of December 1996. Overall, of the 15,910 persons living with HIV, 14,020 were male and 1,890 female; 9,750 live in the Metro Toronto area, 1,600 in Ottawa-Carleton and 4,600 in the rest of the province.

The majority of persons living with HIV (10,940, or 69%) were MSM without other risk factors; the next highest group were persons from HIV-endemic countries representing approximately 1,800 persons, of which 1,200 were male and 650 female. Approximately 1,440 persons were IDU, 460 were MSM-IDU and 1,040 were persons infected by heterosexual contact other than those from HIV endemic regions.

Table 5.3 shows the estimates for HIV incidence for calendar year 1996 for Ontario. Overall, we estimate that 1300 persons were newly infected in Ontario, of whom 1,050 were men and 250 were women. We believe that approximately 700 of these infections occurred among residents in Metro Toronto, 200 in the Ottawa area and almost 400 in the rest of the province. The greatest number of new infections (570, or 44%) were among MSM, followed by IDU (370, or 29%). Finally, about 200 new infections were among persons from HIV-endemic countries, representing 15% of the total new HIV infections.

Based on the Ontario HIV model, we estimated the number and prevalence of adults infected with HIV by health unit and region in Ontario as of December 1996 (Table 5.4, 2 pages). HIV prevalence was 1.9 per 1,000 for Ontario as a whole, and varied from 0.13 in the Northwestern health unit to 15.3 per 1,000 in the City of Toronto. The HIV prevalence was greater than 1.0 per 1000 in eleven public health units and greater than 2.0 per 1,000 in four public health units (City of Toronto, 15.4 per 1,000; East York, 3.8; York City, 2.3; Ottawa-Carleton, 2.2).

4. DISCUSSION

4.1 Summary of findings

In this report, we summarize the HIV/AIDS epidemic in Ontario as of December 1996 using several key indicators, including HIV serodiagnoses, AIDS incidence, AIDS-associated mortality, diagnoses of HIV infection due to maternal-infant transmission and estimates based on statistical modelling.

According to the HIV laboratory data, 17,491 persons have been diagnosed with HIV infection to December 31, 1996. A growing proportion of persons diagnosed for the first time were females, reaching a peak of 18% in 1996. While increasingly fewer new HIV diagnoses are among MSM, the proportion attributable to IDU, HIV-endemic country of origin and heterosexual contact is increasing. The majority (about 67%) of new diagnoses have occurred among residents of the Metro Toronto area. Indications are that first-time HIV diagnoses are increasing in other regions of the province, particularly among IDU in the Ottawa-Carleton, Eastern other and Northern regions. The proportion of first-time HIV diagnoses among persons from HIV-endemic countries was highest in the Ottawa-Carleton region.

From 1981 to 1996, 6,069 cases of AIDS were reported in Ontario. The proportion of AIDS cases reported in females increased, representing 9% in 1996 compared to 1.6% in the period 1981-86. After adjustment for reporting delays, AIDS incidence appears to be declining in MSM and MSM-IDU, and relatively stable among IDU. AIDS incidence among persons reporting heterosexual contact appears to have increased overall (although recent trends were unstable), and has increased markedly in recent years among persons from HIV-endemic countries. The proportion of cases reporting IDU was highest in the Ottawa-Carleton and Northern regions. Ottawa-Carleton also had the greatest proportion of AIDS cases reported among persons from HIV-endemic countries.

AIDS-associated mortality declined dramatically in 1996, by 31% over 1995, almost certainly as a result of the advent of combination therapy and, in particular, the use of protease inhibitors, as well as the availability of viral load testing to guide therapeutic decisions. The number of deaths decreased slightly less in females, by 22% compared to 32% in males.

Interestingly, the extent of the decline in mortality rates varied considerably by region, with large decreases in the three regions with the highest mortality rates in 1995 (Metro Toronto, Ottawa-Carleton and Southwest) and much more modest decreases in three of the four regions with lower mortality rates in 1995 (Eastern other, Northern and Central West). The only exception to this pattern was the Central East other region, which had a lower mortality rate in 1995, and experienced a considerable decline in mortality in 1996. It is not clear why mortality did not decrease substantially in the three regions of lower initial mortality. With the data available, our study cannot directly elucidate the reasons for this differential decline. However, there are several possible explanations. There may be differences in the quality of care, access to diagnostic services and care, and availability and use of HIV testing in the various regions. Treatment of HIV infection is dependent on access to diagnostic services. Thus, further information on access to HIV testing, viral load testing and therapy is required to determine the reasons for the observed differential decreases in AIDS-associated mortality across regions of

Ontario. The fact that mortality declined to a greater extent in the Central East other region suggests that access to care may be an important factor, since this region is adjacent to Metro Toronto. One analysis that may help to shed light on this question would be to examine the time between HIV diagnosis and the onset of AIDS symptoms among AIDS cases.

The number of identified HIV infections due to maternal-infant transmission increased since 1984. One hundred and five (43%) of the 242 infants born to HIV-infected mothers from 1984 to 1997 were born in the period 1994-97. The predominant source of exposure among the mothers of HIV-infected infants was HIV-endemic country of origin (56%), following by heterosexual transmission (27%) and injection drug use (4.9%). The proportion of HIV-infected infants born to women from HIV-endemic countries increased in recent years, from 53% in 1990-91 to 61% in 1992-93 and 70% in 1994-97.

Estimates based on statistical modelling indicate that approximately 15,800 persons are living with HIV in Ontario. In spite of the important indicators of instability in the HIV/AIDS epidemic among IDU and persons from HIV-endemic countries, MSM remain the group most affected by the epidemic to date. We estimate that approximately 11,500 MSM have been diagnosed with HIV infection and that approximately 10,900 are currently living with HIV, constituting 65-70% of the Ontario total. Although MSM also comprised the majority (44%) of estimated new HIV infections in 1996, we estimated that approximately 29% of new HIV infections were among IDU and 15% were among persons from HIV-endemic countries.

For a more detailed synthesis and interpretation of results, please see Section 4.3 below.

4.2 Methodologic limitations

4.2.1 HIV serodiagnoses

The HIV serodiagnostic data must be interpreted in light of the fact that it reflects voluntary HIV testing; not every HIV-infected person in Ontario has been tested. Therefore, the number of first-time HIV diagnoses underestimates the true number of HIV-infected persons in the Ontario population. Also, the rate among those tested may be different than that of the entire population. Rates of HIV-positivity within the testing population are probably higher than the Ontario population prevalence, since persons who seek HIV testing may be at higher risk of HIV infection. This appears to be especially true for persons undergoing repeat HIV testing. A recent study of seroconverters in Ontario observed an incidence density of 3.2 per 100 person-years among MSM (Fearon et al., 1998). This is likely substantially higher than the HIV incidence among MSM in general. HIV incidence among MSM in a cohort study in Montreal has been estimated to be 0.73 per 100 persons-years as of June 1998 (Alary et al., 1998). However, rates of HIV-positivity are not necessarily higher for all persons who seek HIV testing, since persons at increased risk for HIV infection may, under some circumstances, avoid testing. Studies among persons offered HIV testing at STD and family planning clinics found that those who declined HIV testing were, in fact, more likely to be HIV-positive (Hull et al., 1988; Fehrs et al., 1991).

Although every attempt was made to remove repeat tests from the HIV serodiagnostic data at the HIV Laboratory, the system relies on matching of new test results with previous results on file and self-reported previous HIV testing. The quality of the identifying data does not always allow precise matching and not all persons with a previous positive HIV test will have this indicated on the requisition. Consequently, duplicate HIV-positive tests may remain in the serodiagnostic data and thus the number of HIV-positive tests may be an overestimate. Errors in matching may also work in the other direction: persons may indicate having had a previous test when they did not (either in Ontario or elsewhere) and apparent matches may have, in fact, been false matches. According to the HIV Laboratory, the magnitude of such opposite errors are probably roughly equivalent. However, this has not been quantified.

A small number of persons diagnosed with HIV infection (probably less than 100 persons) died of HIV-related disease before the HIV serologic test was available. Thus, our data may slightly underestimate the total number of HIV-infected persons.

We examined HIV diagnoses among infants exposed to HIV infection through their mother. In all, 159 infants were diagnosed, compared to 102 HIV-infected infants in the Ontario Pediatric HIV Network. The apparent discrepancy may be due to several reasons: (1) some of the 159 diagnosed infants likely represent infants with passive HIV antibody who were not truly infected; for the 102 infants in the Pediatric HIV Network, infection was confirmed through either persistent antibody or other techniques such as PCR (polymerase chain reaction), p24 antigen or viral culture; (2) it is possible that not all HIV-infected infants were, in fact, reported to the Pediatric HIV Network; however, the degree of under-reporting is unlikely to be important; and (3) there may be false duplicates within the 159 HIV diagnoses. It is difficult to determine the relative importance of each of these factors.

Many health care providers are involved in obtaining the exposure category information (essentially a checklist) on the HIV test requisition. Thus, the criteria by which exposure categories are defined by the person prescribing the test are not standardized and are probably not consistent over time or across Ontario, particularly in the categories of transfusion recipient, blood product recipient, and heterosexual transmission. The HIV Laboratory does not have access to additional data (e.g., type of blood product received, circumstances surrounding heterosexual transmission, etc.) that would aid in determining exposure classification. Thus, data on exposure category, especially with respect to heterosexual transmission and, to a lesser extent, receipt of transfusion/blood product, must be interpreted with caution.

Approximately 51% of all HIV laboratory requisitions were missing data on exposure category, 4.6% on sex and 1.6% on health region of residence. For some tables, we assigned cases with missing data on the basis of several assumptions. First, we assumed that the sex and regional distributions of unknown cases were the same as those of the known cases. Even if this assumption were not correct, this would not have a substantial impact on our final estimates, since the number of cases with missing sex or region data was small. Second, we reassigned cases according to exposure category using weights derived from call-back data collected in 1994-95. For this purpose, we assumed that the exposure category distribution remained constant through the period 1987-96. We also assumed that the cases for which additional information was obtained through the call-back study were representative of all cases with missing data on exposure. However, the number of first-time HIV diagnoses reassigned to the transfusion category (363) appeared to overestimate the true number of identified persons infected through the blood supply. (It has been estimated that approximately 150 to 200 transfusion-associated HIV infections in Ontario have been diagnosed to 1994 [Remis and Palmer, 1994]). This may be due to limitations in the accuracy of the reported sources of exposure (transfusion may have been reported erroneously in those with exposure information) or in the call-back data. Finally, we assumed that the distribution of exposure category among reassigned cases was the same in all health regions. However, the observed distribution may not have been representative of the entire testing population and these analyses should be interpreted with caution. Nevertheless, the reassigned numbers represent the best estimate, given currently available data, of the number persons diagnosed with HIV according to sex, exposure category and region of residence.

4.2.2 AIDS incidence

Due to under-reporting and reporting delays, our data on reported cases of AIDS are likely to underestimate the true number of AIDS cases in Ontario. A study conducted among reported AIDS cases in Ontario diagnosed between 1985 and 1987 using death certificates during this period as a comparison showed that completeness of reporting was 75.2% (95% CI: 71.0, 79.4%) (Johnson et al., 1989). A similar rate of completeness of AIDS reporting (75%) was found in a study conducted in Quebec comparing cases found through active surveillance with those in the passive surveillance system (Remis et al., 1996). In the Quebec study, the authors also found that a higher proportion of persons from HIV-endemic countries and injection drug users were identified through active compared to passive surveillance. A recent study comparing AIDS cases reported to the Canadian national surveillance system to those identified in the mortality database found that AIDS case reporting was 86% complete overall (Ricketts et al., 1996). The results of this study also suggested that under-reporting may be increasing over time.

Exposure category classification is dependent upon the extent to which this data is available to the physician and staff at the public health unit. Although follow-up of AIDS cases is undertaken by the public health units, there may be considerable variation in the amount of information which is collected. Although the proportion of cases associated with heterosexual transmission is increasing, it should be noted that the “heterosexual, other” category is not well defined in the Ontario database. Therefore, cases without documented sexual contact with an HIV-infected person or a person at high risk for HIV infection may be included in this category. It is also noteworthy that a validation study of exposure classification carried out in Chicago found that the proportion of cases attributable to heterosexual transmission and diagnosed in 1994 fell from 13% to 7% once re-classified (Rybicki et al., 1996). A study is currently underway in Ontario to assess the validity of exposure classification of AIDS cases in the Ontario AIDS Surveillance Program.

Among cases with more than one potential source of exposure, the distribution according to exposure category is a function of the hierarchy used. There were some minor differences in the hierarchy we used compared to that used at the OASP and at LCDC. Some cases were certainly misclassified, since cases were classified according to exposure category on a probabilistic basis. We cannot fairly compare the various hierarchies, since a cross-validation is required; as noted above, a validation study of exposure classification in the OASP is currently underway in Ontario. To classify source of infection properly, specific information not available for this analysis could be used, e.g., for transfusion cases, results of the traceback investigation and for heterosexual cases, information on serostatus and risk factors of sexual partners. There are two possible solutions to this limitation: (1) a "manual override," whereby additional information on source of exposure could be used to assign most likely source of infection on a case-by-case basis and (2) a more sophisticated algorithm could potentially be developed which would incorporate the additional data to assign the exposure category (for at least some cases).

Apart from a slight increase in the mean age at AIDS diagnosis in MSM, we did not observe any trends in age at diagnosis according to exposure category. In addition, no significant trends in age at diagnosis were evident among first-time HIV diagnoses. It is difficult to determine whether age at HIV diagnosis is changing, since the actual date of infection remains unknown. National data show that while AIDS incidence has started to decline among MSM born prior to 1960, incidence continues to rise among younger MSM (Health Canada, 1996). Mean age at AIDS diagnosis, however, is a function of a number of factors, including age at HIV infection, the changing incidence of HIV infection, latency from infection to AIDS (overall and as a function of age and calendar time) and access to testing. Although the relatively constant age at AIDS diagnosis suggests that AIDS incidence may not be rising among young MSM in Ontario, this can not be reasonably concluded without additional analyses taking these factors into consideration.

Due to the way in which the data were compiled, an assumption was involved in the adjustment for reporting delays. Since the correction factors were applied to all cases in each exposure category, it was assumed that cases excluded from the calculation of the correction factors (i.e., cases diagnosed prior to January 1, 1997 and reported during 1997, as well as cases in which the date of report was earlier than date of diagnosis) followed the same reporting delay distribution as the cases which were included in the calculation.

4.2.3 AIDS-associated mortality

Our data on AIDS-associated deaths likely underestimates the true mortality rate associated with HIV infection, due to both unrecognized and unreported cases.

In the United States, it has been estimated that 91% of deaths in women aged 15 to 44 and 96% of deaths in men aged 25 to 44 attributable to an AIDS-defining illness or immune deficiency mention HIV or AIDS on the death certificate (Buehler et al., 1992; Buehler et al., 1990). Among AIDS cases reported through routine surveillance, HIV or AIDS is mentioned on the death certificate in an estimated 88% (Chu et al., 1993). Chu et al. (1993) also found that rates of reporting varied moderately according to exposure category, but did not appear to differ significantly according to sex, ethnicity, age and exposure category.

Recent evidence from Canada suggests that under-reporting of AIDS deaths may not be as marked as that in the U.S. A recent record linkage study of persons who had received antiretroviral therapy in British Columbia suggested that only 7.4% (n=403) of those who had been treated through the province's Drug Treatment Program did not mention HIV/AIDS on the death certificate (Le et al., 1996). Another study of cases identified through an HIV clinic in Ottawa found that HIV/AIDS was documented on 94% of the reviewed death certificates (n=117)

(Kravcik et al., 1996). However, both study populations were treated for HIV/AIDS prior to death, which may have made it more likely that HIV/AIDS was mentioned on the death certificate.

Reporting of AIDS deaths has also been found to be reasonably complete among cases reported through AIDS surveillance. A study conducted in Quebec in 1993 examined death certificates among cases reported to the AIDS surveillance program from 1987 to 1990 (Remis, 1997, personal communication). Among the 350 known AIDS deaths identified in the AIDS surveillance program in which date of birth and date of death were known, 8.8% did not include AIDS as a cause of death. Since AIDS deaths among persons who have not been reported to the AIDS surveillance program are also likely to be unreported, the degree of under-ascertainment is probably greater.

Some degree of under-ascertainment of true mortality rates may be related to cases in which AIDS is unrecognized as the cause of death. This is unlikely to significantly impact mortality rates, but the degree to which this occurs in Ontario or Canada as a whole is unknown.

The mortality rates among those born in HIV-endemic countries must be interpreted with caution, since HIV-endemic classification in our database was determined solely according to country of birth. The length of time spent in the country of origin, length of residency in Canada and whether the individual became infected in their country of birth are unknown. In addition, we used the total HIV-endemic immigrant population in the calculation of rates without specifically excluding countries from which there were no deaths. In this regard, the mortality rates presented for those born in HIV-endemic countries may somewhat underestimate the actual mortality rates in this population. Finally, we observed a high male-to-female ratio of AIDS-associated deaths among persons born in HIV-endemic countries, which was much higher than among AIDS cases in this group. In the AIDS database, cases who have MSM as a risk factor are already excluded from the HIV-endemic category, in which the majority of cases are likely to be due to heterosexual acquisition of HIV infection. The higher male-to-female ratio in the mortality database is almost certainly due to the fact that we classified deaths according to country of birth and an unknown but significant number of deaths among males born in HIV-endemic countries were likely related to sources of exposure other than heterosexual contact, especially MSM.

4.2.4 HIV infection due to mother-infant transmission

The data obtained through the HIV Pediatric Network represents those who receive care at one of the institutions in the Network. Although it is unlikely that a large proportion of HIV-infected infants are tested and cared for outside of these centres, uninfected infants born to HIV-infected mothers are less likely to be seen at one of the Network institutions. Thus, these analyses may under-represent the number of infants born to HIV-positive mothers, especially those who do not become infected themselves.

4.2.5 Ontario HIV model

The component model estimates are limited by the availability and quality of data sources and are based on the following assumptions: (1) the relative HIV incidence among regions remained constant over time; (2) attribution of AIDS cases to region of residence is accurate; (3) the proportion of total population >14 years of age is constant (at 0.75) across public health units; (4) there is a minimal rate of false non-duplicates (overcounting) in the HIV serodiagnostic data; and (5) there is a minimal rate of false duplicates (undercounting) in the HIV serodiagnostic data.

In our modelling, we observed an almost threefold increase in HIV prevalence in women from 1990 to 1996. There are several possible explanations for this increase. First, the serodiagnostic data may be an overestimate of HIV infection among women. Second, the prevalence among newborns may be biased (i.e., underestimate the true prevalence). Conversely, a significant degree of HIV transmission may have occurred in the period 1992-96.

The analysis of the number of infections for certain regions in Ontario differed depending on the analytic approach. The overall estimates using meta-analysis gave comparable numbers for Metro Toronto, but were higher for Ottawa-Carleton in the meta-analysis than the interpolation using recent AIDS cases (1,580 compared to 1,190). Neither of these approaches can be considered to be highly precise and the difference may be due to uncertainties in the methods used. However, the difference may also be due to the fact that the increase in HIV infection among injection drug users in Ottawa-Carleton is recent and not yet fully reflected in AIDS incidence. Thus, the meta-analytic estimate may be more accurate.

4.3 Synthesis and interpretation

The data included in this report present an overview of the state of the HIV epidemic in Ontario. Clearly, the available data confirm that the epidemic is not stable in our population. The following paragraphs describe in each of the affected populations our current understanding of the epidemic based on the indicators examined.

MSM continue to be the group most affected by the epidemic. The majority of HIV infections and diagnoses still occur among MSM. Of course, many of these infections occurred in the remote past, but evidence from a study of seroconverters by Calzavara et al. (1997) show that a substantial number of MSM continue to be infected with HIV. This is consistent with the observations of a cohort study in Montreal which, based on the most recently available analyses, are observing annual incidence rates of 0.73 per 100 person-years (Alary et al., 1998). To determine the absolute number of new infections in this population, we would need to know the size of the population at risk. Although the number of MSM in Ontario is not precisely known, a study carried out in the U.S. provides a plausible range (from 2-3% of adult males) (Fay et al., 1989). Based on this estimate, the incidence rate observed in the Montreal study would translate into approximately 1,000 new infections per year in Ontario.

Although highly affected by the HIV epidemic, MSM are deriving important benefits from the new treatments now available for HIV disease. Mortality data demonstrates a marked decline in AIDS-associated deaths in Ontario, beginning in the fourth quarter of 1995. After a peak in the third quarter of 1995, mortality rates fell in 1996 by over 30% and, in the fourth quarter of 1996, by over 40%. Much of this decline is almost certainly related to the impact of viral load testing and new antiretroviral therapies administered to HIV-infected persons who are, in large part, MSM.

The situation with regard to injection drug use is particularly concerning. Available evidence cited in our report indicates that there is increasing HIV transmission among IDU in the Ottawa-Carleton region and also probably in Sudbury and Thunder Bay. Extremely high HIV incidence (23.7 per 100 person-years) and prevalence (19.2%) has been observed in one Ottawa study (Leonard, 1997) and, although these results may be an overestimate of the true rate (since people who attend needle exchange programs are known to be at particularly high risk for HIV infection) and may reflect the peak of an explosive epidemic spread, the situation is nevertheless unsettling. Data available to date for the Toronto IDU population appear to indicate a slowly increasing HIV prevalence: 4.3% in 1989; 5.7% in 1991-92; 4.8% in 1992-93; 9.0% in 1993-94; 9.5% in 1997-98 (Millson et al., 1998). However, no studies of HIV incidence among IDU in Toronto are yet available. Nevertheless, to date, at least from the serodiagnostic testing, there does not yet appear to be an explosive HIV spread in Toronto IDU.

Persons immigrating from countries where HIV prevalence is high and the predominant mode of spread is heterosexual transmission are becoming an important affected population in Ontario. Persons from HIV-endemic countries represent a growing proportion of AIDS cases and the majority of transmissions of HIV from infected mothers to their newborn infants. The problem seems, for the time being, to be mostly concentrated in Toronto and Ottawa, where these populations reside for the most part. Rates of seropositivity among persons from these countries undergoing diagnostic testing are high as well, though the number and proportion of these populations undergoing HIV testing appears to be low, as least compared to other affected populations.

The spread of HIV infection among Aboriginal populations has been documented in British Columbia and Alberta, largely related to injection drug use and subsequent heterosexual transmission (Nguyen et al., 1998). We have no evidence that this is occurring yet in Ontario but few, if any, studies are available which directly address this issue. Information on ethnicity is also not captured systematically in either the HIV serodiagnostic data or the AIDS surveillance system.

4.4 Perspectives for monitoring the HIV/AIDS epidemic in Ontario

A group of researches in the Public Health Division at the Public Health Laboratory and at universities recently met to develop perspectives for research and surveillance in the province of Ontario for the next 5 years (Remis et al., 1997). The findings of this group are beyond the scope of the present report, but certain orientations are relevant. We must be able to obtain better estimates of HIV incidence among affected populations, both through the exploitation of serodiagnostic testing data and through special studies. HIV and AIDS surveillance systems must be enhanced. In particular, HIV reports to the public health units or through the laboratory require more active follow-up and analysis to better discern the trends of HIV infection among persons who are newly diagnosed.

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APPENDIX A
HIERARCHY FOR EXPOSURE CATEGORY CLASSIFICATION OF AIDS CASES

Exposure category*	Final classification
Sex with same sex and injection drug use and male sex	MSM-IDU
Sex with same sex and male sex	MSM
Injection drug use	IDU
Clotting factor recipient prior to July 1, 1985	Clotting factor
Person who lived in or travelled in an HIV-endemic country	HIV-endemic
Transfusion recipient prior to November 1, 1985	Transfusion
Heterosexual contact	Heterosexual, other
Perinatal transmission	Perinatal
Occupational exposure	Occupational
Clotting factor recipient – date unknown	Clotting factor
Transfusion recipient – date unknown	NIR
No identified risk	NIR
Clotting factor recipient on or after July 1, 1985	NIR
Transfusion recipient on or after November 1, 1985	NIR
Missing information	NIR

*Up to five possible sources of infection are entered into the Reportable Disease Information System

APPENDIX B
COUNTRIES CLASSIFIED AS HIV-ENDEMIC*†

Caribbean:	***Sub-Saharan Africa:***
Anguilla	Africa
Antigua	Angola
Aruba	Botswana
Bahamas	Burkina Faso/Upper Volta/Haute Volta
Barbados	Benin/Dahomey
Barbuda	Burundi
Bermuda	Cameroon
Caicos Islands	Cape Verde
Cayman Islands	Central African Republic
Curacao	Chad
Dominica	Congo
Dominican Republic	Equatorial Guinea/Rio Mundo/Fernando Po.
Grenada	Eritrea
Guadeloupe	Ethiopia
Haiti	Gabon
Jamaica	Gambia
Leeward Islands	Ghana
Martinique	Guinea (Republic)
Montserrat	Guinea-Bissau
Netherlands Antilles	Haute-Volta
Nevis	Ivory Coast
St. Kitts	Kenya
St. Lucia	Lesotho
St. Vincent	Liberia
Tobago	Madagascar
Trinidad	Malawi
Turks Island	Mali
U.S. Virgin Islands	Mauritania
West Indies	Mozambique
Windward Island	Namibia (S.W.)
British Virgin Islands	Niger
British Guiana (Guyana)	Nigeria/Biafra
Dutch Guiana/Surinam	Rwanda
French Guyana	Sao Tome and Principe
	Senegal
	Sierra Leone
	Somalia/French Somalia
	South Africa
	Southwest Africa
	Swaziland
	Spanish Sahara (Western Sahara)
	Sudan
	Tanzania/Tanganyika
	Togo
	Uganda
	West Africa
	Zaire
	Zambia
	Zimbabwe/Southern Rhodesia

* Country names are as coded by the Registrar-General, Vital Statistics

† HIV-endemic classification included northern regions of South America, the Caribbean and sub-Saharan Africa in accordance with Remis (1995) and recent international estimates of adult HIV prevalence (WHO, 1994).

APPENDIX C
METHODOLOGIC DETAILS OF THE ONTARIO HIV MODEL

The overall approach to this analysis was to obtain the best possible data from different sources on which to base estimates of the cumulative incidence, incidence and prevalence of HIV infection and AIDS from 1978 to December 1996. We also assessed annual and cumulative deaths due to AIDS during the same time period.

Initial estimates related to HIV infection, AIDS incidence and AIDS-associated deaths were entered in a spreadsheet (Lotus 1-2-3, Version 4.0) and, where appropriate, data was derived through formulas such that:

? annual HIV incidence in the current and preceding years sums to cumulative HIV incidence at the end of each year;

- annual AIDS incidence in the current and preceding years sums to cumulative AIDS incidence at the end of each year;
- annual AIDS mortality in the current and preceding years sums to cumulative mortality at the end of each year;
- cumulative HIV incidence less mortality equals HIV prevalence ;
- cumulative AIDS incidence less mortality equals AIDS prevalence;
- the number of HIV-infected persons diagnosed matches to data from the Ontario HIV serodiagnostic laboratory.

The specific derivation for each of the parameters used in the models in shown on Table 1. The proportion of Canadian HIV infections from Ontario was estimated using reported AIDS cases. For this purpose, we analysed the proportion of AIDS cases in Canada from Ontario by year of AIDS diagnosis from 1979 to 1995.

APPENDIX C
METHODOLOGIC DETAILS OF THE ONTARIO HIV MODEL

Table 1

Parameter	Derivation
Annual HIV incidence	Adjusted to fit cumulative HIV incidence Component model
Cumulative HIV incidence	Back-calculation, Canada, to end 1989 Back-calculation, Quebec, to end 1992 Cumulative HIV diagnoses and estimates of proportion of infections diagnosed
HIV prevalence	Cumulative HIV incidence less cumulative AIDS mortality Component model
Cumulative HIV diagnoses	Provincial laboratory data on unique HIV-positive results
AIDS incidence	Ontario AIDS Surveillance Program with adjustments for reporting delays and underreporting
Cumulative AIDS incidence	Sum of annual AIDS incidence
AIDS prevalence	Cumulative AIDS incidence less AIDS mortality
Annual AIDS mortality	Vital Statistics, corrected for underascertainment
Cumulative AIDS mortality	Sum of annual AIDS mortality

AIDS cases were adjusted for delayed and under-reporting based on LCDC data.

Various sources of data were used to adjust the model to be consistent with observed data. They are as follows:

(1) back-calculations for Canada, carried out by Drs. Martin Schechter and Steve Marion, UCB and by Ping Yan, LCDC to 1989 <1,2>;

(2) back-calculations for Quebec to 1992 <3>;

(3) overall HIV, AIDS and mortality model for Quebec to the year 2000 <3>;

(4) AIDS incidence for Canada to December 1995 (National AIDS Surveillance Program) <4>;

(5) relative incidence of AIDS for Ontario as a proportion of Canada <4,5>;

(6) AIDS incidence in Ontario in relation to that of Quebec <6>;

(7) results of a key informants meeting, Montreal, March 6, 1997, organized by the Canadian Policy Research Network;

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METHODOLOGIC DETAILS OF THE ONTARIO HIV MODEL

(8) plenary presentation, Dr. Chris Archibald, LCDC, May 1997, issued at the annual CAHR meeting in Winnipeg, indicating plausible estimates for cumulative and annual HIV incidence in Canada to 1995;

(9) the number of persons diagnosed with HIV infection through the provincial laboratory to June 1996, in the context of the National HIV Database Project <7,8>; and

(10) results of HIV seroprevalence studies among groups at varying risk in Ontario <9,10>.

After establishing the appropriate formulas to ensure internal consistency as mentioned above, the estimates were adjusted to best fit the data from the above-mentioned data sources. The proportion of HIV-infected persons who were diagnosed was compared to the total number of HIV-infected persons to ensure it was consistent with survey data on patterns of HIV testing among injection drug users and men who have sex with men. This was in the range of 80% for cumulative HIV incidence and 70% for HIV prevalence, that is, that 70% of persons living with HIV would have had a serodiagnosis to that effect.

To determine the rates and numbers of HIV infections by geographic region, the number of prevalent HIV infections were interpolated to each of the 42 public health units in Ontario using the diagnosed AIDS cases as weights. (In the future, we intend to derive the weighting factors from the most recently diagnosed AIDS cases rather than from overall AIDS cases, since this would be a better reflection of the geographic distribution of HIV infection). The absolute number of HIV infections was then divided by the adult population for each of the public health units (estimated at 75% of the total population for each health unit) to derive HIV prevalence per 1,000. Finally, the number of persons diagnosed with HIV were compared (the number of serodiagnosed persons being distributed by the location of the physician who ordered the HIV test) to the results of the modelling method to determine whether there were regional differences in the comparison of HIV diagnoses to HIV infections.

A similar exercise was carried out for women (15 years of age or older). The model took into account the results of the newborn seroprevalence study carried out in Ontario in 1989-92 <8,9>. To bridge the "gap" between 1992 and 1996, the model was calculated on a yearly basis from 1992 to 1996.

To insure the plausibility of the estimates derived by this method, a modified Delphi technique was adopted whereby persons working in the Ontario HIV serodiagnostic laboratory, physicians providing clinical care to HIV-infected persons, investigators doing HIV-related research and persons involved in HIV prevention activities at the Ministry of Health, including the AIDS Bureau, were invited to review the assumptions on which the model was based and the plausibility of the final results. This group included Carol Major (HIV Laboratory, Ontario Ministry of Health); Drs. Peggy Millson, Liviana Calzavara, and Ted Myers (HIV Studies Unit, University of Toronto); Drs. Evelyn Wallace and Richard Schabas (Public Health Branch, Ontario Ministry of Health); Frank McGee (AIDS Bureau, Ontario Ministry of Health); Robert Palmer (HIV Project Centre); Dr. Greg Robinson (HIV Ontario Observational Database); and Dr. Chris Archibald (Laboratory Centre for Disease Control, Health Canada).

APPENDIX C
METHODOLOGIC DETAILS OF HIV MODEL

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TABLES

Legend

MSM	*Men who have sex with men*
IDU	*Injection drug use(r)*
MSM-IDU	*Men who have sex with men and use injection drugs*
Clotting factor	*Clotting factor recipient*
Blood product	*Blood product recipient*
HIV-endemic	*HIV-endemic country of origin*
Transfusion	*Transfusion recipient*
Occupational	*Occupational exposure*
Perinatal	*Perinatal exposure*
LR hetero	*Low risk heterosexual*
HR hetero	*High risk heterosexual*
Heterosexual	*Heterosexual (other) transmission*
NIR	*No identified risk*

FIGURES

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